Model IR4000M

HART Field Device Specification
Multi-Point Monitor

Instruction Manual **07-08**

MANIR4000MH

Part No. **MANIR4000MH**
Revision **A/07-08**

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1.0 Introduction

1.1 Scope

The IR4000 Monitor System detector complies with HART Protocol Revision 6.0. This document specifies all of the device specific features and documents HART Protocol implementation details. The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

1.2 Purpose

This specification is designed to complement the IR4000 Instruction Manual by providing a complete description of this field device from a HART Communications perspective. This specification is designed to be a technical reference for HART capable host application developers, system integrators, and knowledgeable end users.

1.3 References

DOCUMENT NAME	DOCUMENT RELATIONSHIP
HART Communications Protocol Specifications	This is used to insure compliance with the HART Communication Protocol.
IR4000 Instruction Manual	This is the General Monitors, Inc. IR4000 Product Instruction Manual.

2.0 Device Identification

The following Table 1 is the Field Device Identification Data for the instrument.

Manufacturer's Name	**General Monitors, Inc.**	**Model Number**	**IR4000**
HART ID Code	**223 (DF Hex)**	**Device Type Code:**	**132 (84 Hex)**
HART Protocol Revision	**6.0**	**Device Revision:**	**1**
Number of Device Variables	**0**		
Physical Layers Supported	**1**		
Physical Device Category	**FSK**		

Table 1: Field Device Identification Data

3.0 Product Overview

The IR4000 is a Monitor System from General Monitors. The IR4000 can connect to up to 8 IR400 units which accurately measure combustible gas concentration as a percent of the Lower Explosive Limit (%LEL). The IR4000 displays the LEL and the unit ID of the unit which is reporting the highest LEL measurement.

4.0 Product Interfaces

4.1 Process Interface

This section describes all interfaces between the devices and the measured process.

4.1.1 Sensor Input Channels

4.2 Host Interface

The HART interface uses the 4 – 20mA current loop. Refer to the Installation Manual for connection details.

4.2.1 Analog Output: Percent of Lower Explosive Limit (LEL)

The primary variable is proportional to the percent lower explosive limit. 4.0mA output current corresponds to zero LEL. 20.0mA output current corresponds to 100% LEL.

4.3 Local Interfaces, Jumpers, and Switches

Refer to the Installation Manual for connection details.

4.3.1 Local Controls And Displays

Local controls and displays are described in the IR4000 User Manual

4.3.2 Internal Jumpers And Switches

There are no internal jumpers or switches in the IR4000 unit.

5.0 Device Variables

There are no device variables exposed to the user.

6.0 Dynamic Variables

There are two Dynamic Variables exposed to the user.

6.1 Primary Variable = Percent of Lower Explosive Limit

The primary variable is proportional to the percent lower explosive limit. 4.0mA output current corresponds to zero LEL. 20.0mA output current corresponds to 100% LEL.

6.2 Secondary Variable = Channel Reporting the Highest value LEL or Fault

The secondary variable is proportional to the reporting channel. 6.0mA output current corresponds to channel 1; 8.0mA to channel 2… 20.0mA output current corresponds to channel 8. Table 2 shows the current output corresponding to the channel.

Output mA	Reporting Head LEL/Fault
6.0	1
8.0	2
10.0	3
12.0	4
14.0	5
16.0	6
18.0	7
20.0	8

Table 2: Channel Reporting Output Level

6.3 Tertiary and Quaternary Variables: Not Applicable

There are none defined for the IR4000 product.

7.0 Status Information

The head error status, which is returned via bytes 0 and 1 of Common Practice Command #48, is shown in Table 3.

Byte	Bit	Description	Class	Device Status Bits Set
LSB	0	IR Close to Low	Error	4,7
	1	Negative Drift	Error	4,7
	2	IR is Low	Error	4,7
	3	IR is High	Error	4,7
	4	Brown Wire Short	Error	4,7
	5	Low Line Voltage	Error	4,7
	6	Failed to Calibrate	Error	4,7
	7	Failed to Zero	Error	4,7
MSB	0	Gas Check Timeout	Error	4,7
	1	Active Lamp Fault	Error	4,7
	2	Reference Lamp Fault	Error	4,7
	3	Heater Failure	Error	4,7
	4	FLASH Checksum Error	Error	4,7
	5	RAM Checksum Error	Error	4,7
	6	Excess Negative Drift	Error	4,7
	7	EEPROM Checksum Error	Error	4,7

Table 3: Head Error Status Information

These bits may be set at power up to indicate an instrument failure. They may also be set by a failure detected during continuous background diagnostic testing.

The base error status, which is returned via bytes 2 and 3 of Common Practice Command #48, is shown in Table 4.

Byte	Bit	Description	Class	Device Status Bits Set
LSB	0	RAM Problem	Error	4,7
	1	NVM Problem	Error	4,7
	2	ROM Problem	Error	4,7
	3	Low Line	Error	4,7
	4	Fail Cal I/O	Error	4,7
	5	unused	Error	4,7
	6	Head Critical Fault	Error	4,7
	7	Head Non-Critical Fault	Error	4,7
MSB	0	Comm Error w/ Head 1	Error	4,7
	1	Comm Error w/ Head 2	Error	4,7
	2	Comm Error w/ Head 3	Error	4,7
	3	Comm Error w/ Head 4	Error	4,7
	4	Comm Error w/ Head 5	Error	4,7
	5	Comm Error w/ Head 6	Error	4,7
	6	Comm Error w/ Head 7	Error	4,7
	7	Comm Error w/ Head 8	Error	4,7

Table 4: Base Error Status Information

8.0 Universal Commands

Command 3 returns the current loop variable, the primary variable, and the secondary variable for a total of 14 bytes returned. Command 9 returns the PV and the SV only.

9.0 Common Practice Commands

The following common practice commands are implemented.

9.1 Supported Commands

The following common-practice commands shown in Table 5 are implemented:

Command Number	Byte Number	Meaning
Command 38	N/A	Reset Configuration Changed Flag.
Command 48	0	Returns Head Priority Error Status, High Byte.
Command 48	1	Returns Head Priority Error Status, Low Byte.
Command 48	2	Returns Base Error Status High Byte
Command 48	3	Returns Base Error Status Low Byte
Command 48	4	Returns Power Cycled Flag
Command 48	5	Returns Event Happened Flag
Command 48	6	Value = 0: All OK; Bit 0: Maintenance Required; Bit 1: Critical Fault
Command 48	7	Returns 0

Table 5: IR4000 – Supported Common Practice Commands

9.2 Burst Mode

The IR4000 does not support Burst Mode.

9.3 Catch Device Variable

This Field Device does not support Catch Device Variable.

10.0 Device Specific Commands

The Device Specific commands are used strictly for the unique features of the IR4000 and at the discretion of General Monitors. They are described here in section 10.0 and are summarized in Table 6

Command #131: Do Abort

This sends a command to set active head to run mode.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device Specific Command
7 - 127		Undefined

Command #136: Set Alarm Hi Level

This sets the Alarm Hi level. The level must be <= 95% LEL and must be >= Warning LEL level.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Hi level, % of FS

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Hi level, % of FS

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 – 2	N/A	Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received

Code	Class	Description
6 – 127	N/A	Undefined

Command #137: Set Alarm Lo (Warn) Level

This sets the Alarm Lo (Warn) level. This must be >= 5% LEL and must be <= Alarm LEL.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Lo (warn) level, % of FS

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Lo (warn) level, % of FS

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 – 2	N/A	Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6 – 127	N/A	Undefined

Command #139: Reset Alarms

This resets latching alarms.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 127		Undefined

Command #141: Set Relay (Alarm) Configuration

This sets relay or alarm configuration.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Hi Relay La/nL: 0 – nL, 1 - LA
1	Unsigned-8	Alarm Hi Relay En/dE: 0 – dE, 1 - En
2	Unsigned-8	Alarm Lo Relay La/nL: 0 – nL, 1 - LA
3	Unsigned-8	Alarm Lo Relay En/dE: 0 – dE, 1 - En

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Hi Relay La/nL: 0 – nL, 1 - LA
1	Unsigned-8	Alarm Hi Relay En/dE: 0 – dE, 1 - En
2	Unsigned-8	Alarm Lo Relay La/nL: 0 – nL, 1 - LA
3	Unsigned-8	Alarm Lo Relay En/dE: 0 – dE, 1 - En
4	Unsigned-8	0
5	Unsigned-8	0

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #142: Reset Event Happened flag

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command #143: Read Event Logging Counters

Reads the 5 event logging counters.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	Unsigned-16	Warning Event Counter
2 - 3	Unsigned-16	Alarm Event Counter
4 - 5	Unsigned-16	Fault Event Counter
6 - 7	Unsigned-16	Maintenance Event Counter
8 - 9	Unsigned-16	Calibrate Event Counter

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #144: Clear Event Logging Counters

This resets the 5 event logging counters in the active head to zero.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #145: Read Warning Event Log

This reads Warning Event Log as specified by the event log number. Event 0 is the most recent event. Event 1 is the one just before that and so forth.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Event Running Time (in Seconds)
4– 6	Date	Event Date: Day, Month, Year – 1900
7	Unsigned-8	Event Hour
8	Unsigned-8	Event Minute
9	Unsigned-8	Event Second
10,11	Unsigned- 16	Head Number (top % LEL)
12,13	Unisigned-8	Reserved = 0

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #146: Read Alarm Event Log

This reads Alarm Event Log as specified by the event log number. Event 0 is the most recent event. Event 1 is the one just before that and so forth.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Event Running Time (in Seconds)

4– 6	Date	Event Date: Day, Month, Year – 1900
7	Unsigned-8	Event Hour
8	Unsigned-8	Event Minute
9	Unsigned-8	Event Second
10,11	Unsigned- 16	Head Number (top % LEL)
12,13	Unisigned-8	Reserved = 0

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #147: Read Fault Event Log

This reads Fault Event Log as specified by the event log number. Event 0 is the most recent event. Event 1 is the one just before that and so forth.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Event Running Time (in Seconds)
4– 6	Date	Event Date: Day, Month, Year – 1900
7	Unsigned-8	Event Hour
8	Unsigned-8	Event Minute
9	Unsigned-8	Event Second
10-11	Unsigned-16	Head Number (always 0, since only base faults are logged)
12-13	Unsigned-16	Event Cause – See device specific table

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #148: Read Maintenance Event Log

This reads Maintenance Event Log as specified by the event log number. Event 0 is the most recent event. Event 1 is the one just before that and so forth.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Event Log Number
0 - 3	Unsigned-32	Event Running Time (in Seconds)
4– 6	Date	Event Date: Day, Month, Year – 1900
7	Unsigned-8	Event Hour
8	Unsigned-8	Event Minute
9	Unsigned-8	Event Second
10-11	Unsigned-16	Head Number
12-13	Unsigned-16	Code

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #149: Set Clock

This sets the internal real-time clock.

Request Data Bytes

Byte	Format	Description
0 – 2	Date	Date: Day, Month, Year-1900
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Response Data Bytes

Byte	Format	Description
0 – 2	Date	Date: Day, Month, Year-1900
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #150: Read Clock

This reads the internal real-time clock setting.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 – 2	Date	Date: Day, Month, Year-1900
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #151: Set Run Time Meter

This sets the internal run time meter.

Request Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Run Time Meter Value

Response Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Run Time Meter Value

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #152: Read Run Time Meter

This reads the internal run time meter.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 3	Unsigned-32	Run Time Meter Value

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #154: Set Event Index

This sets the index of logged event to read. 0 – latest event

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sets index of logged event to read using commands 143 – 146. Range 0 – 9.

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Event Index

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 2		Undefined
3	Error	Passed Parameter Too Large
4		Undefined

Code	Class	Description
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #155: Read Event Index

This reads event logged index.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned - 8	Event index

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #156: Read Calibration Event Log

This reads Calibration Event Log as specified by the event log number. Event 0 is the most recent event. Event 1 is the one just before that and so forth.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Event Running Time (in Seconds)
4-6	Date	Event Date: Day, Month, Year – 1900
7	Unsigned-8	Event Hour
8	Unsigned-8	Event Minute
9	Unsigned-8	Event Second
10,11	Unsigned-16	Head Number
12,13	Unsigned -16	Code: 1 - Zero, 2 - Calibration

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #163: Read Fast Changing Information

This reads the fast changing information from the active head.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	Unsigned-16	Mode
2 - 3	Unsigned-16	Sub Mode
4 – 7	Float	Analog Output
8 – 9	Unsigned-16	Priority fault
10 – 11	Bit map	Error status
12	Unsigned-8	Alarm status : 0 – off, 1 – on
13	Unsigned-8	Warn status : 0 – off, 1 – on
14	Unsigned-8	Reserved = 0
15	Unsigned-8	Power cycled flag
16	Unsigned-8	Event happened flag
17	Integer-8	% of FS
18-21	Integer-32	Reserved = 0
22	Unsigned-8	Slave Unit Reporting Analog Output (Secondary Variable)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #164: Read Slow Changing Information

Request slow changing information from the active head.

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	signed-16	Temperature
2 - 5	float	Voltage
6 - 7	signed-16	% blockage or gain

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #165: Read Setup Information

Request setup information from the active head.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Gas ID for head; 0 for base
1	Enumerated	Measured Units
2 - 5	Unsigned-32	Full Scale = 100 %
6	Unsigned-8	Alarm Hi level, % of FS
7	Unsigned-8	Alarm Hi Relay La/nL: 0 – nL, 1 - LA
8	Unsigned-8	Alarm Hi Relay En/dE: 0 – dE, 1 - En
9	Unsigned-8	Alarm Lo level, % of FS
10	Unsigned-8	Alarm Lo Relay La/nL: 0 – nL, 1 - LA
11	Unsigned-8	Alarm Lo Relay En/dE: 0 – dE, 1 - En
12	Unsigned-8	Reserved = 0
13	Unsigned-8	Reserved = 0
14	Unsigned-8	Reserved = 0
15	Unsigned-8	Reserved = 0
16	Unsigned-8	Reserved = 0
17	Unsigned-8	Cal IO type (0 – normal, 1 – manual solenoid, 2 – automatic solenoid) for head, 0 for base;
18-19	Unsigned-16	Reserved = 0

Byte	Format	Description
20	Unsigned-8	Online Unit Count
21	Unsigned-8	Vote Count
22	Unsigned-8	Calibration Level = 50
23	Unsigned-8	Reserved = 0
24	Unsigned-8	Current Range

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #170: Set Current Range

This sets the current range to be either one of 2 possible selections.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	0 – Range 3.5mA - 20mA, 1 -- Range 1.25 - 20mA

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	0 – Range 3.5mA - 20mA, 1 -- Range 1.25 - 20mA

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 2		Undefined
3	Error	Passed Parameter Too Large
4		Undefined
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #186: Set Cal IO type

This sets the parameters for the active head. The active head is set by Command #215.

Request Data Bytes

Byte	Format	Description
0	Unsigned 8	0 – zero switch, 1 – manual solenoid, 2 – automatic solenoid

Response Data Bytes

Byte	Format	Description
0	Unsigned 8	0 – zero switch, 1 – manual solenoid, 2 – automatic solenoid

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6		Device specific command error
7 – 127	Error	Undefined

Command #187: Set Solenoid State

This sets the parameters for the active head. The active head is set by Command #215.

Request Data Bytes

Byte	Format	Description
0	Bits	Solenoid State: 1 - off, 2 - on

Response Data Bytes

Byte	Format	Description
0	Bits	Solenoid State: 0 = disabled, 1 - off, 2 - on

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6		Device specific command error
7 - 127		Undefined

Command #188: Read Solenoid State

This sets the parameters for the active head. The active head is set by Command #215.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned -8	Solenoid State: 0 = disabled, 1 - off, 2 - on

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1- 5		Undefined
6	Error	Device specific command error
7 - 127		Undefined

Command #191: Do Zero

This sends a request to the active head to put the unit to Zero mode.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device Specific Command Error
5 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command #193: Do Zero/Calibration

This sends a request to the active unit to set the unit to Zero/Calibration mode.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 2		Undefined
3	Error	Parameter too Large
4	Error	Parameter too Small
5 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command #195: Do Gas Check

This sends a request to the active unit to put the unit to Gas Check mode.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	N/A	N/A

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 2		Undefined
3	Error	Parameter too Large
4	Error	Parameter too Small
5 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command #211: Set Online Unit Count

This tells the base unit how many head units are connected to it. The units are connected with the first one at location #1 and sequentially up to a possible 8 units.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Online unit count must be between 1 and 8.

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Online unit count

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 – 2	N/A	Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6 – 15	N/A	Undefined
16	Error	Access Restricted
17 – 127	N/A	Undefined

Command #212: Set Vote Count

This tells the base unit how many head units comprise the vote count. The number must be <= the number of connected heads.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Vote Count. Must be between 1 and number of online units.

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Vote Count

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 – 2	N/A	Undefined
3	Error	Passed Parameter Too Large

Code	Class	Description
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6 – 15	N/A	Undefined
16	Error	Access Restricted
17 – 127	N/A	Undefined

Command #215: Set Active Head

This sets the active head to one of the unit numbers. The unit numbers 1 – 8 correspond to the attached heads. Unit 0 refers to the base unit.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Active Head

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Active Head

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 2		Undefined
3	Error	Parameter too Large
4		Undefined
5	Error	Too Few Data Bytes Received
6 - 127		Undefined

Command #216: Read Active Head

This reads the active head to one of the unit numbers. The unit numbers 1 – 8 correspond to the attached heads. Unit 0 refers to the base unit.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned 8	Active head

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #217: Read Fast Active Head Parameters

This reads the fast changing information from the active head connected to the IR4000 base unit.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	Unsigned-16	Mode
2 - 3	Unsigned-16	Sub Mode
4 – 7	Float	Analog Output
8 – 9	Unsigned-16	Priority fault
10	Integer-8	%FS
11-12	Unsigned-16	2 ASCII char - display
13-16		Reserved

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #218: Read Slow Active Head Parameters

Request slow changing information from the active head.

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	signed-16	Temperature/not reported yet = 0 - reserved
2 - 5	float	Voltage/ not reported yet = 0 - reserved
6 - 7	signed-16	% blockage or gain

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #219: Read Setup Active Head Parameters

This sets one of the active head's parameters. If active head is 0 (base), "Passed parameters too small" status will be returned.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Gas ID or sensor type
1	Unsigned-8	Measured units - Not reported yet/for now %LEL
2- 5	Unsigned-32	Full Scale – Not reported yet/ for now 100
6	Unsigned-8	Cal IO type: 0 – zero switch, 1 – manual solenoid, 2 – automatic solenoid
7	Unsigned-8	Calibration Level, % of FS: default is 50%
8-11		Reserved

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command #220: Read Active Constant Information

TBD

Command #228: Set Head's Modbus register (For testing only!!!)

This is used for testing to write to modbus register the active head. If active head is 0 (base), "Passed parameters too small" status will be returned

Request Data Bytes

Byte	Format	Description
0	Unsigned- 8	Head's Modbus register number
1,2	Signed-16	Data

Response Data Bytes

Byte	Format	Description
0	Unsigned- 8	Head's Modbus register number
1,2	Signed-16	Data

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

11.0 Tables

11.1 IR4000 – Device Specific Commands Summary

The following Table 6 is a summary of the IR4000 Device Specific Commands. The Reg values in the Meaning Column denote the corresponding MODBUS Register.

Command Number	Byte Number	Meaning
131		Do Abort
132		Alarm Test
136		Set Alarm Hi Level
137		Set Alarm Lo (Warn) Level
139		Reset Alarms
141		Set Relay (Alarm) Configuration
142		Reset Event Happening Flag
143		Read Event Logging Counters
144		Clear Event Logging Counters
145		Read Warning Event Log
146		Read Alarm Event Log
147		Read Fault Event Log
148		Read Maintenance Log
149		Set Clock
150		Read Clock
151		Set Run Time Meter
152		Read Run Time Meter
154		Set Event Index
155		Read Event Index
156		Read Calibration Event Log
160		Set Password Enabled/Disable
161		Read Password Enabled/Disable
162		Set Password
163		Read Fast Changing Information
164		Read Slow Changing Information
165		Read Setup Information
191		Do Zero
192		Do Calibration
193		Do Zero/Calibration
195		Do Gas Check
211		Set Online Unit Count
212		Set Vote Count
215		Set Active Head
216		Read Active Head
217		Read Fast Head Information
218		Read Slow Head Information
219		Read Head Setup Parameters
220		Read Head Constants
228		Write Active Head's Modbus Register

Table 6: IR4000 – Device Specific Commands

11.2 IR4000 – Operating Mode - PV Values

The following Table 7 is a summary of the IR4000 Operating Mode Values:

Operating Mode	Value in Decimal
INVALID HEAD	0
RUNNING	1
CALIBRATION	2
ZEROING	4
ZEROING COMPLETE	12
CALIBRATION	16
CAL COMPLETE	32
STARTUP	64
TEMPERATURE	128
GAS CHECK	512
ZERO & CAL	1026
ZERO & CAL	1028
ZERO & CAL	1042
CAL COMPLETE	1058

Table 7: IR4000 - Operating Mode Values

Operating Sub-Mode	Value in Decimal
<blank>	1
<blank>	2
<blank>	4
CAL PENDING	12
APPLY GAS	16
REMOVE GAS	32
<blank>	64
TEMPERATURE	128
<blank>	512
CALIBRATING	1026
ZEROING	1028
APPLY GAS	1042
REMOVE GAS	1058

Table 8: IR4000 - Operating Sub-Modes

11.3 Fault Event Log – Cause Description

The following Table 9 describes the cause as reported by the read event log commands:

Bits	Cause
0x0000	<none>
0x0001	FAIL RAM
0x0002	FAIL_NVM
0x0004	FAIL_ROM
0x0008	FAIL_LOW_LINE
0x0010	WIRE_SHORTED
0x0020	FAIL_SETUP_MENU
0x0040	FAIL_SLV_CRITICAL
0x0080	FAIL_SLV_NON_CRITICAL
0x0100	FAIL_SLV_COMM1
0x0200	FAIL_SLV_COMM2
0x0400	FAIL_SLV_COMM3
0x0800	FAIL_SLV_COMM4
0x1000	FAIL_SLV_COMM5
0x2000	FAIL_SLV_COMM6
0x4000	FAIL_SLV_COMM7
0x8000	FAIL_SLV_COMM8

Table 9: Fault Event Log – Cause Description

11.4 IR4000 – Secondary Variable to Channel Correspondence

The following Table 10 is a summary of the Channel ID to the Current output for the HART Secondary Variable.

Secondary Variable - Channel ID	Current Output (mA)
0	4.0 mA
1	6.0 mA
2	8.0 mA
3	10.0 mA
4	12.0 mA
5	14.0 mA
6	16.0 mA
7	18.0 mA
8	20.0 mA

Table 10: Channel ID to Current Output Correspondence

12.0 Performance

12.1 Sampling Rates

The IR4000 samples each detector at 1 msec intervals.

12.2 Power-up

On power up, the IR4000 executes a self-test procedure, which requires approximately 15 seconds. During this time, the analog output is set to 3.5mA. After the self-test is satisfactorily completed, the unit sets the PV to a value representing the mode of the instrument.

12.3 Device Reset

The IR4000 cannot be reset by any command. The unit only resets when power is cycled.

12.4 Self-Test

The IR4000 goes through a self-test upon power cycle. Should any of the tests fail, the unit immediately reports a fault condition.

12.5 Command Response Delay

The IR4000 responds as follows:

Response Type	Response Time
Minimum	20 ms
Typical	50 ms
Maximum	100 ms

Table 11: Command Response Times

12.6 Busy and Delayed-Response

The IR4000 does not use delayed-response times.

12.7 Long Messages

The largest data field used by the IR4000 is in response to Command 21: 34 bytes including the two status bytes.

12.8 Non-Volatile Memory

The IR4000 uses EEPROM to hold the device's configuration parameters. New data is written to this memory immediately on execution of a write command.

12.9 Operating Modes

The IR4000 reports percent of lower explosive limit detected. Various other modes are supported related to the calibration of the instrument.

12.10 Write Protection

The IR4000 does not support any write protection mode.

Annex A. Capability Checklist

Manufacturer, model, and revision	General Monitors, Inc., IR4000, Revision 1
Device type	System Monitor
HART revision	6.0
Device Description available	Yes
Number and type of sensors	8 Channel System Monitor
Number and type of actuators	0
Number and type of host side signals	1: 4 - 20mA analog
Number of Device Variables	0
Number of Dynamic Variables	1
Mappable Dynamic Variables?	No
Number of common-practice commands	2
Number of device-specific commands	30
Bits of additional device status	8
Alternative operating modes?	No
Burst mode?	No
Write-protection?	Mfg Only

Table 12: Capability Checklist

Annex B. Default Configuration

Parameter	Default value
Lower Range Value	N/A
Upper Range Value	N/A
PV Units	Percent Lower Explosive Limit
Sensor type	N/A
Number of wires	3
Damping time constant	N/A
Fault-indication jumper	N/A
Write-protect jumper	N/A
Number of response preambles	5

Table 13: Default Configuration