GENERAL MONITORS

TS4000H HART

HART Communication Manual

Instruction Manual **05-09**

MANTS4000HH

Part No. **MANTS4000HH**
Revision **B/05-09**

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1.0 Introduction

1.1 Scope

The TS4000H HART toxic gas 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 TS4000H 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.
TS4000H Instruction Manual	This is the General Monitors TS4000H 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	TS4000H
HART ID Code	**223 (DF Hex)**	**Device Type Code:**	**137 (89 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 TS4000H is an intelligent sensor for the detection of toxic gas and vapors. The microprocessor-based electronics processes information at the sensor site, within an explosion-proof housing. The TS4000H accurately measures toxic gas and reports the measurement as a parts per million (ppm) of the gas.

3.1 Getting Started

In order to enable HART communication with the TS4000H detector, users may employ several means including HART handheld communicators or PC-based systems. Using a PC-based software application and a HART interface modem, for example, allow operators to access information from the TS4000H. A typical setup is illustrated in Figure 1.

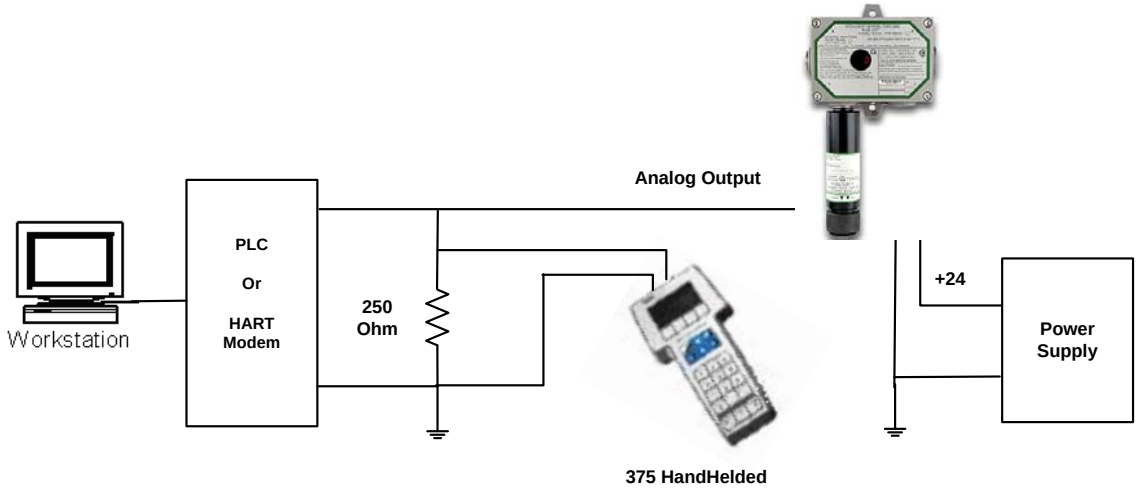

Figure 1: Connecting a PC to a HART device

Once the detector is installed (see TS4000H Instruction Manual) and connected to a PC, host application, or handheld terminal, the master will commonly begin communication to the TS4000H by using the HART Command #0. The field device will then respond only if its tag matches. The data in the reply to Command #11 is identical to that of Command #0, so the master can then construct the Unique Identifier for use with further commands.

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 Process Interface

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

4.1.1 Sensor Input Channels

A digital display provides indications and display codes that can be viewed through a window in the cover. A red LED above the digital display signifies an ALARM condition, while a red LED below the digital display signifies a WARN condition. Analog signal (4-20 mA) and relays provide remote and/or discrete indications of the sensor's operation.

4.2 Host Interface

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

4.2.1 Analog Output: TS4000H Mode

The primary variable is proportional to the part per million. 4.0 mA output current corresponds to 0 ppm. 20.0 mA output current corresponds to 100 ppm or 100% of full scale.

4.3 Local Interfaces, Jumpers, and Switches

4.3.1 Local Controls And Displays

Refer to the Installation Manual for connection details.

4.3.2 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 = Part Per Million

The primary variable is proportional to the part per million 4.0 mA output current corresponds to 0 ppm. 20.0 mA output current corresponds to 100 ppm or 100% of full scale. The device mode is the variable, which corresponds to the Modbus register 0x00.

6.2 Secondary, Tertiary, and Quaternary Variables: Not Applicable

There are none defined for the TS4000H product.

7.0 Status Information

The error status, which is returned via Common Practice Command #48, is shown in Table 2 and corresponds to Modbus register 0x02.

Byte	Bit	Description	Class	Device Status Bits Set
1	0	Switch Error	Error	4,7
	1	Internal error (2.5,15V)	Error	4,7
	2	Not Used	Error	4,7
	3	Not Used	Error	4,7
	4	Not Used	Error	4,7
	5	Fault	Status	4,7
	6	Warning	Status	4,7
	7	Alarm	Status	4,7
0	0	Not Used	N/A	
	1	Low Supply Voltage	Error	4,7
	2	Fail to Calibrate	Error	4,7
	3	Sensor Error	Error	4,7
	4	Flash Error	Error	4,7
	5	EEPROM Error	Error	4,7
	6	Calibration Check Time out	Error	4,7
	7	Set up Error	Error	4,7

Table 2: 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.

8.0 Universal Commands

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

Command Number	Byte Number	Meaning
Command 38	N/A	Reset Configuration Changed Flag
Command 48	0	Returns Priority Fault, High Byte
Command 48	1	Returns Priority Fault, Low Byte
Command 48	2	Returns Error Status (same as Modbus register x02), High Byte
Command 48	3	Returns Error Status (same as Modbus register x02), Low Byte
Command 48	4	Returns Power Cycled Flag
Command 48	5	Returns Event Happened Flag
Command 48	6	Returns 0x01 = “Maintenance Required” or 0x02 = Alarm or Warning
Command 48	7	Returns 0

Table 3: TS4000H – Common Practice Commands

9.2 Burst Mode

The TS4000H does not support Burst Mode.

9.3 Catch Device Variable

This TS4000H does not support Catch Device Variable.

10.0 Device Specific Commands

The Device Specific commands are used strictly for the unique features of the TS4000H and at the discretion of General Monitors. They are described here in Section 10.0 and are summarized in Table 4.

10.1 Command #131: Do Abort

This command aborts calibration or gas check.

Request Data Bytes

Byte	Format	Description
None	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 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

10.2 Command #136: Set Alarm Level

This command sets the Alarm level.

Request Data Bytes

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

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm 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	N/A	Undefined
5	Error	Too Few Data Bytes Received

Code	Class	Description
6 – 15	N/A	Undefined
16	Error	Access Restricted
17 – 127	N/A	Undefined

10.3 Command #137: Set Warn Level

This command sets the Warn level.

Request Data Bytes

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

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm 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	N/A	Undefined
5	Error	Too Few Data Bytes Received
6 – 15	N/A	Undefined
16	Error	Access Restricted
17 – 127	N/A	Undefined

10.4 Command #139: Reset Alarm

This command resets the latching Warn and Alarm relay.

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

Code	Class	Description
1 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

10.5 Command #141: Set Relay (Alarm) Configuration

This command configures the relay settings.

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

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
16	Error	Access Restricted
17 – 127		Undefined

10.6 Command #142: Reset Event Happened Flag

This command resets the 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

10.7 Command #143: Read Event Logging Counters

This command reads five 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

10.8 Command #144: Clear Event Logging Counters

This command resets the 5 event logging counters 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

10.9 Command #145: Read Warning Event Log

This command reads the 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
10-13	Unsigned-8	Reserved = 0

Command-Specific Response Codes

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

10.10 Command #146: Read Alarm Event Log

This command reads the 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
10-13	Unsigned-8	Reserved = 0

Command-Specific Response Codes

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

10.11 Command #147: Read Fault Event Log

This command reads the 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	Event Cause – See device specific table

Command-Specific Response Codes

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

10.12 Command #148: Read Maintenance Event Log

This command reads the 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-8	Reserved = 0
12-13	Unsigned-8	Code: 0-Gas check

Command-Specific Response Codes

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

10.13 Command #149: Set Clock

This command 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

10.14 Command #150: Read Clock

This command 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

10.15 Command #151: Set Run Time Meter

This command 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

10.16 Command #152: Read Run Time Meter

This command 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

10.17 Command #154: Set Event Index

This command 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
5	Error	Too Few Data Bytes Received
6 – 127		Undefined

10.18 Command #155: Get Event Index

This command reads the 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

10.19 Command #156: Read Calibration Event Log

This command reads the 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	Unsigned-8	1 - N/A, 2 – Calibration

Command-Specific Response Codes

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

10.20 Command #163: Get Fast Changing Information

This command reads the 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 – 1	Unsigned-16	Mode – depends on instrument
2 – 3	Unsigned-16	Sub Mode – depends on instrument
4 – 7	Float	Analog Output
8 – 9	Unsigned-16	Priority Fault
10 – 11	Bit map	Error Status
12	Unsigned-8	Alarm Hi status : 0 – off, 1 – on , 2 – accepted

Byte	Format	Description
13	Unsigned-8	Alarm Lo status : 0 – off, 1 – on , 2 – accepted
14	Unsigned-8	Alarm Mid status : 0 – off, 1 – on , 2 – accepted
15	Unsigned-8	Power cycled flag
16	Unsigned-8	Event happened flag
17	Integer-8	% of FS
18-21	Float	ppm level – For all toxic gasses else = 0

Command-Specific Response Codes

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

10.21 Command #164: Get Slow Changing Information

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0 - 1	Signed-16	Reserved = 0
2 - 5	Float	Supply Voltage
6 - 7	Signed-16	Sensor Voltage in miliVolt

Command-Specific Response Codes

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

10.22 Command #165: Get Set Up Information

This command sets the internal real-time clock.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Gas ID or sensor type
1	Enumerated	Measured Units
2- 5	Unsigned-32	Full Scale
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	Alarm Mid level, % of FS
13	Unsigned-8	Alarm Mid Relay En/dE: 0 – dE, 1 - En
14	Unsigned-8	Alarm Mid Relay La/nL: 0 – nL, 1 - LA
15	Unsigned-8	Alarm delay
16	Unsigned-8	Sensitivity
17	Unsigned-8	Cal level, % of FS. Default is 50%
18	Unsigned-8	Cal IO type: 0 – Remote Cal line, 1 – manual solenoid, 2 – automatic solenoid
19-20	Unsigned-16	Configuration Flags: Lock front panel flag, hazard watch, etc
21	Unsigned-8	Units on line
22	Unsigned-8	Number of votes
23	Unsigned-8	Sensor Life
24	Unsigned-8	Current Range: 0= 3.5 – 20, 1=1.25 - 20

Command-Specific Response Codes

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

10.23 Command #170: Set Current Range

Request Data Bytes

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

Response Data Bytes

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

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

10.24 Command #185: Set Gas ID or Sensor Type

This sets sensor type

Request Data Bytes

Byte	Format	Description
0	Unsigned 8	Gas ID or sensor type

Response Data Bytes

Byte	Format	Description
0	Unsigned 8	Gas ID or sensor type

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

10.25 Command #189: Set Sensor Life

Request Data Bytes

Byte	Format	Description
0	Unsigned 8	Sensor life, %

Response Data Bytes

Byte	Format	Description
0	Unsigned 8	Sensor life, %

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

10.26 Command #192: Do Calibration

This sends the unit to 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 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

10.27 Command #195: Do Gas Check

This command sends 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 – 15		Undefined
16	Error	Access Restricted
17 – 127		Undefined

10.28 Command #196: Set Sensor Range (Full Scale)

This sets the sensor range.

Request Data Bytes

Byte	Format	Description
0 – 3	Unsigned-32	Sensor Range Value

Response Data Bytes

Byte	Format	Description
0 – 3	Unsigned-32	Sensor Range Value

Command-Specific Response Codes

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

11.0 Tables

11.1 TS4000H – Device Specific Commands Summary

The following Table 4 is a summary of the **TS4000H** Device Specific Commands..

Command Number	Byte Number	Meaning
131		Do Abort Calibration
136		Set Alarm Level
137		Set Warn Level
139		Reset Alarms
141		Set Relay State
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 Time Clock
150		Read Time Clock
151		Set Running Time
152		Read Running Time
154		Set Event Index
155		Read Event Index
156		Read Calibrate Event Log
163		Get Fast Changing Information
164		Get Slow Changing Information
165		Get setup Information
170		Set Current Range
185		Set Sensor Type
189		Set Sensor Life
190		Set Calibration Level
192		Do Calibration
195		Do Gas Check
196		Set Sensor Range (Full Scale)

Table 4: TS4000H – Device Specific Commands

11.2 TS4000H – Operating Mode - PV Values

The following is a summary of the TS4000H Operating Modes:

Operating Mode	Value in Hex
Run Mode	0x0001
Warn Level	0x0002
Alarm Level	0x0004
Apply Gas	0x0008
Gas Remove	0x0010
Gas Being Read	0x0020
Initial	0x0040
Calibrate	0x0080
Gas Check	0x0100
OK Error	0x0200
Bad Error	0x0400
Sensor Life Reset	0x0800
Base Setup	0x1000
Not Used	0x2000
Not Used	0x4000
Not Used	0x8000

Table 5: TS4000H - Operating Mode - PV Values

11.3 Fault Event Log – Cause Description

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

Bits	Cause
0	F0 – IM Offline
1	F1 – No Sensor
2	F2 – Calibration Timeout
3	F3 – Base unit Error
4	F4 – Sensor Rate of Change Error
5	F5 - Sensor Failure
6	F6 – Low Supply voltage
7	F7 – Base Unit EEPROM Error
8	F8 – Base Setup Timeout
9	F9 – Gas Check Timeout
10	F10 – Switch Error
11	FF – Base Unit RAM Error

Table 6: Fault Event Log – Cause Description

11.4 Sensor Type (ID) – Description

The following describes the sensor type:

Sensor Type	Sensor ID	Full Scale Value
0	No Sensor Detected	None
1	O_2	25% Volume
2	CO – 100	100 ppm
3	CO – 500	500 ppm
4	Cl_2 – 10	10 ppm
5	ClO_2	3 ppm
6	HCl	20 ppm
7	NO	100 ppm
8	NO_2	20 ppm
9	NH_3 – 50	50 ppm
10	NH_3 – 100	100 ppm
11	O_3	1 ppm
12	SO_2 -20	20 ppm
13	SO_2 -100	100 ppm
14	H_2S – 20	20 ppm
15	H_2S-100	100 ppm
16-18	Reserved	N/A
19	Cl_2 – 20	20 ppm
20	H_2S – 50	50 ppm

Table 7: Sensor Type (ID) – Description

12.0 Performance

12.1 Sampling Rates

The TS4000H samples the sensor in 35 millisecond intervals.

12.2 Power-up

On power-up, the TS4000H executes a self-test procedure, which requires approximately 50 seconds. During this time, the analog output is set to1.25 mA or 3.5 mA. After the self-test is satisfactorily completed, the unit sets the primary variable to a value representing the mode of the instrument.

12.3 Device Reset

The TS4000H cannot be reset by any command. The unit only resets when power is cycled.

12.4 Self-Test

The TS4000H 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 TS4000H responds as follows:

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

Table 8: Command Response Times

12.6 Busy and Delayed-Response

The TS4000H does not use delayed-response times.

12.7 Long Messages

The largest data field used by the TS4000H is in response to Command 20 & 22 (Read/Write Long Tag): 34 bytes including the two status bytes.

12.8 Non-Volatile Memory

The TS4000H 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 TS4000H reports parts per million (ppm) detected while in RUN mode. Various other modes are used to support the calibration of the instrument.

12.10 Write Protection

The TS4000H does not support any write protection mode.

Annex A. Capability Checklist

Manufacturer, model, and revision	General Monitors TS4000H
Device type	Toxic Gas Detector
HART revision	6.0
Device Description available	Yes
Number and type of sensors	1 Chemical 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	2
Number of device-specific commands	27
Bits of additional device status	8
Alternative operating modes	No
Burst mode	No
Write-protection	Mfg Only

Table 9: Capability Checklist

Annex B. Default Configuration

Parameter	Default value
Lower Range Value	0 ppm
Upper Range Value	1/3/10/20/50/100/500 ppm
PV Units	Parts per million
Sensor type	Electrochemical Sensor
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 10: Default Configuration

Annex C. Device Descriptor Language Menu