APPENDIX REM – REMOTE CONTROL PROTOCOL

Last Revised: 12 MAY 2014

Software Version: 0.06

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
12 MAY 2014	Updated move state descriptions in status reply.	ECG

1.0 THEORY OF OPERATION

Overview

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

Message Protocol

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

Data Format

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

Message Format

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

Command Message

STX	ADDR	CMD	D_1	D_2	D_3	…	D_N	ETX	CHKSUM

Response Message – Command Acknowledged

ACK	ADDR	CMD	D_1	D_2	D_3	…	D_N	ETX	CHKSUM

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

NAK	ADDR	CMD	ETX	CHKSUM

Figure 1 – Message Format

Message Delimiters

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

Address Byte

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

Command Byte

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

Checksum Byte

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

Message Timing

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

Command Restrictions

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

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

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

State Diagram

The state diagram below illustrates processing of communication messages by the slave device. Each state is represented graphically as a circle with a single-digit number. All transitions between states are represented graphically by arrows between them. Each transition is qualified by conditions that must be true in order for the transition to occur.

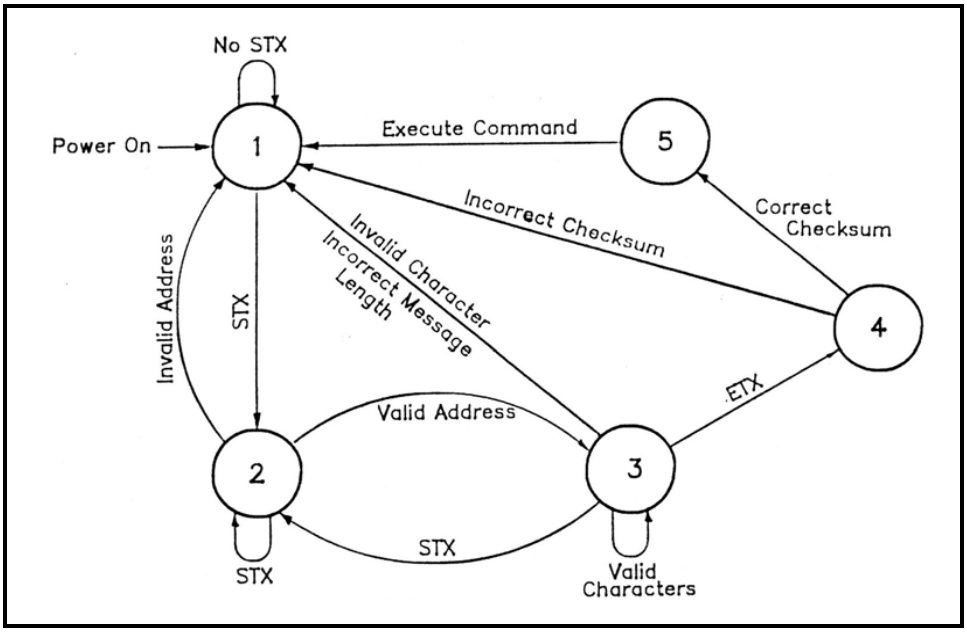

Figure 2 – SA Bus Protocol State Diagram

State Descriptions

- State 1 – Idle State
  - The device is ready to receive a new message. A device always powers on in State 1.
  - The device will enter State 2 only if the STX byte is received.
- State 2 – Addressed State
  - The device is waiting to receive the address byte.
  - The device will enter:
    - State 3 if the received address byte is correct.
    - State 1 if the received address is not correct.
  - The device will stay in State 2 if the STX byte is received.
- State 3 – Data State
  - The device is engaged in receiving the command data from the master.
  - The device will enter:
    - State 4 if the ETX byte is received signifying the end of data in the message.
    - State 1 if the STX byte, an invalid byte, or the incorrect number of data bytes is received.
- State 4 – Data Error State
  - The device is waiting to receive a Checksum byte.
  - A slave will enter:
    - State 5 if the received Checksum byte equals the LRC value computed during message reception.
    - State 1 if the received Checksum byte does not equal the LRC value computed during message reception.
- State 5 – Command Execute State
  - The device begins execution of the received command.
  - The device begins sending the appropriate response message to the master.
  - The device will enter State 1 only when the entire response has been transmitted.

2.0 CONFIGURATION

Electrical Interface

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

Communications Parameters

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.0 DETAILED OPERATION

RC4000 Online/Offline Reply

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

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

RC4000 Unrecognized Commands – NAK Reply

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

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

RC4000 Command Acknowledged – ACK Reply

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

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

Command Set

The following table lists the available RC4000 remote commands.

Each command is detailed in the paragraphs listed below.

Table 1 – Command Set List

CODE (hex)	COMMAND	PARAGRAPH
30	Device Type	3.1
31	Device Status	3.2
32	Auto Move	3.3
33	Azimuth / Elevation / Polarization Jog	3.4
34	Polarization	3.5
35	Query Name	3.6
36	Miscellaneous	3.7
37	Reflect Display	3.8
38	Reserved	
39	Write Satellite Data[1]	3.9
3A	Read Satellite Data	3.10
3B	Write Two Line Element Data[1]	3.11
3C	Read Two Line Element Data	3.12
3D	Write Beacon Data[1]	3.13
3E	Read Beacon Data	3.14
3F	Read Pulse Count	3.15
40	Extended Device Status	3.16
41	Remote Locate	3.17
42	Remote Store	3.18
43	Write Signpost Data[1]	3.19
44	Read Signpost Data	3.20
45	Read Navigation Data	3.21
46	Write Navigation Data	3.22
47	Jog with Minimal Reply	3.23
48	Remote Key Press	3.24
49	Write Config Data[1]	3.25
4A	Reserved	
4B	Custom Device Status[2]	3.26
	1 – requires flash save	
	2 – experimental	

3.1 Device Type Query Command

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

byte 0	STX	
byte 1	A	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	“46”	controller type
bytes 5-8	'”A.BC”	version number – example: 1.22
byte 9	ETX	
byte 10	Checksum	

3.2 Device Status Command

The SA Bus specification requires that command character 31h cause a device to return status information. The reply to this command includes azimuth, elevation and polarization position, current satellite name, as well as limit, alarm and drive status information. The 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	

Device Status Command (continued)

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

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

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

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

These fields contain azimuth, elevation, and polarization limit information. Bits 'A', 'B', and 'C' indicate the limit status. A '0' in a bit position implies that the antenna is not at the limit, a '1' in the bit position implies that the antenna is at the limit. The bit position to limit is defined as:

.

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

byte 35 Polarization equipment and display status code – binary data

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

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 'Y' is defined as:

0 – polarization movements are not allowed
1 – polarization movements are allowed

Where 'ZZZ' is defined as:

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

Device Status Command (continued)

byte 36 Azimuth Movement/Alarm Status – binary data
byte 37 Elevation Movement/Alarm Status – binary data
byte 38 Polarization Movement/Alarm Status – binary data

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

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

Where ‘XXXX’ is defined as:
0000 – No Alarms or Movement
0010 – Negative Jog Movement (CCW, DOWN, CCW)
0011 – Positive Jog Movement (CW, UP, CW)
0100 – Negative Automatic Movement (CCW, DOWN, CCW)
0101 – Positive Automatic Movement (CW, UP, CW)
0111 – Auto Move Is In Progress
1010 – Runaway Alarm Active
1011 – Jammed Alarm Active
1100 – Drive Alarm Active

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 'auto move in progress' rather than 'clockwise movement 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.

The following alarm codes have been defined for software v0.05 and below:

0 – No Alarm Active
1 – Low Battery
2 – Azimuth Jammed
3 – Azimuth Runaway
4 – Elevation Jammed
5 – Elevation Runaway
18 – Time/Date Error
22 – Polarization Jammed
24 – Limits Inactive Warning
27 – Emergency Stop
28 – Flash Version Mismatch
29 – Flash Data Corrupt
30 – NVRAM Version Mismatch
31 – NVRAM Data Corrupt
32 – Antenna Halt

The following alarm codes have been defined for software v0.06 and above:

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

Device Status Command (continued)

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

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

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

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

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

Where ‘CCC’ is defined as:

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

Where ‘L’ is defined as:

1 – lock indicated
0 – no lock indicated

Device Status Command (continued)

byte 46 HPA Relay/Feed ID Status – binary data

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

Where ‘AA’ is defined as:

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

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

byte 47 Special Axis Limits/Movement Status – binary data

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

Where ‘S’ is defined as:

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

Bits A - D indicate the status of Limit A - D respectively. A ‘0’ in a bit position implies that the axis is not at the limit, and a ‘1’ implies that the axis is at the limit. The meaning of each limit is described under Form 3 of the Auto Move command.

bytes 48–49 Reserved

byte 50 ETX
byte 51 Checksum

3.3 Auto Move Command

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

The remote status command can be used to get the current special axis state position if limit switch feedback is available. If a limit is active, a '1' will be present in the bit position indicated below (A, B, C, or D). If a limit is not active, a '0' will be present instead. In the case of a mutually exclusive limit, either a '0' or a '1' will be present.

SPECIAL AXIS	AXIS CODE	DIRECTION CODE	LIMIT CONDITION
Waveguide 1	W	H – horizontal (pos 1)	B = 1
		V – vertical (pos 2)	C = 1
RF Switch	R	1 – path 1	A = 0
		2 – path 2	A = 1
Polarization Mode	P	L – linear mode	B = 1
		C – circular mode	C = 1
Fairing Control	F	D – move to deploy	B = 1
		S – move to stow	C = 1
		M – move to maintenance	D = 1

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 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.

3.5 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.

3.6 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.

3.7 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.

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

3.8 Reflect Display Command

This command requests 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.

3.9 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		ETX
byte 31		Checksum

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

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

3.10 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	ETX	
byte 31	Checksum	

3.11 Write Two Line Element Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	3Bh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-73	TLE Line 1	69 characters (including checksum) of TLE Line 1
bytes 74-142	TLE Line 2	69 characters (including checksum) of TLE Line 2
byte 143	ETX	
byte 144	Checksum	

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

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

3.12 Read Two Line Element Data Command

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

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	

3.13 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 3.25 of this document for more information.

3.14 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

3.15 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	

3.16 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.

Extended Device Status Command (continued)

byte 51	Current State	This byte contains a value reflecting the current state within the current mode. See section A.3 of this document for more information about the available values for this field.
byte 52	Last Mode	This byte contains a value reflecting the previous mode that had control of the RC4000. See section A.3 of this document for more information about the available values for this field.
byte 53	Exit Condition	This byte contains a value reflecting the reason the last mode was terminated and control switched to the current mode. See section A.3 of this document for more information about the available values for this field.
byte 54	Extended Azimuth Position	For mounts with the ability to generate azimuth position to 0.01 degrees, this byte contains the digit for the one hundredth of a degree. This digit is to be added to the rest of the azimuth position contained in bytes 14-19.
byte 55	Extended Elevation Position	For mounts with the ability to generate elevation position to 0.01 degrees, this byte contains the digit for the one hundredth of a degree. This digit is to be added to the rest of the elevation position contained in bytes 20-25.
bytes 56-58	Reserved	
byte 59	ETX	
byte 60	Checksum	

3.17 Remote Locate Command

This command requests the RC4000 to perform a LOCATE operation 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 0 B
```

A – 1 = perform LOCATE to a preset satellite from the user 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 LOCATE to a satellite using name, longitude, inclination and band data supplied in bytes 5-28.

B – Tens digit of preset satellite index (0 if index < 10), or blank if not specifying a preset satellite.

byte 4	Index Ones	Ones digit of preset satellite index, or blank 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	Receive Polarization Selection H – Horizontal V – Vertical N – Neutral X – None NOTE: Not applicable 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

3.18 Remote Store Command

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

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

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

The command contains 48 bytes with the following format:

byte 0	STX	
byte 1	A	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 0 B
```

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

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

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

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

Remote Store 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 Polarization Position	-90.0 to 90.0
bytes 35-39	Vertical Polarization Position	-90.0 to 90.0
		NOTE: Polarization Selection, Horizontal and Vertical Positions are not applicable if feed type is circular
byte 40	Track Polarization	
		Selects which Polarization position to use when TRACK initiated (applicable to inclined orbit satellites only)
		H – Horizontal V – Vertical
bytes 41-45	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 STORE operation will be initiated. NAK implies an error in the supplied satellite data

3.19 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 3.25 of this document for more information.

3.20 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	

3.21 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	

3.22 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 – Execute update sequence (REMOTE_NAV mode). (will move antenna to deploy)
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.

3.23 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	

3.24 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.

3.25 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.

3.26 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

No Communication between RC4000 and the remote control computer.

There are numerous situations that could cause no communication:

1) The address set in the RC4000 is not being used by the remote commands. Check the address in the REMOTE configuration screen and ensure that address is being sent with the commands. Incorrectly addressed commands will be ignored by the RC4000.
2) The baud rate set in the RC4000 is not being used by the remote commands. Check the baud rate in the REMOTE configuration screen and ensure that it is the same as being used by the remote computer. Commands sent at the incorrect baud rate will not be recognized by the RC4000.
3) The remote computer or RC4000 are not both set to RS-232 or RS-422/RS-485. The remote control system should determine whether it is to work in RS-232, -422 or -485 mode. Check the configuration of the remote jumper and the placement of the cable inside of the RC4000, as described in 2.2.11. Also check the cabling between the RC4000 and the remote computer.
4) The RS-422 adapter is not compatible with the RC4000. Occasionally it has been found that a commercially available RS-422 adapter will just not work with the RC4000. To check for this possibility, temporarily mechanize the interface via RS-232 and see if communications is established.
5) The remote computer is not actually transmitting through the intended communication port. To check for this possibility, mechanize a “loop back” right at the communication port of the remote computer. The receive mode of the remote control software should see an exact reflection of the transmitted command.

Unreliable Communications or ACU Reset.

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

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

Value (hex)	Value (dec)	Mode (bytes 45 & 47)	MANUAL States	DEPLOY States	STOW States
20	32	MANUAL	INITIALIZING_MODE	INITIAIZING_MODE	INITIALIZING_MODE
21	33	MENU	JOG_AZIM_CCW		
22	34	POSITION	JOG_AZIM_CW	MOVING_ELEV	STARTING_OPERATION
23	35		JOG_ELEV_DOWN	MOVING_AZIM	MOVING_OUT_OF_DOWN
24	36		JOG_ELEV_UP	MOVING_AZELPL	MOVING_TO_AZPL_POSITION
25	37	LOCATE	JOG_POL_CW	MOVING_SPECIAL_AXIS	
26	38		JOG_POL_CCW	SPECIAL_AXIS_NOT_AT_DEPLOY	SEARCHING_FOR_AZIM_SWITCH
27	39	STORE	AUTO_POL_MOVE		CANNOT_FIND_AZ_SWITCH
28	40	TRACK	IDLE		
29	41				SEARCHING_FOR_POL_SWITCH
2A	42	SPECIAL_AXIS			CANNOT_FIND_POL_SWITCH
2B	43	POS_CONFIRM			
2C	44				MOVING_TO_ELEV_STOW
2D	45	HEADING_FIX			MOVING_SPECIAL_AXIS
2E	46				ELEV_NOT_AT_STOW
2F	47	STOW			SPECIAL_AXIS_NOT_AT_STOW
30	48	DEPLOY			COMPLETE
31	49	RECALL			
32	50	AUTO_MOVE			
33	51				
34	52				
35	53				
36	54	RESET_DRIVE			
37	55	DELETE			
38	56	FLASH_SAVE			
39	57				
3A	58				
3B	59				
3C	60				
3D	61				
3E	62				
3F	63				
40	64				

Value (hex)	Value (dec)	LOCATE States	TRACK States
20	32	ENTERING_MODE	ENTERING_MODE
21	33		
22	34	DEPLOYING_ANTENNA	INITIALIZING_DISPLAY
23	35		DEPLOYING_ELEV_AXIS
24	36		POSITIONING_POLARIZATION
25	37		WAITING_FOR_EXIT_CONFIRMATION
26	38		INITIALIZING_PARAMETERS
27	39		STEP_PEAKING
28	40		STEP_WAITING_FOR_SIGNAL_TO_RETURN
29	41		STEP_IDLE
2A	42	WAITING_FOR_LAT_LON	SEARCH_PERFORMING_SEARCH_PATTERN
2B	43	WAITING_FOR_HEADING	SEARCH_MOVING_TO_FOUND_PEAK
2C	44		SEARCH_WAITING_TO_SEARCH_AGAIN
2D	45		MANUAL_SEARCH_NOMINAL_AZEL_MOVE
2E	46	READY_TO_LOCATE	MANUAL_SEARCH_NOMINAL_ELEV_MOVE
2F	47	AZIMUTH_RANGE_ERROR	MANUAL_SEARCH_NOMINAL_AZIM_MOVE
30	48	ELEVATION_RANGE_ERROR	MANUAL_SEARCH_ACTIVE
31	49		MEMORY_IDLE
32	50		MEMORY_PEAKING
33	51		MEMORY_REPOSITION
34	52		ERROR_CREEP_JAMMED
35	53		ERROR_CREEP_LIMIT
36	54	DETERMINING_TILT	ERROR_CREEP_DRIVE
37	55		ERROR_PEAK_LIMIT
38	56		ERROR_SCALE_FACTOR
39	57		ERROR_GEO
3A	58		ERROR_SYSTEM
3B	59		ERROR_CHECKSUM
3C	60		ERROR_UNDEFINED_STATUS
3D	61		MENU_WAITING_FOR_SELECTION
3E	62	CALCULATING_TLE	MENU_VIEW
3F	63		MENU_MODIFY
40	64	FIRST_MOVEMENT	TLE_IDLE
41	65	AZIM_MOVEMENT	TLE_REPOSITION
42	66	ELEV_MOVEMENT	MANUAL_SEARCH_JOG_AZIM_CCW
43	67	POL_MOVEMENT	MANUAL_SEARCH_JOG_AZIM_CW
44	68	SAMPLE_AGC_DURING_SCAN_STEP	MANUAL_SEARCH_JOG_ELEV_DOWN
45	69	MOVING_TO_INITIAL_SCAN_POSITION	MANUAL_SEARCH_JOG_ELEV_UP
46	70		MANUAL_SEARCH_JOG_POL_CW
47	71	AZIMUTH_SMOOTH_SCAN	MANUAL_SEARCH_JOG_POL_CCW
48	72		MANUAL_SEARCH_AUTO_POL_MOVE
49	73	AZIMUTH_STEP_SCAN	MANUAL_SEARCH_IDLE
4A	74	MOVING_TO_LOCK_CENTER	
4B	75	MOVING_TO_SCAN_PEAK	
4C	76	MOVING_TO_NOMINAL_AZEL	
4D	77		
4E	78	SCAN_NO_PEAK_FOUND	
4F	79	BEGINNING_SPIRAL_SEARCH	
50	80	SPIRAL_MOVING_TO_STARTING_POSITION	
51	81	SPIRAL_SEARCH_STEPPING_CW	
52	82		
53	83		
54	84		
55	85	SPIRAL_SEARCH_STEPPING_UP	
56	86		
57	87	SPIRAL_SEARCH_STEPPING_CCW	
58	88		
59	89		
5A	90		
5B	91	SPIRAL_SEARCH_STEPPING_DOWN	
5C	92	SPIRAL_PEAK_MOVING_TO_PEAK_AZEL	
5D	93	SPIRAL_MOVING_TO_NOMINAL_AZEL	
5E	94		
5F	95	SPIRAL_NO_PEAK_FOUND	

60	96	NO_LAT_LON	
61	97	NO_HEADING	
62	98	FEED_BAND_MISMATCH	
63	99	NO_SAT_DATA	
64	100	PARAMETER_ERROR	
65	101	DETERMINE_NOISE_FLOOR	
66	102	INITIALIZE_DVB	
67	103	PERFORMING_PEAKUP	
68	104	COMPLETE	
69	105	TUNE_BEACON	
6A	106	PERFORMING_POL_PEAKUP	
6B	107	ADJUST_POL_FOR_TILT	
6C	108	NO_RF_DETECTED	
6D	109	DVB_INIT_FAILURE	
6E	110	MOVING_TO_SIGNPOST_ELEV	
6F	111	NO_SIGNPOST_FOUND	
70	112		

Value (hex)	Value (dec)	STORE States	RECALL States	SPECIAL_AXIS States
20	32	ENTERING_MODE	ENTERING_MODE	ELEV_BELOW_DOWN
21	33	ERROR_NO_LAT_LON	NO_SATS_STORED	
22	34	ERROR_NO_SAT_SELECTED		
23	35	ERROR_SATDATA_FULL		
24	36	SAVING_SATDATA		
25	37	MOVING_POL_FOR_TRACK	MOVING_ELEV_INTO_POSITION	
26	38		MOVING_POL_INTO_POSITION	OPENING
27	39		MOVING_AZIM_INTO_POSITION	CLOSING
28	40		MOVING_AZEL_INTO_POSITION	

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	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	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)

OID	Status Item	Format	Description
1.62.0	AXIS_ANGLE_ITEM: AZ	Float	+DDD.D (degrees)
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. Only the values that appear below are possible.

Table 5.4.2 – Alarm Values and Descriptions

Value (dec)	Value (hex)	Description
0	00	NO_ALARM_CODE
1	01	FLASH_VERSION_MISMATCH_CODE
2	02	FLASH_DATA_CORRUPT_CODE
3	03	NVRAM_VERSION_MISMATCH_CODE
4	04	NVRAM_DATA_CORRUPT_CODE
5	05	LOW_BATTERY_ALARM_CODE
6	06	TIME_DATE_ALARM_CODE
7	07	AZIM_JAM_ALARM_CODE
8	08	AZIM_RUNAWAY_ALARM_CODE
9	09	ELEV_JAM_ALARM_CODE
10	0A	ELEV_RUNAWAY_ALARM_CODE
11	0B	POL_JAM_ALARM_CODE
12	0C	POL_RUNAWAY_ALARM_CODE
13	0D	LIMITS_INACTIVE_ALARM_CODE
14	0E	DRIVE_ERROR_ALARM_CODE
15	0F	EMERGENCY_STOP_ALARM_CODE
16	10	HANDCRANK_MISSING_ALARM_CODE
17	11	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. Only the values that are filled in below are possible.

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. Only the values listed below are possible.

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. Only the values that are filled in below are possible.

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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