



PrimaX™ IR

HART Specification



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Instruction Manual

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1.0 Introduction

1.1 Scope

The PrimaX IR Gas Detector complies with HART Protocol Revision 7.0. 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 PrimaX IR Gas Detector 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.
PrimaX IR Gas Detector Instruction Manual	This is the MSA PrimaX IR Gas Detector Product Instruction Manual.

2.0 Device Identification

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

Manufacturer's Name	Mine Safety Appliances, Inc. (MSA)	Model Number	PrimaX IR Detector
HART ID Code	224 (E0 Hex)	Device Type Code:	246 (F6 Hex)
HART Protocol Revision	7.0	Device Revision:	1
Number of Device Variables	0		
Physical Layers Supported	1		
Physical Device Category	FSK		

3.0 Product Overview

The PrimaX IR Gas Detector is an intelligent sensor for the detection of various gases and vapors. The microprocessor-based electronics processes information at the sensor site, within an explosion-proof housing. The PrimaX IR Gas Detector accurately measures the desired gas and reports the measurement as percent lower explosive limit (% LEL).

3.1 Getting Started

In order to enable HART communication with the PrimaX IR Gas Detector, users may employ several means including HART handheld communicators or PC-based systems.

Once the detector is installed (see PrimaX IR Instruction Manual) and connected to either a PC host application or a handheld terminal, the master will commonly begin communication to the PrimaX IR Detector by using the HART Command #0 and address 0. If the field device is programmed with address 0 (factory default is 0), the field device will then respond with the unique identifier information associated with Hart command 0.

NOTE: The handheld device allows for the retrieval of diagnostic information and input of device settings as needed and should not be used as a permanent part of a safety system.

4.0 Product Interfaces

4.1 Host Interface

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

4.1.1 Analog Output: PrimaX IR Mode

The primary variable is proportional to the percent lower explosive limit (% LEL). 4.0 mA output current corresponds to 0 % LEL; 20.0 mA output current corresponds to 100 % LEL or 100% of full scale.

4.2 Local Interfaces, Jumpers, and Switches

4.2.1 Local Controls and Displays

Refer to the Installation Manual for connection details.

4.2.2 Internal Jumpers and Switches

Refer to the Installation Manual for connection details.

5.0 Device Variables

There are no device variables exposed to the user.

6.0 Dynamic Variables

There is only one Dynamic Variable exposed to the user.

6.1 Primary Variable = percent lower explosive limit (% LEL)

The primary variable is proportional to the percent lower explosive limit (% LEL). 4.0 mA output current corresponds to 0 % LEL; 20.0 mA output current corresponds to 100 % LEL or 100% of full scale.

6.2 Secondary, Tertiary, and Quaternary Variables: Not Applicable

There are none defined for the PrimaX IR product.

7.0 Status Information

Various device status bits, which are returned via Universal Command #48, are shown below. The remainder of the bytes (bytes 3-24) transmitted in the response are all zero (not implemented).

Byte	Bit	Description	Class	Device Status Bits Set
0	0	Circuit Fault	Fault	4,7
	1	Lamp Fault	Fault	4,7
	2	Optics Heater Failure	Error	4
	3	Sensor Underrange	Fault	4,7
	4	Not Used	N/A	4
	5	Full Obscuration	Error	4
	6	Cal Cap Attached Timeout Fault	Fault	4,7
	7	Not Used	N/A	4
1	0	Zero Calibration in Progress	Status	4
	1	Span Calibration in Progress	Status	4
	2	Zero Calibration Success Status	Status	4
	3	Span Calibration Success Status	Status	4
	4	Not Used	N/A	4
	5	Not Used	N/A	4
	6	Calibration Aborted	N/A	4
	7	Cal Cap Attached	Status	4
2	0	Cal Signal Enabled	Status	4
	1	Cleaning Mode Detected	Error	4
	2	Leg Heater On	Status	4
	3	Lamp 1 Status (1=On; 0=Off)	Status	4
	4	Lamp 2 Status (1=On; 0=Off)	Status	4
	5	Not Used	N/A	4
	6	Not Used	N/A	4
	7	Not Used	N/A	4

These bits may be set at power up to indicate instrument status. They may also be set by a

change detected during continuous background diagnostic testing.

8.0 Universal Commands

Command 3 returns the current loop variable and the primary variable for a total of 9 bytes returned.

9.0 Common Practice Commands

The following common practice commands are implemented.

9.1 Supported Commands

The following common-practice commands shown below are implemented:

Command Number	Meaning
40	Enter/exit fixed current mode
42	Perform device software reset
43	Set primary variable zero – HART Zero Cmd
45	Trim loop current zero
46	Trim loop current gain
59	Write number of response preambles
80	Read device variable trim points – read span value
82	Write device variable trim point – HART Span Cmd

9.2 Burst Mode

The PrimaX IR Detector does not support Burst Mode.

9.3 Catch Device Variable

This PrimaX IR Detector does not support Catch Device Variable.

10.0 Device Specific Commands

The Device Specific commands are used strictly for the unique features of the PrimaX IR Detector and at the discretion of MSA. They are described here in Section 10.0 and are summarized in Section 11, Table 1.

10.1 Command #135: Read Gas Curve

This command reads the Gas Curve selected on the PrimaX IR Detector The User Gas Name is also returned.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned	Gas Curve Number (see Gas Curve Table 11.2)
1-32	ASCII	User Gas Name, Null-terminated ASCII string

Command-Specific Response Codes

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

10.2 Command #141: Read Cal Signal Setting

This command returns the PrimaX IR Cal Signal status. This is a single byte containing a 0 if disabled or 1 if enabled. If enabled, the output during calibration will be set to the programmed Cal Signal Level (default 3.0 mA). If disabled, the output will track the gas concentration.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Enum	Sensor Cal Signal Status (0=disabled, 1=enabled)

Command-Specific Response Codes

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

10.3 Command #145: Read Loop Signal Levels

This command returns the PrimaX IR loop signaling levels as well as the minimum and maximum range for these levels.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Fault level (mA)
4-7	Float	Obscured, Dirty Optics level (mA)
8-11	Float	Startup, Sensor Calibration level (mA)
12-15	Float	Cleaning, Maintenance level (mA)
16-19	Float	Minimum Signal Level (mA)
20-23	Float	Maximum Signal Level (mA)

Command-Specific Response Codes

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

10.4 Command #150: Write User Gas Name

This command writes the PrimaX IR User Gas Name field. When the gas curve is changed (Command 182) the PrimaX IR Detector will change this field to the default gas name for that particular curve. The user may change this field to better identify the gas being measured.

Request Data Bytes

Byte	Format	Description
0-31	ASCII	Null-terminated ASCII string

Response Data Bytes

Byte	Format	Description
0-31	ASCII	Null-terminated ASCII string

Command-Specific Response Codes

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

10.5 Command #177: Set Span Value

This command writes the PrimaX IR Span Value. The Span Value is used when performing a calibration. When a Span calibration is performed, the device automatically sets the steady reading obtained to this Span Value.

Request Data Bytes

Byte	Format	Description
0-3	Float	Span Value (%LEL)

Response Data Bytes

Byte	Format	Description
0-3	Float	Span Value (%LEL)

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

10.6 Command #178: Set Gas Curve

This command writes the PrimaX IR Gas Curve. Valid values are 1-15. The Gas Curve and User Gas Name are returned as confirmation.

Request Data Bytes

Byte	Format	Description
0	Unsigned	Gas Curve Number

Response Data Bytes

Byte	Format	Description
0	Unsigned	Gas Curve Number
1-31	ASCII	User Gas Name, Null-terminated ASCII string

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

10.7 Command #181: Calibration Signal Enable

This command enables/disables the calibration signal on the PrimaX IR Detector. Refer to command #141.

Request Data Bytes

Byte	Format	Description
0	Unsigned	Cal Signal, 1=enable, 0=disable

Response Data Bytes

Byte	Format	Description
0	Unsigned	Cal Signal, 1=enable, 0=disable

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

10.8 Command #182: Start Calibration

This command writes a calibration mode number to the PrimaX IR. The mode number initiates a calibration sequence in the device.

Request Data Bytes

Byte	Format	Description
0	Unsigned	Calibration Mode Number, 0=Zero, 2=Zero & Span

Response Data Bytes

Byte	Format	Description
0	Unsigned	Calibration Mode Number

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

10.9 Command #183: Calibration Abort

This command writes a calibration Abort command to the PrimaX IR Detector. The calibration abort command instructs the device to suspend the calibration sequence initiated by the calibration mode command. Valid number for this command is 1.

Request Data Bytes

Byte	Format	Description
0	Unsigned	Calibration Abort Command Number (= 1)

Response Data Bytes

Byte	Format	Description
0	Unsigned	Calibration Abort Command Number (= 1)

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

10.10 Command #189: Write Loop Signal Levels

This command writes the PrimaX IR *user-programmable* loop signaling levels. All values are specified in mA (2.00, 3.00 etc.) and displayed with 2 decimal points. The valid range of values is 2.00 to 3.50 mA.

Request Data Bytes

Byte	Format	Description
0-3	Float	Fault level (mA)
4-7	Float	Obscured, Dirty Optics level (mA)
8-11	Float	Startup, Sensor Calibration level (mA)
12-15	Float	Cleaning, Maintenance level (mA)

Response Data Bytes

Byte	Format	Description
0-3	Float	Fault level (mA)
4-7	Float	Obscured, Dirty Optics level (mA)
8-11	Float	Startup, Sensor Calibration level (mA)
12-15	Float	Cleaning, Maintenance level (mA)

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	Error	Too few data bytes
6		Undefined
7	Error	In write-protect mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

11.0 Tables

11.1 PrimaX IR-HART – Device Specific Commands Summary

The following table is a summary of the PrimaX IR Detector Device Specific Commands.

Command Number	Byte Number	Meaning
135		Read Gas Curve
141		Read Cal Signal Setting
145		Read Loop Signal Levels
150		Write User Gas Name
177		Set Span Value
178		Set Gas Curve
181		Calibration Signal Enable
182		Start Calibration
183		Calibration Abort
189		Write Loop Signal Levels

Table 1: Device Specific Commands

12.0 Performance

12.1 Sampling Rates

The PrimaX IR Detector samples the sensor in 1 second intervals.

12.2 Power-up

On power up, the PrimaX IR Detector executes a start-up procedure, which requires approximately 10 seconds. During this time, the analog output is set to the value specified by the Calibration Loop Level (default 3.0 mA). After the start-up is completed, the unit updates based on the primary variable.

12.3 Device Reset

The PrimaX IR Detector can be reset by command 42.

12.4 Self-Test

The PrimaX IR Detector performs continuous diagnostics. Should any of the tests fail, the unit reports a fault condition.

12.5 Command Response Delay

The PrimaX IR Detector has the following Command Response Times:

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

12.6 Busy and Delayed-Response

The PrimaX IR Detector does not use delayed-response times.

12.7 Long Messages

The largest data field used by the PrimaX IR Detector is in response to Command 135 (Read Gas Curve): 35 bytes including the two status bytes.

12.8 Non-Volatile Memory

The PrimaX IR Detector 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 PrimaX IR Detector reports percent of lower explosive limit detected while in RUN mode. Various other modes are used to support the calibration of the instrument.

12.10 Write Protection

The PrimaX IR Detector does not support any write protection mode.

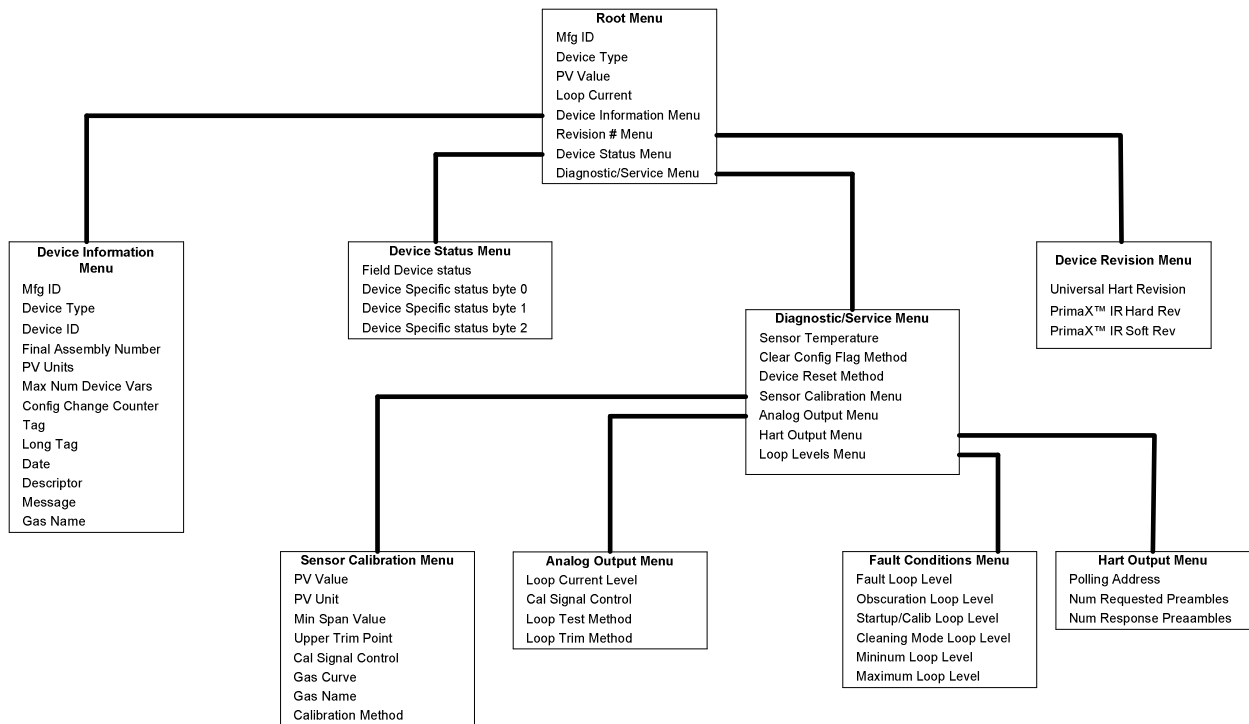
Annex A. Capability Checklist

Manufacturer, model, and revision	MSA PrimaX IR Detector
Device type	IR Gas Detector
HART revision	7.0
Device Description available	Yes
Number and type of sensors	1 IR Sensor
Number and type of actuators	0
Number and type of host side signals	1: 4 – 20 mA analog
Number of Device Variables	0
Number of Dynamic Variables	1
Mapable Dynamic Variables	No
Number of common-practice commands	8
Number of device-specific commands	10
Bits of additional device status	16
Alternative operating modes	No
Burst mode	No
Write-protection	Mfg Only

Annex B. Default Configuration

Parameter	Default value
Lower Range Value	0 % LEL
Upper Range Value	100 % LEL
PV Units	% Lower Explosive limit (LEL)
Sensor type	IR
Number of wires	3
Damping time constant	N/A
Fault-indication jumper	N/A
Write-protect jumper	N/A
Number of response preambles	5

Annex C. Device Descriptor Language Menu





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