Operating Manual

ULTIMA X5000 HART® Specification

Order No.: 10184753/02

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US

MSAsafety.com

WARNING!

These instructions must be provided to users before use of the product and retained for ready reference by the user. Read this manual carefully before using or maintaining the device. The device will perform as designed only if it is used and maintained in accordance with the manufacturer's instructions. Otherwise, it could fail to perform as designed, and persons who rely on this device could sustain serious injury or death.

The warranties made by MSA with respect to the product are voided if the product is not installed and used in accordance with the instructions in this manual. Please protect yourself and your employees by following the instructions.

Please read and observe the WARNINGS and CAUTIONS inside. For additional information relative to use or repair, call 1-800-MSA-2222 during regular working hours.

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1 Introduction

1.1 Scope

The Ultima X5000 Transmitter complies with HART Protocol Revision 7.9. 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 Ultima X5000 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 ULTIMA X5000 Gas Monitor

2 Device Identification

Table 1 Device Identification

Manufacturer Name	Mine Safety Appliances, Inc (MSA)
HART ID Code	227 (0xE3)
HART Protocol Revision	7.9
Number of Device Variables	2
Physical Layers Supported	FSK
Physical Device Category	Transmitter
Model Name	Ultima X5000 Transmitter
Device Type Code	46 (0x2E)
Device Revision	2

3 Product Overview

The Ultima X5000 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 Ultima X5000 Transmitter HART interface is available either via the mA1/GND connection or via the HART barrier port. See the Ultima X5000 installation manual for more information.

5 Device Variables

Device variables are fixed mapped to PV and SV.

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 Status Information

ULTIMA X5000 HART® Specification

7.1 Additional Device Status (Command #48)

The device specific status, which is returned via Common Practice Command #48, is shown in Table Additional Device Status . These bits may be set at power up to indicate an instrument failure or feature. They may also be set by a failure detected during continuous background diagnostic testing.

Table 2 Additional Device Status

Byte	Bit	Name	Description
0	0	Configuration Fault	System configuration fault
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	Reserved	
	6	Reserved	
	7	General System Error	
1	0	Low Supply Voltage Fault	The input power supply voltage is out of low end range.
	1	RAM Checksum Fault	RAM test/check has failed.
	2	Flash Checksum Fault	Flash checksum check has failed.
	3	EEPROM Fault	EEPROM access or checksum check has failed.
	4	Internal Circut Fault	Internal circuitry fault or abnormal internal voltages (except battery)
	5	Sensor 1 Fault	Sensor 1 is in fault condition.
	6	Sensor 2 Fault	Sensor 2 is in fault condition.
	7	Relay Fault	One or more relays are in fault condition.
2	0	LED Control Fault	LED control has failed.
	1	Invalid EEPROM Event Log	Invalid EEPROM access event log index
	2	Invalid EEPROM Bluetooth	Invalid EEPROM access Bluetooth index
	3	Magnetic Switch Fault	Magnetic switch has been left closed for more than two minutes.
	4	Non-Critical Faults	Number of non-critical faults
	5	Reserved	
	6	Reserved	
	7	Reserved	
3	0	EZ-Touch Switch Fault	EZ-Touch switch has been left closed for more than two minutes.
	1	RTC Battery Low Fault	RTC backup battery low.
	2	Display/UI Board Fault	Communication or the power supply to display/UI board has failed.
	3	Fail to Complete Setup Fault	Base unit has been in setup mode for more than six minutes.
	4	Bluetooth Module Fault	Communication to Bluetooth module has failed.
	5	BCM Fault	Communication to BCM has failed. Or, BCM has reported failure.
	6	HART Reference Voltage Fault	HART® reference voltage has failed.
	7	HART Fault	Communication to HART®

Byte	Bit	Name	Description
4	0	Device Specific Command 168	Read Gas Name Device Specific Command (168) supported
	1	Device Specific Command 202/203	Fixed Current Mode Commands 202 & 203 supported
	2	Reserved	
	3	Reserved	
	4	Reserved	
	5	Reserved	
	6	Reserved	
	7	Reserved	

8 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.

9 Common Practice Commands

The Ultima X5000 implements the following Common Practice Commands:

- Command 38 Reset Configuration Changed Flag
- Command 48 Read Additional Device Status
- Command 50 Read Dynamic Variable Assignments
- Command 54 Read Device Variable Information
- Command 59 Write Number Of Response Preambles
- Command 60 Read Analog Channel And Percent Of Range
- Command 63 Read Analog Channel Information
- Command 70 Read Analog Channel Endpoint Values

10 Device Specific Commands

Table 3 Complete List of 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 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	Read Gas Names
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 systems status.
198	Read analog outputs.
199	Read Analog Output
200	Set TruCal Output Enabled Flag
201	Read TruCal Output Enabled Flag
202	Select Fixed Current Mode Channel
203	Set Fixed Current Mode Output Level

10.1 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.

10.1.1 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.
17–217		Undefined.

10.2 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.

10.3 Command #131 - Read Alarm/Warning Setpoints

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

Request Data Bytes

Bytes	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.

10.4 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.

10.5 Command #133 - Read Minimum, Maximum, and Average Parameters

This commands 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

Bytes	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.

10.6 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

Bytes	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.

10.7 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

Bytes	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.

10.8 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

Bytes	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.

10.9 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

Bytes	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.

10.10 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

Bytes	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.

10.11 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

Bytes	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.

10.12 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

Bytes	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.

10.13 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.

10.14 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.

10.15 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.

10.16 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.

10.17 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. See 10.17.1 Relay Configuration Bitmap .

Command-Specific Response Codes

Code	Class	Description

0	Success	No command-specific errors.
1–127		Undefined.

10.17.1 Relay Configuration Bitmap

Bit15	Bit14	Bit13	Bit12
Installed	Fault	Alarm	Warning
0 = Uninstalled. 1 = Installed.	0 = Unpowered. 1 = Powered.		

Bit11	Bit10	Bit9	Bit8
Fault diagnostic	Alarm diagnostic	Warning diagnostic	Reserved
0 = Normal. 1 = Failure.			

Bit7	Bit6	Bit5	Bit4
Zone		Reserved	Reserved
00 = Discrete. 01 = Common. 10 = Horn. 11 = Reserved.			

Bit3	Bit2	Bit1	Bit0
Reserved	Relay2 normal state	Reserved	Relay1 normal state
	0 = De-energized. 1 = Energized.		0 = De-energized. 1 = Energized.

10.18 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	Log index (0 = most recent).
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.

10.19 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.

10.20 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.

10.21 Command #151 - Read Minimum, Maximum, and 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.

10.22 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.

10.23 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 O2 levels.

Command-Specific Response Codes

Code	Class	Description
0	Success	No command-specific errors.
1–15		Undefined.
16	Error	Access restricted.
17–127		Undefined.

10.24 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.

10.25 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. See 10.25.1 Error Bitmap.
6–9	Unsigned-32	Extended error bitmap. See 10.25.2 Extended Error Bitmap.

Command-Specific Response Codes

Code	Class	Description
0	Success	No command-specific errors.
1–15		Undefined.
16	Error	Access restricted.
17–127		Undefined.

10.25.1 Error Bitmap

Byte 2	Bit	Fault Name	Fault Description
	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	Bit	Fault Name	Fault Description
	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	Bit	Fault Name	Fault Description
	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	Bit	Fault Name	Fault Description
	24	Reserved	
	25	Reserved	
	26	Reserved	
	27	Reserved	
	28	Reserved	
	29	Reserved	
	30	Reserved	
	31	Reserved	

10.25.2Extended Error Bitmap

Byte 6	Bit	Fault Name	Fault Description
	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	Bit	Fault Name	Fault Description
	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	Bit	Fault Name	Fault Description
	16	Device Specific Command 168	Read Gas Name Device Specific Command (168) supported
	17	Device Specific Command 202/203	Fixed Current Mode Commands (202, 203) supported
	18	Reserved	
	19	Reserved	
	20	Reserved	
	21	Reserved	
	22	Reserved	
	23	Reserved	

Byte 9	Bit	Fault Name	Fault Description
	24	Reserved	
	25	Reserved	
	26	Reserved	
	27	Reserved	
	28	Reserved	
	29	Reserved	
	30	Reserved	
	31	Reserved	

10.26 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.

10.27 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.

10.28 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.

10.29 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.

10.30 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.

10.31 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.

10.32 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.

10.33 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.

10.34 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	Flaot	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.

10.35 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.

10.36 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.

10.37 Command #167 - Set 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.

10.38 Command #168 - Read Gas Names

This command reads the gas name from the device.

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)
1-6	ISO Latin-1	Gas Name in ISO Latin-1 (ASCII), padded with spaces (0x20)

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

10.39 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.

10.40 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.

10.41 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. See 10.17.1 Relay Configuration Bitmap .

Command-Specific Response Codes

Code	Class	Description
0	Success	No command-specific errors.
1–15		Undefined.
16	Error	Access restricted.
17–127		Undefined.

10.42 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.

10.43 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.

10.44 Command #179 - Reset Data Sheet

This command causes a reset of the selected datasheet — transmitter, first sensor, 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.

10.45 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.

10.46 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.

10.47 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.

10.48 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.

10.49 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.

10.50 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.

10.51 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.

10.52 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.

10.53 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.

10.54 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.

10.55 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.

10.56 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. See 10.56.1 System Status Bitmap.
2–3	Unsigned-16	Non-critical system status bitmap. See 10.56.2 Non-critical System Status Bitmap

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.

10.56.1 System Status Bitmap

Bit15	Bit14	Bit13	Bit12
General System.	Reserved.	Reserved.	Reserved.

Bit11	Bit10	Bit9	Bit8
Reserved.	Reserved.	Reserved.	Invalid configuration.

Bit7	Bit6	Bit5	Bit4
Relay fault.	Sensor 2 fault.	Sensor 1 fault.	Internal circuit fault.

Bit3	Bit2	Bit1	Bit0
EEPROM fault.	FLASH checksum.	RAM checksum.	Low supply voltage.

10.56.2 Non-critical System Status Bitmap

Bit15	Bit14	Bit13	Bit12
Reserved.	Reserved.	Reserved.	Reserved.

Bit11	Bit10	Bit9	Bit8
Reserved.	Reserved.	Reserved.	Reserved.

Bit7	Bit6	Bit5	Bit4
Led control.	HART fault.	BCM fault.	Bluetooth module.

Bit3	Bit2	Bit1	Bit0
Fail to complete setup.	Display/UI board.	RTC battery low.	User input switch.

10.57 Command #198 - Read Analog Output Feedback

This command reads the analog output 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.

10.58 Command #199 - Read Analog Output Type

This command reads Analog Output Type information whether the output type is selectable and if it is source or sink.

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Is Analog Output Selectable (0=No, 1=Yes)
1	Unsigned-8	Is Analog Output Source (0=No, 1=Yes)

Command-Specific Response Codes

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

10.59 Command #200 - Set TruCal Output Enabled Flag

This command sets the TruCal Output Enabled Flag.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	TruCal Output Enabled Flag (0=False, 1=True)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	TruCal Output Enabled Flag (0=False, 1=True)

Command-Specific Response Codes

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

10.60 Command #201 - Read TruCal Output Enabled Flag

This command reads the TruCal Output Enabled Flag.

Request Data Bytes

Byte	Format	Description

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	TruCal Output Enabled Flag (0=False, 1=True)

Command-Specific Response Codes

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

10.61 Command #202 - Select Fixed Current Mode Channel

This command initiates the Fixed Current Mode for the specified analog output channel.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Analog output channel (1, 2)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Analog output channel (1, 2)

Command-Specific Response Codes

Byte	Format	Description
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5-15		Undefined
16	Error	Access Restricted
17-127		Undefined

10.62 Command #203 - Set Fixed Current Mode Output Level

This command sets the fixed current value, in mA, for the currently selected analog output.

Request Data Bytes

Byte	Format	Description
0	Float	Desired Analog Output Level in mA

Response Data Bytes

Byte	Format	Description
0	Float	Analog output level in mA

Command-Specific Response Codes

Byte	Format	Description
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6-7		Undefined
8	Error	Update Failure
9-15		Undefined
16	Error	Access Restricted
17-127		Undefined

ANNEX A. CAPABILITY CHECKLIST

Manufacturer, model and revision	MSA, X5000_WIRE, Rev. 2
Device type	Transmitter
HART revision	7.9
Device Description available	Yes
Number and type of sensors	2
Number and type of actuators	0
Number and type of host side signals	2: 4-20mA analog
Number of Device Variables	0

Number of Dynamic Variables	2
Mappable Dynamic Variables?	No
Number of common-practice commands	8
Number of device-specific commands	62
Bits of additional device status	34
Alternative operating modes?	No
Burst mode?	No
Write-protection?	No

ANNEX B. DEFAULT CONFIGURATION

Parameter	Default Value
Lower Range Value	N/A
Upper Range Value	N/A
PV Units	Varies by sensor
SV Units	Varies by sensor
Sensor Type	Varies by 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

ANNEX C. Revision History

Revision	Date	Author	Description
1	20-Feb-2015	David McMasters	Document creation.
2	29-Apr-2016	David McMasters	Added Read and Set Diffusion Supervision Enable Status. Changed ASIC firmware version to match value sent from sensor.
3	19-May-2016	David McMasters	Changed Event Log Date to HART Date format.
4	10-Aug-2016	David McMasters	Changed Command 198 to return Analog Output Feedback values
5	03-Oct-2016	David McMasters	Added Diffusion Supervision Available flag to Read Diffusion Supervision Enable.
6	17-Jan-2017	David McMasters	Added support for reading the % of Span Value Change field from each sensor.
7	04-Apr-2017	David McMasters	Updated product name, updated Common Practice Command section.
8	17-Apr-2017	David McMasters	Added Sensor Error Bitmap and Extended Error Bitmap tables.
9	18-Apr-2017	David McMasters	Added sensor status 0x7B (123) Calibration Recommended.
10	16-Dec-	David	Updated Common Practice Command list

Revision	Date	Author	Description
	2025	McMasters	Added several Device Specific Commands (168, 199, 200, 201, 202, 203) Added Annex A and Annex B. Changed Revision History to Annex C Revision History