WaterMaster
Electromagnetic flowmeter

WaterMaster FEX100
HART field device specification

Measurement made easy

WaterMaster electromagnetic flowmeter

Introduction

This User Guide Supplement provides HART® field device specification details for WaterMaster electromagnetic flowmeters. The AquaProbe sensor is available for operation with either a WaterMaster transmitter (FET100) or an AquaMaster3 transmitter (FET200).

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Table of contents

1. Introduction

1.1 Scope

The ABB WaterMaster, model FEX100, device revision 0 complies with HART® Protocol Revision 5.7. This document specifies all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

1.2 Purpose

This specification is designed to compliment other documentation (e.g., the *WaterMaster Instruction Manual*) by providing a complete, unambiguous description of this Field Device from a HART Communication perspective.

1.3 Who should use this document?

The 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 Abbreviations and definitions

CPU	Central Processing Unit (of microprocessor).
EEPROM	Electrically-Erasable Read-Only Memory.
FSK	Frequency Shift Keying.
NAMUR	Normenarbeitsgemeinschaft für Mess- Und Regeltechnik in der Chemischen Industrie. Process control standardisation group based in Germany.
PV	Primary Variable.
QV	Quaternary Variable.
RAM	Random Access Memory.
ROM	Read-Only Memory.
SV	Secondary Variable.
TV	Tertiary Variable.

1.5 References

[A] *HART Smart Communications Protocol Specification.* HCF_SPEC-13. Available from the HCF.

[B] *ABB WaterMaster Electromagnetic Flowmeter Data Sheet,* Document DS/WM, Revision D. Available from ABB website.

[C] *ABB WaterMaster Electromagnetic Flowmeter Programming Guide,* Document IM/WMP Revision C. Available from ABB website.

[D] *ABB WaterMaster Electromagnetic Flowmeter Instruction Manual,* Document IM/WM Revision E. Available from ABB website.

[E] *NE107 – Self Monitoring and Diagnosis of Field Devices.* Available from NAMUR website.

[F] *NE043 – Standardization of the Signal Level for the Failure Information of Digital Transmitters.* Available from NAMUR website.

[G] *ISO 80000-3:2006 – Quantities and units – Part 3: Space and time.* Available from ISO website.

[H] *NIST Special Publication 811 – Guide for the Use of the International System of Units (SI).* Available from the NIST website.

2. Device Identification

Manufacturer Name:	ABB	Model Name(s):	FEX100 WaterMaster
Manufacture ID Code:	26 (1A Hex)	Device Type Code:	31 (1F Hex)
HART Protocol Revision	5.7	Device Revision:	0
Number of Device Variables	6		
Physical Layers Supported	FSK		
Physical Device Category	Transmitter, Current Output		

3. Product Overview

The WaterMaster is an electromagnetic flowmeter with a 4-to-20mA output, with either a remote or integrated sensor.

The analogue output of the device is linear with flow over the user-defined working range.

4. Product Interfaces

4.1 Process Interface

4.1.1 Sensor Input Channel

Integrated sensors are pre-wired at the factory. For remote sensors, the terminals marked “M1”, “M2”, “SCR”, “D1/TFE”, “D2”, “3”, “S2”, “E2”, “E1” and “S1” are used for connection to the sensor. Refer to [D] for details.

4.2 Host interface

4.2.1 Current Output

This output corresponds to the Primary Variable with HART Communication also being supported on this loop. It implements levels as defined in the NAMUR standard NE043, refer to [F] for further details.

The two-wire 4-to-20mA current loop is connected on two terminals marked "31" and "32". Refer to [D] for connection details.

Three modes of operation are available – “4 to 20”, “4 to 12 to 20” and "4 to 20 FWD/REV". For “4 to 12 to 20” mode, negative flow values are represented by 4 to 12mA, and positive flow values by 12 to 20mA. In “4 to 20” mode, only positive values are represented. "4 to 20 FWD/REV" mode is used to represent both positive and negative values.

Device malfunction can be indicated by down-scale or up-scale current, with the direction being selectable by the user.

Refer to [C] for full details of configuring the Current Output.

Current values are shown in the table below.

	Direction	Values (percent of range)	Values (mA or V)
Linear over-range	Down	-1.25%	3.8mA
	Up	+103%	20.5mA
Device malfunction indication	Down:		Configurable between 3.5 and 3.6mA.
	Up:		Configurable between 21.00 and 23.00mA.
Maximum current			23mA
Multi-Drop current draw			4mA
Lift-off Voltage			10.5V

4.2.2 Pulse Output 1 / Logic Output 1

Positive and negative flow values can be represented on the first pulse output. This output can also be configured for logic operation, with diagnostic information being indicated by discrete logic levels.

The terminal marked “41” is the output connection, and the terminal marked “42 52 62” the ground connection.

Refer to [C] and [D] for more details.

4.2.3 Pulse Output 2 / Logic Output 2

Negative flow values only can be represented on the second pulse output. As with Pulse Output 1 / Logic Output 1, this output can also be configured for logic operation.

The terminal marked “51” is the output connection, and the terminal marked “42 52 62” the ground connection.

Refer to [C] and [D] for more details,

4.2.4 Logic Output 3

Diagnostic information can be output as discrete logic levels on logic output 3.

The terminal marked “61” is the output connection, and the terminal marked “42 52 62” the ground connection.

Refer to [C] and [D] for further details.

4.2.5 Infra-Red Service Port

HART communication is also possible over the device infra-red service port. Refer to [C] and [D] for further details.

4.3 Local Interfaces, Jumpers and Switches

4.3.1 Local Controls and Displays

This device features a 128 x 64 pixel LCD with four capacitive switches for user input. Refer to [C] and [D] for full details.

4.3.2 Internal Jumpers and Switches

A switch (SW1, marked “READ ONLY”) inside the instrument provides a write-protect function.

For MID meters, this switch is used to disable Service level access, and make MID related parameters read-only. It does not provide write-protection for all parameters in this case.

Refer to [D] for details. See also Section 12.9.

5. Device Variables

Refer to 8.1.1 for details of device variables.

6. Dynamic Variables

Four Dynamic Variables are implemented, as shown in the table below.

	Meaning	Units
PV	Volume Flow	Refer to Table 10.35, Volume Flow Units.
SV	Flow Velocity	Refer to Table 10.34, Velocity Units.
TV	Volume Forward Totalizer	Refer to Table 10.37, Volume Totalizer Units.
QV	Volume Reverse Totalizer	Refer to Table 10.37, Volume Totalizer Units.

7. Status Information

Alarm conditions are categorized into groups and classes as defined in the NAMUR standard NE107. Refer to [E] for further details.

7.1 Device Status

Bit 7 (“Device Malfunction”) is set when any diagnostic alarm of class “Failure” occurs.

Bit 4 ("More Status Available") is set whenever any diagnostic alarm is annunciated.

Command #48 gives further detail. (Refer to 7.2).

7.2 Additional Device Status (Command #48)

Command #48 returns 6 bytes of data, with the following status information:

Byte	Bit	Meaning	Group	Class	Device Status Bits Set
0	0	Simulated/fixed current output	Configuration State	Check Function	3,4 (See Note 1)
	1	Logic simulation selected on OP1	Configuration State	Check Function	4
	2	Pulse simulation selected on OP1	Configuration State	Check Function	4
	3	Logic simulation selected on OP2	Configuration State	Check Function	4
	4	Pulse simulation selected on OP2	Configuration State	Check Function	4
	5	Logic simulation selected on OP3	Configuration State	Check Function	4
	6	Low flow alarm	Operating Conditions	Out Of Specification	4
	7	High flow alarm	Operating Conditions	Out Of Specification	4
1	0	Current output limited Q >103% Qmax	Operating Conditions	Out Of Specification	2, 4 (See Note 1)
	1	Simulation mode On	Configuration State	Check Function	4
	2	Tx. simulator/calibrator mode	Configuration State	Check Function	4
	3	At Qmax, volume display overrun <1600hrs	Operating Conditions	Maintenance Required	4
	4	Totalizer reset	Configuration State	None /Information	4
	5	Intermittent sensor comms	Hardware Status Sensor	Maintenance Required	4
	6	HART multidrop enabled	Configuration State	None / Information	3,4 (See Note 1)
	7	Tx. Memory fault detected	Hardware Status Transmitter	Failure	4,7
2	0	Sensor memory not detected	Hardware Status Sensor	Failure	4,7

Byte	Bit	Meaning	Group	Class	Device Status Bits Set
	1	Tx. Measurement suspended	Operating Conditions	Failure	4,7
	2	Empty pipe	Operating Conditions	Out Of Specification	4
	3	Not used	-	-	-
	4	Not used	-	-	-
	5	Open circuit electrode	Operating Conditions	Out Of Specification	4
	6	Short circuit electrode	Operating Conditions	Out Of Specification	4
	7	Not used	-	-	-
3	0	Installation fault/condition.	Operating Conditions	Failure	4,7
	1	Open circuit coil/wiring.	Operating Conditions	Failure	4,7
	2	Short circuit coil/wiring	Operating Conditions	Failure	4,7
	3	Check cable+coil resistance	Operating Conditions	Failure	4,7
	4	Transmitter hardware fault	Hardware Status Transmitter	Failure	4,7
	5	Bad flow data	Operating Conditions	Failure	4,7
	6	Accuracy warning?	Operating Conditions	Out Of Specification	4
	7	OIML self-check limits exceeded	Hardware Status Transmitter	Maintenance Required	4
4	0	Measurement starting	Hardware Status Transmitter	Out Of Specification	4
	1	Current output hardware fault	Hardware Status Transmitter	Maintenance Required	4
	2	Sensor setup not complete	Hardware Status Sensor	Out Of Specification	4
	3	Incompatible sensor	Hardware Status Sensor	Failure	4,7

Byte	Bit	Meaning	Group	Class	Device Status Bits Set
	4	Tx. code memory fault	Hardware Status Transmitter	Failure	4,7
	5	Tx. data memory fault	Hardware Status Transmitter	Failure	4,7
	6	HART frequency simulation active	Configuration State	Check Function	4
	7	Alarm simulation active	Configuration State	Check Function	4
5	0	Non-Volatile Summary	Hardware Status Transmitter	Failure	4,7
	1	Not used	-	-	-
	2	Not used	-	-	-
	3	Not used	-	-	-
	4	Not used	-	-	-
	5	Not used	-	-	-
	6	Not used	-	-	-
	7	Not used	-	-	-

Note 1 – When multidrop mode is enabled, bit 2, “analogue output saturated” is disabled and bit 3, “analogue output current fixed” bit is set.

"Not used" bits are always set to 0 in the Command 48 response.

These bits are cleared during power up, then set / cleared during continuous background self-testing.

8. Common-Practice Commands

8.1 Supported Commands

The following common-practice commands are implemented:

33 Read Transmitter Variables

34 Write Damping Value

35 Write Range Values

36 Set Upper Range Value

38 Reset "Configuration Changed" Flag

40 Enter/Exit Fixed Current Mode

44 Write PV Units

48 Read Additional Device Status

8.1.1 Command 33 Read Transmitter Variables

The following variables are available for use with Command 33.

Slot	Name	Description
0	Volume Flow	Device PV, refer to Table 10.35 for supported units.
1	Flow Velocity	Device SV, refer to Table 10.34 for supported units.
2	Q%	Percentage of range. Units fixed to % (HART unit code 57).
3	Volume Forward	Device TV, refer to Table 10.37 for supported units.
4	Volume Reverse	Device QV, refer to Table 10.37 for supported units.
5	Volume Net	Sum of Forward and Reverse Volume totalizers, refer to Table 10.37 for supported units.

Any combination of up to four of the above variables can be requested at once using command 33.

8.1.2 Command 35 Write Range Values

The lower range value is fixed to 0.

8.1.3 Command 38 Reset “Configuration Changed” Flag

The “Configuration Changed” flag is only affected by changes to the device configuration made with HART.

8.1.4 Command 44 Write PV Units

Refer to Table 10.35 for details of supported volume flow units.

8.2 Burst Mode

This Field Device does not support Burst Mode.

8.3 Catch Device Variable

This Field Device does not support Catch Device Variable.

9. Device-Specific Commands

The following device-specific commands are implemented:

128	Read Eight-Bit
129	Write Eight-Bit
130	Read Sixteen-Bit
132	Read Single-Precision Floating-Point with Unit
133	Write Single-Precision Floating-Point with Unit
134	Read Single-Precision Floating-Point
135	Write Single-Precision Floating-Point
136	Read String
137	Write String
138	Read Double-Precision Floating-Point with Unit
143	Trigger Action
146	Read Thirty-Two-Bit
148	Read Twenty-Four-Bit ID
150	Read Dynamic Single-Precision Floating-Point Range
180	Trigger Adjust Function
181	Read Adjust Values
182	Additional Diagnostic Information

9.1 Command #128: Read Eight-Bit

Reads an eight-bit variable.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable.
1	Byte	The requested variable value.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Error	Invalid Selection.
5	Error	Too Few Data Bytes Received.

9.2 Command #129: Write Eight-Bit

Writes an eight-bit variable.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to write.
1	Byte	Value of the variable to write.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable.
1	Byte	The value of the variable after the write has completed.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Error	Invalid Selection.
3	Error	Passed Parameter Too Large.
4	Error	Passed Parameter Too Small.
5	Error	Too Few Data Bytes Received.
7	Error	In Write Protect Mode.
16	Error	Access Restricted.

Command 128/129 Slot Content

Slot	Name	Description	Access	Upper Limit	Lower Limit
0	Security Mode	The current security mode of the device. (Refer to 10.1 Security Mode).	RO	-	-
6	Iout For Alarm	The Current Output setting for general alarms. (Refer to 10.2 Current Output Alarm Selection).	R/W	-	-
7	Current Output Mode	The operating mode of the Current Output. (Refer to 10.3 Current Output Mode).	R/W	-	-
9	Cyclic Data Output Flow Group	The enable/disable state of the Flow group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
10	Cyclic Data Output Vol. Totals Group	The enable/disable state of the Volume Totals group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
12	Cyclic Data Output Outputs Group	The enable/disable state of the Outputs group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
13	Cyclic Data Output Electrodes Group	The enable/disable state of the Electrodes group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
16	Cyclic Data Output Status Group	The enable/disable state of the Status group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
17	Cyclic Data Output Coil Group	The enable/disable state of the Coil group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
18	Cyclic Data Output TX Group	The enable/disable state of the Transmitter group for the Cyclic Data Output. (Refer to 10.4 Enable State).	R/W	-	-
20	Simulation Mode	The active simulation mode. (Refer to 10.5 Simulation Mode).	R/W	-	-
21	PCB	The hardware version number of the transmitter.	RO	-	-
24	Transmitter Last Calibration Location	The last location of transmitter calibration. (Refer to 10.6 Device Calibration Location).	RO	-	-
26	Sensor First Calibration Location	The initial location of the sensor calibration. (Refer to 10.6 Device Calibration Location).	RO	-	-
27	Sensor Last Calibration Location	The last location of the sensor calibration. (Refer to 10.6 Device Calibration Location).	RO	-	-
28	Sensor Lining Material	The materials used in construction of the sensor lining. (Refer to 10.7 Sensor Lining Materials).	RO	-	-
29	Sensor Electrode Material	The materials used in construction of the sensor electrodes. (Refer to 10.8 Sensor Electrode Materials).	RO	-	-

Slot	Name	Description	Access	Upper Limit	Lower Limit
30	Sensor Cal. Mode	The mode the sensor was last calibrated in. (Refer to 10.9 Sensor Calibration Mode).	RO	-	-
32	Sensor Cal. Type	The type of calibration performed for the device sensor. (Refer to 10.10 Sensor Calibration Type).	RO	-	-
38	Iout For EP Alarm	The setting of the Current Output in empty pipe alarm conditions. (Refer to 10.11 Current Output Empty Pipe Behaviour).	R/W	-	-
41	DO1 Config Alarm	The setting of Logic Output 1 in general alarm conditions. (Refer to 10.12 Logic Output 1 Alarm Behaviour).	R/W	-	-
42	DO1 Config Empty Pipe	The setting of Logic Output 1 in empty pipe alarm conditions. (Refer to 10.12 Logic Output 1 Alarm Behaviour).	R/W	-	-
44	DO1 Config Min. Alarm	The setting of Logic Output 1 in minimum flow alarm conditions. (Refer to 10.12 Logic Output 1 Alarm Behaviour).	R/W	-	-
45	DO1 Config Max. Alarm	The setting of Logic Output 1 in maximum flow alarm conditions. (Refer to 10.12 Logic Output 1 Alarm Behaviour).	R/W	-	-
46	DO2 Config Alarm	The setting of Logic Output 2 in general alarm conditions. (Refer to 10.13 Logic Output 2 Alarm Behaviour).	R/W	-	-
47	DO2 Config Empty Pipe	The setting of Logic Output 2 in empty pipe alarm conditions. (Refer to 10.13 Logic Output 2 Alarm Behaviour).	R/W	-	-
49	DO2 Config Min. Alarm	The setting of Logic Output 2 in minimum flow alarm conditions. (Refer to 10.13 Logic Output 2 Alarm Behaviour).	R/W	-	-
50	DO2 Config Max. Alarm	The setting of Logic Output 2 in maximum flow alarm conditions. (Refer to 10.13 Logic Output 2 Alarm Behaviour).	R/W	-	-
51	DO3 Config Alarm	The setting of Logic Output 3 in general alarm conditions. (Refer to 10.14 Logic Output 3 Alarm Behaviour).	R/W	-	-
52	DO3 Config Empty Pipe	The setting of Logic Output 3 in empty pipe alarm conditions. (Refer to 10.14 Logic Output 3 Alarm Behaviour).	R/W	-	-
54	DO3 Config Min. Alarm	The setting of Logic Output 3 in minimum flow alarm conditions. (Refer to 10.14 Logic Output 3 Alarm Behaviour).	R/W	-	-
55	DO3 Config Max. Alarm	The setting of Logic Output 3 in maximum flow alarm conditions. (Refer to 10.14 Logic Output 3 Alarm Behaviour).	R/W	-	-
56	Alarm Simulation	The current simulated Diagnostic alarm. (Refer to 10.15 Diagnostic Alarm Simulation). **Note** – this parameter is read-only for MID flowmeters.	R/W	-	-

Slot	Name	Description	Access	Upper Limit	Lower Limit
57	Group Masking Check Function	The setting of the Check Function group Diagnostic alarm mask. (Refer to 10.4 Enable State).	R/W	-	-
58	Group Masking Off Specification	The setting of the Off Specification group Diagnostic alarm mask. (Refer to 10.4 Enable State).	R/W	-	-
59	Group Masking Maintenance	The setting of the Maintenance group Diagnostic alarm mask. (Refer to 10.4 Enable State).	R/W	-	-
60	Individual Masking Overrange 103%	The setting of the mask for the Overrange 103% alarm. (Refer to 10.4 Enable State).	R/W	-	-
61	Individual Masking Min. Alarm	The setting of the mask for the Min. Flow alarm. (Refer to 10.4 Enable State).	R/W	-	-
62	Individual Masking Max. Alarm	The setting of the mask for the Max. Flow alarm. (Refer to 10.4 Enable State).	R/W	-	-
68	Simulation Logic 1	The logic level requested for simulation on Logic Output 1. (Refer to 10.16 Logic Output Simulation).	R/W	-	-
70	Simulation Logic 2	The logic level requested for simulation on Logic Output 2. (Refer to 10.16 Logic Output Simulation).	R/W	-	-
72	Simulation Logic 3	The logic level requested for simulation on Logic Output 3. (Refer to 10.16 Logic Output Simulation).	R/W	-	-
73	DO1 State	The logic level on Logic Output 1. (Refer to 10.17 Logic Output State).	RO	-	-
74	DO2 State	The logic level on Logic Output 2. (Refer to 10.17 Logic Output State).	RO	-	-
75	DO3 State	The logic level on Logic Output 3. (Refer to 10.17 Logic Output State).	RO	-	-
77	DO1 Logic	The signal source used to operate Logic Output 1. (Refer to 10.18 Logic Output Signal Source).	R/W	-	-
78	DO1 Action	The output of Logic Output 1 under action conditions. (Refer to 10.19 Logic Output Action State).	R/W	-	-
80	DO2 Logic	The signal source used to operate Logic Output 2. (Refer to 10.18 Logic Output Signal Source).	R/W	-	-
81	DO2 Action	The output of Logic Output 2 under action conditions. (Refer to 10.19 Logic Output Action State).	R/W	-	-
83	DO3 Logic	The signal source used to operate Logic Output 3. (Refer to 10.18 Logic Output Signal Source).	R/W	-	-
84	DO3 Action	The output of Logic Output 3 under action conditions. (Refer to 10.19 Logic Output Action State).	R/W	-	-

Slot	Name	Description	Access	Upper Limit	Lower Limit
85	DO1/DO2 Function	The operating mode of Digital Outputs 1 and 2. (Refer to 10.20 Digital Output Function).	R/W	-	-
86	Pulse Mode	The mode of pulse operation of Digital Outputs 1 and 2. (Refer to 10.21 Digital Output Pulse Mode).	R/W	-	-
93	Language	The language of the local device display. (Refer to 10.22 Language).	R/W	-	-
94	Operator Page 1 1st Line	The value being displayed on line 1 of device display Operator Page 1. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
95	Operator Page 1 2nd Line	The value being displayed on line 2 of device display Operator Page 1. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
96	Operator Page 1 3rd Line	The value being displayed on line 3 of device display Operator Page 1. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
98	Operator Page 2 1st Line	The value being displayed on line 1 of device display Operator Page 2. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
99	Operator Page 2 2nd Line	The value being displayed on line 2 of device display Operator Page 2. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
100	Operator Page 2 3rd Line	The value being displayed on line 3 of device display Operator Page 2. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
102	Operator Page 3 1st Line	The value being displayed on line 1 of device display Operator Page 3. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
103	Operator Page 3 2nd Line	The value being displayed on line 2 of device display Operator Page 3. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
104	Operator Page 3 3rd Line	The value being displayed on line 3 of device display Operator Page 3. (Refer to 10.23 Operator Page Line Items).	R/W	-	-
110	Contrast	The contrast of the local device display.	R/W	100	0
112	Operator Page 1 Display Mode	The display mode of device display Operator Page 1. (Refer to 10.24 Operator Page 1 Display Modes).	R/W	-	-
113	Operator Page 2 Display Mode	The display mode of device display Operator Page 2. (Refer to 10.25 Operator Pages 2 & 3 Display Modes).	R/W	-	-
114	Operator Page 3 Display Mode	The display mode of device display Operator Page 3. (Refer to 10.25 Operator Pages 2 & 3 Display Modes).	R/W	-	-
120	Flowrate Format	Decimal point setting for volume flow on the device display. (Refer to 10.26 Display Decimal Point Settings).	R/W	-	-
121	Volume Format	Decimal point setting for volume totalizers on the device display. (Refer to 10.26 Display Decimal Point Settings).	R/W	-	-

Slot	Name	Description	Access	Upper Limit	Lower Limit
131	Date / Time Format	Format for dates on the device display. (Refer to 10.27 Display Date Formats).	R/W	-	-
159	Mains Frequency	Mains frequency of the transmitter supply for Acquisition usage. (Refer to 10.28 Mains Frequency).	R/W	-	-
161	Drive Mode	Id of the Acquisition drive mode in use. (Refer to 10.29 Drive Mode).	RO	-	-
167	Sensor Type	The sensor type connected to the transmitter. (Refer to 10.30 Sensor Type).	RO	-	-
168	Sensor Size	The size of the sensor connected to the transmitter. (Refer to 10.31 Sensor Bore Size).	RO	-	-
171	Flow Indication	Sign correction being applied to the flow value. (Refer to 10.32 Flow Direction). **Note** – this parameter is read-only for MID flowmeters.	R/W	-	-
172	Fact. Cutoff No. Av.	Number of samples in use by the cutoff filter.	RO	9	0
173	Meter Mode	Flow directions in which the meter will operate. (Refer to 10.33 Meter Mode). **Note** – this parameter is read-only for MID flowmeters.	R/W	-	-
175	Velocity Unit	The units of velocity values. (Refer to 10.34 Velocity Units).	R/W	-	-
176	Q (Flowrate) Unit	The units of volume flow values. (Refer to 10.35 Volume Flow Units).	R/W	-	-
179	Max Baud Rate	Highest baud rate at which the Service Port will communicate. (Refer to 10.36 Service Port Baudrates).	R/W	-	-
180	Volume & Pulse Unit	Units used for volume flow totalizers and digital outputs. (Refer to 10.37 Volume Totalizer Units). **Note** – this parameter is read-only for MID flowmeters.	R/W	-	-
181	Read Only Switch	Current state of the hardware read only switch. (Refer to 10.38 Read-Only Switch Status).	RO	-	-
184	MID Meter Mode	MID status of meter. (Refer to 10.40 MID Meter Mode).	RO	-	-

9.3 Command #130: Read Sixteen-Bit

Reads a sixteen-bit variable.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable.
1-2	16-bit Integer	The value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Error	Invalid Selection.
5	Error	Too Few Data Bytes Received.

Command 130 Slot Content

Slot	Name	Description	Access	Upper Limit	Lower Limit
1	TX PIN	Pin number used for generating high security access code.	RO	65535	0

9.4 Command #132: Read Single-Precision Floating-Point with Unit

Returns a variable in single-precision floating-point format with its associated HART format unit code.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1	Byte	Associated unit code of the requested variable.
2-5	Single-Precision Floating-Point	Value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too few data bytes received.

9.5 Command #133: Write Single-Precision Floating-Point with Unit

Writes the value and unit to a single-precision floating-point format variable and its associated unit code.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to write.
1	Byte	Unit code value of the variable.
2-5	Single-Precision Floating-Point	Value to write to the variable.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1	Byte	Associated unit code of the requested variable.
2-5	Single-Precision Floating-Point	Value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
3	Failure	Passed Parameter Too Large.
4	Failure	Passed Parameter Too Small.
5	Failure	Too Few Data Bytes Received.
7	Failure	In Write Protect Mode.
16	Failure	Access Restricted.

Command 132/133 Slot Content

Slot	Name	Description	Access	Upper Limit	Lower Limit
0	Output Readings Current	Current value at the Current Output. (Unit fixed to mA, HART unit code 39).	RO	23	3.5
5	Current Output Low Alarm Value	Output current for Current Output low alarm. (Unit code fixed to mA, HART unit code 39).	R/W	3.6	3.5
6	Current Output High Alarm Value	Output current for Current Output high alarm. (Unit code fixed to mA, HART unit code 39).	R/W	23	21
9	Simulation Iout	Fixed current to set on the Current Output. (Unit code fixed to mA, HART unit code 39).	R/W	23	3.5
10	Simulation Pulse 1 / Pulse 2	Fixed frequency to output on Digital Outputs 1 & 2. (Unit code fixed to Hz, HART unit code 38).	R/W	5250	0
11	Output Readings DO1 Pulses	Frequency value at Digital Output 1. (Unit code fixed to Hz, HART unit code 38).	RO	5250	0
12	Output Readings DO2 Pulses	Frequency value at Digital Output 2. (Unit code fixed to Hz, HART unit code 38).	RO	5250	0
13	Pulse Width	Pulse width setting for Digital Outputs 1 & 2. (Unit code fixed to ms, manufacturer specific unit code 253).	R/W	2000	0.09
14	Limit Frequency	Limit frequency setting for Digital Outputs 1 & 2. (Unit code fixed to Hz, HART unit code 38).	R/W	Refer to Command 150, Slot 1	Refer to Command 150, Slot 1
15	Fullscale Frequency	Full scale frequency setting for Digital Outputs 1 & 2. (Unit code fixed to Hz, HART unit code 38).	R/W	10000000	0.25
16	DC Back Off V	Internal DC back-off voltage within the Transmitter. (Unit code fixed to V, HART unit code 58).	RO	3	-3
23	Coil L	Inductance of the connected sensor coil. (Unit code fixed to mH, HART unit code 255 for unsupported unit).	RO	-	-
29	Elec. R E1	Resistance of electrode 1. (Unit code fixed to kOhms, HART unit code 163).	RO	-	-
34	Elec. R E2	Resistance of electrode 2. (Unit code fixed to kOhms, HART unit code 163).	RO	-	-
72	TX Av. Gain Shift	Shift in transmitter calibration values. (Unit code fixed to %, HART unit code 57).	RO	-	-
75	Coil I Alarm Band	The tolerance band for the coil current, outside which an alarm is annunciated. (Unit code fixed to %, HART unit code 57).	RO	10	0.1
117	Excitation Current	The excitation current being applied to the sensor coils. (Unit code fixed to mA, HART unit code 39).	RO	200	10

Slot	Name	Description	Access	Upper Limit	Lower Limit
119	Elec. V -Limit	The minimum negative electrode voltage before the accuracy of measurement can be affected and an alarm is annunciated. (Unit code fixed to V, HART unit code 58).	RO	2	-2
120	Elec. V +Limit	The maximum positive electrode voltage before the accuracy of measurement can be affected and an alarm is annunciated. (Unit code fixed to V, HART unit code 58).	RO	2	-2
122	Elec. V Diff. Limit	The maximum electrode voltage difference permitted before an alarm is annunciated and the flow-rate measurement stopped. (Unit code fixed to V, HART unit code 58).	RO	2	-2
124	Coil S/C R Limit	The minimum resistance value of the coil and cable resistance before a short circuit coil alarm is annunciated. (Unit code fixed to Ohms, HART unit code 37).	RO	550	2
125	Coil O/C R Limit	The maximum resistance value of the coil and cable resistance before an open circuit alarm is annunciated. (Unit code fixed to Ohms, HART unit code 37).	RO	550	2
128	Elec. R Alarm Min	The minimum resistance value of the electrodes and associated wiring, below which a short circuit electrode alarm is annunciated. (Unit code fixed to kOhms, HART unit code 163). **Note** – this parameter is read-only for MID flowmeters.	R/W	1000	0
129	Elec. R Alarm Max EP	The maximum allowable resistance of electrodes before an empty pipe alarm is annunciated. (Unit code fixed to kOhms, HART unit code 163). **Note** – this parameter is read-only for MID flowmeters.	R/W	1000	0
140	Coil Measurement F	Frequency of coil test measurement signal. (Unit code fixed to Hz, HART unit code 38).	RO	1000	1
147	Qmax	Selects the measurement range for forward and reverse flow-rate. (Refer to 10.35 Volume Flow Units for supported units).	R/W	Refer to Command 150, Slot 5	Refer to Command 150, Slot 5
148	QmaxDN	The nominal maximum flow-rate. (Refer to 10.35 Volume Flow Units for supported units).	RO	Refer to Command 150, Slot 5	Refer to Command 150, Slot 5
150	TX Cal'd Velocity	The velocity value before sensor calibration factors are applied. (Unit code fixed to m/s, HART unit code 21).	RO	-	-
151	Snsr Cal'd Velocity	The velocity value after factory sensor calibration factors are applied. (Unit code fixed to m/s, HART unit code 21).	RO	-	-

Slot	Name	Description	Access	Upper Limit	Lower Limit
152	Snsr User Velocity	The velocity value after user calibration factors are applied. (Unit code fixed to m/s, HART unit code 21).	RO	-	-
153	Velocity	The final output flow velocity value. (Refer to 10.34 Velocity Units for supported units).	RO	-	-
154	Volume Flowrate	The output volume flow value. (Refer to 10.35 Volume Flow Units for supported units).	RO	-	-
155	Q %	The volume flow-rate expressed as a percentage of Qmax. (Unit code fixed to %, HART unit code 57).	RO	-	-
157	Simulation Velocity	Fixed velocity value to output. (Refer to 10.34 Velocity Units for supported units). **Note** – this parameter is read-only for MID flowmeters.	R/W	Refer to Command 150, Slot 2	Refer to Command 150, Slot 2
158	Simulation Q	Fixed volume flow-rate to output. (Refer to 10.35 Volume Flow Units for supported units). **Note** – this parameter is read-only for MID flowmeters.	R/W	Refer to Command 150, Slot 4	Refer to Command 150, Slot 4
159	Simulation Q%	Fixed value of Flow % to output. (Unit code fixed to %, HART unit code 57). **Note** – this parameter is read-only for MID flowmeters.	R/W	200	-200
160	TX Zero	Zero velocity correction factor being applied. (Unit code fixed to mm/s, manufacturer specific unit code 240).	RO	50	-50
161	TX Span	Span velocity correction factor being applied. (Unit code fixed to %, HART unit code 57).	RO	120	80
162	Zero Sz	Factory set sensor zero velocity factor. (Unit code fixed to mm/s, manufacturer specific unit code 240).	RO	50	-50
163	Span Ss	Factory set sensor span factor. (Unit code fixed to %, HART unit code 57).	RO	500	-500
164	Trim St	Trim calibration factor being applied. (Unit code fixed to %, HART unit code 57).	RO	50	-50
166	QmaxDN (Special)	QmaxDN value for special sensor sizes. (Refer to 10.35 Volume Flow Units for supported units).	R/W	100000	0
167	Special Size (Bore)	Special sensor bore. (Unit code fixed to mm, HART unit code 49).	RO	5000	1
168	User Zero	User Zero value. (Unit code fixed to mm/s, manufacturer specific unit code 240). **Note** – this parameter is read-only for MID flowmeters.	R/W	50	-50

Slot	Name	Description	Access	Upper Limit	Lower Limit
169	User Span	User Span value. (Unit code fixed to %, HART unit code 57). **Note** – this parameter is read-only for MID flowmeters.	R/W	250	-250
171	Damping	System damping value. (Unit code fixed to s, HART unit code 51).	R/W	60	0.02
172	Factory Cutoff	Factory cutoff level velocity. (Unit code fixed to mm/s, manufacturer specific unit code 240).	RO	50	0
173	Flow Cutoff Level	User flow cutoff percentage of Qmax. (Unit code fixed to %, HART unit code 57). **Note** – this parameter is read-only for MID flowmeters.	R/W	10	0
174	Hysteresis	User hysteresis value for flow cutoff level. (Unit code fixed to %, HART unit code 57). **Note** – this parameter is read-only for MID flowmeters.	R/W	50	0
175	Flowrate Limits Min. Alarm	Minimum percentage of Qmax before low flow alarm. (Unit code fixed to %, HART unit code 57).	R/W	130	0
176	Flowrate Limits Max. Alarm	Maximum percentage of Qmax before high flow alarm. (Unit code fixed to %, HART unit code 57).	R/W	130	0
185	Probe Pipe Bore	Bore of the pipe in use with probe type sensor. (Unit code fixed to mm, HART unit code 49).	R/W	5000	1
188	Sensor L Shift	Shift in sensor inductance. (Unit code fixed to %, HART unit code 57).	RO	100	-100
190	Volume Forward	Volume forward totalizer in single-precision floating point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO	-	-
191	Volume Reverse	Volume reverse totalizer in single-precision floating point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO	-	-
192	Volume Net	Volume net totalizer in single-precision floating point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO	-	-

9.6 Command #134: Read Single-Precision Floating-Point

Reads a variable in single-precision floating-point format.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1-4	Single-Precision Floating-Point	Value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

9.7 Command #135: Write Single-Precision Floating-Point

Writes the value to a variable in single-precision floating-point format.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to write.
1-4	Single-Precision Floating-Point	Value to write to the variable.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1-4	Single-Precision Floating-Point	Value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
3	Failure	Passed Parameter Too Large.
4	Failure	Passed Parameter Too Small.
5	Failure	Too Few Data Bytes Received.
7	Failure	In Write Protect Mode.
16	Failure	Access Restricted.

Command 134/135 Slot Content

Slot	Name	Description	Access	Upper Limit	Lower Limit
0	Pulse Factor	Pulse Factor parameter for Digital Outputs 1 & 2.	R/W	10000000	0.00001
16	Insertion Factor	Insertion Factor for probe type sensors.	R/W	3.0	1.0
17	Profile Factor	Profile Factor for probe type sensors.	R/W	3.0	1.0

9.8 Command #136: Read String

Reads a twenty-character string.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the string to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1-21	Byte	Value of the requested string variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

9.9 Command #137: Write String

Writes a twenty-character string.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the string to read.
1-21	Byte	String data to write.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1-21	Byte	Value of the requested string variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.
7	Failure	In Write Protect Mode.
16	Failure	Access Restricted.

Command 136/137 Slot Content

Slot	Name	Description	Access
0	TX Version Application	Transmitter firmware version number.	RO
1	TX Version Bootloader	Transmitter bootloader firmware version number.	RO
2	TX Run Hours	Run-hours counter of the transmitter.	RO
3	Sensor Run Hours	Run-hours counter of the sensor.	RO
4	TX Calibration First Cal. Date	Date of initial transmitter calibration.	RO
5	TX Calibration Last Cal. Date	Date of the most recent transmitter calibration.	RO
6	Sensor Calibration First Cal. Date	Date of initial sensor calibration.	RO
7	Sensor Calibration Last Cal. Date	Date of the most recent sensor calibration.	RO
8	Application CRC	CRC value of the application firmware.	RO
9	Manufacturer Address 1	First line of the manufacturer address.	RO
10	Manufacturer Address 2	Second line of the manufacturer address.	RO
11	Manufacturer Contact	Contact details for the manufacturer.	RO
12	Transmitter TAG	User defined transmitter descriptive text.	R/W
13	Transmitter SAP/ERP Number	Manufacturer assigned transmitter SAP/ERP number.	RO
16	TX Version H/W	Hardware version code of the transmitter hardware.	RO
17	Sensor TAG	User defined sensor descriptive text.	R/W
18	Sensor Calibration Certificate Number	Calibration facility assigned certificate number.	RO
19	Sensor SAP/ERP Number	Manufacturer assigned sensor SAP/ERP number.	RO
21	Transmitter Location String	User defined text to describe the transmitter installation details.	R/W
22	Sensor Location String	User defined text to describe the sensor installation details.	R/W
23	Manufacturer	Name of the transmitter manufacturer.	RO
24	HART F/W	Version number of the HART modem firmware.	RO
25	Term Board S/W	Version number of the remote sensor memory firmware.	RO

9.10 Command #138: Read Double-Precision Floating-Point with Unit

Reads a variable in double-precision floating-point format with its associated unit code.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1	Byte	The requested variable associated unit code.
2-9	Double-Precision Floating-Point	The requested variable value.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 138 Slot Content

Slot	Name	Description	Access
0	Volume Forward	Forward volume totalizer in double-precision floating-point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO
1	Volume Reverse	Reverse volume totalizer in double-precision floating-point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO
2	Volume Net	Net volume totalizer in double-precision floating- point format. (Refer to 10.37 Volume Totalizer Units for supported units).	RO

9.11 Command #143: Trigger Action

Triggers a transmitter action.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the action to trigger.
1	Byte	Dummy write value.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested action.
1	Byte	Echo of dummy write value.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.
7	Failure	In Write Protect Mode.
16	Failure	Access Restricted.

Command 143 Slot Content

Slot	Name	Description
5	Clear Alarm History	Clears the process alarm history in the transmitter. **Note** – this parameter is read-only for MID flowmeters.
13	Reset Totalizer All Volume	Resets all volume totalizers. **Note** – this parameter is read-only for MID flowmeters.
14	Reset Totalizer Volume FWD	Resets the forward volume totalizer. **Note** – this parameter is read-only for MID flowmeters.
15	Reset Totalizer Volume REV	Resets the reverse volume totalizer. **Note** – this parameter is read-only for MID flowmeters.
16	Reset Totalizer Volume NET	Resets the net volume totalizer. **Note** – this parameter is read-only for MID flowmeters.
20	User Defaults Restore	Restores factory set default values and ROM based default values where these are unavailable to installation type data. **Note** – this parameter is read-only for MID flowmeters.

9.12 Command #146: Read Thirty-Two-Bit

Reads a thirty-two-bit variable.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the variable to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested variable.
1-4	32-bit integer	Value of the requested variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 146 Slot Content

Slot	Name	Description
4	TX ID	Transmitter unique id number in thirty-two-bit format.
5	Sensor ID	Sensor unique id number in thirty-two-bit format.

9.13 Command #148: Read Twenty-Four-Bit Id

Reads a device identifier in HART format (24-bit).

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the id to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested id.
1-3	Byte	Value of the requested device id.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 148 Slot Content

Slot	Name	Description
0	TX ID	Unique Transmitter id number in twenty-four-bit format.
1	Sensor ID	Unique Sensor id number in twenty-four-bit format.

9.14 Command #150: Read Dynamic Single-Precision Floating-Point Range

Reads single-precision floating-point based dynamic ranges associated with other parameters.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the range item to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested range item.
1-4	Single-Precision Floating-Point	The upper range value of the requested item.
5-8	Single-Precision Floating-Point	The lower range value of the requested item.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 150 Slot Content

Slot	Name	Description
0	Fixed Current Output	Range of Current Output values that can be simulated.
1	Digital Output Limit Frequency	Range of the Digital Output Limit Frequency parameter.
2	Simulated Velocity Limits	Range of velocity simulation values.
3	Velocity Limits	Range of velocity values.
4	Simulated Flowrate	Range of flowrate simulation values.
5	Flowrate	Range of flowrate values.

9.15 Command #180: Trigger Adjust Function

Triggers a calibration adjustment function.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the adjust function to trigger.
1	Byte	Dummy write value.

Response Data Bytes

Byte	Format	Description
0	Byte	Slot number of the requested adjust function.
1	Byte	Echo of dummy write variable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.
7	Failure	In Write Protect Mode.
16	Failure	Access Restricted.
114	Failure	Access Restricted – Action Not Available.

Command 180 Slot Content

Slot	Name	Description
2	User Zero Adjust	Starts adjustment of the User Zero. **Note** – this parameter is read-only for MID flowmeters.

9.16 Command #181: Read Adjust Values

Reads the adjustment values of the selected adjustment function.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the adjustment function results to read.

Response Data Bytes

Byte	Format	Description
0	Byte	Requested slot number of the adjustment function results.
1	Byte	Progress Time of the adjustment operation.
2	Byte	Current result of the adjustment operation. (Refer to 10.39 Adjustment Operation Result
3-6	Single-Precision Floating-Point	Mean of the adjustment operation data.
7-10	Single-Precision Floating-Pont	Standard deviation of the adjustment operation data.
11-14	Single-Precision Floating-Point	Maximum value of the adjustment operation data.
15-18	Single-Precision Floating-Point	Minimum value of the adjustment operation data.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 181 Slot Content

Slot	Name	Description
2	User Zero Adjust Results	Results of the User Zero Adjustment operation.

9.17 Command #182: Read Additional Diagnostic Information

Reads information pertaining to transmitter alarms.

Request Data Bytes

Byte	Format	Description
0	Byte	Slot number of the alarm to read additional information for.

Response Data Bytes

Byte	Format	Description
0	Byte	Requested slot number of the alarm additional information is requested for.
1-2	16-bit integer	Number of times the alarm has occurred.
3-6	32-bit integer	Total number of milliseconds for which the alarm has been active.
7-8	16-bit integer	Total number of days for which the alarm has been active.
9-12	32-bit integer	Number of milliseconds since the last alarm instance.
13-14	16-bit integer	Number of days since the last alarm instance.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors.
2	Failure	Invalid Selection.
5	Failure	Too Few Data Bytes Received.

Command 182 Slot Content

Slot	Name	Description
0	Simulated/fixed current output	Details of the 'Simulated/fixed current output' alarm.
1	Logic simulation selected on OP1	Details of the 'Logic simulation selected on OP1' alarm.
2	Pulse simulation selected on OP1	Details of the 'Pulse simulation selected on OP1' alarm.
3	Logic simulation selected on OP2	Details of the 'Logic simulation selected on OP2' alarm.
4	Pulse simulation selected on OP2	Details of the 'Pulse simulation selected on OP2' alarm.
5	Logic simulation selected on OP3	Details of the 'Logic simulation selected on OP3' alarm.
6	Low flow alarm	Details of 'Low flow alarm'.
7	High flow alarm	Details of 'High flow alarm'.
8	Current output limited Q >103% Qmax	Details of the 'Current output limited Q >103%Qmax' alarm.
9	Simulation mode On	Details of the 'Simulation mode On' alarm.
10	Tx. simulator/calibrator mode	Details of the 'Tx. simulator/calibrator mode' alarm.
11	At Qmax, volume display overrun <1600hrs	Details of the 'At Qmax, volume display overrun <1600hrs' alarm.
12	Totalizer reset	Details of the 'Totalizer reset' alarm.
13	Intermittent sensor comms	Details of the 'Intermittent sensor comms' alarm.
14	HART multidrop enabled	Details of the 'HART multidrop enabled' alarm.
15	Tx. Memory fault detected	Details of the 'Tx. Memory fault detected' alarm.
16	Sensor memory not detected	Details of the 'Sensor memory not detected' alarm.
17	Tx. Measurement suspended	Details of the 'Tx. Measurement suspended' alarm.
18	Empty pipe	Details of the 'Empty pipe' alarm.
21	Open circuit electrode	Details of the 'Open circuit electrode' alarm.
22	Short circuit electrode	Details of the 'Short circuit electrode' alarm.
24	Installation fault/condition	Details of the 'Installation fault/condition' alarm.
25	Open circuit coil/wiring	Details of the 'Open circuit coil/wiring' alarm.
26	Short circuit coil/wiring	Details of the 'Short circuit coil/wiring' alarm.
27	Check cable+coil resistance	Details of the 'Check cable+coil resistance' alarm.
28	Transmitter hardware fault	Details of the 'Transmitter hardware fault' alarm.
29	Bad flow data	Details of the 'Bad flow data' alarm.
30	Accuracy warning?	Details of the 'Accuracy warning?' alarm.
31	OIML self-check limits exceeded	Details of the 'OIML self-check limits exceeded' alarm.
32	Measurement starting	Details of the 'Measurement starting' alarm.
33	Current output hardware fault	Details of the 'Current output hardware fault' alarm.
34	Sensor setup not complete	Details of the 'Sensor setup not complete' alarm.
35	Incompatible sensor	Details of the 'Incompatible sensor' alarm.
36	Tx. code memory fault	Details of the 'Tx. code memory fault' alarm.
37	Tx. data memory fault	Details of the 'Tx. data memory fault' alarm.
38	HART frequency simulation	Details of the 'HART frequency simulation' alarm.
39	Alarm simulation active	Details of the 'Alarm simulation active' alarm.
40	Non-Volatile Summary	Details of the 'Non-Volatile Summary' alarm.

Note – All additional diagnostic information is reset before transmitters are shipped from the factory.

10. Tables

10.1 Security Mode

0	High Security Disabled
1	High Security Enabled

10.2 Current Output Alarm Selection

0	High Alarm
1	Low Alarm
2	Off

10.3 Current Output Mode

0	4 .. 20mA
1	4 .. 12 .. 20mA
2	4 .. 20 mA FWD/REV

10.4 Enable State

0	Disabled
1	Enabled

10.5 Simulation Mode

0	Off
1	Flow Velocity
2	Q
3	Q%
4	Iout
5	Pulse 1
6	Pulse 2
7	Logic 1
8	Logic 2
9	Logic 3

Note – Flow Velocity, Q and Q% are not available for MID flowmeters.

10.6 Device Calibration Location

0	Stonehouse
1	Goettingen
2	Warminster
3	Moorebank
4	Shanghai
5	Burlington
6	Not Specified

10.7 Sensor Lining Materials

0	PTFE
1	Tefzel ETFE
2	PEEK
3	Hard Rubber
4	Linatex
5	Elastomer
6	Elastomer ACS
7	Elastomer NSF61
8	POMC
9	PFA
10	PPS
11	Soft Rubber
12	Polyurethane
13	Polypropylene
14	THICK PTFE
15	Ceramic Carbide
16	FEP
17	Neoprene
18	Other

10.8 Sensor Electrode Materials

0	Stainless Steel
1	Hastelloy C4
2	Hastelloy C276
3	Titanium
4	Tantalum
5	Hastelloy B3
6	Platinum Iridium
7	Duplex Steel
8	Nickel
9	St. Steel 316TI
10	Hastelloy C(DL)
11	Tungsten Carbide
12	Hastelloy C22
13	Super Austenitic Steel
14	Other

10.9 Sensor Calibration Mode

0	WaterMaster
1	ProcessMaster

10.10 Sensor Calibration Type

0	Retrofit
1	OIML Class 1
2	OIML Class 2
3	Special
4	OIML Certified Class 1
5	OIML Certified Class 2
6	Probe
7	NMI
8	Select

10.11 Current Output Empty Pipe Behaviour

0	Off
1	Q = 0%
2	High Alarm
3	Low Alarm

10.12 Logic Output 1 Alarm Behaviour

0	Off
1	On

10.13 Logic Output 2 Alarm Behaviour

2	Off
3	On

10.14 Logic Output 3 Alarm Behaviour

4	Off
5	On

10.15 Diagnostic Alarm Simulation

0	None
1	Iout Simulated
2	Logic OP1 Simulated
3	Pulse OP1 Simulated
4	Logic OP2 Simulated
5	Pulse OP2 Simulated
6	Logic OP3 Simulated
7	Min Flow Value
8	Max Flow Value
9	103% Reached
10	Simulated Flow
11	Calibrator
12	Display Overrange
13	Totalizer Reset
14	Poor Sensor Comms
15	Address Not Zero
16	TX Memory Fail
17	No Sensor
18	Measurement Offline
19	Empty Pipe
20	Elec. Open Circuit
21	Elec. Short Circuit
22	Installation Fault
23	Coil Open Circuit
24	Coil Short Circuit
25	Loop Resistance
26	TX Hardware
27	Bad Flow Data
28	Electrode Voltage
29	OIML Self Check
30	Measurement Starting
31	Iout Hardware Fault
32	Not Calibrated
33	Calibration Mismatch
34	ROM Error
35	RAM Error

36	HART Simulation
37	NV Summary Alarm

10.16 Logic Output Simulation

0	Off
1	On

10.17 Logic Output State

0	Open
1	Closed

10.18 Logic Output Signal Source

0	No Logic Source
1	Forward/Reverse Flow
2	Digital Output Alarm

10.19 Logic Output Action State

0	Normally Open
1	Normally Closed

10.20 Digital Output Function

0	Pulse F/Pulse R
1	Pulse F/Logic
2	Pulse FR/Logic
3	Logic/Logic

10.21 Digital Output Pulse Mode

0	Pulse / Unit
1	Fullscale Frequency

10.22 Language

0	English
1	German
2	French
3	Spanish
4	Italian
9	Polish

10.23 Operator Page Line Items

0	Volume Flowrate
1	Q%
2	Current Out
3	Velocity
4	Volume Forward
5	Volume Reverse
6	Volume Net

10.24 Operator Page 1 Display Modes

5	1 x 6
6	1 x 6 + Bargraph
7	1 x 9
8	1 x 9 + Bargraph
9	2 x 9
10	2 x 9 + Bargraph
11	3 x 9

10.25 Operator Pages 2 & 3 Display Modes

0	Off
5	1 x 6
6	1 x 6 + Bargraph
7	1 x 9
8	1 x 9 + Bargraph
9	2 x 9
10	2 x 9 + Bargraph
11	3 x 9

10.26 Display Decimal Point Settings

0	x
1	x.x
2	x.xx
3	x.xxx
4	x.xxxx
5	x.xxxxx

10.27 Display Date Formats

0	DD-MM-YYYY
1	MM-DD-YYYY
2	YYYY-MM-DD

10.28 Mains Frequency

50	50Hz
60	60Hz

10.29 Drive Mode

0	User
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	3A
10	4A
11	5A
12	5B
13	6A
14	6B
15	7A
16	7B
17	7C
18	7D
19	8A
20	8B
21	8C

10.30 Sensor Type

0	Probe
1	Process
2	Hygienic
3	WM Reduced Throat
4	WM Full Bore
5	DE4
6	DE2
7	Process OIML
8	Hygienic OIML
9	No Sensor

10.31 Sensor Bore Size

0	DN1
1	DN1_5
2	DN2
3	DN3
4	DN4
5	DN6
6	DN8
7	DN10
8	DN15
9	DN20
10	DN25
11	DN32
12	DN40
13	DN50
14	DN65
15	DN80
16	DN100
17	DN125
18	DN150
19	DN200
20	DN250
21	DN300
22	DN350
23	DN400
24	DN450
25	DN500
26	DN600
27	DN700
41	DN750
28	DN760
29	DN800
30	DN900
31	DN1000
32	DN1050
33	DN1100
34	DN1200

42	DN1350
35	DN1400
36	DN1500
37	DN1600
43	DN1650
38	DN1800
44	DN1950
39	DN2000
45	DN2100
46	DN2200
47	DN2400
40	Special

10.32 Flow Direction

0	Normal
1	Reversed

10.33 Meter Mode

0	Forward And Reverse
1	Forward Only
2	Reverse Only

10.34 Velocity Units

20	ft/s
21	m/s
114	in/s
115	in/min
116	ft/min

10.35 Volume Flow Units

15	ft^3/min
16	ugal/min
17	l/min
18	igal/min
19	m^3/h
22	ugal/s
23	Mugal/d
24	l/s
25	Ml/d
26	ft^3/s
27	ft^3/d
28	m^3/s
29	m^3/d
30	igal/h
31	igal/d
130	ft^3/h
131	m^3/min
136	ugal/h
137	igal/s
138	l/h
235	ugal/d
241	bls/h
242	hl/h
243	kugal/min

10.36 Service Port Baudrates

0	2400bps
1	4800bps
2	9600bps
3	19200bps
4	38400bps

10.37 Volume Totalizer Units

40	ugal
41	l
42	igal
43	m^3
112	ft^3
236	hl
244	kugal
245	ml
247	Ml

10.38 Read-Only Switch Status

0	Inactive
1	Active

10.39 Adjustment Operation Result

0	OK
15	Error

10.40 MID Meter Mode

0	Non-MID
1	MID Unlocked
2	MID Locked

11. Unit Conversion

The units used for internal values are shown below.

Measurement	Internal Unit
Volume Flow	l/s
Flow Velocity	m/s
Volume	l

To convert volume flow, velocity and totalizer values to other units, the following equation is used.

$$V_2 = (V_1 * cf_1) * cf_2$$

V_2 Updated value

V_1 Original value

cf_1 Conversion factor to base units, from units of original value

cf_2 Conversion factor from base units to units of updated flow value

To convert to base units from other units, the following equation is used.

$$V_2 = V_1 * cf_1$$

V_2 Value in base units

V_1 Value in original unit

cf_1 Conversion factor to base units

11.1 Conversion factors for volume flow units from l/s

Unit Code	Unit	Conversion Factor
24	l/s	1
17	l/min	60
138	l/h	3600
242	hl/h	36
25	Ml/d	0.0864
28	m^3/s	0.001
131	m^3/min	0.06
19	m^3/h	3.6
29	m^3/d	86.4
26	ft^3/s	0.03531467
15	ft^3/min	2.1188802
130	ft^3/h	127.132812
27	ft^3/d	3051.187488
22	ugal/s	0.264172
16	ugal/min	15.85032
136	ugal/h	951.0192
235	ugal/d	22824.4608
23	Mugal/d	0.022824461
137	igal/s	0.2199688
18	igal/min	13.198128
30	igal/h	791.88768
31	igal/d	19005.30432
241	bls/h	30.6780444

11.2 Conversion factors for volume flow units to l/s

Unit Code	Unit	Conversion Factor
24	l/s	1.00
17	l/min	0.016666667
138	l/h	0.000277778
242	hl/h	0.027777778
25	Ml/d	11.57407407
28	m^3/s	1000
131	m^3/min	16.66666667
19	m^3/h	0.277777778
29	m^3/d	0.011574074
26	ft^3/s	28.31685
15	ft^3/min	0.4719475
130	ft^3/h	0.007865792
27	ft^3/d	0.000327741
22	ugal/s	3.785413
16	ugal/min	0.063090217
136	ugal/h	0.001051504
235	ugal/d	0.0000438127
23	Mugal/d	43.81265046
137	igal/s	4.546099
18	igal/min	0.075768317
30	igal/h	0.001262805
31	igal/d	0.0000526169
241	bls/h	0.032596611

11.3 Conversion factors for velocity units from m/s

Unit Code	Unit	Conversion Factor
21	m/s	1.00
114	in/s	39.370079
115	in/min	2362.20483
20	ft/s	3.28083992
116	ft/min	196.850403

11.4 Conversion factors for velocity units to m/s

Unit Code	Unit	Conversion Factor
21	m/s	1.00
114	in/s	0.0253999997
115	in/min	0.000423333317
20	ft/s	0.304800004
116	ft/min	0.00508000003

11.5 Conversion factors for volume units from l

Unit Code	Unit	Conversion Factor
43	m^3	0.001
245	ml	1000
41	l	1
236	hl	0.00999999978
247	Ml	0.000000999999997
112	ft^3	0.0353146717
42	igal	0.219968796
40	ugal	0.264171988
248	Mugal	0.000000264172002
246	bls	0.00852167886

11.6 Conversion factors for volume units to l

Unit Code	Unit	Conversion Factor
43	m^3	1000
245	ml	0.001
41	l	1
236	hl	100
247	Ml	1000000
112	ft^3	28.3168507
42	igal	4.54609919
40	ugal	3.78541303
248	Mugal	3785413.0
246	bls	117.347801

Note – All conversion factors are represented as floating-point values used within application code.

12. Performance

12.1 Sampling Rates

Typical sampling rates are shown in the following table.

PV digital value calculation	10 per second
Analogue output update	20 per second

12.2 Power-Up

On power up, the transmitter loads non-volatile data from the sensor and transmitter. For integral sensors this process takes approximately 2 seconds. For remote sensors, the slower serial communications between the transmitter and sensor increase this time to approximately 10 seconds.

During this period, the device will not respond to HART commands, and the analogue output is set to 0mA. After all non-volatile data is loaded, the system starts and can accept HART commands. The current output is set to 4mA until the first PV value is read.

Only after the Acquisition subsystem has completed initialisation will the first measurement be made, the PV value set, and the analogue output be set to a value representing the measurement. The slew rate of this movement is limited by the 'Damping' parameter.

Any alarms of class "Failure" occurring during power-up will force the PV to 0. Depending on its configuration, the analogue output will be set to either the "High Alarm" or "Low Alarm" value.

The device will still respond to HART commands during a fault condition.

12.3 Self-Test

The self-test procedure is executed continuously during transmitter operation, with the following items being checked.

- RAM
- Program ROM
- Configuration storage EEPROM
- Transmitter calibration

12.4 Command Response Times

Minimum	85ms
Typical	110ms
Maximum	150ms

12.5 Busy and Delayed-Response

The transmitter does not support the "device is busy" status.

Delayed-response is not used.

12.6 Long Messages

The largest data field used in a command response is to Command 3, 33 (with the maximum number of variables being read) or 48 - 26 bytes including the two status bytes.

12.7 Non-Volatile Memory

EEPROM is used to hold the device's configuration parameters. New data is written to this memory within 100ms of a write command.

12.8 Modes

Fixed current mode is implemented, using Command 40. This mode is cleared by power loss, reset or setting a fixed current value of 0mA. Refer to Section 4.2.1 for details of current output operating modes during normal operation.

12.9 Write Protection

Write-protection is provided, selected by an internal switch (see Section 4.3.2). When the switch is set to 'ON', no "write" or "action" commands are accepted. The switch status is read once only during transmitter power-up.

For MID meters, this switch only blocks access to MID related parameters. Non-MID related parameters are still writable. Refer to parameters MID Meter Mode and Sensor Cal. Type for determining the MID status of the Flowmeter.

12.10 Damping

Damping is standard, affecting all process and device variables and the loop current signal.

Annex A. Capability Checklist

Manufacturer, model and revision	ABB FEX100 WaterMaster, rev. 0
Device type	Transmitter
HART revision	5.7
Device Description available	Yes
Number and type of sensors	1(integral or remote depending on transmitter model)
Number and type of host side signals	1: 4 - 20mA analogue 2: Digital Output 1 or Logic Output 1 3: Digital Output 2 or Logic Output 2 4: Logic Output 3 5: Infra-Red Service Port
Number of Device Variables	6
Number of Dynamic Variables	4
Mappable Dynamic Variables?	No
Number of common-practice commands	8
Number of device-specific commands	17
Number of Slot Variables (Accessed via device-specific commands)	226
Bits of additional device status	38
Alternative operating modes?	No
Burst mode?	No
Write-protection?	Yes

Annex B. Default Configuration

Parameter	Default value
Lower Range Value	0
Upper Range Value	100
PV Units	m^3/h
Damping time constant	1 second
Write-protect switch	Inactive (i.e. write enabled)
Number of response preambles	5
Security Mode	High Security Enabled
Iout For Alarm	High Alarm
Current Output Mode	4 .. 20mA
Cyclic Data Output Flow Group	Disabled
Cyclic Data Output Vol. Totals Group	Disabled
Cyclic Data Output Outputs Group	Disabled
Cyclic Data Output Electrodes Group	Disabled
Cyclic Data Output Status Group	Disabled
Cyclic Data Output Coil Group	Disabled
Cyclic Data Output TX Group	Disabled
Simulation Mode	Off
PCB	Hardware revision dependent
Transmitter Last Calibration Location	Stonehouse
Sensor First Calibration Location	Stonehouse
Sensor Last Calibration Location	Stonehouse
Sensor Lining Material	Polypropylene
Sensor Electrode Material	Stainless Steel
Sensor Cal. Mode	WaterMaster
Sensor Cal. Type	OIML Class 1
Iout For EP Alarm	Off
DO1 Config Alarm	On
DO1 Config Empty Pipe	Off
DO1 Config Min. Alarm	Off
DO1 Config Max. Alarm	Off
DO2 Config Alarm	On
DO2 Config Empty Pipe	Off
DO2 Config Min. Alarm	Off
DO2 Config Max. Alarm	Off
DO3 Config Alarm	On
DO3 Config Empty Pipe	Off

Parameter	Default value
DO3 Config Min. Alarm	Off
DO3 Config Max. Alarm	Off
Alarm Simulation	None
Group Masking Check Function	Off
Group Masking Off Specification	Off
Group Masking Maintenance	Off
Diagnostic Masking Overflow 103%	On
Individual Masking Min. Alarm	On
Individual Masking Max. Alarm	On
Logic 1	Off
Logic 2	Off
Logic 3	Off
DO1 State	Open
DO2 State	Open
DO3 State	Open
DO1 Logic	No Logic Source
DO1 Action	Normally Open
DO2 Logic	No Logic Source
DO2 Action	Normally Open
DO3 Logic	No Logic Source
DO3 Action	Normally Open
DO1/DO2 Function	Pulse FR/Logic
Pulse Mode	Pulse / Unit
Language	English
Operator Page 1 1st Line	Volume Flowrate
Operator Page 1 2nd Line	Volume Flowrate
Operator Page 1 3rd Line	Volume Flowrate
Operator Page 2 1st Line	Volume Flowrate
Operator Page 2 2nd Line	Volume Flowrate
Operator Page 2 3rd Line	Volume Flowrate
Operator Page 3 1st Line	Volume Flowrate
Operator Page 3 2nd Line	Volume Flowrate
Operator Page 3 3rd Line	Volume Flowrate
Contrast	50
Operator Page 1 Display Mode	1 x 6
Operator Page 2 Display Mode	Off
Operator Page 3 Display Mode	Off
Flowrate Format	x.xx

Parameter	Default value
Volume Format	x
Date / Time Format	YYYY-MM-DD
Mains Frequency	50Hz
Drive Mode	5A
Sensor Type	DE4
Sensor Size	DN20
Flow Indication	Normal
Fact. Cutoff No. Av.	4
Meter Mode	Forward And Reverse
Velocity Unit	m/s
Q (Flowrate) Unit	m^3/h
Max Baud Rate	38400bps
Volume & Pulse Unit	m^3
Read Only Switch	Inactive
MID Meter Mode	Non-MID
TX PIN	0
Current	0
Low Alarm Value	3.5
High Alarm Value	21.8
Iout	0
Pulse 1 / Pulse 2	0
DO1 Pulses	0
DO2 Pulses	0
Pulse Width	5
Limit Frequency	5250
Fullscale Frequency	5000
DC Back Off V	0
Coil L	0
Elec. R E1	0
Elec. R E2	0
TX Av. Gain Shift	0
Coil I Alarm Band	1
Excitation Current	100
Elec. V -Limit	-1.5
Elec. V +Limit	1.8
Elec. V Diff. Limit	0.5
Coil S/C R Limit	5
Coil O/C R Limit	500

Parameter	Default value
Elec. R Alarm Min	0.1
Elec. R Alarm Max EP	200
Coil Measurement F	40
Qmax	2.5
QmaxDN	2.5
TX Cal'd Velocity	0
Snsr Cal'd Velocity	0
Snsr User Velocity	0
Velocity	0
Volume Flowrate	0
Q %	0
Simulation Velocity	0
Simulation Q	0
TX Zero	0
TX Span	100
Zero Sz	0
Span Ss	100
Trim St	0
QmaxDN (Special)	2.5
Special Size (Bore)	20
User Zero	0
User Span	100
Damping	1
Factory Cutoff	0
Flow Cutoff Level	0.5
Hysteresis	20
Min. Alarm	0
Max. Alarm	110
Probe Pipe Bore	250
Sensor L Shift	0
Volume Forward	0
Volume Reverse	0
Volume Net	0
Pulse Factor	50
Insertion Factor	1
Profile Factor	1

Notes

Acknowledgments

- HART is a registered trademark of the FieldComm Group.
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OI/FEX100HART-EN Rev. B 10.2018