Endress+Hauser
People for Process Automation

Liquiline pHORP – Revision 4

HART Field Device Specification

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Table of Contents

1. Introduction

1.1. Scope

The Endress+Hauser analysis transmitter, model Liquiline pHORP 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 (BA382) 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
HCF: HART Communication Foundation
n. A.: Not applicable
SCS: Sensor check system
NaN: Not a number
ENP: Electronic nameplate

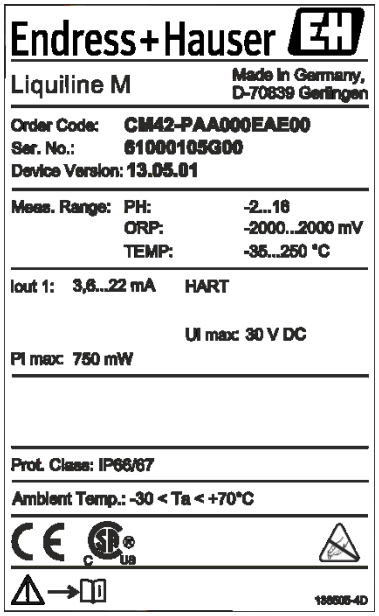
1.5. References

HCF_SPEC-12: HART Smart Communications Protocol Specification. Available from the HCF.
BA00381C + BA00382C: Operating Instructions.

2. Device identification

Manufacturer name:	Endress+Hauser
Model name:	Liquiline pHORP
Manufacturer ID code:	17 (11_h)
Device type code:	160 ($A0_h$)
Expanded device type code:	4512 ($11A0_h$)
HART protocol revision:	7.5
Device revision:	4
Number of device variables:	9
Physical layers supported:	FSK
Physical device category:	Transmitter, non DC isolated bus device

The nameplate is located on the right side of the housing and indicates model name, order code, and serial number of the device. The expanded device type code and device revision are shown on the device's power-up screen.



A nameplate example

Liquiline

3. Product overview

Liquiline pHORP is a robust 2 wire loop powered transmitter for pH/ORP measurement in all process applications.
Different pH or ORP sensors with or without integrated temperature sensor can be connected for different use cases. For more information please refer to the Operating Instructions.

4. Product interfaces

4.1. Process interface

4.1.1. Sensor input channels

Depending on Liquiline version different sensors can be connected to different terminals. Please refer to the Operating Instructions.

4.2. Host interface

Current output 1 terminals are 133 (+) and 134 (-). Liquiline is powered by current output 1. Depending on the Liquiline version current output 2 is present and can be connected by using terminals 233 (+) and 234 (-).

4.2.1. Analog output 1

This output is available in all HART Liquilines. Any of the device variables described in chapter 5 can be assigned to analog output 1. Depending on the selection the output is scaled according to the configured range of the instrument. Analog output 1 corresponds to the HART primary variable. HART communication is supported on this loop, only.
Linear overrange is possible from 3.8 mA to 20.5 mA. Device malfunction can be indicated by error current if selected. Current values are shown in the table below:

Downwards linear over-range:	3.8 mA
Upwards linear over-range:	20.5 mA
Device malfunction indication (detection by software, high):	21.5 mA
Device malfunction indication (detection by software, low):	3.6 mA
Device malfunction indication (detection by hardware):	22.0 mA
Minimum current:	3.6 mA
Maximum current:	22.0 mA
Multidrop current draw:	4.0 mA (power-up: 22.0 mA)
Lift-off Voltage:	18 V

4.2.2. Analog output 2

This output is available in certain Liquiline versions, only. Any of the device variables described in chapter 5 can be assigned to analog output 2. HART communication is not supported on this loop.
Linear overrange is possible from 3.8 mA to 20.5 mA. Device malfunction can be indicated by error current if selected. Current values are shown in the table below:

Downwards linear over-range:	3.8 mA
Upwards linear over-range:	20.5 mA
Device warning indication (detection by software):	21.5 mA
Device error indication (detection by hardware):	22.0 mA
Minimum current:	3.6 mA
Maximum current:	22.0 mA
Multidrop current draw:	n. A.
Lift-off Voltage:	n. A.

4.3. Local interfaces, jumpers and switches

4.3.1. Local controls and displays

Liquiline has four buttons, one navigator and a large dot matrix LC display for user interaction. All buttons and the navigator are software controlled. For detailed information refer to the Operating Instructions.

4.3.2. Internal jumpers and switches

There are no controls inside the housing.

5. Device variables

5.1. Device variable 0 - Main process value

The value and the unit of this device variable depend on the present Liquiline operation mode. Not all operation modes are available with all Liquiline versions.
The unit might differ from the unit shown on Liquiline's display.

pH mode:

Device variable classification:	Analytical	81 (51_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	pH	59 ($3B_h$)
Device variable lower limit:	-2 pH	
Device variable upper limit:	16 pH	

Raw value and ORP mV mode:

Device variable classification:	EMF/Voltage	83 (53_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	mV	36 (24_h)
Device variable lower limit:	-2000 mV	
Device variable upper limit:	2000 mV	

ORP % mode:

Device variable classification:	Analytical	81 (51_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	%	57 (39_h)
Device variable lower limit:	-3000 %	
Device variable upper limit:	3000 %	

rH mode:

Device variable classification:	None	0 (0_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	rH	247 ($F7_h$)
Device variable lower limit:	0 rH	
Device variable upper limit:	70 rH	

Temperature mode:

Device variable classification:	Temperature	64 (40_h)
Device family:	Not used	250 (FA_h)
Device variable units:	°C, °F, K	32, 33, 35 (20_h, 21_h, 23_h)
Device variable lower limit:	-50 °C	
Device variable upper limit:	150 °C	

5.2. Device variable 1 - pH

This value returns the damped temperature compensated pH value.
If the device is not in pH mode this device variable should not be used.

Device variable classification:	Analytical	81 (51_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	pH	59 ($3B_h$)
Device variable lower limit:	-2 pH	
Device variable upper limit:	16 pH	

5.3. Device variable 2 - ORP %

This value returns the ORP % value.
If the device is not in ORP mode this device variable should not be used.

Device variable classification:	Analytical	81 (51_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	%	57 (39_h)
Device variable lower limit:	-3000 %	
Device variable upper limit:	3000 %	

5.4. Device variable 3 - Raw value

This device variable returns the pH raw value in millivolts.
If the device is not in pH mode this device variable should not be used.

Device variable classification:	EMF/Voltage	83 (53_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	mV	36 (24_h)
Device variable lower limit:	-2000 mV	
Device variable upper limit:	2000 mV	

5.5. Device variable 4 - Temperature

This device variable returns the main process temperature value. This variable will return the real process value if a temperature sensor is present and activated only. If a special temperature is set by the user (e.g. when no temperature sensor is present) the device variable will return that temperature.
The unit might differ from the unit shown on Liquiline's display, i.e. setting Liquiline to °F will not set device variable 4 to °F. Device variable 4 can be set to °F by sending command 53.

Device variable classification:	Temperature	64 (40_h)
Device family:	Not used	250 (FA_h)
Device variable units:	°C, °F, K	32, 33, 35 (20_h, 21_h, 23_h)
Device variable lower limit:	-50 °C	
Device variable upper limit:	150 °C	

5.6. Device variable 5 - rH

This value returns the rH value calculated from a pH and mV value.
If the device is not in rH mode this device variable should not be used.

Device variable classification:	None	0 (0_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	rH	247 ($F7_h$)
Device variable lower limit:	0 rH	
Device variable upper limit:	70 rH	

5.7. Device variable 6 - ORP mV

This value returns the ORP mV value.
If the device is not in ORP mode this device variable should not be used.

Device variable classification:	EMF/Voltage	83 (53_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	mV	36 (24_h)
Device variable lower limit:	-2000 mV	
Device variable upper limit:	2000 mV	

5.8. Device variable 7 - Glass impedance

This value returns the Glass impedance value.
If the device is not in pH mode this device variable should not be used.
This device variable cannot be mapped to PV.

Device variable classification:	Resistance	85 (55_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	MΩ	170 (AA_h)
Device variable lower limit:	0 MΩ	
Device variable upper limit:	200000 MΩ	

5.9. Device variable 8 - Reference impedance

This value returns the reference impedance value.
If the device is not in pH mode or reference measurement is not active this device variable should not be used.
This device variable cannot be mapped to PV.

Device variable classification:	Resistance	85 (55_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	kΩ	163 ($A3_h$)
Device variable lower limit:	0 kΩ	
Device variable upper limit:	2000 kΩ	

5.10. Device variable status

Bit 0:	Not used	
Bit 1:	Not used	
Bit 2:	Not used	
Bit 3:	Not used	
Bit 5+4:	Limit status	00: Not limited 01: Low limited 10: High limited 11: Constant
Bit 7+6:	Process data status	00: Bad 01: Poor accuracy 10: Manual / fixed 11: Good

5.11. Manufacturer specific unit codes

Code	**Code$_h$**	**Unit**
247	F7$_h$	rH

5.12. Standardized device variables

These device variables have to be present in every HART 7 device.
Standardized device variables cannot be mapped to PV, SV, TV or QV using command 51.

5.12.1. Battery life

This device variable will always return NaN, as Liquiline is not battery powered.

Device variable number:	243 ($F3_h$)	
Device variable classification:	None	0 (0_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	Not used	250 (FA_h)
Device variable lower limit:	NaN	
Device variable upper limit:	NaN	

5.12.2. Percent range

This device variable returns the PV percentage corresponding to its user set limits. The value will always follow the PV even if the limits are exceeded, or the device is in an error state.

Device variable number:	244 ($F4_h$)	
Device variable classification:	Analytical	81 (51_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	%	57 (39_h)
Device variable lower limit:	-1000 %	
Device variable upper limit:	1000 %	

5.12.3. Loop current

This device variable returns the loop current on current output 1 even if the device is in an error or simulation state.

Device variable number:	245 ($F5_h$)	
Device variable classification:	Current	84 (54_h)
Device family:	Not used	250 (FA_h)
Device variable unit:	mA	39 (27_h)
Device variable lower limit:	0 mA	
Device variable upper limit:	23 mA	

5.12.4. Primary variable

This device variable returns the primary variable (PV).

Device variable number:	246 ($F6_h$)	
Device variable classification:	Depends on PV settings	
Device family:	Not used	250 (FA_h)
Device variable unit:	Depends on PV settings	
Device variable lower limit:	Depends on PV settings	
Device variable upper limit:	Depends on PV settings	

5.12.5. Secondary variable

This device variable returns the secondary variable (SV).

Device variable number:	247 ($F7_h$)	
Device variable classification:	Depends on SV settings	
Device family:	Not used	250 (FA_h)
Device variable unit:	Depends on SV settings	
Device variable lower limit:	Depends on SV settings	
Device variable upper limit:	Depends on SV settings	

5.12.6. Tertiary variable

This device variable returns the tertiary variable (TV).

Device variable number:	248 ($F8_h$)	
Device variable classification:	Depends on TV settings	
Device family:	Not used	250 (FA_h)
Device variable unit:	Depends on TV settings	
Device variable lower limit:	Depends on TV settings	
Device variable upper limit:	Depends on TV settings	

5.12.7. Quaternary variable

This device variable returns the quaternary variable (QV).

Device variable number:	249 ($F9_h$)	
Device variable classification:	Depends on QV settings	
Device family:	Not used	250 (FA_h)
Device variable unit:	Depends on QV settings	
Device variable lower limit:	Depends on QV settings	
Device variable upper limit:	Depends on QV settings	

6. Dynamic variables

All 4 dynamic variables (primary variable PV, secondary variable SV, tertiary variable TV and quaternary variable QV) are implemented in Liquiline devices.

6.1. Fixed dynamic variables

There are no fixed dynamic variables.

6.2. Dynamic variables with configurable mapping

PV can be mapped to device variables 0 - 6.
SV, TV and QV can be mapped to any device variable.
Changing the PV dynamic variable will change the current output 1 source, too.

Default mapping:
PV returns the current output 1 source - Device variable 0 - Main process value
SV returns device variable 4 - Temperature
TV returns device variable 3 - Raw value
QV returns device variable 2 - ORP %

7. Status information

7.1. Device status

Bit 0 (01_h, "Primary variable out of limits") is set whenever diagnostic message 404 or 405 is set.
Bit 1 (02_h, "Non-primary variable out of limits") is not used.
Bit 2 (04_h, "Loop current saturated") is set whenever diagnostic message 404 or 405 is set.
Bit 3 (08_h, "Loop current fixed") is set when simulation or multidrop mode or hold is active.
Bit 4 (10_h, "More status available") is set whenever a diagnostic message change is detected. This bit can be reset by user interaction.
Bit 5 (20_h, “Cold start") is set after device reset. It is reset after the first HART communication request.
Bit 6 (40_h, “Configuration changed") is set whenever a persistent parameter was changed. This bit stays set until it is reset by user interaction.
Bit 7 (80_h, "Device malfunction") is set when the present highest priority diagnostic code is classified as F.

7.2. Extended device status

Bit 0 (01_h, "Maintenance required") is set when the present highest priority diagnostic code is classified as M.
Bit 1 (02_h, "Device variable alert") is not used.
Bit 2 (04_h, "Critical power failure") is not used.
Bit 3 (08_h, "Failure") is set when the present highest priority diagnostic code is classified as F.
Bit 4 (10_h, "Out of specification") is set when the present highest priority diagnostic code is classified as S.
Bit 5 (20_h, "Function check") is set when the present highest priority diagnostic code is classified as C.
Bit 6 (40_h) is not used.
Bit 7 (80_h) is not used.

7.3. Standardized status 0

Bit 0 (01_h, "Device variable simulation active") is not used.
Bit 1 (02_h, "Non-volatile memory defect") is not used.
Bit 2 (04_h, "Volatile memory defect") is not used.
Bit 3 (08_h, "Watchdog reset executed") is set when a software exception caused the last device reset. The bit stays set until the next normal device startup.
Bit 4 (10_h, "Power supply conditions out of range”) is not used.
Bit 5 (20_h, "Environmental conditions out of range”) is set if there is a diagnostic code present marked in column ENV in chapter 7.7.
Bit 6 (40_h, "Electronic defect”) is set if there is a diagnostic code present marked in column DEF in chapter 7.7.
Bit 7 (80_h, "Device configuration locked”) is set if write protection is enabled or the device is locked using command 71.

7.4. Standardized status 1

Bit 0 (01_h, "Status simulation active") is set when status simulation is set via command 526.
Bit 1 (02_h, "Discrete variable simulation active") is not used.
Bit 2 (04_h, "Event notification overflow") is not used.
Bit 3 (08_h) is not used.
Bit 4 (10_h) is not used.
Bit 5 (20_h) is not used.
Bit 6 (40_h) is not used.
Bit 7 (80_h) is not used.

7.5. Standardized status 2

Standardized status 2 is not used.

7.6. Standardized status 3

Standardized status 3 is not used.

7.7. Additional device status - command 48

Bits not described below are set to 0.

Bit	Byte	Bit2	524 index	Liquiline diagnostic message	Status	Code	ENV	DEF
0	0	0	8	Temp. sensor failure	F	3		X
1	0	1	9	Scanning sensor	C	4		
2	0	2	10	Sensor initialization	C	10		
3	0	3	11	Sensor no communication	F	11		X
4	0	4	12	Sensor failure	F	12		X
5	0	5	13	Wrong sensor type	F	13		
6	0	6	14	Invalid sensor data	C	14		
7	0	7	15	Sensor supply bad	F	104		
8	1	0	16	Temp offset upper limit	F	119		
9	1	1	17	Temp offset lower limit	F	120		
10	1	2	18	Invalid TAG group	F	127		
11	1	3	19	Invalid TAG	F	128		
12	1	4	20	Sensor change aborted	C	129		
13	1	5	21	Calibration active	C	130		
14	1	6	22	PV not stable	M	131		
15	1	7	23	Temperature not stable	M	132		
16	2	0	24	Zero pnt. too high alarm	M	134	X	
17	2	1	25	Zero pnt. too high warning	M	135		
18	2	2	26	Zero pnt. too low warning	M	136		
19	2	3	27	Zero pnt. too low alarm	M	137	X	
20	2	4	28	Slope too low alarm	M	138	X	
21	2	5	29	Slope too low warning	M	139		
22	2	6	30	Leakage current alarm	F	140	X	
23	2	7	31	Leakage current warn	M	145		
24	3	0	32	Operating time alarm	M	172	X	
25	3	1	33	Oper.time >80°C alarm	M	173	X	
26	3	2	34	Oper.time >100°C alarm	M	174	X	
27	3	3	35	Cal. expired alarm	M	180	X	
28	3	4	36	SIP, CIP, autoclaving alarm	M	181	X	
29	3	5	37	Operating time warning	M	182		
30	3	6	38	Oper.time >80°C warn	M	183		
31	3	7	39	Oper.time >100°C warn	M	184		
32	4	0	40	Cal. expired warning	M	190		
33	4	1	41	SIP, CIP, autoclaving warning	M	191		
34	4	2	42	Wrong transmitter type	F	203		X
35	4	3	43	Simulation active	C	215		
36	4	4	44	Current output not available	F	218		X
37	4	5	45	Power supply bad	C	219	X	
38	4	6	46	Meas. value out of range	S	322	X	
39	4	7	47	Comm. module defect	F	380		X

40	5	0	48	Comm. module incomp	F	381		X
41	5	1	49	Lower limit current output	S	404		
42	5	2	50	Upper limit current output	S	405		
43	5	3	51	SETUP active	OK	406		
44	5	4	52	Diag. active	OK	407		
45	5	5	53	Calibration aborted	M	408		
46	5	6	54	Sensor change	C	409		
47	5	7	55	Device open	M	501		
112	14	0	120	Device alarm	F	513		X
113	14	1	121	Device warning	M	514		X
114	14	2	122	Logbook 20 % remain	S	530		
115	14	3	123	Logbook full	S	531		
116	14	4	124	Calibration timer expired	M	532		
117	14	5	125	PV upper limit alarm	F	810	X	
118	14	6	126	PV lower limit alarm	F	811	X	
119	14	7	127	Temperature out of range	F	812	X	
120	15	0	128	PV upper limit warning	M	840		
121	15	1	129	PV lower limit warning	M	841		
136	17	0	144	Glass impedance alarm	F	100		X
137	17	1	145	Ref. impedance alarm	F	101		X
138	17	2	146	Glass imp. too low alarm	F	102		X
139	17	3	147	Ref. imp. too low alarm	F	103		X
140	17	4	148	Glass impedance warning	M	106		
141	17	5	149	Ref. impedance warning	M	107		
142	17	6	150	Glass imp. too low warning	M	111		
143	17	7	151	Ref. imp. too low warning	M	112		
144	18	0	152	SCC electrode cond. bad	M	142		X
145	18	1	153	SCC electrode sufficient	M	148		
146	18	2	154	Operating point too high alarm	M	153	X	
147	18	3	155	Operating point too high warning	M	154		
148	18	4	156	Operating point too low warning	M	155		
149	18	5	157	Operating point too low alarm	M	156	X	
150	18	6	158	Oper.time <-300mV alarm	M	175	X	
151	18	7	159	Oper.time >300mV alarm	M	176	X	
152	19	0	160	Delta slope alarm	M	177	X	
153	19	1	161	Delta zero alarm	M	178	X	
154	19	2	162	Delta oper.point alarm	M	179	X	
155	19	3	163	Oper.time <-300mV warn	M	185		
156	19	4	164	Oper.time >300mV warn	M	186		
157	19	5	165	Delta slope warning	C	238		
158	19	6	166	Delta zero warning	C	239		
159	19	7	167	Delta oper.point warning	C	240		
160	20	0	168	Glass imp. too high alarm	M	318		X
161	20	1	169	Ref. imp. too high alarm	M	319		X

162	20	2	170	Glass imp. too high warning	M	320	
163	20	3	171	Ref. imp. too high warning	M	321	
164	20	4	172	PCS Alarm	F	802	X
165	20	5	173	Sensor deactivated	F	770	

8. Supported commands

It is not suggested to use HART at command level directly.
Endress+Hauser provides device descriptions (DD) and device type managers (DTM) for a variety of control systems.

8.1. Read unique identifier - 0 (00_h)

This command reads fundamental information about the connected device.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	254
1-2	Enum	Expanded device type
3	Unsigned-8	Minimum request preambles
4	Unsigned-8	Universal command revision
5	Unsigned-8	Device revision
6	Unsigned-8	Software revision
7	Unsigned-8	Hardware revision / Physical signaling code
8	Bits	Flags
9-11	Unsigned-24	Device ID
12	Unsigned-8	Minimum response preambles
13	Unsigned-8	Maximum number of device variables
14-15	Unsigned-16	Configuration change counter
16	Bits	Extended field device status
17-18	Enum	Manufacturer identification code
19-20	Enum	Private label distributor code
21	Enum	Device profile

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.2. Read primary variable - 1 (01_h)

This command reads the primary variable (PV). The primary variable is given by the source of the current output 1. The PV is one of the device variables described in chapter 5. Supported units can be found in chapter 5.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Enum	Primary variable unit
1-4	Float	Primary variable

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.3. Read loop current and percent of range - 2 (02_h)

This command reads the loop current and the percent of range of current output 1.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-3	Float	Loop current [mA]
4-7	Float	Percent of range [%]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.4. Read dynamic variables and loop current - 3 (03_h)

This command reads the loop current and up to four predefined dynamic variables. Every dynamic variable corresponds to one device variable. Supported units can be found in chapter 5.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-3	Float	Loop current [mA]
4	Enum	Primary variable unit
5-8	Float	Primary variable
9	Enum	Secondary variable unit
10-13	Float	Secondary variable
14	Enum	Tertiary variable unit
15-18	Float	Tertiary variable
19	Enum	Quaternary variable unit
20-23	Float	Quaternary variable

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.5. Write polling address - 6 (06_h)

This command writes the polling address and the loop current mode. The polling address can be set at the Liquiline operating panel, too ("Setup/General settings/Bus address").

Request data bytes

Byte	Format	Description
0	Unsigned-8	Polling address
1	Enum	Loop current mode (optional)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Polling address
1	Enum	Loop current mode

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid address
5	Error	Too few data bytes received
7	Error	In write protect mode
12	Error	Invalid mode
16	Error	Access restricted
32	Error	Busy

Loop current mode

Disabled: 0
Enabled: 1

8.6. Read loop configuration - 7 (07_h)

This command reads the loop current and the polling address.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	Polling address
1	Enum	Loop current mode

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.7. Read dynamic variable classification - 8 (08_h)

This command reads the classification associated with the dynamic variables. Reading the classification is necessary to select the correct unit code table. Supported units and classification codes can be found in chapter 5.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	Primary variable classification
1	Unsigned-8	Secondary variable classification
2	Unsigned-8	Tertiary variable classification
3	Unsigned-8	Quaternary variable classification

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.8. Read device variables with status - 9 (09_h)

This command reads up to four device variables with their status. If more than 4 device variables are requested only the first four are returned and response code 30 is set.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device variable code
1	Unsigned-8	Slot 1: Device variable code (optional)
2	Unsigned-8	Slot 2: Device variable code (optional)
3	Unsigned-8	Slot 3: Device variable code (optional)
4	Unsigned-8	Slot 4: Device variable code (optional)
5	Unsigned-8	Slot 5: Device variable code (optional)
6	Unsigned-8	Slot 6: Device variable code (optional)
7	Unsigned-8	Slot 7: Device variable code (optional)

Response data bytes

Byte	Format	Description
0	Bits	Extended device status
1	Unsigned-8	Slot 0: Device variable code
2	Enum	Slot 0: Device variable classification
3	Enum	Slot 0: Device variable unit
4-7	Float	Slot 0: Device variable value
8	Bits	Slot 0: Device variable status
9	Unsigned-8	Slot 1: Device variable code
10	Enum	Slot 1: Device variable classification
11	Enum	Slot 1: Device variable unit
12-15	Float	Slot 1: Device variable value
16	Bits	Slot 1: Device variable status
17	Unsigned-8	Slot 2: Device variable code
18	Enum	Slot 2: Device variable classification
19	Enum	Slot 2: Device variable unit
20-23	Float	Slot 2: Device variable value
24	Bits	Slot 2: Device variable status
25	Unsigned-8	Slot 3: Device variable code
26	Enum	Slot 3: Device variable classification
27	Enum	Slot 3: Device variable unit
28-31	Float	Slot 3: Device variable value
32	Bits	Slot 3: Device variable status
33-36(*)	Time	Data time stamp

(*) Timestamp is always present, even if less than 4 device variables were requested. Its position is always at the end of the frame. Timestamp is in format 1/32 ms since midnight (Unsigned-32).

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
30	Warning	Command response truncated

8.9. Read unique identifier associated with tag - 11 ($0B_h$)

This command reads fundamental information about the connected device.
The device will not respond to this command unless the short tag matches.

Request data bytes

Byte	Format	Description
0-5	Packed ASCII	Tag

Response data bytes

Byte	Format	Description
0	Unsigned-8	254
1-2	Enum	Expanded device type
3	Unsigned-8	Minimum request preambles
4	Unsigned-8	Universal command revision
5	Unsigned-8	Device revision
6	Unsigned-8	Software revision
7	Unsigned-8	Hardware revision / Physical signaling code
8	Bits	Flags
9-11	Unsigned-24	Device ID
12	Unsigned-8	Minimum response preambles
13	Unsigned-8	Maximum number of device variables
14-15	Unsigned-16	Configuration change counter
16	Bits	Extended field device status
17-18	Enum	Manufacturer identification code
19-20	Enum	Private label distributor code
21	Enum	Device profile

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.10. Read message - 12 ($0C_h$)

This command reads the message.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-23	Packed ASCII	Message

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.11. Read tag, descriptor and date - 13 ($0D_h$)

This command reads the short tag, descriptor and the date.
The short HART tag is completely separated from the long tag.
The short tag can be read and written via HART only.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-5	Packed ASCII	Short tag
6-17	Packed ASCII	Descriptor
18-20	Unsigned-24	Date

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.12. Read primary variable transducer information - 14 ($0E_h$)

This command reads the serial number, limits and the minimum span for the primary variable transducer. The serial number is always 0. As there is no minimum span, this value is set to NaN.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-2	Unsigned-24	Transducer serial number
3	Enum	Transducer limits and span unit
4-7	Float	Upper transducer limit
8-11	Float	Lower transducer limit
12-15	Float	Minimum transducer span

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.13. Read device information - 15 ($0F_h$)

This command reads additional information of the device.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Enum	PV alarm selection code
1	Enum	PV transfer function code
2	Enum	PV range value unit
3-6	Float	PV upper range value
7-10	Float	PV lower range value
11-14	Float	PV damping value [s]
15	Enum	Write protect code
16	Unsigned-8	Reserved
17	Enum	PV analog channel flags

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.14. Read final assembly number - 16 (10_h)

This command reads the final assembly number of the device.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-2	Unsigned-24	Final assembly number

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.15. Write message - 17 (11_h)

This command writes the message.

Request data bytes

Byte	Format	Description
0-23	Packed ASCII	Message

Response data bytes

Byte	Format	Description
0-23	Packed ASCII	Message

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.16. Write tag, descriptor and date - 18 (12_h)

This command writes the short tag, descriptor and the date.
The short HART tag is completely separated from the long tag. The short tag can be read and written via HART only.

Request data bytes

Byte	Format	Description
0-5	Packed ASCII	Short tag
6-17	Packed ASCII	Descriptor
18-20	Unsigned-24	Date

Response data bytes

Byte	Format	Description
0-5	Packed ASCII	Short tag
6-17	Packed ASCII	Descriptor
18-20	Unsigned-24	Date

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.17. Write final assembly number - 19 (13_h)

This command writes the final assembly number.

Request data bytes

Byte	Format	Description
0-2	Unsigned-24	Final assembly number

Response data bytes

Byte	Format	Description
0-2	Unsigned-24	Final assembly number

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.18. Read long tag - 20 (14_h)

This command reads the long tag.
The long HART tag corresponds to the Liquiline tag shown on the display and in the setup menu ("Setup/General settings/TAG number"). This tag can be edited via HART and the local operating panel.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-31	Latin-1	Long tag

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.19. Read unique identifier associated with long tag - 21 (15_h)

This command reads fundamental information about the connected device.
The device will not respond to this command unless the long tag matches.

Request data bytes

Byte	Format	Description
0-31	Latin-1	Tag

Response data bytes

Byte	Format	Description
0	Unsigned-8	254
1-2	Enum	Expanded device type
3	Unsigned-8	Minimum request preambles
4	Unsigned-8	Universal command revision
5	Unsigned-8	Device revision
6	Unsigned-8	Software revision
7	Unsigned-8	Hardware revision / Physical signaling code
8	Bits	Flags
9-11	Unsigned-24	Device ID
12	Unsigned-8	Minimum response preambles
13	Unsigned-8	Maximum number of device variables
14-15	Unsigned-16	Configuration change counter
16	Bits	Extended field device status
17-18	Enum	Manufacturer identification code
19-20	Enum	Private label distributor code
21	Enum	Device profile

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.20. Write long tag - 22 (16_h)

This command writes the long tag.
The long HART tag corresponds to the Liquiline tag shown on the display and in the setup menu ("Setup/General settings/TAG number"). This tag can be edited via HART and the local operating panel.

Request data bytes

Byte	Format	Description
0-31	Latin-1	Long tag

Response data bytes

Byte	Format	Description
0-31	Latin-1	Long tag

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.21. Read device variable - 33 (21_h)

This command reads up to 4 device variables.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device variable code
1	Unsigned-8	Slot 1: Device variable code (optional)
2	Unsigned-8	Slot 2: Device variable code (optional)
3	Unsigned-8	Slot 3: Device variable code (optional)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device variable code
1	Enum	Slot 0: Device variable unit
2-5	Float	Slot 0: Device variable value
6	Unsigned-8	Slot 1: Device variable code
7	Enum	Slot 1: Device variable unit
8-11	Float	Slot 1: Device variable value
12	Unsigned-8	Slot 2: Device variable code
13	Enum	Slot 2: Device variable unit
14-17	Float	Slot 2: Device variable value
18	Unsigned-8	Slot 3: Device variable code
19	Enum	Slot 3: Device variable unit
20-23	Float	Slot 3: Device variable value

Command specific response codes

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

8.22. Write primary variable damping value - 34 (22_h)

This command writes the primary variable damping value.
This value can also be set using the Liquiline local operating panel (“Setup/Sensor pH/Damping”).

Request data bytes

Byte	Format	Description
0-3	Float	Primary variable damping value [s]

Response data bytes

Byte	Format	Description
0-3	Float	Primary variable damping value [s]

Command specific response codes

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

8.23. Write primary variable range values - 35 (23_h)

This command defines the relationship between the loop current and the primary variable.
These values can also be set using the Liquiline local operating panel ("Setup/Current output/Current output 1/Low value" and "Setup/Current output/Current output 1/Upper value").

Request data bytes

Byte	Format	Description
0	Enum	Range value unit
1-4	Float	Upper range value (value at 20 mA)
5-8	Float	Lower range value (value at 4 mA)

Response data bytes

Byte	Format	Description
0	Enum	Range value unit
1-4	Float	Upper range value (value at 20 mA)
5-8	Float	Lower range value (value at 4 mA)

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
9	Error	Lower range value too high
10	Error	Lower range value too low
11	Error	Upper range value too high
12	Error	Upper range value too low
13	Error	Upper and lower range value out of limits
14	Warning	Span too small
16	Error	Access restricted
18	Error	Invalid units code
32	Error	Busy

8.24. Set primary variable upper range value - 36 (24_h)

As soon as this command is issued, the present primary variable value is copied into the upper range value. The upper range can be set below the lower range.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
None		

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
7	Error	In write protect mode
9	Error	Applied process too high
10	Error	Applied process too low
16	Error	Access restricted
32	Error	Busy

8.25. Set primary variable lower range value - 37 (25_h)

As soon as this command is issued, the present primary variable value is copied into the lower range value. At the same time, the upper range will be shifted to keep the span constant.
The lower range can be set above the upper range.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
None		

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
7	Error	In write protect mode
9	Error	Applied process too high
10	Error	Applied process too low
16	Error	Access restricted
32	Error	Busy

8.26. Reset configuration changed flag - 38 (26_h)

This command will reset one of the configuration changed flags, depending on the sending master.
If the configuration change counter value is sent, the device will check it versus the current counter value.
If both match, the configuration changed flag will be reset.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Configuration change counter (optional)

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Configuration change counter

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
7	Error	In write protect mode
9	Error	Configuration change counter mismatch
16	Error	Access restricted
32	Error	Busy

8.27. Set simulation current - 40 (28_h)

This command sets a certain fixed current on current output 1 (current simulation).
To disable simulation mode a value of 0.0 has to be set.
The simulation mode and the current value can also be set using the Liquiline local operating panel ("Diag/Service/Simulation/Current output 1").
Simulation values in the range from 3.6 to 21.5 mA are valid.

Request data bytes

Byte	Format	Description
0-3	Float	Fixed current value [mA]

Response data bytes

Byte	Format	Description
0-3	Float	Fixed current value [mA]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
3	Error	Passed parameter too large
4	Error	Passed parameter too small
5	Error	Too few data bytes received
7	Error	In write protect mode
11	Error	Loop current not active (multidrop mode)
16	Error	Access restricted
32	Error	Busy

8.28. Perform self-test - 41 (29_h)

This command answers the request, only. It is implemented for compatibility reasons.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
None		

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.29. Reset device - 42 ($2A_h$)

This command triggers a reset. Liquiline will need about 30 seconds to initialize and to be back online.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
None		

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
16	Error	Access restricted

8.30. Write primary variable unit - 44 ($2C_h$)

This command selects the unit in which the primary variable and its range will be returned. Possible units depending on different operating modes are listed in chapter 5.

Request data bytes

Byte	Format	Description
0	Enum	Primary variable unit

Response data bytes

Byte	Format	Description
0	Enum	Primary variable unit

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.31. Trim loop current zero - 45 ($2D_h$)

Command 45 and 46 can do a recalibration of the current output 1 loop.
These commands will not overwrite the factory current output calibration, but do a second user calibration.
To restore the original values a "Factory default" in the Liquiline diagnostics menu has to be executed or command 45 with value 0.0 mA has to be sent.

Command 45 recalibrates the lower range of the current output.

Before sending command 45 command 40 with a value of 4 mA has to be sent.
The value to be sent with command 45 must be measured with an external ampere meter.

Request data bytes

Byte	Format	Description
0-3	Float	Externally measured loop current [mA]

Response data bytes

Byte	Format	Description
0-3	Float	Loop current [mA]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
3	Error	Passed parameter too large
4	Error	Passed parameter too small
5	Error	Too few data bytes received
7	Error	In write protect mode
9	Error	Incorrect loop current mode or value
11	Error	Loop current not active (multidrop mode)
16	Error	Access restricted
32	Error	Busy

8.32. Trim loop current gain - 46 ($2E_h$)

Command 45 and 46 can do a recalibration of the current output 1 loop.
These commands will not overwrite the factory current output calibration, but do a second user calibration.
To restore the original values a "Factory default" in the Liquiline diagnostics menu has to be executed or command 45 with value 0.0 mA has to be sent.

Command 46 recalibrates the upper range of the current output.

Before sending command 46 command 40 with a value of 20 mA has to be sent.
The value to be sent with command 46 must be measured with an external ampere meter.

Request data bytes

Byte	Format	Description
0-3	Float	Externally measured loop current [mA]

Response data bytes

Byte	Format	Description
0-3	Float	Loop current [mA]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
3	Error	Passed parameter too large
4	Error	Passed parameter too small
5	Error	Too few data bytes received
7	Error	In write protect mode
9	Error	Incorrect loop current mode or value
11	Error	Loop current not active (multidrop mode)
16	Error	Access restricted
32	Error	Busy

8.33. Read additional status - 48 (30_h)

This command returns device status information not included in the response code or device status byte. A description of the single bits meanings can be found in chapter 7.7.
If data is included when sending command 48 this data is checked versus the current device status. If all data matches the “more status available” flag is reset.

Request data bytes

Byte	Format	Description
0-5	Bits	See chapter 7.7 (optional)
6	Bits	Extended device status (optional)
7	Bits	Device operating mode (optional)
8	Bits	Standardized status 0 (optional)
9	Bits	Standardized status 1 (optional)
10	Bits	Analog channel saturated (optional)
11	Bits	Standardized status 2 (optional)
12	Bits	Standardized status 3 (optional)
13	Bits	Analog channel fixed (optional)
14-24	Bits	See chapter 7.7 (optional)

Response data bytes

Byte	Format	Description
0-5	Bits	See chapter 7.7
6	Bits	Extended device status
7	Bits	Device operating mode
8	Bits	Standardized status 0
9	Bits	Standardized status 1
10	Bits	Analog channel saturated
11	Bits	Standardized status 2
12	Bits	Standardized status 3
13	Bits	Analog channel fixed
14-24	Bits	See chapter 7.7

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.34. Read dynamic variable assignments - 50 (32_h)

This command returns the mapping between device and dynamic variables (see chapter 6.2).

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	Device variable assigned to primary variable
1	Unsigned-8	Device variable assigned to secondary variable
2	Unsigned-8	Device variable assigned to tertiary variable
3	Unsigned-8	Device variable assigned to quaternary variable

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.35. Write dynamic variable assignments - 51 (33_h)

This command sets the mapping between device and dynamic variables (see chapter 6.2).

Request data bytes

Byte	Format	Description
0	Unsigned-8	Device variable to assign to primary variable
1	Unsigned-8	Device variable to assign to secondary variable
2	Unsigned-8	Device variable to assign to tertiary variable
3	Unsigned-8	Device variable to assign to quaternary variable

Response data bytes

Byte	Format	Description
0	Unsigned-8	Device variable assigned to primary variable
1	Unsigned-8	Device variable assigned to secondary variable
2	Unsigned-8	Device variable assigned to tertiary variable
3	Unsigned-8	Device variable assigned to quaternary variable

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.36. Write device variable unit - 53 (35_h)

This command selects the unit in which a certain device variable and its range will be returned. Possible units depending on different operating modes are listed in chapter 5.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Device variable code
1	Enum	Device variable unit

Response data bytes

Byte	Format	Description
0	Unsigned-8	Device variable code
1	Enum	Device variable unit

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
11	Error	Invalid device variable code
12	Error	Invalid unit code
16	Error	Access restricted
32	Error	Busy

8.37. Read device variable information - 54 (36_h)

This command reads more information about a device variable.
Device variable transducer serial number and family classification are not supported and will return 0.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Device variable code

Response data bytes

Byte	Format	Description
0	Unsigned-8	Device variable code
1-3	Unsigned-24	Transducer serial number
4	Enum	Transducer limits and span unit
5-8	Float	Upper transducer limit
9-12	Float	Lower transducer limit
13-16	Float	Damping value [s]
17-20	Float	Minimum span
21	Enum	Device variable classification
22	Enum	Device variable family
23-26	Time	Acquisition period
27	Bits	Device variable properties

Command specific response codes

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

8.38. Write number of response preambles - 59 ($3B_h$)

This command sets the number of response preambles.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Number of response preambles

Response data bytes

Byte	Format	Description
0	Unsigned-8	Number of response preambles

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
3	Error	Passed parameter too large
4	Error	Passed parameter too small
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.39. Lock device - 71 (47_h)

This command locks the device to one HART master and prevents changes from the other master and the operating panel.
If the device is locked by this command, the local operating panel does not respond to any user action.
A key icon appears in the status bar on the top of the display.
If a permanent lock was set and the device loses power, the lock will be set again as soon as the first HART frame is detected. If a permanent lock has to be reset, the HART master the lock was set with has to be used. If this is not possible then Liquiline has to be restarted without HART communication and a factory default has to be executed.
“Lock all” prevents any master from writing. Then any master can reset the lock, though.

Request data bytes

Byte	Format	Description
0	Enum	Lock code

Response data bytes

Byte	Format	Description
0	Enum	Lock code

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
10	Error	Invalid lock code
16	Error	Access restricted
32	Error	Busy

Lock code

Unlock:	0
Lock temporary:	1
Lock permanent:	2
Lock all:	3

8.40. Squawk - 72 (48_h)

This command can be used to invert the display of Liquiline.
If no data byte is sent with the command the display is reset to normal condition after 10 seconds.
This command can be used to identify a certain device in large installations.

Request data bytes

Byte	Format	Description
0	Enum	Squawk code (optional)

Response data bytes

Byte	Format	Description
0	Enum	Squawk code

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

Squawk code

Off: 0
On: 1
10 seconds: 2

8.41. Find device - 73 (49_h)

The device will not respond to this command unless the user sets “Setup/General settings/Bus find response” to “on”.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	254
1-2	Enum	Expanded device type
3	Unsigned-8	Minimum request preambles
4	Unsigned-8	Universal command revision
5	Unsigned-8	Device revision
6	Unsigned-8	Software revision
7	Unsigned-8	Hardware revision / Physical signaling code
8	Bits	Flags
9-11	Unsigned-24	Device ID
12	Unsigned-8	Minimum response preambles
13	Unsigned-8	Maximum number of device variables
14-15	Unsigned-16	Configuration change counter
16	Bits	Extended field device status
17-18	Enum	Manufacturer identification code
19-20	Enum	Private label distributor code
21	Enum	Device profile

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.42. Read lock device state - 76 ($4C_h$)

This command reads the current state of the device lock.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Bits	Lock state

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

Lock state

Locked:	1
Permanent:	2
Locked by primary master:	4
All locked:	8

8.43. Set real time clock - 89 (59_h)

This command sets the real time clock of Liquiline or determines the roundtrip time for setting the real time clock.

Request data bytes

Byte	Format	Description
0	Enum	Time set code
1-3	Date	Date to set
4-7	Time	Time to set
8-9	Unsigned-16	Always 0

Response data bytes

Byte	Format	Description
0	Enum	Time set code
1-3	Date	Liquiline date
4-7	Time	Liquiline time

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid time set code
3	Error	Passed parameter too large
5	Error	Too few data bytes received
7	Error	In write protect mode
9	Error	Invalid date
16	Error	Access restricted
32	Error	Busy

Time set code
Read receive time: 0
Write date and time: 1

Time is in format 1/32 ms since midnight (Unsigned-32).
Date is in format day, month, (year -1900) (Unsigned-24).

8.44. Read real time clock - 90 ($5A_h$)

This command reads the current date and time from Liquiline.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-2	Date	Liquiline date
3-6	Time	Liquiline time
7-9	Date	Date clock was last set
10-13	Time	Time clock was last set
14	Bits	Flags

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

Flags
Nonvolatile clock: 1
Clock uninitialized: 2

8.45. Read communication statistics - 95 ($5F_h$)

This command reads the current communication statistics. The counters roll over to 0 if they reach their maximum. This will happen about once a day, assuming one communication per second.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Number of HART requests received
2-3	Unsigned-16	Number of HART responses sent
4-5	Unsigned-16	Always 0

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.46. Write primary variable alarm code - 100 (64_h)

This command will set the current output 1 behavior if condensed status is “F”.
The parameters “Setup/General settings/Alarms/Alarm message/Alarm active” and “Setup/General settings/Alarms/Alarm message/Alarm value” will be set accordingly.

Request data bytes

Byte	Format	Description
0	Enum	PV alarm selection code

Response data bytes

Byte	Format	Description
0	Enum	PV alarm selection 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
16	Error	Access restricted
32	Error	Busy

Alarm selection code
High (fixed 21.5 mA): 0
Low (fixed 3.6 mA): 1
Hold last value: 239 (EF_h)

8.47. Read parameter group - 140 ($8C_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Group index

Response data bytes

Byte	Format	Description
0	Unsigned-8	Group index
1-n	Unsigned-8 [ ]	Parameter group

Command specific response codes

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

8.48. Set diagnostic code behavior - 150 (96_h)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Diagnostic code
2	Unsigned-8	Extended device status code to set

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Diagnostic code
2	Unsigned-8	Extended device status 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
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.49. Read diagnostic code behavior - 151 (97_h)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Diagnostic code

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Diagnostic code
2	Unsigned-8	Extended device status 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

8.50. Set logbook control - 160 ($A0_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Transfer ID number
1	Unsigned-8	Access type
2	Unsigned-8	Attribute
3-6	Unsigned-32	Data

Response data bytes

Byte	Format	Description
0	Unsigned-8	Transfer ID number
1	Unsigned-8	Access type
2	Unsigned-8	Attribute
3-6	Unsigned-32	Data
7	Unsigned-8	Status

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.51. Read logbook data - 161 ($A1_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0	Unsigned-8	Transfer ID number
1	Unsigned-8	Access type
2	Unsigned-8	Status
3-43	Unsigned-32	Data

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.52. Read extended communication statistics - 170 (AA_h)

This command reads the current extended communication statistics of Liquiline. The counters roll over to 0 if they reach their maximum.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-3	Unsigned-32	Number of HART requests received
4-7	Unsigned-32	Number of HART responses sent
8-11	Unsigned-32	Number of parity errors
12-15	Unsigned-32	Number of framing errors
16-19	Unsigned-32	Number of overrun errors
20-23	Unsigned-32	Number of overflow errors
24-27	Unsigned-32	Number of checksum errors
28-31	Unsigned-32	Number of busies

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.53. Write parameter - 211 ($D3_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-n	Unsigned-8 [ ]	Parameter value

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-n	Unsigned-8 [ ]	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.54. Write parameter attribute - 212 ($D4_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-6	Unsigned-32	Attribute code
7-n	Unsigned-8 [ ]	Parameter value

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-6	Unsigned-32	Attribute code
7-n	Unsigned-8 [ ]	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.55. Read parameter - 213 ($D5_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-n	Unsigned-8 [ ]	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received

8.56. Read parameter attribute - 214 ($D6_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-6	Unsigned-32	Attribute code

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3-6	Unsigned-32	Attribute code
7-n	Unsigned-8 [ ]	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
16	Error	Access restricted

8.57. Read float parameter - 215 ($D7_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3	Unsigned-8	Unit table
4	Unsigned-8	Unit
5-8	Float	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
16	Error	Access restricted

8.58. Write float parameter - 216 ($D8_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3	Unsigned-8	Unit table number
4	Unsigned-8	Unit
5-8	Float	Parameter value

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Parameter ID
2	Unsigned-8	Parameter set
3	Unsigned-8	Unit table number
4	Unsigned-8	Unit
5-8	Float	Parameter value

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.59. Reset device - 217 ($D9_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Reset code

Response data bytes

Byte	Format	Description
0	Unsigned-8	Reset 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
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.60. Read software version - 226 ($E2_h$)

This command reads the software version.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index (always 0)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-16	Latin-1	Software version string

Command specific response codes

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

8.61. Read serial number - 227 ($E3_h$)

This command reads the serial number.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index (always 0)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-16	Latin-1	Serial number string

Command specific response codes

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

8.62. Read extended order code - 228 ($E4_h$)

This command reads the extended order code. As the device does not support the extended order code the normal order code is returned.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Index (always 0)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Index
1-20	Latin-1	Order code string

Command specific response codes

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

8.63. Write serial number - 229 ($E5_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-16	Latin-1	Serial number string

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-16	Latin-1	Serial number string

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.64. Write extended order code - 230 ($E6_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-20	Latin-1	Order code string

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-20	Latin-1	Order code string

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.65. Check device status - 231 ($E7_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1	Unsigned-8	Device status
2-3	Unsigned-16	Number of the highest priority error

Command specific response codes

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

8.66. Write service code - 232 ($E8_h$)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0-1	Unsigned-16	Service access code

Response data bytes

Byte	Format	Description
0-1	Unsigned-16	Service access 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
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.67. Read order code - 233 ($E9_h$)

This command reads the order code.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index (always 0)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-20	Latin-1	Order code string

Command specific response codes

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

8.68. Read ENP version - 234 (EA_h)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index (always 0)

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-16	Latin-1	ENP version string

Command specific response codes

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

8.69. Write order code - 235 (EB_h)

This command is for Endress+Hauser internal use, only.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Module index (always 0)
1-20	Latin-1	Order code string

Response data bytes

Byte	Format	Description
0	Unsigned-8	Module index
1-20	Latin-1	Order code string

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.70. Read startup behavior - 236 (EC_h)

This command reads the startup behavior of Liquiline.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-3	Float	Minimal startup voltage [V]
4-7	Float	Startup current [mA]
8-9	Unsigned-16	Time until HART communication possible [s]
10-13	Float	Minimal operating voltage [V]
14-17	Float	Multidrop current [mA]
18-19	Unsigned-16	Time until measurement values are present [s]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.71. Read device location - 516 (0204_h)

This command reads the location of Liquiline. Content has to be set by user using command 517.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-3	Float	Latitude [°]. N = +, S = -
4-7	Float	Longitude [°] E = +, W = -
8	Enum	Location method/quality
9-12	Float	Altitude [m]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.72. Write device location - 517 (0205_h)

This command writes the device location.

Request data bytes

Byte	Format	Description
0-3	Float	Latitude [°]. N = +, S = -
4-7	Float	Longitude [°] E = +, W = -
8	Enum	Location method/quality
9-12	Float	Altitude [m]

Response data bytes

Byte	Format	Description
0-3	Float	Latitude [°]. N = +, S = -
4-7	Float	Longitude [°] E = +, W = -
8	Enum	Location method/quality
9-12	Float	Altitude [m]

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid location method
3	Error	Latitude or longitude to large
4	Error	Latitude or longitude to small
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

Location method

No fix:	0
GPS or SPS fix:	1
Differential GPS fix:	2
PPS fix:	3
RTK fixed solution:	4
RTK float solution:	5
Estimated dead reckoning:	6
Manual input mode:	7
Simulation mode:	8

8.73. Read location description - 518 (0206_h)

This command reads the location description.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-31	Latin-1	Location description

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.74. Write location description - 519 (0207_h)

This command writes the location description.

Request data bytes

Byte	Format	Description
0-31	Latin-1	Location description

Response data bytes

Byte	Format	Description
0-31	Latin-1	Location description

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.75. Read process unit tag - 520 (0208_h)

This command reads the process unit tag.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
0-31	Latin-1	Process unit tag

Command specific response codes

Code	Class	Description
0	Success	No command specific errors

8.76. Write process unit tag - 521 (0209_h)

This command writes the process unit tag.

Request data bytes

Byte	Format	Description
0-31	Latin-1	Process unit tag

Response data bytes

Byte	Format	Description
0-31	Latin-1	Process unit tag

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.77. Read condensed status mapping array - 523 ($020B_h$)

This command reads the status mapping array or a part of it.
The status mapping array determines the devices behavior depending on the highest priority diagnostic message.
The default mapping can be found in chapter 7.7.
No more than 84 status maps can be read at once.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Starting status map index (see chapter 7.7)
1	Unsigned-8	Number of entries to read

Response data bytes

Byte	Format	Description
0	Unsigned-8	Actual starting status map index
1	Unsigned-8	Number of entries actually returned
2 (bits 0-3)	Enum	First status map code
2 (bits 4-7)	Enum	Second status map code
3 (bits 0-3)	Enum	Third status map code
...	Enum	Remaining status map codes

Command specific response codes

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

8.78. Write condensed status mapping array - 524 ($020C_h$)

This command writes the status mapping array or a part of it.
The status mapping array determines the devices behavior depending on the highest priority diagnostic message.
The default mapping can be found in chapter 7.7.
Only index 8 - 55 and 120 - 172 can be changed.
At least 2 status maps must be written.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Starting status map index (see chapter 7.7)
1	Unsigned-8	Number of entries to write
2 (bits 0-3)	Enum	First status map code
2 (bits 4-7)	Enum	Second status map code
3 (bits 0-3)	Enum	Third status map code
...	Enum	Remaining status map codes

Response data bytes

Byte	Format	Description
0	Unsigned-8	Actual starting status map index
1	Unsigned-8	Number of entries actually returned
2 (bits 0-3)	Enum	First status map code
2 (bits 4-7)	Enum	Second status map code
3 (bits 0-3)	Enum	Third status map code
...	Enum	Remaining status map codes

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
8	Warning	Set to nearest possible value
9	Error	Starting status map index must be even
16	Error	Access restricted
32	Error	Busy

Condensed status mapping code

N:	0
M:	1
F:	3
S:	4
C:	5

8.79. Reset condensed status map - 525 ($020D_h$)

This command restores the condensed status map factory settings.

Request data bytes

Byte	Format	Description
None		

Response data bytes

Byte	Format	Description
None		

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

8.80. Write status simulation - 526 ($020E_h$)

This command enables or disables status simulation.

Request data bytes

Byte	Format	Description
0	Enum	Status simulation mode

Response data bytes

Byte	Format	Description
0	Enum	Status simulation mode

Command specific response codes

Code	Class	Description
0	Success	No command specific errors
2	Error	Invalid selection
5	Error	Too few data bytes received
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

Status simulation mode

Disabled: 0
Enabled: 1

8.81. Simulate status bit - 527 ($020F_h$)

This command sets or resets a specific status bit (see chapter 7.7) while simulation mode is enabled.

Request data bytes

Byte	Format	Description
0	Unsigned-8	Index of bit to be simulated
1	Enum	Simulated value code

Response data bytes

Byte	Format	Description
0	Unsigned-8	Index of bit to be simulated
1	Enum	Simulated value 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
7	Error	In write protect mode
16	Error	Access restricted
32	Error	Busy

Simulated value

Reset: 0
Set: 1

9. Performance

9.1. Sampling rates

All sensors sample: ≥1 per second
All device variables digital value calculation: ≥1 per second
All analog outputs update: ≥1 per second

9.2. Power-up

On power-up, the transmitter has to initialize itself, which takes up to 30 seconds. During this period, the device will not respond to HART commands.
As soon as the measurement screen appears on the display, Liquiline is ready to communicate via HART, no matter if there are errors present or not.
Fixed current and simulation modes are cancelled by power loss.

9.3. Reset

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

9.4. Self-test

This field device does not support a self-test.

9.5. Command response times

Minimum:	0 ms
Typical:	50 ms
Maximum:	200 ms

9.6. Busy and delayed response

The Liquiline will respond with "busy" status whenever the requested action occupies the CPU for more than 200 ms.
Delayed response mechanism is not used.

9.7. Long messages

The largest data field can be 44 bytes.

9.8. Nonvolatile memory

The device‘s configuration parameters are saved into a flash memory. New data is written to this memory by a special flash handler. Data will not be saved immediately on execution of a write command, but with a short delay or at power loss.

9.9. Operating modes

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

9.10. Write protection

Write protection can be set on Liquiline's operating panel "Setup/General settings/Bus write protection". When write protection is enabled all HART write commands will be blocked and return response code 7. Write protection has no influence on the local operating panel.

9.11. Burst mode

Liquiline does not support burst mode.

9.12. Catch device variable

Liquiline does not support device variable catching.

10. Annex A: Capability checklist

Manufacturer, model and revision:	Endress+Hauser Liquiline pHORP rev. 4
Device type:	Transmitter
HART revision:	7
Device description available:	Yes
Number and type of sensors:	1 or 2 pH/redox sensors, 1 temperature sensor (optional)
Number and type of actuators:	0
Number and type of host side signals:	2x 4 20 mA analog
Number of device variables:	7.5
Number of dynamic variables:	4
Mappable dynamic variables:	Yes / 4
Number of common practice commands:	35
Number of device specific commands:	24
Bits of additional device status:	108
Alternative operating modes:	No
Burst mode:	No
Write protection:	Yes
Condensed status:	Yes

11. Annex B: Default configuration

Please refer to the Operating Instructions.

12. Annex C: Revision history

Rev. 1, 07-Jan-2015:	Initial revision
Rev. 2, 07-Aug-2015:	Added device variables 7 and 8.
Rev. 3, 31-May-2016:	Fixed additional device status table
Rev. 4, 04-Apr-2017	Added bits to additional status

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