Baumer

Passion for Sensors

HART® Field Device Specification

Baumer *CombiFlow* PF75x

Revision 1

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1. Introduction

1.1 Scope

The *BAUMER* flow meter transmitter, model *PF75x* complies with HART Protocol Revision 7.0. This document specifies all the device specific features and documents HART Protocol implementation details.
The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

1.2 Purpose

This specification is designed to compliment other documentation (e.g., the "Operating manual PF75x") 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

PV	Primary Variable
SV	Secondary Variable
TV	Tertiary Variable
QV	Quaternary Variable
ADC	Analog to Digital Converter
DAC	Digital to Analog Converter
ROM	Read-Only Memory
RAM	Random Access
WP	Write Protect

1.5 References

- *"HART Smart Communications Protocol Specification"*. HCF_SPEC-12, available from HCF.
- *"PF75x Operating manual"* from the Baumer Electric AG.

2. Device Identification

Manufacturer Name:	Baumer Electric AG	**Model Name(s):**	PF75x
Manufacture ID Code:	24712 (6088 Hex)	**Device Type Code:**	58268 (E39C Hex)
HART Protocol Revision	7.0	**Device Revision:**	0
Number of Device Variables	8		
Physical Layers Supported	FSK		
Physical Device Category	Transmitter, High Impedence		

The *PF75x* device it is provided with a waterproof case where the device is already installed.

The name plate is located on the side of the case and indicates the model name and revision.

3. Product Overview

The *PF75x* are a flow meter transmitter, with a 4-to-20mA output.
The analogue output of this device is linear with flow rate over the working range of all supported sensor types.

4. Product Interfaces

4.1. Process Interface

4.1.1. Sensor Input Channels

Refer to the Installation Manual for connection details.

4.2. Host interface

4.2.1. Analog Output 1: Flow Rate

The two-wire 4-to-20mA current loop is connected on two terminals.
Refer to the Installation Manual for connection details.

This output representing the process flow rate measurement, linearized and scaled, according to the configured range of the instrument.
This output corresponds to the Primary Variable. HART Communication is supported on this loop.

	Direction	Values (Percent of Range)	Values (mA or V)
Linear	Down	0.0 %	4.0 mA
Over-Range	Up	100.0 %	20.0 mA
Maximum Current		+100.0%	20.0 mA
Multi-Drop Current Draw			4.0 mA

4.3. Local Interfaces, Jumpers And Switches

4.3.1. Local Controls And Displays

The device *PF75x* has a display that allows to set some parameters of the HART. The

HART parameters are:

Parameter	Description
Address	Device address for communication.
Preambles	Number of preambles.
Write Protect	Flag that allows the setting of the "Write Protect" provided by the Device Specific Command #128.
Output Control	Hart output control
Find Device	Hart Find Device – The device respond or not to Command#73. (ON = ARM, OFF = DISARM)

4.3.2. Internal Jumpers And Switches

No internal jumpers or switches are used for HART protocol.

5. Device Variables

This Field Device exposes **8** Device Variables.

5.1. Device Variable 0 – Flow Rate

The Device Variable 0 is connected to the flow rate measurement.
The flow rate is calculated using the velocity of the fluid (measured by the sensor) and the pipe section (set by the user).

Device Variable - 0			
Number:	0	**Name:**	FLOW RATE
Classification:	VOLUMETRIC FLOW	**Unit Codes:**	All *Volumetric Flow Unit Codes* (Table 2.66, HCF_SPEC-183)

5.2. Device Variable 1 – Flow Velocity

The Device Variable 1 is connected to the flow velocity measurement.
The flow velocity is detected directly by the electromagnetic sensor.

Device Variable - 1			
Number:	1	**Name:**	FLOW VELOCITY
Classification:	VELOCITY	**Unit Codes:**	All *Velocity Unit Codes* (Table 2.67, HCF_SPEC-183)

5.3. Device Variable 2 – Board Temperature 1

The Device Variable 2 is connected to the primary temperature board.
The temperature is detected directly by a temperature sensor placed on the main board.

Device Variable - 2			
Number:	2	**Name:**	BOARD TEMPERATURE 1
Classification:	TEMPERATURE	**Unit Codes:**	All *Temperature Unit Codes* (Table 2.64, HCF_SPEC-183)

5.4. Device Variable 3 – Board Temperature 2

The Device Variable 3 is connected to the secondary temperature board.
The temperature is detected directly by another temperature sensor placed on the main board.

Device Variable - 3			
Number:	3	**Name:**	BOARD TEMPERATURE 2
Classification:	TEMPERATURE	**Unit Codes:**	All *Temperature Unit Codes* (Table 2.64, HCF_SPEC-183)

5.5. Device Variable 4 – Totalizer Positive

The Device Variable 4 is connected to the positive totalizer.
The positive totalizer is the volume of the direct flow that has passed through the pipe.

Device Variable - 4			
Number:	4	**Name:**	DIRECT FLOW TOTALIZER
Classification:	VOLUME / MASS (It depends on the device setting)	**Unit Codes:**	All *Volume/Mass Unit Codes* (Table 2.68/2.71, HCF_SPEC-183)

5.6. Device Variable 5 – Totalizer Negative

The Device Variable 5 is connected to the negative totalizer.
The negative totalizer is the volume of the inverse flow that has passed through the pipe.

Device Variable - 5			
Number:	5	**Name:**	INVERSE FLOW TOTALIZER
Classification:	VOLUME / MASS (It depends on the device setting)	**Unit Codes:**	All *Volume/Mass Unit Codes* (Table 2.68/2.71, HCF_SPEC-183)

5.7. Device Variable 6 – Partial Totalizer Positive

The Device Variable 6 is connected to the partial positive totalizer.
The partial positive totalizer is the volume of the direct flow that has passed through the pipe.

Device Variable - 6			
Number:	6	**Name:**	PARTIAL DIRECT FLOW TOT.
Classification:	VOLUME / MASS (It depends on the device setting)	**Unit Code**	All *Volume/Mass Unit Codes* (Table 2.68/2.71, HCF_SPEC-183)

5.8. Device Variable 7 – Partial Totalizer Negative

The Device Variable 7 is connected to the partial negative totalizer.
The partial negative totalizer is the volume of the inverse flow that has passed through the pipe.

Device Variable - 7			
Number:	7	**Name:**	PARTIAL INVERSE FLOW
Classification:	VOLUME / MASS (It depends on the device setting)	**Unit Codes:**	All *Volume/Mass Unit Codes* (Table 2.68/2.71, HCF_SPEC-183)

6. Dynamic Variables

This Field Device has **4** Dynamic Variables.
The Dynamic Variables have a fixed mapping from the Device Variables.

Dynamic Variable	Device Variable Number	Name
PV	0	Flow Rate
SV	1	Flow Velocity
TV	2	Board Temperature - 1
QV	3	Board Temperature - 2

7. Status Information

7.1. Device Status

The Field Device sets:

- ***Bit 0*** whenever the PV is beyond its operating limits.
- ***Bit 2*** if the Loop Current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.
- ***Bit 3*** if the Loop Current is being held at a fixed value and is not responding to process variations.
- ***Bit 4*** ("More Status Available") whenever any failure is detected. Command #48 gives further detail. (see Section 7.3)
- ***Bit 5*** if a power failure or Device Reset has occurred.
- ***Bit 6*** if an operation was performed that changed the device's configuration.
- ***Bit 7*** if the device detected a serious error or failure that compromises device operation.

7.2. Extended Device Status

This Field Device doesn't use the "Extended Device Status".

7.3. Additional Device Status (Command #48)

Command #48 returns 1 bytes of data, with the following status information:

Byte	Bit	Meaning	Class	Device Status Bits
0	0	Flow Rate Overflow	Error	4 - 7
	1	Pulse overflow 2	Error	4 - 7
	2	Pulse overflow 1	Error	4 - 7
	3	ADC Signal Saturation	Error	4 - 7
	4	Excitation Error	Error	4 - 7
	5	Cumulative Inputs Errors	Error	4 - 7
	6	Input Amplifier Signal Saturation	Error	4 - 7
	7	Pipe Empty	Error	4 - 7

"Not used" bits are always set to 0.
All bits used in this transmitter indicate device or sensor failure, and therefore also set bit 4 of the Device Status byte (Additional Device status) and bit 7 (Device malfunction).
These bits are set or cleared by the self-test executed at power up.

8. Universal Commands

The Field Device implements **all** Universal Commands.

Some details below:

COMMAND	DETAILS
3	It returns PV, SV, TV and QV. See Section 6.
14	It also returns the sensor S/N corresponding to the S/N assigned by Isoil-Hemina

9. Common-Practice Commands

9.1. Supported Commands

The Field Device manages the following Common-Practice Commands:

COMMAND #	NAME
33	Read Device Variables
34	Write Primary Variable Damping Value
35	Write Primary Variable Range Value
40	Enter/Exit Fixed Current Mode
41	Perform Self Test
42	Perform Device Reset
44	Write Primary Variable Units
47	Write Primary Variable Transfer Function
49	Write Primary Variable Transducer Serial Number
50	Read Dynamic Variable Assignments
53	Write Device Variable Units
54	Read Device Variable Information
59	Write Number Of Response Preambles
73	Find Device

9.2. Burst Mode

This Field Device does not support Burst Mode.

9.3. Catch Device Variable

This Field Device does not support Catch Device Variable.

10. Device-Specific Commands

The Field Device manages the following Device-Specific Commands:

COMMAND #	NAME
128	Set/Reset Write Protect Mode
129	Clear All Device Status
130	Reset Totalizer
131	Read Tube Diameter
132	Read Coil Frequency
133	Read Low Flow Cut Off
134	Read Density
135	Read Flow Direction
136	Read Mass Unit Enable

10.1. Command#128: Set/Reset Write Protect Mode

This Command allows the user to enable or disable the Write Protection Flag.
The Command#128 takes effect only if the writing of WP flag is enabled.
The parameter that allows the change is set via display in the specific menu.
Refer to the MV110-Manual for more details.

Request Data Bytes

Byte	Format	Description
0	Enum	Set/Reset Writ Protect

Response Data Bytes

Byte	Format	Description
0	Enum	Write Protect Mode

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received

10.2. Command#129: Clear All Device Status

This Command allows the user to clear all device status.

Request Data Bytes

Byte	Format	Description
0	Enum	Clear All Device Status

Response Data Bytes

Byte	Format	Description
0	Enum	Clear All Device Status Feedback

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received

Command#130: Reset Totalizer

This Command allows the user to Reset a Specific Totalizer.
The Command 130 takes effect only if the selected Totalizer is enable to be reset.
Refer to the MV110-Manual for more details about the procedure for reset the totalizers.

Request Data Bytes

Byte	Format	Description
0	Enum	Totalizer ID To Reset

Response Data Bytes

Byte	Format	Description
0	Enum	Totalizer ID Resetted

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received
7	Error	In Write Protect Mode

10.3. Command#131: Read Tube Diameter

This Command returns the Tube Diameter in a fixed Unit (mm).

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Unit Code (Fixed)
1-4	Float	Tube Diameter

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

10.4. Command#132: Read Coil Frequency

This Command returns the Coil Frequency in a Fixed Unit (Hz).

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Unit Code (Fixed)
1-4	Float	Coil Frequency

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

10.5. Command#133: Read Low Flow Cut Off

This Command returns the Low Flow Cut Off setting in Fixed Unit (%).

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Unit Code (Fixed)
1-4	Float	Low Flow Cut Off

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

10.6. Command#134: Read Density

This Command returns the Fluid Density setting in Fixed Unit (Kg/l).

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Unit Code (Fixed)
1-4	Float	Density

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

10.7. Command#135: Read Flow Direction

This Command returns the Flow Direction.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Flow Direction

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

10.8. Command#136: Read Mass Unit Enable

This Command returns the Mass Unit Enable setting.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Mass Unit Enable

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors

11. Tables

11.1. Write Protect

Value	Description
0	Not Write Protected
1	Write Protected

11.2. Totalizers

Value	Description
0	Totalizer Positive (Flow Rate Positive)
1	Totalizer Negative (Flow Rate Negative)
2	Partial Totalizer Positive (Flow Rate Positive)
3	Partial Totalizer Negative (Flow Rate Negative)

11.3. Flow Direction

Value	Description
0	Flow Direction Positive
1	Flow Direction Negative

12. Performance

12.1. Sampling Rates

Typical sampling rates are shown in the following table.

Variable	Sampling Rate
Primary Flow Rate Sensor Sample	20 per second
PV Digital Value Calculation	20 per second
SV Digital Value Calculation	20 per second
TV Digital Value Calculation	20 per second
QV Digital Value Calculation	20 per second
Analog Output Update	20 per second

12.2. Power-Up

On Power-Up, the device performs a full Self-Test procedure, which takes about 2 seconds. During this time, the analog output is set to 4.0mA and the HART communication is offline.

When the self-test was perfomed, the measurement begins and data is available for HART communication.

Fixed-current mode is reset by power loss.

12.3. Reset

Command-42 performs a Device Reset.
The procedure is executed immediately after the device has answered to the master as feedback. After the reset, the device follows the Power-Up procedure (see Section 12.2).

12.4. Self-Test

Command-41 performs a Self-Test.
This procedure immediately updates the error flags read through Command-48.
Error flags are also refreshed at each cycle of the main program.

To perform a complete test of the device, you must reset the device. In this case, the self-test procedure verifies the following parts:

- Microcontroller
- RAM
- Program ROM
- Memory Configuration
- ADC
- DAC

The full Self-Test takes about 5 seconds.
During this time, the analog output is set to 4.0mA and the HART communication is offline.

12.5. Command Response Times

	Times
Minimum	5 ms
Typical	10 ms
Maximum	50 ms

12.6. Busy and Delayed-Response

The transmitter may respond with "busy" status if a further command is received while self-test is underway.

Delayed-response is not used.

12.7. Long Messages

The largest data field used is in the response to *Command#20*:
34 bytes including the two status bytes.

12.8. Non-Volatile Memory

Non-Volatile Memory is used to hold the device's configuration parameters.
New data is written to this memory immediately on execution of a write command.

12.9. Modes

Fixed current mode is implemented, using *Command#40*.
This mode is cleared by power loss or reset.

12.10. Write Protection

Write-protection is provided with Device Specific *Command#128*.
This command takes effect only if the writing of WP flag is
enabled.
The parameter that allows the change is set via display in the specific menu.

Refer to the "PF75x Operating manual" for more details.

12.11. Damping

Damping is standard, affecting only the PV and the loop current signal.

ANNEX A. CAPABILITY CHECKLIST

Manufacturer, Model and Revision	Baumer Electric AG, MV121, rev. 0
Device Type	Transmitter
HART Revision	7.0
Device Description available	Yes
Number and Type of Sensors	1
Number and Type of Actuators	None
Number and Type of Host Side Signals	1: 4 - 20mA Analog
Number of Device Variables	8
Number of Dynamic Variables	4
Mappable Dynamic Variables?	No
Number of Common-Practice Commands	14
Number of Device-Specific Commands	9
Bits of Additional Device Status	8
Alternative Operating Modes?	No
Burst mode?	No
Write-protection?	Yes

ANNEX B. DEFAULT CONFIGURATION

Parameter	Default Value
Lower Range Value	0 - Depends on configuration
Upper Range Value	0 - Depends on configuration
PV Units	l/sec
Sensor Type	Check the coupled sensor
Number of Wires	3
Damping Time Constant	1 second
Fault-Indication Jumper	Not Used
Write-Protect Jumper	Not Used
Number of Response Preambles	5 to 20