4.3 Host Computer Remote Communications

Control and status messages are conveyed between the DD240 and the subsidiary modems and the host computer using packetized message blocks in accordance with a proprietary communications specification. This communication is handled by the Radyne ComStream Link Level Protocol (RLLP), which serves as a protocol ‘wrapper’ for the RM&C data.

Complete information on monitor and control software is contained in the following sections.

4.3.1 Protocol Structure

The Communications Specification (COMMSPEC) defines the interaction of computer resident Monitor and Control software used in satellite earth station equipment such as modems, redundancy switches, multiplexers, and other ancillary support gear. Communication is bi-directional, and is normally established on one or more full-duplex 9600-baud multi-drop control buses that conform to EIA Standard RS-485.

Each piece of earth station equipment on a control bus has a unique physical address, which is assigned during station setup/configuration or prior to shipment. Valid decimal addresses on one control bus range from 032 through 255 for a total of up to 224 devices per bus. Address 255 of each control bus is usually reserved for the M&C computer.

4.3.2 Protocol Wrapper

The Radyne ComStream COMMSPEC is byte-oriented, with the Least Significant Bit (LSB) issued first. Each data byte is conveyed as mark/space information with one marks comprising the stop data. When the last byte of data is transmitted, a hold comprises one steady mark (the last stop bit). To begin or resume data transfer, a space (00h) substitutes this mark. This handling scheme is controlled by the hardware and is transparent to the user. A pictorial representation of the data and its surrounding overhead may be shown as follows:

ST	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7	S1	ST, etc.

The stop bit S1 is a mark. Data flow remains in a hold mode until the start bit ST is replaced by a space. The start bit (ST) is not part of the actual data (B_0 - B_7).

The above byte-oriented protocol is standard for UART based serial communication ports such as Workstation or Personal Computer (PC) COM ports. COM ports should be configured for 8 data bits, no parity, and one stop bit. For example, for 9600-baud operation, COM ports should be configured as:

9600, 8, N, 1

The COMMSPEC developed for use with the Radyne ComStream Link Level Protocol (RLLP) organizes the actual monitor and control data within a shell, or "protocol wrapper", that surrounds the data. The format and structure of the COMMSPEC message exchanges are described herein. Decimal numbers have no suffix; hexadecimal numbers end with a lower case h suffix and binary values have a lower case b suffix. Thus, 22 = 16h = 000010110b. The principal elements of a data frame, in order of occurrence, are summarized as follows:

<SYNC> - the message format header character, or ASCII sync character, that defines the beginning of a message. The <SYNC> character value is always 16h.

<BYTE COUNT> - the Byte Count is the number of bytes in the <DATA> field, ranging from 0 through 509. This field is 2 bytes long for the DD240 protocol.

<SOURCE ID> - the Source Identifier defines the multi-drop address origin. Note that all nodes on a given control bus have a unique address that must be defined.

<DESTINATION ID> - The Destination Identifier serves as a pointer to the multi-drop destination device that indicates where the message is to be sent.

<FRAME SEQUENCE NUMBER> - The FSN is a tag with a value from 0 through 255 that is sent with each message. It assures sequential information framing and correct equipment acknowledgment and data transfers.

<OPCODE> - The Operation Code field contains a number that identifies the message type associated with the data that follows it. Equipment under MCS control recognizes this field firmware identification and subsequently steers the DATA accordingly to perform a specific function or series of functions. Acknowledgment and error codes are returned in this field. This field is 2 Bytes for the DD240 protocol.

<...DATA...> - The Data field contains the binary, bi-directional data bytes associated with the <OPCODE>. The number of data bytes in this field is indicated by the <BYTE COUNT> value.

<CHECKSUM> - The checksum is the modulo 256 sum of all preceding message bytes, excluding the <SYNC> character. The checksum determines the presence or absence of errors within the message. In a message block with the following parameters, the checksum is computed as shown below in Table B-1.

Table B-1. Checksum Calculation Example

BYTE FIELD	DATA CONTENT	RUNNING CHECKSUM
<BYTE COUNT> (Byte 1)	00h = 00000000b	00000000b
<BYTE COUNT> (Byte 2)	02h = 00000010b	00000010b
<SOURCEID>	F0h = 11110000b	11110010b
<DESTINATION ID>	2Ah = 00101010b	00011100b
<FSN>	09h = 00001001b	00100101b
<OPCODE> (Byte 1)	00h = 00000000b	00100101b
<OPCODE> (Byte 2)	03h = 00000011b	00101000b
<DATA> (Byte 1)	DFh = 11011111b	00000111b
<DATA> (Byte 2)	FEh = 11111110b	00000101b

Thus, the checksum is 00000101b; which is 05h or 5 decimal. Alternative methods of calculating the checksum for the same message frame are:

00h + 02h + F0h + 2Ah + 09h + 00h + 03h + DFh + FEh = 305h.

Since the only concern is the modulo 256 (modulo 100h) equivalent (values that can be represented by a single 8-bit byte), the checksum is 05h.

For a decimal checksum calculation, the equivalent values for each information field are:

0 + 2 + 240 + 42 + 9 + 0 + 3 + 223 + 254 = 773;

773/256 = 3 with a remainder of 5. This remainder is the checksum for the frame.

5 (decimal) = 05h = 0101b = <CHECKSUM>

4.3.3 Frame Description and Bus Handshaking

In a Monitor and Control environment, every message frame on a control bus port executes as a packet in a loop beginning with a wait-for-SYNC-character mode. The remaining message format header information is then loaded, either by the M&C computer or by a subordinate piece of equipment requesting access to the bus. Data is processed in accordance with the OPCODE, and the checksum for the frame is calculated. If the anticipated checksum does not match then a checksum error response is returned to the message frame originator. The entire message frame is discarded and the wait-for-SYNC mode goes back into effect. If the OPCODE resides within a command message, it defines the class of action that denotes an instruction that is specific to the device type, and is a prefix to the DATA field if data is required. If the OPCODE resides within a query message packet, then it defines the query code, and can serve as a prefix to query code DATA.

The Frame Sequence Number (FSN) is included in every message packet, and increments sequentially. When the M & C computer or bus-linked equipment initiates a message, it assigns the FSN as a tag for error control and handshaking. A different FSN is produced for each new message from the FSN originator to a specific device on the control bus. If a command packet is sent and not received at its intended destination, then an appropriate response message is not received by the packet originator. The original command packet is then re-transmitted with the same FSN. If the repeated message is received correctly at this point, it is considered a new message and is executed and acknowledged as such.

If the command packet is received at its intended destination but the response message (acknowledgment) is lost, then the message originator (usually the M&C computer) re-transmits the original command packet with the same FSN. The destination device detects the same FSN and recognizes that the message is a duplicate, so the associated commands within the packet are not executed a second time. However, the response packet is again sent back to the source as an acknowledgment in order to preclude undesired multiple executions of the same command.

To reiterate, valid equipment responses to a message require the FSN tag in the command packet. This serves as part of the handshake/acknowledge routine. If a valid response message is absent, then the command is re-transmitted with the same FSN. For a repeat of the same command involving iterative processes (such as increasing or decreasing transmit power level), the FSN is incremented after each message packet. When the FSN value reaches 255, it overflows and begins again at zero. The FSN tag is a powerful tool that assures sequential information framing, and is especially useful where commands require more than one message packet.

The full handshake/acknowledgment involves a reversal of source and destination ID codes in the next message frame, followed by a response code in the <OPCODE> field of the message packet from the equipment under control.

If a command packet is sent and not received at its intended destination, a timeout condition can occur because a response message is not received by the packet originator. On receiving devices slaved to an M & C computer, the timeout delay parameters may be programmed into the equipment in accordance with site requirements by Radyne ComStream Corporation prior to shipment, or altered by qualified personnel. The FSN handshake routines must account for timeout delays and be able to introduce them as well.

4.3.4 Global Response Operational Codes

In acknowledgment packets the operational code, <OPCODE>, field of the message packet is set to 0 by the receiving devices when the message intended for the device is evaluated as valid. The device that receives the valid message then exchanges the <SOURCE ID> with the <DESTINATION ID>, sets the <OPCODE> to zero in order to indicate that a good message was received, and returns the packet to the originator. This "GOOD MESSAGE" Opcode is one of three global responses.

If a bad parameter or inconsistent value is sent in an RLLP Message, the reply packet will have an operational code value of 00FFh and the unit will log an event. The operator should inspect the event log to determine the reason for a message failure.

Table B-2. Response OPCODES	
RESPONSE OPCODE	**DESCRIPTION OPCODE**
Good Message	000d = 0000h
Bad Parameter	255d = 00FFh
Bad Opcode	254d = 00FEh

4.3.5 Collision Avoidance

When properly implemented, the physical and logical devices and ID addressing scheme of the COMMSPEC normally precludes message packet contention on the control bus. The importance of designating unique IDs for each device during station configuration cannot be overemphasized. One pitfall, which is often overlooked, concerns multi-drop override IDs. All too often, multiple devices of the same type are assigned in a direct-linked ("single-thread") configuration accessible to the M&C computer directly. For example, if two DD240 Demodulators with different addresses (DESTINATION IDs) are linked to the same control bus at the same hierarchical level, both will attempt to respond to the M&C computer when the computer generates a multi-drop override ID of 23. If their actual setup parameters, status, or internal timing differs, they will both attempt to respond to the override simultaneously with different information, or asynchronously in their respective message packets and response packets, causing a collision on the serial control bus.

To preclude control bus data contention, different IDs must always be assigned to the equipment. If two or more devices are configured for direct-linked operation, then the M&C computer and all other devices configured in the same manner must be programmed to inhibit broadcast of the corresponding multi-drop override ID.

The multi-drop override ID is always accepted by devices of the same type on a common control bus, independent of the actual DESTINATION ID. These Override IDs with the exception of “BROADCAST” are responded to by all directly linked devices of the same type causing contention on the bus. The “BROADCAST” ID, on the other hand, is accepted by all equipment but none of them returns a response packet to the remote M&C.

The following multi-drop override IDs are device-type specific, with the exception of "BROADCAST". These are summarized below with ID values expressed in decimal notation:

Table B-3. Broadcast IDs	
Directly-Addressed Equipment	**Multi-Drop Override ID**
Broadcast (all directly-linked devices)	00
DMD-3000/4000, 4500 or 5000 Mod Section, DMD15	01
DMD-3000/4000, 4500 or 5000 Demod Section, DMD15	02
RCU-340 1:1 Switch	03
RCS-780 1:N Switch	04
RMUX-340 Cross-Connect Multiplexer	05
CDS-780 Clock Distribution System	06
SOM-340 Second Order Multiplexer	07
DMD-4500/5000 Modulator Section	08
DMD-4500/5000 Demodulator Section	09
RCU-5000 M:N Switch	10
DMD15 Modulator	20

DMD15 Demodulator	21
DMD15 Modem	22
DVB3030 Video Modulator, DD240	23
Reserved for future equipment types	24-31

Note that multi-drop override ID 01 can be used interchangeably to broadcast a message to a DMD-3000/4000 modem, a DMD-4500/5000, a DMD15 modem, or a DVB3030. Radyne ComStream Corporation recommends that the multi-drop override IDs be issued only during system configuration as a bus test tool by experienced programmers, and that they not be included in run-time software. It is also advantageous to consider the use of multiple bus systems where warranted by a moderate to large equipment complement.

Therefore, if a DMD15 Modulator is queried for its equipment type identifier, it will return a "20" and DMD15 Demodulator will return a "21". A DMD15 Modem will also return a "22". A DVB3030 Video Modulator will return a “23.”

4.3.6 Software Compatibility

The COMMSPEC, operating in conjunction within the RLLP shell, provides for full forward and backward software compatibility independent of the software version in use. New features are appended to the end of the DATA field without OPCODE changes. Older software simply discards the data as extraneous information without functional impairment for backward compatibility.

If new device-resident or M&C software receives a message related to an old software version, new information and processes are not damaged or affected by the omission of data.

The implementation of forward and backward software compatibility often, but not always, requires the addition of new Opcodes. Each new function requires a new Opcode assignment if forward and backward compatibility cannot be attained by other means.

When Radyne ComStream Corporation equipment is queried for information (Query Mod, Query Demod, etc.) it responds by sending back two blocks of data; a non-volatile section (parameters that can be modified by the user) and a volatile section (status information). It also returns a count value that indicates how large the non-volatile section is. This count is used by M&C developers to index into the start of the volatile section.

When new features are added to Radyne ComStream Corporation equipment, the control parameters are appended to the end of the non-volatile section, and status of the features, if any, are added at the end of the volatile section. If a remote M&C queries two pieces of Radyne ComStream Corporation equipment with different revision software, they may respond with two different sized packets. The remote M&C MUST make use of the non-volatile count value to index to the start of the volatile section. If the remote M&C is not aware of the newly added features to the Radyne ComStream Corporation product, it should disregard the parameters at the end of the non-volatile section and index to the start of the volatile section.

If packets are handled in this fashion, there will also be backward-compatibility between Radyne ComStream Corporation equipment and M&C systems. Remote M&C systems need not be modified every time a feature is added unless the user needs access to that feature.

4.3.7 RLLP Summary

The RLLP is a simple send-and-wait protocol that automatically re-transmits a packet when an error is detected, or when an acknowledgment (response) packet is absent.

During transmission, the protocol wrapper surrounds the actual data to form information packets. Each transmitted packet is subject to ‘time out’ and ‘frame sequence’ control parameters, after which the packet sender waits for the receiver to convey its response. Once a receiver verifies that a packet sent to it is in the correct sequence relative to the previously received packet, it computes a local checksum on all information within the packet excluding the <SYNC> character and the <CHECKSUM> fields. If this checksum matches the packet <CHECKSUM>, the receiver processes the packet and responds to the packet sender with a valid response (acknowledgment) packet. If the checksum values do not match, the receiver replies with a negative acknowledgment (NAK) in its response frame.

The response packet is therefore either an acknowledgment that the message was received correctly, or some form of a packetized NAK frame. If the sender receives a valid acknowledgment (response) packet from the receiver, the <FSN> increments and the next packet is transmitted as required by the sender. However, if a NAK response packet is returned the sender re-transmits the original information packet with the same embedded <FSN>.

If an acknowledgment (response) packet or a NAK packet is lost, corrupted, or not issued due to an error and is thereby not returned to the sender, the sender re-transmits the original information packet; but with the same <FSN>. When the intended receiver detects a duplicate packet, the packet is acknowledged with a response packet and internally discarded to preclude undesired repetitive executions. If the M&C computer sends a command packet and the corresponding response packet is lost due to a system or internal error, the computer times out and re-transmits the same command packet with the same <FSN> to the same receiver and waits once again for an acknowledgment or a NAK packet.

To reiterate, the format of the message block is shown in Table 4, Link Level Protocol Message Block.

Table B-4. Link Level Protocol Message Block

SYNC	COUNT	SRC ADDR	DEST ADDR	FSN	OPCODE	DATA BYTES	CHECKSUM

4.3.8 Remote Port Packet Structure

The RLLP Remote Port Packet structure is as follows:

<SYNC>: Message format header character that defines the beginning of a message. The <SYNC> character value is always 0x16. (1 byte)

<BYTE COUNT>: Number of bytes in the <DATA> field. (2 bytes)

<SOURCE ID>: Identifies the address of the equipment from where the message originated. (1 byte)

<DEST. ID>: Identifies the address of the equipment where the message is to be sent. (1 byte)

<FSN>: Frame sequence number ensures correct packet acknowledgment and data transfers. (1 byte)

<OPCODE>: This field identifies the message type associated with the information data. The equipment processes the data according to the value in this field. Return error codes and acknowledgment are also included in this field. (2 bytes)

<...DATA...>: Information data. The number of data bytes in this field is indicated by the <BYTE COUNT> value.

<CHECKSUM>: The modulo 256 sum of all preceding message bytes excluding the <SYNC> character. (1 byte)

4.3.9 DD240 Opcode Command Set

The data rate and symbol rate values must be range checked when altering: Data Rate, Symbol Rate, Inner FEC, Modulation Type, or Framing. Use the following formulas for range checking:

Max Symbol Rate >= Symbol Rate = (Data Rate * Overhead) / (Code Rate * Modulation)

Max Data Rate >= Data Rate = (Symbol Rate * Code Rate * Modulation) / Overhead

Overhead	204/188 when framing is set to 188 bytes. 204/204 when framing is set to 204 bytes. 204/187 when framing is set to none.
Modulation	16QAM = 4 8PSK = 3 QPSK = 2
Code Rate	1/2, 2/3, 5/6, 3/4, 7/8, 8/9

Also, if an interface is being used which does not have buffering capability the buffer size may only be set to 0 milliseconds.

Other restrictions, rules or formatting are described in the front panel or SNMP MIB portions of the equipment manual.

The DD240 Opcode Command Set is listed below.

4.3.9.1 Demodulator Command Set

Queries	Opcode
Query Configuration and Status	2401h
Query Status	240Ch
Query Latched Alarms	2406h
Query Current Alarms	2409h
Query Time	240Eh
Query Date	240Fh
Query Test Status	2440h
Query Terrestrial Gig Ethernet Configuration	2550h
Query Terrestrial Gig Ethernet Status	2551h

Commands	Opcode
Set configuration	2A00h
Set frequency	2A01h
Set data rate	2A02h
Set acquisition range	2A04h
Set demodulation	2A07h
Set inner FEC rate	2A08h
Set network specification	2A0Bh

Set spectral inversion	2A0Fh
Set buffer size	2A10h
Set Rx clock source	2A11h
Set Rx Clock Polarity	2A12h
Set PRBS test pattern	2A17h
Set terrestrial interface type	2A1Fh
Center buffer	2A20h
Set data polarity	2A21h
Set terrestrial framing	2A40h
Set Nyquist roll off	2A41h
Set symbol rate	2A43h
Set terrestrial streaming	2A44h
Clear events	2A45h
Reset test	2A46h
Set Terrestrial Gig Ethernet Configuration	2B50h
Clear Terrestrial Gig Ethernet	2B51h
Clear latched alarms	2C03h
Set time	2C04h
Set date	2C05h

4.3.10 Detailed Command Descriptions

Opcode: <2401h> Query Configuration and Status

Response		
<1>	Number of configuration bytes	Number of Configuration Bytes
Configuration Bytes		
<1>	Network Specification	0 = DVB-S, 1 = DVB-S2-BS-NBC, 2 = DTV-AMC-NBC
<4>	Carrier Frequency	In 1 Hz steps, IF Range = 50 MHz to 180 MHz, L-Band Range = 950 MHz to 2150 MHz
<1>	Demodulation	0 = QPSK, 2 = 8PSK, 3 = 16QAM
<1>	Inner FEC Rate	1 = 1/2 Rate, 2 = 2/3 Rate, 3 = 3/4 Rate, 4 = 5/6 Rate, 5 = 7/8 Rate, 8 = 8/9 Rate, 9 = 9/10 Rate, 10 = 10/11 Rate, 11 = 11/12 Rate, 12 = 3/5 Rate, 13 = 4/5 Rate, 14 = 6/7 Rate
<4>	Data Rate	In 1 bps steps
<4>	Symbol Rate	Symbols per second
<1>	Spectral Inversion	0 = Inverted, 1 = Normal
<1>	Nyquist roll off	0 = 0.35, 20 = 0.20, 25 = 0.25
<1>	Last rate control	0 = Symbol Rate, 1 = Data Rate, 2 Auto
<4>	Acquisition Range	In 1 Hz steps, Max: 7.5 MHz, Min: Symbol Rate/10 and when demodulation is 8PSK Min: Symbol Rate/20
<1>	LNB DC Power	0 = disable, 1 = enable
<1>	Interface	0 = RS422 Serial, 2 = ASI, 3 = AASI, 4 = G703 E3 UNBAL, 5 = G703 T3 UNBAL, 6 = G703 STS1 UNBAL, 7 = HSSI, 8 = DVB Parallel, 9 = M2P Parallel, 10 = ECL BAL/UNBAL, 11 = GIGE
<1>	Terrestrial Framing	0 = 188 byte, 1 = 204 byte, 2 = no framing
<1>	Data Polarity	0 = normal, 1 = inverted
<1>	Rx Clock Source	3 = RX SAT, 4 = EXC direct, 5 = EXC Referenced PLL
<1>	Rx Clock Polarity	0 = normal, 1 = inverted
<1>	Buffer Size	In 1 msec steps Range = 0 msec to 64 msec
<4>	Exc Clock Frequency	1000000 | 1544000 | 2000000 | 2048000 | 5000000 | 6312000 | 8448000 | 10000000

<1>	Test Pattern	0 = none, 1 = (2^{15}-1), 23 = (2^{23}-1)
<2>	Eb/No Alarm Limit	With implied decimal point. 1030 = 10.30 dB. Range 100 to 1500, 1.00 to 15.00 db
<1>	Major Alarms Mask 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = Mask, 1 = Allow
<1>	Major Alarms Mask 2	Bit 0 = demod subsystem comm fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = Mask, 1 = Allow
<1>	Minor Alarms Mask 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = Mask, 1 = Allow
<1>	Minor Alarms Mask 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = EXC clock activity Bit 5 = loss of EXC PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = Mask, 1 = Allow
<1>	Common Faults Mask	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC Supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = Mask, 1 = Allow
<1>	Pilot Symbols	0 = Off, 1 = On
<4>	PL Header Scrambler Seq Index	Binary
<4>	Gold Code Seq Index	Binary
	Status Bytes	
<1>	Last Rate Control Status	0 = symbol rate, 1 = data rate
<1>	Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA configuration alarm Bit 5 = reserved for deframer FIFO fault

		Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Major Alarms 2	Bit 0 = demod subsystem comm Fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC Supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm
<1>	Latched Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA Configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Latched Major Alarms 2	Bit 0 = demod subsystem comm fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved

		0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Latched Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm
<1>	+5 Voltage	With implied decimal point. 49 = +4.9V
<1>	+12 Voltage	With implied decimal point. 118 = +11.8V
<1>	-12 Voltage	With implied decimal point and minus sign. 118 = -11.8V
<1>	+24 Voltage	With implied decimal point. 245 = 24.5V
<2>	Input Level	In 1.0 dBm steps, Two's Compliment, Implied Decimal point
<4>	Frequency Offset	Hz, Two's Compliment
<4>	Symbol Rate Offset	Hz, Two's Compliment
<2>	Estimated Eb/No	dB, implied decimal point (i.e. 1030 = 10.30 dB)
<2>	Estimated BER Mantissa	With implied decimal point 493 = 4.93
<2>	Estimated BER Exponent	Exponent, -6 = 10^{-6}, Two's Compliment
<2>	Test Pattern BER Mantissa	With implied decimal point 493 = 4.93
<2>	Test Pattern BER Exponent	Exponent, -6 = 10^{-6}, Two's Compliment
<8>	Test Pattern Error Count	Bits
<4>	Test Run Time	Seconds
<1>	BER Status	Bit 0 = BER after outer FEC status (1 = valid) Bit 1 = test Pattern BER status (1 = valid)
<1>	Buffer Fill Level	Percent (0 - 100)
<1>	Eb/No Validity	Bits 0 - 1: 00b = invalid, 01b = valid, 10b = Eb/No is less than indicated value, 11b = Eb/No is greater than indicated value.
<1>	Terrestrial Streaming	0 = burst packets, 1=continuous bytes
<1>	Test Early Sync Loss	0 = false, 1=true
<1>	Test Pattern Sense	0= normal, 1= inverted

Opcode: <240Ch> Query Status

Response		
<1>	Last Rate Control Status	0 = symbol rate, 1 = data rate
<1>	Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA configuration alarm Bit 5 = reserved for deframer FIFO fault

		Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Major Alarms 2	Bit 0 = demod subsystem comm Fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC Supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm
<1>	Latched Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA Configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Latched Major Alarms 2	Bit 0 = demod subsystem comm fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved

		0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Latched Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm
<1>	+5 Voltage	With implied decimal point. 49 = +4.9V
<1>	+12 Voltage	With implied decimal point. 118 = +11.8V
<1>	-12 Voltage	With implied decimal point and minus sign. 118 = -11.8V
<1>	+24 Voltage	With implied decimal point. 245 = 24.5V
<2>	Input Level	In 1.0 dBm steps, Two's Compliment, Implied Decimal point
<4>	Frequency Offset	Hz, Two's Compliment
<4>	Symbol Rate Offset	Hz, Two's Compliment
<2>	Estimated Eb/No	dB, implied decimal point (i.e. 1030 = 10.30 dB)
<2>	Estimated BER Mantissa	With implied decimal point 493 = 4.93
<2>	Estimated BER Exponent	Exponent, -6 = 10-^{6}, Two's Compliment
<2>	Test Pattern BER Mantissa	With implied decimal point 493 = 4.93
<2>	Test Pattern BER Exponent	Exponent, -6 = 10^{-6}, Two's Compliment
<8>	Test Pattern Error Count	Bits
<4>	Test Run Time	Seconds
<1>	BER Status	Bit 0 = BER after outer FEC status (1 = valid) Bit 1 = test Pattern BER status (1 = valid)
<1>	Buffer Fill Level	Percent (0 - 100)
<1>	Eb/No Validity	Bits 0 - 1: 00b = invalid, 01b = valid, 10b = Eb/No is less than indicated value, 11b = Eb/No is greater than indicated value.
<1>	Terrestrial Streaming	0 = burst packets, 1=continuous bytes
<1>	Test Early Sync Loss	0 = false, 1=true
<1>	Test Pattern Sense	0= normal, 1= inverted

Opcode: <2406h> Query Latched alarms and

Response		
<1>	Latched Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA Configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault

		Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Latched Major Alarms 2	Bit 0 = demod subsystem comm fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = no alarm, 1 = alarm
<1>	Latched Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Latched Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm

Opcode: <2409h> Query Current Alarms

Response		
<1>	Major Alarms 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = no alarm, 1 = alarm
<1>	Major Alarms 2	Bit 0 = demod subsystem comm Fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock

		Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = no alarm, 1 = alarm
<1>	Minor Alarms 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = Exc clock activity Bit 5 = loss of Exc PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = no alarm, 1 = alarm
<1>	Common Faults	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC Supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = no alarm, 1 = alarm

Opcode: <240Eh> Query Time

Response		
<1>	Hour	0 – 23
<1>	Minute	0 – 59
<1>	Second	0 – 59

Opcode: <240Fh> Query Date

Response		
<1>	Year	0 – 99
<1>	Month	0 – 11
<1>	Day	0 – 30

Opcode: <2440h> Query Test Status

Response		
<1>	Test Pattern	0 = none, 1 = (2^{15} -1), 23 = (2^{23}-1)
<1>	Test Sync	0 = false, 1 = true
<1>	Test Early Sync Loss	0 = false, 1 = true
<1>	Test Pattern Sense	0 = normal, 1 = inverted
<8>	Test Pattern Error Count	Bits
<8>	Test Bit Count	Bits
<2>	Test Pattern BER Mantissa	With implied decimal point 493 = 4.93
<2>	Test Pattern BER Exponent	Exponent, -6 = 10^{-6}
<8>	Test Pattern Error Count	Bits
<4>	Test Run Time	Seconds

Opcode: <2550> Query Terrestrial Gig Ethernet Configuration

Response		
<8>	Mac Address	Binary Value

<4>	IP Address	Binary Address
<2>	UDP Port	0-32767
<8>	Destination Mac Address	Binary Value
<4>	Destination IP Address	Binary Value
<2>	Destination UDP Port	Binary Value
<1>	Ethernet Mode	0 = UDP 1 = COP3 2 = COP3 FEC
<1>	Block Aligned	0 = Aligned 1 = Not Aligned
<1>	FEC Column L	Binary Value
<1>	FEC Column D	Binary Value

Opcode: <2551> Query Terrestrial Gig Ethernet Status

Response		
<1>	Ethernet Port Status	0 = Down 1 = Unresolved 2 = 10 M Half 3 = 100 M Half 4 = 10 M Full 5 = 100 M Full 6 = 1000 M Half 7 = 1000 M Full
<4>	Total Packets	Binary Value
<4>	FEC Column Packets	Binary Value
<16>	Revision	

Opcode: <2A00h> Set Configuration

<1>	Network Specification	0 = DVB-S, 1 = DVB-S2-BS-NBC, 2 = DTV-AMC-NBC
<4>	Carrier Frequency	In 1 Hz steps, IF Range = 50 MHz to 180 MHz, L-Band Range = 950 MHz to 2150 MHz
<1>	Demodulation	0 = QPSK, 2 = 8PSK, 3 = 16QAM
<1>	Inner FEC Rate	1 = 1/2 Rate, 2 = 2/3 Rate, 3 = 3/4 Rate, 4 = 5/6 Rate, 5 = 7/8 Rate, 8 = 8/9 Rate, 9 = 9/10 Rate, 10 = 10/11 Rate, 11 = 11/12 Rate, 12 = 3/5 Rate, 13 = 4/5 Rate, 14 = 6/7 Rate
<4>	Data Rate	In 1 bps steps
<4>	Symbol Rate	Symbols per second
<1>	Spectral Inversion	2 = auto
<1>	Nyquist roll off	0 = 0.35, 20 = 0.20, 25 = 0.25
<1>	Last rate control	0 = Symbol Rate, 1 = Data Rate, 2 = Auto
<4>	Acquisition Range	In 1 Hz steps, Max: 7.5 MHz, Min: Symbol Rate/10 and when demodulation is 8PSK Min: Symbol Rate/20
<1>	LNB DC Power	0 = disable, 1 = enable
<1>	Interface	0 = RS422 Serial, 2 = ASI, 3 = AASI, 4 = G703 E3 UNBAL, 5 = G703 T3 UNBAL, 6 = G703 STS1 UNBAL, 7 = HSSI, 8 = DVB Parallel, 9 = M2P Parallel, 10 = ECL BAL/UNBAL, 11 = GIGE
<1>	Terrestrial Framing	0 = 188 byte, 1 = 204 byte, 2 = no framing
<1>	Data Polarity	0 = normal, 1 = inverted
<1>	Rx Clock Source	3 = RX SAT, 4 = EXC direct, 5 = EXC Referenced PLL
<1>	Rx Clock Polarity	0 = normal, 1 = inverted
<1>	Buffer Size	In 1 msec steps Range = 0 msec to 64 msec
<4>	Exc Clock Frequency	1000000 | 1544000 | 2000000 | 2048000 | 5000000 | 6312000 | 8448000 | 10000000
<1>	Test Pattern	0 = none, 1 = (2^{15} -1), 23 = (2^{23}-1)

<2>	Eb/No Alarm Limit	With implied decimal point. 1030 = 10.30 dB. Range 100 to 1500, 1.00 to 15.00 db
<1>	Major Alarms Mask 1	Bit 0 = loss of signal lock Bit 1 = loss of synthesizer PLL lock Bit 2 = input level alarm Bit 3 = reserved for POST alarm Bit 4 = FPGA configuration alarm Bit 5 = reserved for deframer FIFO fault Bit 6 = reserved for deframer PLL lock fault Bit 7 = carrier subsystem comm fault 0 = Mask, 1 = Allow
<1>	Major Alarms Mask 2	Bit 0 = demod subsystem comm fault Bit 1 = loss of clock activity Bit 2-7 = reserved 0 = Mask, 1 = Allow
<1>	Minor Alarms Mask 1	Bit 0 = reserved for loss of buffer clock Bit 1 = loss of Rx data activity Bit 2 = loss of demodulation lock Bit 3 = loss of inner FEC lock Bit 4 = loss of outer FEC lock Bit 5 = loss of DVB frame lock Bit 6 = Eb/No alarm Bit 7 = reserved 0 = Mask, 1 = Allow
<1>	Minor Alarms Mask 2	Bit 0 = terrestrial buffer underflow Bit 1 = terrestrial buffer overflow Bit 2 = terrestrial buffer near empty Bit 3 = terrestrial buffer near full Bit 4 = EXC clock activity Bit 5 = loss of EXC PLL lock Bit 6 = IP Destination Address Fault Bit 7 = Ethernet Link Status Fault 0 = Mask, 1 = Allow
<1>	Common Faults Mask	Bit 0 = -12 V alarm Bit 1 = +12 V alarm Bit 2 = +5 V alarm Bit 3 = +24 V alarm Bit 4 = reserved for temperature alarm Bit 5 = LNB DC Supply Bit 6 = DEMOD HW Fault Bit 7 = Reserved 0 = Mask, 1 = Allow
<1>	Pilot Symbols	0 = Off, 1 = On
<4>	PL Header Scrambler Seq Index	Binary
<4>	Gold Code Seq Index	Binary

Opcode: <2A01h> Set frequency

<4>	Carrier Frequency	In 1 Hz steps, IF Range = 50 MHz to 180 MHz, L-Band Range = 950 MHz to 2150 MHz

Opcode: <2A02h> Set data rate

<4>	Data Rate	In 1 bps steps

Opcode: <2A04h> Set acquisition range

<4>	Acquisition Range	In 1 Hz steps, Max: 7.5 MHz, Min: Symbol Rate/10 and when demodulation is 8PSK Min: Symbol Rate/20

Opcode: <2A07h> Set demodulation

<1>	Demodulation	0 = QPSK, 2 = 8PSK, 3 = 16QAM

Opcode: <2A08h> Set inner FEC rate

<1>	Inner FEC Rate	1 = 1/2 Rate, 2 = 2/3 Rate, 3 = 3/4 Rate, 4 = 5/6 Rate, 5 = 7/8 Rate, 8 = 8/9 Rate, 9 = 9/10 Rate, 10 = 10/11 Rate, 11 = 11/12 Rate, 12 = 3/5 Rate, 13 = 4/5 Rate, 14 = 6/7 Rate

Opcode: <2A0Bh> Set network specification

<1>	Network Specification	0 = DVB-S, 1 = DVB-S2-BS-NBC, 2 = DTV-AMC-NBC

Opcode: <2A0Fh> Set spectral inversion

<1>	Spectral Inversion	2 = auto

Opcode: <2A10h> Set buffer size

<1>	Buffer Size	In 1 msec steps Range = 0 msec to 64 msec

Opcode: <2A11h> Set Rx Clock Source

<1>	Rx Clock Source	3 = RX SAT, 4 = EXC direct, 5 = EXC Referenced PLL

Opcode: <2A12h> Set Rx Clock Polarity

<1>	Rx Clock Polarity	0 = normal, 1 = inverted

Opcode: <2A17h> Set PRBS test pattern

<1>	Test Pattern	0 = none, 1 = (2^{15} -1), 23 = (2^{23}-1)

Opcode: <2A1Fh> Set terrestrial interface type

<1>	Interface	0 = RS422 Serial, 2 = ASI, 3 = AASI, 4 = G703 E3 UNBAL, 5 = G703 T3 UNBAL, 6 = G703 STS1 UNBAL, 7 = HSSI, 8 = DVB Parallel, 9 = M2P Parallel, 10 = ECL BAL/UNBAL, 11 = GIGE

Opcode: <2A20> Center Buffer

No Parameters

Opcode: <2A21h> Set data polarity

<1>	Data Polarity	0 = normal, 1 = inverted

Opcode: <2A40h> Set framing mode

<1>	Terrestrial Framing	0 = 188 byte, 1 = 204 byte, 2 = no framing

Opcode: <2A41h> Set Nyquist roll off

<1>	Nyquist roll off	0 = 0.35, 20 = 0.20, 25 = 0.25

Opcode: <2A43h> Set symbol rate

<4>	Symbol Rate	Symbols per second

Opcode: <2A44h> Set terrestrial streaming

<1>	Terrestrial Streaming	0 = burst packets, 1=continuous bytes

Opcode: <2A45h> Clear Events

No Parameters

Opcode: <2A46h> Reset test

No Parameters

Opcode: <2B50> Set Terrestrial Gig Ethernet Configuration

<8>	Mac Address	Binary Value
<4>	IP Address	Binary Address
<2>	UDP Port	0-32767
<8>	Destination Mac Address	Binary Value
<4>	Destination IP Address	Binary Value
<2>	Destination UDP Port	Binary Value
<1>	Ethernet Mode	0 = UDP 1 = COP3 2 = COP3 FEC
<1>	Block Aligned	0 = Aligned 1 = Not Aligned
<1>	FEC Column L	Binary Value
<1>	FEC Column D	Binary Value

Opcode: <2B51> Set Terrestrial Gig Ethernet Stats

<1>	Clear Ethernet Stats	0

Opcode: <2C03h> Clear latched alarms

No Parameters

Opcode: <2C04h> Set time

<1>	Hour	0 – 23
<1>	Minute	0 – 59
<1>	Second	0 – 59

Opcode: <2C05h> Set date

<1>	Year	0 – 99
<1>	Month	0 – 11

<1>	Day	0 – 30