HART® Field Device Specification

T72

Document LIT-18 T72, Rev 1.2

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1. Introduction

1.1. Scope

The temperature transmitter, T72 complies with HART protocol revision 7. 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 complement the operating instructions 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

FSK: Frequency Shift Keying
FCG: Field Comm Group
n.A.: Not Applicable
Index: Parameter Index, identifies a single parameter in the device. Please refer to chapter 11.1.

1.5. References

Operating manual T72

Available from the FCG:

HCF_SPEC-99, FCG TS20099, Revision 10.0	Command Summary Specification
HCF_SPEC-127, Revision 7.1	Universal Command Specification
HCF_SPEC-151, FCG TS20151, Revision 11.0	Common Practice Command Specification
HCF_SPEC-183, FCG TS20183, Revision 24.0	Common Tables Specification
HCF_LIT-18, Revision 11.0	Field Device Specification Guide

2. Device identification

Manufacturer Name:	Pyromation LLC
Model Name:	T72
Manufacturer ID Code:	181 (0x00B5)
Expanded Device Type Code:	46467 (0xB583)
HART Protocol Revision:	7.8
Device Revision:	1 (0x01)
Number of Device Variables:	2
Physical Layers Supported:	FSK
Physical Device Category:	Transmitter, non DC isolated Bus Device

The nameplate is located at the housing and indicates the model name and revision.
Devices for use in area with potentially explosive atmosphere have additional information on the nameplate and indicate the device certification number.

3. Product overview

The device is a two-wire loop-powered temperature transmitter, with a 4-to-20mA output. Its two sensor input channels support a wide range of RTD- and thermocouple- sensors.

4. Product interfaces

4.1. Process interface

4.1.1. Sensor input channels

The sensor input provides a single input for RTDs, Thermocouples, resistance and voltage measurement. Refer to the Installation Manual for connection details.

4.2. Host interface

4.2.1. Analog Output 1: Main Process Value

The two-wire 4-to-20mA current loop is connected on two terminals marked "+" and "-". Refer to the installation manual for connection details.
The output from this transmitter represents the measured value, 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.
Device malfunction can be indicated by down-scale or up-scale current. The direction is selectable by the user. Refer to the operating instruction.

4.3. Local interfaces, jumpers and switches

4.3.1. Local controls and displays

There are no local controls for configuration. An optional module offers display and write lock functionality via DIP-switch. For detailed information refer to the operating instructions.

4.3.2. Internal jumpers and switches

Not applicable.

5. Device variables

Overview about the DeviceVariables of the temperature transmitter.

5.1. Device Variable 0 “Sensor1”

Device variable name:	Sensor1
Device variable number:	0
Index:	14337 / 0x3801
Device variable classification:	Not classified
Device variable unit(s):	˚C, ˚F, K, mV, Ohm
Device variable lower limit:	depends on configuration (sensortype)
Device variable upper limit:	depends on configuration (sensortype)
Device family:	Not Used

5.2. Device Variable 1 “Device Temperature”

Device variable name:	Device Temperature
Device variable number:	1
Index:	14346 / 0x380A
Device variable classification:	Not classified
Device variable unit(s):	˚C, ˚F, K
Device variable lower limit:	-50˚C
Device variable upper limit:	87°C
Device family:	Not Used

6. Dynamic variables

All 4 dynamic variables (PV, SV, TV and QV) are implemented.

The Dynamic Variables are mapped to the Device Variables, like defined in following table.

Code	Device Variable:	Block	PV	SV	TV	QV
0	Sensor1	Sensor	☑	☐	☑	☑
1	DeviceTemperature	Sensor	☐	☑	☐	☐

7. Status information

7.1. Field Device Status

The Field Device Status is contained in the second data byte in a Slave-to-Master frame as a bit field table (refer to the FCG documentation - Command Summary Specification):

Bit Mask	Definition	Supported
0x80	Device Malfunction – The device detected a serious error or failure that compromises device operation.	Yes
0x40	Configuration changed – An operation was performed that changed the device's configuration.	Yes
0x20	Cold Start – A power failure or device reset has occurred.	Yes
0x10	More Status available – More status information is available via Command #48.	Yes
0x08	Loop current fixed – The loop current is being held at a fixed value and is not responding to process variations.	Yes
0x04	Loop current saturated – The loop current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.	Yes
0x02	Non-Primary Variable out of limits.	Yes
0x01	Primary variable out of limits.	Yes

7.2. Extended Device Status

The Extended Device Status contains the status bits Failure, Out of Specification, Function Check and Maintenance Required. These four bits summarize the overall status of the field device according to the Condensed Status requirements found in NAMUR NE107.

The "Device Variable Alert Bit" depends on all Device variable status:
If status of device variable 0 (sensor 1) or 1 (device temperature) is not Good (< 0xC0) the Device Variable Alert bit is set (Extended Device Status = 0x02)

Bit Mask	Definition		Supported
0x01	Maintenance Required	[Condensed Status]	Yes
0x02	Device Variable Alert		Yes
0x04	Critical Power Failure		No
0x08	Failure	[Condensed Status]	Yes
0x10	Out of Specification	[Condensed Status]	Yes
0x20	Function Check	[Condensed Status]	Yes

7.3. Additional Device Status and Standardized Status Bytes - command #48

This device does support “Condensed Status Commands”. The declared “Status Category” is the default value for each single bit.
The command #48 returns the following bytes:

Byte	Bit	Diagnostic Number	Text	Status Category
0	0	041	041-Sensor interrupted	Failure
	1	042	042-Sensor corroded	Maintenance
	2	043	043-Short circuit	Failure
	3	047	047-Sensor limit reached-Sensor 1	Out of specification
	4	047	047-Sensor limit reached-Device temperature	Out of specification
	5	047	047-Sensor limit reached-Sensor RJ	Out of specification
	6	145	145-Compensation refrence point-Sensor 1	Failure
	7	201	201-Electronics faulty	Failure
1	0	201	201-Electronics faulty-Sensor 1	Failure
	1	201	201-Electronics faulty-Device temperature	Failure
	2	201	201-Electronics faulty-Sensor RJ	Failure
	3	221	221-Reference sensor defective	Maintenance
	4	221	221-Reference sensor defective-Sensor RJ	Maintenance
	5	401	401-Factory reset active	Check
	6	402	402-Initialization active	Check
	7	402	402-Initialization active-Sensor 1	Check
2	0	402	402-Initialization active-Device temperature	Check
	1	402	402-Initialization active-Sensor RJ	Check
	2	410	410-Data transfer failed	Failure
	3	411	411-Up-/download active	Check
	4	435	435-Linearization faulty-Sensor 1	Failure
	5	435	435-Linearization faulty	Failure
	6	435	435-Linearization faulty-Sensor RJ	Failure
	7	485	485-Process variable simulation active-Sensor 1	Check
3	0	485	485-Process variable simulation active-Device temperature	Check
	1	491	491-Output simulation-Current output	Check
	2	495	495-Diagnostic event simulation active	Check
	3	531	531-Factory adjustment missing-Sensor 1	Failure
	4	531	531-Factory adjustment missing-Current output	Failure
	5	537	537-Configuration	Failure
	6	537	537-Configuration-Sensor 1	Failure
	7	537	537-Configuration-Current output	Failure
4	0	582	582-Sensor diagnostics TC deactivated	Check
	1	801	801-Supply voltage too low	Out of specification
	2	825	825-Operating temperature	Out of specification
	3	844	844-Process value out of specification	Out of specification
	4	-	NotUsed	Undefined
	5	-	NotUsed	Undefined
	6	-	NotUsed	Undefined
	7	-	NotUsed	Undefined

5	0	-	NotUsed	Undefined
	1	-	NotUsed	Undefined
	2	-	NotUsed	Undefined
	3	-	NotUsed	Undefined
	4	-	NotUsed	Undefined
	5	-	NotUsed	Undefined
	6	-	NotUsed	Undefined
	7	-	NotUsed	Undefined
6	0	-	MaintenanceRequired	No Effect
	1	-	DeviceVariableAlert	No Effect
	2	-	CriticalPowerFailure	Failure
	3	-	Failure	No Effect
	4	-	OutOfSpecification	No Effect
	5	-	FunctionCheck	No Effect
	6	-	NotUsed	Undefined
	7	-	NotUsed	Undefined
7	0	-	DeviceOperatingMode1	No Effect
	1	-	DeviceOperatingMode2	No Effect
	2	-	DeviceOperatingMode3	No Effect
	3	-	DeviceOperatingMode4	No Effect
	4	-	DeviceOperatingMode5	No Effect
	5	-	DeviceOperatingMode6	No Effect
	6	-	DeviceOperatingMode7	No Effect
	7	-	DeviceOperatingMode8	No Effect
8	0	-	DeviceVariableSimulationActive	Check
	1	-	NonVolatileMemoryDefect	Failure
	2	-	VolatileMemoryDefect	Failure
	3	-	WatchdogResetExecuted	Failure
	4	-	PowerSupplyConditionsOutOfRange	Out of specification
	5	-	EnvironmentalConditionsOutOfRange	Out of specification
	6	-	ElectronicDefect	Failure
	7	-	DeviceConfigurationLocked	No Effect
9	0	-	StatusSimulationActive_	No Effect
	1	-	DiscreteVariableSimulationActive	Check
	2	-	EventNotificationOverflow	No Effect
	3	-	BatteryOfPowerSupplyNeedsMaintenance	Maintenance
	4	-	NotUsed	Undefined
	5	-	NotUsed	Undefined
	6	-	NotUsed	Undefined
	7	-	NotUsed	Undefined
10	0	-	AnalogChannel1Saturated	Out of specification
	1	-	AnalogChannel2Saturated	Out of specification
	2	-	AnalogChannel3Saturated	Out of specification
	3	-	AnalogChannel4Saturated	Out of specification
	4	-	NotUsed	Undefined
	5	-	NotUsed	Undefined
	6	-	NotUsed	Undefined
	7	-	NotUsed	Undefined
11	0	-	SubDeviceListChanged	No Effect
	1	-	DuplicateMasterDetected	Maintenance
	2	-	SubDeviceMismatch	Maintenance
	3	-	SubDeviceWithDuplicateIdsFound	No Effect
	4	-	StateDataNotice	Out of specification

	5	**-**	**NotUsed**	**Undefined**
	6	**-**	**NotUsed**	**Undefined**
	7	**-**	**NotUsed**	**Undefined**
12	**0**	**-**	**CapacityDenied**	**Maintenance**
	1	**-**	**NotUsed**	**No Effect**
	2	**-**	**BandwidthAllocationPending**	**No Effect**
	3	**-**	**BlockTransferPending**	**No Effect**
	4	**-**	**RadioFailure**	**Failure**
	5	**-**	**NotUsed**	**Undefined**
	6	**-**	**NotUsed**	**Undefined**
	7	**-**	**NotUsed**	**Undefined**
13	**0**	**-**	**AnalogChannel1Fixed**	**Check**
	1	**-**	**AnalogChannel2Fixed**	**Check**
	2	**-**	**AnalogChannel3Fixed**	**Check**
	3	**-**	**AnalogChannel4Fixed**	**Check**
	4	**-**	**NotUsed**	**Undefined**
	5	**-**	**NotUsed**	**Undefined**
	6	**-**	**NotUsed**	**Undefined**
	7	**-**	**NotUsed**	**Undefined**

For more information about errors and the corresponding classes refer to the operating instructions.
For how to configure the alarms please refer to the operating instructions.
Bits not specified are “Not used” and always set to 0.

8. Universal commands

One way to configure the device is from a process control system by using the device description. If use of device description is not desired or not possible, the device can be handled by universal commands.
All universal commands are implemented.
Command #3 –"Read dynamic variables and P.V. current" returns PV, SV, TV and QV.
For information about HART framing refer to the FCG documentation.

9. Common practice commands

9.1. Supported commands

The following common practice commands are implemented:

33	Read Device Variable
34	Write P.V. damping value
35	Write P.V. range values
40	Enter/Exit fixed current mode
42	Perform device reset
44	Write P.V. Unit
45	Trim Loop Current Zero
46	Trim Loop Current Gain
50	Read Dynamic Variable Assignments
54	Read Device Variable Information
59	Write number of response preambles
72	Squawk
95	Read Device Communication Statistics
100	Write Primary Variable Alarm Code
516	Read Device Location
517	Write Device Location
518	Read Location Description
519	Write Location Description
520	Read Process Unit Tag
521	Write Process Unit Tag
523	Read Condensed Status Mapping Array
524	Write Condensed Status Mapping Array
525	Reset Condensed Status Mapping Array
526	Write Simulation Mode
527	Simulate Status Bit

9.2. Burst mode

The Burst Mode is not supported.

9.3. Catch device variable

Catch Device Variable is not implemented.

10. Device specific commands

10.1. Command #167 -ReadSimulation

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Unsigned-32	Diagnostics - Simulation	0x3022
4 - 5	Unsigned-16	Current output simulation - Mode	0x4012
6 - 9	Float	Current output simulation - Value	0x4013
10	Unsigned-8	Sensor simulation - Mode	0x1825
11 - 14	Float	Sensor simulation - Value	0x1820

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.2. Command #168 -ReadAdvancedDiagnostics

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Unsigned-32	Advanced diagnostics 1	0x3024
4 - 7	Unsigned-32	Advanced diagnostics 2	0x3025
8 - 11	Unsigned-32	Advanced diagnostics 3	0x3026

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.3. Command #170 - Read Parameter

Request Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Index (please refer to chapter 11.1 Parameter Indexfor details)

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Index (please refer to chapter 11.1 Parameter Index for details)
2-x	---	Parameter data

Command Specific Response Codes

Code	Class	Description

0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.4. Command #171 - Write Parameter

Request Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Index (please refer to chapter 11.1 Parameter Index for details)
2-x	---	Parameter data

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Index (please refer to chapter 11.1 Parameter Index for details)
2-x	---	Parameter data

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
3	Error	Value too large
4	Error	Value too small
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

10.5. Command #173 -ReadDisplayParameter

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Display interval	0x4801
1	Unsigned-8	Value 1 display	0x4814
2	Unsigned-8	Decimal places 1	0x4817
3	Unsigned-8	Value 2 display	0x481E
4	Unsigned-8	Decimal places 2	0x4821
5	Unsigned-8	Value 3 display	0x4828
6	Unsigned-8	Decimal places 3	0x482B
7	Unsigned-8	Format display	0x4802

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.6. Command #174 -ReadMasterSetup

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Unit	0x2801
1	Unsigned-8	UnitDifference	0x2803
2	Unsigned-8	Device temperature unit	0x2002
3	Unsigned-8	Connection type	0x180B
4	Unsigned-8	Sensor type	0x1804
5	Unsigned-8	Reference junction	0x180F
6	Unsigned-8	Primary Variable (PV) - Damping	0x3867
7 - 8	Unsigned-16	Device reset	0x002C
9	Unsigned-8	Alarm delay	0x3003

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.7. Command #175 -ReadActualDiagnostics

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 1	Unsigned-16	Actual diagnostics 1 - Category and Number	0x3028
2	Unsigned-8	Actual diagnostics 1 - Channel	0x3029
3 - 4	Unsigned-16	Actual diagnostics 2 - Category and Number	0x302A
5	Unsigned-8	Actual diagnostics 2 - Channel	0x302B
6 - 7	Unsigned-16	Actual diagnostics 3 - Category and Number	0x302C
8	Unsigned-8	Actual diagnostics 3 - Channel	0x302D

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.8. Command #176 -ReadLastDiagnostics

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 1	Unsigned-16	Previous diagnostics 1 - Category and Number	0x3046
2	Unsigned-8	Previous diagnostics 1 - Channel	0x3047
3 - 4	Unsigned-16	Previous diagnostics 2 - Category and Number	0x3048

5	Unsigned-8	Previous diagnostics 2 - Channel	0x3049
6 - 7	Unsigned-16	Previous diagnostics 3 - Category and Number	0x304A
8	Unsigned-8	Previous diagnostics 3 - Channel	0x304B
9 - 10	Unsigned-16	Previous diagnostics 4 - Category and Number	0x304C
11	Unsigned-8	Previous diagnostics 4 - Channel	0x304D
12 - 13	Unsigned-16	Previous diagnostics 5 - Category and Number	0x304E
14	Unsigned-8	Previous diagnostics 5 - Channel	0x304F
15 - 16	Unsigned-16	Previous diagnostics 6 - Category and Number	0x3050
17	Unsigned-8	Previous diagnostics 6 - Channel	0x3051
18 - 19	Unsigned-16	Previous diagnostics 7 - Category and Number	0x3052
20	Unsigned-8	Previous diagnostics 7 - Channel	0x3053
21 - 22	Unsigned-16	Previous diagnostics 8 - Category and Number	0x3054
23	Unsigned-8	Previous diagnostics 8 - Channel	0x3055
24 - 25	Unsigned-16	Previous diagnostics 9 - Category and Number	0x3056
26	Unsigned-8	Previous diagnostics 9 - Channel	0x3057
27 - 28	Unsigned-16	Previous diagnostics 10 - Category and Number	0x3058
29	Unsigned-8	Previous diagnostics 10 - Channel	0x3059

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.9. Command #177 -ReadHARTInfo

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	No. of preambles	0x1012
1	Unsigned-8	HART address	0x1014
2	Unsigned-8	Device revision	0x101B
3	Unsigned-8	HART revision	0x101C
4	Unsigned-8	Hardware revision	0x101D
5	Unsigned-8	Software revision	0x101E
6 - 9	Unsigned-32	Device ID	0x100D
10 - 11	Unsigned-16	Device type	0x1039

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.10. Command #178 -ReadActualDiagnosticsTimestamps

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index

0 - 3	Unsigned-32	Timestamp 1	0x3036
4 - 7	Unsigned-32	Timestamp 2	0x3037
8 - 11	Unsigned-32	Timestamp 3	0x3038

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.11. Command #179 -ReadDeviceIdentification2

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 15	Latin-1	Serial number	0x001B
16 - 47	Latin-1	Manufacturer	0x0017
48 - 55	Latin-1	Firmware version	0x0018
56 - 57	Unsigned-16	Manufacturer ID	0x0016

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.12. Command #180 -WriteDisplayParameter

Request Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Display interval	0x4801
1	Unsigned-8	Value 1 display	0x4814
2	Unsigned-8	Decimal places 1	0x4817
3	Unsigned-8	Value 2 display	0x481E
4	Unsigned-8	Decimal places 2	0x4821
5	Unsigned-8	Value 3 display	0x4828
6	Unsigned-8	Decimal places 3	0x482B
7	Unsigned-8	Format display	0x4802

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Display interval	0x4801
1	Unsigned-8	Value 1 display	0x4814
2	Unsigned-8	Decimal places 1	0x4817
3	Unsigned-8	Value 2 display	0x481E
4	Unsigned-8	Decimal places 2	0x4821
5	Unsigned-8	Value 3 display	0x4828
6	Unsigned-8	Decimal places 3	0x482B
7	Unsigned-8	Format display	0x4802

Command Specific Response Codes

Code	Class	Description
16	Error	AccessRestricted

7	Error	InWriteProtectMode
2	Error	InvalidSelection
3	Error	ValueTooLarge
4	Error	ValueTooSmall
6	Error	DeviceSpecificCommandError
32	Error	Busy
0	Success	NoCommandSpecificErrors

10.13. Command #181 -WriteSensorSettings

Request Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Call./v. Dusen coeff. A	0x1811
4 - 7	Float	Call./v. Dusen coeff. B	0x1812
8 - 11	Float	Call./v. Dusen coeff. C	0x1813
12 - 15	Float	Call./v. Dusen coeff. R0	0x1814
16 - 19	Float	RJ preset value	0x1810
20 - 23	Float	Polynomial coeff. A	0x1815
24 - 27	Float	Polynomial coeff. B	0x1816
28 - 31	Float	Polynomial coeff. R0	0x1818
32 - 35	Float	Sensor offset	0x180A
36 - 39	Float	2-wire compensation	0x180E

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Call./v. Dusen coeff. A	0x1811
4 - 7	Float	Call./v. Dusen coeff. B	0x1812
8 - 11	Float	Call./v. Dusen coeff. C	0x1813
12 - 15	Float	Call./v. Dusen coeff. R0	0x1814
16 - 19	Float	RJ preset value	0x1810
20 - 23	Float	Polynomial coeff. A	0x1815
24 - 27	Float	Polynomial coeff. B	0x1816
28 - 31	Float	Polynomial coeff. R0	0x1818
32 - 35	Float	Sensor offset	0x180A
36 - 39	Float	2-wire compensation	0x180E

Command Specific Response Codes

Code	Class	Description
16	Error	AccessRestricted
7	Error	InWriteProtectMode
2	Error	InvalidSelection
3	Error	ValueTooLarge
4	Error	ValueTooSmall
6	Error	DeviceSpecificCommandError
32	Error	Busy
0	Success	NoCommandSpecificErrors

10.14. Command #182 -ReadDeviceIdentification1

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 15	Latin-1	Device name	0x0014
16 - 35	Latin-1	Order code	0x001E
36 - 51	Latin-1	Hardware revision	0x0048

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.15. Command #183 -WriteLocationInformation

Request Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Altitude	0x7822
4 - 7	Float	Latitude	0x7821
8	Unsigned-8	Location method	0x7823
9 - 12	Float	Longitude	0x7820

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Altitude	0x7822
4 - 7	Float	Latitude	0x7821
8	Unsigned-8	Location method	0x7823
9 - 12	Float	Longitude	0x7820

Command Specific Response Codes

Code	Class	Description
16	Error	AccessRestricted
7	Error	InWriteProtectMode
2	Error	InvalidSelection
3	Error	ValueTooLarge
4	Error	ValueTooSmall
6	Error	DeviceSpecificCommandError
32	Error	Busy
0	Success	NoCommandSpecificErrors

10.16. Command #184 -ReadDynamicValues

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Output current	0x4007
4 - 7	Float	Current output - Percent of range	0x4027
8 - 11	Float	Sensor value	0x1801
12 - 15	Float	Sensor raw value	0x1802
16 - 19	Float	Device temperature	0x2000
20 - 23	Float	Primary Variable (PV) - Value	0x3863
24 - 27	Float	Secondary Variable (SV) - Value	0x3864
28 - 31	Float	Tertiary Variable (TV) - Value	0x3865
32 - 35	Float	Quatenary Variable (QV) - Value	0x3866

36 - 39	Unsigned-32	Operating time	0x3004
40 - 41	Unsigned-16	Active user level	0x0026
42 - 43	Bits	Locking status	0x0029

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.17. Command #185 -ReadCurrentOutputSettings

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Failure mode	0x402A
1 - 4	Float	Failure current	0x4028
5 - 8	Float	Current output - Lower range value	0x401A
9 - 12	Float	Current output - Upper range value	0x401B
13 - 16	Float	Minimum span	0x4032
17 - 20	Float	Current trimming 20 mA	0x4014
21 - 24	Float	Current trimming 4 mA	0x4015

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.18. Command #186 -ReadMinMaxValues

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Sensor min value	0x1809
4 - 7	Float	Sensor max value	0x1808
8 - 11	Float	Device temperature min	0x200B
12 - 15	Float	Device temperature max	0x200A

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.19. Command #187 -ReadHARTVariables

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Assign Primary Variable (PV)	0x385F
1	Unsigned-8	Assign Secondary Variable (SV)	0x3860
2	Unsigned-8	Assign Tertiary Variable (TV)	0x3861
3	Unsigned-8	Assign Quatenary Variable (QV)	0x3862

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.20. Command #188 -ReadLastDiagnosticsTimestamps

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Unsigned-32	Timestamp 1	0x303C
4 - 7	Unsigned-32	Timestamp 2	0x303D
8 - 11	Unsigned-32	Timestamp 3	0x303E
12 - 15	Unsigned-32	Timestamp 4	0x303F
16 - 19	Unsigned-32	Timestamp 5	0x3040
20 - 23	Unsigned-32	Timestamp 6	0x3041
24 - 27	Unsigned-32	Timestamp 7	0x3042
28 - 31	Unsigned-32	Timestamp 8	0x3043
32 - 35	Unsigned-32	Timestamp 9	0x3044
36 - 39	Unsigned-32	Timestamp 10	0x3045

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.21. Command #190 -ReadSensorSettings

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	2-wire compensation	0x180E
4 - 7	Float	Sensor offset	0x180A
8 - 11	Float	RJ preset value	0x1810
12 - 15	Float	Sensor lower limit	0x1807
16 - 19	Float	Sensor upper limit	0x1806

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.22. Command #193 -ReadCVDPolynomSettingsSensor1

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 3	Float	Call./v. Dusen coeff. A	0x1811
4 - 7	Float	Call./v. Dusen coeff. B	0x1812
8 - 11	Float	Call./v. Dusen coeff. C	0x1813
12 - 15	Float	Call./v. Dusen coeff. R0	0x1814
16 - 19	Float	Polynomial coeff. A	0x1815
20 - 23	Float	Polynomial coeff. B	0x1816
24 - 27	Float	Polynomial coeff. R0	0x1818

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.23. Command #194 -ReadLocationInformation

Request Data Bytes

Byte	Format	Description	Parameter Index
None			

Response Data Bytes

Byte	Format	Description	Parameter Index
0 - 31	Latin-1	Process Unit Tag	0x781E
32	Unsigned-8	Location method	0x7823
33 - 36	Float	Altitude	0x7822
37 - 40	Float	Longitude	0x7820
41 - 44	Float	Latitude	0x7821

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

10.24. Command #196 - Read Condensed Status Mapping Array

This command is identical to the common practice command #523.
For detailed description see HCF_SPEC-151.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Starting status map index.
1	Unsigned-8	Number of entries to read (“n”)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Actual starting status map index

1	Unsigned-8	Number of entries actually returned (“n”)
2.0-2.3	Enum-4	1st status map code (i.e., status_map_array [actual_starting_index +0])
2.4-2.7	Enum-4	2nd status map code
3.0-3.3	Enum-4	3rd status map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) status map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth status map code

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError
8	Warning	Set to nearest possible value

10.25. Command #197 - Write Condensed Status Mapping Array

This command is identical to the common practice command #524.
For detailed description see HCF_SPEC-151.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Starting status map index
1	Unsigned-8	Number of entries to write (“n”)
2.0-2.3	Enum-4	1st status map code (i.e., status_map_array [actual_starting_index +0])
2.4-2.7	Enum-4	2nd status map code
3.0-3.3	Enum-4	3rd status map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) status map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth status map code (i.e., status_map_array [starting_index +(n -1)])

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Actual starting status map index
1	Unsigned-8	Number of entries actually returned (“n”)
2.0-2.3	Enum-4	1st status map code
2.4-2.7	Enum-4	2nd status map code
3.0-3.3	Enum-4	3rd status map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) status map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth status map code

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError
7	Error	In write protect mode
8	Warning	Set to nearest possible value
16	Error	Access restricted
32	Error	Busy

10.26. Command #198 - Read Diagnostic Behaviour Mapping Array

This command is similar to the common practice command #523 but its object is the diagnostic behaviour mapping array.
Each diagnostic behaviour map code in the array is associated with one of the bits returned in field device status or in command #48 response. This command reads the currently configured mapping. Two diagnostic behaviour map codes are packed into one byte with the least significant nibble corresponding to the smaller of the two indices into the status map array.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Starting diagnostic behaviour map index.
1	Unsigned-8	Number of entries to read (“n”)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Actual starting diagnostic behaviour map index
1	Unsigned-8	Number of entries actually returned (“n”)
2.0-2.3	Enum-4	1st diagnostic behaviour map code
2.4-2.7	Enum-4	2nd diagnostic behaviour map code
3.0-3.3	Enum-4	3rd diagnostic behaviour map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) diagnostic behaviour map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth diagnostic behaviour map code

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError
8	Warning	Set to nearest possible value

10.27. Command #199 - Write Diagnostic Behaviour Mapping Array

This command is similar to the common practice command #524 but its object is the diagnostic behaviour mapping array.
Each diagnostic behaviour map code in the array is associated with one of the bits returned in field device status or in command #48 response. This command modifies the specified diagnostic behaviour mapping. The modified mapping takes effect immediately upon field device execution of this command and may result in immediate changes in device behaviour.

Two diagnostic behaviour map codes are packed into one byte with the least significant nibble corresponding to the smaller of the two indices into the status map array.

"Diagnostic Behaviour Map Index" or "Number of entries to write" may be modified and "Set to Nearest Value" response code returned. This command must always write at least two diagnostic behaviour maps (i.e., Number of Entries to write shall be at least 2 with diagnostic behaiour map index adjusted as needed).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Starting diagnostic behaviour map index
1	Unsigned-8	Number of entries to write (“n”)
2.0-2.3	Enum-4	1st diagnostic behaviour map code
2.4-2.7	Enum-4	2nd diagnostic behaviour map code
3.0-3.3	Enum-4	3rd diagnostic behaviour map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) diagnostic behaviour map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth diagnostic behaviour map code

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Actual starting diagnostic behaviour map index
1	Unsigned-8	Number of entries actually returned (“n”)
2.0-2.3	Enum-4	1st diagnostic behaviour map code
2.4-2.7	Enum-4	2nd diagnostic behaviour map code
3.0-3.3	Enum-4	3rd diagnostic behaviour map code
…		
(2+(n-2)/2).0 (2+(n-2)/2).3	Enum-4	(n-1) diagnostic behaviour map code
(2+(n-2)/2).4 (2+(n-2)/2).7	Enum-4	nth diagnostic behaviour map code

Command Specific Response Codes

Code	Class	Description

0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError
7	Error	In write protect mode
8	Warning	Set to nearest possible value
16	Error	Access restricted
32	Error	Busy

10.28. Command #226 - Read Firmware Version

Read the firmware version of the device or its sub modules e.g. 01.02.04-ABCDEFG.
Unused characters are filled with spaces (0x20), no zero termination.
If the requested module index>0 does not exist, response code 2 (invalid selection) has to be returned.
Module index =0 must not return response code 2 (invalid selection).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Module Index (=0)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Module Index (=0)	---
1-16	Latin-1	Firmware version string	0x0018

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.29. Command #227 - Read Serial Number

Read the serial number of the device or its sub modules e.g. 5A00010GABC.
Unused characters are filled with spaces (0x20), no zero termination.
If the requested module index>0 does not exist, response code 2 (invalid selection) has to be returned.
Module index =0 must not return response code 2 (invalid selection).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Module Index (=0)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Module Index (=0)	---
1-16	Latin-1	Serial number string	0x001B

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.30. Command #228 - Read Extended Order Code

Read the extended order code of the device.
Unused characters are filled with spaces (0x20), no zero termination.

If the requested index is >2, response code 2 (invalid selection) has to be returned.
A request with index=0 will return the first 20 characters.
A request with index=1 will return the following 20 characters, and so on.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Index (0,1,2)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Index (0,1,2)	---
1-24	Latin-1	Extended Order code string	0x0032 - 0x0034

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.31. Command #231 - Check Device Status

Read the device status of the device or its sub modules.
The returned bit field meets the requirements of the NE107.

0x01 = **F**ailure detected
0x02 = Function **C**heck
0x04 = **M**aintenance required
0x08 = Out of **S**pecification

The “Present highest priority diagnosis number” is 0 if no error is present.

If the requested module index>0 does not exist, response code 2 (invalid selection) has to be returned.
Module index =0 must not return response code 2 (invalid selection).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Module Index (=0)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Module Index (=0)	---
1	Bits	Standard 150 device status	0x3028 (Bits 12..15)
2..3	Unsigned-16	Present highest priority diagnosis number	0x3028 (Bits 0..11)

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.32. Command #233 - Read Order Code

Read the order code of the device or its sub modules.
Unused characters are filled with spaces (0x20), no zero termination.
If the requested module index>0 does not exist, response code 2 (invalid selection) has to be returned.
Module index =0 must not return response code 2 (invalid selection).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Module Index (=0)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Module Index (=0)	---
1..20	Latin-1	Order code string	0x001E

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.33. Command #234 - Read ENP Version

Read the ENP-(Electronic Name Plate) version of the device or its sub modules e.g. 01.02.04-ABCDEFG.
Unused characters are filled with spaces (0x20), no zero termination.
If the requested module index>0 does not exist, response code 2 (invalid selection) has to be returned.
Module index =0 must not return response code 2 (invalid selection).

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Module Index (=0)

Response Data Bytes

Byte	Format	Description	Parameter Index
0	Unsigned-8	Module Index (=0)	---
1..16	Latin-1	ENP version string	0x0020

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors

2	Error	Invalid selection
5	Error	Too few data bytes received
6	Error	DeviceSpecificCommandError

10.34. Command #236 - Read Start Up Behaviour

Read the start-up and operation behavior of the field device.

The behavior of the field device can be affected by environmental conditions, different parameterization or run modes. The values provided by this command shall ensure a proper start-up and operation of the field device under all circumstances with the least power consumption.

Request Data Bytes

Byte	Format	Description
None		

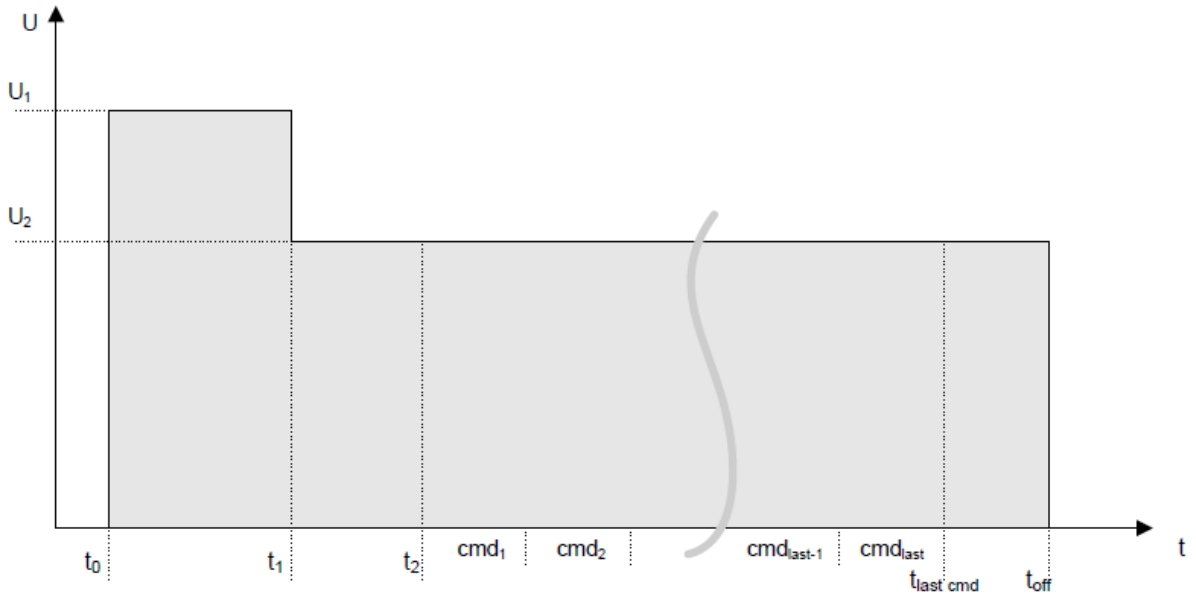
Response Data Bytes

Byte	Format	Description
0..3	Float	Minimal start-up voltage [V] (10 V)
4..7	Float	Maximal start-up current [mA] (3.58 mA)
8..9	Unsigned-16	Start-up time [s] (2 s)
10..13	Float	Minimal operating voltage [V] (10 V)
14..17	Float	Multidrop current [mA] (4.0 mA)
18..19	Unsigned-16	Maximal lead time [s] (5 s)

Command Specific Response Codes

Code	Class	Description
0	Success	No command specific errors
6	Error	DeviceSpecificCommandError

Powering the Field Device via Battery Powered Adapters
Power On/Off of the connected field device must follow a specific procedure to reduce power consumption of the SWA70 (Solution WirelessHART® Adapter) and also to ensure safe operation of the SWA70. The following diagram illustrates the power on/off sequence of the device. It shows the *voltages* which should be supplied to the field device, not the generated voltages.



U_1	**Minimal start-up voltage:** Minimal start-up voltage means minimal voltage under worst conditions (e.g. least current) for fail safe operation. valid range: 8..22V, resolution: 0.1V, related to start-up time and maximal start-up current.
U_2	**Minimal operating voltage:** valid range: 8..22V, resolution: 0.1V
$t_1 - t_0$	**Start-up time:** Time elapsed during which **minimal start-up voltage U_1** and **maximal start-up current** are provided to the field device. Normal operation with HART® communication is possible afterwards. valid range: 0..1800s, resolution: 1s Note: values for t_1 smaller than 1s are silently extended to 1s for short circuit detection
$t_2 - t_1$	**Maximal Lead time:** Time elapsed from the point of time when **minimal operating voltage U_2** is provided to the field device until the point of time when the device is ready to provide a valid measurement. valid range: 0..1800s, resolution: 1s
	Maximal start-up current: Maximal current drawn by the field device during start-up time. Value is used to calculate the internal step-up voltage to deliver the correct minimal start-up voltage. Valid range: 3..50mA, resolution: 0.1mA
	Multidrop current Value is not used by the LWA. Valid range: 3..50mA, resolution: 0.1mA

10.35. Detailed Parameter Type Description

Format	No. Of bytes	Type
Bits	1...N	Each individual bit in the byte has a specific meaning. Bit 0 is the least significant bit.
Unsigned-8	1	An Unsigned integer of 8-bit
Unsigned-16	2	An Unsigned integer of 16-bit
Unsigned-24	3	An Unsigned integer of 24-bit (only used for device id, sensor serial number, final assembly number)
Unsigned-32	4	An Unsigned integer of 32-bit
Float	4	An IEEE754 single precision floating point number
Latin-1	1 . . . N	A string using the 8-bit Latin-1 character set
Packed ASCII	1 . . . N	A string consiting of 6-bit alpha-numeric characters that are subset of the ASCII character set
Date	3	The date consists of three 8-bit unsigned integers representing respectively, the day, the month, and year minus 1900.
Time	4	Time consists of a unsigned 32-bit binary integer with the least significant bit representing 1/32 of a millisecond (i.e. 0.03125 ms)
Bytearray-nn	1...nn	Array of bytes consisting of “nn” Bits (only multiple of 8 allowed) – interpretation of datatype of this bytes is not specified!

MSB is sent first for all types of variables.

11. Tables

11.1. Parameter Index

HART index	Parameter name	Datatype	Acc.	Values/ Default
Standard				
0x0014	ENPDeviceName	STRING16	R	T72
0x0016	ManufacturerID	UINT16	R	181
0x0017	ManufacturerName	STRING32	R	Pyromation LLC
0x0018	ENPDeviceFirmwareRevision	STRING8	R	01.01
0x001B	ENPDeviceSerialNumber	STRING16	R	- none -
0x001E	ENPDeviceOrderIdent	STRING20	R	
0x001F	ENPDeviceTag	STRING32	R	HART TemperatureTransmitter T72
0x0024	LanguagesSupported	BIT_ENUM32	R	1 = EnglishSupported 2 = GermanSupported
0x0026	Active user level	ENUM16	R	33014 = Operator **32959 = Maintenance** 2128 = ProductionLabel 32807 = Production 32791 = Development
0x0029	LockingState	BIT_ENUM16	R	256 = HardwareLocked
0x002C	ResetLevel	ENUM16	R	**32989 = None** 33125 = Warmstart 33052 = ToDeliveryState 33053 = ToFactoryStandard
0x0032	Extended order code 1	STRING20	R	
0x0033	ENPDeviceOrderCodeAPS2	STRING20	R	
0x0034	ENPDeviceOrderCodeAPS3	STRING20	R	
0x0048	HardwareVersion	STRING16	R	01.01.00
0x008C	PasswordEnter	PASSWORD	RW	
0x008D	PasswordFeedback	ENUM16	R	**33296 = Idle** 3277 = WrongPassword 3278 = RuleViolated 3279 = Accepted 3280 = ResetNotPossible 3462 = PasswortMismatch 3282 = ResetAccepted 3487 = InvalidUser 3514 = WrongOrderOfEntry
0x0093	PasswordEnterRecovery	PASSWORD	RW	
ModuleInfo				
0x0814	ModuleHardwareRevision	STRING16	R	01.01.00
0x0815	ModuleHardwareID	STRING16	R	01.01.00
0x0817	ModuleName	STRING16	R	T72
0x0818	ModuleSerialNumber	STRING16	R	- none -
HARTOutput				
0x100B	DateCode	STRING10	R	2010-01-01

0x100C	Descriptor	P_STRING12	R	????????????????
0x100D	DeviceID	UINT32	R	123456
0x1011	Message	P_STRING24	R	????????????????????????????????
0x1012	MinNrPreambleResp	UINT8	R	5
0x1014	PollingAddress	UINT8	R	0
0x1016	ConfigChanged	BIT_ENUM8	R	1 = ByPrimMaster 2 = BySecondaryMaster
0x101B	RevDevice	UINT8	R	1
0x101C	RevHART	UINT8	R	7
0x101D	RevisionHW	UINT8	R	1
0x101E	RevSW	UINT8	R	1
0x1022	Tag	P_STRING6	R	????????
0x1039	ExpandedDeviceType	UINT16	R	46467
SensorTransducer1				
0x1801	SensorValue	FLOAT	R	NaN
0x1802	SensorRawValue	FLOAT	R	NaN
0x1804	SensorType	ENUM8	R	**12 = Pt100_IEC751_ID01** 13 = Pt200_IEC751_ID02 14 = Pt500_IEC751_ID03 15 = Pt1000_IEC751_ID04 22 = Pt100_JIS_ID05 72 = Ni100_DIN_ID06 73 = Ni120_DIN_ID07 248 = Ni100_OIML_GOST_ID12 249 = Ni120_OIML_GOST_ID13 246 = TcA_ID30 131 = TcB_ID31 132 = TcC_ID32 133 = TcD_ID33 134 = TcE_ID34 136 = TcJ_ID35 137 = TcK_ID36 138 = TcN_ID37 139 = TcR_ID38 140 = TcS_ID39 141 = TcT_ID40 142 = TcL_ID41 148 = TcL_GOST_ID43 143 = TcU_ID42 241 = Pt50_GOST_ID08 242 = Pt100_GOST_ID09 243 = Cu50_GOST_ID10 105 = Cu100_GOST_ID11 244 = Cu50_OIML_ID10 245 = Cu50_OIML_GOST_ID14 3 = CallendarVanDusen 240 = NiPolynom 247 = CuPolynom 1 = x400_OhmRange 2 = x2000_OhmRange
0x1806	SensorUpperLimit	FLOAT	R	850.0
0x1807	SensorLowerLimit	FLOAT	R	-200.0
0x1808	SensorMaxIndicator	FLOAT	R	-1.0e+20
0x1809	SensorMinIndicator	FLOAT	R	1.0e+20
0x180A	SensorOffset	FLOAT	R	0

0x180B	SensorConnection	ENUM8	R	2 = TwoWire 3 = ThreeWire **4 = FourWire**
0x180E	WireCompensation	FLOAT	R	0
0x180F	RjType	ENUM8	R	**1 = InternalMeasurement** 3 = RJFixedValue 5 = RJExtMeasurement
0x1810	FixedRjValue	FLOAT	R	0.0
0x1811	CalVandusenA	FLOAT	R	3.9083E-03
0x1812	CalVandusenB	FLOAT	R	-5.775E-07
0x1813	CalVandusenC	FLOAT	R	-4.183E-12
0x1814	CalVandusenR0	FLOAT	R	100
0x1815	PolyNickelCopperA	FLOAT	R	5.4963E-03
0x1816	PolyNickelCopperB	FLOAT	R	6.75560E-06
0x1818	PolyNickelCopperR0	FLOAT	R	100
0x1820	Sensor simulation - Value	FLOAT	R	0.0
0x1825	Sensor simulation - Mode	ENUM8	R	**0 = Off** 1 = On
0x1851	CorrosionWireResThreshold	FLOAT	R	50
0x1852	CorrosionWireResistance	FLOAT	R	NaN
ModuleInfoBTuC				
DevTempTransducer				
0x2000	Value	FLOAT	R	NaN
0x2002	Unit	ENUM8	R	**32 = Celsius** 33 = Fahrenheit 35 = Kelvin
0x200A	MaxIndicator	FLOAT	R	-1.0e+20
0x200B	MinIndicator	FLOAT	R	1.0e+20
MeasurementSettings				
0x2801	Unit	ENUM8	R	**32 = Celsius** 33 = Fahrenheit 35 = Kelvin 37 = Ohm 36 = milliVolt
0x2802	MainsFilter	ENUM8	R	**0 = x50Hz** 1 = x60Hz
0x2803	UnitDifference	ENUM8	R	**32 = DifferenceCelsius** 35 = DifferenceKelvin 33 = DifferenceFahrenheit 36 = DifferenceMilliVolt 37 = DifferenceOhm
0x2814	TCDiagnostics	ENUM16	R	On (33006)
DeviceSettings				
0x3001	StaticRevision	UINT16	R	0
0x3003	AlarmDelay	UINT8	R	2
0x3004	OperatingTime	UINT32	R	0

0x3022	Diagnostics - Simulation	ENUM32	R	201 = x201_ElectronicError 801 = x801_SupplyVoltage 65737 = x201_ElectronicErrorSensor1 196809 = x201_ElectronicErrorDeviceTemperature 917705 = x201_ElectronicErrorRJ 66067 = x531_FactoryCalibrationSensor1 721427 = x531_FactoryCalibration 721740 = x844_ProcessLimitOvershoot 825 = x825_AmbientTemperature 410 = x410_LastParaDownloadNotSuccessful 537 = x537_Configuration 66073 = x537_ConfigurationSensor1 721433 = x537_ConfigurationCurrentOutput 65971 = x435_LinearizationSensor1 197043 = x435_LinearizationDeviceTemperature 917939 = x435_LinearizationRJSensor 196829 = x221_ElectronicReference 917725 = x221_ElectronicReferenceRJSensor 65577 = x041_Sensor1BrokenTemperature 65579 = x043_ShortCircuit 65578 = x042_SensorCorroded 65681 = x145_CompensationReferenceSensor1 65583 = x047_SensorLimitLowSensor1 196655 = x047_SensorLimitLowDeviceTemperature 917551 = x047_SensorLimitLowRJSensor 411 = x411_UpDownloadC 401 = x401_FactoryReset 402 = x402_ConfigurationInitialization
0x3024	ActualDiagnostics1NE107	ENUM32	R	DeviceOK (0)
0x3025	ActualDiagnostics2NE107	ENUM32	R	DeviceOK (0)
0x3026	ActualDiagnostics3NE107	ENUM32	R	DeviceOK (0)
0x3027	ActualDiag1StatusSignal	ENUM8	R	**0 = EventNone** 3 = EventFailure 5 = EventCheck 4 = EventOutOfSpecification 1 = EventMaintenance 16 = EventOffline
0x3028	Actual diagnostics 1 - Category and Number	ENUM16	R	DeviceOK (0)
0x3029	Actual diagnostics 1 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x302A	Actual diagnostics 2 - Category and Number	ENUM16	R	DeviceOK (0)
0x302B	Actual diagnostics 2 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x302C	Actual diagnostics 3 - Category and Number	ENUM16	R	DeviceOK (0)
0x302D	Actual diagnostics 3 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3036	ActualDiagTimestamp01	UINT32	R	0
0x3037	ActualDiagTimestamp02	UINT32	R	0

0x3038	ActualDiagTimestamp03	UINT32	R	0
0x303C	LastDiagTimestamp01	UINT32	R	0
0x303D	LastDiagTimestamp02	UINT32	R	0
0x303E	LastDiagTimestamp03	UINT32	R	0
0x303F	LastDiagTimestamp04	UINT32	R	0
0x3040	LastDiagTimestamp05	UINT32	R	0
0x3041	LastDiagTimestamp06	UINT32	R	0
0x3042	LastDiagTimestamp07	UINT32	R	0
0x3043	LastDiagTimestamp08	UINT32	R	0
0x3044	LastDiagTimestamp09	UINT32	R	0
0x3045	LastDiagTimestamp10	UINT32	R	0
0x3046	Previous diagnostics 1 - Category and Number	ENUM16	R	DeviceOK (0)
0x3047	Previous diagnostics 1 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3048	Previous diagnostics 2 - Category and Number	ENUM16	R	DeviceOK (0)
0x3049	Previous diagnostics 2 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x304A	Previous diagnostics 3 - Category and Number	ENUM16	R	DeviceOK (0)
0x304B	Previous diagnostics 3 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x304C	Previous diagnostics 4 - Category and Number	ENUM16	R	DeviceOK (0)
0x304D	Previous diagnostics 4 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x304E	Previous diagnostics 5 - Category and Number	ENUM16	R	DeviceOK (0)
0x304F	Previous diagnostics 5 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3050	Previous diagnostics 6 - Category and Number	ENUM16	R	DeviceOK (0)
0x3051	Previous diagnostics 6 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ

0x3052	Previous diagnostics 7 - Category and Number	ENUM16	R	DeviceOK (0)
0x3053	Previous diagnostics 7 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3054	Previous diagnostics 8 - Category and Number	ENUM16	R	DeviceOK (0)
0x3055	Previous diagnostics 8 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3056	Previous diagnostics 9 - Category and Number	ENUM16	R	DeviceOK (0)
0x3057	Previous diagnostics 9 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
0x3058	Previous diagnostics 10 - Category and Number	ENUM16	R	DeviceOK (0)
0x3059	Previous diagnostics 10 - Channel	ENUM8	R	**0 = DiagChannelNone** 1 = DiagChannelSensor1 3 = DiagChannelDeviceTemperature 11 = DiagChannelCurrentOutput 14 = DiagChannelSensorRJ
CurrentOutput				
0x4007	OutValue	FLOAT	R	3.58
0x4012	Current output simulation - Mode	ENUM16	R	**33004 = Off** 33006 = On
0x4013	Current output simulation - Value	FLOAT	R	3.58
0x4014	TrimValueHi	FLOAT	R	20
0x4015	TrimValueLo	FLOAT	R	4
0x401A	Current output - Lower range value	FLOAT	R	0.0
0x401B	Current output - Upper range value	FLOAT	R	100
0x4027	Current output - Percent of range	FLOAT	R	NaN
0x4028	HiAlarmOutCurrent	FLOAT	R	22.5
0x402A	FailureMode	ENUM8	R	2 = LHHigh **0 = LHLow**
0x4032	MinSpan	FLOAT	R	10.0
DeviceVariables				
0x3801	Var0_Value	FLOAT	R	NaN

0x3802	Var0_Status	ENUM8	R	0 = BadNotLimited 16 = BadLowLimited 32 = BadHighLimited **48 = BadConstant** 64 = UncertainNotLimited 80 = UncertainLowLimited 96 = UncertainHighLimited 112 = UncertainConstant 128 = ManualFixedNotLimited 144 = ManualFixedLowLimited 160 = ManualFixedHighLimited 176 = ManualFixedConstant 192 = GoodNotLimited 208 = GoodLowLimited 224 = GoodHighLimited
0x3805	Var0_UpperLimit	FLOAT	R	850.0
0x3806	Var0_LowerLimit	FLOAT	R	-200.0
0x3807	Var0_MinSpan	FLOAT	R	10.0
0x380A	Var1_Value	FLOAT	R	NaN
0x380B	Var1_Status	ENUM8	R	0 = BadNotLimited 16 = BadLowLimited 32 = BadHighLimited **48 = BadConstant** 64 = UncertainNotLimited 80 = UncertainLowLimited 96 = UncertainHighLimited 112 = UncertainConstant 128 = ManualFixedNotLimited 144 = ManualFixedLowLimited 160 = ManualFixedHighLimited 176 = ManualFixedConstant 192 = GoodNotLimited 208 = GoodLowLimited 224 = GoodHighLimited
0x380E	Var1_UpperLimit	FLOAT	R	87.0
0x380F	Var1_LowerLimit	FLOAT	R	-50.0
0x3810	Var1_MinSpan	FLOAT	R	10.0
0x385F	Assign Primary Variable (PV)	ENUM8	R	**0 = Sensor1**
0x3860	Assign Secondary Variable (SV)	ENUM8	R	0 = Sensor1 **1 = DeviceTemperature**
0x3861	Assign Tertiary Variable (TV)	ENUM8	R	**0 = Sensor1** 1 = DeviceTemperature
0x3862	Assign Quatenary Variable (QV)	ENUM8	R	**0 = Sensor1** 1 = DeviceTemperature
0x3863	Primary Variable (PV) - Value	FLOAT	R	NaN
0x3864	Secondary Variable (SV) - Value	FLOAT	R	NaN
0x3865	Tertiary Variable (TV) - Value	FLOAT	R	NaN
0x3866	Quatenary Variable (QV) - Value	FLOAT	R	NaN
0x3867	Primary Variable (PV) - Damping	UINT8	R	0
DisplaySettings				
0x4801	AlternatingTime	UINT8	R	4
0x4802	Format	ENUM8	R	**0 = ValueOnly** 1 = ValueAndBargraph

0x4814	ValSelector1	ENUM8	R	**13 = ProcessValue** 10 = OutCurrent 11 = PercentOfRange 1 = DeviceTemperature
0x4817	DecimalPlaces1	ENUM8	R	255 = Automatic 0 = X
0x481E	ValSelector2	ENUM8	R	**12 = Off** 13 = ProcessValue 10 = OutCurrent 11 = PercentOfRange
0x4821	DecimalPlaces2	ENUM8	R	255 = Automatic 0 = X
0x4828	ValSelector3	ENUM8	R	**12 = Off** 13 = ProcessValue 10 = OutCurrent 11 = PercentOfRange
0x482B	DecimalPlaces3	ENUM8	R	255 = Automatic 0 = X
Bluetooth				
0x6807	Activated	ENUM16	R	33004 = Off **33006 = On**
DeviceInfo				
0x781E	ProcessUnitTag	STRING32	R	????????????????????????????????
0x781F	LocationDescription	STRING32	R	????????????????????????????????
0x7820	Longitude	FLOAT	R	0
0x7821	Latitude	FLOAT	R	0
0x7822	Altitude	FLOAT	R	0.0
0x7823	LocationMethode	ENUM8	R	0 = Location_NoFix 1 = Location_GPSorSPSfix 2 = Location_DifferentialGPSfix 3 = Location_PPSfix 4 = Location_RTKfixedSolution 5 = Location_RTKfloatSolution 6 = Location_EstimatedDeadReckoning **7 = Location_ManualInputMode** 8 = Location_SimulationMode

11.2. Unit Codes

The unit codes that are overall relevant for this device are summarized at following table:

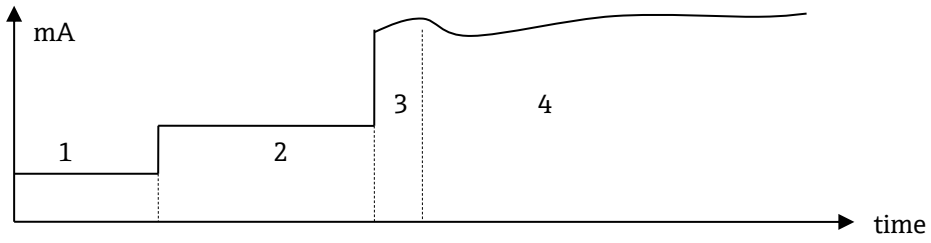
Hart Code	Text	Unit Name
32	**°C**	**degCelsius**
33	**°F**	**degFahrenheit**
35	**K**	**Kelvin**
36	**mV**	**milliVolt**
37	**Ohm**	**Ohm**
251	**None**	**NoneUnit**

12. Performance

12.1. Power up

The power-up performance times are as follows:

Indicator	Power-up phase	Time	Current Loop
1	Initialization/Selftests; No HART communication; No measurement	2 s	About 3.3 mA
2	Intialization/Selftests; HART communication active; No measurement	3 s	3.58 mA
3	Measurement active, status uncertain	2 s	measurement current
4	Measurement active, status good	---	measurement current



On power up, the transmitter has to initialise itself/ do selftests, which takes at maximum **2 seconds**.
Typically **2 seconds** after power up, the device will respond to HART commands.
Typically **5 seconds** after power up, current loop provides the measurement value.
Typically **7 seconds** after power up, digitally valid measurement values are available.
Fixed current mode (current simulation) is cancelled by power loss.

12.2. Reset

Command #42 ("Device Reset") causes the device to reset. The resulting restart is identical to the normal power up sequence.

12.3. Selftest

This field device does not support a selftest that can be started on request.
Some selftests are executed at each startup. Furthermore some selftests are performed in background during normal operation. Overall these selftests and verifications comprise:

- Stack usage
- Task surveillance
- Program Flash/ROM
- Configuration storage EEPROM
- General measurement errors (Cold-junction, external sensors)

12.4. Command response times

	At simple CMDs e.g. CMD#1,#20 … (few parameters)	At complex/long CMDs e.g. CMD#0 (many parameters)	At “normal” CMDs e.g. CMD#33,#3 (some parameters)	At write CMDs e.g. CMD #6, #171
Minimum:	5 ms	10 ms	5 ms	10 ms
Typical:	10 ms	15 ms	10 ms	15 ms
Max. (without Busy):	20 ms	20 ms	20 ms	20 ms
Max. (with Busy):	250 ms	250 ms	250 ms	250 ms

12.5. Busy and delayed response

The device responds with "busy" status, if the requested action occupies the CPU for more than 250ms. Delayed response is not used.

12.6. Long Messages

The largest number of response data bytes is used at the command #9: 71 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 immediately on execution of a write command.

12.8. Modes

Fixed current mode is implemented, using Command #40. This mode is cleared by power loss or reset. If the LoopCurrentMode is disabled (0) by Command #6 the Loop Current is fixed to 4.0 mA.

12.9. Write protection

There is one way to protect the device against write access.
When the device is in write protection, no "write commands" are accepted, except Command #38 and #42.

HW Lock

The HW solution for write protection works by use of a dip-switch on the optional display. Refer to chapter **4.3.1 Local controls and displays.**

SW Lock

There is no dedicated SW lock. With user administration it is possible to set the device from maintenance into operator mode where many parameters are locked.

12.10. Damping

Damping is disabled by default but can be enabled. It affects only the device variable that is mapped to PV and therefore it affects also PV and loop current signal.

Annex A. Capability checklist

T72

Manufacturer, model and revision:	Pyromation LLC, T72, Device Revision 1
Device type:	Transmitter
HART revision:	7
Device description available:	Yes
Number and type of sensors:	1 temperature sensor
Number and type of actuators:	0
Number and type of host side signals:	4 - 20mA analog
Number of device variables:	2
Number of dynamic variables:	4
Mappable dynamic variables:	No
Number of common practice commands:	25
Number of device specific commands:	34
Bits of additional device status:	36
Alternative operating modes:	No
Burst mode:	No
Write protection:	Yes

Annex B. Default configuration

Please refer to the operating instructions.

Annex C. Revision history

Rev. 1.0, 2023-02-12: Initial revision
Rev. 1.1, 2023-08-09: Changed HART Protocol Revision to 7.8
Rev. 1.2, 2023-09-15: Changed help texts for commando 226, 227, 231, 233, 234