General Monitors S5000 HART® Specification

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1. Introduction

1.1. Scope

The S5000 Transmitter complies with HART Protocol Revision 7.5. This document specifies all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). 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 S5000 Transmitter Instruction Manual by providing a complete description of this field device from a HART 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

- *HART Communications Protocol Specification*, HCF_Spec-013 – to insure compliance with the HART Communication Protocol
- Operating Manual S5000 Gas Monitor

2. Device Identification

Table 1 Device Identification

Manufacturer Name	General Monitors, an MSA company	**Model Name**	S5000 Transmitter
HART ID Code	227 (0xE3)	**Device Type Code**	115 (0x73)
HART Protocol Revision	7.5	**Device Revision**	1
Number of Device Variables	2		
Physical Layers Supported	FSK		
Physical Device Category	Transmitter		

3. Product Overview

The S5000 Transmitter is an intelligent interface for the detection of various gases and vapors. The microprocessor-based electronics processes information at the sensor site, within an explosion-proof housing. The transmitter is capable of reading up to two sensors.

4. Product Interfaces

The S5000 Transmitter HART interface is available either via the mA1/GND connection or via the HART barrier port. See the S5000 installation manual for more information.

5. Device Variables

There are no device variables exposed to the user.

6. Dynamic Variables

There are two dynamic variables exposed to the user.

6.1. Primary Variable = Sensor 1 gas reading.

The Primary Variable is the current gas reading for Sensor 1. Units and scaling information are provided via Device Specific Commands.

6.2. Secondary Variable = Sensor 2 gas reading.

The Secondary Variable is the current gas reading for Sensor 2. Units and scaling information are provided via Device Specific Commands.

7. Universal Commands

Command 3 returns the current loop variable for Sensor 1, the Primary Variable and Units Code, and the Secondary Variable and Units Code for a total of 14 bytes returned.

8. Common Practice Commands

The S5000 implements Common Practice Command 42, Perform Device Reset.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
None		

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

9. Device Specific Commands

Table 2 Device Specific Commands

Command Number	Description
129	Read Sensor Static Parameters
130	Read % of Span Value Change
131	Read Alarm/Warning Setpoints
132	Read Alarm Actions
133	Read Min/Max/Avg Parameters
134	Read Previous Calibration Date
135	Read Gas Table
136	Set Alarm/Warning Setpoints
137	Read Drift Counter
138	Read Span Value
139	Reset Alarms
140	Read Swap Delay Setting
141	Set Alarm Actions
143	Read Event Logging Counters
144	Clear Event Logging Counters
145	Read Event Log
146	Read Relay Configuration
147	Read Sensor Life
149	Set Clock
150	Read Clock
151	Read Min/Max/Avg Values
152	Read Custom mA Levels
153	Read Current Range
154	Read Transmitter Version
155	Read Sensor Status
156	Read Calibration Mode
157	Read Temperatures
158	Read Sensor Mode
159	Read Language
160	Read Sensor Full-scale Value
161	Read Sensor Enable
162	Read Voltages
163	Read Fast Changing Information

164	Read Slow Changing Information
165	Read Diffusion Supervision Enable
166	Set Diffusion Supervision Enable
167	Read Alternate Toxic Units
168	
169	Set Custom mA Levels
170	Set Current Range
171	Set Relay Configuration
172	
173	
174	
175	
176	Set Min/Max/Avg Parameters
177	
178	Set Gas Table
179	Reset Datasheets
180	Sensor Swap Delay
181	Set Sensor Enable
182	
183	
184	
185	Set Language
186	
187	
188	Set Alternate Toxic Units
189	Set Sensor Life
190	Set Span Value
191	Set Sensor Full-scale Value
192	Start Calibration
193	Calibration Abort
194	Calibration Step
196	Read Analog Output Calibration
197	Read System Status
198	Read Analog Outputs

9.1. Command #129 – Read Sensor Static Parameters

This command reads the static parameters of the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0=first sensor, 1=second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0=first sensor, 1=second sensor)
1-2	Unsigned-16	Sensor Type
3	Unsigned-8	Sensor Bus Type
4	Unsigned-8	Sensor Firmware Version (4.4 format, 0x11 = 1.1, 0x20 = 2.0)
5	Unsigned-8	Sensor Build Number

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

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9.2. Command #130 – Read % of Span Value Change

This command reads the % of Span Value Change at the last calibration for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0=first sensor, 1=second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0=first sensor, 1=second sensor)
1	Unsigned-8	% of Span Value Change

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.3. Command #131 – Read Alarm/Warning Setpoints

This command reads the alarm or warning setpoint of the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2-5	Float	Value

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.4. Command #132 – Read Alarm/Warning Actions

This command reads the alarm or warning action of the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2	Unsigned-8	Action Bitmap Bit0 = Enabled (0 = false, 1 = true) Bit1 = Increasing (0 = false, 1 = true) Bit2 = Latching (0 = false, 1 = true)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.5. Command #133 – Read Minimum, Maximum, Average Parameters

This command reads the interval and start hour for the minimum, maximum, and average values.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Interval (1, 8, 24)
1	Unsigned-8	Start Hour (0 – 23)

Command-Specific Response Codes

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

9.6. Command #134 – Read Previous Calibration Dates

This command reads the previous zero and span calibration dates.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-3	Date	Zero Date – Day, Month, Year - 1900
4-6	Date	Span Date – Day, Month, Year - 1900

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.7. Command #135 – Read Gas Table

This command reads the previous zero and span calibration dates.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Gas Table

Command-Specific Response Codes

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

9.8. Command #136 – Set Alarm/Warning Setpoint

This command sets the alarm or warning setpoint of the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2-5	Float	Value

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2-5	Float	Value

Command-Specific Response Codes

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

9.9. Command #137 – Read Drift Counter

This command reads the drift counter for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Drift Counter

Command-Specific Response Codes

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

9.10. Command #138 – Read Span Value

This command reads the span value for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Span Value

Command-Specific Response Codes

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

9.11. Command #139 – Reset Alarms

This command resets any latching alarms and warnings.

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

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9.12. Command #140 – Read Swap Delay

This command reads the sensor swap delay flag.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Swap Delay Flag (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

9.13. Command #141 – Set Alarm/Warning Actions

This command sets the alarm or warning action of the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2	Unsigned-8	Action Bitmap Bit0 = Enabled (0 = false, 1 = true) Bit1 = Increasing (0 = false, 1 = true) Bit2 = Latching (0 = false, 1 = true)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Setpoint (0 = warning, 1 = alarm)
2	Unsigned-8	Action Bitmap Bit0 = Enabled (0 = false, 1 = true) Bit1 = Increasing (0 = false, 1 = true) Bit2 = Latching (0 = false, 1 = true)

Command-Specific Response Codes

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

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9.14. Command #143 – Read Event Log Counters

This command reads the counts of the various event logs.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm Counts
1	Unsigned-8	Warning Counts
2	Unsigned-8	Maintenance Counts
3	Unsigned-8	Calibration Counts
4	Unsigned-8	Fault Counts
5	Unsigned-8	Restart Counts

Command-Specific Response Codes

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

9.15. Command #144 – Clear Event Log Counters

This command clears all event log counters.

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

9.16. Command #145 – Read Event Log

This command reads the entry specified by the Log Index and Log Type. All values will return zero if there is no data in the log at the specified index.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Log Index (0 = most recent)
1	Unsigned-8	Log Type 0 = Alarm Log 1 = Warning Log 2 = Maintenance Log 3 = Calibration Log 4 = Fault Log 5 = Restart Log

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Log Index (0 = most recent)
1	Unsigned-8	Log Type 0 = Alarm Log 1 = Warning Log 2 = Maintenance Log 3 = Calibration Log 4 = Fault Log 5 = Restart Log
2-4	Unsigned-8	Date – Day, Month, Year-1900
5	Unsigned-8	Hour
6	Unsigned-8	Minute
7	Unsigned-8	Second
8-9	Unsigned-16	Cause Code
10-13	Unsigned-32	Timestamp (seconds since 01-Jan-2014); 0x00000000 indicates empty index

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-127		Undefined

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9.17. Command #146 – Read Relay Configuration

This command reads the relay configuration.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Relay Configuration Bitmap - Table 3

Command-Specific Response Codes

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

Table 3 Relay Configuration Bitmap

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Installed	Fault	Alarm	Warning	Fault Diagnostic	Alarm Diagnostic	Warning Diagnostic	Reserved
0=Uninstalled 1=Installed	0=Unpowered 1=Powered			0=Normal 1=Failure			
Bit7	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
Zone		Reserved	Reserved	Reserved	Relay2 Normal State	Reserved	Relay1 Normal State
00 = Discrete 01 = Common 10 = Horn 11 = Reserved					0 = De-energized 1 = Energized		0 = De-energized 1 = Energized

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9.18. Command #147 – Read Sensor Life

This command reads the sensor life for the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-2	Unsigned-16	Sensor Life

Command-Specific Response Codes

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

9.19. 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

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9.20. Command #150 – Read Clock

This command reads the internal real-time clock.

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

9.21. Command #151 – Read Minimum, Maximum, Average Values

This command reads the minimum, maximum, and average values for the specified sensor over the preceding interval.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Minimum Value
5-8	Float	Maximum Value
9-12	Float	Average Value
13	Unsigned-8	Status Bitmap Bit0 = Current Reading Overrange (0 = false, 1 = true) Bit1 = Current Reading Underrange (0 = false, 1 = true) Bit2 = Min, Max, Avg Ready (0 = false, 1 = true) Bit3 = Min, Max, Avg Overrange (0 = false, 1 = true) Bit4 = Min, Max, Avg Underrange (0 = false, 1 = true)

Command-Specific Response Codes

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

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9.22. Command #152 – Read Custom mA Output Levels

This command reads the custom current output levels. Values are returned as floats in mA.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Calibration Output Level
4-7	Float	Fault Output Level
8-11	Float	Setup Output Level
12-15	Float	Cleaning Mode Output Level

Command-Specific Response Codes

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

9.23. Command #153 – Read Current Range

This command reads the current range.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Current Range 0 = Hazard Watch Disabled 1 = Reserved 2 = 3.5 mA with HART 3 = 1.25 mA with HART 4 = Custom Levels 5 = Custom O_2 Levels

Command-Specific Response Codes

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

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9.24. Command #154 – Read Transmitter Version

This command reads the firmware version of the transmitter. The version should be displayed Major.Minor.Sub-minor (1.2.1006).

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Major Version
1	Unsigned-8	Minor Version
2-3	Unsigned-16	Sub-minor Version

Command-Specific Response Codes

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

9.25. Command #155 – Read Sensor Status

This command reads the status of the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Sensor Status 1 = Bad FLASH CRC 5 = Defective RAM 7 = Sensor Error 10 = Bad Datasheet CRC 30 = Vdd Range Error 31 = Factory Setup 32 = Lamp Fault 40 = External Memory Read/Write Error 45 = External Memory Checksum Error 47 = Sensor Missing 58 = Negative Supply Out of Range 59 = Reference Channel Failure 60 = Temperature Out of Range 61 = Analytical Channel Failure 62 = Input Signal Low 63 = Parameter Out of Range 64 = Self Calibration Failure 65 = Sensor in ZERO Mode 66 = Sensor in SPAN Mode 123 = TruCal Calibration Recommended 124 = Sensor Sleeping 125 = Sensor in WARMUP Mode 126 = Power-On-Reset 127 = Sensor Normal
2-5	Unsigned-32	Error Bitmap (Table 4)
6-9	Unsigned-32	Extended Error Bitmap (Table 5)

Command-Specific Response Codes

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

Table 4 Error Bitmap

	Bit	Fault Name	Fault Description
Byte 2	00	Sensor Missing	Sensor module is not connected to the base unit or communication to sensor failed.
	01	Sensor Supply Voltage Fault	Supply voltage for sensor module is out of specified range.
	02	Invalid Sensor Parameters in EEPROM	Sensor Parameters in main board EEPROM are invalid.
	03	Sensor Element Error	Sensor pellement is open or short. Or, there is negative drift, AFE error, or no output signal.
	04	Sensor Heater Fault	Sensor heater is open or shorted (MOS and IR only for now).
	05	Other Sensor Internal Faults	Sensor module internal faults not defined here. Details are shown in the Extended Sensor Fault register bitmap.
	06	TEDS CRC-16 Error	TEDS stored CRC-16 doesn’t match the calculated CRC-16.
	07	Sensor EOL Fault	Indication the sensor has met the end of life (EOL) condition.
Byte 3	08	Sensor Blockage Fault	Sensor gas flow path or IR beam path blockage has been detected.
	09	Negative Drift	Negative gas reading has been detected.
	10	CAL Line Shortage Fault	Calibration Line is shorted to ground.
	11	Zero Calibration Fault	Failed to start or perform zero calibration.
	12	Span Calibration Fault	Failed to perform span calibration.
	13	Gas Check Timeout	Check Gas is left on for more than 6 minutes.
	14	Sensor Configuration Reset	The sensor’s datasheet was set back to its default values.
	15	Calibration Required	The sensor requires calibration for operation.
Byte 4	16	Beads Off	The combustible sensor beads are off.
	17	Reserved	
	18	Reserved	
	19	Reserved	
	20	Reserved	

	21	Reserved
	22	Reserved
	23	Reserved
Byte 5	24	Reserved
	25	Reserved
	26	Reserved
	27	Reserved
	28	Reserved
	29	Reserved
	30	Reserved
	31	Reserved

Table 5 Extended Error Bitmap

	Bit	Fault Name	Fault Description
Byte 6	00	General Sensor Internal Fault	General sensor fault. Specific fault cause is not covered by items listed below.
	01	Sensor Negative Supply Fault	Negative supply in sensor module has failed.
	02	Sensor FLASH Error	Sensor module FLASH test has failed.
	03	Sensor RAM Error	Sensor module RAM test has failed.
	04	External Memory Access Error	External memory in sensor module cannot be accessed.
	05	External Memory Checksum Error	External memory in sensor module has invalid checksum.
	06	Parameter Out of Range Fault	Indicates that a parameter is out of range for sensor module that can calculate gas reading directly.
	07	High IR Fault	IR reading is too high.
Byte 7	08	Lamp Fault	Lamp has failed.
	09	Reference Failure	Reference channel in IR sensor has failed.
	10	Analytical Failure	Analytical channel in IR sensor has failed.
	11	Low Signal Failure	Input signal in IR sensor is too low.
	12	Clipping Fault	IR signal clipping has been detected.
	13	End of Life Fault	The sensor has reached the end of life value and needs to be replaced.
	14	Open Load	The mA output detected that there is no load resistor installed.
	15	Unknown Fault	This is a fault that is unknown to the instruments software.
Byte 8	16	Reserved	
	17	Reserved	
	18	Reserved	
	19	Reserved	
	20	Reserved	
	21	Reserved	
	22	Reserved	
	23	Reserved	
Byte 9	24	Reserved	
	25	Reserved	
	26	Reserved	
	27	Reserved	
	28	Reserved	
	29	Reserved	
	30	Reserved	
	31	Reserved	

9.26. Command #156 – Read Sensor Calibration Request Mode

This command reads the calibration mode of the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Sensor Calibration Request Mode 0 = None 1 = Zero Calibration 2 = Auto Calibration 3 = Gas Check 4 = uCal

Command-Specific Response Codes

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

9.27. Command #157 – Read Temperatures

This command reads the transmitter and sensor temperatures.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Transmitter Temperature
4-7	Float	Sensor 1 Temperature
8-11	Float	Sensor 2 Temperature

Command-Specific Response Codes

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

9.28. Command #158 – Read Sensor Operating Mode

This command reads the operating mode of the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Sensor Operating Mode 0 = STARTUP 1 = OPERATE 2 = CAL_INIT 3 = RESET_SENSOR_LIFE 4 = WAIT_FOR_ZERO_GAS 5 = SOAK_ZERO_GAS 6 = ZERO_IN_PROGRESS 7 = ZERO_PASS 8 = WAIT_SPAN_FOR_GAS 9 = SOAK_SPAN_GAS 10 = SPAN_IN_PROGRESS 11 = SPAN_REMOVE_GAS 12 = SPAN_PASS 13 = CAL_ABORT 14 = CAL_FAIL 15 = WAIT_FOR_CAL_CHECK_GAS 16 = GAS_CHECK_IN_PROGRESS 17 = GAS_CHECK_PASS 18 = GAS_CHECK_ABORT 19 = GAS_CHECK_FAIL

Command-Specific Response Codes

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

9.29. Command #159 – Read Language

This command reads the transmitter language.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Transmitter Language 0 = English 1 = French 2 = Spanish 3 = Portuguese 4 = Italian 5 = Dutch 6 = Russian 7 = Chinese 8 = German

Command-Specific Response Codes

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

9.30. Command #160 – Read Full Scale Value

This command reads the full scale value for the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Sensor Full Scale Value

Command-Specific Response Codes

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

US

9.31. Command #161 – Read Sensor Enable

This command reads the sensor enabled flag for the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Sensor Enable (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

US

9.32. Command #162 – Read Voltages

This command reads the voltages from the transmitter.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Input Line Voltage
4-7	Float	24 VDC
8-11	Float	24.5 VDC
12-15	Float	12 VDC
16-19	Float	5 VDC
20-23	Float	3.3 VDC
24-27	Float	HART Reference
28-31	Float	RTC Battery Voltage

Command-Specific Response Codes

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

US

9.33. Command #163 – Read Fast Changing Information

This command reads the fast changing information from the transmitter.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Sensor 1 Reading
4-7	Float	Sensor 2 Reading
8-11	Float	Analog Output 1
12-15	Float	Analog Output 2

Command-Specific Response Codes

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

9.34. Command #164 – Read Slow Changing Information

This command reads the slow changing information from the transmitter.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Transmitter Temperature
4-7	Float	Sensor 1 Temperature
8-11	Float	Sensor 2 Temperature
12-15	Float	Input Line Voltage
16-19	Float	24 VDC
20-23	Float	24.5 VDC
24-27	Float	12 VDC
28-31	Float	5 VDC
32-35	Float	3.3 VDC
36-39	Float	2.5 VDC
40-43	Float	RTC Battery Voltage

Command-Specific Response Codes

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

9.35. Command #165 – Read Diffusion Supervision Enable

This command reads the diffusion supervision enable state for the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Diffusion Supervision Enable (0 = disabled, 1 = enabled)
2	Unsigned-8	Diffusion Supervision Available (0=unavailable, 1=available)

Command-Specific Response Codes

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

9.36. Command #166 – Set Diffusion Supervision Enable

This command sets the diffusion supervision enable state for the specified sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Diffusion Supervision Enable (0 = disabled, 1 = enabled)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Diffusion Supervision Enable (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

9.37. Command #167 – Read Alternate Toxic Units

This command reads the alternate toxic sensor units.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alternate Toxic Units 0 = PPM 1 = MG_PER_M3 2 = UMOL_PER_MOL 255 = None

Command-Specific Response Codes

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

US

9.38. Command #169 – Set Custom mA Output Levels

This command reads the custom current output levels. Values are returned as floats in mA.

Request Data Bytes

Byte	Format	Description
0-3	Float	Calibration Output Level
4-7	Float	Fault Output Level
8-11	Float	Setup Output Level
12-15	Float	Cleaning Mode Output Level

Response Data Bytes

Byte	Format	Description
0-3	Float	Calibration Output Level
4-7	Float	Fault Output Level
8-11	Float	Setup Output Level
12-15	Float	Cleaning Mode Output Level

Command-Specific Response Codes

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

US

9.39. Command #170 – Set Current Range

This command sets the desired current range for the analog outputs.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Current Range 0 = Hazard Watch Disabled 1 = Reserved 2 = 3.5 mA with HART 3 = 1.25 mA with HART 4 = Custom Levels 5 = Custom O_2 Levels

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Current Range 0 = Hazard Watch Disabled 1 = Reserved 2 = 3.5 mA with HART 3 = 1.25 mA with HART 4 = Custom Levels 5 = Custom O_2 Levels

Command-Specific Response Codes

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

US

9.40. Command #171 – Set Relay Configuration

This command sets the relay configuration.

Request Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Relay Configuration Bitmap NOTE: The most significant byte of the bitmap is ignored by the device.

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Relay Configuration Bitmap - Table 3

Command-Specific Response Codes

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

9.41. Command #176 – Set Minimum, Maximum, and Average Parameters

This command sets the interval and start hour for the minimum, maximum, and average values.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Interval (1, 8, 24)
1	Unsigned-8	Start Hour (0 – 23)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Interval (1, 8, 24)
1	Unsigned-8	Start Hour (0 – 23)

Command-Specific Response Codes

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

9.42. Command #178 – Set Gas Table

This command sets the gas table.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Gas Table

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Gas Table

Command-Specific Response Codes

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

9.43. Command #179 – Reset Data Sheet

This command causes a reset of the selected datasheet – transmitter, first or second sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor, 255 = transmitter)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor, 255 = transmitter)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.44. Command #180 – Set Swap Delay

This command enables/disables the swap delay.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = disabled, 1 = enabled

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = disabled, 1 = enabled

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.45. Command #181 – Set Sensor Enable

This command enables/disables the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	0 = disabled, 1 = enabled

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	0 = disabled, 1 = enabled

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.46. Command #185 – Set Language

This command sets the selected language.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Transmitter Language 0 = English 1 = French 2 = Spanish 3 = Portuguese 4 = Italian 5 = Dutch 6 = Russian 7 = Chinese 8 = German

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Transmitter Language 0 = English 1 = French 2 = Spanish 3 = Portuguese 4 = Italian 5 = Dutch 6 = Russian 7 = Chinese 8 = German

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.47. Command #188 – Set Alternate Toxic Units

This command sets the alternate toxic units.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Alternate Toxic Units 0 = PPM 1 = MG_PER_M3 2 = UMOL_PER_MOL 255 = None

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alternate Toxic Units 0 = PPM 1 = MG_PER_M3 2 = UMOL_PER_MOL 255 = None

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.48. Command #189 – Set Sensor Life

This command sets the sensor life value for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-2	Unsigned-16	Sensor Life

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-2	Unsigned-16	Sensor Life

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.49. Command #190 – Set Span Value

This command sets the span value for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Span Value

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Span Value

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

US

9.50. Command #191 – Set Sensor Full Scale Value

This command sets the sensor full scale value for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Sensor Full Scale Value

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1-4	Float	Sensor Full Scale Value

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.51. Command #192 – Calibrate Sensor

This command requests the selected calibration mode for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Mode 0 = None 1 = Zero Calibration 2 = Auto Calibration 3 = Gas Check 4 = uCal

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)
1	Unsigned-8	Mode 0 = None 1 = Zero Calibration 2 = Auto Calibration 3 = Gas Check 4 = uCal

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

US

9.52. Command #193 – Calibrate Abort

This command requests a calibration abort for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

9.53. Command #194 – Calibrate Step

This command requests a calibration step for the selected sensor.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensor (0 = first sensor, 1 = second sensor)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

US

9.54. Command #196 – Read Analog Output Calibration

This command reads the analog output calibration data.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Signed-16	DAC 1 Slope
2-3	Signed-16	DAC 1 Offset
4-5	Signed-16	ADC 1 Slope
6-7	Signed-16	ADC 1 Offset
8-9	Signed-16	DAC 2 Slope
10-11	Signed-16	DAC 2 Offset
12-13	Signed-16	ADC 2 Slope
14-15	Signed-16	ADC 2 Offset

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

US

9.55. Command #197 – Read System Status

This command reads the system status bitmaps.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	System Status Bitmap -Table 6
2-3	Unsigned-16	Non-Critical System Status Bitmap - Table 7

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Table 6 System Status Bitmap

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
General System	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Invalid Configuration
Bit7	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
Relay Fault	Sensor 2 Fault	Sensor 1 Fault	Internal Circuit Fault	EEPROM Fault	FLASH Checksum	RAM Checksum	Low Supply Voltage

Table 7 Non-Critical System Status Bitmap

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Bit7	**Bit6**	**Bit5**	**Bit4**	**Bit3**	**Bit2**	**Bit1**	**Bit0**
Led Control	HART Fault	BCM Fault	Bluetooth Module	Fail to Complete Setup	Display/UI Board	RTC Battery Low	User Input Switch

US

9.56. Command #198 – Read Analog Output Feedback

This command reads the analog outputs feedback.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Float	Analog Output 1 Feedback in mA
4-7	Float	Analog Output 2 Feedback in mA

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-15		Undefined
16	Error	Access Restricted
17-127		Undefined

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