APPENDIX REM – REMOTE CONTROL PROTOCOL

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

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

Revision History

01 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
10 OCT 2016	Corrected extended status mode/state byte references.	ECG

1.0 THEORY OF OPERATION

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 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 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.

1.3 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.

1.4 Message Format

Figure 1 illustrates the format of the command and response messages.

A command message begins with STX (02 hex). A response begins with ACK (06 hex) or NAK (15 hex) depending on the result of the command execution.

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

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

All messages end with the ETX (03 hex) followed by a Checksum byte. The checksum 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.

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

1.5 State Diagram

Figure 2 illustrates the implementation of the slave device. A numbered circle represents each state the device can assume. Transitions between states are represented by arrows labeled with the conditions that must be true in order for the transition to occur.

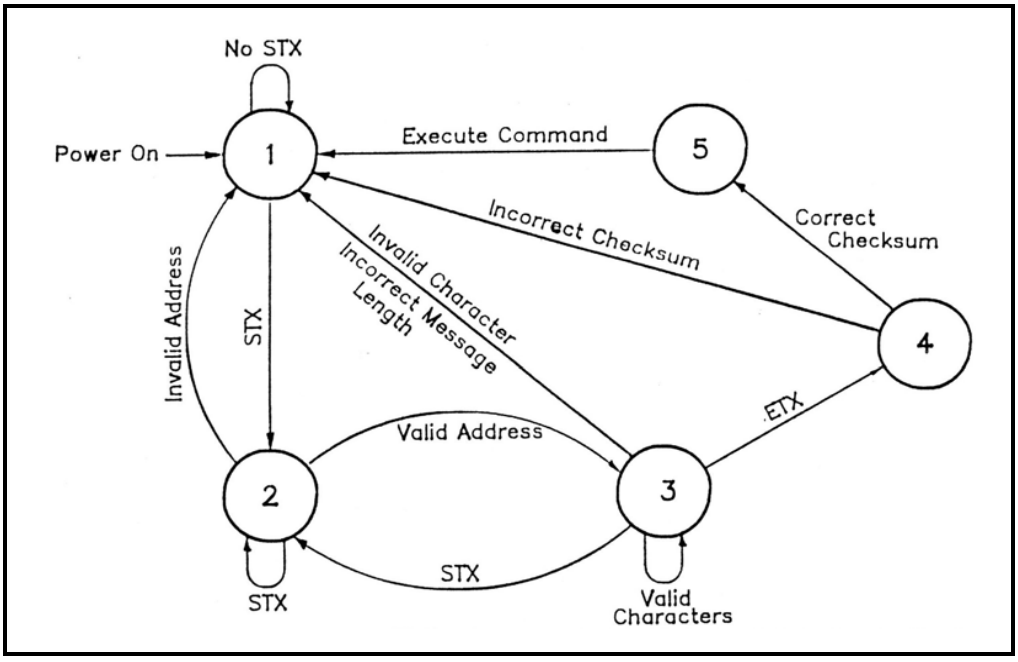

Figure 2 – Slave Device State Diagram

The following describes each state and transition in detail:

- 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 is correct.
    - State 1 if the received address is not correct.
    - State 2 if STX 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 ETX is received signifying the end of data in the message.
    - State 1 if STX, an invalid byte, or the incorrect number of 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 Checksum equals the computed LRC value.
    - State 1 if the Checksum does not equal the computed LRC value.
- 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.

1.6 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.

2.0 CONFIGURATION

2.1 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.

2.2 Communications Parameters

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.0 DETAILED OPERATION

3.1 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	

3.2 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	

3.3 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	

3.4 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	3.4.1
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	Query Name	3.4.6
36	Miscellaneous	3.4.7
37	Reflect Display	3.4.8
38	Reserved	
39	Write Satellite Data[1]	3.4.9
3A	Read Satellite Data	3.4.10
3B	Write Two Line Element Data[1]	3.4.11
3C	Read Two Line Element Data	3.4.12
3D	Write Beacon Data[1]	3.4.13
3E	Read Beacon Data	3.4.14
3F	Read Pulse Count	3.4.15
40	Extended Device Status	3.4.16
41	Remote Locate	3.4.17
42	Remote Store	3.4.18
43	Write Signpost Data[1]	3.4.19
44	Read Signpost Data	3.4.20
45	Read Navigation Data	3.4.21
46	Write Navigation Data	3.4.22
47	Jog with Minimal Reply	3.4.23
48	Remote Key Press	3.4.24
49	Write Config Data[1]	3.4.25
4A	Reserved	
4B	Custom Device Status[2]	3.4.26
	1 – requires flash save	
	2 – experimental	

3.4.1 Device Type Query Command

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

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

The reply to this query will consist of 11 bytes:

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

3.4.2 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 status poll command message consists of 5 bytes and the format is:

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

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

byte 0	ACK	
byte 1	A	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	
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

Device Status Command (continued)

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

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.

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 – Hand Crank Interlock
17 – Movement Interlock
18 – Local Jog Connected

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

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

Where ‘BBB’ is defined as:

000 – Reserved
001 – X Band
010 – Ka Band
011 – S Band
100 – C Band
101 – Ku Band
110 – Reserved
111 – L Band

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

Device Status Command (continued)

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

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.

Device Status Command (continued)

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

3.4.3 Auto Move Command

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

byte 0	STX	
byte 1	A	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 zeroes. 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 zeroes. Bytes 10 to 13 should be filled with blanks. For example, if byte 3 is ‘A’ and bytes 4 – 9 contain ‘-12345’, an azimuth auto move to the target of -123.45 will be initiated. Note 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 zeroes. 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 target positions for a move are not specified properly a NAK reply will be sent to the host. If the command specifies polarization movement but the Polarization Type is set to CIRCULAR, ACK will be received, but no movement will occur.

3.4.4 Azimuth/Elevation/Polarization Jog Command

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

byte 0	STX	
byte 1	A	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: 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.

3.4.5 Polarization Command

The following command specifies a move to a calculated polarization position. The command contains 6 bytes. The format of the command is as follows:

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

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

3.4.6 Query Name Command

This command can be used to retrieve the name of a satellite saved via the controller's STORE mode. The command contains the index of the desired entry in the satellite list. A maximum of 50 satellites can be stored in memory.

This query command contains 7 bytes and the format is:

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

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

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

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

3.4.7 Miscellaneous Command

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

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

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

'X' = 'R'	This sub-command can be used to reset the azimuth, elevation, or polarization drive alarms. The sub-command parameter 'Y' must be 'A', 'E', or 'P' (for azimuth, elevation, or polarization respectively).
'X' = 'T'	This sub-command can be used to reset track mode errors with parameter 'Y' = R. When the TRACK sub-mode ERROR is active this command will cause the ERROR sub-mode to terminate. The controller will react as if TRACK mode was activated via RECALL mode. 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 condition which generated the system error must be rectified or the controller will immediately return to the TRACK mode ERROR sub-mode. This sub-command can also be used to switch bands when a dual band satellite is being tracked. A sub-command parameter of 'C' will specify C band and 'K' will specify K band. The reply will be a NAK if TRACK mode is not active or the satellite being tracked was not specified as a dual band satellite (when the track was initiated via SETUP mode).
'X' = 'S'	This sub-command is used to initiate an automatic antenna STOW via the RC4000.
'X' = 'D'	This sub-command is used to initiate an automatic antenna DEPLOY via the RC4000.
'X' = 'B'	This sub-command is used to manually select the band 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.

3.4.8 Reflect Display Command

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

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

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

byte 0	ACK	
byte 1	A	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 not blinking, 1 = cursor blinking
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.

3.4.9 Write Satellite Data Command

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

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	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)
byte 24	Ephem	Ephemeris Data Present (0-none, 1-TLE, 2-IESS-412)
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	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.

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 3.4.25 of this document for more information.

3.4.10 Read Satellite Data Command

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

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 reply to this command is as follows:

byte 0		ACK or NAK
byte 1		address
byte 2		3Ah
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	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)
byte 24	Ephem	Ephemeris Data Present (0-none, 1-TLE, 2-IESS-412)
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	Default Pol	Default polarization for remote LOCATE command H – Horizontal V – Vertical X – None
byte 31	ETX	
byte 32	Checksum	

3.4.11 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.

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 3.4.25 of this document for more information.

3.4.12 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.

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 reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	A	
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	

3.4.13 Write Beacon Data Command

This command writes beacon frequency and tuning data into the RC4000. The index must be the same as the associated sat preset data index.

byte 0	STX	
byte 1	A	address
byte 2	3Dh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-12	H-Freq	Horizontal beacon frequency (MHz) in the format (ddddd.dd)
bytes 13-20	V-Freq	Vertical beacon frequency (MHz) in the format (ddddd.dd)
byte 21	Demod	Beacon modulation: ‘0’ = CW, ‘1’ = BPSK
bytes 22-31	Reserved	fill with zeroes 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 3.4.25 of this document for more information.

3.4.14 Read Beacon Data Command

This command reads beacon frequency and tuning data. The index must be the same as the associated sat preset data index.

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 reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	A	
byte 2	3Eh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-12	H-Freq	Horizontal beacon frequency (MHz) in the format (ddddd.dd)
bytes 13-20	V-Freq	Vertical beacon frequency (MHz) in the format (ddddd.dd)
byte 21	Demod	Beacon modulation: ‘0’ = CW, ‘1’ = BPSK
bytes 22-31	Reserved	
byte 32		ETX
byte 33		Checksum

3.4.15 Read Pulse Count Command

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

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

The reply to this query will consist of 15 bytes:

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	

3.4.16 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 Extended Device Status Poll command consists of 5 bytes with 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 A.3 of this document for more information about the available values for this field.
byte 51	Current State	This byte contains a value reflecting the current state within the current mode. See section A.3 of this document for more information about the available values for this field.
byte 52	Last Mode	This byte contains a value reflecting the previous mode that had control of the RC4000. See section A.3 of this document for more information about the available values for this field.
byte 53	Last State	This byte contains a value reflecting the previous state of the previous mode. See section A.3 of this document for more information about the available values for this field.

Extended Device Status Command (continued)

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

3.4.17 Remote Locate Command

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

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

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

The command contains 37 bytes with the following format:

byte 0	STX	
byte 1	A	address
byte 2	41h	command code
byte 3	Preset Flag & Preset Index Tens 7 6 5 4 3 2 1 0 0 1 0 A $ 0 0 B B A – 1 = perform LOCATE using data from the preset satellite stored in the RC4000 NOTE: Bytes 5-28 should be set to blanks. NOTE: This option is required to locate a satellite that has beacon or ephemeris data associated with it. A – 0 = perform LOCATE to a satellite using name, longitude, inclination and band data supplied in bytes 5-28. 'BB' – Tens digit of preset satellite index (0 if index <10), or zero if not specifying a preset satellite.	
byte 4	Index Ones	Ones digit of preset satellite 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	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)

Remote Locate Command (continued)

bytes 24-28	Pol Offset	Satellite Polarization Offset (relative to equatorial plane) -90.0 to 90.0 (CCW negative) Left Justify and pad with blanks
byte 29	Polarization Selection	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	A – 0 = use locate source config value A – 1 = locate source specified in 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

3.4.18 Remote Store/Track Command

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

The RC4000 will automatically sequence through a STORE operation. Any action that normally requires confirmation from the front panel will be automatically initiated. If a particular satellite name has already been stored, its data will be overwritten. At the end of the STORE operation, the ACU will enter TRACK if the satellite is inclined.

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

The command contains 48 bytes with the following format:

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

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

A – 1 = perform STORE using data from the preset satellite list stored in the RC4000
NOTE: Bytes 5-28 should be set to blanks.
NOTE: This option is required to locate a satellite that has beacon or ephemeris data associated with it.

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

'BB' – Tens digit of preset satellite index (0 if index <10), or zero if not specifying a preset satellite.

byte 4	Index Ones	Ones digit of preset satellite 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	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)

Remote Store/Track Command (continued)

bytes 24-28	Pol Offset	Satellite Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 29	Polarization Selection	C – use calculated H,V values NOTE: Requires that a LOCATE function has been preformed immediately prior to the Remote Store. S – use H,V values supplied in bytes 30-39 H – use current pol as horizontal and calculate vertical V – use current pol as vertical and calculate horizontal
bytes 30-34	Horizontal Pol Position	-90.0 to 90.0 degrees
bytes 35-39	Vertical Pol Position	-90.0 to 90.0 degrees
byte 40	Track Polarization	Selects which Polarization position to use when TRACK initiated (applicable to inclined orbit satellites only) H – Horizontal V – Vertical NOTE: Polarization Selection, Horizontal/Vertical Pol Positions, and Track Polarization are not applicable if feed type is circular.
bytes 41-45	Reserved	fill with zeroes or blanks
byte 46		ETX
byte 47		Checksum

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

3.4.19 Write Signpost Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	43h	command code
byte 3-4	Index	Signpost data table index (01–10)
bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
bytes 11-15	Frequency	10700 to 12750 Left Justify and pad with blanks
bytes 16-20	Symbol Rate	1000 to 40000 Left Justify and pad with blanks
byte 21	FEC	Forward Error Correction Code type 1 – 9 1 = 1 / 2, 2 = 2 / 3, 3 = 3 / 4, 5 = 5 / 6, 6 = 6 / 7, 7 = 7 / 8, 9 = AUTO
byte 22	Polarization	H = horizontal, V = vertical L = LHCP, R = RHCP
bytes 23-28	Reserved	fill with zeros of blanks
byte 29	Priority	0 – 9 relative search priority
byte 30	Standard	1 = DVB-S1 2 = DVB-S2
byte 31	Modulation	1 = QPSK 2 = 8PSK 3 = 16PSK
bytes 32-33	Reserved	fill with zeros or blanks
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 3.4.25 of this document for more information.

3.4.20 Read Signpost Data Command

This command uploads a stored set of signpost data.

byte 0	STX	
byte 1	A	address
byte 2	44h	command code
byte 3-4	Index	Signpost data table index (01–10)
byte 5	ETX	
byte 6	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	44h	command code
byte 3-4	Index	Signpost data table index (01–10)
bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
bytes 11-15	Frequency	10700 to 12750 Left Justify and pad with blanks
bytes 16-20	Symbol Rate	1000 to 40000 Left Justify and pad with blanks
byte 21	FEC	Forward Error Correction Code type 1 – 9 1 = 1 / 2, 2 = 2 / 3, 3 = 3 / 4, 5 = 5 / 6, 6 = 6 / 7, 7 = 7 / 8, 9 = AUTO
byte 22	Polarization	H = horizontal, V = vertical L = LHCP, R = RHCP
bytes 23-28	Reserved	
byte 29	Priority	1 – 9 relative search priority
byte 30	Standard	1 = DVB-S1 2 = DVB-S2
byte 31	Modulation	1 = QPSK 2 = 8PSK 3 = 16PSK
bytes 32-33	Reserved	
byte 34	ETX	
byte 35	Checksum	

3.4.21 Read Navigation Data Command

This command uploads the current values of navigation data.

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

The reply to this command is as follows:

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 – Reserved 110 – 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 – 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	

3.4.22 Write Navigation Data Command

This command downloads antenna position data into the RC4000.

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 A $ 0 0 0 0	
	where ‘A’ is ...	0 – Update source flags only 1 – Immediately move antenna to update position data (REMOTE_NAV mode)
bytes 22-26	Reserved	fill with zeroes 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.

3.4.23 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 reply to this query will consist of 12 bytes:

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	

3.4.24 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 format of the command is as follows:

byte 0	STX	
byte 1	A	address
byte 2	48h	command code
byte 3	Key Code	key codes 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.

3.4.25 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 Commands have been sent and acknowledged.

The save command should be in the following format:

byte 0	STX	
byte 1	A	address
byte 2	49h	command code
byte 3-15	"SAVE"	The save command should be 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.

3.4.26 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.

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 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.

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	2	2
ETX	3	3
ACK	6	6
NAK	15	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 values for the Current/Last Mode and Current/Last State fields of the Extended Device Status Poll reply. Possible values are listed for the RC4000 operating mode and state. Note: The states listed in the following table are common to all modes.

Table 5.3.1 – Operating Modes and Common Mode States

Value (hex)	Value (dec)	Mode (byte 45 & 47)	Common Mode States (byte 46 & 48)
20	32	MANUAL	INITIALIZING_MODE
21	33	MENU	USER_INPUT
22	34	POSITION	MOVING_TO_DEPLOY
23	35		MOVING_TO_STOW
24	36		
25	37	LOCATE	
26	38		MOVING_OUT_OF_DOWN
27	39	STORE	MOVING_AZIMUTH
28	40	TRACK	MOVING_ELEVATION
29	41		MOVING_POLARIZATION
2A	42	SPECIAL_AXIS	MOVING_AZELPL
2B	43	POS_CONFIRM	MOVING_SPECIAL_AXIS
2C	44		SEARCHING_FOR_AZIM_STOW_SWITCH
2D	45	HEADING_FIX	SEARCHING_FOR_POL_STOW_SWITCH
2E	46		ERROR_CANNOT_FIND_AZIM_STOW_SWITCH
2F	47	STOW	ERROR_CANNOT_FIND_POL_STOW_SWITCH
30	48	DEPLOY	ERROR_EVEN_NOT_IN_POSITION
31	49	RECALL	ERROR_SPECIAL_AXIS_NOT_IN_POSITION
32	50	MOVETO	ERROR_ANTENNA_NOT_AT_STOW
33	51		ERROR_ANTENNA_NOT_AT_DEPLOY
34	52		WAITING_FOR_LATLON
35	53		WAITING_FOR_HEADING
36	54	RESET_DRIVE	WAITING_FOR_TILT
37	55	DELETE	ERROR_NO_GPS_INPUT_DETECTED
38	56	FLASH_SAVE	ERROR_NO_HEADING_INPUT_DETECTED
39	57		ERROR_NO_TILT_INPUT_DETECTED
3A	58		MOVING_TO_DETERMINE_LATLON
3B	59	REMOTE_POS	MOVING_TO_DETERMINE_HEADING
3C	60	WIND_HOLD	MOVING_TO_DETERMINE_TILT
3D	61	PEAKUP	MOVING_TO_SYNC_PULSES
3E	62	SHAKE	
3F	63		

The following tables define additional values for bytes 46 and 48 of the Extended Device Status Poll reply. Possible values are listed for unique mode states. No unique states exist if the mode is not found in the following tables.

Table 5.3.2 – Unique Mode States

Value (hex)	Value (dec)	MANUAL States	STOW States	LOCATE States
40	64	JOG_AZIM_CCW	STOW_COMPLETE	ERROR_NO_LATLON
41	65	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_CW		ERROR_AZIMUTH_RANGE
45	69	JOG_POL_CCW		ERROR_ELEVATION_RANGE
46	70	AUTO_MOVE_POL		ERROR_PARAMETER_MISSING
47	71	IDLE		WAITING_FOR_MODEM
48	72			
49	73			
4A	74			
4B	75			CALCULATING_TLE
4C	76			WAITING_FOR_POL_SELECTION
4D	77			READY_TO_LOCATE
4E	78			LOCATE_COMPLETE
4F	79			LOCATE_FAILED
50	80			
51	81			MOVING_TO_TARGET_POSITION
52	82			MOVING_TO_INITIAL_SCAN_POSITION
53	83			ERROR_NO_RF_DETECTED
54	84			DETERMING_NOISE_FLOOR
55	85			MOVING_TO_SCAN_ELEVATION
56	86			
57	87			
58	88			TUNING_DVB
59	89			TUNING_BEACON
5A	90			TUNE_FAILURE
5B	91			
5C	92			
5D	93			AZIMUTH_SMOOTH_SCAN
5E	94			AZIMUTH_STEP_SCAN
5F	95			
60	96			
61	97			SAMPLING_AGC
62	98			MOVING_TO_LOCK_CENTER
63	99			MOVING_TO_PEAK
64	100			NO_PEAK_MOVING_TO_NOMINAL
65	101			ERROR_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
76	118			

Table 5.3.3 – Unique Mode States (continued)

Value (hex)	Value (dec)	STORE States	RECALL States	TRACK States
40	64	ERROR_NO_LAT_LON	NO_SATS_STORED	WAITING_FOR_BAND_SELECTION
41	65	ERROR_NO_SAT_SELECTED	WAITING_FOR_SAT_SELECTION	INITIALIZING_DISPLAY
42	66	ERROR_SATDATA_FULL	ERROR_INVALID_DATA	DEPLOYING_ELEVATION_AXIS
43	67	SAVING_SATDATA	WAITING_FOR_POL_SELECTION	POSITIONING_POLARIZATION
44	68	MOVING_POL_FOR_TRACK	MOVING_ELEV_INTO_POSITION	WAITING_FOR_EXIT_CONFIRMATION
45	69		MOVING_POL_INTO_POSITION	INITIALIZING_PARAMETERS
46	70		MOVING_AZIM_INTO_POSITION	STEP_PEAKING
47	71		MOVING_AZEL_INTO_POSITION	STEP_WAITING_FOR_SIGNAL_TO_RETURN
48	72			STEP_IDLE
49	73			SEARCH_PERFORMING_SEARCH_PATTERN
4A	74			SEARCH_MOVING_TO_FOUND_PEAK
4B	75			SEARCH_WAITING_TO_SEARCH_AGAIN
4C	76			MANUAL_SEARCH_NOMINAL_AZEL_MOVE
4D	77			MANUAL_SEARCH_NOMINAL_ELEV_MOVE
4E	78			MANUAL_SEARCH_NOMINAL_AZIM_MOVE
4F	79			MANUAL_SEARCH_ACTIVE
50	80			MEMORY_IDLE
51	81			MEMORY_PEAKING
52	82			MEMORY_REPOSITION
53	83			ERROR_CREEP_JAMMED
54	84			ERROR_CREEP_LIMIT
55	85			ERROR_CREEP_DRIVE
56	86			ERROR_PEAK_LIMIT
57	87			ERROR_SCALE_FACTOR
58	88			ERROR_GEO
59	89			ERROR_SYSTEM
5A	90			ERROR_CHECKSUM
5B	91			ERROR_UNDEFINED
5C	92			MENU_WAITING_FOR_SELECTION
5D	93			MENU_VIEW
5E	94			MENU_MODIFY
5F	95			TLE_IDLE
60	96			TLE_REPOSITION
61	97			MANUAL_SEARCH_JOG_AZIM_CCW
62	98			MANUAL_SEARCH_JOG_AZIM_CW
63	99			MANUAL_SEARCH_JOG_ELEV_DOWN
64	100			MANUAL_SEARCH_JOG_ELEV_UP
65	101			MANUAL_SEARCH_JOG_POL_CW
66	102			MANUAL_SEARCH_JOG_POL_CCW
67	103			MANUAL_SEARCH_AUTO_POL_MOVE
68	104			MANUAL_SEARCH_IDLE
69	105			

5.4 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	MODE_ITEM	Unsigned	See Section 5.3
1.1.0	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 5.4.2
1.10.0	LOCAL_JOG_CONNECTED_ITEM	Unsigned	0=Not Connected, 1=Connected
1.13.0	POS_SAVED_ITEM	Unsigned	0 = Not Saved, 1=Saved
1.14.0	POS_LOC_SOURCE_ITEM	Enumeration	Table 5.4.3 – Location
1.15.0	POS_LOC_LAT_ITEM	Signed	+DDMM (degrees/minutes)
1.16.0	POS_LOC_LON_ITEM	Signed	+DDDMM (degrees/minutes)
1.17.0	POS_LOC_ALT_ITEM (future)	Unsigned	AAAA (meters)
1.18.0	POS_HDG_SOURCE_ITEM	Enumeration	Table 5.4.3 – Heading
1.19.0	POS_HDG_ITEM	Float	DDD.DD (degrees)
1.20.0	POS_TILT_SOURCE_ITEM	Enumeration	Table 5.4.3 – Tilt
1.21.0	POS_TILT_PITCH_ITEM	Signed	+DD.D (degrees)
1.22.0	POS_TILT_ROLL_ITEM	Signed	+DD.D (degrees)
1.29.0	SAT_SOURCE_ITEM	Enumeration	Table 5.4.3 – Satellite
1.30.0	SAT_POLARIZATION_ITEM	Enumeration	Table 5.4.3 – Polarization
1.31.0	SAT_PRESET_NUM_ITEM	Unsigned	0 – 19
1.32.0	SAT_NAME_ITEM	ASCII String	10 Characters
1.33.0	SAT_LON_ITEM	Float	+DDD.D (degrees)
1.34.0	SAT_INCLIN_ITEM	Signed	+DD (degrees)
1.35.0	SAT_BAND_ITEM	Enumeration	Table 5.4.3 – Band
1.36.0	SAT_POL_OFFSET_ITEM	Float	+DD.D (degrees)
1.37.0	SAT_EPHEM_ITEM	Unsigned	0=None, 1=TLE
1.38.0	SAT_BEACON_FREQ_ITEM (future)	Unsigned	DDDDDDDD (kHz)
1.39.0	SAT_BEACON_ATTEN_ITEM (future)	Unsigned	DD (dB)
1.40.0	SAT_BEACON_DEMOD_ITEM (future)	Unsigned	0=CW, 1=BPSK
1.49.0	TARGET_AZ_ITEM	Float	+DDD.D (degrees)
1.50.0	TARGET_EL_ITEM	Float	+DDD.D (degrees)
1.51.0	TARGET_PL_H_ITEM	Float	+DDD.D (degrees)
1.52.0	TARGET_PL_V_ITEM	Float	+DDD.D (degrees)
1.53.0	TARGET_RANGE_ITEM	Unsigned	+DDDDD (miles)
1.62.0	AXIS_ANGLE_ITEM: AZ	Float	+DDD.D (degrees)

OID	Status Item	Format	Description
1.62.1	AXIS_ANGLE_ITEM: EL	Float	+DDD.D (degrees)
1.62.2	AXIS_ANGLE_ITEM: PL	Float	+DDD.D (degrees)
1.63.0	AXIS_COUNT_ITEM: AZ	Unsigned	0 – 65535
1.63.1	AXIS_COUNT_ITEM: EL	Unsigned	0 – 65535
1.63.2	AXIS_COUNT_ITEM: PL	Unsigned	0 – 65535
1.64.0	AXIS_LIMITS_ITEM: AZ	Hexadecimal	Table 5.4.4
1.64.1	AXIS_LIMITS_ITEM: EL	Hexadecimal	Table 5.4.4
1.64.2	AXIS_LIMITS_ITEM: PL	Hexadecimal	Table 5.4.4
1.65.0	AXIS_ALARMS_ITEM: AZ	Hexadecimal	Table 5.4.5
1.65.1	AXIS_ALARMS_ITEM: EL	Hexadecimal	Table 5.4.5
1.65.2	AXIS_ALARMS_ITEM: PL	Hexadecimal	Table 5.4.5
1.75.0	TRACK_STATUS_ITEM	Unsigned	Table 5.4.6 – Status
1.76.0	TRACK_ERROR_ITEM	Unsigned	Table 5.4.6 – Error
1.77.0	TRACK_BAND_ITEM	Enumeration	Table 5.4.3 – Band
1.86.0	SIGNAL_SOURCE_ITEM	Enumeration	Table 5.4.3 – Signal
1.87.0	SIGNAL_LEVEL_ITEM	Unsigned	0 – 4095
1.88.0	SIGNAL_LOCK_ITEM	Unsigned	0=Off, 1=On, 2=None Defined
1.93.0	HPA_ENABLE_ITEM	Unsigned	0=Disabled, 1=Tx Mute, 2=Enabled
1.94.0	FEED_INDEX_ITEM	Unsigned	0 – 7
1.95.0	AUTO_LOCATE_ACTIVE_ITEM	Unsigned	1=Active

The following table lists possible values and description for the ACTIVE_ALARM_ITEM.

Table 5.4.2 – Alarm Values and Descriptions

Value (dec)	Description
0	NO_ALARM_CODE
1	FLASH_VERSION_MISMATCH_CODE
2	FLASH_DATA_CORRUPT_CODE
3	NVRAM_VERSION_MISMATCH_CODE
4	NVRAM_DATA_CORRUPT_CODE
5	LOW_BATTERY_ALARM_CODE
6	TIME_DATE_ALARM_CODE
7	AZIM_JAM_ALARM_CODE
8	AZIM_RUNAWAY_ALARM_CODE
9	ELEV_JAM_ALARM_CODE
10	ELEV_RUNAWAY_ALARM_CODE
11	POL_JAM_ALARM_CODE
12	POL_RUNAWAY_ALARM_CODE
13	LIMITS_INACTIVE_ALARM_CODE
14	DRIVE_ERROR_ALARM_CODE
15	EMERGENCY_STOP_ALARM_CODE
16	HANDCRANK_MISSING_ALARM_CODE
17	MOVEMENT_INTERLOCK_ALARM_CODE

The following table lists possible values for the following items: POS_LOC_SOURCE_ITEM, POS_HDG_SOURCE_ITEM, POS_TILT_SOURCE_ITEM, SAT_SOURCE_ITEM, SAT_POLARIZATION_ITEM, SAT_BAND_ITEM, TRACK_BAND_ITEM, and SIGNAL_SOURCE_ITEM.

Table 5.4.3 – Multiple Item Values and Descriptions

Value (dec)	Location Source	Heading Source	Tilt Source	Satellite Source	Polarization	Band	Signal Source
0	None	None	None	None	None	C	None
1	GPS	Compass	Auto	Manual	Horzontal	Ku	Receiver 1 (External)
2	Manual	Manual Magnetic	Remote	Preset	Vertical	C/Ku	Receiver 2 (Internal)
3	Preset	Manual True		Longitude + Band	Right-Hand	L	Reserved
4	Reserved	Heading Fixed			Left-Hand	X	Reserved
5	Remote	Auto Fixed			Neutral	Ka	L-Band Power
6		Remote				S	DVB
7							Remote

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

Table 5.4.4 – Axis Limit 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 1-byte bitmask containing axis alarm information.

Table 5.4.5 – Axis Alarm Mask

Value (hex)	JAMMED	RUNAWAY	DRIVE	HALT
00				
01	Yes			
02		Yes		
03	Yes	Yes		
04			Yes	
05	Yes		Yes	
06		Yes	Yes	
07	Yes	Yes	Yes	
08				Yes
09	Yes			Yes
0A		Yes		Yes
0B	Yes	Yes		Yes
0C			Yes	Yes
0D	Yes		Yes	Yes
0E		Yes	Yes	Yes
0F	Yes	Yes	Yes	Yes

The following table lists possible values for TRACK_STATUS_ITEM and TRACK_ERROR_ITEM.

Table 5.4.6 – Track Status and Track Error Descriptions

Value (dec)	Status Description	Error Description
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

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