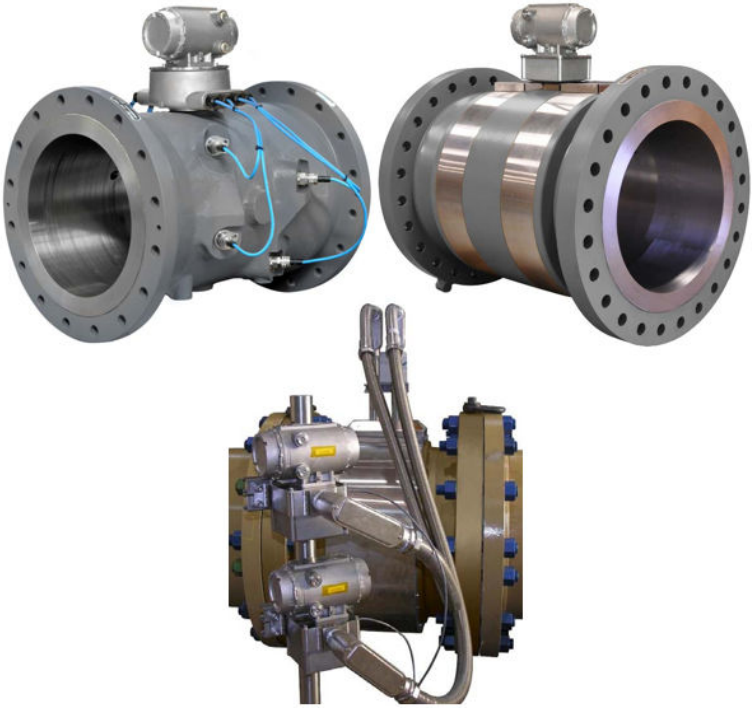
Quick Start Guide
00825-0300-3810, Rev AB
November 2023

Rosemount™ 3810 Series Liquid Ultrasonic Meters

HART® Field Device Specification



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Contents

1 Introduction

1.1 Scope

The scope of this document is to define the HART® revision 7 functional requirements, device specific commands and all Universal and the supported Common Practice commands supported by the HART interface for the Rosemount 3810 Series Liquid Ultrasonic Flow Meters.

1.2 Purpose

The purpose of this document is to list the functional requirements for developing the 3810 Series Liquid Ultrasonic Flow Meters HART® rev 7 firmware. This document complies with HART Protocol Revision 7 and Field Device Specification HCF_LIT-18, Revision 11.0 in preparation and development of engineering regression tests of functionality not covered by the HCF-Kit-192.

1.3 Who should use this document?

This specification is designed to be a technical reference for HART capable Host Application Developers, System Integrators, and knowledgeable End Users. It also provides functional specifications (e.g., commands, enumerations and performance requirements) used during Field Device Development, maintenance and testing. This document assumes the reader is familiar with HART Protocol requirements and terminology.

1.4 Definitions, acronyms, abbreviations and references

The following is a list of commonly used definitions used throughout this document.

1.4.1 Definitions

Table 1-1: Definitions

Name	Definition
Emerson Field Communicator	AMS™ Trex field communicator handheld device

1.4.2 Acronyms

Table 1-2: Acronyms

Acronym	Definition
ADC	Analog to Digital Converter
API	Application Program Interface
ATEX	Atmospheres Explosives (French)
CPU	Central Processing Unit
D/A	Digital-to-Analog
DAC	Digital to Analog Converter
DD	Device Description (HART)
EDDL	Electronic Device Description Language (HART)
FPGA	Field-Programmable Gate Array
HART	Highway Addressable Remote Transducer
I/O	Input(s)/Output(s)
LED	Light-Emitting Diode

1.4.3 Abbreviations

Table 1-3: Abbreviations

Abbreviation	Definition
°C	Degrees Celsius (alternatively, degrees Centigrade)
A/D	Analog-to-Digital
D/A	Digital-to-Analog
Enum	Enumerated
Hz	Hertz
mA	Milliamperes (also referred to as milliamps)
RX	Receive
TX	Transmit

1.4.4 References

The documents referenced within the text of this document are listed in Table 1-4.

Table 1-4: Reference documentation

Title	Document number, revision, date
American Petroleum Institute (API) Manual of Petroleum Measurement Standards (MPMS) Chapter 21 - Flow Measurement Using Electronic Metering Systems Section 1 - Electronic Gas Measurement	First Edition (01 September, 1993)
HART SMART Communications Protocol Specification (also includes the specifications listed below)	HCF_SPEC 13, Rev. 7.8 (08 February, 2022)
FSK Physical Layer Specification	HCF_SPEC 54, Rev. 9.1 (27 May, 2016)
Data Link Layer Specification	HCF_SPEC - 81, Rev. 9.1 (03 December, 2019)
Command Summary Specification	HCF_SPEC 99, Rev. 10.1 (08 January, 2020)
Universal Command Specification	HCF_SPEC - 127, Rev. 7.2 (22 June, 2020)
Common Practice Command Specification	HCF_SPEC-151, Rev. 12.0 (06 July, 2020)
Common Tables	HCF_SPEC 183, Rev. 24.0 (30 June, 2016)
Command Specific Response Code Definitions	HCF_SPEC - 307, Rev. 6.0 (05 September, 2007)

2 Device identification

This section details the Rosemount 3810 Series Liquid Ultrasonic Flow Meter identification and physical description.

2.1 Rosemount 3810 Series Liquid Ultrasonic Flow Meter identification

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter Field Device Identification summary is shown in Table 2-1.

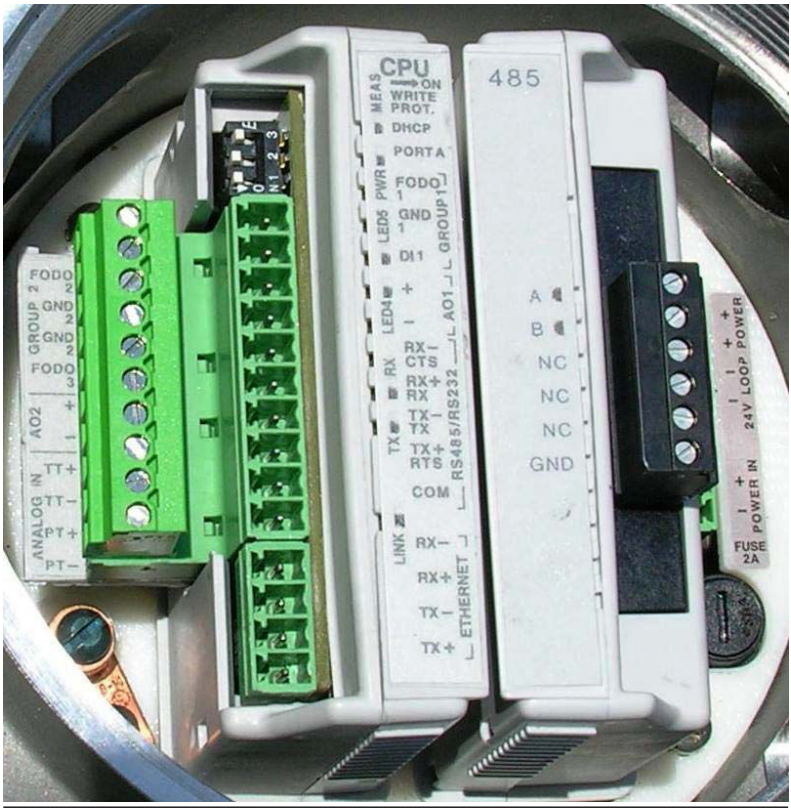
Table 2-1: 3810 Series Liquid Ultrasonic Flow Meter device identification

Manufacturer name	Emerson	Model name(s)	Rosemount 3810 Series Liquid Ultrasonic Flow Meter
Manufacturer ID Code	38 (26 Hex)	Device Type Code	154 (9A Hex)
HART Protocol Revision	7.8	Device Revision	7
Number of Device Variables	5		
Physical Layers Supported	Bell 202 FSK	**Note** HART Hardware Revision	4
Physical Device Category	Rosemount 3810 Series Liquid Ultrasonic Flow Meter	HART Software Revision	26

2.2 Physical description

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter electronics enables the meter to easily communicate with other field devices, and ultimately, communicate key diagnostic information through PlantWeb™ architecture. Any programmable device, such as the FPGA, is programmed via the CPU Module. The CPU Module part number is P/N 1-360-03-001).

Figure 2-1: 3810 Series Liquid Ultrasonic Flow Meter electronics - CPU Module



3 Product overview

This section specifies the purpose and application of the Rosemount 3810 Series Liquid Ultrasonic Flow Meter for HART communication.

3.1 Device function, purpose and features

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter communicates with other field devices, and ultimately, communicates key diagnostic information through the PlantWeb™ architecture.

All analog inputs and outputs are isolated from each other and isolated from the system with a minimum isolation of 500 V.

3.2 Process connections

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter's updated electronics includes the firmware, CPU Module and the Acquisition module allows communications with other field devices.

3.3 External interfaces (electrical and non-electrical)

Any pressure and/or temperature input read via Rosemount 3810 Series Liquid Ultrasonic Flow Meter is configurable using a hand-held communicator (e.g., Emerson's AMS Trex™ Field Communicator) and not via meter such as for device address, device tag, limits, and units.

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter is compliant with Asset Management Solutions, AMS™ Device Manager, software applications that provides operator interface between the HART enabled field device and a remote PC.

3.4 Other required equipment

A RS-232C/RS-485 (half duplex) serial communication port for Modbus communication is provided as Port A, Port B and Port C.

Any programmable device aboard the Rosemount 3810 Series Liquid Ultrasonic Flow Meter (such as an FPGA) is programmed via the CPU Module.

4 Product interfaces

This section discusses the Rosemount 3810 Series Liquid Ultrasonic Flow Meter for HART communications, electrical interface, and input and output requirements.

4.1 Process interface

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter is capable of communicating with a flow computer or other interface devices (e.g. AMS™ Device Manager or an Emerson Field Communicator, etc.) via HART and enables PlantWeb connectivity.

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter provides an RS-232C/RS-485 half-duplex serial communications port (Port A) connected via the CPU Module. Two independent analog input circuits and 16-bit, 4-20 mA analog output circuits are supported. Note that CPU module Revision 2 supports two analog outputs (AO1 and AO2). On CPU Rev 4, only AO1 is supported and AO2 is not supported.

LED status indicators show 24 V power, 24 V current limit, TX and RX serial communication ports, and HART slave communication via Analog Output 1.

4.1.1 Sensor input channels

Rosemount 3810 Series Liquid Ultrasonic Flow Meters support analog and discrete inputs as shown below.

Name	Functional description
Analog Input 1	4-20 mA Input for temperature device
Analog Input 2	4-20 mA Input for pressure device **Note** AI-1 and AI-2 are electronically isolated and operate in sink mode. The input contains a series resistance so HART Communicators can be connected to configure sensors. A 24 Volt DC power supply is available to provide power to the sensors.
Digital Input(s) (Selectable)	(1) Single polarity (for flow calibration gating - contact closure) • Single input for starting and stopping • Four pulse configurations available

Name	Functional description
Ethernet Port	One Ethernet Port (TCP/IP) • Up to 100 Mbps • Modbus TCP
Frequency/Digital Output(s)	Maximum frequency for the frequency outputs • 1000 Hz • 5000 Hz Mode options: • Open Collector (requires external excitation supply voltage and pull-up resistor) • TTL (internally powered by the meter 0-5 Vdc signal)
Serial Port	One serial RS-232/RS-485 port (115 kbps baud rate) (Modbus RTU/ASCII)
Transducers	• LT-01 • LT-03 • LT-04 • LT-05 • LT-06 • LT-07 • LT-08 • LT-09 • LT-10 • LT-11 • LT-14 • LT-15 • LT-16 • LT-17 **Note** The process temperature must not exceed the operating temperature range of the transducers.

4.1.2 Sensor analog output channels

The firmware supports two independently-configurable analog outputs (AO1 and AO2) with CPU Rev. 2. On CPU Rev. 4, only AO1 is supported and AO2 is not supported. For conventional operation, the analog output channels provide identical but separate configuration parameters including, but not limited to, the currently available AO1 configuration parameters (for content and scaling configuration). These configuration parameters follow the same naming convention as the AO1 related configuration parameters (which retain their current names). The Boolean data point, `IsAO1Avail` indicates the presence of Analog Output 1 (AO1).

Note
HART communication is available over AO1 only.

Table 4-1: Analog output configuration parameters

Direction		Values (percent of range)	Values (e.g., in mA)
Linear over-range	Down greater than	-3.125%	3.5 mA
	Up less than	+106.25%	21 mA
Maximum current		+106.25%	21 mA
Multi-drop current draw		4 mA (available in sink mode only)	
Lift-off voltage		7 V	@ full scale

Choose the HART selectable output Primary or Secondary Variable (via any serial, Ethernet, or HART slave port) from among the following choices:

- uncorrected volumetric flow rate
- average flow velocity
- average speed of sound

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter output Third and Fourth Variables (via any serial, Ethernet, or HART slave port) from among the choices available for the Primary Variable and additionally the following choices (if applicable):

- live pressure value
- live temperature value

NOTICE

Configuration via the HART slave port, requires device-specific commands.

- for each frequency output: maximum frequency, content, relationship to flow direction, B channel action upon error, A and B channel phase relationship, and output scaling
- for each digital output: content, and polarity
- for each analog output (conventional 4-20 mA operation): content, relationship to flow direction, and output scaling

Trim the analog outputs via HART, serial or Ethernet interfaces.

- The HART slave output supports configurable preamble length.
- The HART slave supports the HART Rev. 7 commands listed in Universal commands through Performance.
- The HART slave does not support transfer functions.

Each analog output has individually configurable alarm selections. The selections include:

- Very low (3.5 mA)
- Low (4.0 mA)
- High (20 mA)
- Very high (20.5 mA)
- Hold last value
- None

Trim the analog outputs via, serial or Ethernet interfaces. The `AOXActionUponInvalidContent` data point specifies the action for Analog Output 1 current when the content is invalid. No special action is taken when set to none.

Each analog output is considered saturated if the "pre-trimmed" value is (strictly) outside the range (3.5, 20.5) mA. Note that a value less than 4 mA should only occur if the output is invalid and the invalid content is selected to be represented by a fixed 3.5 mA output. The database point `AOXIsSaturated` shall be used to indicate the saturation status.

For each analog output, after the saturation determination is made, then the DAC-limits of (3.5, 21) mA is applied to the pre-trimmed value. The resulting value is written to the appropriate `AOXOutput`

database point (so that the point's meaning is consistent with the pre-HART firmware).

The analog output trim zero and gain values (stored in database points `AOXCurrentTrimZero` and `AOXCurrentTrimGain`, respectively) are always applied to the analog output's pre-trimmed, DAC-limited value (i.e., the value stored in the database point `AOXOutput`) as shown in Equation 4-1 (all values in milliamps except the dimensionless gain). The DAC-limits (3.5, 21 mA) is applied to the resultant trim value (`AOXTRIM`) and DAC-limited result shall be stored in the database point `AOXOutputTrimmed` and output to the DAC.

Equation 4-1: AO(X) Output Trim

$$AOX_{TRIM} = (AOXCurrentTrimGain\ x\ (AOXOutput - 4)) + 4 + \text{AOXCurrentTrimZero}$$

The user shall be able to zero the meter (i.e., perform zero-flow calibration) via any serial, Ethernet, or HART slave port.

4.1.3 Time stamp

A time stamp shall be calculated for each of the HART device variables when the device variable is updated and the status is good. The time stamps shall be associated with the corresponding data points shown in Table 4-2.

Table 4-2: Device variables time stamp

Device variable	Associated time stamp data point name
Uncorrected flow rate (QFlow)	HARTQFlowUpdateTime
Average flow velocity	HARTAvgFlowUpdateTime
Average speed of sound	HARTAvgSndVelUpdateTime
Pressure (FlowPressure)	HARTPressureUpdateTime
Temperature (FlowTemperature)	HARTTemperatureUpdateTime

Time stamps shall be calculated for additional device variables that indicate percent of range and loop current.

Table 4-3: Time stamp calculations for additional device variables

Device variable	Associated time stamp data point name
Percent range	HARTPercentRangeUpdateTime

Table 4-3: Time stamp calculations for additional device variables *(continued)*

Device variable	Associated time stamp data point name
Analog output 1	HARTAO1OutputUpdateTime

Time stamps shall:

- be unsigned 32 bit integer with least significant bit of time value representing 1/32 of milliseconds
- indicate time since midnight and shall rollover after 24 hours
- have units of milliseconds

5 Device variables

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter does not use Device Family commands.

5.1 Device variable 0 - uncorrected flow rate

The flow-condition volumetric flow rate is the result of applying expansion correction and flowprofile correction to the raw volumetric flow rate derived as shown in Equation C-1 subject to the low-flow cut-off (see Device variable calculations). If the resulting value is below the low-flow cut-off value, it is set to zero. The low-flow cut-off volumetric flow rate (`QCutOff`) is the specified low-flow velocity threshold (`ZeroCut`) converted to a volumetric flow rate.

Device variable			
Number:	0	Name:	Uncorrected Flow Rate
Classification:	66 Volumetric Flow	Unit Codes:	see Volumetric flow rate units

5.2 Device variable 2 - average flow velocity

The meter uses two calibration steps: “dry” calibration and “wet” calibration.

The dry-calibration gas flow velocity is the result of applying a third-order polynomial equation to the average weighted gas flow velocity as shown in Equation C-3.

Note
The meter provides two sets of dry calibration coefficients - one set for each flow direction.

Device variable			
Number:	2	Name:	Average Flow Velocity
Classification:	67 Volumetric Flow	Unit Codes:	see Velocity units

5.2.1 Wet calibration

The Rosemount Ultrasonic meter offers three selections for wet calibration: 12-point piecewise linearization, a third-order polynomial,

or none. The wet calibration method to use is selected via the CalMethod data point with “None” being the default value. The wet calibration gas flow velocity is calculated from the dry calibration gas flow velocity as shown in Equation C-4.

5.2.2 Piece-wise linearization

If the 12-point piece-wise linearization (PWL) wet calibration method is selected, then the drycalibration gas flow velocity is calculated as shown in Equation C-5.

The inputs to the 12-point piece-wise linearization are the (up to) 12 pairs of volumetric flow rate and meter factor for each flow direction ([`FwdFlwRt1, FwdMtrFctr1`], ..., [`FwdFlwRt12, FwdMtrFctr12`] for forward flow; [`RevFlwRt1, RevMtrFctr1`], ..., [`RevFlwRt12, RevMtrFctr12`] for reverse flow).

The linear meter factor is determined by the PWL inputs, the flow direction, and the drycalibration gas flow velocity.

5.2.3 Third-order polynomial

If the third-order polynomial wet calibration method is selected, then the wet-calibration gas flow velocity is calculated as shown in Equation C-6.

Note
The meter provides two sets of wet calibration polynomial coefficients - one set for each flow direction.

5.2.4 No wet calibration

If no wet calibration is selected, then the wet calibration gas flow velocity is equal to the dry calibration gas flow velocity (see No wet calibration).

5.3 Device variable 3 - average speed of sound

The average (weighted) sound velocity is calculated as the weighted average of the active chord sound velocity measurements as shown in Equation C-7.

Device variable			
Number:	3	Name:	Average Sound Velocity
Classification:	67 Velocity	Unit Codes:	see Velocity units

5.4 Device variable 6 - pressure

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter samples the input analog signal(s) and updates the corresponding data point (`LiveFlowPressure`) once per second regardless of the input selection (disabled, live, or fixed).

Every five seconds, the meter updates the “in-use” flow-condition pressure and temperature values (`FlowPressure` and `AbsFlowPressure`) depending upon the input selection, validity of the input data, and the selected data source upon alarm in Pressure and temperature tables.

The flow-condition pressure is configurable (via the `EnablePressureInput` data point) to be:

- disabled (0)
- live (1) (4-20 mA input signal) or
- fixed (2)

Device variable			
Number:	6	Name:	Pressure
Classification:	65 Pressure	Unit Codes:	see Pressure units

If an input is live, then the values corresponding to the minimum and maximum input (4 and 20 mA, respectively) are specified via data points `MinInputPressure` and `MaxInputPressure`.

To configure the live pressure, plus associated alarms, configure the data points in Pressure and temperature tables.

5.5 Device variable 7 - temperature

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter samples the input analog signal(s) and updates the corresponding data point (`LiveFlowTemperature`) once per second regardless of the input selection (disabled, live, or fixed).

Every five seconds, the meter updates the “in-use” flow-condition pressure and temperature values (`FlowTemperature`) depending upon the input selection, validity of the input data, and the selected data source upon alarm according to Equation C-12.

The flow-condition temperature is configurable (via the `EnableTemperatureInput` data point) to be:

- disabled (0)
- live (1) (4-20 mA input signal, requires a CPU Module)
- fixed (2)

Device variable			
Number:	7	Name:	Temperature
Classification:	64 Temperature	Unit Codes:	see Temperature units

If an input is live, then the values corresponding to the minimum and maximum input (4 and 20 mA, respectively) are specified via data points `MinInputTemperature` and `MaxInputTemperature`.

To configure the live pressure, plus associated alarms, configure the data points in Pressure and temperature tables.

5.6 HART slave device variables good status indicators

Refer to Table 5-1 for HART Slave Device Variables database points indicating the response status is good.

Table 5-1: Device variable good indicators

Device variable Code - content	Device variable Classification code	Device variable Good indicators
0 - Uncorrected flow rate	66	QFlowValidity
2 - Average flow velocity	67	N/A (always valid)
3 - Average speed of sound	67	N/A (always valid)
6 - Pressure (3rd and 4th variable only)	65	HARTIsPressureGood
7 - Temperature (3rd and 4th variable only)	64	HARTIsTemperatureGood

6 Dynamic variables

This section documents the HART primary, secondary, tertiary, and quaternary variables.

6.1 Fixed dynamic variables

There are no fixed Dynamic Variables for this device.

6.2 Dynamic variables with configurable mapping

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter allows the following user-configurable dynamic variables mapped to the device variables:

Table 6-1: Dynamic variables configurable mapping

Dynamic variable	Device variable number	Name
PV (Primary Variable)	0	• 0 - Uncorrected flow rate • 2 - Average flow velocity • 3 - Average speed of sound
SV (Secondary Variable)	0	0 - Uncorrected flow rate
TV (Third Variable)	0, 6 or 7	0, 6, 7: PV + Pressure, Temperature
QV (Fourth Variable)	0, 6 or 7	0, 6, 7: PV + Pressure, Temperature

The default primary Dynamic Variable is Uncorrected Flow Rate for all meters.

7 Status information

This section documents the HART primary, secondary, third, and fourth variables for the Rosemount Liquid Ultrasonic Flow Meter.

The meter status information is derived from Boolean database points. For host display purposes, the status information is divided into three categories:

Failed	indications that the meter is not working properly and has lost measurement
Maintenance	indications that the meter requires operator intervention
Advisory	indications that the meter has information but is still measuring flow and does not require operator intervention

The meter uses the following mechanisms for communicating the status information to the host system:

- the Device Status Byte sent with every slave response
- the Read Additional Device Status Universal Command 48 (see Additional device status (Command 48))
- the device-specific command for reading detailed status information Command 140 (see Command 140 Read detailed status).

Device-Specific Command 141 (see Command 141 Acknowledge alarm) is used to acknowledge status Boolean database points that require acknowledgment.

Alerts are sorted into three groups: Failed, Maintenance, and Advisory. These groups are displayed in AMS™ Device Manager and communicated via Universal Command 48 (see Additional device status (Command 48)) unless it is indicated via the device status byte.

The database point mapping for the Device Status Byte is shown in Table 7-1. Command 48 database point mapping is shown in Table 7-2. Note that for Command 48, only the first 16 bytes (numbered 0 through 15) shall be sent by the HART Slave. Additional Device Status information shall be communicated via Device-Specific Command 140 (illustrated in the command definition in Command 140 Read detailed status).

7.1 Device Status

Table 7-1: Device status byte database point mapping

Device status bit	Definition	Explanation	Related database point(s)
7 (msb)	Device Malfunction - The device detected a serious error or failure that compromises device operation.	This will be the logical OR'ing of the related database points.	• IsAcqModuleError • IsCorePresent • WatchDogReset • IsElecVoltOutOfRange • IsAcqModuleIncompatible
6	Configuration Changed - An operation was performed that changed the device's configuration.	Configuration Changed flag of corresponding master. If the request is made by primary master then primary master config changed flag will be communicated else secondary master config changed flag.	• HARTDidPrimaryConfigChange Or • HARTDidSecondaryConfigChange
5	Cold Start - A power failure or Device Reset has occurred.	A separate Cold Start bit in the Device Status byte must be provided for each master (i.e. one for Primary master and another for the Secondary Master). Cold start status of corresponding master will be communicated.	• HARTDidPowerFailPrimary Or • HARTDidPowerFailSecondary
4	More Status Available - More status information is available via Command 48, Read Additional Status Information.	This bit shall be set whenever a Command 48 bit is active. Refer to Additional device status (Command 48) for the Command 48 bit map.	N/A

Table 7-1: Device status byte database point mapping *(continued)*

Device status bit	Definition	Explanation	Related database point(s)
3	Loop Current Fixed - The Loop Current is being held at a fixed value and is not responding to process variations.	This bit shall be set whenever the AO1current output is fixed (whether via HART Command 40 or via enabling the test mode). Thus, it shall be the logical OR'ing of the related database points.	• IsAO1EnableTest • AO1IsFixed
2	Loop Current Saturated - The loop Current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.		AO1IsSaturated
1	Non-Primary Variable Out of Limits - A Device Variable not mapped to the PV is beyond its operating limits.	This bit shall be set whenever any Device Variable not mapped to the PV is out-of-limits. It shall be the logical OR'ing of the related out-of-limits database points. It shall use the AO1-Content database point to determine which Device Variable is mapped to the PV.	• FlowPressureIsOutOfLimits • FlowTemperatureIsOutOfLimits
0 (lsb)	Primary Variable Out of Limits - The Primary Variable is beyond its operating limit.	This bit shall be set whenever the Device Variable mapped to the PV is out-of-limits. It shall use the AO1Content database point to determine which Device Variable is mapped to the PV. Note that some Device Variables do not have limits and thus do not have associated out-of-limits database points.	AO1Content

7.2 Additional device status (Command 48)

Command 48 returns the first 16 data bytes (numbered 0 through 15) by the HART Slave. Additional Device Status information is communicated via Device-Specific Command 140.

Request Data Bytes

Table 7-2: Additional device status (Command 48)

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>0</td><td>Bits</td><td>Byte 0
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Acquisition mode indicator</td><td>IsAcqMode</td></tr>
<tr><td>6</td><td>Meter cold-start indicator</td><td>DidColdStart</td></tr>
<tr><td>5</td><td>Acquisition mode latched indicator</td><td>IsAcqModeLatched</td></tr>
<tr><td>4</td><td>Number of operating chords below specified minimum latched indicator</td><td>IsTooFewOperChordsLatched</td></tr>
<tr><td>3</td><td>Number of operating chords below specified minimum</td><td>IsTooFewOperChords</td></tr>
<tr><td>2</td><td>Acquisition board communications error latched indicator</td><td>IsAcqModuleErrorLatched</td></tr>
<tr><td>1</td><td>Acquisition module error latched indicator</td><td>IsAcqModuleIncompatible</td></tr>
<tr><td>0 (lsb)</td><td>Acquisition module error</td><td>IsAcqModuleError</td></tr>
</table></td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>1</td><td>Bits</td><td>Byte 1
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Chord A is hard failed</td><td>IsHardFailedA</td></tr>
<tr><td>6</td><td>Chord B is hard failed</td><td>IsHardFailedB</td></tr>
<tr><td>5</td><td>Chord C is hard failed</td><td>IsHardFailedC</td></tr>
<tr><td>4</td><td>Chord D is hard failed</td><td>IsHardFailedD</td></tr>
<tr><td>3</td><td></td><td>Reserved</td></tr>
<tr><td>2</td><td></td><td>Reserved</td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>0 (lsb)</td><td>Meter velocity is above the maximum limit</td><td>IsMeterVelAboveMaxLmt</td></tr>
</table></td></tr>
<tr><td>2</td><td>Bits</td><td>Byte 2
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Flow-condition pressure invalid</td><td>PressureInvalid</td></tr>
<tr><td>6</td><td>Flow-condition temperature invalid</td><td>TemperatureInvalid</td></tr>
<tr><td>5</td><td></td><td>Reserved</td></tr>
<tr><td>4</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>2</td><td>Live digital pressure latched indicator</td><td>PressureInvalidLatched</td></tr>
<tr><td>1</td><td>Live digital temperature latched indicator</td><td>TemperatureInvalidLatched</td></tr>
<tr><td>0 (lsb)</td><td></td><td>Reserved</td></tr>
</table></td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>3</td><td>Bits</td><td>Byte 3
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Clock is not set correctly</td><td>IsClkInvalid</td></tr>
<tr><td>6</td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td></tr>
<tr><td>4</td><td>Indicator that the meter should be warm-started</td><td>IsWarmStartReq</td></tr>
<tr><td>3</td><td>Chord A failed for current batch</td><td>IsFailedForBatchA</td></tr>
<tr><td>2</td><td>Chord B failed for current batch</td><td>IsFailedForBatchB</td></tr>
<tr><td>1</td><td>Chord C failed for current batch</td><td>IsFailedForBatchC</td></tr>
<tr><td>0 (lsb)</td><td>Chord D failed for current batch</td><td>IsFailedForBatchD</td></tr>
</table></td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>4</td><td>Bits</td><td>Byte 4
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Invalid measurement indicator - logical OR'ing of the related database points</td><td>• QFlowValidity (inverted)
• Freq1DataValidity (inverted)
• Freq2DataValidity (inverted)
• AO1DataValidity (inverted)
• AO2DataValidity (inverted)
• HARTTVValidity (inverted)
• HARTQVValidity (inverted)
• HARTSlot0Validity (inverted)
• HARTSlot1Validity (inverted)
• HARTSlot2Validity (inverted)
• HARTSlot3Validity (inverted)</td></tr>
<tr><td>6</td><td>Enables test mode for Digital Output 1 pair</td><td>DO1PairTestEnable</td></tr>
<tr><td>5</td><td>Enables test mode for Digital Output 2 pair</td><td>DO2PairTestEnable</td></tr>
<tr><td>4</td><td>Power failure</td><td>DidPowerFail</td></tr>
<tr><td>3</td><td>Latched alarm</td><td>IsMeterVelAboveMaxLmtLatched</td></tr>
<tr><td>2</td><td>Configuration checksum changed</td><td>DidCnfgChksumChg</td></tr>
<tr><td>1</td><td>Average sound velocity range error</td><td>IsAvgSoundVelRangeErr</td></tr>
</table></td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>0 (lsb)</td><td>Latched alarm</td><td>IsAvgSoundVelRangeErrLatched</td></tr>
</table>
</td></tr>
<tr><td>5</td><td>Bits</td><td>Byte 5
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>One or more logs full indicator - logical OR'ing of the related database points</td><td>• IsHourlyLogFull
• IsDailyLogFull
• IsAuditLogFull
• IsAlarmLogFull
• IsSystemLogFull</td></tr>
<tr><td>6</td><td>Frequency Output 1 pair test enable</td><td>IsFreq1EnableTest</td></tr>
<tr><td>5</td><td>Frequency Output 2 pair test enable</td><td>IsFreq2EnableTest</td></tr>
<tr><td>4</td><td>Flow-condition pressure out of limits</td><td>FlowPressureIsOutOfLimits</td></tr>
<tr><td>3</td><td>Flow-condition temperature out of limits</td><td>FlowTemperatureIOutOfLimits</td></tr>
<tr><td>2</td><td>Forward baseline not set</td><td>IsFwdBaselineNotSet</td></tr>
<tr><td>1</td><td>Reverse baseline is not set</td><td>IsRevBaselineNotSet</td></tr>
<tr><td>0 (lsb)</td><td>Electronics temperature is out of nominal range</td><td>IsElecTempOutOfRange</td></tr>
</table>
</td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>6</td><td>Enum-8</td><td>Extended device status (See Table 17 of HCF-SPEC-183)
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>1</td><td>HART device status alert</td><td>HARTIsDeviceVarAlert</td></tr>
<tr><td>0 (lsb)</td><td>HART maintenance required</td><td>HARTIsMaintenanceReq</td></tr>
</table></td></tr>
<tr><td>7</td><td>Enum-8</td><td>Device operating mode shall be set 0 since it is reserved by HCF (See Table 14 of HCF-SPEC- 183)</td></tr>
<tr><td>8</td><td>Bits</td><td>Standardized Status 0
<table>
<tr><th>Code</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>0x08</td><td>Watchdog reset executed</td><td>WatchdogReset</td></tr>
<tr><td>0x10</td><td>Voltage condition out of range</td><td>IsElecVoltOutOfRange</td></tr>
<tr><td>0x20</td><td>Environmental conditions out of range</td><td>IsElecTempOutOfRange</td></tr>
</table>
Remaining Bits shall be set to 0.</td></tr>
<tr><td>9</td><td>Bits</td><td>Standardized status 1 shall be set 0 since it is reserved by HCF (See Table 30 of HCF-SPEC-183)</td></tr>
<tr><td>10</td><td>Bits</td><td>Analog Output Saturated, Respectively LSB to MSB: <code>AO2IsSaturated</code>, (bit mapped). Only bit for AO2 will be used.</td></tr>
<tr><td>11</td><td>Bits</td><td>Standardized status 2, shall be set to 0.</td></tr>
<tr><td>12</td><td>Bits</td><td>Standardized status 3, shall be set to 0.</td></tr>
<tr><td>13</td><td>Bits</td><td>Analog Output Fixed, Respectively LSB to MSB: AO2 (bit mapped) where each bit is the OR'ing of the related database points of <code>IsAO<n>EnableTest</code> and <code>AO<n>IsFixed</code>. Only the bit for AO2 is used.</td></tr>
</table>

Table 7-2: Additional device status (Command 48) *(continued)*

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>14</td><td>Bits</td><td>Byte 14
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td></td><td>Reserved</td></tr>
<tr><td>6</td><td></td><td>Reserved</td></tr>
<tr><td>5</td><td></td><td>Reserved</td></tr>
<tr><td>4</td><td></td><td>Reserved</td></tr>
<tr><td>3</td><td>Reverse flow detected</td><td>IsReverseFlowDetected</td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>0 (lsb)</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>15</td><td>Bits</td><td>Byte 15
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td></td><td>Reserved</td></tr>
<tr><td>6</td><td></td><td>Reserved</td></tr>
<tr><td>5</td><td></td><td>Reserved</td></tr>
<tr><td>4</td><td></td><td>Reserved</td></tr>
<tr><td>3</td><td>Reverse flow detected, latched until acknowledged</td><td>IsReverseFlowDetectedLatched</td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>0 (lsb)</td><td>Transducer firing synchronization error</td><td>IsXdcrFiringSyncError</td></tr>
</table></td></tr>
<tr><td>16-24</td><td>Bits, Unsigned-24 or Enum</td><td>Not used at this time and thus not sent.</td></tr>
</table>

8 Universal commands

This section documents the HART Slave universal commands.

8.1 HART universal commands

The HART Slave implements the HART universal commands available with the Rosemount 3810 Series Liquid Ultrasonic Flow Meter as shown in Table 8-1.

Table 8-1: Universal commands for slave implementation

Command	Function	Description
0	Read Unique Identifier	Returns identity information about the meter including: the Device Type, revision levels, and Device ID.
1	Read Primary Variable	Returns the Primary Variable value along with its Unit Code.
2	Read Loop Current and Percent Of Range	Reads the Loop Current and its associated Percent of Range.
3	Read Dynamic Variables and Loop Current	Reads the Loop Current and up to four predefined Dynamic Variables. The Dynamic Variables and associated units are defined via Commands 51 and 53.
6	Write Polling Address	Used to set the meter's polling address and loop current mode.
7	Read Loop Configuration	Read the polling address and the loop current mode.
8	Read Dynamic Variable Classifications	Reads the classification associated with the Dynamic variables.
9	Read Device Variables with Status	This command allows a master to request the value and status of up to eight device or dynamic variables.
11	Read Unique Identifier Associated With Tag	If the specified tag matches that of the meter, it responds with the Command 0 response.
12	Read Message	Reads the Message contained within the meter.
13	Read Tag, Descriptor, Date	Reads the Tag, Descriptor, and Date contained within the meter.

Table 8-1: Universal commands for slave implementation *(continued)*

Command	Function	Description
14	Read Primary Variable Transducer Information	Reads the Transducer (meter) Serial Number, Limits/Minimum Span Unit Codes, Upper Transducer Limit, Lower Transducer Limit, and Minimum Span for the Primary Variable transducer.
15	Read Device Information	Reads the alarm selection code, transfer function code, range values unit codes - upper range value, Primary Variable lower range value, damping value, write protect code, and private label distributor code.
16	Read Final Assembly Number	Reads the Final Assembly Number associated with the meter.
17	Write Message	Write the Message into the meter.
18	Write Tag, Descriptor, Date	Write the Tag, Descriptor, and Date Code into the meter.
19	Write Final Assembly Number	Write the Final Assembly Number into the meter.
20	Read Long Tag	Reads the 32-byte long tag.
21	Read Unique Identifier Associated with Long Tag	If the specified long tag matches that of the meter, it responds with the command 0 response.
22	Write Long Tag	Writes the long tag into meter.
38	Reset Configuration Changed Flag	If the received configuration changed counter matches with device configuration changed counter, then resets the configuration changed flag (Device Status Byte bit 6) of the requesting master (i.e. Primary/Secondary).
48	Read Additional Device Status	Returns meter status information not included in the Response Code or Device Status Byte.

9 Common-practice commands

This section documents the HART additional device status optional Common-Practice Commands.

Note
Common Commands follow the convention of numbering the first analog channel as zero which in this document is referred to as AO1.

9.1 Supported commands

The device features, functionality, and restrictions of Common-Practice Commands are listed in the table below.

Table 9-1: Common-practice commands

Command	Function	Description
33	Read Device Variables	Allows a Master to request the value of up to four Device Variables.
35	Write Primary Variable Range Values	Writes Primary Variable Upper Range Value and Lower Range Value and returns actual values used by device in given units.
40	Enter/Exit Fixed Current Mode	Forces the Loop Current for Primary Variable to the requested value.
42	Perform Device Reset	Forces the meter to perform a warm start (equivalent to cycling the power off and then back on to the meter).
44	Write Primary Variable Units	Selects the units in which the Primary Variable and its range will be returned.
45	Trim Loop Current Zero	Trims the zero or lower endpoint value of the Loop Current exactly to its minimum. This trim is typically performed by adjusting the Loop Current to 4.0 mA and sending the measured value to the meter.
46	Trim Loop Current Gain	Trims the gain or upper endpoint value of the Loop Current exactly to its maximum. This trim is typically performed by adjusting the Loop Current to 20.0 mA and sending the measured value to the meter.
50	Read Dynamic Variable Assignments	Reads the Device Variables assigned to the Primary, Secondary, Tertiary, and Quaternary Variables.

Table 9-1: Common-practice commands *(continued)*

Command	Function	Description
51	Write Dynamic Variable Assignments	Allows the user to assign Device Variables to the Primary, Secondary, Tertiary, and Quaternary Variables.
53	Write Device Variable Units	Selects the units in which the selected Device Variable will be returned.
54	Read Device Variable Information	Responds with the transducer serial number, the Limits, Damping Value (not applicable), and Minimum Span of the Device Variable along with the corresponding engineering units.
59	Write Number Of Response Preambles	Sets the number of asynchronous preamble bytes to be sent by the meter before the start of a response message.
60	Read Analog Channel And Percent Of Range	Read the Analog Level and Percent of Range of the selected Analog Channel.
63	Read Analog Channel Information	Read the configuration of the Analog Channel including: the Alarm Selection Code, Transfer Function Code, Range Unit Code, Upper Range Value, Lower Range Value, and Damping Value.
66	Enter/Exit Fixed Analog Output Mode	Similar to command 40 but allows selection of any analog port not just the Primary Variable.
67	Trim Analog Output Zero	Analog Output current calibration zero (offset).
68	Trim Analog Output Gain	Analog Output current calibration gain.
70	Read Analog Channel Endpoint Values	Read the endpoint values for the selected Analog Channel.
72	Squawk	Causes the addressed device to visually indicate the reception of this command.
89	Set Real-Time Clock	If the Time-set code is 0, responds with the internal time at which the request was received. If the Time-set code is 1, sets Real-Time Clock of meter to have value same as received value.
90	Read Real-Time Clock	Reads the Real-Time Clock including the current time as estimated by the meter and the last time the clock was set.
95	Read Device Communication Statistics	Responds with counts of STX messages received, ACK messages sent and BACK messages sent.

9.2 Burst mode

This device does not support Burst mode.

9.3 Catch device variable

This device does not support the Catch Device Variable.

10 Device-specific commands

This section documents the Device-Specific Commands implemented for the Rosemount 3810 Series Liquid Ultrasonic Flow Meter.

10.1 Public, device-specific commands

The Rosemount 3810 Series Liquid Ultrasonic Flow Meter device-specific commands in each of the following subsections as defined by:

- command number and command name
- functional description
- command's operation (i.e., read/write/command)
- request data (Byte stream position, data format and descriptions)
- response data (Byte stream position, data format and descriptions)
- Command-specific response codes

10.1.1 Command 128 Write analog output configuration

This command is used to configure the meter's specified analog output. The meter provides two analog outputs: Analog Output 1 (AO1) and Analog Output 2 (AO2). Analog Output 1 supports both conventional 4-20 mA output and HART output, whereas Analog Output 2 supports only conventional 4-20 mA output. This command is primarily provided to allow configuration of Analog Output 2. It can be used to configure Analog Output 1 but the preferred method is to configure the output via the supported HART Universal and Common commands.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog output selector	Used to select which analog output to be configured. This is an informational index variable; when written, it is not updated in the device.
1	Unsigned-8	Device variable assigned to the specified analog output	Used to set AOXContent. When this assignment is a configuration change, the remaining data bytes are ignored. However, for the response, the remaining data bytes should reflect the data for the newly assigned device variable.
2	Enum-8	Upper and Lower Range Values Unit Code (Tables)	Specifies the units for the requested Upper and Lower Range Values. This unit code is only pertinent for interpreting this command's data values and for the units of the response's data values. It does not update any units-related data points. This is an informational variable; when written, it is not updated in the device.
3-6	Float	Upper Range Value	Writes: • AOXFullScaleVolFlowRate • AOXMaxVel
7-10	Float	Lower Range Value	Writes AOXMinVel

Byte	Format	Description	Explanation
11	Enum-8	Flow direction to be represented by specified analog output	Writes AOXDir
12	Enum-8	Alarm Selection Code (Tables)	Writes AOXActionUponInvalidContent

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1	Error	Undefined	
2	Error	Invalid Selection	Unit code, flow direction or alarm code selection invalid.
3-4	Error	Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	Lower range value > Upper range value
7	Error	In Write Protect Mode	
8		Undefined	
9	Error	Lower Range Value Too High	Lower Range Value was above the Upper Transducer Limit or some other physical device limitation is exceeded.
10	Error	Lower Range Value Too Low	Lower Range Value was below the Lower Transducer Limit or some other physical device limitation is exceeded.
11	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.
12	Error	Upper Range Value Too Low	Upper Range Value was below Lower Transducer Limit.
13-14		Undefined	
15	Error	Invalid Analog Channel Code Number	The analog channel does not exist in this field device.
16-27		Undefined	

Code	Class	Description	Explanation
28	Error	Invalid Device Variable Index	The requested Device Variable does not exist in this field device or is not supported by the requested command or operation.
29-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.2 Command 129 Read analog output configuration

This command is used to read the meter's specified analog output configuration. The meter provides two analog outputs: Analog Output 1 (AO1) and Analog Output 2 (AO2). Analog Output 2 supports only conventional 4-20 mA output whereas Analog Output 1 supports both conventional 4-20 mA output and HART output.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog output selector (0 for Analog Output 1, 1 for Analog Output 2)	Used to select which analog output to be configured.

Response data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog output selector	Specifies which analog output is being read.
1	Unsigned-8	Device variable assigned to the specified analog output	Reads AOXContent
2	Enum-8	Upper and Lower Range Values Unit Code	Specifies the units for the Upper and Lower Range Values.
3-6	Float	Upper Range Value	Reads: • AOXFullScaleVolFlowRate • AOXMaxVel
7-10	Float	Lower Range Value	Reads AOXMinVel
11	Enum-8	Flow direction to be represented by specified analog output	Reads AOXDir
12	Enum-8	Alarm Selection Code	Reads AOXActionUponInvalidContent
13	Enum-8	Analog output availability	Reads IsAOXAvail

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-4		Undefined	

Code	Class	Description	Explanation
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	
7-14		Undefined	
15	Error	Invalid Analog Channel Code Number	The analog channel does not exist in this field device.
16-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.3 Command 130 Write Frequency/Digital Output configuration

This command is used to configure the meter's specified frequency output pair and its associated digital output pair. The meter provides two frequency output pairs: Frequency Output Pair 1 (Freq1A and Freq1B) and Frequency Output Pair 2 (Freq2A and Freq2B). Associated with each frequency output pair is a digital output pair: Digital Output Pair 1 (DO1A and DO1B) is associated with Frequency Output Pair 1, Digital Output Pair 2 (DO2A and DO2B) is associated with Frequency Output Pair 2.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Frequency/Digital Output Pair selector	Used to select which Frequency/Digital Output pair to be configured. This is an informational index variable; when written, it is not updated in the device.
1	Unsigned-8	Frequency Output Content selector	Writes `FreqXContent`. When this assignment is a configuration change, the remaining data bytes are ignored. However, for the response, the remaining data bytes should reflect the data for the newly assigned frequency output content.
2	Enum-8	Upper and Lower Range Values Unit Code (Tables)	Specifies the units for the requested Frequency Output Content Upper and Lower Range Values. This unit code is only pertinent for interpreting this command's data values and for the units of the response's data values. If Frequency Output Content selection is Profile Factor, HART unit None (251) shall be used. This is an informational variable; when written, it is not updated in the device.

Byte	Format	Description	Explanation
3-6	Float	Upper Range Value	Writes: • `FreqXFullScaleVolFlowRate` • `FreqXFullScaleProfileFactor` Always zero. Write shall be rejected if the Lower Range Value is non-zero. This value corresponds to the maximum frequency.
7-10	Float	Lower Range Value	Always zero. Write shall be rejected if the Lower Range Value is non-zero. This value corresponds to zero frequency.
11-12	Enum-16	Maximum Frequency (Hertz)	Writes `FreqXMaxFrequency`
13	Enum-8	Flow direction to be represented by Frequency Output Pair	Writes `FreqXDir`
14	Enum-8	Frequency B Phase zero-on-error configuration	Writes `IsFreqXBZeroedOnErr`
15	Enum-8	Frequency B Phase relative to Frequency A Phase configuration	Writes `FreqXBPhase`
16	Unsigned-8	Frequency feedback correction percentage	Writes `FreqXFeedbackCorrectionPcnt`
17	Enum-8	Selected Digital Output A inverted polarity configuration	Writes `DOXAIsInvPolarity`
18	Enum-8	Selected Digital Output A content selector	Writes `DOXAContent`
19	Enum-8	Selected Digital Output B inverted polarity configuration selector	Writes `DOXBIsInvPolarity`
20	Enum-8	Selected Digital Output B content selector	Writes `DOXBContent`

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Requested maximum frequency, feedback percentage invalid Frequency Phase B, Digital Output inverted polarity or Digital Output content invalid.
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	Lower Range Value > Upper Range Value
7	Error	In Write Protect Mode	
8		Undefined	
9	Error	Lower Range Value Too High	Lower Range Value was above the Upper Transducer Limit or some other physical device limitation is exceeded.
10	Error	Lower Range Value Too Low	Lower Range Value was below the Lower Transducer Limit or some other physical device limitation is exceeded.
11	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.
12	Error	Upper Range Value Too Low	Upper Range Value was below Lower Transducer Limit.
13-14		Undefined	
15	Error	InvalidFrequency/Digital Output Pair Number	The Frequency/Digital Output pair requested does not exist in this field device.
16-27		Undefined	
28	Error	Invalid Device Variable Index	The requested Frequency Output Content does not exist in this field device or is not supported by the requested command or operation.

Code	Class	Description	Explanation
29-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.4 Command 131 Read Frequency/Digital Output configuration

This command is used to read the meter's specified frequency output pair and its associated digital output pair configuration. The meter provides two frequency output pairs: Frequency Output Pair 1 (Freq1A and Freq1B) and Frequency Output Pair 2 (Freq2A and Freq2B). Associated with each frequency output pair is a digital output pair: Digital Output Pair 1 (DO1A and DO1B) is associated with Frequency Output Pair 1, Digital Output Pair 2 (DO2A and DO2B) is associated with Frequency Output Pair 2. The parameters are returned using the unit code selection for the device variable represented by the specified frequency output pair.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Frequency/Digital Output Pair selector	Used to select which Frequency/Digital Output pair to be configured.

Response data bytes

Same as Command 130 Write Frequency/Digital Output configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	
7-14		Undefined	
15	Error	Invalid Frequency/Digital Output Pair selector	The frequency/digital output pair does not exist in this field device.
16-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.5 Command 132 Write flow pressure configuration

This command is used to configure the meter's flow-condition pressure. The input can be disabled, a conventional 4-20 mA input or fixed at a specified value. For conventional 4-20 mA, Analog Input 2 (AI2) is used for pressure.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Input Selector Code	Writes `EnablePressureInput`
1	Enum-8	Unit Code (Tables)	Specifies the units for related values (such as alarm values, range values, fixed (specified) value). This unit code is only pertinent for interpreting this command's data values and for the units of the response's data values. This is an informational variable; when written, it is not updated in the device.
2-5	Float	Conventional Analog or Fixed Upper Alarm Value	Writes `HighPressureAlarm`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog) or 2 (fixed/specified). It is ignored for all other Input Selector Code values.
6-9	Float	Conventional Analog or Fixed Upper Alarm Value	Writes `LowPressureAlarm`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog) or 2 (fixed/specified). It is ignored for all other Input Selector Code values.
10-13	Float	Conventional Analog or Fixed Upper Alarm Value	Writes `MaxInputPressure`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog). It is ignored for all other Input Selector Code values.

Byte	Format	Description	Explanation
14-17	Float	Conventional Analog Lower Range Value	Writes `MinInputPressure`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog). It is ignored for all other Input Selector Code values.
18-21	Float	Fixed Value	Writes `SpecFlowPressure`. This value is only applicable if the Input Selector Code is 2 (fixed/specified). It is ignored for all other Input Selector Code values.
22	Enum-8	Pressure and Temperature Alarm Selection Code (see Tables)	This selects the input action upon alarm and is applicable to both pressure and temperature inputs. Writes `FlowPOrTSrcUponAlarm` although it is not a direct mapping: • **239 Hold Last Output Value → set FlowPOrTSrcUponAlarm to 0** • **242 Used Fixed Value → set FlowPOrTSrcUponAlarm to 1 (Fixed value)** .
23	Enum-8	Absolute pressure input type indicator	Writes `InputPressureUnit`
24-27	Float	Atmospheric Pressure Value	Required when the input pressure is gage. Writes `AtmosphericPress`

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	

Code	Class	Description	Explanation
1		Undefined	
2	Error	Invalid Selection	Input selector code or alarm code selection invalid.
3	Error	Passed Parameter Too High	Upper alarm value, lower alarm value, fixed value, and/or atmospheric pressure value too high.
4	Error	Passed Parameter Too Low	Upper alarm value, lower alarm value, fixed value, and/or atmospheric pressure value too low.
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	• Either (a) Lower Alarm Value > Upper Alarm Value or (b) Lower Range Value > Upper Range Value. • Also indicates EnablePressureInput is selected as None when HCH_Method is Gross Method 1, Gross Method 2 or Detailed Method. • Also indicates `EnableExpCorrPress` is set as True when `EnablePressureInput` is None.
7	Error	In Write Protect Mode	
8	Error	Undefined	
9	Error	Lower Range Value Too High	Lower Range Value was above the Upper Transducer Limit or some other physical device limitation is exceeded.
10	Error	Lower Range Value Too Low	Lower Range Value was below the Lower Transducer Limit or some other physical device limitation is exceeded.
11	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.
12	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.

Code	Class	Description	Explanation
13-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.6 Command 133 Read flow pressure configuration

This command is used to read the meter's flow-condition pressure input configuration. The parameters are returned using the Pressure device variable configured unit code.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 132 Write flow pressure configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.7 Command 134 Write flow temperature configuration

This command is used to configure the meter's flow-condition temperature. The input can be disabled, a conventional 4-20 mA input, a HART input, or fixed at a specified value. For conventional 4-20 mA and HART inputs, Analog Input 1 (AI1) is used for temperature.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Input Selector Code	Writes `EnableTemperatureInput`
1	Enum-8	Unit Code (see Tables)	Specifies the units for related values (such as alarm values, range values, fixed (specified) value). This unit code is only pertinent for interpreting this command's data values and for the units of the response's data values. This is an informational variable; when written, it is not updated in the device.
2-5	Float	Conventional Analog or Fixed Upper Alarm Value	Writes `HighTemperatureAlarm`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog) or 2 (fixed/specified). It is ignored for all other Input Selector Code values.
6-9	Float	Conventional Analog or Fixed Lower Alarm Value	Writes `LowTemperatureAlarm`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog) or 2 (fixed/specified). It is ignored for all other Input Selector Code values.

Byte	Format	Description	Explanation
10-13	Float	Conventional Analog Upper Range Value	Writes `MaxInputTemperature`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog). It is ignored for all other Input Selector Code values.
14-17	Float	Conventional Analog Lower Range Value	Writes `MinInputTemperature`. This value is only applicable if the Input Selector Code is 1 (live conventional 4-20 mA analog). It is ignored for all other Input Selector Code values.
18-21	Float	Fixed Value	Writes `SpecFlowTemperature`. This value is only applicable if the Input Selector Code is 2 (fixed/specified). It is ignored for all other Input Selector Code values.
22	Enum-8	Pressure and Temperature Alarm Selection Code (see Tables)	This selects the input action upon alarm and is applicable to both pressure and temperature inputs. Writes `FlowPOrTSrcUponAlarm` although it is not a direct mapping: • **239 Hold Last Output Value → set FlowPOrTSrcUponAlarm to 0**; • **242 Used Fixed Value → set FlowPOrTSrcUponAlarm to 1 (Fixed value)**.
23	Enum-8	Enable temperature-effect expansion correction	Writes `EnableExpCorrTemp`.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Input selector code or alarm code selection invalid.
3	Error	Passed Parameter Too High	Upper alarm value, lower alarm value, or fixed value too high.
4	Error	Passed Parameter Too Low	Upper alarm value, lower alarm value, or fixed value too low.
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	This is used(1) to indicate an error when either: • lower alarm value > upper alarm value • lower range value > upper range value • requested value is outside its sanity limits • Also indicates `EnableExpCorrTemp` is set as True when `EnableTemperatureInput` is None.
7	Error	In Write Protect Mode	
8		Undefined	
9	Error	Lower Range Value Too High	Lower Range Value was above the Upper Transducer Limit or some other physical device limitation is exceeded.
10	Error	Lower Range Value Too Low	Lower Range Value was below the Lower Transducer Limit or some other physical device limitation is exceeded
11	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.
12	Error	Upper Range Value Too Low	Upper Range Value was below the Lower Transducer Limit.

Code	Class	Description	Explanation
13-31		Undefined	
32	Error	Busy	
33-127		Undefined	

(1) Also used for unsupported selector code, e.g. Live HART is not supported v1.60 and later firmware.

10.1.8 Command 135 Read flow temperature configuration

This command is used to read the meter's flow-condition temperature input configuration. The parameters are returned using the Temperature Device Variable configured unit code.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 134 Write flow temperature configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.9 Command 136 Write device units

This command is used to write the device's units. Note that the meter shall utilize the Flow Rate Time Unit Code to derive all flow rate units. For example, the Volumetric Flow Rate Unit Code (used for the uncorrected volumetric flow rate device variable) shall be derived from the Volume Unit Code and the Flow Rate Time Unit Code: if the Volume Unit Code is cubic meters and the Flow Rate Time Unit Code is hourly, then the derived Volumetric Flow Rate Unit Code shall be cubic meters per hour. The supported HART Unit Codes are listed in Tables.

Request data bytes

Byte	Format	Description
0	Enum-8	Volume units
1	Enum-8	Volumetric flow rate units
2	Enum-8	Pressure units
3	Enum-8	Temperature units
4	Enum-8	Velocity units
5	Enum-8	Mass unit code (HARTMassUnit)
6	Enum-8	Energy unit code (HARTEnergyUnit)
7	Enum-8	Length units
8	Enum-8	Length units
9	Enum-8	Viscosity units
10	Enum-8	Pressure units
11	Enum-8	Young's Modulus unit code (HARTYoungsModulusPressureUnit)
12	Enum-8	Density unit code (HARTDensityUnit)

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	One or more of the unit code selection(s) is/are invalid.

Code	Class	Description	Explanation
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.10 Command 137 Read device units

This command is used to read the device's units.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31			
32	Error	Busy	
33-127		Undefined	

10.1.11 Command 138 Write device variable range

This command is used to write a specified device variable's upper and lower range values. This command is used to scale graphs, charts, etc. for displaying device variable values on the host system (AMS™ Device Manager).

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Device variable selector	Specifies the device variable for which the range values are to be set. This is an informational variable; when written, it is not updated in the device.
1	Enum-8	Tables	Specifies the units for the specified range values. This unit code is only pertinent for interpreting this command's data values and for the units of the response's data values. This is an informational variable; when written, it is not updated in the device.
2-5	Float	Upper Range Value	
6-9	Float	Lower Range Value	

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid selection	Unit code selection invalid.
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	Lower Range Value is greater than Upper Range Value.
7-8		Undefined	

Code	Class	Description	Explanation
9	Error	Lower Range Value Too High	Lower Range Value was above the Upper Transducer Limit or some other physical device limitation is exceeded.
10	Error	Lower Range Value Too Low	Lower Range Value was below the Lower Transducer Limit or some other physical device limitation is exceeded.
11	Error	Upper Range Value Too High	Upper Range Value was above Upper Transducer Limit.
12	Error	Upper Range Value Too Low	Upper Range Value was below the Lower Transducer Limit.
13-27		Undefined	
28	Error	Invalid Device Variable Index	The requested Device Variable does not exist in this field device or is not supported by the requested command or operation.
29-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.12 Command 139 Read device variable range

This command is used to read a specified device variable's upper and lower range values. This command is expected to be used to scale graphs, charts, etc. for displaying device variable values on host system (AMS) screens.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Device variable selector	Specifies the device variable for which the range values are to be read.

Response data bytes

Same as Command 138 Write device variable range.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	
7-27		Undefined	
28	Error	Invalid device variable index	The requested device variable does not exist in this field device or is not supported by the requested command or operation.
29-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.13 Command 140 Read detailed status

This command is used to read detailed status information (i.e., status information that provides detail beyond that of the response status byte and Common Command 48 (Read Additional device status (Command 48)). The purpose of having a separate device-specific command is to limit what is seen and logged by the AMS™ Device Manager Alert Monitor.

Request data bytes

Byte	Format	Description	Explanation
None			

Request Data Bytes

Byte	Format	Description
0	Bits	Failed Detail Status Byte 0

Bit	Description	Related database point(s)
7 (msb)	Indicates a diagnostic core file was generated.	`IsCorePresent`
6		
5	Indicates electronics voltage out-of-range.	`IsElecVoltOutOfRange`
4		
3	Indicates the watchdog performed a meter warm-start.	`WatchDogReset`
2	Indicates unknown Acquisition module revision - firmware upgrade is required.	`IsAcqModuleIncompatible`
1		
0 (lsb)		

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>1</td><td>Bits</td><td>Maintenance Detail Status Byte 0
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td></td><td>Reserved</td></tr>
<tr><td>6</td><td></td><td></td></tr>
<tr><td>5</td><td></td><td>Reserved</td></tr>
<tr><td>4</td><td></td><td>Reserved</td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>0 (lsb)</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>2</td><td>Bits</td><td>Advisory Detail Status Byte 0
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Flow-condition volumetric flow rate validity</td><td><code>QFlowValidity</code> (inverted)</td></tr>
<tr><td>6</td><td></td><td>Reserved</td></tr>
<tr><td>5</td><td></td><td>Reserved</td></tr>
<tr><td>4</td><td></td><td>Reserved</td></tr>
<tr><td>3</td><td></td><td>Reserved</td></tr>
<tr><td>2</td><td></td><td>Reserved</td></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>0 (lsb)</td><td></td><td></td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>3</td><td>Bits</td><td>Advisory Detail Status Byte 1
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Analog Output 2 test enable</td><td>IsAO2EnableTest</td></tr>
<tr><td>6</td><td>Analog Output 1 test enable</td><td>IsAO1EnableTest</td></tr>
<tr><td>5</td><td>Frequency Output 2 data is invalid</td><td>Freq2DataValidity (inverted)</td></tr>
<tr><td>4</td><td>Frequency Output 1 data is invalid</td><td>Freq1DataValidity (inverted)</td></tr>
<tr><td>3</td><td>Analog Output 2 validity</td><td>AO2DataValidity (inverted)</td></tr>
<tr><td>2</td><td>Analog Output 1 validity</td><td>AO1DataValidity (inverted)</td></tr>
<tr><td>1</td><td>Analog Output 2 (HART SV) current is in test mode and fixed.</td><td>AO2IsFixed</td></tr>
<tr><td>0 (lsb)</td><td>Analog Output 1 (HART PV) current is in test mode and fixed.</td><td>AO1IsFixed</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>4</td><td>Bits</td><td>Advisory Detail Status Byte 2
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td>Hourly log full indicator</td><td><code>IsHourlyLogFull</code></td></tr>
<tr><td>6</td><td>Daily log full indicator</td><td><code>IsDailyLogFull</code></td></tr>
<tr><td>5</td><td>Audit log full indicator</td><td><code>IsAuditLogFull</code></td></tr>
<tr><td>4</td><td>Alarm log full indicator</td><td><code>IsAlarmLogFull</code></td></tr>
<tr><td>3</td><td>System log full indicator</td><td><code>IsSystemLogFull</code></td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>1</td><td>HART third variable validity</td><td><code>HARTTVValidity</code> (inverted)</td></tr>
<tr><td>0 (lsb)</td><td>HART fourth variable validity</td><td><code>HARTQVValidity</code> (inverted)</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>5</td><td>Bits</td><td>Advisory Detail Status Byte 3
<table>
<tr><th>Bit</th><th>Description</th><th>Related database point(s)</th></tr>
<tr><td>7 (msb)</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td>Reserved</td></tr>
<tr><td>5</td><td>Flow-condition pressure out-of-limits indicator</td><td>FlowPressureIsOutOfLimits</td></tr>
<tr><td>4</td><td>Flow-condition temperature out-of-limits indicator</td><td>FlowTemperatureIsOutOfLimits</td></tr>
<tr><td>3</td><td>The HART Slot 0 value as defined by the HART device variable selection</td><td>HARTSlot0Validity (inverted)</td></tr>
<tr><td>2</td><td>The HART Slot 1 value as defined by the HART device variable selection</td><td>HARTSlot1Validity (inverted)</td></tr>
<tr><td>1</td><td>The HART Slot 2 value as defined by the HART device variable selection</td><td>HARTSlot2Validity (inverted)</td></tr>
<tr><td>0 (lsb)</td><td>The HART Slot 3 value as defined by the HART device variable selection</td><td>HARTSlot3Validity (inverted)</td></tr>
</table></td></tr>
</table>

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.14 Command 141 Acknowledge alarm

This command is used to acknowledge (clear/reset) an acknowledgeable alarm. The request shall include an enumeration to specify which alarm to acknowledge where the enumeration shall be as listed in the table below:

Enumeration	Alarm
0	IsCorePresent
1	IsAvgSoundVelRangeErrLatched
2	WatchDogReset
3	DidCnfgChksumChg
4	DidColdStart
5	DidPowerFail
6	
7	
8	
9	
10	
11	
12	IsReverseFlowDetectedLatched
13	
14	IsAcqModuleErrorLatched
15	IsMeterVelAboveMaxLmtLatched
16	TemperatureInvalidLatched
17	PressureInvalidLatched
18	IsAcqModeLatched
19	IsTooFewOperChordsLatched
20	IsFwdBaselineNotSet
21	IsRevBaselineNotSet

The DidPowerFail acknowledgeable alarm is automatically reset according to the HART Device Status requirements. The meter shall

also reset any `DidColdStart` alarm when the `DidPowerFail` alarm is automatically reset. However, this “automatic reset” only applies to HART (for the Field Device Status byte) and does not clear the database point(s). Acknowledging `DidColdStart` or `DidPowerFail` via this command clears the specified database point.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Alarm identifier	Selects the alarm to be acknowledged.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	The selected alarm to acknowledge does not exist.
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.15 Command 142 Write digital input configuration

This command is used to configure the meter's specified digital input configuration. The meter provides a single digital input that can be used to gate a calibration pass (such as for synchronizing the meter's calibration with prover switches).

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	General purpose polarity	Applicable when the digital input is used as a general purpose input. Specifies the digital input polarity for interpreting the input value. Used to set `DI1IsInvPolarity`.
1	Enum-8	Calibration input polarity	Applicable when the digital input is used for calibration. Specifies the digital input polarity for starting/stopping calibration. Used to set `IsDI1ForCalActiveLow`.
2	Enum-8	Calibrating gating type	Applicable when the digital input is used for calibration. Specifies the digital input polarity for starting/stopping calibration. Used to set `IsDI1ForCalStateGated`.
3	Enum-8	Digital input 1 mode	Writes `DI1Mode`

Response data bytes

Same as Request data bytes.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	

Byte	Format	Description	Explanation
2	Error	Invalid selection	`Dl1IsInvPolarity`, `IsDl1ForCalActiveLow`, `IsDl1ForCalStateGated` or `Dl1Mode` selection invalid.
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6		Undefined	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.16 Command 143 Read digital input configuration

This command is used to read the meter's specified digital input configuration. The meter provides a single digital input that can be used to gate a calibration pass (such as for synchronizing the meter's calibration with prover switches).

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 142 Write digital input configuration.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.17 Command 144 Read velocity zero calibration status

Commands 144 and 145 are used to perform velocity zero calibration on liquid ultrasonic flow meters. Two commands are used to achieve command-query separation (see link below).

http://en.wikipedia.org/wiki/Command-Query_Separation

This simplifies the acquisition of velocity zero calibration status in a HART host edit display or when used in a DDL method. The engineering units for velocity are pre-configured in the device (see Pressure units).

The command's request and response data bytes as well as the command-specific response codes are indicated below (with the functional requirements following associated Command 145):

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th></tr>
<tr><td>0</td><td>Enum-8</td><td>Zero calibration process status. This should be included in the AMS™ Device Manager so that a DDL post-read method can use status change to 2 to accept/reject proposed zero calibration value.
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>0</td><td>Zero calibration process inactive</td></tr>
<tr><td>1</td><td>Zero calibration process in progress</td></tr>
<tr><td>2</td><td>Zero calibration process completed successfully</td></tr>
<tr><td>3</td><td>Zero calibration process failed due to chord failure during process</td></tr>
<tr><td>4</td><td>Zero calibration process failed due to too-large offset</td></tr>
<tr><td>5</td><td>Zero calibration process failed due to too-large estimated maximum deviation</td></tr>
<tr><td>6</td><td>Zero calibration process failed due to high viscosity calibration method selection change while zero calibration process in progress</td></tr>
</table></td></tr>
<tr><td>1</td><td>Unsigned-8</td><td>Zero calibration duration in minutes (<code>ZeroFlowCalReqDuration</code>)</td></tr>
<tr><td>2</td><td>Unsigned-8</td><td>Zero calibration progress % (zero when status is 0) updated every 5 seconds (<code>ZeroFlowCalProgress</code>)</td></tr>
<tr><td>3</td><td>Enum-8</td><td>Zero flow velocity Unit Code (Velocity units)</td></tr>
<tr><td>4-7</td><td>Float</td><td>Instantaneous zero flow velocity (<code>DryCalVel</code>) (included for display/charting purposes)</td></tr>
<tr><td>8-11</td><td>Float</td><td>Proposed zero calibration value (Zero flow velocity offset) (only relevant when the zero calibration process status is 2)</td></tr>
<tr><td>12</td><td>Enum-8</td><td>High viscosity calibration method selector (<code>HighViscosityMethod</code>)</td></tr>
</table>

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Busy	
7-31		Undefined	
32	Error		
33-127		Undefined	

10.1.18 Command 145 Write velocity zero calibration control

This command is used to control the velocity zero calibration process on liquid ultrasonic flow meters. The command's request and response data bytes as well as the command-specific response codes are indicated below (with the functional requirements following)

Request data bytes

<table>
<tr><th>Byte</th><th>Format</th><th>Description</th><th>Explanation</th></tr>
<tr><td>0</td><td>Enum-8</td><td>Zero calibration control<table><tr><th>Code</th><th>Description</th></tr><tr><td>0</td><td>Abort zero calibration process</td></tr><tr><td>1</td><td>Start zero calibration process</td></tr><tr><td>2</td><td>Accept proposed zero calibration value and exit process</td></tr></table></td><td>Controls the meter's zero calibration process. This sets the <code>ZeroFlowCalReqControl</code> data point</td></tr>
<tr><td>1</td><td>Unsigned-8</td><td>Zero calibration duration (minutes)</td><td>This byte is only relevant when the zero calibration control value is 1.This value specifies the zero calibration process duration in minutes within the range [2, 10]. The default duration is 4 minutes. This shall set the (new) ZeroFlowCalReqDuration data point.</td></tr>
</table>

Response data bytes

Same as Request data bytes.

Command-specific response codes

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

Code	Class	Description	Explanation
2	Error	Invalid Selection	The requested zero calibration control value is invalid (outside of its limits) or the specified duration is outside of its limits.
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	The requested zero calibration control value is inappropriate (such as - attempting to abort a zero calibration when zero calibration is inactive; attempting to start a zero calibration while zero calibration is already in progress; attempting to accept a zero calibration value when zero calibration is inactive, in progress or failed).
7	Error	InWrite Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

Velocity zero flow calibration functional requirements

These database points are read every second (`DryCalVel`, `AvgWtdFlowVel`, `IsFailedForBatchA, … IsFailedForBatchD`) and success/failure criteria are used. Running values are not available during the calibration process - only the proposed zero calibration value (`ZeroFlowCalResult` (i.e., the value to be written to `FwdA0` and `RevA0` when `HighViscosityMethod` is Disabled, or written to `FwdA0HighViscosity` and `RevA0HighViscosity` when `HighViscosityMethod` is Enabled) is available upon successful completion.

The functional requirements for performing zero flow calibration via the request and response messages listed above are as follows:

Procedure

1. When the meter is not currently in the zero calibration process, it enters the zero calibration process upon receiving

HART Command 145 with the zero calibration control value of 1. Upon entering the zero calibration process, the zero calibration process status is set to 1 (in progress).

2. The zero calibration process duration (in minutes) is set according to the Zero calibration duration value received with the calibration start command (if valid).
3. While in the zero calibration process, once per second the meter reads the uncalibrated and dry-calibrated flow velocities (via the `AvgWtdFlowVel` and `DryCalVel` data points) and the meter's chord status values (via the `IsFailedForBatchA`...`IsFailedForBatchD` data points) and meter's high viscosity calibration method selection (`HighViscosityMethod`).
4. While in the zero calibration process, once per five seconds the meter updates the zero calibration progress which is a percentage of completion based upon the specified duration. A new data point (`ZeroFlowCalProgress`) indicates the progress.
5. The meter exits any calibration process in progress if any chord failure is detected (via the `IsFailedForBatchA`... `IsFailedForBatchD` data points). In this case, the meter responds to a calibration status read request (via Command 144) with the zero calibration process status value of 3.
6. While the meter is in the zero calibration process prior to the completion of the specified process duration, it responds to an abort request (via Command 145 control value of 0). In this case, the meter changes the zero calibration process status value to 0 (inactive).
7. While the meter is in the zero calibration process prior to the completion of the specified process duration, it ignores requests to re-start the calibration (via Command 145 control value of 1) and shall respond with the Device-Specific Command Error Response Code.
8. While the meter is in the zero calibration process prior to the completion of the specified process duration, it responds to all calibration status read requests (via Command 144) with the zero calibration process status value of 1 (zero calibration in progress).
9. While the meter is in the zero calibration process prior to the completion of the specified process duration, it ignores requests to accept the proposed zero calibration value (via Command 145 control value of 2) and responds with the Device-Specific Command Error Response Code.

10. 10. When the zero calibration process reaches the specified process duration, then the meter determines whether the calibration was successful or not as follows:

    a) If the absolute value of the proposed zero calibration value (calculated as shown below) is greater than 0.02 ft/sec, then the zero calibration failed. In this case, the meter responds to the next calibration process status read request (via Command 144) with a zero calibration process status value of 4.

       The proposed zero calibration value is calculated as follows:

       $$ZeroCalibrationValue = -\overline{AvgWtdFlowVel}$$

       where

       $\overline{AvgWtdFlowVel}$ is the average of the average weighted flow velocity values (ft/sec)

    b) If the dry-calibrated flow velocity Estimated Maximum Deviation (calculated as shown below) is greater than 0.002 ft/sec, then the zero calibration failed. In this case, the meter responds to the next calibration process status read request (via Command 144) with a zero calibration process status value of 5

       The dry-calibrated flow velocity Estimated Maximum Deviation is calculated as follows:

       $$EstimatedMaximumDeviation_{DryCalVel} = 3 \times \frac{\delta_{DryCalVel}}{\sqrt{N}}$$

       where

       $\delta_{DryCalVel}$ is the dry-calibrated flow velocity standard deviation during the process (ft/ sec)

       N is the number of dry-calibrated flow velocity values taken during the process

    c) Otherwise, the zero calibration completed successfully and the meter responds to the next calibration process status read request (via Command 144) with a zero calibration process status value of 2 and the proposed

zero calibration value (in the HART-configured velocity units).

11. When a zero calibration process ends unsuccessfully (i.e., with a status value of 3, 4, or 5), the meter ignores requests to accept the proposed zero calibration value (via Command 145 control value of 2). In this case, the meter responds with the Device- Specific Command Error Response Code.
12. When a zero calibration process ends unsuccessfully (i.e., with a status value of 3, 4, or 5), the meter continues to respond to zero calibration process status read requests (via Command 144) with the same status response until the calibration is exited/aborted (via Command 145 control value of 0) or re-started (via Command 145 control value of 1).
    a) In this case, the meter responds to the exit/abort command by setting the status value to 0 (inactive).
    b) In this case, the meter responds to the start command by setting the status value to 1 (in progress).
13. 13. When the zero calibration process ends successfully, the meter continues to respond to zero calibration process status read requests (via Command 144) with the successful completion response (status value of 2) until any other following occurs:
    a) The proposed zero calibration value is accepted (via Command 145 control value of 2).
        1. If `HighViscosityMethod` is set to **Disabled**, then the meter shall write the proposed zero calibration value to the `FwdA0` and `RevA0` data points and set the status value to 0 (inactive).
        2. If `HighViscosityMethod` is set to Enabled, then the meter shall write the proposed zero calibration value to the `FwdA0HighViscosity` and `RevA0HighViscosity` data points. Changes to `FwdA0HighViscosity` and `RevA0HighViscosity` shall be audit-logged.
    b) The proposed zero calibration value is rejected via aborting the process (via Command 145 control value of 0) - the meter discards the proposed zero calibration value and set the status value to 0 (in active).
    c) The proposed zero calibration value is rejected via re-starting the process (via Command 145 control value of

1) - the meter discards the proposed zero calibration value and re-start the process. In this case, the meter sets the status value to 1 (in progress).

14. When the meter is not in the zero calibration process, it responds to requests to abort (via Command 145 control value of 0) with the Device-Specific Command Error Response Code.
15. When the meter is not in the zero calibration process, it responds to requests to accept the proposed zero calibration value (via Command 145 control value of 2) with the Device-Specific Command Error Response Code.
16. The meter shall exit any calibration process in progress if the `HighViscosityMethod` value is changed. In this case, the meter responds to a calibration status read request (via Command 144) with the zero calibration process status value of 6.

Possible HART® master perspective

From the user a HARTmaster's perspective, the process for performing a zero calibration might be as follows:

Note
There is more than one way to implement the process.

Procedure

1. Issue Command 145 with zero calibration control value of 1 (start zero calibration process) and a calibration duration. The meter will respond with response code 2 if the calibration duration is outside of its limits. The meter will respond with response code 6 if zero calibration control value is inappropriate (such as attempting to accept a zero calibration value after a failed calibration or attempting to start a zero calibration while one is already in progress).
2. Repeatedly issue Command 144 while the meter responds with a zero calibration process status value of 1 (process in progress).
3. If the zero calibration process completed successfully, then the zero calibration value is returned in the previously-configured velocity units. Issue Command 145 with zero calibration control value of 2 to accept the new zero calibration value (which writes the new value to the `FwdA0` and `RevA0` non-volatile data points if `HighViscosityMethod` is set to **Disabled** or to the `FwdA0HighViscosity` and `RevA0HighViscosity` non-volatile data points if `HighViscosityMethod` is set to **Enabled**) or 0 to abort the

zero calibration process (which rejects the zero calibration result).

4. If the zero calibration process completed unsuccessfully, then issue Command 145 with zero calibration control value of 0 (abort zero calibration process) to exit the process.

10.1.19 Command 146 Read miscellaneous non-write protected parameters

This command is used to read miscellaneous non-write protected parameters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as .

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.20 Command 147 Read miscellaneous write protected parameters

This command is used to read miscellaneous write protected parameters.

Request data bytes

Byte	Format	Description	Explanation
None			

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Polling Address	Reads HARTPollingAddress (the least-significant 4 bits of the short frame address)
1	Unsigned-8	Number of Slave response preamble bytes	Reads HARTNumPreambleBytesFromSlave
2	Unsigned-8	Number of Master command preamble bytes	Reads HARTMinNumPreambles
3	Unsigned-8	Non-normal operation timeout	Reads NonNormalModeTimeout used for frequency testing in units of minute
4	Unsigned-8	Hour of day to log daily record in military time	Reads ContractHour
5	Enum-8	Modbus access units system	Reads UnitsSystem
6	Enum-8	Flow rate time unit for Modbus communications	Reads VolFlowRateTimeUnit
7	Enum-8	U.S. Customary volume unit for Modbus communications	Reads VolUnitUS
8	Enum-8	Metric volume unit for Modbus communications	Reads VolUnitMetric

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	

Byte	Format	Description	Explanation
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.21 Command 153 Read running averages

This command reads the running average data. The running average reported is a snapshot capture from the latest register point update in the HART slave. Units for turbulence, Cross Flow, Symmetry, and Profile values are percentages. Swirl Angle is always in degrees. The unit codes for other values in the message are only the units allowed for that type of variable. See Tables for the unit code tables used by the meter.

Note
Chords C and D are not available for 3812 Liquid Ultrasonic Flow Meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Average Flow Temperature	Reads RunningAvgFlowTemperature
4-7	Float	Average Flow Pressure	Reads RunningAvgFlowPressure
8-11	Float	Average Turbulence A	Reads RunningAvgTurbulenceA
12-15	Float	Average Turbulence B	Reads RunningAvgTurbulenceB
16-19	Float	Average Turbulence C	Reads RunningAvgTurbulenceC
20-23	Float	Average Turbulence D	Reads RunningAvgTurbulenceD
24-27	Float	Average Flow	Reads RunningAvgAvgFlow
28-31	Float	Average Cross Flow	Reads RunningAvgCrossFlow
32-35	Float	Average Profile Factor	Reads RunningAvgProfileFactor
36-39	Float	Average Swirl Angle	Reads RunningAvgSwirlAngle
40-43	Float	Average Symmetry	Reads RunningAvgSymmetry

Byte	Format	Description	Explanation
44-47	Float	Average Standard Deviation of Cross Flow	Reads RunningAvgSDevCrossFlow
48-51	Float	Average Standard Deviation of Profile Factor	Reads RunningAvgSDevProfileFactor
52-55	Float	Average Standard Deviation of Symmetry	Reads RunningAvgSDevSymmetry
56	Enum-8	Running average validity	Reads IsRunningAvgValid
57	Enum-8	Flow Direction	Reads FlowDirection
58	Enum-8	Temperature units	Units for Average Flow Temperature. Can only be valid units for temperature (HARTTemperatureUnit).
59	Enum-8	Pressure units	Units for Average Flow Pressure. Can only be valid units for pressure (HARTPressureUnit).
60	Enum-8	Velocity units	Unit codes for Average Flow. Can only be valid units for flow velocity (HARTVelUnit).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.22 Command 154 Read Baselines

This command will read the forward or reverse baseline values depending upon the parameter passed in the command request.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Forward/Reverse selection	1. 0= Reverse 2. 1 = Forward

Response data bytes

Byte	Format	Description	Explanation
0	Enum-8	Forward/Reverse selection	1. 0= Reverse 2. 1 = Forward
1-4	Float	Profile Factor	Reads XBaselineProfileFactor.
5-8	Float	FlowPressure	Reads XbaselineFlowPressure.
9-12	Float	Turbulence A	Reads XBaselineTurbulenceA. Constant units of percentage.
13-16	Float	Turbulence B	Reads XBaselineTurbulenceB. Constant units of percentage.
17-20	Float	Turbulence C	Reads XBaselineTurbulenceC. Constant units of percentage.
21-24	Float	Turbulence D	Reads XBaselineTurbulenceD. Constant units of percentage.
25-28	Float	Average Flow	Reads XBaselineAvgFlow.
29-32	Float	CrossFlow	Reads XBaselineCrossFlow.
33-36	Float	SwirlAngle	Reads XBaselineSwirlAngle. Constant units of degrees.
37-40	Float	Symmetry	Reads XBaselineSymmetry.
41-44	Float	Temperature	Read XBaselineFlowTemperature.
45	Unsigned-8	Baseline Not Set Boolean	Reads IsXBaselineNotSet.
46	Enum-8	Unit Code for Flow Temperature	Units for Flow Temperature. This can only be a unit code allowed for temperature values (HARTTemperatureUnit).

Byte	Format	Description	Explanation
47	Enum-8	Unit Code for Flow Pressure	Units for Flow Pressure. This can only be a unit code allowed for pressure values (HARTPressureUnit).
48	Enum-8	Unit Code for Flow Velocity	Units for Average Flow. This can only be a unit code allowed for flow velocity values (HARTVelUnit).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Invalid value for Forward / Reverse Selection
3-4		Undefined	
5	Error	Too Few Data Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.23 Command 155 Write baselines

Writes forward or reverse baseline values depending upon first byte in the command request.

The `IsXBaselineNotSet` Boolean will be cleared if the baseline set was successful.

If `IsAnyBaselineAvail` is FALSE, then this command will respond with success and existing baseline parameters in the meter, without writing new baseline parameters in the meter.

Request data bytes

Byte	Format	Description	Explanation
0	Enum	Forward/ Reverse Selection	• 0=Reverse • 1=Forward This is an informational index variable; when written, it is not updated in the device. **Note** Contrary to device-specific commands guideline 'Indices format should be Unsigned<#bits>', format Enum-8 is used for backward compatibility.
1-4	Float	Profile Factor	Writes XBaselineProfileFactor
5-8	Float	Flow Pressure	Writes XBaselineFlowPressure
9-12	Float	Turbulence A	Constant units of percentage. Writes XBaselineTurbulenceA.
13-16	Float	Turbulence B	Constant units of percentage. Writes XBaselineTurbulenceB.
17-20	Float	Turbulence C	Constant units of percentage. Writes XBaselineTurbulenceC.
21-24	Float	Turbulence D	Constant units of percentage. Writes XBaselineTurbulenceD.
25-28	Float	Average Flow	Writes XBaselineAvgFlow
29-32	Float	Cross Flow	Writes XBaselineCrossFlow
33-36	Float	Swirl Angle	Writes XBaselineSwirlAngle. Constant units of degrees.

Byte	Format	Description	Explanation
37-40	Float	Symmetry	Writes XBaselineSymmetry
41-44	Float	Flow Temperature	Writes XBaselineFlowTemperature
45	Enum-8	Temperature units	Units for Flow Temperature. This can only be a unit code allowed for temperature values (HARTTemperatureUnit). This is an INFO variable; when written, it is not updated in the device.
46	Enum-8	Pressure units	Units for Flow Pressure. This can only be a unit code allowed for pressure values (HARTPressureUnit). This is an INFO variable; when written, it is not updated in the device.
47	Enum-8	Velocity units	Units for Average Flow. This can only be a unit code allowed for flow velocity values (HARTVelUnit). This is an INFO variable; when written, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Invalid value for Forward/ Reverse Selection
3	Error	Passed Parameter Too High	A baseline value was too high
4	Error	Passed Parameter Too Low	A baseline value was too low
5	Error	Too Few Bytes Received	
6		Device-Specific Command Error	

Byte	Format	Description	Explanation
7	Error	In Write Protect Mode	
8-17		Undefined	
18	Error	Invalid Unit Codes	One or more of the unit codes are invalid
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.24 Command 159 Read meter chord data

This command will read meter flow related data (flow velocities, sound velocities and turbulence). The unit code values for velocity are specified in Velocity units. Turbulence units are always percentage.

Note
Chords C and D are not available for Model 3812 Liquid Ultrasonic Flow Meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Flow Velocity Chord A	Reads FlowVelA
4-7	Float	Flow Velocity Chord B	Reads FlowVelB
8-11	Float	Flow Velocity Chord C	Reads FlowVelC
12-15	Float	Flow Velocity Chord D	Reads FlowVelD
16-19	Float	Sound Velocity Chord A	Reads SndVelA
20-23	Float	Sound Velocity Chord B	Reads SndVelB
24-27	Float	Sound Velocity Chord C	Reads SndVelC
28-31	Float	Sound Velocity Chord D	Reads SndVelD
32-35	Float	Turbulence Chord A	Reads TurbulenceA
36-39	Float	Turbulence Chord B	Reads TurbulenceB
40-43	Float	Turbulence Chord C	Reads TurbulenceC
44-47	Float	Turbulence Chord D	Reads TurbulenceD
48	Enum-8	Velocity units	Unit codes that applies to all velocity values in this message.

Command-specific response codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined

Code	Class	Description
6	Error	Device-Specific Command Error
7-31		Undefined
32	Error	Busy
33-127		Undefined

10.1.25 Command 160 Read meter flow data

This command reads flow related data (symmetry, cross flow, flow direction, profile factor, and swirl angle). The unit codes for velocity and volume are defined in Tables. Symmetry, Cross-Flow, and Profile Factor are ratios and do not have units. Swirl Angle is always in degrees. SOS Comparison difference unit is always in percentage. These measurements are applicable for meters with four or more chords.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Symmetry	Reads Symmetry
4-7	Float	Cross-Flow	Reads CrossFlow
8-11	Float	Profile Factor	Reads Profile Factor
12-15	Float	Swirl Angle	Reads SwirlAngle
16-19	Float	Average Flow Velocity	Reads AvgFlow
20-23	Float	Average Sound Velocity	Reads AvgSndVel
24-27	Float	Reverse Flow Volume	Reads ReverseFlowVol
28-31			Reserved
32-35			Reserved
36	Enum-8	Sets the flow direction	Flow direction
37	Enum-8	Unit codes for velocity	Unit code that applies to all velocity values in this message (see Velocity units).
38	Enum-8	Unit codes for volume	Unit codes for volume values (see Volume units).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	

Byte	Format	Description	Explanation
32	Error	Busy	
33-127		Undefined	

10.1.26 Command 161 Read path signal amplitude data

This command reads the path Signal Amplitude data. See Voltage units.

Note
Chords C and D are not available for Model 3812 Liquid Ultrasonic Flow Meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Signal Amplitude A upstream	Reads SignalAmplitudeA1
4-7	Float	Signal Amplitude A downstream	Reads SignalAmplitudeA2
8-11	Float	Signal Amplitude B upstream	Reads SignalAmplitudeB1
12-15	Float	Signal Amplitude B downstream	Reads SignalAmplitudeB2
16-19	Float	Signal Amplitude C upstream	Reads SignalAmplitudeC1
20-23	Float	Signal Amplitude C downstream	Reads SignalAmplitudeC2
24-27	Float	Signal Amplitude D upstream	Reads SignalAmplitudeD1
28-31	Float	Signal Amplitude D downstream	Reads SignalAmplitudeD2
32	Enum-8	Units for amplitude points	A HART Units enum indicating the units for all the amplitude values in this message. This must be Millivolts units (see Voltage units).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	

Byte	Format	Description	Explanation
33-127		Undefined	

10.1.27 Command 162 Read noise amplitudes

This command reads the path noise amplitudes. Unit codes for voltage are specified in Voltage units.

Note
Chords C and D are not available for Model 3812 Liquid Ultrasonic Flow meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Noise Amplitude A upstream	Reads NoiseAmplitudeA1
4-7	Float	Noise Amplitude A downstream	Reads NoiseAmplitudeA2
8-11	Float	Noise Amplitude B upstream	Reads NoiseAmplitudeB1
12-15	Float	Noise Amplitude B downstream	Reads NoiseAmplitudeB2
16-19	Float	Noise Amplitude C upstream	Reads NoiseAmplitudeC1
20-23	Float	Noise Amplitude C downstream	Reads NoiseAmplitudeC2
24-27	Float	Noise Amplitude D upstream	Reads NoiseAmplitudeD1
28-31	Float	Noise Amplitude D downstream	Reads NoiseAmplitudeD2
32	Enum-8	Units for amplitudes.	A HART Units enum value indicating the units of all points read in this command. This must be Millivolts unit codes (see Voltage units).

Command-specific response codes

Byte	Format	Description
0	Success	No Command-Specific Errors
1-31		Undefined
32	Error	Busy

Byte	Format	Description
33-127		Undefined

10.1.28 Command 163 Read path SNR data

This command reads the SNR (signal-to-noise ratio) values for each path. SNR values are in decibels. Unit codes for decibels are specified in Decibel units.

Note
Chords C and D are not available for Model 3812 Liquid Ultrasonic Flow meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Signal Noise Ratio A upstream	Reads SNRA1
4-7	Float	Signal Noise Ratio A downstream	Reads SNRA2
8-11	Float	Signal Noise Ratio B upstream	Reads SNRB1
12-15	Float	Signal Noise Ratio B downstream	Reads SNRB2
16-19	Float	Signal Noise Ratio C upstream	Reads SNRC1
20-23	Float	Signal Noise Ratio C downstream	Reads SNRC2
24-27	Float	Signal Noise Ratio D upstream	Reads SNRD1
28-31	Float	Signal Noise Ratio D downstream	Reads SNRD2
32	Enum-8	Unit decibel codes	HART Unit code for SNR ratio. Must be decibel units (see Decibel units).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.29 Command 164 Read path percent good

This command reads the percentage of “good” batch firings for all paths for upstream and downstream flow directions. Units are fixed to percentage.

Note
Chords C and D are not available for Model 3812 Liquid Ultrasonic Flow meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Percent Good Path A upstream	Reads PctGoodA1
4-7	Float	Percent Good Path A downstream	Reads PctGoodA2
8-11	Float	Percent Good Path B upstream	Reads PctGoodB1
12-15	Float	Percent Good Path B downstream	Reads PctGoodB2
16-19	Float	Percent Good Path C upstream	Reads PctGoodC1
20-23	Float	Percent Good Path C downstream	Reads PctGoodC2
24-27	Float	Percent Good Path D upstream	Reads PctGoodD1
28-31	Float	Percent Good Path D downstream	Reads PctGoodD2

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	

Byte	Format	Description	Explanation
33-127		Undefined	

10.1.30 Command 165 Read path gains

This command reads all path gain values. The decibel unit code is a device specific unit code (see Decibel units).

Note
If the gains in the meter are currently in some other unit than decibels (such as hardware or software gain), the HART slave must convert the values to decibels.

Note
Chords C and D are not available for 3812 Liquid Ultrasonic Flow meters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Gain when transducer A1 (upstream) is receiving a signal	Reads GainA1
4-7	Float	Gain when transducer A2 (downstream stream) is receiving a signal	Reads GainA2
8-11	Float	Gain when transducer B1 (upstream) is receiving a signal	Reads GainB1
12-15	Float	Gain when transducer B2 (downstream stream) is receiving a signal	Reads GainB2
16-19	Float	Gain when transducer C1 (upstream) is receiving a signal	Reads GainC1
20-23	Float	Gain when transducer C2 (downstreamstream) is receiving a signal	Reads GainC2
24-27	Float	Gain when transducer D1 (upstream) is receiving a signal	Reads GainD1

Byte	Format	Description	Explanation
28-31	Float	Gain when transducer D2 (downstreamstream) is receiving a signal	Reads GainD2
32	Enum-8	Units decibel codes	HART Units enum for all gain points read. Must be dB units (see Decibel units).

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.31 Command 166 Read flow analysis configuration

This command reads flow analysis configuration data (see Velocity units and Volume units).

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Float	Reads the database point Flow Analysis Low Flow Limit	Reads FlowAnalysisLowFlowLmt
4-7	Float	Reads the database point Flow Analysis High Flow Limit	Reads FlowAnalysisHighFlowLmt
8-11	Float	Reads the database point Reverse Flow Volume Limit	Reads ReverseFlowVolLmt
12-15	Float	Reads the database point Reverse Flow Detection Zero Cut. This value is a flow velocity and has the same units as the other flow velocity values in this message.	Reads ReverseFlowDetectionZeroCut
16	Enum-8	Reads the Unit codes enum for flow velocity	Unit codes for all flow velocity values in this message (see Velocity units).
17	Enum-8	Reads the Unit codes for volume values	Unit codes for ReverseFlowVolLmt (see Volume units).
18	Enum-8	Enables reverse flow detection. Reads thedatabase point Reverse Flow Detection Enabled	Reads IsReverseFlowDetectionEnabled
19	Enum-8	Are Baselines Available. If this database point is FALSE, the baselines are not available to be set in the meter (does not apply to this meter type). The DD can use this variable to disable the baseline menus.	Reads IsAnyBaselineAvail

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.32 Command 167 Write flow analysis configuration

This command writes flow analysis related data (see Velocity units and Volume units).

Request data bytes

Byte	Format	Description	Explanation
0-3	Float	Writes the database point Flow Analysis Low Flow Limit	Reads FlowAnalysisLowFlowLmt
4-7	Float	Writes the database point Flow Analysis High Flow Limit	Reads FlowAnalysisHighFlowLmt
8-11	Float	Writes the database point Reverse Flow Volume Limit	Reads ReverseFlowVolLmt
12-15	Float	Writes the database point Reverse Flow Detection Zero Cut	Reads ReverseFlowDetectionZeroCut
16	Enum-8	Unit code for flow velocity values (see Velocity units)	Unit code for flow velocity values. This unit applies to all flow values including Reverse Flow Limit. This must be a unit code that is valid for velocity
17	Enum-8	Unit code for volume values	Unit code for Reverse Flow Limit. This must be a valid unit code for volume (see Volume units). This is an INFO variable; when written, it is not updated in the device.
18	Enum-8	Enable for reverse flow detection. Writes the point Reverse Flow Detection Enabled.	Reads IsReverseFlowDetectionEnabled

Response data bytes

Same as Request data bytes.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Boolean neither 0 or 1

Byte	Format	Description	Explanation
3	Error	Passed Parameter Too High	Alarm limit too high
4	Error	Passed Parameter Too Low	Alarm limit too low (or negative)
5	Error	Too Few Bytes Received	
6	Error	Undefined	
7	Error	In Write Protect Mode	
8-11		Undefined	
12	Error	Invalid Unit Codes	The unit codes for velocity or volume is not valid.
13-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.33 Command 168 Read general meter information

Reads the General meter information for use in the device information screen.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-1	Unsigned Integer	DeviceNumber	Reads the database point Device Number
2-7	Packed ASCII	FirmwareVersion	Reads a PACKED ASCII string, the major and the minor version number, followed by spaces padded out to 8 characters. This string is not stored in nvram but is created from the CPUBdSwIntVer by the HART Slave. The string will be in the format%d.%d (major.minor), numbers only.
8-19	Packed ASCII	MeterSerialNumber	Reads the database point MeterSerialNumber converted to a PACKED ASCII 16 character string. If serial number is shorter than 16 char- acters, the number will be padded with spaces, if it is longer than 16 characters, the number will be truncated to 16 characters.
20	Enum-8	Chordal configuration	Reads the database point ChordalConfig
21	Unsigned-8	Optional I/O Module type in slot 1.	Reads the database point OptIOModule1Type
22	Unsigned-8	Optional I/O Module type in slot 2.	Reads the database point OptIOModule2Type

Command-specific response codes

Byte	Format	Descriptione
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-31		Undefined
32	Error	Busy
33-127		Undefined

10.1.34 Command 169 Read flow totals

This command reads the flow totals. The flow totals will be sent as 4 byte integers rolling over at 999,999,999 so that same mechanism used in Modbus for flow totals can be used. See Tables for unit code values. Values that do not exist or are not supported set values to 0.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
0-3	Unsigned-32	Reads the database point PosVolFlow with a maximum limit of 999,999,999	Reads PosVolFlow
4-7	Unsigned-32	Reads the database point NegVolFlow with a maximum limit of 999,999,999.	Reads NegVolFlow
8-11	Unsigned-32	Reads the database point PosVolBase with a maximum limit of 999,999,999.	Reads PosVolBase
12-15	Unsigned-32	Reads the database point NegVolBase with a maximum limit of 999,999,999	Reads NegVolBase
16-19			Reserved
20- 23			Reserved
24-27			Reserved
28-31			Reserved
32	Enum-8	Unit codes for volume	Unit codes for all volume related values in this message. This must be a valid unit code for volume values (see Volume units).
33	Enum-8		Reserved
34	Enum-8		Reserved

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.35 Command 172 Write Ethernet configuration

This command writes configuration parameters for the Ethernet port(s).

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Ethernet port selector	Select which Ethernet Port Number to configure. This is an informational variable; when written, it is not updated in the device.
1-15	Latin-1	Ethernet port IP address	Writes Eth<PortNumber>IPAddr This must be in the format X.X.X.X where each X is 0 to 255. Meter must validate that this is a valid IP address. If it is shorter than 15 characters, it will be padded with zeros (0x00).
16-30	Latin-1	Ethernet port subnet mask	Writes Eth<PortNumber>SubnetMask This must be in the format X.X.X.X where each X is 0 to 255. Meter must validate that this is a valid subnet mask. If it is shorter than 15 characters, it will be padded with zeros (0x00).
31-45	Latin-1	Ethernet default gateway address	Writes Eth<PortNumber>DfltGatewayAddr This must be in the format X.X.X.X whereeach X is 0 to 255. Meter must validate that this is a valid IP address. If it is shorter than 15 characters, it will be padded with zeros (0x00).
46-49	Unsigned-32	Alternate TCP port used for Modbus TCP	Writes Eth<PortNumber>AltModbusPort
50	Unsigned-8	Ethernet port Modbus ID	Writes Eth<PortNumber>ModbusID

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific errors	
1		Undefined	
2	Error	Invalid selection	Indicates the Ethernet port selector was invalid.
3	Error	Passed parameter too large	The value written for Eth<PortNumber>AltModbusPort is above a maximum limit.
4	Error	Passed parameter too small	The value written for Eth<PortNumber>ModbusID is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-Specific command error	
7-28	Error	Undefined	
29	Error	Invalid IP format	Either Ethernet port IP address, Ethernet port subnet mask or Ethernet default gateway address format is invalid or value written for Eth<PortNumber>AltModbusPort is reserved.
30-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.36 Command 173 Read Ethernet Configuration

This command reads the configuration parameters for the Ethernet port(s).

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Ethernet port selector	Selects which Ethernet port to read.

Response data bytes

Same as Command 172 Write Ethernet configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific errors	
1		Undefined	
2	Error	Invalid selection	The Ethernet port selector requested does not exist in this field device.
3-4		Undefined	
5	Error	Too few bytes received	
6	Error	Device-Specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.37 Command 174 Write serial port configuration

This command writes configuration parameters for the Serial ports.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Serial port selector	Selects which serial port to read. This is an INFO INDEX variable; when written, it is not updated in the device.
1	Enum-8	Communication port availability	IsPort<PortNumber>Avail This is an INFO variable; when written, it is not updated in the device.
2	Enum-8	Communication port baud rate	Writes BaudPort<PortNumber> Constant units of bits per second.
3	Unsigned-8	Communication port Modbus ID	Writes ModbusIDPort<PortNumber>
4	Enum-8	Hardware protocol on Communication port	Writes DriverSelectionPort<PortNumber> Currently available for Port B and Port C.
5	Unsigned-8	Communication port response delay	Writes CommRspDlyPort<PortNumber> Constant units of millisecond.
6	Unsigned-8	Communication port timeout value	Writes CommTimeoutPort<PortNumber> Constant units of second.
7-8	Unsigned-16	Communication port handshaking RTS off delay time.	Writes RTSOffDelayPort<PortNumber> for Port A only. For all other ports this must be written 0. Constant units of millisecond.

Byte	Format	Description	Explanation
9-10	Unsigned-16	Communication port handshaking RTS on delay time	Writes RTSOnDelayPort<PortNumber> for Port A. For all other ports this must be written 0. Constant units of millisecond.
11	Unsigned-8	Inactivity timeout for PPP connections	Writes CommTCPTimeoutPort<PortNumber>. Constant units of second.
12	Enum-8	Enable communication port hardware flow control	Writes IsHWFlowControlEnabledPort<PortNumber> for Port A only. For all other ports this must be written 0.
13-14	Unsigned-16	Maximum Datagram Size	Writes CommTCPMaxDatagramSizePort<PortNumber>.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid selection	The serial port requested does not exist in this field device. Also indicates BaudPort<PortNumber> or IsHWFlowControlEnabledPort<PortNumber> is invalid.

Code	Class	Description	Explanation
3	Error	Passed parameter too large	Indicates ModbusIDPort<PortNumber>, DriverSelectionPort<PortNumber>, CommRspDlyPort<PortNumber>, RTSOffDelayPort<PortNumber>, RTSOnDelayPort<PortNumber>, CommTCPTimeoutPort<PortNumber> or CommTCPMaxDatagramSizePort<PortNumber> is above a maximum limit.
4	Error	Passed parameter too small	Indicates ModbusIDPort<PortNumber>, DriverSelectionPort<PortNumber>, CommRspDlyPort<PortNumber>, RTSOffDelayPort<PortNumber>, RTSOnDelayPort<PortNumber>, CommTCPTimeoutPort<PortNumber> or CommTCPMaxDatagramSizePort<PortNumber> is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.38 Command 175 Read serial port configuration

This command reads configuration parameters for the Serial ports.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Serial port selector	Used to select which serial port to read.

Response data bytes

Same as Command 174 Write serial port configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	The serial port requested does not exist in this field device.
3-4		Undefined	
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.39 Command 176 Write transducer chord configuration

This command writes configuration parameters for each transducer chord.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Transducer chord selector	Used to select which transducer chord to configure. This is an information index variable; when written, it is not updated in the device.
1	Enum-8	Chord inactive control	Writes to ChordInactv<Chord>
2-5	Float	Chord “X” dimension	Writes to X<Chord>
6-9	Float	Chord “L” dimension	Writes to L<Chord>
10-13	Float	Chord average delay time	Writes AvgDly<Chord> Constant units of microsecond.
14-17	Float	Chord delta delay time	Writes DltDly<Chord>. Constant units of microsecond.
18	Enum-8	Unit code for all lengths (Length units)	Unit code of length. This must be a valid unit code for length values (HARTLengthUnit). This is an information index variable, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	Indicates transducer chord selector or ChordInactv<Chord> is invalid.

Code	Class	Description	Explanation
3	Error	Passed parameter too large	Indicates X<Chord>, L<Chord>, AvgDly<Chord> or DltDly<Chord> is above a maximum limit.
4	Error	Passed parameter too small	Indicates X<Chord>, L<Chord>, AvgDly<Chord> or DltDly<Chord> is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7	Error	In write protect mode	
8-17		Undefined	
18	Error	Invalid unit code	Indicates that an invalid unit code was written.
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.41 Command 178 Write polynomial calibration configuration

This command writes calibration configuration parameters for a particular direction.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to configure. This is an informational index variable; when written, it is not updated in the device.
1-4	Float	Factory calibration A0 coefficient	Writes to <Dir>A0. Constant units of meters per second.
5-8	Float	Factory calibration A1 coefficient	Writes to <Dir>A1.
9-12	Float	Factory calibration A2 coefficient	Writes to <Dir>A2. Constant units of seconds percmeter.
13-16	Float	Factory calibration A3 coefficient	Writes to <Dir>A3. Constant units of seconds squared per meter squared.
17-20	Float	Factory calibration C0 coefficient	Writes to <Dir>C0. Constant units of meters per second.
21-24	Float	Factory calibration C1 coefficient	Writes to <Dir>C1.
25-28	Float	Factory calibration C2 coefficient	Writes to <Dir>C2. Constant units of seconds per meter.
29-32	Float	Factory calibration C3 coefficient	Writes to <Dir>C3. Constant units of seconds squared per meter squared.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates the direction selector is invalid.

Code	Class	Description	Explanation
3	Error	Passed Parameter too Large	Indicates <Dir>A0, <Dir>A1, <Dir>A2, <Dir>A3, <Dir>C0, <Dir>C1, <Dir>C2 or <Dir>C3 is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>A0, <Dir>A1, <Dir>A2, <Dir>A3, <Dir>C0, <Dir>C1, <Dir>C2 or <Dir>C3 is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.42 Command 179 Read polynomial calibration configuration

This command reads calibration configuration parameters for a particular direction.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 178 Write polynomial calibration configuration

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates the direction selector is invalid.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.43 Command 180 Write meter factor

This command writes meter factor for the liquid ultrasonic meter.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to configure. Thisis an informational index variable; when written, it is not updated in the device.
1-4	Float	Flow calibration meter factor	Writes to <Dir>MtrFctr

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates the direction selector is invalid.
3	Error	Passed Parameter too Large	Indicates <Dir>MtrFctr is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>MtrFctr is above a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.44 Command 181 Read meter factor

This command writes meter factor for the liquid ultrasonic meter.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 180 Write meter factor.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates the direction selector is invalid.
3-4	Error	Undefined	
5	Error	Too Few Bytes Received	
6-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.45 Command 182 Write archive log configuration

This command writes configuration parameters for the archive logs.

Request data bytes

Byte	Format	Description	Explanation
0-1	Unsigned-16	Alarm log hysteresis filter number of occurrences	Writes AlarmTurnOffHysterisisCount
2-3	Unsigned-16	Alarm log hysteresis filter time span	Writes AlarmTurnOffHysterisisTimeSpan. Constant units of second.
4	Enum-8	Old unread alarm log records can be overwritten	Writes DoOverwriteUnreadAlarmLog
5	Enum-8	Old unread alarm log records can be overwritten	Writes DoOverwriteUnreadAuditLog
6	Enum-8	Old unread alarm log records can be overwritten	Writes DoOverwriteUnreadHourlyLog
7	Enum-8	Old unread alarm log records can be overwritten	Writes DoOverwriteUnreadDailyLog
8	Enum-8	Old unread alarm log records can be overwritten	Writes DoOverwriteUnreadSystemLog

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates DoOverwriteUnreadAlarmLog, DoOverwriteUnreadAuditLog, DoOverwriteUnreadHourly-Log, DoOverwriteUnreadDailyLog, or DoOverwriteUnreadSystemLog is invalid.

Code	Class	Description	Explanation
3	Error	Passed Parameter too Large	Indicates AlarmTurnOffHysterisisCount or AlarmTurnOffHysterisisTimeSpan is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates AlarmTurnOffHysterisisCount or AlarmTurnOffHysterisisTimeSpan is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.46 Command 183 Read Archive Log configuration

This command reads configuration parameters for the archive logs.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 182 Write archive log configuration

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.47 Command 184 Write acquisition configuration

This command writes configuration parameters that control how the meter acquires data.

Note
Chords C and D are unavailable for Model 3412 and Model 3411 meters.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Number of batches to hold velocity constant when re-acquiring	Writes VelHold.
1	Unsigned-8	Maximum number of consecutive batches without new data	Writes MaxNoDataBatches.
2-3	Enum-16	Specified batch update period (may be overridden if stacking is selected)	Writes SpecBatchUpdtPeriod. Constant units of millisecond.
4-7	Float	Desired transducer firing (emission) rate	Writes EmRateDesired. Constant units of millisecond.
8-11	Float	Desired stacking transducer firing (emission) rate	Writes StackEmRateDesired. Constant units of millisecond.
12	Enum-8	Transducer firing sequence selector	Writes FireSeq.
13	Unsigned-8	Minimum number of operating chords for valid measurement	Writes MinChord.
14-15	Unsigned-16	Number of consecutive batches that a chord must fail before declared "hard failed"	Writes AlarmDef.
16	Enum-8	Meter installed backwards control	Writes FlowDir.
17	Enum-8	Enables dithering (progressive jitter after each transducerfiring)	Writes DitherEnable.
18	Enum-8	Customer-calibration method selector	Writes CalMethod.

Byte	Format	Description	Explanation
19-20	Unsigned-16	Number of consecutive batches without chord failures required for updating chord proportions.	Writes PropUpdtBatches.
21-22	Unsigned-16	Chord proportions update factor	Writes NumVals.
23	Unsigned-8	Minimum percentage of good measurements for working chord	Writes MinPctGood. Constant units of percent.
24	Unsigned-8	Number of sequences between gain/hold time/ tracking updates	Writes BatchSize.
25	Enum-8	Co-located meter mode	Writes ColocMeterMode. Applicablefor Four Chord meters, for others will always be Disable (0).
26	Enum-8	Transducer firing synchronization	Writes XdcrFiringSync. Applicable only if ColocMeterMode is not disabled (0), else will always be Disable (0).
27	Enum-8	Peak switch detection mode	Writes PeakSwithDetectMode.
28-29	Unsigned-16	Elapsed time without chord failure required for updating chord proportions	Writes PropUpdtSeconds.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	

Code	Class	Description	Explanation
2	Error	Invalid selection	Indicates: • SpecBatchUpdtPeriod, FlowDir, CalMethod,XdcrFiringSync, or PeakSwitchDetectMode is invalid. • ColocMeterMode or XdcrFiringSync cannot be written because of interdependency. • SpecBatchUpdtPeriod cannot be written because of dependency with StackSize or Filter.
3	Error	Passed parameter too large	Indicates VelHold, SpecBatchUpdtPeriod, MaxNoDataBatches, EmRateDesired, StackEmRateDesired, FireSeq, MinChord, AlarmDef, CalMethod, DitherEnable, PropUpdtBatches, NumVals, MinPctGood, BatchSize, ColocMeterMode, PeakSwitchDetectMode, or PropUpdtSeconds is above a maximum limit.
4	Error	Passed parameter too small	Indicates VelHold, SpecBatchUpdtPeriod, MaxNoDataBatches, EmRateDesired, StackEmRateDesired, FireSeq, MinChord, AlarmDef, CalMethod, DitherEnable, PropUpdtBatches, NumVals, MinPctGood, BatchSize, ColocMeterMode, PeakSwitchDetectMode, orPropUpdtSeconds is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7	Error	In write-protect mode	
8-31		Undefined	

Code	Class	Description	Explanation
32	Error	Busy	
33-127		Undefined	

10.1.48 Command 185 Read acquisition configuration

This command reads configuration parameters that control how the meter acquires data.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 184 Write acquisition configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-SpecificCommand Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.49 Command 186 Write meter limits

This command writes meter flow and SOS limit parameters.

Request data bytes

Byte	Format	Description	Explanation
0-3	Float	Maximum percentage chord sound speed deviation	Writes CRange. Constant units of percent.
4-7	Float	Velocity threshold below which the flow velocity is considered zero	Writes ZeroCut
8-11	Float	Maximum meter velocity	Writes MeterMaxVel
12-15	Float	Minimum sound speed	Writes SSMin
16-19	Float	Maximum sound speed	Writes SSMax
20-23	Float	Sound velocity lo-alarm limit	Writes AvgSoundVelLoLmt
24-27	Float	Sound velocity hi-alarm limit	Writes AvgSoundVelHiLmt
28-31	Float	Minimum flow velocity for CRange test	Writes SndSpdChkMinVel
32-35	Float	Maximum flow velocity for CRange test	Writes SndSpdChkMaxVel
36	Unsigned-8	Minimum velocity for updating chord proportions	Writes LowFlowLmt
37	Enum-8	Unit code of velocity	Unit code of velocity (Velocity units). This is an informational variable; when written, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

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

Code	Class	Description	Explanation
2	Error	Invalid Selection	Indicates: • ZeroCut is above FlowAnalysisLowFlowLmt. • SSMin is above SSMax. • SndSpdChkMinVel is above SndSpdChkMaxVel
3	Error	Passed Parameter too Large	Indicates CRange, ZeroCut, MeterMaxVel, SSMin, SSMax, AvgSoundVelLoLmt, AvgSoundVelHiLmt, SndSpdChkMinVel, SndSpdChkMaxVel, or LowFlowLmt is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates CRange, ZeroCut, MeterMaxVel, SSMin, SSMax, AvgSoundVelLoLmt, AvgSoundVelHiLmt, SndSpdChkMinVel, SndSpdChkMaxVel, or LowFlowLmt is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-17		Undefined	
18	Error	Invalid Unit Code	Indicates that an invalid unit code was written.
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.50 Command 187 Read meter limits

This command reads meter flow and SOS limit parameters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 186 Write meter limits.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.51 Command 188 Write meter body configuration

This command writes meter body configuration parameters.

Request data bytes

Byte	Format	Description	Explanation
0-3	Float	Pipe inside diameter	Writes PipeDiam
4-7	Float	Pipe outside diameter	Writes PipeOutsideDiameter
8-11	Float	Young's Modulus value (tensile stress to tensile strain ratio)	Writes YoungsModulus
12-15	Float	Poisson's Ratio value (absolute ratio of lateral strain to axial strain)	Writes PoissonsRatio
16-19	Float	Linear expansion coefficient	Writes LinearExpansionCoef
20-23	Float	Reference temperature for linear expansion	Writes RefTempLinearExpCoef
24-27	Float	Pressure-effect expansion coefficient	Writes RefPressExpCoef
28	Enum-8	Unit code of length for PipeDiam, PipeOutsideDiameter	Unit code for length (HARTLengthUnit). This is an Informational variable; when written, it is not updated in the device.
29	Enum-8	Variable classification code for Young's Modulus	Must be 65. This is an informational variable; when written, it is not updated in the device
30	Enum-8	Unit code of Pressure for Young's Modulus	This must be a valid unit code for pressure values (HARTYoungsModulusPressureUnit). This is an Informational variable; when written, it is not updated in the device.
31	Enum-8	Variable classification code for LinearExpansionCoef	Must be 107. This is an INFO variable; when written, it is not updated in the device.

Byte	Format	Description	Explanation
32	Enum-8	Unit code of thermal expansion for LinearExpansionCoef	Unit code of thermal expansion (Thermal expansion units). **Note** Unit code 170 (Inverse degrees Celsius) is used when HARTTemperatureUnit is either Degrees Celsius or Kelvin. This is an Informational variable; when written, it is not updated in the device
33	Enum-8	Unit code of temperature for RefTempLinearExpCoef	Unit code of temperature (Temperature units). This is an Informational variable; when written, it is not updated in the device
34	Enum-8	Unit code of pressure for RefPressExpCoef	Unit code of pressure (Pressure units). This is an Informational variable; when written, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates PipeDiam is above PipeOutsideDiameter.
3	Error	Passed Parameter too Large	Indicates PipeDiam, PipeOutsideDiameter, YoungsModulus,PoissonsRatio, LinearExpansionCoef, RefTempLinearExpCoef, RefPressExpCoef, or WallRoughness is above a maximum limit.

Code	Class	Description	Explanation
4	Error	Passed Parameter too Small	Indicates PipeDiam, PipeOutsideDiameter, YoungsModulus,PoissonsRatio , LinearExpansionCoef, RefTempLinearExpCoef, RefPressExpCoef, or WallRoughness is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-17		Undefined	
18	Error	Invalid Unit Code	Indicates that an invalid unit code was written
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.52 Command 189 Read meter body configuration

This command reads meter body configuration parameters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 188 Write meter body configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.53 Command 190 Write signal parameters

This command writes parameters used to configure transducer firing and sampling and detection limits.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	First peak amplitude threshold	Writes Pk1Thrsh
1	Unsigned-8	Parameter used to locate the signal start	Writes Pk1Pct. Constant unit of (%).
2	Unsigned-8	Minimum signal-to-noise threshold	Writes SNRatio
3-6	Unsigned-32	Maximum noise energy threshold	Writes MaxNoise
7	Unsigned-8	Minimum acceptable signal quality	Writes MinSigQlty
8-11	Float	Transducer frequency	Writes XdcrFreq. Constant units of kHz.
12	Unsigned-8	Number of cycles for transducer	Writes XdcrNumDriveCycles
13-16	Float	Sampling (rate) interval. Changing this value requires re-booting the meter.	Writes SampInterval. Constant units of nanosecond.
17	Enum-8	Samples per cycle	Writes SampPerCycle
18-21	Float	Minimum sampling hold time	Writes MinHoldTime. Constant units of microsec- ond.
22-25	Float	Maximum sampling hold time	Writes MaxHoldTm. Constant units of microsecond.
26-29	Float	Measurement Quality check deviation factor	Writes TmDevFctr1
30-31	Unsigned-16	Minimum negative pulse width	Writes NegSpanSI. Constant units of microsecond.
32-33	Unsigned-16	Minimum positive pulse width	Writes PosSpanSI. Constant units of microsecond.
34-35	Unsigned-16	Transit time standard deviation threshold for measurement quality check	Writes TmDevLow1SI. Constant units of sample intervals.
36-37	Unsigned-16	Maximum peak pulse width	Writes PkPlsWdthSI. Constant units of sample intervals.

Byte	Format	Description	Explanation
38-39	Unsigned-16	Delta time check parameter	Writes DltChkSI. Constant units of sample intervals.
40-43	Float	Gain range for transducer maintenance	Writes XdcrMaintenanceGainRange. Constant units of decibel(dB).
44-47	Float	SNR range for transducer maintenance	Writes XdcrMaintenanceSNRRange. Constant units of decibel (dB).

Response data bytes

Same as Request data bytes

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates: • Pk1Pct, XdcrFreq, SampIntervalXdcrFreq, SampPerCycle is invalid. • MinHoldTime is above MaxHoldTm
3	Error	Passed Parameter too Large	Indicates Pk1Thrsh, Pk1Pct, SNRatio, MaxNoise, MinSigQlty, XdcrFreq, XdcrNumDriveCycles, SampInterval, MinHoldTime, MaxHoldTm, TmDevFctr1, NegSpan, PosSpan, TmDevLow1, Pk1Wdth, SampPerCycle, DltChk, or XdcrMaintenanceGainRange is above a maximum limit.

Code	Class	Description	Explanation
4	Error	Passed Parameter too Small	Indicates Pk1Thrsh, Pk1Pct, SNRatio, , MaxNoise, MinSigQlty, XdcrFreq, XdcrNumDriveCycles, SampInterval, MinHoldTime, MaxHoldTm, TmDevFctr1, NegSpan, PosSpan, TmDevLow1, Pk1Wdth, SampPerCycle, DltChk, XdcrMaintenanceGainRange, or XdcrMaintenanceSNRRange is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.54 Command 191 Read signal parameters

This command reads parameters for transducer firing and sampling and detection limits.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 190 Write signal parameters.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.55 Command 192 Write target parameters

This command writes target parameters used for signal detection.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Default tracking target Pf distance	Writes Tspf. Constant units of sample intervals.
1	Unsigned-8	Tracking target Pf distance low limit	Writes TspfLo. Constant units of sample intervals.
2	Unsigned-8	Tracking target Pf distance high limit	Writes TspfHi. Constant units of sample intervals.
3	Unsigned-8	Tracking target Pf sensitivity	Writes TspfSen. Constant units of sample intervals.
4	Signed-8	Default tracking target Pe distance	Writes Tspe. Constant units of sample intervals.
5	Signed-8	Tracking target Pe distance low limit	Writes TspeLo. Constant units of sample intervals.
6	Signed-8	Tracking target Pe distance high limit	Writes TspeHi. Constant units of sample intervals.
7	Unsigned-8	Tracking target Pe sensitivity	Writes TspeSen. Constant units of sample intervals.
8-9	Unsigned-16	Tracking target abs (Pe-Pf) limit	Writes TspeLmt. Constant units of sample intervals.
10	Signed-8	Default tracking target normalized amplitude	Writes Tamp. Constant units of percent.
11	Unsigned-8	Tracking target normalized amplitude low limit	Writes TampLo. Constant units of percent.
12	Unsigned-8	Tracking target normalized amplitude high limit	Writes TampHi. Constant units of percent .
13	Unsigned-8	Tracking target normalized amplitude sensitivity	Writes TampSen. Constant units of percent.
14-17	Float	Tracking target Pf weighting factor	Writes TspfWt
18-21	Float	Tracking target Pe weighting factor	Writes TspeWt
22-25	Float	Tracking target normalized amplitude weighting factor	Writes TampWt

Byte	Format	Description	Explanation
26	Unsigned-8	Track parameter auto reset threshold: • 0=always reset • 100=disable auto reset	Writes TspfMatch. Constant unit of percent.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates: • TspfLo is above TspfHi or Tspf is below TspfLo or Tspf is above TspfHi. • TspeLo is above TspeHi or Tspe is below TspeLo or Tspe is above TspeHi. • TampLo is above TampHi or Tamp is below TampLo or Tamp is above TampHi.
3	Error	Passed Parameter too Large	Indicates Tspf, TspfLo, TspfHi, TspfSen, Tspe, TspeLo, TspeHi, TspeSen, TspeLmt, Tamp, TampLo, TampHi, TampSen, TspfWt, TspeWt, TampWt, or TspfMatch is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates Tspf, TspfLo, TspfHi, TspfSen, Tspe, TspeLo, TspeHi, TspeSen, TspeLmt, Tamp, TampLo, TampHi, TampSen, TspfWt, TspeWt, TampWt, or TspfMatch is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	

Code	Class	Description	Explanation
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.56 Command 193 Read target parameters

This command read target parameters used for signal detection.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 192 Write target parameters.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.57 Command 194 Reset chord proportions to defaults

This command executes operation to reset chord proportions to default values (writes `ResetProp` internally).

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
None			

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-5		Undefined	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.58 Command 195 Enter/exit fixed frequency output mode

This command puts the selected frequency output in or out of test mode.

Note
The effect of this Command command is not retained through a device reset or removal of power from the field device.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Frequency output selector	This is an informational index variable; when written, it is not updated in the device.
1	Enum-8	Enables/Disables test mode.	Writes IsFreq<FrequencyNumber>EnableTest
2	Unsigned-8	Percentage of scale to output on frequency output. (Valid range from 0 to 150).	Writes Freq<FrequencyNumber>TestModeOutputPercent. Constant unit of percent.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates: • Frequency output selector is invalid • IsFreq<FrequencyNumber>EnableTest is invalid
3	Error	Passed Parameter too Large	Indicates Freq<FrequencyNumber>TestModeOutputPercent is above a maximum limit.

Code	Class	Description	Explanation
4	Error	Passed Parameter too Small	Indicates Freq<FrequencyNumber>TestModeOutputPercent is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.59 Command 196 Enter/exit fixed digital output mode

This command puts the selected digital output in or out of test mode.

Note
The effect of this Command command is not retained through a device reset or removal of power from the field device.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Digital output selector	0=Pair 1, 1=Pair 2. This is an INFO INDEX variable; when written, it is not updated in the device.
1	Enum-8	Enables/Disables test mode	Writes DO<DigitalNumber>PairTestEnable
2	Enum-8	Digital output phase A test mode value	Writes DO<DigitalNumber>ATestVal
3	Enum-8	Digital output phase B test mode value	Writes DO<DigitalNumber>BTestVal

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates: • digital output selector is invalid • one of the following is invalid: — DO<DigitalNumber>PairTestEnable — DO<DigitalNumber>ATestVal — DO<DigitalNumber>BTestVal

Code	Class	Description	Explanation
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.60 Command 197 Set transducer type

This command sets the transducer type and returns the values of the affected configuration parameters.

Request data bytes

Byte	Format	Description	Explanation
1	Unsigned-8	Sets up tracking parameters to default values for a particular model of transducer	Writes SetXdcrType.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates SetXdcrType is invalid
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.61 Command 198 Write Frequency/Digital Output sources

This command writes the sources for Command 198 Write Frequency/Digital Output sources.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Frequency/Digital Output 1 availability	IsFODO1Avail. Indicates the presence of the first Frequency/Digital Output port (FODO1). This is an INFO variable; when written, it is not updated in the device.
1	Enum-8	Source assigned to Frequency/ Digital Output 1	Writes FODO1Source
2	Enum-8	Frequency/Digital Output 1 Mode	Writes FODO1Mode
3	Enum-8	Frequency/Digital Output 2 availability	IsFODO2Avail Indicates the presence of the second Frequency/ Digital Output port (FODO2). This is an INFO variable; when written, it is not updated in the device.
4	Enum-8	Source assigned to Frequency/ Digital Output 2	Writes FODO2Source
5	Enum-8	Frequency/Digital Output 2 Mode	Writes FODO2Mode
6	Enum-8	Frequency/Digital Output 3 availability	IsFODO3Avail Indicates the presence of the third Frequency/ Digital Output port (FODO3). This is an INFO variable; when written, it is not updated in the device.
7	Enum-8	Source assigned to Frequency/ Digital Output 3	Writes FODO3Source
8	Enum-8	Frequency/Digital Output 3 Mode	Writes FODO3Mode

Byte	Format	Description	Explanation
9	Enum-8	FODO4 availability	IsFODO4Avail. Indicatesthe presence of the fourth Frequency/ Digital Output port (FODO4). This is an INFO variable; when written, it is not updated in the device.
10	Enum-8	Source assigned to FODO4	Writes FODO4Source
11	Enum-8	FODO4 Mode	Writes FODO4Mode
12	Enum-8	FODO5 availability	IsFODO5Avail. Indicates the presence of the fifth Frequency/Digital Output port (FODO5). This is an INFO variable; when written, it is not updated in the device.
13	Enum-8	Source assigned to FODO5	Writes FODO5Source
14	Enum-8	FODO5 Mode	Writes FODO5Mode
15	Enum-8	FODO6 availability	IsFODO6Avail. Indicates the presence of the sixth Frequency/Digital Output port (FODO6). This is an INFO variable; when written, it is not updated in the device.
16	Enum-8	Source assigned to FODO6	Writes FODO6Source
17	Enum-8	FODO6 Mode	Writes FODO6Mode

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates FODO<1..6>Source or FODO<1..6>Mode is invalid.
3-4		Undefined	
5	Error	Too Few Bytes Received	

Code	Class	Description	Explanation
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.62 Command 199 Read Frequency/Digital Output sources

This command reads the Frequency/Digital Output source settings.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 198 Write Frequency/Digital Output sources.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.63 Command 200 Write miscellaneous write protected parameters

This command is used to write miscellaneous write protected parameters.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Number of Master command preamble bytes	Writes HARTMinNumPreambles
1	Unsigned-8	Non-normal operation timeout	Writes NonNormalModeTimeout. Constant units of minute.
2	Unsigned-8	Hour of day to log daily record in military time	Writes ContractHour
3	Enum-8	Modbus access units system	Writes UnitsSystem
4	Enum-8	Flow rate time unit for Modbus communications	Writes VolFlowRateTimeUnit
5	Enum-8	U.S. Customary volume unit for Modbus communications	Writes VolUnitUS
6	Enum-8	Metric volume unit for Modbus communications	Writes VolUnitMetric

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1-2		Undefined	
3	Error	Passed Parameter too Large	Indicates HARTMinNumPreambles, NonNormalModeTimeout, UnitsSystem, or VolFlowRateTimeUnit is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates HARTMinNumPreambles, NonNormalModeTimeout, UnitsSystem, or VolFlowRateTimeUnit is below a minimum limit.

Code	Class	Description	Explanation
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.64 Command 201 Write analog input calibration

This command writes configuration parameters analog input calibration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog input selector	Used to select which analog input to configure. This is an informational index variable; when written, it is not updated in the device.
1-4	Float	Live flow condition calibration offset value	Writes to LiveFlow<PressureTemperature>Offset
5-8	Float	Live flow condition calibration gain value	Writes to LiveFlow<Pressure/Temperature>Gain
9	Enum-8	Unit code for live flow condition calibration offset value	Unit code for only the live flow condition calibration offset value. This must be a valid unit code for Pressure (HARTPressureUnit) (when Analog input selector is 1 i.e., Pressure) or a valid unit code for Temperature (HARTTemperatureUnit) (when Analog input selector is 0 i.e Temperature). This is an informational variable; when written, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that analog input requested does not exist in this field device.

Code	Class	Description	Explanation
3	Error	Passed Parameter too Large	Indicates LiveFlow<Pressure/ Temperature>Offset or LiveFlow<Pressure/ Temperature>Gain is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates LiveFlow<Pressure/ Temperature>Offset or LiveFlow<Pressure/ Temperature>Gain is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-17		Undefined	
18	Error	Invalid Unit Code	Indicates that an invalid unit code was written
19-31			
32	Error	Busy	
33-127		Undefined	

10.1.65 Command 202 Read analog input calibration

This command reads configuration parameters analog input calibration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog input selector	Selects which analog input to read. • 0=Temperature • 1=Pressure

Response data bytes

Code	Class	Description	Explanation
0	Unsigned-8	Analog input selector	0=Temperature and 1=Pressure. Reads which analog input is configured.
1-4	Float	Live flow condition calibration offset value	Reads LiveFlow<Pressure/ Temperature>Offset.
5-8	Float	Live flow condition calibration gain value	Reads LiveFlow<Pressure/ Temperature>Gain.
9	Enum-8	Unit code for live flow condition calibration offset value	Unit code for live flow condition calibration offset value and Live flow condition value.
10-13	Float	Live flow condition value	Reads LiveFlowTemperature/ Pressure.
14-17	Float	Live Analog Input current value	Reads live current value in mA corresponding to Analog Input 1 i.e Temperature (when Analog input selector is 0 i.e Temperature) or Analog Input 2 i.e. Pressure (when Analog input selector is 1 i.e Pressure).

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	

Code	Class	Description	Explanation
1		Undefined	
2	Error	Invalid Selection	The analog input requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.66 Command 203 Write piecewise linearization flow rates

This command writes piecewise linearization flow rates configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to configure. • 0=Reverse<Rev> • 1=Forward <Fwd> This is an informational index variable; when written, it is not updated in the device.
1-4	Float	Piecewise linearization volumetric flow rate 1	Writes to <Dir>FlwRt1
5-8	Float	Piecewise linearization volumetric flow rate 2	Writes to <Dir>FlwRt2
9-12	Float	Piecewise linearization volumetric flow rate 3	Writes to <Dir>FlwRt3
13-16	Float	Piecewise linearization volumetric flow rate 4	Writes to <Dir>FlwRt4
17-20	Float	Piecewise linearization volumetric flow rate 5	Writes to <Dir>FlwRt5
21-24	Float	Piecewise linearization volumetric flow rate 6	Writes to <Dir>FlwRt6
25-28	Float	Piecewise linearization volumetric flow rate 7	Writes to <Dir>FlwRt7
29-32	Float	Piecewise linearization volumetric flow rate 8	Writes to <Dir>FlwRt8
33-36	Float	Piecewise linearization volumetric flow rate 9	Writes to <Dir>FlwRt9
37-40	Float	Piecewise linearization volumetric flowrate 10	Writes to <Dir>FlwRt10
41-44	Float	Piecewise linearization volumetric flow rate 11	Writes to <Dir>FlwRt11
45-48	Float	Piecewise linearization volumetric flow rate 12	Writes to <Dir>FlwRt12

Byte	Format	Description	Explanation
49	Enum-8	Unit code for volumetric flow rate	Unit code for piecewise linearization volumetric flow rate values. This must be a valid unit code for volumetric flow rate (refer to Volumetric flow rate units derived as per selection of HARTVolUnit and HARTRateTimeUnit). This is an informational index variable; when written, it is not updated in the device.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that flow direction requested does not exist in this field device
3	Error	Passed Parameter too Large	Indicates <Dir>FlwRt<1..12> is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>FlwRt<1..12> is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-17		Undefined	
18	Error	Invalid Unit Code	Indicates that an invalid unit code was written.
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.67 Command 204 Read piecewise linearization flow rates

This command reads piecewise linearization flow rates configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read. • 0=Reverse <Rev> • 1=Forward <Fwd>

Response data bytes

Same as Command 203 Write piecewise linearization flow rates.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	The flow direction requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.68 Command 205 Write piecewise linearization meter factors

This command writes piecewise linearization meter factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to configure. • 0=Reverse <Rev> • 1=Forward <Fwd> This is an informational index variable; when written, it is not updated in the device.
1-4	Float	Piecewise linearization meter factor 1	Writes to <Dir>MtrFctr1
5-8	Float	Piecewise linearization meter factor 2	Writes to <Dir>MtrFctr2
9-12	Float	Piecewise linearization meter factor 3	Writes to <Dir>MtrFctr3
13-16	Float	Piecewise linearization meter factor 4	Writes to <Dir>MtrFctr4
17-20	Float	Piecewise linearization meter factor 5	Writes to <Dir>MtrFctr5
21-24	Float	Piecewise linearization meter factor 6	Writes to <Dir>MtrFctr6
25-28	Float	Piecewise linearization meter factor 7	Writes to <Dir>MtrFctr7
29-32	Float	Piecewise linearization meter factor 8	Writes to <Dir>MtrFctr8
33-36	Float	Piecewise linearization meter factor 9	Writes to <Dir>MtrFctr9
37-40	Float	Piecewise linearization meter factor 10	Writes to <Dir>MtrFctr10
41-44	Float	Piecewise linearization meter factor 11	Writes to <Dir>MtrFctr11
45-48	Float	Piecewise linearization meter factor 12	Writes to <Dir>MtrFctr12

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that flow direction requested does not exist in this field device.
3	Error	Passed Parameter too Large	Indicates <Dir>MtrFctr<1..12> is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>MtrFctr<1..12> is below a minimum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.69 Command 206 Read piecewise linearization meter factors

This command reads piecewise linearization meter factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 205 Write piecewise linearization meter factors.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	The flow direction requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.70 Command 207 Write meter text

This command writes meter information related texts.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Text selector	Used to select which meter text to configure. This is an informational index variable; when written, it is not updated in the device.
1-64	Latin-1	Meter Text	Writes to MeterName, StationName, Address, City, StateAndCountry, UserScratch1, or UserScratch2 depending upon Text selector index selection. If text is shorter than 64 characters, it will be padded with zeros (0x00).

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that meter text requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-29		Undefined	
30	Warning	Command Response Truncated	Indicates meter text was longer than can be displayed over the HART interface and was replaced by shorter text.

Code	Class	Description	Explanation
31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.71 Command 208 Read meter text

This command reads meter information related texts.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Text selector	Used to select which meter text to read.

Response data bytes

Same as Command 207 Write meter text.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that meter text requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.72 Command 217 Write baseline times and comments

Writes forward or reverse baseline date, time and comments depending upon first byte in the Command command request.

If IsAnyBaselineAvail is FALSE, then this command will respond with success and existing baseline parameters are not updated in the meter. New baseline parameters are not written in the meter.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Direction selector	Used to select which direction to configure. This is an informational index variable; when written, it is not updated in the device. **Note** Contrary to device-specific commands guideline 'Indices format should be Unsigned-<#bits>', format Enum-8 is used for uniformity with command 155 Write Baselines.
1-3	Date	Date of flow baseline	Writes the Date part of database point XBaselineTime
4-7	Time	Time of flow baseline	Writes the Time part of database point XBaselineTime
8-71	Latin-1	Comment to flow baseline	Writes the string database point XbaselineComment. If comment is shorter than 64 characters, it will be padded with zeros (0x00).

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	

Code	Class	Description	Explanation
2	Error	Invalid Selection	Invalid value for Forward/ Reverse Selection
3	Error	Passed parameter too large	Invalid value for Time of Flow Baseline
4	Error	Undefined	
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7	Error	In Write-Protect mode	
8		Undefined	
9	Error	Invalid Date Code detected	Indicates: • Invalid value for Date of Flow Baseline • Xbaseline date and time is out of range Jan 1, 1970 00:00:00 UTC to Jan 19,203803:14:07 UTC
10-29		Undefined	
30	Warning	Command response is truncated	Indicates Xbaseline comment was longer than can be displayed over the HART interface and was replaced by shorter comment.
31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.73 Command 218 Read baseline times and comments

This command reads the forward or reverse baseline date, time and comments depending upon the parameter passed in the command request.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 217 Write baseline times and comments.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	Invalid value for Forward/ Reverse Selection
3-4		Undefined	
5	Error	Too few bytes received	
6-31		Undefined	
32	Error	Busy	
33-127		No command-specific errors	

10.1.74 Command 219 Reset tracking targets to defaults

This command executes operation to reset tracking targets to default values (writes to `ResetTrkParam` internally).

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Byte	Format	Description	Explanation
None			

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1-5		Undefined	
6	Error	Device-specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.75 Command 220 Write local display configuration

This command writes local display configuration parameters.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Local display availability	Indicates the presence of a local display (IsLocalDisplayAvail). This is an informational variable; when written, it is not updated in the device.
1	Enum-8	Local display item 1	Writes LocalDisplayItem1
2	Enum-8	Local display item 2	Writes LocalDisplayItem2
3	Enum-8	Local display item 3	Writes LocalDisplayItem3
4	Enum-8	Local display item 4	Writes LocalDisplayItem4
5	Enum-8	Local display item 5	Writes LocalDisplayItem5
6	Enum-8	Local display item 6	Writes LocalDisplayItem6
2	Enum-8	Local display item 2	Writes LocalDisplayItem2
3	Enum-8	Local display item 3	Writes LocalDisplayItem3
4	Enum-8	Local display item 4	Writes LocalDisplayItem4
5	Enum-8	Local display item 5	Writes LocalDisplayItem5
6	Enum-8	Local display item 6	Writes LocalDisplayItem6
7	Enum-8	Local display item 7	Writes LocalDisplayItem7
8	Enum-8	Local display item 8	Writes LocalDisplayItem8
9	Enum-8	Local display item 9	Writes LocalDisplayItem9
10	Enum-8	Local display item 10	Writes LocalDisplayItem10
11	Unsigned-8	Local display scroll delay	• Writes LocalDisplayScrollDelay • Constant units of second
12	Enum-8	Volumetric flow rate time unit for the local display	Writes LocalDisplayFlowRateTimeUnit
13	Enum-8	U.S. Customary volume unit for the local display	Writes LocalDisplayVolUnitUS
14	Enum-8	Metric volume unit for the local display	Writes LocalDisplayVolUnitMetric

Byte	Format	Description	Explanation
15	Enum-8	Local display mode	Writes LocalDisplayMode

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	LocalDisplayItem<1..10> is invalid.
3	Error	Passed parameter too large	Indicates LocalDisplayItem<1..10> is above a maximum limit.
4	Error	Passed parameter too small	Indicates LocalDisplayItem<1..10> is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7	Error	In Write-Protect mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.76 Command 221 Read local display configuration

This command reads local display configuration parameters.

Request data bytes

Byte	Format	Description	Explanation
None			

Response data bytes

Same as Command 220 Write local display configuration.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1-5		Undefined	
6	Error	Device-specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.77 Command 222 Enable local display test mode

This command enables the local display test mode.

Note
The effect of this command is not retained through a device reset or removal of power from the field device.

Request data bytes

Byte	Format	Description	Explanation
1	Enum-8	Enables local display test mode	Writes IsLocalDisplayEnableTest

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	Indicates: • IsLocalDisplayEnableTest is invalid • local display test mode cannot be enabled because local display is in Squawk mode
3-4		Undefined	
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.78 Command 223 Write general meter information

Writes general meter information for use in the device information screen.

Request data bytes

Byte	Format	Description	Explanation
0-1	Unsigned-16	Device number	Writes DeviceNumber
2-13	Packed ASCII	Meter serial number	Writes MeterSerialNumber converted to a PACKED ASCII 16-character string. If serial number is shorter than 16 characters, the number will be padded with spaces.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	Indicates Device Number or Meter Model or Meter nominal size requested
3-4		Undefined	
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7	Error	In write-protect mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.79 Command 224 Write miscellaneous non-write protected parameters

This command is used to write miscellaneous non-write protected parameters.

Request data bytes

Byte	Format	Description	Explanation
0	Enum-8	Batch smoothing factor: specifies percentage total data to be taken from previous data	• Writes BatchPercentSmoothing • Constant units of percent
1	Enum-8	Stack size	Writes StackSize
2	Enum-8	Bandpass filter switch	Writes Filter
3-6	Float	Liquid dynamic viscosity	Writes Viscosity
7	Enum-8	Variable classification code for viscosity	Must be 74. This is an informational variable; when written, it is not updated in the device.
8	Enum-8	Unit code for viscosity	Unit code of Viscosity (HARTViscosityUnit). See Viscosity units. This is an informational variable; when written, it is not updated in the device.
9	Enum-8	High viscosity calibration method selector	Writes HighViscosityMethod

Response data bytes

Same as Request data bytes

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	

Code	Class	Description	Explanation
2	Error	Invalid selection	Indicates: • BatchPercentSmoothing, StackSize, or Filter is invalid • StackSize or Filter cannot be written because of dependency with SpecBatchUpdtPeriod
3	Error	Passed parameter too large	Indicates BatchPercentSmoothing, StackSize, SpecRhoMixFlow, SpecZFlow, SpecZBase, SpecCorrectionFactor, or Viscosity is above a maximum limit.
4	Error	Passed parameter too small	Indicates BatchPercentSmoothing, StackSize, SpecRhoMixFlow, SpecZFlow, SpecZBase, SpecCorrectionFactor, or Viscosity is below a minimum limit.
5	Error	Too few bytes received	
6	Error	Device-specific command error	
7-17		Undefined	
18	Error	Invalid unit code	Indicates that an invalid unit code was written.
19-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.80 Command 225 Write Piecewise Linearization High Viscosity Meter Factors parameters

This command is used to write piecewise linearization high viscosity meter factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Float	Direction selector	This is an informational variable; when written, it is not updated in the device.
1-4	Float	Piecewise linearization high viscosity meter factor 1	Writes to <Dir>MtrFctrHighViscosity1
5-8	Float	Piecewise linearization high viscosity meter factor 2	Writes to <Dir>MtrFctrHighViscosity2
9-12	Float	Piecewise linearization high viscosity meter factor 3	Writes to <Dir>MtrFctrHighViscosity3
13-16	Float	Piecewise linearization high viscosity meter factor 4	Writes to <Dir>MtrFctrHighViscosity4
17-20	Float	Piecewise linearization high viscosity meter factor 5	Writes to <Dir>MtrFctrHighViscosity5
21-24	Float	Piecewise linearization high viscosity meter factor 6	Writes to <Dir>MtrFctrHighViscosity6
25-28	Float	Piecewise linearization high viscosity meter factor 7	Writes to <Dir>MtrFctrHighViscosity7e
29-32	Float	Piecewise linearization high viscosity meter factor 8	Writes to <Dir>MtrFctrHighViscosity8e
33-36	Float	Piecewise linearization high viscosity meter factor 9	Writes to <Dir>MtrFctrHighViscosity9e
37-40	Float	Piecewise linearization high viscosity meter factor 10	Writes to <Dir>MtrFctrHighViscosity10
41-44	Float	Piecewise linearization high viscosity meter factor 11	Writes to <Dir>MtrFctrHighViscosity11
45-48	Float	Piecewise linearization high viscosity meter factor 12	Write sto <Dir>MtrFctrHighViscosity12

Response data bytes

Same as Request data bytes.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that flow direction requested does not exist in this field device.
3	Error	Passed Parameter too Large	Indicates <Dir>MtrFctrHighViscosity<1..12> is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>MtrFctrHighViscosity<1..12> is above a maximum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.81 Command 226 Read Piecewise Linearization High Viscosity Meter Factors

This command reads piecewise linearization high viscosity meter factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 225 Write Piecewise Linearization High Viscosity Meter Factors parameters.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	The flow direction requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.82 Command 227 Write Piecewise Linearization Profile Factors

This command writes piecewise linearization profile factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Usedto select which direction to configure. Thisis an informational variable; when written, it is not updated in the device
1-4	Float	Piecewise linearization profile factor 1	Writes to <Dir>ProfileFactor1
5-8	Float	Piecewise linearization profile factor 2	Writes to <Dir>ProfileFactor2
9-12	Float	Piecewise linearization profile factor 3	Writes to <Dir>ProfileFactor3
13-16	Float	Piecewise linearization profile factor 4	Writes to <Dir>ProfileFactor4
17-20	Float	Piecewise linearization profile factor 5	Writes to <Dir>ProfileFactor5
21-24	Float	Piecewise linearization profile factor 6	Writes to <Dir>ProfileFactor6
25-28	Float	Piecewise linearization profile factor 7	Writes to <Dir>ProfileFactor7
29-32	Float	Piecewise linearization profile factor 8	Writes to <Dir>ProfileFactor8
33-36	Float	Piecewise linearization profile factor 9	Writes to <Dir>ProfileFactor9
37-40	Float	Piecewise linearization profile factor 10	Writes to <Dir>ProfileFactor10
41-44	Float	Piecewise linearization profile factor 11	Writes to <Dir>ProfileFactor11
45-48	Float	Piecewise linearization profile factor 12	Writes to <Dir>ProfileFactor12

Response data bytes

Same as Request data bytes.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	Indicates that flow direction requested does not exist in this field device.
3	Error	Passed Parameter too Large	Indicates <Dir>ProfileFactor<1..12> is above a maximum limit.
4	Error	Passed Parameter too Small	Indicates <Dir>ProfileFactor<1..12> is above a maximum limit.
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7	Error	In Write Protect Mode	
8-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.83 Command 228 Read Piecewise Linearization Profile Factors

This command reads piecewise linearization profile factors configuration.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Direction selector	Used to select which direction to read.

Response data bytes

Same as Command 227 Write Piecewise Linearization Profile Factors.

Command-specific response codes

Byte	Format	Description	Explanation
0	Success	No Command-Specific Errors	
1		Undefined	
2	Error	Invalid Selection	The flow direction requested does not exist in this field device.
3-4		Undefined	
5	Error	Too Few Bytes Received	
6	Error	Device-Specific Command Error	
7-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.1.84 Command 231 Enter/Exit Fixed Analog Output Mode

This command puts the selected analog output in or out of test mode.

Note
This command is not retained through a device reset or removal of power from the field device.

Request data bytes

Byte	Format	Description	Explanation
0	Unsigned-8	Analog output selector	This is an INFO INDEX variable; when written, it is not updated in the device.
1	Enum-8	Enables/disables test mode.	Writes IsAO<1/2>EnableTest
2	Unsigned-8	Percentage of scale to output on analog output.	Writes AO<1/2>TestModeOutputPercent Constant unit of %.

Response data bytes

Same as Request data bytes.

Command-specific response codes

Code	Class	Description	Explanation
0	Success	No command-specific errors	
1		Undefined	
2	Error	Invalid selection	Indicates: • frequency output selector is invalid • IsAO<1/2>EnableTest is invalid
3	Error	Passed parameter too large	IndicatesAO<1/2>TestModeOutputPercent is above a maximum limit.
4	Error	Passed parameter too small	Indicates AO<1/2>TestModeOutputPercent is below a minimum limit.
5	Error	Too few bytes received	

Code	Class	Description	Explanation
6	Error	Device-specific command error	
7	Error	In Write-Protect mode	
8-10		Undefined	
11	Error	In multi-drop mode	Indicates that device is in Multi-Drop mode
12-31		Undefined	
32	Error	Busy	
33-127		Undefined	

10.2 Device-specific command error (response code 6)

The following Universal and Common-practice commands support device-specific command error (Response code 6):

Command	Function	Explanation
6	Write Polling Address	Analog output test mode is enabled and loop current mode is disabled
45	Trim Loop Current Zero	Loop current is not set to lower end value
46	Trim Loop Current Gain	Loop current is not set to upper end value
67	Trim Analog Channel Zero	Loop current of selected analog channel is not set to lower end value
68	Trim Analog Channel Gain	Loop current of selected analog channel is not set to upper end value

11 Tables

Units tables and conversion factors in this section are used for ultrasonic measurement.

11.1 Volume units

Unit code	Description
43	Cubic meters
112	Cubic feet

11.2 Time units (flow rate)

Unit code	Description
51	Second
52	Hour
53	Day

11.3 Volumetric flow rate units

Unit code	Description
19	Cubic meters per hour
26	Cubic feet per second
27	Cubic feet per day
28	Cubic meters per second
29	Cubic meters per day
130	Cubic feet per hour

11.4 Pressure units

Note
This table refers to unit code expansion table for Pressure (variable classification code 65) values.

Unit code	Description
6	Pounds per square inch
11	Pascals

Unit code	Description
12	Kilopascals
237	Megapascals
180	IE6 Pounds per square inch

11.5 Temperature units

Unit code	Description
32	Degrees Celsius
33	Degrees Fahrenheit
35	Kelvin

11.6 Velocity units

Unit code	Description
20	Feet per second
21	Meters per second

11.7 Decibel units

Unit code	Description
247	Decibels (dB)

11.8 Voltage units

Unit code	Description
36	Millivolts
58	Volts

11.9 Current units

Unit code	Description
39	Milliamps

11.10 Percent units

Unit code	Description
57	Percent

11.11 Length units

Note
This table refers to unit code expansion table for Length (variable classification code 69) values.

Unit code	Description
45	Meters
47	Inches
170	Micrometer
171	Microinch

11.12 Thermal expansion units

Note
This table refers to unit code expansion table for Thermal Expansion (variable classification code 107 values.

Unit code	Description
170	Inverse degrees Celsius
171	Inverse degrees Fahrenheit

11.13 Viscosity units

Note
This table refers to unit code expansion table for Viscosity (variable classification code 74) values.

Unit code	Description
55	Centipoise
170	Pascal second

11.14 Unit conversion factors

Conversion factors	Unit of Measurement
(°F-32)x(5/9)->°C (°C+273.15)->K	
1	K/°C
5/9	°C/°F
10^{-6}	MPa/Pa
0.006894757	MPa/psi
0.1	MPa/bar
0.101325	MPa/atm
0.000133322	MPa/mmHg
0.3048	m/ft
0.0254	m/in
10^{3}	dm^3/m^3
10^{-6}	$m^3/cc(=m^3/cm^3)$
0.3048^3	m3/ft3
0.0254^3	m^3/in^3
3600	s/h
86400	s/day
10^{3}	g/kg
0.45359237	kg/lbm
4.1868	kJ/kcal
1.05505585262	kJ/BtuIT
10^{-3}	Pa•s/cPoise
1.488	Pa•s/(lb/(ft•s))

11.15 Pressure and temperature tables

Input type (EnablePressureInput or EnableTemperatureInput)	Data validity (PressureValidity or TemperatureValidity)	Data source upon alarm (FlowPOrTSrcUponAlarm)	“In-use” data source (FlowPressure or FlowTemperature)
Disabled	N/A	N/A	“In-Use” value unchanged

Input type (EnablePressureInput or EnableTemperatureInput)	Data validity (PressureValidity or TemperatureValidity)	Data source upon alarm (FlowPOrTSrcUponAlarm)	"In-use" data source (FlowPressure or FlowTemperature)
Live	Valid(1)	N/A	Average of live values (LiveFlowPressure or LiveFlowTemperature)
	Invalid	Last good value	"In-Use" value unchanged
		Fixed	Fixed data point (SpecFlowPressure or SpecFlowTemperature)
Fixed	Valid(1)	N/A	Fixed data point (SpecFlowPressure or SpecFlowTemperature)
	Invalid	Last good value	"In-Use" value unchanged
		Fixed	Fixed data point (SpecFlowPressure or SpecFlowTemperature)

(1) Live input can be invalid due to (a) one or more live values is/are at or outside the alarm limits, or (b) the input is being calibrated.

11.15.1 Live pressure

Table 11-1: Data points for pressure inputs

MeterLink display name	Database points affected	Options	Guidelines
Is pressure gage or absolute?	InputPressureUnit	• Gage (FALSE) • Absolute (TRUE)	
Atmospheric pressure	AtmosphericPress	Enter a value (KPaa or psia) within the range [30.0, 108.40 KPaa]	This data point is only applicable when the input pressure unit is specified as gage.
Live pressure, Min input	MinInputPressure	Enter the pressure (KPag or psig if gage, KPaa or psia if absolute) that corresponds to a 4 mA input signal. The pressure must be within the range [0, 280e3 KPag or KPaa].	

Table 11-1: Data points for pressure inputs *(continued)*

MeterLink display name	Database points affected	Options	Guidelines
Live pressure, Max input	MaxInputPressure	Enter the pressure (KPag or psig if gage, KPaa or psia if absolute) that corresponds to a 20 mA input signal. The pressure must be within the range [0, 280e3 KPag or KPaa].	
Pressure alarm, Low limit	LowPressureAlarm	Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or below this limit value.	
Pressure alarm, High limit	HighPressureAlarm	Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or above this limit value.	

11.15.2 Live temperature

Table 11-2: Data points for teamperature inputs

MeterLink display name	Database points affected	Options	Guidelines
Live temperature, Min input	MinInputTemperature	Enter the temperature (°C or °F) that corresponds to a 4 mA input signal. The temperature must be within the range (-273.15 °C, 200 °C).	
Live temperature, Max input	MaxInputTemperature	Enter the temperature (°C or °F) that corresponds to a 20 mA input signal. The temperature must be within the range (-273.15 °C, 200 °C).	

Table 11-2: Data points for teamperature inputs *(continued)*

MeterLink display name	Database points affected	Options	Guidelines
Temperature alarm, Low limit	LowTemperatureAlarm	Enter a value (°C or °F) within the range [-130 °C, 200 °C]. An alarm is generated when the temperature is at or below this limit value.	
Temperature alarm, High limit	HighTemperatureAlarm	Enter a value (°C or °F) within the range (-130 °C, 200 °C). An alarm is generated when the temperature is at or above this limit value.	

12 Performance

12.1 Sampling rates

The typical update rate of each HART® device and dynamic variable is once per second. Stack size and Filters are two operational conditions which cause variance in the update rate.

Table 12-1: Sampling rates

Sensor	Rate
Primary temperature sensor	Live values = 1/sec Calc.= on average of 5 sec
Internal (cold-junction) sensor sample	1per second
PV digital value calculation SV digital value calculations	Depends on Configuration Typical 1 per second Can be as long as 1 per 5 seconds
Analog output update	Depends on configuration 250 ms Can be as long as 1 second

12.2 Power-up

On power-up, when functioning correctly, the CPU Module green LED indicators show 3.3 volt and +24 volt power. A red LED for +24V current limit reached indicator.

A pair of TX active and RX active green LED indicators are provided for each serial communication port.

A pair of TX active and RX active green LED indicators are provided for the HART slave communication via Analog Output 1.

All LED indicators are located on the card edge that is visible when the meter electronics enclosure end cap is removed.

12.3 Device reset

This section describes the effect of Device Reset (Command 42) and any other reset methods. The device must respond to Command 42 before executing the Device reset. Command 42 forces the meter to

perform a warm start (equivalent to cycling the power to the meter off and then back on).

Table 12-2: Command 42 device reset

Typical time to reset	Maximum delay	Mode(s) affected
120 seconds	180 seconds	All modes are affected

12.4 Command response delay

Table 12-3 shows the minimum, typical, and maximum delays before the device responds to a HART command (Timed from end of the stop bit of the Check Byte of the master request (STX), to the beginning of the start bit of the first preamble character of the response (ACK)). The response delay is not command specific, however, the write configuration commands generally require more time.

Table 12-3: Command response delay

Response	Delay time
Minimum	42 ms
Typical	60 ms
Maximum	200 ms

12.4.1 Long messages

Largest size of data field used for Commands 217 and 218 is 74 response bytes (including the two status bytes).

12.4.2 Non-volatile memory

Rosemount Liquid Ultrasonic Flow Meters use Flash and NVRAM technology for non-volatile memory.

All configuration parameters are held in non-volatile memory until a “write command” is executed. Flash memory (the operating system kernel, the file system, and the firmware) is upgraded via MeterLink. Refer to the Rosemount 3810 Series Liquid Ultrasonic Flow Meter Installation Manual (00825-0100-3814) for detailed instructions.

https://www.emerson.com/en-us

12.4.3 Operating modes

No alternative operating modes are available for this device.

12.4.4 Write protection

Rosemount Liquid Ultrasonic Flow Meters have a write protection hardware switch located on the CPU Module (labeled WRITE PROT (See Figure 2-1)). Refer to the Rosemount 3810 Series Liquid Ultrasonic Flow Meter Installation Manual (00825-0100-3814) or to the Rosemount 3810 Series Liquid Ultrasonic Flow Meter Operations manual (00809-0200-3810).

HART Device-Specific Commands are rejected in write-protect mode (see Supported commands for a detailed list of applicable commands).

12.4.5 Damping value

Damping value is defined as the output response to a step input reaches 63% of final steadystate value after this time has elapsed. The Damping Value is read via Universal Command 15.

Damping time for Rosemount 3810 Series Liquid Ultrasonic Meters is approximately 1.63 seconds affecting only the PV and the loop current signal and is calculated as a function of the batch period according to the equation below. The 0.015 seconds is the average time to perform the batch calculations and update the output.

Equation 12-1: Damping calculation

$$(DampingValue(sec) = (2 - 0.37Batches)x(\text{sec}perbatch)) + 0.015sec$$

The equation states that the worst case time for reaching 63% of the final steady-state value is 1.63 batch times after the step input. This case occurs when the step input occurs at 0.37 batch periods after the start of a batch. The 0.015 seconds is the average time to perform the batch calculations and update the output.

A Device capability checklist

A.1 Device capability

An overall checklist of the device capabilities is shown below.

Table A-1: Capability checklist

Manufacturer, model, and revision	Emerson Rosemount 3810 Series Liquid Ultrasonic Flow Meter Rev. 3
Device type	Sensor
HART protocol revision	Rev. 7.0
Number and type of process connections	2- Pressure and Temperature
Number and type of host connections	2- AMS™ Device Manager and AMS Trex Field Communicator
Number of Device Variables	5
Number of Dynamic Variables	4
Mappable Dynamic Variables?	Yes
Device description available	Yes
Number of Common-practice commands	22
Number of Device-specific commands	84
Bits of additional device status	55 (Command 48)
Alternative operating modes?	N/A (HART® Rev. 7)
Burst-Mode?	No
Capture Device Variable?	No
Write-protection?	Yes

B Default device configuration

B.1 Default factory settings

Table B-1 shows a list of the default device configuration (parameter values, variable mapping, switch positions) which are factory set, unless user-specified when the device is ordered.

Table B-1: Device factory settings configuration

Parameter	Default value
AO1 Zero Scale Volume Flow Rate Lower Range Value	0 (Cubic meters/hour)
AO1 Full Scale Volume Flow Rat Upper Range Value	200,000 (Cubic meters/hour)
AO1 Content PV Unit(s)	Uncorrected Flow Rate (Cubic meters/hour)
Sensor Type	Pressure/Temperature
Number of Wires	2
Damping Time Constant	~1.64
Fault-indication	LED Status Indicators
Write Protection switch	CPU Module (WRITE PROT. OFF)
DHCP switch	CPU Module (DHCP ON)
Number of Response Preambles	5 minimum 20 maximum

C Device variable calculations

This section consists of the calculations used by Rosemount 3810 Series Liquid Ultrasonic Flow meters for the device variables summarized in Device variables.

C.1 Uncorrected flow rate

Equation C-1: Flow-condition volumetric flow rate

$$Q_{Flow} = (Q_{Raw})(ExpCorr_P)(ExpCorr_T)(CorrFctr)$$

where

- Q_{Flow} flow-condition volumetric flow rate (m^3/h) (**QFlow**)
- Q_{Raw} "raw" volumetric flow rate (m^3/h) (**QMeter**)
- $ExpCorr_P$ expansion correction factor due to pressure (dimensionless) (**ExpCorrPressure**)
- $ExpCorr_T$ expansion correction factor due to temperature (dimensionless) (**ExpCorrTemperature**)
- $CorrFctr$ profile-effect correction factor (**CorrectionFactor**)

C.2 Corrected flow rate

Equation C-2: Base-condition volumetric flow rate

$$Q_{Base} = Q_{Flow}\left(\frac{P_{abs,f}}{P_{abs,b}}\right)\left(\frac{T_b}{T_f}\right)\left(\frac{Z_b}{Z_f}\right)$$

where

- Q_{Base} "raw" volumetric flow rate (m^3/h) (**QMeter**)
- Q_{Flow} flow-condition volumetric flow rate (m^3/h) (**QFlow**)
- $P_{abs,b}$ base-condition absolute pressure (MPaa) (**PBase**)
- $P_{abs,f}$ flow-condition absolute pressure (MPaa) (**AbsFlowPressure**)
- T_b base-condition temperature (K) (**TBase**)
- T_f flow-condition temperature (K) (**FlowTemperature**)
- Z_b base-condition compressibility factor (**ZBase**)
- Z_f flow-condition compressibility factor (**ZFlow**)

C.3 Average flow velocity

C.3.1 Dry-calibration

Equation C-3: Dry-calibration gas flow velocity

$$V_{DryCal} = A_0 + A_1 V_{AvgWtd} + A_2 V^2{}_{AvgWtd} + A_3 V^3{}_{AvgWtd}$$

where

V_{DryCal}	dry-calibration gas flow velocity (m/s) (**DryCalVel**)
V_{AvgWtd}	average weighted gas flow velocity (m/s) (**AvgWtdFlowVel**)
A_0	dry-calibration 0th order coefficient (m/s) (**FwdA0** or **RevA0**)
A_1	dry-calibration 1st order coefficient (dimensionless) (**FwdA1** or **RevA1**)
A_2	dry-calibration 2nd order coefficient (s/m) (**FwdA2** or **RevA2**)
A_3	dry-calibration 3rd order coefficient (s^2/m^2) (**FwdA3** or **RevA3**)

C.3.2 Wet-calibration

Equation C-4: Wet-calibration gas flow velocity

$$V_{WetCal} = WetCalFunction\left(V_{DryCal}\right)$$

where

V_{WetCal}	wet-calibration gas flow velocity (m/s) (**AvgFlow**)
V_{DryCal}	dry-calibration gas flow velocity (m/s) (**DryCalVel**)
WetCalFunction(x)	selected wet calibration function

C.3.3 Piece-wise linearization

Equation C-5: Wet Calibration - 12-Point piece-wise linearization

$$V_{WetCal} = V_{DryCal} ¥ LinearMeterFctr$$

where

V_{WetCal}	wet-calibration gas flow velocity (m/s) (**AvgFlow**)
V_{DryCal}	dry-calibration gas flow velocity (m/s) (**DryCalVel**)

LinearMeterFctr linear meter factor (dimensionless) (**LinearMeterFctr**)

C.3.4 Third-order polynomial

Equation C-6: Wet Calibration - third-order polynomial

$$V_{WetCal} = V_{DryCal} ¥ LinearMeterFctr$$

where

V_{WetCal} wet-calibration gas flow velocity (m/s) (**AvgFlow**)

V_{DryCal} dry-calibration gas flow velocity (m/s) (**DryCalVel**)

C_0 wet-calibration 0th order coefficient (m/s) (**FwdC0** or **RevC0**)

C_1 wet-calibration 1st order coefficient (dimensionless) (**FwdC1** or **RevC1**)

C_2 wet-calibration 2nd order coefficient (s/m) (**FwdC2** or **RevC2**)

C_3 wet-calibration 3rd order coefficient (s^2/m^2) (**FwdC3** or **RevC3**)

C.3.5 No wet calibration

See Equation C-3.

C.4 Average sound velocity

Equation C-7: Average weighted sound velocity

$$V_{WetCal} = V_{DryCal} ¥ LinearMeterFctr$$

where

C_{Avg} average weighted sound velocity (m/s) (**AvgSndVel**)

Wt_{chord} chord weight (dimensionless) (**WtA** ... **WtD**)

C_{chord} chord average sound velocity (m/s) (**SndVelA** ... **SndVelD**)

NumActiveChords number of active chords

C.4.1 Optional AGA10 sound velocity calculation and comparison

AGA10SndVelStatusvalue	Description
0	Calculation OK (no errors).
1	Calculation not performed as the feature is not enabled. AGA10SndVel is set to zero.
2	Calculation not performed as the selected AGA8 method is not the Detailed Method (HCH_Method notset to Detailed Method(3)). AGA10SndVel is set to zero.
3	Calculation not performed due to invalid AGA8 calculation results. AGA10SndVel is set to zero.
4	Calculation error due to division by zero. AGA10SndVel is set to zero.

C.5 Mass rate

Equation C-8: Mass rate

$$MassRate = Q_{Flow} ¥ \rho_{Flow}$$

where

MassRate mass rate (kg/h) (**MassRate**)

Q_{Flow} flow-condition volumetric flow rate (m^3/h) (**QFlow**)

ρ_{Flow} “in-use” flow-condition gas mass density (kg/m^3) (**RhoMixFlow**)

C.6 Energy rate

Equation C-9: Energy rate

$$Q_E = Q_{Base} ¥ HV ¥ \frac{1MJ}{1000kJ} ¥ \frac{1000dm^3}{1m^3}$$

where

Q_E energy rate (MJ/h) (**EnergyRate**)

Q_{Base} base-condition volumetric flow rate (m^3/h) (**QBase**)

HV “in-use” heating value (kJ/dm^3) (**HeatingValueInUse**)

C.7 Pressure

Equation C-10: Flow-condition absolute pressure (InputPressureUnit = FALSE(Gage)

$$P_{abs,f} = P_f + P_{Atmosphere}$$

Equation C-11: Flow-condition absolute pressure (InputPressureUnit = TRUE(Absolute)

$$P_{abs,f} = P_f$$

where

$P_{abs,f}$	flow-condition absolute pressure (MPaa) (**AbsFlowPressure**)
P_f	flow-condition pressure (MPa if InputPressureUnit=FALSE, MPaa if InputPressureUnit=TRUE) (**FlowPressure**)
$P_{Atmosphere}$	(specified) atmospheric pressure (MPaa) (**AtmosphericPress**)

C.8 Temperature

The meter is capable of correcting the raw volumetric flow rate for the effect of pipe expansion due to temperature changes. Note that for the temperature-effect expansion correction factor to be calculated, the correction must be enabled (via the EnableExpCorrTemp data point) and the flow-condition temperature must be available (i.e., the EnableTemperatureInput data point must be set to 'Live'(1) or 'Fixed'(2), see Process interface). The temperature-effect calculation is shown in Equation C-12. If the temperature-effect expansion correction factor is not calculated, it is set to 1.0.

Equation C-12: Temperature-Effect Expansion Correction

$$ExpCorr_T = 1 + \left[3¥\alpha¥\left(T_f - T_{ref}\right)\right]$$

where

$ExpCorr_T$	expansion correction factor due to temperature (dimensionless) (**ExpCorrTemperature**)
α	pipe linear expansion coefficient due to temperature (K^{-1}) (**LinearExpansionCoef**)

T_f flow-condition temperature (K) (**FlowTemperature**)

T_{ref} reference temperature for the pipe linear expansion coefficient (K) (**RefTempLinearExpCoef**)

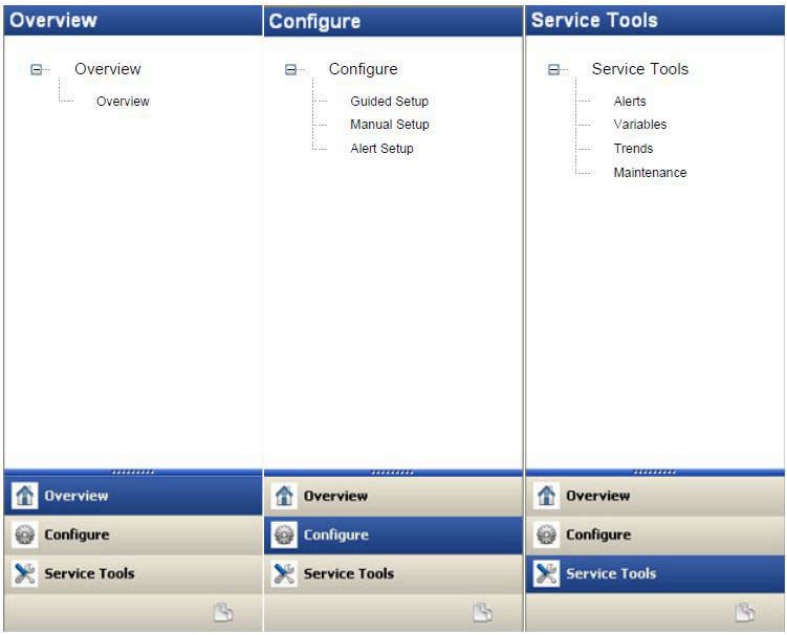
D Supported field device operations

For detailed information, refer to the AMS Device Manager Books Online (PN: 10P5824A501).

https://www.emerson.com/en-us/automation/asset-performance-management/field-device-management/asset-management-software/ams-device-manager

D.1 AMS Device Manager

This section consists of the AMS Device Manager configurations and settings used by Rosemount 3810 Series Liquid Ultrasonic Flow Meters and assumes the device is connected, power is applied and the device is functioning correctly. AMS Device view selections include Overview, Configure and Service Tools.



E Revision history

E.1 Document release

This is this initial release of the Rosemount 3810 Series Liquid Ultrasonic Flow Meter HART Field Device Specification Guide.

E.2 Changes revision 2

Page/section	Description of change
Title Page	Changed manual title - removed “Guide” Revision level from 1 to 2 Date from March 2011 to 17 September 2012
Preface	Changed title Important instructions to Important Safety Instructions. Changed copyright from 2011 to 2012 (Also on back page)
Table of Contents List of Figures List of Tables	Changed title from Contents to Table of Contents Updated TOC to add changes to section numbering and pagination Date from 01 November 2011 to September 2012

Page/section	Description of change
Sections	Changed all section header dates to January and manual revision from 1 to 2 Section 1.1 Changed HART rev 5 to HART rev 7. Section 2, Table 2-1 changed HART rev 5 to HART rev 3. Changed document type in Header from Device Specification Guide 3410 Series Gas Ultrasonic Meter to HART Field Device Specification 3410/4410 Series Ultrasonic Meter Section 3-4, Deleted firmware version level backward compatibility. Section 4.1.2, Changed HART rev 5 to HART rev 7. Section 5.5 and 5.6 Swapped sections 5.5 is Energy rate and 5.6 is Mass rate per database AO1- Content. Section 5.78 Changed Table 5-6 device variable name from pressure to temperature Section 5.9, New section: HART slave device variables good status indicators. Changed document type in Header from Device Specification Guide 3410 Series Ultrasonic Meter to HART Field Device Specification 3410 Series Ultrasonic Meter. Changed Energy rate classification from 0 to 79. Section 6, Changed section numbers and header dates and revision from 1 to 2. Section 7, Changed Table 7-1 changed Device Status Bit 5 (Cold Start) and 6 (Configuration Changed) and changed database point name from `DidPrimaryConfigChange` or `DidSecondaryConfigChange` to `HARTDidPrimaryConfigChange` or `HARTDidSecondaryConfigChange`. Table 7-2 Byte 10: Update 'Analog Output Saturated, Respectively LSB to MSB: AO2IsSaturated, ...AO25IsSaturated (bit mapped) changed to LSB to MSB: AO1IsSaturated, AO2IsSaturated... (bit mapped). Only bit for AO1 is used.'; Byte 11: update 'Standardized status' as 'Standardized status 2, shall be set to 0'; Byte 12: update 'Standardized status 2, shall be set to 0.' as 'Standardized status 3, shall be set to 0.'; Byte 13: update 'Analog Output Fixed, Respectively LSB to MSB: AO2 ... AO25 (bit mapped) where each bit is the OR'ing of the related database points of `IsAO<n>EnableTest`and `AO<n>IsFixed`. Only the bit for AO2 is used' as 'Analog Output Fixed, Respectively LSB to MSB: AO1, AO2... (bit mapped) where each bit is the OR'ing of the related database points of `IsAO<n>EnableTest` and `AO<n>IsFixed`. Only the bit for AO1 is used.

Page/section	Description of change
	Related database points of `IsAO<n>EnableTest` and `AO<n>IsFixed`. Only the bit for AO1 is used. Backed out AO1 saturated to AO2 per BZ 6198. Section 8, Table 8-1 added commands 33 Moved commands 38 and 48 to this table from Table 9-1. Section 9, Table 9-1 Moved commands 38 and 48 to this table from Table 8-1 Section 10, Changed section numbers and header dates and revision from 1 to 2. Changed Units syntax to match FRS revision 3.38 and later. Section 11, Changed title from Units Tables to Tables, section numbers and header dates and revision from 1 to 2 Section 12.3, Table 12-2 Command 42 device reset changed minimum and maximum startup delay times from 67 seconds and 78 seconds to 242 seconds and 250 seconds. Corrected typo-from effected to affected. Section 12.5.1, Removed Busy and Delay Response since it not supported.
Annexes	Annex A, Table A-1 Changed HART rev 5 to HART rev 7, number of Common practicecommands from 16 to 14 (moved commands 38 and 48 to Universal commands), changed section A.1 title from Introduction to Device capability. Annex B, changed section B.1 title from Introduction to Default factory settings, changed header revision and date and corrected Table B-1 formatting Annex C, Annex E Updated Revision history added Section E-2, header dates and revision from 1 to 2. Annex D, Removed word Introduction and renumbered following sections Annex E, Updated revision history page
Global changes	Removed HART registered mark from manual sections. Kept on Title page Changed document type in Header from Device Specification Guide 3410 Series Ultrasonic Meter to HART Field Device Specification 3410 Series Ultrasonic Meter Removed word Section from section headings Removed Introduction from sections Changed all header dates from August to September.

E.3 Changes revision 3

Page/section	Description of change
Global changes	Revision 2 to Revision 3 Date from September 2012 to January 2014 (section headers)
Title Page	Revision level from 2 to 3 Date from 17 September 2012 to 31 January 2014
Table of Contents List Of Figures List of Tables	Updated TOC to add changes to section numbering and pagination
All Sections	Changed Header date from March 2012 to January 2014 Changed revision from 2 to 3
Section	Section 1 Section 1.1 Deleted note Section 1.4.3, Table 1-3 changed HZ to Hz Section 1.4.4, Table 1-4 updated references
Sections	Section 4 Section 4.1 Reworded paragraph. Section 4.1.1 Section 4.1.1 Added T-32 transducer type and deleted operating temperatures per clarification of Lit-18 requirements. New section 4.1.3 Time stamp
	Section 5 Added 5.9 HART slave device variables good status indicators
	Section 7 Section 7.1 Device status Edit device status bit 5: Cold Start, removed reference to Liquid Ultrasonic Meter and reworded to be consistent with the FRS. Section 7. 7.2 Command 48 Advisory Status Byte 0, Bit 7 —removed `HARTAO2SVValidity` (inverted).
	Section 8 Section 8.1 Universal commands - Table 8-1 added Commands — 18, 20, 21, 22, Moved Common Practice commands 38, and 48 to Universal commands.
	Section 9 Common-practice commands Table 9-1: added Commands 72, 89, 90 and 95.

Page/section	Description of change
	Section 10 Removed redundant mention of response data bytes for all commands per FRS v3.1.10. Command 128 — Byte 0 — added sentence: This is an informational index variable; when written, it is not updated in the device. Command 129 — edit Command-specific response codes table, Code 1-5, 6, and 7-14. Command 130 — deleted Response data bytes table. Inserted sentence: Same as Request data bytes. Command 131 — edit Command-specific response codes. Command 132 — added Code 28 Device-specific command error (Response code 6). Command 147 — changed command title and edited Response Data Bytes table. Edited Command-specific response codes. Command 148 — edit Command-specific response code 6. Command 150 - deleted Response data bytes table. Inserted sentence: Same as Request data bytes. Command 154 — edit Command-specific response code 6. Command 155 — edited Request data bytes table. Deleted Response data bytes table. Inserted sentence: Same as Request data bytes. Command 156 — deleted Response data bytes table. Inserted sentence: Same as Command 157. Command 167 — deleted Response data bytes table. Inserted sentence: Same as Request data bytes. Command 170 — deleted Response data bytes table. Inserted sentence: Same as Command 171 Write flow analysis related configuration. Added commands: Command 171— 179, 182 — 197, 200 — 224. Added Section 10.2 Device-specific command error (response code 6).
	Section 11 Added Thermal Expansion units, Table 11-16.

Page/section	Description of change
Annexes	Annex A Updated HART® protocol revision as Rev. 7.0. Updated Bits of additional device status from 45 to 40. Updated number of Common-Practice Commands from 14 to 18. Number of Device-specific commands from 44 - 95. Annex D Changed heading level from D1.1 to D.1. Annex E Updated revision history page with all changes for revision 3, HART 7 protocol.

E.4 Changes revision 4

Page/section	Description of change
Global changes	Revision 3 to Revision 4 Date from January 2014 to July 2014 (section headers)
Title Page	Revision level from 3 to 4 Date from 31 January 2014 to 31 July 2014
Table of Contents List of Figures List of Tables	Updated TOC to add changes to section numbering and pagination
All Sections	Changed header date from January 2014 to July 2014 Changed revision from 3 to 4

Page/section	Description of change
Section	Section 2 Changed HART Software Revision from 15 to 17 (Table 2-1) Section 10 Removed duplicate information in Cmd 149 & 151. Response Data Bytes. Added reference to their respective Write Command. Updated command 130/131 for `FreqXContent` and Unit Code, Upper/Lower Range Value. Updated command 48: `DidCnfgChksumChg`, `IsFailedForBatch<A/B/C/D>`, `IsBatchDataRcvFailed`, `IsAvgSoundVelRangeErr`, `IsAvgSoundVelRangeErrLatched`. Updated command 141: `DidCnfgChksumChg`, `IsAvgSoundVelRangeErrLatched`. Updated command 168 for `ChordalConfig`. Added RC#5 under command 131 (also 129, 154) Updated command 130 byte 18 and 20 explanation.
Menu tree drawing	Changed available device descriptions 3410 from Devv3, DD v1 to Dev v4, DD v1

E.5 Changes Revision 5

Page/section	Description of change
Global changes	Revision 4 to Revision 5 Date from January 2014 to January 2015 (section headers)
Title Page	Revision level from 4 to 5 Date from 31 January 2014 to 31 July 2014
Table of Contents List of Figures List of Tables	Updated TOC to add changes to section numbering and pagination
All Sections	Changed header date from January 2014 to January 2015 Changed revision from 4 to 5
Section 2	Section 2.1 Changed Device Revision from 4 to 5 and software revision from 17 to 18.
Section 3	Section 3.4 added serial Ports B and C

Page/section	Description of change
Section 7	Section 7.2: Alert `IsPeakSwitchDetected<A..D>`, `IsXdcrMaintenanceRequired<A..D>` was removed from Command 48.
Section 10	Section 10.1.45 and 10.1.46: Updated command 174/175 to add Serial port selector option for Port C. Section 10.1.53 and 10.1.54: Updated command 184/185 for `PeakSwitchDetectMode` and `PropUpdtSeconds`. Section 10.1.59 and 10.1.60: Updated command 190/191 to add `XdcrMaintenanceGainRange` and `XdcrMaintenanceSNRRange`. Section 10.1.39: Updated command 168 to add `OptIOModule1Type` and `OptIOModule2Type`.
Section 11	Tables Table 11-23 Daniel CUI to MeterLink.
Menu tree drawing	Changed available device descriptions 3410 from Dev v4, DD v1 to 1-12 HART Rev 5, 3810 1-10 HART Rev 5.

Quick Start Guide
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