

Appendix B - RCS20 Remote Communications

B.1 Host Computer Remote Communications

Control and status messages are conveyed between the RCS20 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 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 Radyne RLLP Protocol Reference Guide.

B.1.1 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 32 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.

B.1.2 Protocol Wrapper

The Radyne COMMSPEC is byte-oriented, with the Least Significant Bit (LSB) issued first. Each data byte is conveyed as mark/space information with one mark 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:



The stop bits, S1 and S2 are each a mark. Data flow remains in a hold mode until S2 is replaced by a space. If S2 is followed by a space, it is considered a start bit for the data byte and not part of the actual data (B₀ - B₇).

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 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 = 00010110b. 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, (1 byte).

<BYTE COUNT> - the Byte Count is the number of bytes in the <DATA> field, (2 bytes).

<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, (1 byte).

<DESTINATION ID> - the Destination Identifier serves as a pointer to the multi-drop destination device that indicates where the message is to be sent, (1 byte).

<**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, (1 byte).

<**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 these bytes via 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, (2 bytes).

<**...DATA...**> - the Data field contains the binary, bi-directional data bytes associated with the command indicated by the <Opcode> field. The number of 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, (1 byte). 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 in Table 1.

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

Table 1. Checksum Calculation Example

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

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

Since the only concern is the modulo 256 (modulo 1 00h) 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:

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

$$773/256 = 3 \text{ with a remainder of } 5.$$

This remainder is the checksum for the frame.
5 (decimal) = 05h = 0101b = <CHECKSUM>

B.1.3 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 (such as the RCS20) 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, which 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, 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 the packet originator does not receive a response message. 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 Corp. 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.

B.1.4 Global Response Operational Codes

In acknowledgment (response) 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 nine global responses. Global response opcodes are common responses, issued to the M&C computer or to another device, that can originate from and are interpreted by all Radyne equipment in the same manner. These are summarized as follows (all opcode values are expressed in decimal form):

RESPONSE OPCODE DESCRIPTION	OPCODE
Good Message	000 = 0000h
Bad Parameter	255 = 00FFh
Bad Opcode	254 = 00FEh
Bad Checksum	253 = 00FDh
Command Not Allowed in LOCAL Mode	252 = 00FCh
Command Not Allowed in AUTO Mode	251 = 00FBh
Bad Destination	250 = 00FAh
Unable to Process Command	249 = 00F9h
Packet Too Long	248 = 00F8h

Table 2. Response Opcodes

The following response error codes are specific to the RCS20:

RCS20 RESPONSE ERROR CODES DESCRIPTION	OPCODE	DESCRIPTION
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SPARM_DATACOUNT_ERROR	0201	Invalid number of data bytes
SPARM_CHANNELNUM_ERROR	0202	Invalid number of M for N channels
SPARM_CHANNELBYTES_ERROR	0203	Invalid number of bytes per channel
SPARM_MODBACKUPDELAY_ERROR	020A	Invalid modulator backup delay
SPARM_DEMODBACKUPDELAY_ERROR	020B	Invalid demodulator backup delay
SPARM_BACKUPMODE_ERROR	020C	Backup channel 1
SPARM_CHAN0CONFIG_ERROR	0213	Channel 0 Hardware Configuration
SPARM_BACKUPCHANNEL_ERROR	0214	Backup Channel
SPARM_MODEMNUMBER_ERROR	0217	Invalid prime to backup
SPARM_NOMODEMINSLOT_ERROR	0218	Prime is not present
SPARM_BACKUP_NOT_PRESENT_ERROR	02B3	Backup is not present
SPARM_BACKUP_IN_AUTO_MODE_ERROR	02B5	Backup is in automatic mode
SPARM_MODEM9_IN_TRAFFIC_MODE_ERROR	02B6	Modem is in traffic mode
SPARM_MOD_AUTOBACKEDUP_ERROR	02BC	Modulator is already auto backed up
SPARM_DEMOD_AUTOBACKEDUP_ERROR	02BD	Demodulator is already auto backed up
SPARM_PRIME_IN_SERVICE_MODE_ERROR	02BE	Prime is in service mode
SPARM_BACKUP_IN_SERVICE_MODE_ERROR	02BF	Backup is in service mode
SPARM_PRIME_BACKEDUP_TRAFFIC_ERROR	02C1	Prime backed up
SPARM_PRIME_HS_TRAFFIC_ERROR	02C2	Is in Hot Standby
SPARM_MODEM9_IN_BACKUP_MODE_ERROR	02C3	Modem is in backup mode
SPARM_NOBACKUPASSIGNED_ERROR	02C5	No backups assigned for this mod
SPARM_MODEMNOTLEARNED_ERROR	02C6	Modem is not learned
SPARM_COPYDESTINATION_ERROR	02CB	Invalid copy destination

B.1.5 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 DMD15 Modems 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 22. 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:

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
DVB3000/DVB3030/DM45 Video Modulator	23
RCS20 M: N Switch	24
RCS10 M: N Switch	25
RCS11 1:1 Switch	26
DMD2401/VHS-101/VME2401 Modem	27
Reserved for future equipment types	28-31

Table 3. Broadcast IDs

Note that multi-drop override IDs 01 or 02 can be used interchangeably to broadcast a message to a DMD-3000/4000 modem, or to a DMD-4500/5000, or to a DMD15 modem. Radyne Corp. 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 an RCS20 switch is queried for its equipment type identifier, it will return a "24."

B.1.6 Software Compatibility



The RCS20 RLLP is not software-compatible with the following previous Radyne products: RCU5000 and DMD4500. These products may not occupy the same bus while using this protocol as equipment malfunction and loss of data may occur.

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 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. M&C developers to index into the start of the volatile section use this count.

When new features are added to Radyne 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 equipment with different revision software, they might 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 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 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.

B.1.7 Flow Control and Task Processing

The original packet sender (the M&C computer) relies on accurate timeout information with regard to each piece of equipment under its control. This provides for efficient bus communication without unnecessary handshake overhead timing. One critical value is designated the Inter-Frame Space (FS). The Inter-Frame Space provides a period of time in which the packet receiver and medium (control bus and M&C computer interface) fully recover from the packet transmission/reception process and the receiver is ready to accept a new message. The programmed value of the Inter-Frame Space should be greater than the sum of the "turnaround time" and the round-trip (sender/receiver/bus) propagation time, including handshake overhead. The term "turnaround time" refers to the amount of time required for a receiver to be re-enabled and ready to receive a packet after having just received a packet. In flow control programming, the Inter-Frame Space may be determined empirically in accord with the system configuration, or calculated based on established maximum equipment task processing times.

Each piece of supported equipment on the control bus executes a Radyne Link Level Task (RLLT) in accordance with its internal hardware and fixed program structure. In a flow control example, the RLLT issues an internal "message in" system call to invoke an I/O wait condition that persists until the task receives a command from the M & C computer. The RLLT has the option of setting a timeout on the incoming message. Thus, if the equipment does not receive an information/command packet within a given time period, the associated RLLT exits the I/O wait state and takes appropriate action.

Radyne equipment is logically linked to the control bus via an Internal I/O Processing Task (IOPT) to handle frame sequencing, error checking, and handshaking. The IOPT is essentially a link between the equipment RLLT and the control bus. Each time the M&C computer sends a message packet, the IOPT receives the message and performs error checking. If errors are absent, the IOPT passes the message to the equipment's RLLT. If the IOPT detects errors, it appends error messages to the packet. Whenever an error occurs, the IOPT notes it and discards the message; but it keeps track of the incoming packet. Once the packet is complete, the IOPT conveys the appropriate message to the RLLT and invokes an I/O wait state (wait for next <SYNC> character).

If the RLLT receives the packetized message from the sender before it times out, it checks for any error messages appended by the IOPT. In the absence of errors, the RLLT processes the received command sent via the transmitted packet and issues a "message out" system call to ultimately acknowledge the received packet. This call generates the response packet conveyed to the sender. If the IOPT sensed errors in the received packet and an RLLT timeout has not occurred, the RLLT causes the equipment to issue the appropriate error message(s) in the pending equipment response frame.

To maintain frame synchronization, the IOPT keeps track of error-laden packets and packets intended for other equipment for the duration of each received packet. Once the packet is complete, the IOPT invokes an I/O wait state and searches for the next <SYNC> character.

NOTE: When transmitting a packet, the Remote M&C should ensure that the timeout value between characters does not exceed the time it takes to transmit 200 characters (\approx 200 msec). If this timeout value is exceeded, the equipment will timeout.

B.1.8 RLLP Summary

The RLLP is a simple send-and-wait protocol that automatically re-transmits a packet whenever 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 timeout 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.

SYNC	COUNT	SOURCE ADDRESS	DESTINATION ADDRESS	FSN	OPCODE	DATA BYTES	CHECKSUM
1 BYTE	2 BYTES	1 BYTE	1 BYTE	1 BYTE	2 BYTES	(COUNT) BYTES	1 BYTE

Table 4. Link Level Protocol Message Block

B.2 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 byte 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).

RCS20 Channel Definitions

The RCS20 organized the modems connected to the switch according to satellite communications channels. These channels are labeled on the DDS20 and IFS20 panels, and are defined as follows:

Channel 0 - Backup 1
 Channel 1 - Modem 1
 Channel 2 - Modem 2
 Channel 3 - Modem 3
 Channel 4 - Modem 4
 Channel 5 - Modem 5
 Channel 6 - Modem 6
 Channel 7 - Modem 7
 Channel 8 - Modem 8
 Channel 9 - Modem 9/Backup 2

RCS20 Switch Command Set

Command	Opcode	Description
Query Identification	2403h	Returns RCS20 Device ID (24 decimal)
Query Control Mode	2404h	Returns current RCS20 control mode
Query Switch Status	2001h	Returns current RCS20 status bytes
Query Switch Configuration	2002h	Returns current RCS20 configuration/status bytes
Query Switch Modem Remote Addresses	2003h	Returns current RCS20 modem addresses
Query Switch Backup Mode	2004h	Returns current RCS20 backup mode
Query Switch Expansion Module Configuration	2005h	Returns RCS20 plug in expansion module information
Query Reference Distribution Configuration	2010h	Returns current RCS20 RDM configuration
Query Switch Time	240Eh	Returns current RCS20 time
Query Switch Date	240Fh	Returns current RCS20 date
Query Switch Time and Date	2410h	Returns current RCS20 time and date
Command Control Mode	2600h	Set RCS20 control mode
Command Switch Relay Modem Packet	2200h	Relay message from RCS20 to modem
Command Switch Configuration	2202h	Set RCS20 configuration
Command Switch Backup Mode	2204h	Set RCS20 backup mode
Command Switch Clear Alarms	2205h	Clear all RCS20 current and latched alarms
Command Switch Force Manual Backup	2206h	Force RCS20 to manually backup
Command Switch Reference Distribution Configuration	2210h	Set RCS20 RDM configuration
Command Switch Set Time	2C04h	Set time for real-time clock
Command Switch Set Date	2C05h	Set date for real-time clock
Command Switch Set Time and Date	2C06h	Set time and date for real-time clock
Command Switch Learn Modem Configuration	2216h	Learn a modem's configuration
Command Switch Learn All Modem Configuration	2217h	Learn all modem's configuration
Command Switch Copy Modem Configuration	2218h	Copy a learned modem configuration
Command Switch Backup Test Modem Configuration	2219h	Backup test a modem's configuration
Command Switch Backup Test All Modem's Configuration	221Ah	Backup test all modem's configuration

**** NOTE: When new features are added to Radyne equipment, the control parameters are appended to the end of the non-volatile section, and statuses of the features, if any, are added at the end of the volatile section. If a remote M&C queries two pieces of Radyne equipment with different revision software, they might 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 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 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.

OPCODE DESCRIPTIONS

Opcode <2403h> Query RCS20 Device Identification

Query Response Data Field (1 Byte)		
<1>	Device Identification	24 decimal for RCS20

Opcode <2404h> Query RCS20 Switch Control Mode

Query Response Data Field (1 Byte)		
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<1>	Control Mode	0 = Front Panel, 1 = Terminal Mode, 2 = Remote Port
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Opcode <2001h> Query RCS20 Switch Status

Query Response Data Field (44 bytes) (64 bytes release 4.0)		
<1>	Control Mode	0 = Front Panel, 1 = Terminal Mode, 2 = Remote Port (Computer RLLP)
<1>	Software Revision	Binary number, decimal point implied
<1>	Number of Channels	10 decimal for RCS20
<1>	Number of Status Bytes Per Channel	Maximum number of bytes per channel (3 as of release 1.0, 5 as of release 4.0) *This number of bytes per channel might change with newer release numbers. It is set to 3 up to release 3.9, and 5 bytes as of release 4.0. **Remote M&C developers must make use of this value to find out how many bytes per channel are being transmitted.
<1>	*Channel 0 Status	Bit 0 = modulator failure flag (0 = no failure, 1 = failure) Bit 1 = demodulator failure flag (0 = no failure, 1 = failure) Bit 2 = switch communication in process (0 = no communication in process, 1 = communication in process) Bit 3 = modem communication fault (0 = no failure, 1 = failure) Bit 4 = modulator present (0= not present, 1= present) Bit 5 = demodulator present (0= not present, 1= present)
<1>	*Backed up Modulator	0 = This channel not a backup channel, or this channel is a backup channel but currently not backing up a mod, 1-9 = This channel currently backing up a mod, channel number as indicated.
<1>	*Backed up Demodulator	0 = This channel not a backup channel, or this channel is a backup channel but currently not backing up a demod, 1-9 = This channel currently backing up a demod, channel number as indicated.)
<1>	*Module 0 Alarms 2 Status	Bit 0 = Mod learned (0 = Mod is not learned, 1 = Mod is learned) Bit 1 = Demod learned (0 = Demod is not learned, 1 = Demod is learned) Bit 2 = Mod configuration changed (0 = Mod configuration has not changed, 1 = Mod configuration is changed) Bit 3 = Demod configuration changed (0 = Demod configuration has not changed, 1 = Demod configuration is changed) Bits 4 through 7 = Spares
<1>	*Module 0 Alarms 3 Status	Bits 0 and 1 = Mod backup 1 test status (0 = No Mod backup 1 test performed, 1 = Mod backup 1 test pass, 2 = Mod backup 1 test fail) Bits 2 and 3 = Demod backup 1 test status (0 = No Demod backup 1 test performed, 1 = Demod backup 1 test pass, 2 = Demod backup 1 test fail) Bits 4 and 5 = Mod backup 2 test status (0 = No Mod backup 2 test

		<p>performed, 1 = Mod backup 2 test pass, 2 = Mod backup 2 test fail)</p> <p>Bits 6 and 7 = Demod backup 2 test status (0 = No Demod backup 2 test performed, 1 = Demod backup 2 test pass, 2 = Demod backup 2 test fail)</p> <p>*Notes: These 3 bytes repeat for channels 1 - 9 (5 bytes as of release 4.0) 27 additional bytes (45 additional bytes as of release 4.0)</p>
<1>	Switch Major Alarms	<p>Bit 0 = RAM/ROM fault</p> <p>Bit 1 = No Backup for Faulted Prime</p> <p>Bit 2 = Error During Backup</p> <p>Bit 3 = Backup 1 Mod Error</p> <p>Bit 4 = Backup 1 Demod Error</p> <p>Bit 5 = Backup 2 Mod Error</p> <p>Bit 6 = Backup 2 Demod Error</p> <p>Bit 7 = Spare</p> <p>(0 = no alarm, 1 = alarm)</p>
<1>	Switch Minor Alarms 1	<p>Bit 0 = Power Supply #1 Present</p> <p>Bit 1 = Power Supply #1 Voltage</p> <p>Bit 2 = Power Supply #2 Present</p> <p>Bit 3 = Power Supply #2 Voltage</p> <p>Bit 4 = Communications Error</p> <p>Bit 5 = Faulted Prime Modem</p> <p>Bit 6 = Faulted Backup Modem</p> <p>Bit 7 = Modem Configuration Change</p> <p>(0 = no alarm, 1 = alarm)</p>
<1>	Switch Minor Alarms 2	<p>Bit 0 = CDM Error</p> <p>Bit 1 = Reserved (RCS10 only)</p> <p>Bit 2 = Reserved (RCS10 only)</p> <p>Bit 3 = Reserved (RCS10 only)</p> <p>Bit 4 = Backup 1 Test Fault</p> <p>Bit 5 = Backup 2 Test Fault</p> <p>Bit 6 = Reserved (RCS10 only)</p> <p>Bit 7 = Spare</p> <p>(0 = no alarm, 1 = alarm)</p>
<1>	Latched Switch Major Alarms	<p>Bit 0 = RAM/ROM fault</p> <p>Bit 1 = No Backup for Faulted Prime</p> <p>Bit 2 = Error During Backup</p> <p>Bit 3 = Backup 1 Mod Error</p> <p>Bit 4 = Backup 1 Demod Error</p> <p>Bit 5 = Backup 2 Mod Error</p> <p>Bit 6 = Backup 2 Demod Error</p> <p>Bit 7 = Spare</p> <p>0 = no alarm, 1 = alarm</p>
<1>	Latched Switch Minor Alarms 1	<p>Bit 0 = Power Supply #1 Present</p> <p>Bit 1 = Power Supply #1 Voltage</p> <p>Bit 2 = Power Supply #2 Present</p>

		Bit 3 = Power Supply #2 Voltage Bit 4 = Communications Error Bit 5 = Faulted Prime Modem Bit 6 = Faulted Backup Modem Bit 7 = Modem Configuration Change (0 = no alarm, 1 = alarm)
<1>	Latched Switch Minor Alarms 2	Bit 0 = CDM Error Bit 1 = Reserved (RCS10 only) Bit 2 = Reserved (RCS10 only) Bit 3 = Reserved (RCS10 only) Bit 4 = Backup 1 Test Fault Bit 5 = Backup 2 Test Fault Bit 6 = Reserved (RCS10 only) Bit 7 = Spare (0 = no alarm, 1 = alarm)
<1>	Backup 1 Mod Hot Standby Channel	Channel number (1 to 9) (0 = No hot standby for backup 1 mod)
<1>	Backup 1 Demod Hot Standby Channel	Channel number (1 to 9) (0 = No hot standby for backup 1 Demod)
<1>	Backup 2 Mod Hot Standby Channel	Channel number (1 to 8) (0 = No hot standby for backup 2 mod, or channel 9 not configured as backup)
<1>	Backup 2 Demod Hot Standby Channel	Channel number (1 to 8) (0 = No hot standby for backup 2 Demod, or Channel 9 not configured as backup)

Opcode <2002h> Query RCS20 Switch Configuration

Query Response Data Field (285 bytes)		
Configuration Bytes		
<2>	Nonvolatile Bytes	Number of nonvolatile RCS20 configuration memory bytes, including these 2 bytes (221 decimal for RCS20)
<1>	Number of Channels	Maximum number of prime and backup channels available to the RCS20 switch. (10 decimal for RCS20 as of Release 1.0)
<1>	Nonvolatile Bytes per Channel	Number of nonvolatile memory bytes per channel. This number may vary with the release number. (10 bytes for RCS20 as of release 1.0 and 13 bytes as of release 4.0) **Remote M&C developers must make use of this value to find out how many bytes per channel are being transmitted.
<1>	*Channel 0 Configuration	Bit 0 = Modulator present Bit 1 = Demodulator present (0 = not present, 1 = present)
<2>	*Channel 0 Mod Backup Delay	0h - BB7h in tenths of a second; decimal point implied

<2>	*Channel 0 Demod Backup Delay	0h - BB7h in tenths of a second; decimal point implied
<1>	*Channel 0 Mod Backup Configuration	Bit 0 = Backup 1 assigned to this modulator Bit 1 = Backup 2 assigned to this modulator (0 = not assigned, 1 = assigned)
<1>	*Channel 0 Demod Backup Configuration	Bit 0 = Backup 1 assigned to this demodulator Bit 1 = Backup 2 assigned to this demodulator (0 = not assigned, 1 = assigned)
<1>	*Channel 0 Mod Priority	Channel 0 Modulator backup priority (0-9)
<1>	*Channel 0 Demod Priority	Channel 0 Demodulator backup priority (0-9)
<1>	*Channel 0 Switch Style	0 = Switch Mod and Demod separately, 1 = Switch Mod and Demod together
<2>	*Channel 0 Demod Acquisition Delay	0h-BB7h in tenths of a second; decimal point implied. For example, a value of 100 means 10.0 sec.
<1>	*Channel 0 Service Mode	0 = Normal, 1 = Service *NOTE: These 10 bytes (13 bytes as of release 4.0) repeat for channels 1 – 9 (uses 90 additional bytes) (uses 117 additional bytes as of release 4.0). NOTE: The Backup Delays and Demod Acquisition Delay applies only to channels 1 - 9 (the four channel 0 bytes are ignored). If channel 9 is configured as backup 2, then the four channel 0 Backup Delay bytes and the two Demod Acquisition Delay bytes are ignored.
<1>	Switch Major Alarm Mask	Bit 0 = RAM/ROM fault Bit 1 = No Backup for Faulted Prime Bit 2 = Error During Backup Bit 3 = Backup 1 Mod Error Bit 4 = Backup 1 Demod Error Bit 5 = Backup 2 Mod Error Bit 6 = Backup 2 Demod Error Bit 7 = Spare (0 = mask, 1 = allow)
<1>	Switch Minor Alarm 1 Mask	Bit 0 = Power Supply #1 Present Bit 1 = Power Supply #1 Voltage Bit 2 = Power Supply #2 Present Bit 3 = Power Supply #2 Voltage Bit 4 = Communications Error Bit 5 = Faulted Prime Modem Bit 6 = Faulted Backup Modem Bit 7 = Modem Configuration Change

		(0 = mask, 1 = allow)
<1>	Switch Minor Alarm 2 Mask	Bit 0 = CDM Error Bit 1 = Reserved (RCS10 only) Bit 2 = Reserved (RCS10 only) Bit 3 = Reserved (RCS10 only) Bit 4 = Backup 1 Test Fault Bit 5 = Backup 2 Test Fault Bit 6 = Reserved (RCS10 only) Bit 7 = Spare (0 = Mask, 1 = Allow)
<1>	Maximum Number of Backup Channels	2 for RCS20
<1>	Nonvolatile bytes per Backup Channel	4 for RCS20
<1>	Backup 1 (Channel 0) Configuration	0 = Backup modem
<1>	Backup 1 (Channel 0) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 1 (Channel 0) Force Manual Modulator Backup	Channel number for manual backup (1 to 9) (ignored if in automatic mode)
<1>	Backup 1 (Channel 0) Force Manual Demodulator Backup	Channel number for manual backup (1 to 9) (ignored if in automatic mode)
<1>	Backup 2 (Channel 9) Configuration	0 = Backup modem, 1 = Preempt able prime modem, 2 = Prime Modem
<1>	Backup 2 (Channel 9) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 2 (Channel 0) Force Manual Modulator Backup	Channel number for manual backup (1 to 8) (ignored if in automatic mode or if channel 9 is configured as prime)
<1>	Backup 2 (Channel 0) Force Manual Demodulator Backup	Channel number for manual backup (1 to 8) (ignored if in automatic mode or if channel 9 is configured as prime)
<4>	Reserved	(Reserved for RCS10, set to zero)
<4>	Reserved	(Reserved for RCS10, set to zero)
<1>	Reserved	(Reserved for RCS10, set to zero)
<1>	Reserved	(Reserved for RCS10, set to zero)

<1>	Reserved	(Reserved for RCS10, set to zero)
<1>	Learn Modem	0 = Modem 0, 1 = Modem 1, 2 = Modem 2, 3 = Modem 3, 4 = Modem 4, 5 = Modem 5, 6 = Modem 6, 7 = Modem 7, 8 = Modem 8, 9 = Modem 9, 10 = All Modems
<1>	Test Modem	0 = Modem 1, 1 = Modem 2, 2 = Modem 3, 3 = Modem 4, 4 = Modem 5, 5 = Modem 6, 6 = Modem 7, 7 = Modem 8, 8 = Modem 9, 9 = All Modems, , 10 = None Note: This byte should be forced to 10 if no tests are desired, failure to do so may result in momentary loss of link on selected modem(s).
<1>	Additional Bytes per Channel	6 bytes as of release 4.0
<1>	*Channel 0 Alarm 2 Mask	Bit 0 = Mod learned Bit 1 = Demod learned Bit 2 = Mod configuration changed Bit 3 = Demod configuration changed Bits 4 through 7 = Spares (0 =Mask, 1 = Allow)
<1>	*Channel 0 Alarm 3 Mask	Bits 0 and 1 = Mod Backup 1 Test Status Mask Bits 2 and 3 = Demod Backup 1 Test Status Mask Bits 4 and 5 = Mod Backup 2 Test Status Mask Bits 6 and 7 = Demod Backup 2 Test Status Mask (0 = Mask, 1 = Allow)
<4>	*Spares for Channel 0	Spare Bytes *Note: These 6 bytes will repeat for channels 1 through 9 (54 additional bytes used).
Status Bytes		
<1>	Control Mode	0 = Front Panel, 1 = Terminal Mode, 2 = Remote Port (Computer RLLP)
<1>	Software Revision	Binary number, decimal point implied
<1>	Number of Channels	10 decimal for RCS20
<1>	Number of Status Bytes Per Channel	Maximum number of bytes per channel (3 as of release 1.0, 5 as of release 4.0) *This number of bytes per channel might change with newer release numbers. It is set to 3 up to release 3.9, and 5 bytes as of release 4.0. **Remote M&C developers must make use of this value to find out how many bytes per channel are being transmitted.

<1>	*Channel 0 Status	Bit 0 = modulator failure flag (0 = no failure, 1 = failure) Bit 1 = demodulator failure flag (0 = no failure, 1 = failure) Bit 2 = switch communication in process (0 = no communication in process, 1 = communication in process) Bit 3 = modem communication fault (0 = no failure, 1 = failure) Bit 4 = modulator present (0= not present, 1= present) Bit 5 = demodulator present (0= not present, 1= present)
<1>	*Backed up Modulator	0 = This channel not a backup channel, or this channel is a backup channel but currently not backing up a mod, 1-9 = This channel currently backing up a mod, channel number as indicated.
<1>	*Backed up Demodulator	0 = This channel not a backup channel, or this channel is a backup channel but currently not backing up a demod, 1-9 = This channel currently backing up a demod, channel number as indicated.)
<1>	*Module 0 Alarms 2 Status	Bit 0 = Mod learned (0 = Mod is not learned, 1 = Mod is learned) Bit 1 = Demod learned (0 = Demod is not learned, 1 = Demod is learned) Bit 2 = Mod configuration changed (0 = Mod configuration has not changed, 1 = Mod configuration is changed) Bit 3 = Demod configuration changed (0 = Demod configuration has not changed, 1 = Demod configuration is changed) Bits 4 through 7 = Spares
<1>	*Module 0 Alarms 3 Status	Bits 0 and 1 = Mod backup 1 test status (0 = No Mod backup 1 test performed, 1 = Mod backup 1 test pass, 2 = Mod backup 1 test fail) Bits 2 and 3 = Demod backup 1 test status (0 = No Demod backup 1 test performed, 1 = Demod backup 1 test pass, 2 = Demod backup 1 test fail) Bits 4 and 5 = Mod backup 2 test status (0 = No Mod backup 2 test performed, 1 = Mod backup 2 test pass, 2 = Mod backup 2 test fail) Bits 6 and 7 = Demod backup 2 test status (0 = No Demod backup 2 test performed, 1 = Demod backup 2 test pass, 2 = Demod backup 2 test fail)
<1>	Switch Major Alarms	*Notes: These 3 bytes repeat for channels 1 - 9 (5 bytes as of release 4.0) 27 additional bytes (45 additional bytes as of release 4.0) Bit 0 = RAM/ROM fault Bit 1 = No Backup for Faulted Prime Bit 2 = Error During Backup Bit 3 = Backup 1 Mod Error Bit 4 = Backup 1 Demod Error Bit 5 = Backup 2 Mod Error Bit 6 = Backup 2 Demod Error Bit 7 = Spare (0 = no alarm, 1 = alarm)
<1>	Switch Minor Alarms 1	Bit 0 = Power Supply #1 Present

		Bit 1 = Power Supply #1 Voltage Bit 2 = Power Supply #2 Present Bit 3 = Power Supply #2 Voltage Bit 4 = Communications Error Bit 5 = Faulted Prime Modem Bit 6 = Faulted Backup Modem Bit 7 = Modem Configuration Change (0 = no alarm, 1 = alarm)
<1>	Switch Minor Alarms 2	Bit 0 = CDM Error Bit 1 = Reserved (RCS10 only) Bit 2 = Reserved (RCS10 only) Bit 3 = Reserved (RCS10 only) Bit 4 = Backup 1 Test Fault Bit 5 = Backup 2 Test Fault Bit 6 = Reserved (RCS10 only) Bit 7 = Spare (0 = no alarm, 1 = alarm)
<1>	Latched Switch Major Alarms	Bit 0 = RAM/ROM fault Bit 1 = No Backup for Faulted Prime Bit 2 = Error During Backup Bit 3 = Backup 1 Mod Error Bit 4 = Backup 1 Demod Error Bit 5 = Backup 2 Mod Error Bit 6 = Backup 2 Demod Error Bit 7 = Spare 0 = no alarm, 1 = alarm
<1>	Latched Switch Minor Alarms 1	Bit 0 = Power Supply #1 Present Bit 1 = Power Supply #1 Voltage Bit 2 = Power Supply #2 Present Bit 3 = Power Supply #2 Voltage Bit 4 = Communications Error Bit 5 = Faulted Prime Modem Bit 6 = Faulted Backup Modem Bit 7 = Modem Configuration Change (0 = no alarm, 1 = alarm)
<1>	Latched Switch Minor Alarms 2	Bit 0 = CDM Error Bit 1 = Reserved (RCS10 only) Bit 2 = Reserved (RCS10 only) Bit 3 = Reserved (RCS10 only) Bit 4 = Backup 1 Test Fault Bit 5 = Backup 2 Test Fault Bit 6 = Reserved (RCS10 only) Bit 7 = Spare (0 = no alarm, 1 = alarm)
<1>	Backup 1 Mod Hot Standby Channel	Channel number (1 to 9) (0 = No hot standby for backup 1 mod)
<1>	Backup 1 Demod Hot	Channel number (1 to 9) (0 = No hot standby for backup 1 Demod)

	Standby Channel	
<1>	Backup 2 Mod Hot Standby Channel	Channel number (1 to 8) (0 = No hot standby for backup 2 mod, or channel 9 not configured as backup)
<1>	Backup 2 Demod Hot Standby Channel	Channel number (1 to 8) (0 = No hot standby for backup 2 Demod, or Channel 9 not configured as backup)

Opcode <2003h> Query RCS20 Modem Addresses

Query Response Data Field (11 bytes)		
<1>	Number of Channels	10 for RCS20
<1>	Modem Address 0	Modem Remote Address for channel 0 (BU 1)
<1>	Modem Address 1	Modem Address 1 (Modem Remote Address for channel 1 (Prime 1))
<1>	Modem Address 2	Modem Address 2 (Modem Remote Address for channel 2 (Prime 2))
<1>	Modem Address 3	Modem Address 3 (Modem Remote Address for channel 3 (Prime 3))
<1>	Modem Address 4	Modem Address 4 (Modem Remote Address for channel 4 (Prime 4))
<1>	Modem Address 5	Modem Address 5 (Modem Remote Address for channel 5 (Prime 5))
<1>	Modem Address 6	Modem Address 6 (Modem Remote Address for channel 6 (Prime 6))
<1>	Modem Address 7	Modem Address 7 (Modem Remote Address for channel 7 (Prime 7))
<1>	Modem Address 8	Modem Address 8 (Modem Remote Address for channel 8 (Prime 8))
<1>	Modem Address 9	Modem Address 9 (Modem Remote Address for channel 9 (Prime 9 / BU 2))

Opcode <2004h> Query RCS20 Backup Mode

Query Response Data Field (3 bytes)		
<1>	Maximum Number of Backup Channels	2 for RCS20
<1>	Backup 1 (Channel 0) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 2 (Channel 9) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive (Ignore if Channel 9 is not configured as backup)

Opcode <2005h> Query RCS20 Expansion Module Information

Query Response Data Field (7 bytes)		
<1>	Number of Expansion Slots	6 for RCS20
<1>	Slot 0 Expansion Type	255 decimal = no expansion card present, 0 = RCS20 Interface

<1>	Slot 1 Expansion Type	Control Module, 1 = RCS20 Bank Control Module, 2 = RCS20 Ethernet Interface Module, 3 = RCS20 Reference Distribution Module
<1>	Slot 2 Expansion Type	255 decimal = no expansion card present, 0 = RCS20 Interface Control Module, 1 = RCS20 Bank Control Module, 2 = RCS20 Ethernet Interface Module, 3 = RCS20 Reference Distribution Module
<1>	Slot 3 Expansion Type	255 decimal = no expansion card present, 0 = RCS20 Interface Control Module, 1 = RCS20 Bank Control Module, 2 = RCS20 Ethernet Interface Module, 3 = RCS20 Reference Distribution Module
<1>	Slot 4 Expansion Type	255 decimal = no expansion card present, 0 = RCS20 Interface Control Module, 1 = RCS20 Bank Control Module, 2 = RCS20 Ethernet Interface Module, 3 = RCS20 Reference Distribution Module
<1>	Slot 5 Expansion Type	255 decimal = no expansion card present, 0 = RCS20 Interface Control Module, 1 = RCS20 Bank Control Module, 2 = RCS20 Ethernet Interface Module, 3 = RCS20 Reference Distribution Module

Opcode <2010h> Query RCS20 Reference Distribution Module Configuration

Command Data Field (1 byte)

<1>	RDM Slot Number	Slot number on the RCU20 for the RDM to be queried
Query Response Data Field (4 bytes)		
<1>	RDM Status	Bit 0 = Ext A Activity Bit 1 = Ext B Activity Bit 2 = Internal Ref. Activity
<1>	RDM Fallback Selection	0 = External A Only, 1 = Internal Only, 2 = Ext A → Int., 3 = Int. → Ext A, 4 = Ext A → Ext B, 5 = Ext A → Ext B → Int., 6 = Int. → Ext A → Ext B
<1>	RDM Internal Reference Frequency	0 = 10 MHz, 1 = 5 MHz, 2 = 2.5 MHz, 3 = 1.25 MHz
<1>	RDM Currently Selected Source	0 = External A, 1 = External B, 2 = Internal

Opcode: <240Eh> Query Time

Query Response		
<1>	Hour	0 - 23

<1>	Minute	0 - 59
<1>	Second	0 - 59

Opcode: <240Fh> Query Date

Query Response		
<1>	Year	0 - 99
<1>	Month	0 - 11
<1>	Day	0 - 30

Opcode: <2410h> Query Time and Date

Query Response		
<1>	Year	0 - 99
<1>	Month	0 - 11
<1>	Day	0 - 30
<1>	Hour	0 - 23
<1>	Minute	0 - 59
<1>	Second	0 - 59

Opcode <2600h> Set RCS20 Switch Control Mode

Command Data Field (1 byte):

<1>	Control Mode	0 = Front Panel, 1 = Terminal, 2 = Remote Port (Computer RLLP)
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Opcode <2200h> Relay Command or Query to Modem

Command Data Field (n+1 bytes):

<1>	Channel Number	Channel number for the modem for which the message is to be relayed (0 to 9 for the RCS20)
<n>	RLLP Packet from Modem	Complete, addressed RLLP message block with (variable number of bytes) sync byte, source address, destination address, opcode, byte count, data field and checksum) (Contents of Response Packet Data Field: Dependent upon message relayed to modem.

Opcode <2202h> Set RCS20 Configuration

Command Data Field:

<2>	Nonvolatile Bytes	Number of nonvolatile RCS20 configuration memory bytes, including these 2 bytes (221 decimal for RCS20)
<1>	Number of Channels	Maximum number of prime and backup channels available to the RCS20 switch. (10 decimal for RCS20 as of Release 1.0)
<1>	Nonvolatile Bytes per Channel	Number of nonvolatile memory bytes per channel. This number may vary with the release number. (10 bytes for RCS20 as of release 1.0)

		and 13 bytes as of release 4.0)
		**Remote M&C developers must make use of this value to find out how many bytes per channel are being transmitted.
<1>	*Channel 0 Configuration	Bit 0 = Modulator present Bit 1 = Demodulator present (0 = not present, 1 = present)
<2>	*Channel 0 Mod Backup Delay	0h - BB7h in tenths of a second; decimal point implied
<2>	*Channel 0 Demod Backup Delay	0h - BB7h in tenths of a second; decimal point implied
<1>	*Channel 0 Mod Backup Configuration	Bit 0 = Backup 1 assigned to this modulator Bit 1 = Backup 2 assigned to this modulator (0 = not assigned, 1 = assigned)
<1>	*Channel 0 Demod Backup Configuration	Bit 0 = Backup 1 assigned to this demodulator Bit 1 = Backup 2 assigned to this demodulator (0 = not assigned, 1 = assigned)
<1>	*Channel 0 Mod Priority	Channel 0 Modulator backup priority (0-9)
<1>	*Channel 0 Demod Priority	Channel 0 Demodulator backup priority (0-9)
<1>	*Channel 0 Switch Style	0 = Switch Mod and Demod separately, 1 = Switch Mod and Demod together
<2>	*Channel 0 Demod Acquisition Delay	0h-BB7h in tenths of a second; decimal point implied. For example, a value of 100 means 10.0 sec.
<1>	*Service Mode	0 = Normal, 1 = Service
		*NOTE: These 10 bytes (13 bytes as of release 4.0) repeat for channels 1 – 9 (uses 90 additional bytes) (uses 117 additional bytes as of release 4.0).
		NOTE: The Backup Delays and Demod Acquisition Delay applies only to channels 1 - 9 (the four channel 0 bytes are ignored). If channel 9 is configured as backup 2, then the four channel 0 Backup Delay bytes and the two Demod Acquisition Delay bytes are ignored.
<1>	Switch Major Alarm Mask	Bit 0 = RAM/ROM fault Bit 1 = No Backup for Faulted Prime Bit 2 = Error During Backup Bit 3 = Backup 1 Mod Error Bit 4 = Backup 1 Demod Error Bit 5 = Backup 2 Mod Error

		Bit 6 = Backup 2 Demod Error Bit 7 = Spare (0 = mask, 1 = allow)
<1>	Switch Minor Alarm 1 Mask	Bit 0 = Power Supply #1 Present Bit 1 = Power Supply #1 Voltage Bit 2 = Power Supply #2 Present Bit 3 = Power Supply #2 Voltage Bit 4 = Communications Error Bit 5 = Faulted Prime Modem Bit 6 = Faulted Backup Modem Bit 7 = Modem Configuration Change (0 = mask, 1 = allow)
<1>	Switch Minor Alarm 2 Mask	Bit 0 = CDM Error Bit 1 = Reserved (RCS10 only) Bit 2 = Reserved (RCS10 only) Bit 3 = Reserved (RCS10 only) Bit 4 = Backup 1 Test Fault Bit 5 = Backup 2 Test Fault Bit 6 = Reserved (RCS10 only) Bit 7 = Spare (0 = Mask, 1 = Allow)
<1>	Maximum Number of Backup Channels	2 for RCS20
<1>	Nonvolatile bytes per Backup Channel	4 for RCS20
<1>	Backup 1 (Channel 0) Configuration	0 = Backup modem
<1>	Backup 1 (Channel 0) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 1 (Channel 0) Force Manual Modulator Backup	Channel number for manual backup (1 to 9) (ignored if in automatic mode)
<1>	Backup 1 (Channel 0) Force Manual Demodulator Backup	Channel number for manual backup (1 to 9) (ignored if in automatic mode)
<1>	Backup 2 (Channel 9) Configuration	0 = Backup modem, 1 = Preempt able prime modem, 2 = Prime Modem
<1>	Backup 2 (Channel 9) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 2 (Channel 0) Force Manual Modulator Backup	Channel number for manual backup (1 to 8) (ignored if in automatic mode or if channel 9 is configured as prime)

<1>	Backup 2 (Channel 0) Force Manual Demodulator Backup	Channel number for manual backup (1 to 8) (ignored if in automatic mode or if channel 9 is configured as prime)
<4>	Reserved	(Reserved for RCS10, set to zero)
<4>	Reserved	(Reserved for RCS10, set to zero)
<1>	Reserved	(Reserved for RCS10, set to zero)
<1>	Reserved	(Reserved for RCS10, set to zero)
<1>	Reserved	(Reserved for RCS10, set to zero)
<1>	Learned Modem	0 = Modem 0, 1 = Modem 1, 2 = Modem 2, 3 = Modem 3, 4 = Modem 4, 5 = Modem 5, 6 = Modem 6, 7 = Modem 7, 8 = Modem 8, 9 = Modem 9, 10 = All Modems
<1>	Test Modem	0 = Modem 1, 1 = Modem 2, 2 = Modem 3, 3 = Modem 4, 4 = Modem 5, 5 = Modem 6, 6 = Modem 7, 7 = Modem 8, 8 = Modem 9, 9 = All Modems, , 10 = None Note: This byte should be forced to 10 if no tests are desired, failure to do so may result in momentary loss of link on selected modem(s).
<1>	Additional Bytes per Channel	6 bytes as of release 4.0
<1>	*Channel 0 Alarm 2 Mask	Bit 0 = Mod learned Bit 1 = Demod learned Bit 2 = Mod configuration changed Bit 3 = Demod configuration changed Bits 4 through 7 = Spares (0 =Mask, 1 = Allow)
<1>	*Channel 0 Alarm 3 Mask	Bits 0 and 1 = Mod Backup 1 Test Status Mask Bits 2 and 3 = Demod Backup 1 Test Status Mask Bits 4 and 5 = Mod Backup 2 Test Status Mask Bits 6 and 7 = Demod Backup 2 Test Status Mask (0 = Mask, 1 = Allow)
<4>	*Spares for Channel 0	Spare Bytes *Note: These 6 bytes will repeat for channels 1 through 9 (54 additional bytes used).

Opcode <2204h> Set RCS20 Backup Mode

Command Data Field (3 bytes):

<1>	Maximum Number of Backup Channels	2 for RCS20
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<1>	Backup 1 (Channel 0) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive
<1>	Backup 2 (Channel 9) Backup Mode	0 = Manual, 1 = Automatic non-Revertive, 2 = Automatic Revertive (will be ignored if Channel 9 is not configured as backup)

Opcode <2205h> Clear RCS20 Latched Alarms

There is no data field for this command.

Opcode <2206h> Force RCS20 Manual Backup

Command Data Field (3 bytes)

<1>	Maximum Number of Backup Channels	2 for RCS20
<1>	Backup 1 (Channel 0) Channel to Backup	1 to 8 (if Channel 9 configured as backup) (use 0 to un-back) 1 to 9 (if Channel 9 not configured as backup) (use 0 to un-back) Bits 0-3 = Modulator Bits 4-7 = Demodulator
<1>	Backup 2 (Channel 9) Channel to Backup	(1 to 8) (use 0 to un-back) Bits 0-3 = Modulator Bits 4-7 = Demodulator
<p>Notes: 1. Command will return an error if Backup 1 and Backup 2 are forced to backup the same channel. 2. Set channel = 255 decimal if no forced backup is desired for either backup channel. 3. Command will return an error if trying to force a backup for a backup channel not configured in manual backup mode.</p>		

Opcode <2210h> Set RCS20 Frequency Distribution Module Configuration

Command Data Field (3 bytes):

<1>	RDM Slot Number	Slot number on the RCU20 for the RDM to be configured.
<1>	RDM Fallback Mode	0 = External A Only, 1 = Internal Only, 2 = Ext A → Int., 3 = Int. → Ext A, 4 = Ext A → Ext B, 5 = Ext A → Ext B → Int., 6 = Int. → Ext A → Ext B)
<1>	RDM Internal Reference Frequency	0 = 10 MHz, 1 = 5 MHz, 2 = 2.5 MHz, 3 = 1.25 MHz

Opcode: <2C04h> Command Set Time

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

Opcode: <2C05h> Command Set Date

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

Opcode: <2C06h> Command Set Date and Time

<1>	Year	0 - 99
<1>	Month	0 - 11
<1>	Day	0 - 30
<1>	Hour	0 - 23
<1>	Minute	0 - 59
<1>	Second	0 - 59

Opcode <2216h> Learn Modem Configuration

Command Data Field (1 byte)

<1>	Modem Number	0 = Modem 0, 1 = Modem 1, 2 = Modem 2, 3 = Modem 3, 4 = Modem 4, 5 = Modem 5, 6 = Modem 6, 7 = Modem 7, 8 = Modem 8, 9 = Modem 9
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Opcode <2217h> Learn All Modem's Configurations

There is no data field for this opcode.

Note: In order to learn a modem's configuration, a modem must be a backup modem or a prime modem that has been assigned a backup. The modem must be present in the chassis.

Opcode <2218h> Copy Modem Configuration

Command Data Field (2 bytes)

<1>	From Modem	0 = Modem 0, 1 = Modem 1, 2 = Modem 2, 3 = Modem 3, 4 = Modem 4, 5 = Modem 5, 6 = Modem 6, 7 = Modem 7, 8 = Modem 8, 9 = Modem 9. Modem configuration <i>must be</i> learned.
<1>	To Modem	0 = Backup 1, 1 = Modem 1, 2 = Modem 2, 3 = Modem 3, 4 = Modem 4, 5 = Modem 5, 6 = Modem 6, 7 = Modem 7, 8 = Modem 8, 9 = Modem 9, 10 = All Modems

Note: The 'From' and 'To' modems must be present in the chassis and not equal to each other. You can not copy a modem's configuration onto itself. The Mod configuration will be copied and if successful, the Demod configuration will be copied. If any errors occur, appropriate error Opcodes will be returned.

Opcode <2219h>* Backup Test Modem Configuration

Command Data Field (1 byte)

<1>	Modem Number	1 to 8 if channel 9 is configured as backup 1 to 9 if channel 9 is not configured as backup
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Opcode <221Ah>* Backup Test All Modem's Configurations

There is no data field for this command.

***Note: In order to backup test a modem configuration, a modem must be a prime modem that has been assigned a backup. The prime modem's configuration must be learned and its assigned backup present in the chassis.**

