Operating Instructions

Honeywell

CM4 Serial Communication Protocol

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CM4 refers to any of the CM4 instruments Honeywell Analytics has designed and markets, and is the trademark of the family.

Contents

Introduction

Overview

The CM4 serial communications protocol was designed and developed by Honeywell Analytics, and is proprietary information. This manual will describe the setup and operation of the communication protocol.

Your CM4 four-point continuous monitor is equipped with an optional serial remote device communication port. With this communication port, you can monitor the CM4 system's operation with equipment from a remote location. It will also allow you to gather gas concentration data for analysis or reports.

The CM4 monitor accepts commands and issues responses to any valid command it receives. The CM4 monitor is always considered the "slave" device, and the remote equipment is the "master" device. The remote equipment can be a personal computer (PC), a programmable logic controller (PLC), or other device capable of RS-232, RS-422, or RS-485 serial communications. This configuration requires a "master" device. Therefore, one CM4 monitor will not communicate directly with another CM4 monitor. However, one master can be used to communicate with more than one CM4 monitor on a two-wire RS-485 bus.

The CM4 monitor supports multiple baud rates. These user selectable rates are 1200, 2400, 4800, 9600, and 19,200. Additional port settings are 8-bit, 1 stop bit, and no parity.

The slave is identified by an address programmed into the CM4 monitor (selectable 1-255). If more than one CM4 monitor is used, each must have a unique address.

The equipment (master) is always at address 0. Each CM4 monitor will respond to a signal directed to it from the equipment. To prevent a collision of messages, the master must avoid transmitting any information after a packet until the slave responds. Typically this occurs within 1000 milliseconds.

Glossary

The following terms are used in this manual:

Byte: A byte is a collection of 8 bits (or pieces) of information used in the communication process. A byte refers to these 8 bits as a single entity. Each bit has a value of either 0 or 1.

Communication: The act or process of passing digital information between two points.

Data: Information that is transferred between the equipment and the CM4 monitor. Data refers to the information contained within a packet (see Packet). This information may be gas concentration, date, or other information.

Equipment: This term is used to refer to the master device which is used to communicate with the CM4 monitor(s). The equipment can be a personal computer (PC) or other device capable of performing the digital communications described in this protocol.

Handshake: The process of acknowledging a communication has been received. The CM4 monitor uses ACK/NAK responses.

Hexadecimal: A type of numbering system with a base of 16. In this numerical system, numbers 10 through 15 are represented by the letters A through F respectively. The shortened version of the word hexadecimal is generally "Hex," as in "Hex 42." "0x" is the notation used in this manual for hexadecimal (e.g. 0x42).

Instrument: This term is used to refer to the CM4 four-point continuous monitor.

Master: Another computer which communicates with slaves using the CM4 protocol.

Packet: A block of information that is passed between the instrument and the equipment. A packet is made from many bytes of information.

Protocol: The manner in which data is transferred and the format used for the transfer. CM4 protocol refers to the packets of transferred data the CM4 instrument recognizes.

Slave: The MDA Scientific CM4 gas monitor. A network may have several slaves.

Time-Out: The maximum amount of time allowed between the time the last byte of a packet is sent from the “master” device to the time the “slave” device responds. The time-out period for this protocol is one second.

Communication Port

Access to the CM4 protocol is through the COM port. This port is a DB-9 female connector. This port is designed for bidirectional communications between the CM4 instrument and your equipment. Signals present at the port conform to RS-232, RS-422, or RS-485 specifications. Again, this is based on which interface option was installed in your CM4 instrument. The pin-out specifications for each option are as follows:

RS-232 (Part Number 874270)	
Pin Number	**Signal**
2	Transmit
3	Receive
5	Ground

RS-422 (Part Number 874326)	
Pin Number	**Signal**
2	Receive +
3	Receive -
4	Transmit -
5	Transmit +

RS-485 (Part Number 874556)	
Pin Number	**Signal**
2	B (Transmit/Receive +)
3	A (Transmit/Receive -)
7	Signal Ground

Set up Procedure

After the networking cabling has been connected to the slave, the slave must be configured to communicate. Baud rate, address, and protocol version are selectable. Configuration is performed with the following sequence:

<PROGRAM> <1> is pressed to stop monitoring.

SELECT PROGRAM < >

The keys 3 3 1 are pressed to go to the COM port setup menu.

SET COM PORT

One of the four protocol configurations must be selected.

COM PORT DISABLED

or

COM PROTOCOL VER 1

or

COM PROTOCOL VER 2

or

COM PROT. LONWORKS

Protocol 1 is recommended for compatibility with existing master computers. Protocol 2 provides superior data integrity, but requires a change to the master. LONWORKS requires extra hardware.
The selection is made by pressing <ENTER>.

COM PORT 9600 BAUD

Baud rates of 1200, 2400, 4800, 9600, and 19200 are available. 9600 baud is recommended for most applications. The selection is made by pressing <ENTER>.

SET INST. ADDRESS

INST. ADDRESS 001

Every slave on a network must have a unique address from 1 to 255. If only one slave is present, this value may remain at 1. After entering a unique number, press <ENTER>.

After these steps the COM port setup is complete. Normal operation is restored by pressing <MONITOR>

Protocol Specifics

The protocol has been designed for flexibility and efficiency. This byte-wise protocol communicates information by transferring bytes of data back and forth between master and slave. A group of bytes for each communication is called a packet.

The master and slave(s) transfer information via data packets. These packets will always contain bytes to start communication, an address, a packet length, a command, and a checksum.

Additional optional variable-length data bytes or optional parameters can also be sent or received. This section is a brief overview of the protocol specifics.

Data and Packets

A byte is a piece of data. It is a way to indicate information and is composed of eight bits of information. A bit is the smallest possible piece of information. It can only be two possible values, 1 or 0 (True or False). A byte can have a decimal value from 0 to 255. In hexadecimal representation, a byte's value can range from 0x00 to 0xFF. Hexadecimal representation will be used for the remainder of this manual. The number may be interpreted in a manner other than a number, for example, as a letter.

Using ASCII characters, where 0x41 is the letter A, 0x42 is the letter B, 0x43 is C, and so on, a message can be written as these numbers. Each number is a byte. For example, the word "BAD" is 0x42, 0x41, 0x44.

The collection of the three bytes in our message (0x42, 0x41, 0x44) may be referred to as a packet, since these bytes are always associated with each other.

Just as all words are not the same length (number of letters), packets may also vary in length. One way to denote the size of the word is to put the number of letters you have in the word as the first number in your packet. Your data packet containing the word (or command) "BAD" will then become 0x03, 0x42, 0x41, 0x44.

Checksum (Check Character)

During transmission of the packet, an error could change the value of the data. Suppose in our example, for instance, the packet 0x03, 0x42, 0x41, 0x44 is actually 0x03, 0x42, 0x30, 0x44. How can you determine that the numbers you get are the same as the numbers sent? Using a check-character is a method of assigning a value to the packet to check if any of bytes have been modified.

If all the data bytes are added together and this sum made into a byte, that byte could be called a check character, or more commonly referred to as a checksum. For the CM4 instrument, the checksum is the negated sum of all the bytes in the packet. In our example, the packet is 0x03, 0x42, 0x41, 0x44, 0x36. For this packet, the sum modulo 0x100 of all the bytes added to the checksum must equal zero (0). Any other result indicates there is an error with the data.

The slave's data contained within the packet is interpreted in a somewhat different manner than our example. The data is composed of two sections, a command and one or more parameters. The command indicates what type of information is being transmitted in the packet.
The parameters contain specific arguments or data values to be interpreted. Parameters for most CM4 instrument's packet require at least four bytes for the Date and Time stamps. This information is important to provide a date and time reference for each communication from the instrument. You should ensure that the date and time have been set accurately in each CM4 monitor.

Every packet sent by the CM4 instrument also contains an address, a length, a command and its associated parameters, and a checksum. The CM4 instrument assumes that the master's address is 0 (zero). You assign a unique address to each slave which communicates with the master.

ACK/NAK Handshake

Each slave (CM4) uses a handshake scheme between itself and the master. The simplest response back from the instrument is called an ACK (an abbreviation for ACKnowledge). When the slave receives a command packet from the equipment, it will send back an ACK response if the command is received, but no additional data has been requested in the command.

If however, the checksum does not match, the slave will send a NAK (an abbreviation for Negative AcKnowledge). A NAK indicates that a data packet has been received, but the checksum did not match with the packet data. The master may send the request again. An example of an ACK packet is 0x40, 0x00, 0x05, 0x20, 0x9B (40 + 0 + 5 + 20 + 9B = 0x100).

Protocol Packet Definition

Packet Format

Two similar protocols are supported by CM4 software. The original protocol with a minimum packet length of five bytes is included for compatibility with previous software. Additionally, a new protocol with a minimum packet length of six bytes is included for greater robustness. Examples of packets using both protocols are included at the end of this book.

The format of packets using original version 1 protocol is as follows:

start code	receiver address	length	command	data	checksum

The format of packets using the new version 2 protocol is similar:

start code	receiver address	transmitter address	length	command	data	checksum

Start Code Size: 1 byte. Always 0x40

Receiver Address Size: 1 byte
For responses from slave to master, this is always 0. For inquiries from master to slave, this must match the slave's address as set with menu function 3.3.1.

Transmitter Address Size: 1 byte
For inquiries from master to slave, this is always 0. For responses from slave to master, this will match the slave's address as set with menu function 3.3.1.

Length Size: 1 byte
The length of the total packet from start code to checksum.

Command Size: 1 byte
This is 0x28 to 0x69 as defined in the remainder of this book.

Data Size: 0-250 byte(s)
This section varies according to the command chosen and is often empty.

Checksum Size: 1 byte
The two's complement of the sum of all the previous bytes in the packet. This makes the sum of the entire packet a multiple of 0x100.

Generic Data Formats

Date Format

2 bytes

- Year: (7 bits)
- Month: (4 bits)
- Day: (5 bits)

Year is based from 1980. 1989 would be 89 - 80 = 9.

Time Format

2 bytes

- Hours: (5 bits)
- Minutes: (6 bits)
- Seconds/2: (5 bits)

Date/Time Examples:

Date: 1F 56 Oct. 22. 1995
Date: 1F 75 Nov. 21, 1995

Time: 13 C0 02:30:00
Time: 74 23 14:33:06
Time: 4C 09 09:32:18

Concentration Data Format Code

U0XXXYYY

U = 0 concentration of PPB
1 concentration of PPM
0 = future use
XXX = future use
YYY = used for PPB/PPM (bit 7), and indicates where the decimal place is located:

- 000 = no decimal places
- 001 = 1 decimal place
- 010 = 2 decimal places
- 011 = 3 decimal places

For example, (HEX) 82 (1000 0010) represents PPM with 2 decimal places.

For a concentration value of 317:

Format Code	Interpretation
0000 0010 (02)	3.17 PPB
1000 0010 (82)	3.17 PPM
0000 0000 (00)	317 PPB

Generic Responses

The CM4 monitor will return generic responses to the equipment if there is not a specific response defined, or if there is a problem in the communication transactions. There are four generic responses. Each of these response packets are 5 bytes, and contain only the start byte, address, length command code, and checksum.

ACK - 0x20	This is used for an acknowledgement of a command.
NAK - 0x21	This is used for a negative acknowledgement of command. The last received command had an incorrect checksum.
Bad CMD - 0x66	This is sent to the master when the command is expected or is not appropriate for the current state.
Unknown CMD -	This response is sent by the slave when a 0x67 command is not recognized.

Protocol Command Definition

Status and Query Commands

These commands indicate the function and expected response format for each command. Command numbers are in hexadecimal. If a specific response is required, the response packet will have the same command code as the command packet sent to the slave. If no specific response packet is specified, a general ACK response is sent to acknowledge the command.

NOP - 0x28

This is used to test for communication between the master and the specified slave.

Command packet to instrument:
- Command Code (0x28) - 1 byte

Get System Information 0x30

This packet requests information about the slave system only and the software version currently in use.

Command packet to instrument:
- Command Code (0x30) - 1 byte

Response packet from instrument:
- Command Code (0x30) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Serial # - 2 bytes, product code 851 is assumed.
- Software Rev.
  - Major - 1 byte
  - Minor - 1 byte
  - VIP - 2 bytes - 0xFFFF as default
- Prom Check Sums
  - MSB PROM - 2 bytes
  - LSB PROM - 2 bytes
- Status - 1 byte
  - 0x00 Read verified
  - 0xff Error in reading

Software Rev. Examples (Major/Minor/VIP):
- 01/07/FFFF - Rev. 1.07
- 03/0C/FFFF - Rev. 3.12
- 03/0C/0066 - Rev. 3.12-102
- 04/12/017A - Rev 4.18-378

Get Unit Status
0x31

This command requests the current condition or status of the slave. This command allows the master to inquire about the general operating condition of the system.

Command packet to instrument:
- Command Code (0x31) - 1 byte

Response packet from instrument:
- Command Code (0x31) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- General Status - 2 bytes
  - bit 0: Current Operating mode
    - 0 = Not monitoring
    - 1 = Monitoring
  - bit 1: Keyboard Lockout state
    - 0 = Disabled
    - 1 = Enabled
  - bit 2: Key pad status
    - 0 = unlock
    - 1 = locked
  - bit 3: Chemcassette counter status
    - 0 = Counter disabled
    - 1 = Counter enabled
  - bit 4: 2mA Fault operation
    - 0 = Feature disabled
    - 1 = Feature enabled
  - bit 5: Point Lock-ON
    - 0 = No Lock-ON
    - 1 = Lock-ON
  - bits 6-7: Point Locked (Ignore if bit 5 is 0.)
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
  - bit 8: Date Format
    - 0 = MM/DD/YY
    - 1 = DD/MM/YY
  - bits 9-12: Points enable when No Lock on
    - 0x01 = Point 1 enabled
    - 0x02 = Point 2 enabled
    - 0x04 = Point 3 enabled
    - 0x08 = Point 4 enabled

(continued)

(Get Unit Status 0x31, continued)

bit 13: Relay state
0 = De-energized
1 = Energized
bit 14: Relay Latching state
0 = Non-latching
1 = Latching
bit 15: Alarm Simulation state
0 = Unit not in alarm simulation mode
1 = Unit in alarm simulation mode

New Events - 1 byte
bit 0: The alarm history contains an entry which has not been read via packet 0x36 or 0x47.
1 = a new entry exists
0 = no new entries
bit 1: The fault history contains an entry which has not been read via packet 0x3D
1 = a new entry exists
0 = no new entries
bits 2-7: undefined

Concentration Summary - 1 byte
bits 0-1: concentration summary integer (CSI) for point 1
bits 2-3: CSI for point 2
bits 4-5: CSI for point 3
bits 6-7: CSI for point 4

The CSI expresses the concentration relative to the alarm levels according to the following enumeration:

0 0.0 == concentration
1 0.0 < concentration < AL1
2 AL1 <= concentration < AL2
3 AL2 <= concentration

Chemcassette windows remaining - 2 bytes
Chemcassette days remaining - 2 bytes
Internal Filter 2 bytes (days in use)
External Filter - 2 bytes (days in use)
Flow Rate Point 1 - 2 bytes (cc/Min)
Flow Rate Point 2 - 2 bytes
Flow Rate Point 3 - 2 bytes
Flow Rate Point 4 - 2 bytes

(continued)

(Get Unit Status 0x31, continued)

Optics Cal Status - 1 byte
- bit 0: Optics have been calibrated
  - 0 = Not Tested
  - 1 = Tested
- bits 1-4: Optics test results
  - 0x01 = Passed optics 1
  - 0x02 = Passed optics 2
  - 0x04 = Passed optics 3
  - 0x08 = Passed optics 4
- bits 5-7: Undefined

Maintenance Status
- 0x01 = low flow point 1
- 0x02 = low flow point 2
- 0x04 = low flow point 3
- 0x08 = low flow point 4
- 0x10 = low Chemcassette tape
- 0x20 = Maint. Relay
- 0x40 = Instr. Fault Relay

Get Idle Time 0x32

This command inquires about how long the unit can be left out of analysis before setting an Instrument Fault. Idle time is used to notify operators that the unit is not monitoring. An idle time of 0 disables this option.

Command packet to instrument:
- Command Code (0x32) - 1 byte

Response packet from instrument:
- Command Code (0x32) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Idle Time - 1 byte (0 disabled, 1-45 minutes)
- Status - 1 byte
  - 0x00 = No errors in reading
  - 0xff = Error in reading

Get Date & Time 0x33

This command retrieves the current date and time from the unit.

Command packet to instrument:
- Command Code (0x33) - 1 byte

Response packet from instrument:
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Date and Time READ
  - 0xff = Read problem

Get Maintenance Dates - 0x34

This command queries the maintenance items.

Command packet to instrument:

- Command Code (0x34) - 1 byte

Response packet from instrument:

- Command Code (0x34) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Last Power Down Date - 2 bytes
- Last Power Down Time - 2 bytes
- Last Power Up Date - 2 bytes
- Last Power Up Time - 2 bytes
- Flow Balance Date - 2 bytes
- Flow Balance Time - 2 bytes
- Optics Calibration Date - 2 bytes
- Optics Calibration Time - 2 bytes
- Date Chemcassette Replaced - 2 bytes
- Time Chemcassette Replaced - 2 bytes
- Date Int. Filter Replaced - 2 bytes
- Date Ext. Filter Replaced - 2 bytes
- Status - 1 byte
  - 0x00 = No errors
  - 0xFF = Error

Get Point Configuration 0x35

This command queries an individual point for its current configuration.

Command packet to instrument:
- Command Code (0x35) - 1 byte
- Point Flag - 1 byte
  - bits 0-1: Point Number
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
  - bits 2-7: Undefined

Response packet from instrument:
- Command Code (0x35) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Point Status Flag - 1 byte
  - bit 0: Point Enable/Disable bit
    - 0 = Disabled
    - 1 = Enabled
  - bits 1-2: Point locked status
    - 00 = Normal (No point lock-on)
    - 01 = Lock-on for this point
    - 10 = Lock-on for another point
    - 11 = Undefined
  - bits 3-7: Undefined
- MDA Gas Abbr. - 6 bytes (not null terminated)
- Gas Table number - 1 byte (0 is the first table)
- Format Code - 1 byte
- Alarm Level 1 - 2 bytes
- Alarm Level 2 - 2 bytes
- 20 mA - 2 bytes
- Full Scale - 2 bytes
- Point ID - 20 bytes
- Status - 1 byte
  - 0x00 = Point read
  - 0xff = Error

Get Alarm History 0x36

This command queries the unit for any alarms. The unit saves only the 16 most recent alarms regardless of point. The alarms can all be on one point or there can be alarms from several points.

Command packet to instrument:
- Command Code (0x36) - 1 byte

Response packet from instrument:
- Command Code (0x36) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- # of Alarms - 1 byte
- (alarm data, up to 16 possible)
- CM4 Date of Alarm - 2 bytes
- CM4 Time of Alarm - 2 bytes
- Gas Abbr. 6 bytes
- Point # - 1 byte
  - bits 0-1: Point #
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
  - bits 2-7: Undefined
- Format Code - 1 byte
- Conc. - 2 bytes
- Alarm Level - 1 byte
  - bit 0: Alarm Level
    - 0 = Level 1
    - 1 = Level 2
  - bits 1-5: Undefined
  - bit 6: Previously Read
    - 0 = new (not previously read)
    - 1 = old (previously read)
  - bit 7: Undefined

Get Current Point Status 0x37

This command queries an individual point for its current status.

Command packet to instrument:

- Command Code (0x37) - 1 byte
- Point # - 1 byte
  - bits 0-1: Point #
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
  - bits 2-7: Undefined

Response Packet from instrument:

- Command Code (0x37) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
  - (If point is Disabled/Invalid/Locked out, fill with zeroes)
- MDA Gas Abbr. - 6 bytes (not null terminated)
- Format Code - 1 byte
- Flow Rate - 2 bytes (current flow)
- TWA Start Date - 2 bytes
- TWA Start Time - 2 bytes
- TWA End Date -2 bytes
- TWA End Time - 2 bytes
- TWA Conc. - 2 bytes
- Last Conc. - 2 bytes (last reported conc.)
- Alarm Status - 1 byte (0 none, 1 or 2 level) (Fill for all conditions)
- Status - 1 byte
  - 0x00 = Data valid
  - 0x01 = Point Disabled (no data filled)
  - 0x02 = Point Locked Out (no data filled)
  - 0x04 = No TWA calculated
  - 0x08 = No concentration available
  - 0x10 = Alarm Simulation mode active
  - 0xff = Invalid data

Get TWA Time 0x38

This command queries the three TWA output time in a 24-hour format. Each of the TWA times are eight hours apart.

Command packet to instrument:
- Command Code (0x38) - 1 byte

Response packet from instrument:
- Command Code (0x38) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- TWA time 1 - 2 bytes
- TWA time 2 - 2 bytes
- TWA time 3 - 2 bytes
- Status - 1 byte
  - 0x00 = Time read
  - 0xff = Error in reading

Get Display Cycle Time 0x39

This command queries for the length (in seconds) that the concentration for each point is displayed while the unit is in the Monitoring mode.

Command packet to instrument:
- Command Code (0x39) - 1 byte

Response packet from instrument:
- Command Code (0x39) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Cycle Time - 1 byte
  (valid 2-10 sec., default 4 sec.)
- Status - 1 byte
  - 0x00 = No error
  - 0xff = Error

Get the Number of Gas Tables Available 0x3A

This command allows you to query the unit for the number of loaded gas tables in the unit.

Command packet to instrument:
- Command Code (0x3A) - 1 byte

Response packet:
- Command Code (0x3A) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- # of Gas Tables - 1 byte (1-255)

Get Printer Setup 0x3B

This command queries the unit for the printer configuration.

Command packet to instrument:
- Command Code (0x3B) - 1 byte

Response packet from instrument:
- Command Code (0x3B) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Setup Status - 1 byte
  - bit 0: Printer port enable/disable
    - 0 = Disable
    - 1 = Enable
  - bits 1-2: Printer report format
    - 00 = Continuous
    - 01 = Summary
    - 10 = Compressed
    - 11 = Invalid
  - bits 3-5: Printer baud rate
    - 000 = 1200
    - 001 = 2400
    - 010 = 4800
    - 011 = 9600
    - 100 = 19200
  - bit 6: Printer hardware handshaking (flow control)
    - 0 = Disabled
    - 1 = Enabled
  - bit 7: Undefined

Get Gas Table Data - 0x3C

This command allows you to view individual gas tables that are contained within the system.

Command packet to instrument:

- Command Code (0x3C) - 1 byte
- Gas to table to retrieve - 1 byte (0-255)

Response packet from instrument:

- Command Code (0x3C) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
  (filled with zeroes if error)
- MDA Gas Abbr. - 6 bytes (not null terminated)
- Full Scale - 2 bytes
- TLV - 2 bytes
- LAL - 2 bytes
- LDL - 2 bytes
- Format Code - 1 byte
- Revision # - 1 byte (1-255) (always filled)
- Status
  - 0x00 = Read OK
  - 0x01 = Invalid Gas # index
  - 0xff = Bad read

Get Fault History - 0x3D

This command will query the unit for the latest fault(s). There can be as many as four and as few as zero faults. General system faults are indicated by bit 0 of the point status byte. If bit 0 is set to 1, bits 1-2 should be ignored. The point status byte is invalid for Fault 17 (Voltage Fail) and Fault 18 (Relay Fail).

Command packet to instrument:

Command Code (0x3D) - 1 byte

Response packet from instrument:

Command Code (0x3D) - 1 byte
CM4 Date - 2 bytes
CM4 Time - 2 bytes
# of faults - 1 byte (0-4 maximum)
(fault data, maximum of four possible)
Date of fault - 2 bytes
Time of fault - 2 bytes
Fault # -1 byte
Point Status -1 byte
bit 0: General fault bit
0 = point specific
1 = general
bits 1-2: Point # where fault occurred (ignored if bit 0 is 1 and for Faults 17 and 18)
00 = Point 1
01 = Point 2
10 = Point 3
11 = Point 4
bits 3-5: Undefined
bit 6: Previously Read
0 = new (not previously read)
1 = old (previously read)
bit 7: Instrument Fault
0 = maintenance fault -- the CM4's ability to monitor is not compromised.
1 = instrument fault -- the CM4's ability to monitor is compromised.

Get K-Factor
0x3E

This command will inquire about K-Factor settings for all points. An individual point is assigned with a K-Factor times 1000 (a K-Factor of 1.000 is sent as 1000). The K-Factor is used to change the sensitivity of a point in the range of 0.200-5.000. This adjustment is made after the calculation of concentration.

Command packet to instrument:

Command Code (0x3E) - 1 byte

Response packet from instrument:

Command Code (0x3E) - 1 byte
CM4 Date: - 2 bytes
CM4 Time - 2 bytes
K-Factor (x 1000) Point 1 - 2 bytes
K-Factor (x 1000) Point 2 - 2 bytes
K-Factor (x 1000) Point 3 - 2 bytes
K-Factor (x 1000) Point 4 - 2 bytes
Status

0x00 = Point read
0xff = Read problem

Get Pyrolyzer Temperatures 0x42

This command returns the temperatures of the four pyrolyzers, in integer degrees Celsius the slave's internal temperature. This is applies to a model CM4-P only and not to an ordinary CM4.

Command Packet to slave:
- Command code (0x42) - 1 byte

Response from slave:
- Command code (0x42) - 1 byte
- CM4 date 2 bytes
- CM4 time 2 bytes
- pyrolyzer temp pt1 - 2 bytes
- pyrolyzer temp pt2 - 2 bytes
- pyrolyzer temp pt3 - 2 bytes
- pyrolyzer temp pt4 - 2 bytes
- Status - 1 byte (always 0x00 as implemented)

Get Pump Limits 0x43

This command returns the user's settings for pump limits.

Command Packet to slave:
- Command code (0x43) - 1 byte

Response from slave:
- Command code (0x43) - 1 byte
- CM4 date 2 bytes
- CM4 time 2 bytes
- High Limit - 2 bytes (defaults to 600)
- Low Limit - 2 bytes (defaults to 400)
- Status - 1 byte (always 0x00 as currently implemented)

Get Filter Life
0x44

This command returns the user's settings for total filter lifetime. Lifetime is set by the user to indicate how often the filters should be changed.
A maintenance fault will be issued when the filters are this old. The valid range is 30 to 365 days.
Zero lifetime means a filter maintenance.

Command Packet to slave:

Command code (0x44) - 1 byte

Response from slave:

Command code (0x44) - 1 byte
CM4 date - 2 bytes
CM4 time - 2 bytes
Internal filter life - 2 bytes
External filter life - 2 bytes
Status - 1 byte (alway

Get Floating Status
0x45

This packet returns general information about the slave. It combines the information of packet 0x37 (Get Point Status) and 0x31 (Get Unit Status). However, it reports the concentration in IEEE floating-point format instead of as a scaled integer. Since it provides information that would otherwise require five interrogations, this should permit faster polling of slaves on a multidrop RS-485 bus.

Command Packet to Slave:
- Command code (0x45) - 1 byte

Response from Slave:
- Command code (0x45) - 1 byte
- CM4 date - 2 bytes
- CM4 time - 2 bytes
- Status - 1 byte
  - 0x01 - in monitor
  - 0x02 - maintenance fault relay activated
  - 0x04 - instrument fault relay activated
  - 0x08 - (1 bit) undefined
  - 0x10 - A new fault has occurred since the last time packet 0x3D (Get Fault History) was requested.
  - 0x20 - A new alarm has occurred since the last time packet 0x36 (Get Alarm History) was requested.
  - 0xC0 - (2 bits) undefined
- (The 7 byte Point Structure repeats 4 times)
  - Concentration - 4 byte floating point Number in PPM
  - Flow - 2 byte integer in CC/min
  - Point status - 1 byte
    - 0x01 - point disabled in configuration
    - 0x02 - point disabled now (It may have become disabled because of a fault.)
    - 0x04 - point locked out
    - 0x08 - low flow
    - 0x30 - (2 bits) concentration summary integer. The meaning of this field is as follows:
      00: 0.0 == Concentration

01: 0.0 < Concentration <AL1
10: AL1 <= Concentration < AL2
11: AL2 <= Concentration

0xC0 - (2 bits) current alarm level
0x45 00: no alarm
01: alarm level 1 active
10: alarm level 2 active

(End of Point Structure)
Total size is 34 bytes

Example

The following example is an illustration of the above packet using serial communication protocol version 2. The address of the slave is 42 (0x2A). Point 1 is in a level 2 alarm, but the gas concentration has decreased below AL2 and AL1 to 42.2 ppb. The other three points are reading zero concentration. The instrument fault relay is activated and point 4 is disabled because of loss of flow. Both the Fault History and the Alarm History have new entries which have not been read yet. Point 3 is configured to be disabled via menu function 3.1. All four flows are near the norm of 180 cc/min except for point 4, which is 139 cc/min.

Master:	40 2A 00 06 45 4B;	inquiry
Slave:	40 00 2A 27 45	23 64 66 DA; header, date/time
	3D;	unit status byte
	3D 2C E2 19 00 BB 90;	point 1 data
	00 00 00 00 00 BD 00;	point 2 data
	00 00 00 00 00 C4 03;	point 3 data
	00 00 00 00 00 8B 0A;	point 4 data
	5E; checksum	

Get One Alarm
0x47

This packet returns the oldest unread entry from the alarm history. It duplicates the functionality of packet 0x36 in a form that some masters may find more convenient. Note that this packet causes an alarm to be marked as read in the same way as packet 36. If no unread entries exist in the history, the response packet will contain zeros in the alarm date field.

Command packet to slave:
- Command Code (0x47) - 1 byte

Response packet from slave
- Command Code (0x47) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Alarm Date - 2 bytes
- Alarm Time - 2 bytes
- Gas abbreviation - 6 bytes (not null terminated)
- Point number - 1 byte
  - bits 0-1 point number
  - bits 2-7 undefined
- Concentration - 4 bytes (in IEEE floating point format)
- Alarm Level - 1 byte
  - bit 0: alarm level
    - 0= level 1
    - 1= level 2
  - bits 1-7: undefined

Configuration and Directive Commands

These are the commands and responses that the CM4 system will support for remote control and configuration.

Set K-Factor
0x50

This command configures the manual K-Factor for a specific point. An individual point is given a K-Factor times 1000. The K-Factor is used to change the sensitivity of a point in the range of 0.200-5.000.

Command packet to instrument:
- Command Code (0x50) - 1 byte
- Point # - 1 byte
  - bit 0-1: Point to set K-Factor
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
  - bits 2-7: Undefined

K-Factor (x 1000) value - 2 bytes (200-5000)

Response packet from instrument:
- Command Code (0x50) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Point configured and verified
  - 0x01 = Factor <0.200
  - 0x02 = Factor >5.000
  - 0xff = Save problem,
    - K-Factor unchanged

Reset Fault or Alarm - 0x51

This command allows a remote reset of any faults or alarm conditions.

Command packet to instrument:

- Command Code (0x51) - 1 byte
- Flag - 1 byte
  - bits 0-4: Reset selection
    - 0x01 = Point 1 alarms
    - 0x02 = Point 2 alarms
    - 0x04 = Point 3 alarms
    - 0x08 = Point 4 alarms
    - 0x10 = Faults

Response packet from instrument:

- Command Code (0x51) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Alarms reset
  - 0xff = Error

Set Key-Code
0x52

This command allows you to reconfigure the keypad lock-out and key code. The keypad can be disabled, preventing unauthorized user intervention by enabling the keypad lockout (bit 0). This configures the keypad and a new key code. The old key code must match the code currently programmed into the CM4 monitor for this command to succeed in changing the code.

Command packet to instrument:

- Command Code (0x51) - 1 byte
- Keypad Status - 1 byte
  - bit 0: Keypad lock-out function
    - 0 = Disable
    - 1 = Enable
  - bits 1-7: Undefined
- Old Key code - 2 bytes (valid 0000-9999)
- New Key code - 2 bytes (valid 0000-9999)

Response packet from instrument:

- Command Code (0x51) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status -1 byte
  - 0x00 = Saved and verified
  - 0x01 = Key code invalid
  - 0xff = Error, not saved

Lock Keyboard 0x53

This command allows you to lock out the keyboard. The keyboard can be disabled, preventing unauthorized user intervention by enabling the keypad lock out and sending a valid key code. This allows only persons with the key code to operate the keypad.

Command packet to instrument:
- Command Code (0x53) - 1 byte
- Keypad Status -1 byte
  - bit 0: Lock or unlock keypad
    - 0 = Unlocked
    - 1 = Locked
  - bits 1-7: Undefined
- Key code - 2 bytes (valid 0000-9999)

Response packet from instrument:
- Command Code (0x53) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status -1 byte
  - 0x00 = Saved and verified
  - 0x01 = Key code invalid
  - 0xff = Error, not saved

Set 2mA Fault Operation - 0x54

This command configures the unit for an output option of 2 milliamperes rather than the default 4 milliamperes.

Command packet to instrument:
- Command Code (0x54) - 1 byte
- Enable/Disable - 1 byte
  - 0 = Featured disabled
  - 1 = Feature enabled

Response packet from instrument:
- Command Code (0x54) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time -2 bytes
- Status - 1 byte
  - 0x00 = Feature programmed
  - 0xff = Error occurred

Start New Cycle 0x55

This command allows you to toggle the unit into and out of the Monitor mode.

Command packet to instrument:
- Command Code (0x55) - 1 byte
- State - 1 byte
  - bit 0: Take/put into analysis
    - 0 = Take out of Monitor mode
    - 1 = Put in Monitor or pull window
  - bits 1-7: Undefined

Response packet from instrument:
- Command Code (0x55) - 1 byte
  - CM4 Date - 2 bytes
  - CM4 Time - 2 bytes
  - Status - 1 byte
    - 0x00 = Request Executed
    - 0xff = Error

Program Chemcassette Counter - 0x56

This command enables/disables the Chemcassette counter. When enabled, the system will provide a fault when there is approximately 24 hours of Chemcassette remaining.

Command packet to instrument:
- Command Code (0x56) - 1 byte
- Enable/disable -1 byte
  - bit 0: Enable/disable the Chemcassette counter
    - 0 = Disable
    - 1 = Enable
  - bits 1-7: Undefined

Response packet from instrument:
- Command Code (0x56) - 1 byte
  - CM4 Date - 2 bytes
  - CM4 Time -2 bytes
  - Return Status - 1 byte
    - 0x00 = Counter is enable/ disable
    - 0x01 = No windows left
    - 0x02 = Maintenance status exists (Low Chemcassette)
    - 0xff = Error in programming counter

Set Printer Configuration 0x57

This command configures the printer for output.

Command packet to instrument:

- Command Code (0x57) - 1 byte
- Setup Status - 1 byte
  - bit 0: Printer port enable/disable
  - bits 1-2: Printer Report format
    - 00 = Continuous (prints all conc. for each pt)
    - 01 = Summary (prints alarms, faults, and TWA only)
    - 10 = Compressed (prints conc. At or above LDL)
    - 11 = Invalid
  - bits 3-5: Printer baud rate
    - 000 = 1200
    - 001 = 2400
    - 010 = 4800
    - 011 = 9600
    - 100 = 19200
  - bit 6: printer hardware handshaking (flow control)
    - 0 = Disabled
    - 1 = Enabled
  - bit 7: Undefined

Response packet from instrument:

- Command Code (0x57) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status Flag - 1 byte
  - 0x00 = Printer programmed
  - 0x01 = Invalid report format
  - 0xff = Printer programming error

Set Point Enable/Disable 0x58

This command enables or disables points on the CM4 monitor.

Command packet to instrument:

- Command Code (0x58) - 1 byte
- Point enable mask - 1 byte
  - bits 0-3: Point selection
    - 0x01 = Point 1 enabled
    - 0x02 = Point 2 enabled
    - 0x04 = Point 3 enabled
    - 0x08 = point 4 enabled
  - bits 4-7: Undefined

Response packet from instrument:

- Command Code (0x58) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Point enable updated and verified
  - 0xff = Error, not saved

Set Point Configuration 0x59

This command configures an individual point. The point can be configured even if it is disabled.

Command packet to instrument:

- Command Code (0x59) - 1 byte
- Point to be configured - 1 byte
  - bits 0-1: Point #
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4
- Gas Table # - 1 byte (0 = first table)
- Alarm Level 1 - 2 bytes
- Alarm Level 2 - 2 bytes
- 20 mA Full Scale - 2 bytes
- Point ID - 20 bytes

Response packet from instrument:

- Command Code (0x59) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Point configured and verified
  - 0x01 = Gas error
  - 0x02 = Alarm 1 Error (L1 < LAL or L1 > FS)
  - 0x04 = Alarm 2 Error (L2 < L1 or L2 > FS)
  - 0x08 = 20 mA Error (< LAL or > FS)
  - 0xff = Save problem

Set TWA Time 0x5A

This command configures the TWA time output. You need to enter only the initial TWA output time. The other two time factors are calculated automatically.

Command packet to instrument:
- Command Code (0x5A) - 1 byte
- TWA Time - 2 bytes

Command Code (0x5A) - 1 byte
- CM4 Date -2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Value saved and verified
  - 0x01 = Hours Invalid
  - 0x02 = Minutes Invalid
  - 0xff = Not saved

Set Display Cycle Time 0x5B

This command configures the length in seconds that the concentration for each point is displayed while in the Monitor mode.

Command packet to instrument:
- Command Code (0x5B) - 1 byte
- Cycle time - 1 byte (valid 2-10 seconds)

Response packet from instrument:
- Command Code (0x5B) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Value saved and verified
  - 0x01 = Value < 2 seconds
  - 0x02 = Value > 10 seconds
  - 0xff = Not saved

Set Idle Time 0x5C

This command configures how long the unit can be left out of analysis before setting an Instrument fault. Idle time allows you to exit the Monitoring mode without causing an Instrument fault (if the idle time is > 0). You simply set the idle time to an appropriate idle (non-monitoring) time. If the idle time has expired and the unit is not in the Monitoring mode, an instrument fault will be issued. An idle time setting of 0 disables this option.

Command packet to instrument:

- Command Code (0x5C) - 1 byte
- Idle Time - 1 byte (0 disabled, 1-45 minutes)

Response packet from instrument:

- Command Code (0x5C) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Value saved and verified
  - 0x01 = Value > 45
  - 0xff = Not saved

Set Date Format 0x5D

This command changes the current date format on the display and printer outputs only. It does not change the date format for communication.

Command packet to instrument:

- Command Code (0x5D) - 1 byte
- Format Flag - 1 byte
  - bit 0: Date format
    - 0 = MM/DD/YY
    - 1 = DD/MM/YY

Response packet from instrument:

- Command Code (0x5D) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Format changed
  - 0xff = Error

Set Date and Time 0x5E

This command allows you to configure the unit to a new time and date. Use this feature to synchronize the time and date between the remote equipment and multiple CM4 monitors.

Command packet to instrument:

- Command Code (0x5E) - 1 byte
- New Date - 2 bytes
- New Time - 2 bytes

Response packet from instrument:

- Command Code (0x5E) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Date and time configured and verified
  - 0x01 = Month bad
  - 0x02 = Day bad
  - 0x04 = Year bad
  - 0x10 = Hour bad
  - 0x20 = Minutes bad
  - 0x40 = Seconds bad
  - 0xff = save problem

Set Relay State
0x5F

This command allows you to configure the relay states. The relays are normally de-energized, and can be configured to operate in the energized fail-safe condition. When the relays are latched, they are cleared by operator intervention. Non-latching relays are cleared automatically once the concentration decreases below the alarm level threshold, or the fault is corrected without operator intervention.

Command packet to instrument:

- Command Code (0x5F) - 1 byte
- Relay Flags - 1 byte
  - bit 0: Relay state
    - 0 = De-energized
    - 1 = Energized
  - bit 1: Relay latching state
    - 0 = Non-latching
    - 1 = Latching
  - bits 2-7: Undefined

Response packet from instrument:

- Command Code (0x5F) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = relays state set
  - 0xff = Error, relays state not changed

End Point Lock-on - 0x60

This command unlocks the unit from a single point lock-on to all other points that are enabled. When this command is issued, a new TWA start for all points.

Command packet to instrument:
- Command Code (0x60) - 1 byte

Response packet from instrument:
- Command Code (0x60) - 1 byte
- CM4 Date: - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Points unlocked
  - 0xff = Error

Start Point Lock-on - 0x61

This command locks the unit to one specific point. When this command is issued, all other points are disabled and locked-on point continues to monitor for concentration and TWA.

Command packet to instrument:
- Command Code (0x61) - 1 byte
- Point Lock - 1 byte
  - bits 0-1: point to lock on
    - 00 = Point 1
    - 01 = Point 2
    - 10 = Point 3
    - 11 = Point 4

Response packet from instrument:
- Command Code (0x61) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Point locked
  - 0x01 = Selected point not enabled
  - 0xff = Error

Save Current Configuration 0x62

This command saves a backup copy of the current configuration to nonvolatile memory in the CM4 monitor. This configuration can be restored using the Restore Configuration command.

Command packet to instrument:
- Command Code (0x62) - 1 byte

Response packet from instrument:
- Command Code (0x62) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Configuration saved
  - 0xff = Error

Restore Configuration 0x63

This command restores a configuration that was previously saved to nonvolatile memory in the CM4 monitor.

Command packet to instrument:
- Command Code (0x63) - 1 byte

Response packet from instrument:
- Command Code (0x63) - 1 byte
- CM4 Date - 2 bytes
- CM4 Time - 2 bytes
- Status - 1 byte
  - 0x00 = Configuration restored
  - 0xff = Error, configuration unchanged

Set Duty Cycle
0x65

This command allows a master to set the minimum window time and the monitor relay response bits on a slave. Please see packet 0x69, GetDutyCycle for a discussion of these parameters.

Command packet to slave:

- Command code (0x65) - 1 byte
- Bits permitting monitor relay action during duty cycle - 1 byte
  - bit 0 point1
  - bit 1 point2
  - bit 2 point3
  - bit 3 point4
  - bits 4-7 unused (ignored by slave)
  - Minimum window time (seconds) - 2 bytes

Response from slave:

- Command code (0x65) - byte
- CM4 date 2 bytes
- CM4 time 2 bytes
- Status - 1 byte
  - 0x00 packet accepted
  - 0x01 time > 900 seconds, unacceptable
  - 0x02 time < 0 seconds, unacceptable
  - 0xFF slave in monitor, unable to accept changes

Set Filter
0x66

This command allows a master to set the lifetime of a filter. See packet 44 for a discussion of these parameters. The valid range of lifetimes is 30 to 365 days. The system maintains the number of days remaining as a constant if the lifetime changes.

Command packet to instrument:

- Command code (0x66) - 1 byte
- Internal filter lifetime (days) - 2 bytes
- External filter lifetimes (days) - 2 bytes

Response from instrument:

- Command code (0x66) - 1 byte
- CM4 date - 2 bytes
- CM4 time - 2 bytes
- Status - 1 byte
  - 0x00 = packet accepted
  - 0x01 = internal filter lifetime unacceptable
  - 0x02 = external filter lifetime unacceptable
  - 0xFF = slave in monitor, unable to accept changes

Get Duty Cycle
0x69

This command allows the master to find out the minimum window time and the monitor relay action during duty cycle bits on a slave. The minimum window time (or duty cycle) defaults to zero seconds. But it may be set larger to conserve tape in installations that have some concentration of gas for long periods of time. The tape will not advance until the minimum window time has accumulated even if the tape is saturated. During periods when the tape is saturated but prevented from advancing, the CM4 will continue to report the most recent concentration reading. Unfortunately it will not be able to detect any changes in concentration during this period because the tape is saturated.

By default, the monitor relay (RY6) will energize when monitoring is temporarily suspended because of tape saturation. However this reaction can be inhibited for individual points.
The “monitor relay action during duty cycle” bits default to TRUE but can be set to FALSE via either the keypad or serial packet 0x65, Set Duty Cycle.

Command Packet to slave:
- Command code (0x69) - 1 byte

Response from slave:
- Command code (0x69) - 1 byte
- CM4 date 2 bytes
- CM4 time 2 bytes
- Bits permitting monitor relay action during Duty cycle - 1 byte
  - bit 0 point1
  - bit 1 point2
  - bit 2 point3
  - bit 3 point4
  - bits 4-7 unused (always 0)
- Minimum window time (seconds) - 2 bytes
- Status - 1 byte (always 0x00)

Operation

CM4 Instrument Power-up

Upon power-up, the CM4 instrument conducts a self-diagnostic procedure to check its memory, hardware, and voltages. After the selfdiagnostics, the instrument automatically begins monitoring, and the COM port (if enabled) is activated.

Commands

Your CM4 instrument will accept and process commands sent to it from your equipment.

Responses

The CM4 instrument will send a return communication for any message it receives at its address. Included in most response packets from the CM4 instrument are date and time stamps.

Example Packets

The following section contains examples of packets from a master to a slave and the slave's responses. Protocol version 2 is used. The address of the slave is 1. All numbers are in hexadecimal.

Master	:	40 01 00 06 28 91
Slave	:	40 00 01 06 20 99
Master	:	40 01 00 06 31 88
Slave	:	40 00 01 20 31 24 A6 47 31 5E C1 02 00 00 00 00 00 FF FF FF FF 00 B9 00 A5 00 A4 00 CD 00 00 40
Master	:	40 01 00 06 35 84
Slave	:	40 00 01 30 35 24 A6 47 33 01 4E 48 33 2D 49 49 00 81 00 FA 01 F4 02 EE 02 EE 50 54 31 2D 43 4D 34 2D 38 35 31 2D 30 30 30 36 20 20 20 20 00 39
Master	:	40 01 00 06 37 82
Slave	:	40 00 01 21 37 24 A6 47 35 4E 48 33 2D 49 49 81 00 B9 24 A6 47 10 24 A6 47 35 00 00 00 00 00 00 F8
Master	:	40 01 00 06 3C 7D
Slave	:	40 00 01 1B 3C 24 A6 47 39 4E 48 33 2D 49 49 02 EE 00 FA 00 1E 00 1E 81 04 00 EB
Master	:	40 01 00 06 3D 7C
Slave	:	40 00 01 1D 3D 24 A6 47 3A 03 24 A6 46 E2 09 81 24 A6 46 CF 09 81 24 A5 81 17 09 81 47
Master	:	40 01 00 06 45 74
Slave	:	40 00 01 27 45 24 A6 47 45 09 00 00 00 00 00 BA 00 00 00 00 00 00 A6 00 00 00 00 00 00 A3 00 00 00 00 00 00 CC 00 25
Master	:	40 01 00 09 50 00 03 E8 7B
Slave	:	40 00 01 0B 50 24 A6 47 6A 00 E9
Master	:	40 01 00 07 51 1F 48
Slave	:	40 00 01 0B 51 24 A6 47 50 00 02
Master	:	40 01 00 07 55 00 63
Slave	:	40 00 01 0B 55 24 A6 47 60 00 EE
Master	:	40 01 00 22 59 00 00 00 FA 01 F4 02 EE 50 4F 49 4E 54 5F 49 44 5F 53 54 52 49 4E 47 5F 00 00 00 00 5A
Slave	:	40 00 01 0B 59 24 A6 48 30 00 19

(continued)

Example Packets (continued)

The following section contains examples of packets from a master to a slave and the slave's responses. Protocol version 1 is used.

Master : 40 01 05 28 92
Slave : 40 00 05 20 9B

Master : 40 01 05 30 8A
Slave : 40 00 14 30 22 A6 43 C8 00 06 02 05 FF FF 37 AB 71 A5 00 A6

Master : 40 01 05 31 89
Slave : 40 00 1F 31 22 A6 43 CB 5E CA FF FF 0C 1C 00 20 00 2A 00 2A 00 00 00 00 00 00 00 00 1F 00 B9

Master : 40 01 05 32 88
Slave : 40 00 0B 32 22 A6 43 FA 2D 00 51

Master : 40 01 05 33 87
Slave : 40 00 0A 33 22 A6 43 E9 00 8F

Master : 40 01 05 34 86
Slave : 40 00 22 34 22 A6 43 D8 22 A5 6A 7B 22 A5 6A 7D 22 A6 41 78 22 A6 41 89 22 A6 41 4E 22 A6 22 A6 00 33

Master : 40 01 06 35 00 84
Slave : 40 00 2F 35 22 A6 43 FD 01 4E 48 33 2D 49 49 00 81 00 FA 01 F4 02 EE 02 EE 50 54 31 2D 43 4D 34 2D 38 35 31 2D 30 30 30 36 20 20 20 20 00 77

Master : 40 01 05 36 84
Slave : 40 00 64 36 22 A6 43 E0 06 22 A5 6A E8 4E 48 33 2D 49 49 03 81 02 EE 01 22 A5 6A CA 4E 48 33 2D 49 49 03 81 02 EE 01 22 A5 6A 06 4E 48 33 2D 49 49 02 81 02 EE 01 22 A5 6A 06 4E 48 33 2D 49 49 01 81 02 EE 01 22 A5 69 F2 4E 48 33 2D 49 49 02 81 02 EE 01 22 A5 69 F2 4E 48 33 2D 49 49 01 81 02 EE 01 87

Master : 40 01 06 37 00 82
Slave : 40 00 20 37 22 A6 43 E5 4E 48 33 2D 49 49 81 00 00 22 A6 00 F9 22 A6 41 06 00 00 00 00 00 00 A0

Master : 40 01 05 38 82
Slave : 40 00 10 38 22 A6 44 03 00 00 40 00 80 00 00 A9

(continued)

Example Packets (continued)

Master	:	40 01 05 39 81
Slave	:	40 00 0B 39 22 A6 44 06 04 00 66
Master	:	40 01 05 3B 7F
Slave	:	40 00 0A 3B 22 A6 44 09 1D 49
Master	:	40 01 05 3D 7D
Slave	:	40 00 22 3D 22 A6 43 ED 04 22 A5 6A 9D 1B 02 22 A5 69 DD 05 01 22 A5 69 BC 05 01 22 A5 69 B1 05 01 8E
Master	:	40 01 05 3E 7C
Slave	:	40 00 12 3E 22 A6 44 0C 03 E8 03 E8 03 E8 03 E8 00 AC
Master	:	40 01 05 43 77
Slave	:	40 00 0E 43 22 A6 43 F1 01 F4 01 90 00 ED
Master	:	40 01 05 44 76
Slave	:	40 00 0E 44 22 A6 43 F4 00 2A 00 2A 00 1B
Master	:	40 01 08 50 00 04 57 0C
Slave	:	40 00 0A 50 22 A6 44 85 00 D5
Master	:	40 01 06 51 1F 49
Slave	:	40 00 0A 51 22 A6 44 17 00 42
Master	:	40 01 0A 52 01 04 57 00 00 07
Slave	:	40 00 0A 52 22 A6 44 8E 00 CA
Master	:	40 01 08 53 00 04 57 09
Slave	:	40 00 0A 53 22 A6 44 20 00 37
Master	:	40 01 06 54 01 64
Slave	:	40 00 0A 54 22 A6 44 93 00 C3
Master	:	40 01 06 55 01 63
Slave	:	40 00 0A 55 22 A6 44 25 00 30
Master	:	40 01 06 56 01 62
Slave	:	40 00 0A 56 22 A6 44 97 00 BD

(continued)

Example Packets (continued)

Master	:	40 01 06 57 1B 47
Slave	:	40 00 0A 57 22 A6 44 A1 00 B2
Master	:	40 01 06 58 0D 54
Slave	:	40 00 0A 58 22 A6 44 A7 00 AB
Master	:	40 01 07 5A 09 60 F5
Slave	:	40 00 0A 5A 22 A6 44 AD 00 A3
Master	:	40 01 06 5B 02 5C
Slave	:	40 00 0A 5B 22 A6 44 B1 00 9E
Master	:	40 01 06 5C 2C 31
Slave	:	40 00 0A 5C 22 A6 44 B8 00 96
Master	:	40 01 06 5D 00 5C
Slave	:	40 00 0A 5D 22 A6 44 BC 00 91
Master	:	40 01 09 5E 22 A6 44 67 E5
Slave	:	40 00 0A 5E 22 A6 44 35 00 17
Master	:	40 01 06 5F 02 58
Slave	:	40 00 0A 5F 22 A6 44 C4 00 87
Master	:	40 01 05 60 5A
Slave	:	40 00 0A 60 22 A6 44 76 00 D4
Master	:	40 01 06 61 00 58
Slave	:	40 00 0A 61 22 A6 44 72 00 D7
Master	:	40 01 08 65 0F 00 64 DF
Slave	:	40 00 0A 65 22 A6 44 CB 00 7A
Master	:	40 01 05 69 51
Slave	:	40 00 0D 69 22 A6 44 11 0F 00 00 00 1E

(continued)

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