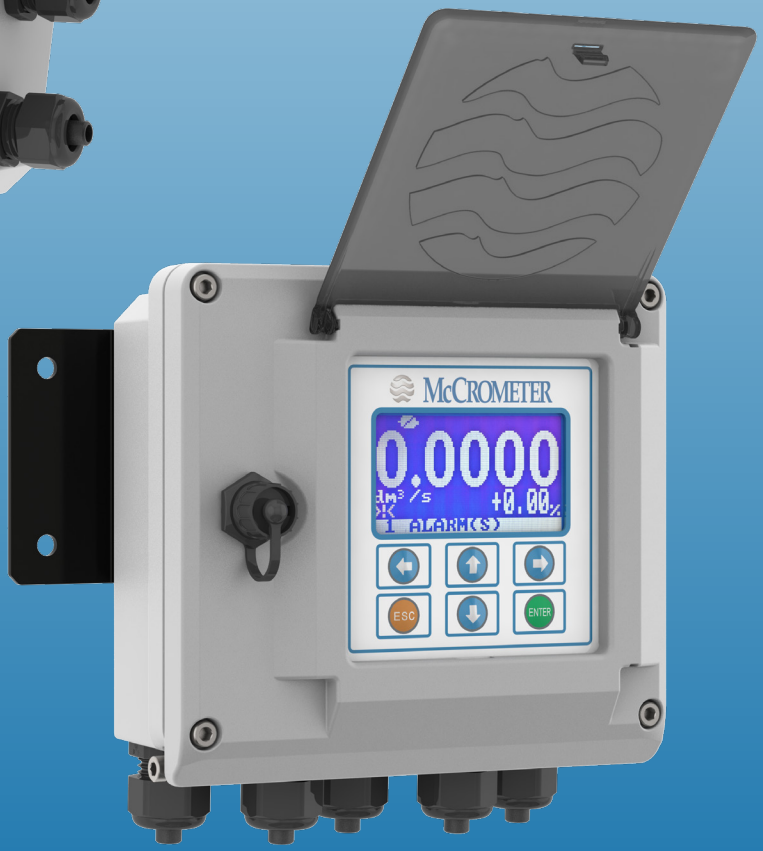
ProComm

Hart Protocol User Manual

For use with ProComm Converter

30125-48 Rev. 1.0
August 5, 2021



McCROMETER

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SAFETY

Safety Symbols

Throughout this manual are safety warning and caution information boxes. Each warning and caution box will be identified by a large symbol indicating the type of information contained in the box. The symbols are explained below:

Safety Warnings

This symbol indicates important safety information. Failure to follow the instructions can result in serious injury or death.

This symbol indicates important information. Failure to follow the instructions can result in permanent damage to the meter or installation site.

When installing, operating, and maintaining McCrometer equipment where hazards may be present, you must protect yourself by wearing Personal Protective Equipment (PPE) and be trained to enter confined spaces. Examples of confined spaces are manholes, pumping stations, pipelines, pits, septic tanks, sewage digesters, vaults, degreasers, storage tanks, boilers, and furnaces.

WARNING!
Incorrect installation or removal of FPI Mag meters can result in serious injury or death. Read the instructions in this manual on the proper procedures carefully.

WARNING!
Never enter a confined space without testing the air at the top, middle, and bottom of the space. The air may be toxic, oxygen deficient, or explosive. Do not trust your senses to determine if the air is safe. You cannot see or smell many toxic gases.

WARNING!
Never enter a confined space without the proper safety equipment. You may need a respirator, gas detector, tripod, lifeline, and other safety equipment.
WARNING!

Never enter a confined space without standby/rescue personnel within earshot. Standby/rescue personnel must know what action to take in case of an emergency.
WARNING!

Pressurized pipes should only be hot tapped, cut, or drilled by qualified personnel. If possible, depressurize and drain the pipe before attempting any installation.
WARNING!
Carefully read all safety warning tags attached to the meter.

At the end of its lifetime, this product shall be disposed of in full compliance with the environmental regulations of the state in which it is located.

1.0 Introduction

1.1 Scope

The ProComm converter 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 supplement the ProComm IOM 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

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

1.5 References

HART Smart Communications Protocol Specification, HCF_SPEC-12, available from HCF

Common Tables Specification, HCF_SPEC-183, available from HCF

30124-60, ProComm IOM Manual

1.6 Device Identification

The ProComm converter 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.

2.0 Product Overview

The ProComm converter is 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.

3.0 Product Interfaces

3.1 Host interface

Analog Output 1: Flow Rate

The two-wire 4-to-20mA current loop is connected on two terminals. Refer to the ProComm IOM manual for connection details. This output represents the process flow rate measurement, linearized and scaled, according to the configured range of the instrument, and it corresponds to the primary variable. HART Communication is supported on this loop.

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

3.2 Local Interfaces, Jumpers and Switches

3.2.1 Local Controls and Displays

Some Hart parameters can be set on the ProComm converter user interface. The HART parameters are:

Menu Position	Parameter	Description
8.1	**Hart Preamble**	Number of preamble
8.2	**Hart Bus Output Control**	Hart output control
8.3	**Hart Find Device Function**	Hart Find Device Function – When armed, will respond to Command#73. (ON = ARM, OFF = DISARM)
8.4	**Hart Write Protect**	Flag that allows write protect through command #128
8.5	**Device Address**	Device address for communication

See the ProComm IOM manual for specific converter function codes and MCP commands.

3.2.2 Internal Jumpers and Switches

No internal jumpers or switches are used for HART protocol.

4.0 Device Variables

The ProComm converter using the Hart protocol uses eight device variables.

Device Variable	Name	Classification	Description
0	Flow rate	Volumetric flow	This variable represents flow rate measurement. Flow rate is calculated using the velocity of the fluid (measured by the sensor) and the pipe section (set by the user).
1	Flow velocity	Velocity	This variable represents flow velocity. Flow velocity is detected directly by the sensor.
2	Board temperature 1	Temperature	This variable represents the primary board temperature. Temperature is detected directly by the primary temperature sensor placed on the main board.
3	Board temperature 2	Temperature	This variable represents the secondary board temperature. Temperature is detected directly by the secondary temperature sensor placed on the main board.
4	Direct flow totalizer	Volume/mass (as determined by device setting)	This variable represents the positive totalizer. The positive totalizer is the volume of the direct flow that has passed through the pipe. This is expressed by the units of measurement set by the user in the device configuration.
5	Inverse flow totalizer	Volume/mass (as determined by device setting)	This variable represents the negative totalizer. The negative totalizer is the volume of the inverse flow that has passed through the pipe. This is expressed by the units of measurement set by the user in the device configuration.
6	Partial direct flow totalizer	Volume/mass (as determined by device setting)	This variable represents the partial positive totalizer. The partial positive totalizer is the volume of the direct flow that has passed through the pipe. This is expressed by the units of measurement set by the user in the device configuration.
7	Partial inverse flow totalizer	Volume/mass (as determined by device setting)	This variable represents the partial negative totalizer. The partial negative totalizer is the volume of the inverse flow that has passed through the pipe. This is expressed by the units of measurement set by the user in the device configuration.

NOTE All Unit Codes for these variables can be found in Table 2.68/2.71, HCF_SPEC-183.

5.0 Dynamic Variables

This ProComm converter using the Hart protocol uses four dynamic variables. These variables are linked to 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

6.0 Status Information

6.1 Device Status

The converter sets a device status variable to indicate certain conditions.

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

6.2 Extended Device Status

This Field Device does not use the "Extended Device Status".

6.3 Additional Device Status (Command #48)

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

Bit	Meaning	Class	Device Status Bits Set
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 sets 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.

7.0 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

8.0 Common-Practice Commands

8.1 Supported Commands

The Field Device manages the following Common-Practice Commands:

Command	Details
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

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.

9.0 Device-Specific Commands

The converter manages the following device-specific commands:

Command	Details
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

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 write protect flag is enabled. The parameter that allows the change is set via display in the specific menu. Refer to ProComm IOM Manual for the converter function code and MCP command.

	Byte	Format	Description
Request Data Bytes	0	Enum	Set / reset write protection
Response Data Bytes	0	Enum	Write protect mode
Command-Specific Response Codes	0	Success	No command-specific errors
	1		Undefined
	2	Error	Invalid selection
	3 - 4		Undefined
	5	Error	Too few data bytes received

Command #129: Clear All Device Status

This command allows the user to clear all device status.

	Byte	Format	Description
Request Data Bytes	0	Enum	Set / reset write protection
Response Data Bytes	0	Enum	Write protect mode
Command-Specific Response Codes	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. It takes effect only if the selected totalizer is enable to be reset. Refer to ProComm IOM Manual for the converter function code and MCP command.

	Byte	Format	Description
Request Data Bytes	0	Enum	Totalizer ID to reset
Response Data Bytes	0	Enum	Totalizer ID reset
Command-Specific Response Codes	0	Success	No command-specific errors
	1		Undefined
	2	Error	Invalid selection
	3 - 4		Undefined
	5	Error	Too few data bytes received
	7	Error	Device In write protect mode

Command #131: Read Tube Diameter

This command returns the tube diameter in a fixed unit (mm).

	Byte	Format	Description
Request Data Bytes	0		
Response Data Bytes	0	Enum	Unit code (fixed)
	1 - 4	Float	Tube diameter
Command-Specific Response Codes	0	Success	No command-specific errors

Command #132: Read Coil Frequency

This command returns the coil frequency in a fixed unit (Hz).

	Byte	Format	Description
Request Data Bytes	0		
Response Data Bytes	0	Enum	Unit code (fixed)
	1 - 4	Float	Coil frequency
Command-Specific Response Codes	0	Success	No command-specific errors

Command #133: Read Low Flow Cut-Off

This command returns the low flow cut-off setting in fixed unit (%).

	Byte	Format	Description
Request Data Bytes	0		
Response Data Bytes	0	Enum	Unit code (fixed)
	1 - 4	Float	Coil frequency
Command-Specific Response Codes	0	Success	No command-specific errors

Command #134: Read Density			
This command returns the fluid density setting in fixed unit (Kg/l).			
	Byte	**Format**	**Description**
Request Data Bytes	0		
Response Data Bytes	0	Enum	Unit code (fixed)
	1 - 4	Float	Density
Command-Specific Response Codes	0	Success	No command-specific errors

Command #135: Read Flow Direction			
This command returns the flow direction.			
	Byte	**Format**	**Description**
Request Data Bytes	0		
Response Data Bytes	0	Enum	Flow direction
Command-Specific Response Codes	0	Success	No command-specific errors

Command #136: Read Mass Unit Enable			
This command returns the mass unit enable setting.			
	Byte	**Format**	**Description**
Request Data Bytes	0		
Response Data Bytes	0	Enum	Mass unit enable
Command-Specific Response Codes	0	Success	No command-specific errors

10.0 Tables

10.1 Write Protect

Value	Description
0	Not Write Protected
1	Write Protected

10.2 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)

10.3 Flow Direction

Value	Description
0	Flow Direction Positive
1	Flow Direction Negative

11.0 Performance

11.1 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

11.2 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.

11.3 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).

11.4 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.

11.5 Command Response Times

	Times
Minimum	5 ms
Typical	10 ms
Maximum	50 ms

11.6 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.

11.7 Long Messages

The largest data field used is in the response to Command#20:

34 bytes including the two status bytes.

11.8 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.

11.9 Modes

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

11.10 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 ProComm Converter IOM manual for more details.

11.11 Damping

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

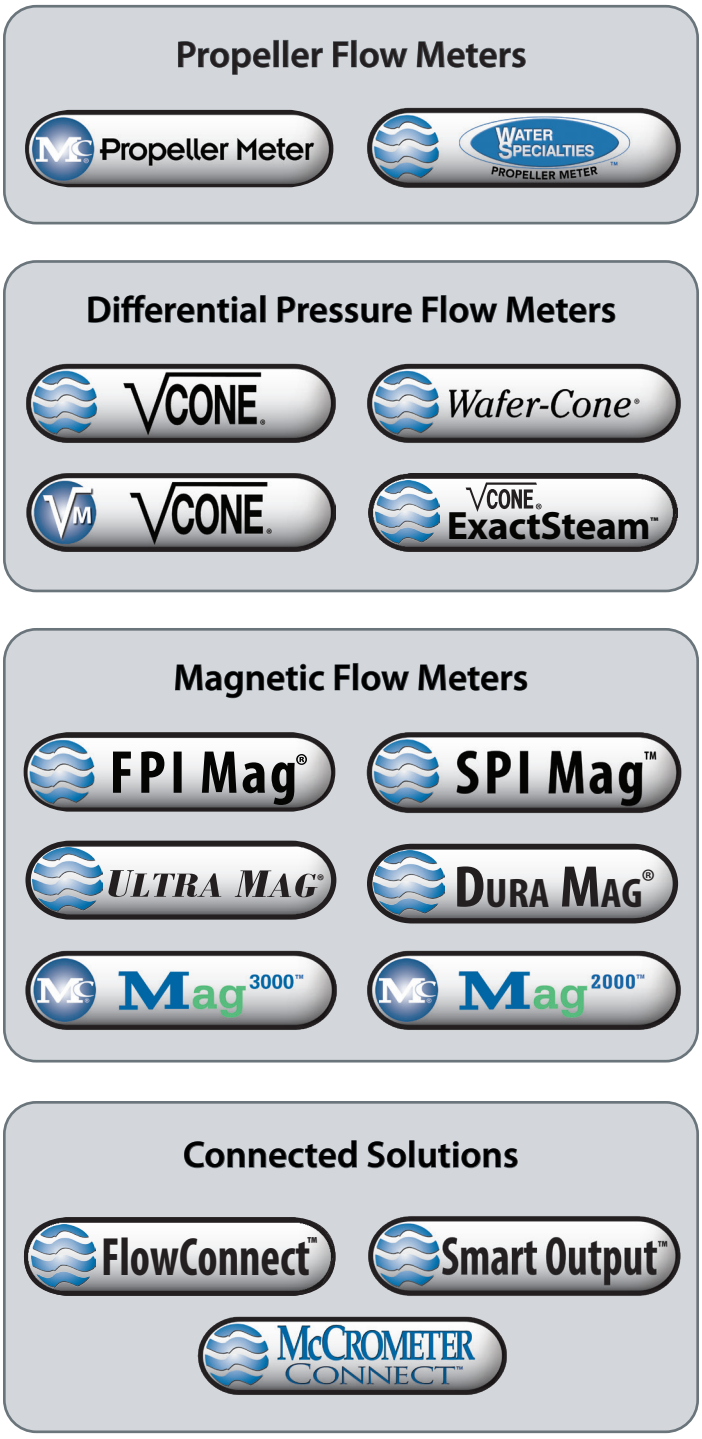
APPENDIX A - CAPABILITY CHECKLIST

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

APPENDIX 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

OTHER McCROMETER PRODUCTS INCLUDE:



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