HART Interface
for
FLUXUS ADM 7x07, G70x
FLUXUS ADM 8x27, G80x

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Supplement to User Manual FLUXUS
SUFLUXUS_HARTV2-0EN, 2011-09-08

HART Interface (Option)

The HART interface is an option for the flowmeters FLUXUS ADM 7407, G704, ADM 7407 A2, G704 A2, ADM 7907, G709, ADM 8x27, G80x (except for ADM 8x27C24, G80xC24, ADM8027LC24) with firmware V5.90 and higher. If the flowmeter is equipped with the HART interface, the option RS485 based interfaces is not possible.

A HotCode has to be entered to select HART mode.

Settings at the Transmitter

Input of HotCode

FLUXUS ADM 7x07, G70x

Press key C. Enter the HotCode.

FLUXUS ADM 8x27, G80x

```
SYSTEM settings↕
Miscellaneous
```

Select `Special Funct.\SYSTEM settings\Miscellaneous`.

```
Input a HOTCODE
 no        >YES<
```

Select `yes`, to enter a HotCode.

```
Please input a
HOTCODE: 000000
```

Enter HotCode **485000**. Press ENTER.

Selection of HART Mode

```
HART interface
 OnlyLoop >HART<
```

Select `HART` to use HART.

Select `OnlyLoop` to operate the output as current loop.

Press ENTER.

```
HART protected
 no        >YES<
```

Select `yes` to protect the HART interface from an external configuration. Press ENTER.

This display is indicated only if `HART` has been selected.

Connection

flowmeter	terminal strip	terminal
ADM 7407, G704	KL4	P1+, P1-
ADM 7907, G709	KL1	P1+, P1-
ADM 8x27, G80x	KL2	1(-), 2(+)

Program Branch `Output Options`

```
I1: Current Loop
in HART mode
```

If HART mode is selected, a message will be displayed in program branch `Output Options` that the current loop can not be configured on the flowmeter but via the HART communication.

1 HART Field Device Specification

Table of Contents

A.1 Abbreviations

DD	device description
DTM	Device Type Manager
FDT	Field Device Tool
FSK	frequency shift keying
HCF	HART Communication Foundation
LSB	least significant bit
MSB	most significant bit
PDU	protocol data unit
PLC	programmable logic controller
PV	primary variable
QV	quaternary variable
SV	secondary variable
TV	tertiary variable

A.2 Introduction

The flowmeter FLUXUS complies with HART protocol revision 7. This document specifies all the device specific features and documents HART protocol implementation. The functionality of the flowmeter is described sufficiently to allow its proper application in a process and its complete support in HART capable host applications.

A.3 HART Communication - Basics

HART (Highway Addressable Remote Transducer) is a digital protocol for field communication. In industry it is widely accepted as a standard for digitally enhanced 4...20 mA communication with smart and microprocessor based field devices.

HART is principally a digital master/slave protocol which means a slave only sends information if it is requested to do so by a master. The digital signal is modulated on the analog current loop without affecting it. The 4...20 mA current loop reports only one process variable but at the fastest possible rate. The co-existing serial digital data channel is used to configure the device also allowing access to multiple process variables. To superimpose the digital signal with the current loop, a frequency shift keying (FSK) technique, based on the Bell 202 communication standard is used. Two frequencies, 1200 Hz and 2200 Hz are used to represent binary 1 and 0. Thus, HART communication is limited to 1200 Baud.

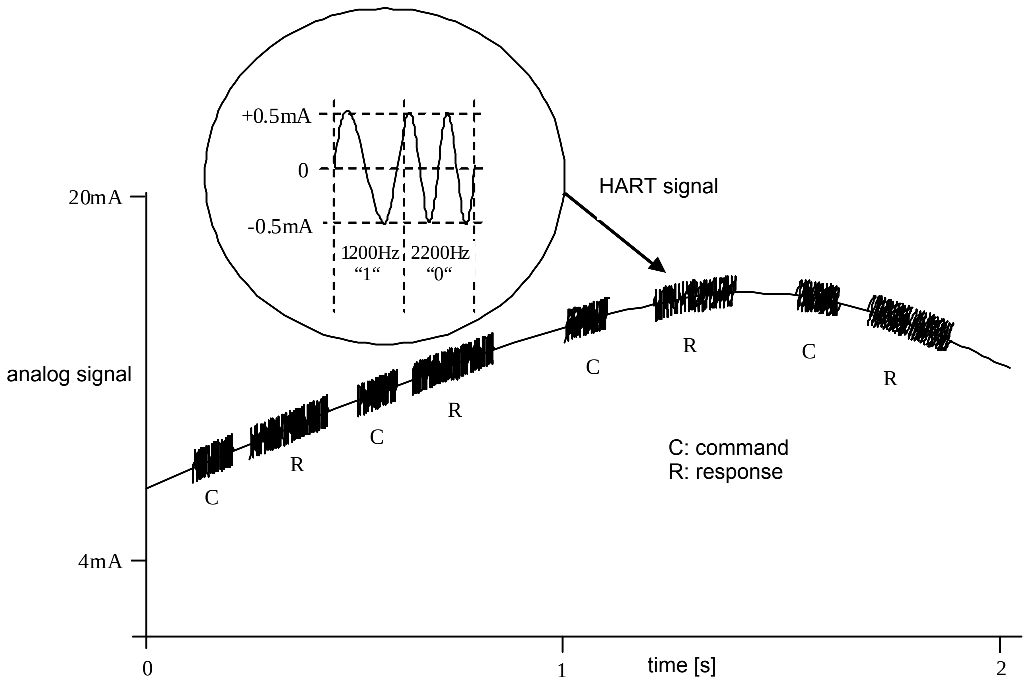

Fig. A.1: HART signal imposed on 4...20 mA

HART provides two different masters (primary and secondary) to each loop. Primary masters are typically PLCs, computer based controllers or monitoring systems. Secondary masters are for example handheld communicators. Both masters can be connected to one current loop without disturbing the communication.

HART devices can operate in one of two network configurations:

- point-to-point
- multidrop connection

In case of a point-to-point connection, the 4...20 mA signal is used to communicate one process variable, while other process variables or configuration data are transferred digitally.

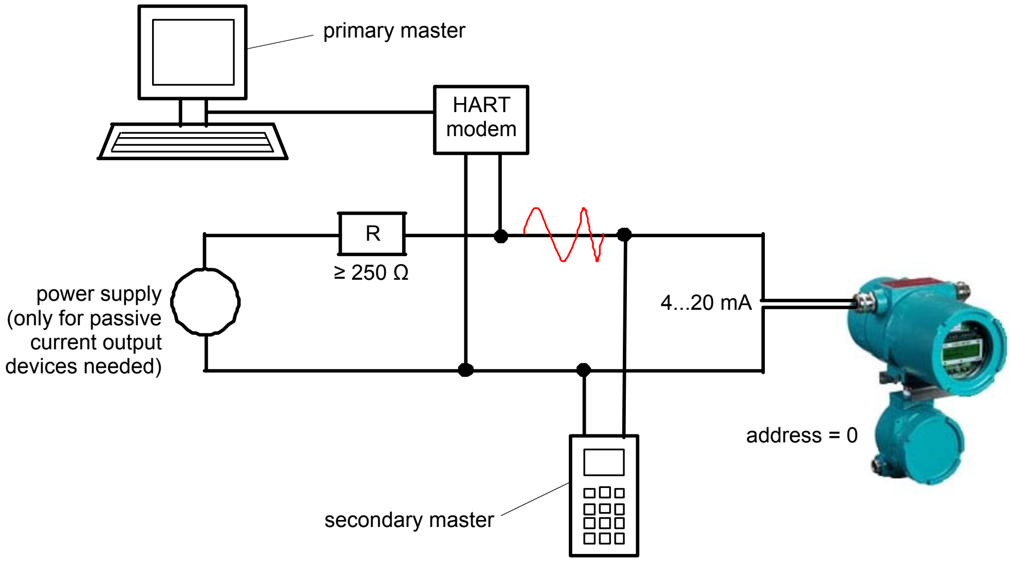

Fig. A.2: Point-to-point network

The HART protocol also has the possibility of connecting several passive current output field devices on the same loop in a multidrop network configuration. In this case, communication is limited to digital communication only. The current of each field device is fixed to 4 mA, the analog signal does not carry any information about a process variable.

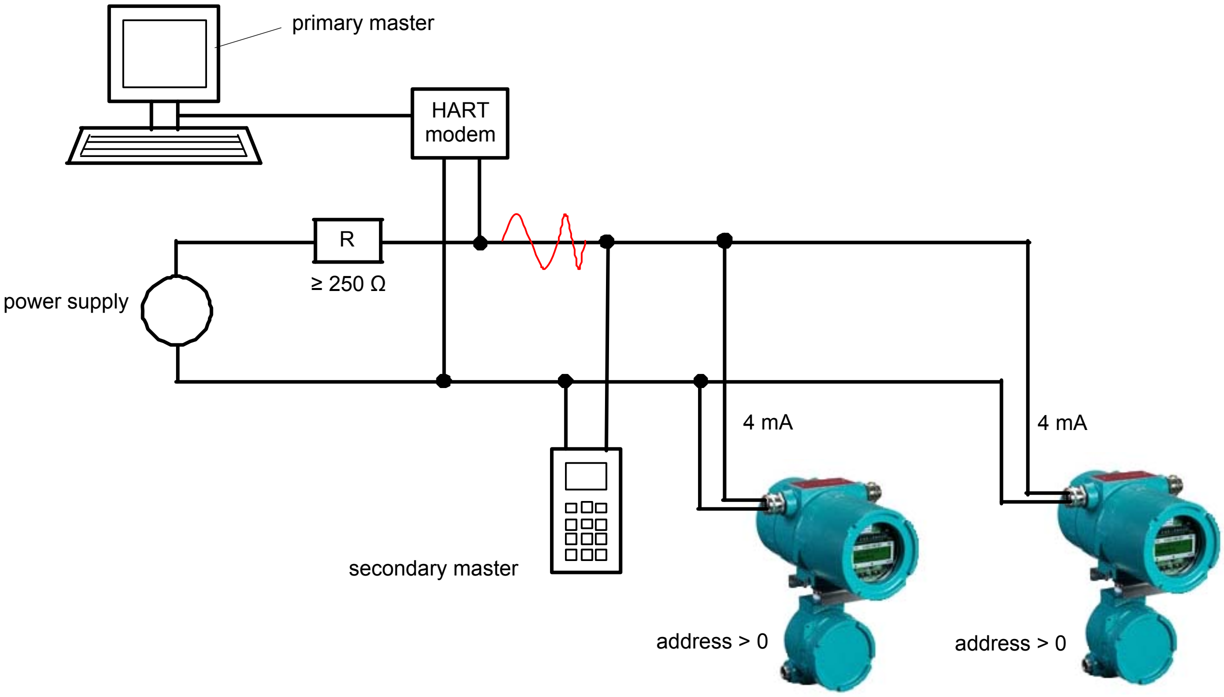

Fig. A.3: Multidrop network

It is also possible to combine passive and active current output devices in one multidrop network. For the connection see : Multidrop network with passive and active current output devices. A HART master can be connected across A and B, across B and C or across a field device to communicate with any field device.

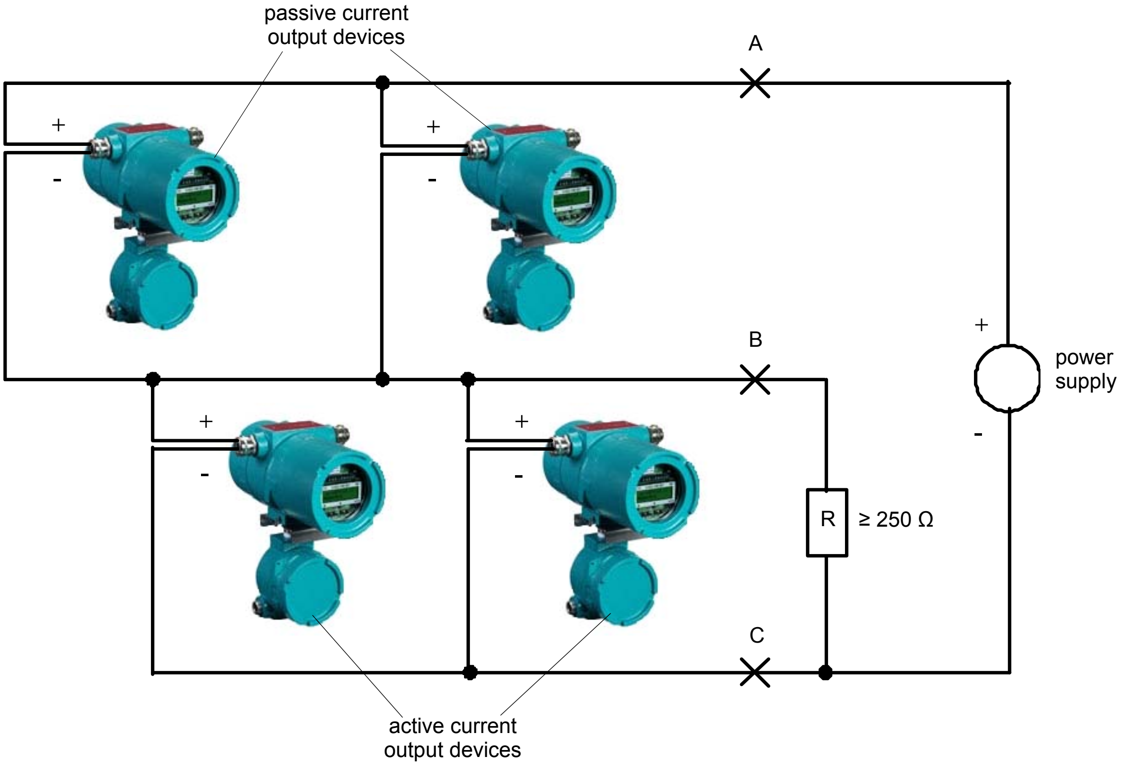

Fig. A.4: Multidrop network with passive and active current output devices

The HART protocol follows the ISO/OSI reference model. As in most field communication systems, HART uses only layer one, two and seven.

Tab. A.1: HART protocol as ISO/OSI reference model

OSI layer		function	HART
7	application	provides the user with network capable applications	command oriented, predefined data types and application procedures
6	presentation	converts application data between network and local machine formats	
5	session	connection management services for applications	
4	transport	converts application data between network and local machine formats	
3	network	end to end routing of packets, resolving network addresses	
2	data link	establishes data packet structure, framing, error detection	a binary, byte oriented, token passing, master/ slave protocol
1	physical	mechanical/electrical connection, transmits raw bit stream	simultaneous analog and digital signal, normal 4...20 mA copper wiring

A HART frame consist of the following nine fields:

Tab. A.2

field	explanation
preamble	consist of at least three 0xFF bytes, needed for synchronization of master and slave
delimiter	The start byte/delimiter shows which device (master, slave, slave in burst mode) sends and whether short or long PDU (protocol data unit) is used
address	If short addressing is used, the address consist of 1 byte. The first bit is used to differentiate between primary and secondary master. The second bit is used to identify a burst message. The addressing of a field device is provided by 4 bits (address 0...15) ≤ Rev6 or by 6 bits (address 0...63) > Rev6. The address for long addressing consists of 5 bytes
[expansion bytes]	option, definition controlled by the HART Communication Foundation
command	byte for HART command
byte count	length of the data field (status and data bytes)
status	1 byte each for communication error/response code and device status
[data]	option, for information transferred between the host application and the field device
check byte	XOR checksum across all message bytes starting with the delimiter

A.4 General Field Device Information

The flowmeter FLUXUS has a 4...20 mA current output and HART capability. Dependent on device configuration the current output can be operate in active or passive mode.

The flowmeter FLUXUS communicates only as non-bursting slaves and must be used in a system with a HART primary or secondary master.

Tab. A.3: Field device identification summary

manufacturer name	FLEXIM
manufacturer ID code	6021 (Hex)
model name	FLUXUS
expanded device type code	E0BD (Hex)
device revision	3
HART protocol revision	7
physical layers supported	Bell 202 FSK
physical device category	ultrasonic flowmeter

A.4.1 HART Specific Default Settings

Tab. A.4: HART specific default settings

HART parameter	default value
slave address	0
number of response preambles	5
tag	*-FLX-*
descriptor	*-*FLUXUS*-*
message	F-L-X-F-L-X-F-L-X-F-L-X-F-L-X-
long tag	FLX - LONG TAG
final assembly number	0
day/month/year	28/01/1980
PV lower range value	0
PV upper range value	30
dynamic variable PV	7 (volumetric flow rate)
dynamic variable SV	8 (volumetric flow rate, positive totalizer)
dynamic variable TV	5 (sound speed)
dynamic variable QV	6 (flow velocity)
PV unit	19 (m^3/h)
SV unit	43 (m^3)
TV unit	21 (m/s)
QV unit	21 (m/s)
configuration changed primary master	false
configuration changed secondary master	false
configuration changed counter	0
count of STX messages received	0
count of ACK messages sent	0
count of BACK messages sent	0
current loop output error value	21

A.4.2 Device Description

The Electronic Device Description Language is used to describe information and data which are accessible in the field device. The result is a text based file, the device description (DD).

This DD can be interpreted by several programs and must be used for enhanced configuration of the flowmeter FLUXUS by HART protocol, including device specific commands. For the time of publication of this document, the DD Rev.1, 2 and 3 were tested with the following tools:

- SDC625 V.2.1.1
- SIEMENS SIMATIC PDM V6.0 SP4
- 375 Field Communicator HART Toolkit Revision 3.1.1
- FieldMate Advance R2.01.10 (trial edition)

A.4.3 Device Type Manager

The Device Type Manager (DTM) is a non-standalone windows PC program. It has to be installed and has to be executed in a frame application called Field Device Tool (FDT) container (e.g. PACTware or M&Ms fdtCONTAINER). The FLUXUS DTM is programmed according to FDT specification 1.2 and includes the device specific information to communicate and configure HART capable FLUXUS transmitters.

A.5 Analog Output

The 2-wire 4...20 mA passive current output of the flowmeter will be used as HART interface. This output corresponds to the PV. The process value will be output linearized and scaled as configured on the flowmeter.

The update time of the current loop in mode `OnlyLoop` is 250 ms. If `HART` is activated, the update time of the current loop increases to 500 ms.

For connection and configuration of the analog output see the FLUXUS user manual.

Tab. A.5: Analog output characteristics

		values (percent of range)	**values**
linear range	down	0 %	4.0 mA
	up	+100 %	20.0 mA
current	min.	-3.125 %	3.5 mA
	max.	+106.25 %	21 mA
multidrop current draw		0 %	4 mA
min. lift-off voltage			7 V

Linear Range

The PV process value is scaled linearly on the current output.

Current Loop Output Error Value

In case of an error (e.g. measurement is not started and the error value delay is expired), an error value is output. The error value will be set by HART command 191. Range: 3.5...22 mA, default: 21 mA.

Current Minimum/Maximum

The min. and max. configurable current, e.g. by command 40 (Enter/Exit Fixed Current Mode).

Multidrop Current Draw

To enable multidrop mode (parallel connected devices), the process value will not be output. A fixed current value of 4 mA will be output instead.

Lift-off Voltage

The connection of a voltage source of min. 7 V is required for the correct operation of the current output.

A.6 Supported HART Commands

A.6.1 Universal Commands

All devices using the HART protocol must recognize and support the universal commands. The flowmeter FLUXUS support all 22 specified universal HART commands:

Tab. A.6: Supported universal commands

command	name
0	read unique identifier
1	read primary variable
2	read loop current and percent of range
3	read dynamic variables and loop current
6	write polling address
7	read loop configuration
8	read dynamic variable classifications
9	read device variables with status
11	read unique identifier associated with tag
12	read message
13	read tag, descriptor, date
14	read primary variable transducer information
15	read device information
16	read final assembly number
17	write message
18	write tag, descriptor, date
19	write final assembly number
20	read long tag
21	read unique identifier associated with long tag
22	write long tag
38	reset configuration changed flag
48	read additional device status

The data types used in following tables are indicated as follows:

Tab. A.7: Data types

A	ASCII string (packed 4 characters per 3 bytes)
B	bit mapped flags
D	date (3 bytes: day, month, year 1900)
E	enum
F	floating point (4 bytes IEEE 754)
I	integer
P	packed ASCII

Tab. A.8: **Command 0**: read unique identifier
(returns identity information about the field device)

request data bytes	none			
response data bytes	**byte no.**		**value**	**data type**
	0	"254" (expansion)	- 254	I
	1...2	expanded device type (MSB...LSB)	- 0xE0BD	E
	3	number of request preambles	- 5	I
	4	HART protocol major revision	- 7	I
	5	device revision level	- X	I
	6	software revision	- X	I
	7	hardware revision(MS5B)/ physical signaling code (LS3B)	- XXXXX000	I E
	8	flags	- 1	B
	9...11	device ID number (MSB...LSB)	- X	I
	12	minimum number of response preambles	- 5	I
	13	maximum number of device variables	- 179	I
	14...15	configuration change counter (MSB...LSB)	- X	I
	16	extended field device status	- X	B
	17...18	manufacturer identification code	- 0x6021	E
	19...20	private label distributor code	- 0x6021	E
	21	device profile	- 1	E
response codes	0	no command specific errors		

X - device specific

The device ID consist of three bytes. These three bytes are different for every existing field device. The first byte represents the device class (see : FLUXUS device types). The second and third bytes (16 bit) describe an incremented number (last digit of serial number).

Tab. A.9: FLUXUS device types

device class	**device type**	**first byte**
7407	ADM 7407, G704 ADM 7407 A2, G704 A2	5
ADM 7907	ADM 7907, G709	8
8027	ADM 8027, G800	9
8127	ADM 8127, G801	10
unknown device		255

Tab. A.10: **Command 1**: read primary variable
(reads the primary variable with its unit code)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	primary variable unit code	E
	1...4	primary variable (F)	F
response codes	0	no command specific errors	

Tab. A.11: **Command 2**: read loop current and percent of range
(reads the loop current and its associated percent of range)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...3	primary variable loop current in mA (F)	F
	4...7	primary variable percent of range (F)	F
response codes	0	no command specific errors	

Tab. A.12: **Command 3**: read dynamic variables and loop current
(reads the loop current and max. 4 predefined dynamic variables)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...3	primary variable loop current in mA (F)	F
	4	primary variable unit code	E
	5...8	primary variable (F)	F
	9	secondary variable unit code	E
	10...13	secondary variable (F)	F
	14	tertiary variable unit code	E
	15...18	tertiary variable (F)	F
	19	quaternary variable unit code	E
	20...23	quaternary variable (F)	F
response codes	0	no command specific errors	

Tab. A.13: **Command 6**: write polling address
(writes the polling address and the loop current mode to the field device)

request data bytes	**byte no.**		**data type**
	0	polling address of device	I
	1	loop current mode	E
response data bytes	**byte no.**		**data type**
	0	polling address of device	I
	1	loop current mode	E
response codes	0	no command specific errors	
	2	invalid poll address selection	
	5	too few data bytes received	
	12	invalid mode selection	

Tab. A.14: **Command 7**: read loop configuration
(read polling address and the loop current mode)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	polling address of device	I
	1	loop current mode	E
response codes	0	no command specific errors	

Tab. A.15: **Command 8**: read dynamic variable classifications
(reads the classification associated with the dynamic variables)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	primary variable classification	E
	1	secondary variable classification	E
	2	tertiary variable classification	E
	3	quaternary variable classification	E
response codes	0	no command specific errors	

Tab. A.16: **Command 9**: read device variables with status
(allows a master to request the value and status of max. 8 device variables)

request data bytes	**byte no.**		**data type**
	0...7	slot 0...slot 7: device variable code	I
response data bytes	**byte no.**		**data type**
	0	extended field device status	B
	1	slot 0: device variable code	E
	2	slot 0: device variable classification	E
	3	slot 0: unit code	E
	4...7	slot 0: device variable value (F)	F
	8	slot 0: device variable status	B
	9	slot 1: device variable code	E
	10	slot 1: device variable classification	E
	11	slot 1: unit code	E
	12...15	slot 1: device variable value (F)	F
	16	slot 1: device variable status	B
	17	slot 2: device variable code	E
	18	slot 2: device variable classification	E
	19	slot 2: unit code	E
	20...23	slot 2: device variable value (F)	F
	24	slot 2: device variable status	B
	25	slot 3: device variable code	E
	26	slot 3: device variable classification	E
	27	slot 3: unit code	E
	28...31	slot 3: device variable value	F
	32	slot 3: device variable status	B
	33	slot 4: device variable code	E
	34	slot 4: device variable classification	E
	35	slot 4: unit code	E
	36...39	slot 4: device variable value (F)	F
	40	slot 4: device variable status	B
	41	slot 5: device variable code	E
	42	slot 5: device variable classification	E
	43	slot 5: unit code	E
	44...47	slot 5: device variable value (F)	F
	48	slot 5: device variable status	B
	49	slot 6: device variable code	E
	50	slot 6: device variable classification	E
	51	slot 6: unit code	E
	52...55	slot 6: device variable value (F)	F
	56	slot 6: device variable status	B
	57	slot 7: device variable code	E
	58	slot 7: device variable classification	E
	59	slot 7: unit code	E
	60...63	slot 7: device variable value (F)	F
	64	slot 7: device variable status	B
response codes	0	no command specific errors	

Tab. A.17: **Command 11**: read unique identifier associated with tag
(This command may be issued using either the device's long frame address or the broadcast address. No response is made unless the tag matches that of the device. The command returns the same identity information as command 0.)

request data bytes	**byte no.**		**data type**
	0...5	tag - 8 chars	P
response data bytes	0...21	same as command 0: read unique identifier	
response codes	0	no command specific errors	

Tab. A.18: **Command 12**: read message
(reads the message contained within the device)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...23	message	P
response codes	0	no command specific errors	

Tab. A.19: **Command 13**: read tag, descriptor, date
(reads the tag, descriptor and date contained within the device)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...5	tag - 8 chars	P
	6...17	descriptor - 16 chars	P
	18...20	date	D
response codes	0	no command specific errors	

Tab. A.20: **Command 14**: read primary variable transducer information
(reads the transducer serial number, limits/minimum span unit code, upper transducer limit, lower transducer limit and minimum span for the primary variable transducer)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...2	transducer serial number (24 bit)	I
	3	transducer limits and min. span unit code	E
	4...7	upper transducer limit	F
	8...11	lower transducer limit	F
	12...15	min. span (F)	F
response codes	0	no command specific errors	

Tab. A.21: **Command 15**: read device information
(reads the alarm selection code, transfer function code, range values unit code, PV upper range value, PV lower range value, damping value and write protection code)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	PV alarm selection code	E
	1	PV transfer function code	E
	2	PV upper and lower range values unit code	E
	3...6	PV upper range value (F)	F
	7...10	PV lower range value (F)	F
	11...14	PV damping value (units of seconds) (F)	F
	15	write protect code	E
	16	reserved by HCF, must be set to 250, not used	E
	17	PV analog channel flags	B
response codes	0	no command specific errors	

Tab. A.22: **Command 16**: read final assembly number
(reads the final assembly number associated with the device)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...2	final assembly number	I
response codes	0	no command specific errors	

Tab. A.23: **Command 17**: write message
(writes the message into the device)

request data bytes	**byte no.**		**data type**
	0...23	message	P
response data bytes	**byte no.**		**data type**
	0...23	message	P
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.24: **Command 18**: write tag, descriptor, date
(writes the tag, descriptor, and date into the device)

request data bytes	**byte no.**		**data type**
	0...5	tag - 8 chars	P
	6...17	descriptor - 16 chars	P
	18...20	date	D
response data bytes	**byte no.**		**data type**
	0...5	tag - 8 chars	P
	6...17	descriptor - 16 chars	P
	18...20	date	D
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.25: **Command 19**: write final assembly number
(writes final assembly number into the device)

request data bytes	**byte no.**		**data type**
	0...2	final assembly number	I
response data bytes	**byte no.**		**data type**
	0...2	final assembly number	I
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.26: **Command 20**: read long tag
(reads the (32 character full ISO Latin-1 ASCII) long tag)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...31	long tag	A
response codes	0	no command specific errors	

Tab. A.27: **Command 21**: read Unique Identifier Associated With long tag
(This command may be issued using the either the device's long frame address ort he broadcast address.)

request data bytes	**byte no.**		**data type**
	0...31	long tag	A
response data bytes	0...21	same as command 0: read unique identifier	
response codes	0	no command specific errors	

Tab. A.28: **Command 22**: write long tag
(writes the 32-byte long tag)

request data bytes	**byte no.**		**data type**
	0...31	long tag	A
response data bytes	**byte no.**		**data type**
	0...31	long tag	A
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.29: **Command 38**: reset configuration changed flag
(resets the bit 6 of the device status byte)

request data bytes	**byte no.**		**data type**
	0...1	configuration changed counter	I
response data bytes	**byte no.**		**data type**
	0...1	configuration changed counter	I
response codes	0	no command specific errors	
	7	in write protect mode	
	9	configuration change counter mismatch	

Tab. A.30: **Command 48**: read additional device status

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...5	device specific status	B
	6	extended device status	B
	7	device operating mode	B
	8	standardized status 0	B
response codes	0	no command specific errors	

A.6.2 Common Practice Commands

The following table shows the supported common practice commands.

Tab. A.31: Supported common practice commands

command	designation
33	read device variables
35	write primary variable range values
40	enter/exit fixed current mode
44	write primary variable unit
50	read dynamic variable assignments
51	write dynamic variable assignments
53	write device variable units
59	write number of response preambles
79	write device variable
95	read device communication statistics

The data types used in following tables are indicated as follows:

Tab. A.32: Data types

A	ASCII string (packed 4 characters per 3 bytes)
B	bit mapped flags
D	date (3 bytes: day, month, year 1900)
E	enum
F	floating point (4 bytes IEEE 754)
I	integer
P	packed ASCII

Tab. A.33: **Command 33**: read device variables
(allows a master to request the value of max. 4 device variables.
It is not necessary to read 4 variables. 1, 2 or 3 variable codes can be transferred, too.
The response contains 6, 12, 18 or 24 data bytes correspondingly.)

request data bytes	**byte no.**		**data type**
	0	transmitter variable code for slot 0	E
	1	transmitter variable code for slot 1	E
	2	transmitter variable code for slot 2	E
	3	transmitter variable code for slot 3	E
response data bytes	**byte no.**		**data type**
	0	slot 0: device variable code	E
	1	slot 0: unit code	E
	2...5	slot 0: device variable value	F
	6	slot 1: device variable code	E
	7	slot 1: unit code	E
	8...11	slot 1: device variable value	F
	12	slot 2: device variable code	E
	13	slot 2: unit code	E
	14...17	slot 2: device variable value	F
	18	slot 3: device variable code	E
	19	slot 3: unit code	E
	20...23	slot 3: device variable value	F
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	

Tab. A.34: **Command 35**: write primary variable range values
(defines the relationship between the loop current 4.00 and 20.00 mA points and the primary variable value)

request data bytes	**byte no.**		**data type**
	0	upper and lower range values unit code	E
	1...4	upper range value	F
	5...8	lower range value	F
response data bytes	**byte no.**		**data type**
	0	upper and lower range values unit code	E
	1...4	upper range value	F
	5...8	lower range value	F
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	
	9	lower range value too high	
	10	lower range value too low	
	11	upper range value too high	
	12	upper value too low	
	18	invalid unit code	
	29	invalid span	

Tab. A.35: **Command 40**: enter/exit fixed current mode
(The device is placed in fixed current mode with the loop current set to the value received.
The value returned in the response data bytes reflects the rounded or truncated value actually
used by the device. A level of 0 exits the fixed current mode. Fixed current mode will also be
exited when power is removed from device.)

request data bytes	**byte no.**		**data type**
	0...3	fixed current level in mA	F
response data bytes	**byte no.**		**data type**
	0...3	fixed current level in mA	F
response codes	0	no command specific errors	
	3	passed parameter too large	
	4	passed parameter too small	
	5	too few data bytes received	
	7	in write protect mode	
	11	loop current not active (device in multidrop mode)	

Tab. A.36: **Command 44**: write primary variable units
(selects the units in which the primary variable and its range will be returned. This command also
selects the unit for transducer limits and minimum span)

request data bytes	**byte no.**		**data type**
	0	primary variable unit code	E
response data bytes	**byte no.**		**data type**
	0	primary variable unit code	E
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.37: **Command 50**: read dynamic variable assignments
(responds with the device variable numbers that are assigned to the primary, secondary, tertiary and quaternary variables)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	device variable assigned to the primary variable	E
	1	device variable assigned to the secondary variable	E
	2	device variable assigned to the tertiary variable	E
	3	device variable assigned to the quaternary variable	E
response codes	0	no command specific errors	

Tab. A.38: **Command 51**: write dynamic variable assignments
(assigns device variables to the primary, secondary, tertiary and quaternary variables)

request data bytes	**byte no.**		**data type**
	0	device variable assigned to the primary variable	E
	1	device variable assigned to the secondary variable	E
	2	device variable assigned to the tertiary variable	E
	3	device variable assigned to the quaternary variable	E
response data bytes	**byte no.**		**data type**
	0	device variable assigned to the primary variable	E
	1	device variable assigned to the secondary variable	E
	2	device variable assigned to the tertiary variable	E
	3	device variable assigned to the quaternary variable	E
response codes	0	no command specific errors	

Tab. A.39: **Command 53**: write device variable units
(selects the units in which the selected device variable will be returned)

request data bytes	**byte no.**		**data type**
	0	device variable code	E
	1	device variable unit code	E
response data bytes	**byte no.**		**data type**
	0	device variable code	E
	1	device variable unit code	E
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	
	11	invalid device variable code	
	12	invalid unit code	

Tab. A.40: **Command 59**: write number of response preambles
(sets the number of asynchronous 0xFF preamble bytes to be sent before the start of a response message.)

request data bytes	**byte no.**		**data type**
	0	number of response preambles	I
response data bytes	**byte no.**		**data type**
	0	number of response preambles	I
response codes	0	no command specific errors	
	3	passed parameter too large	
	4	passed parameter too small	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.41: **Command 79**: write device variable
(a device variable is set to a fixed value temporarily or a device variable is simulated)

request data bytes	**byte no.**		**data type**
	0	device variable code	E
	1	write device variable command code	E
	2	device variable unit code	E
	3...6	device variable value	F
	7	device variable status	B
response data bytes	**byte no.**		**data type**
	0	number of response preambles	E
	1	write device variable command code	E
	2	device variable unit code	E
	3...6	device variable value	F
	7	device variable status	B
response codes	0	no command specific errors	
	5	too few data bytes received	
	7	in write protect mode	
	10	invalid write device variable code	
	12	invalid unit code	
	17	invalid device variable index	

code	**write device variable command description**
0	normal
1	fixed value

code	**device variable status**
0xC0	good
0x40	poor accuracy
0x80	manual/fixed
0x00	bad

Tab. A.42: **Command 95**: read device communication statistics
(reads the communication statistic of the field device. This includes the received messages from the master (STX - start of transaction) and the sent messages by the field device in burst bode (BACK - burst acknowledge) and normal mode (ACK - acknowledge))

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...1	count of STX messages received by the device	I
	2...3	count of ACK messages sent from the device	I
	4...5	count of BACK messages sent from the device	I
response codes	0	no command specific errors	

A.6.3 Device Specific Commands

The following table shows the supported device specific commands.

Tab. A.43: Supported device specific commands

command	designation
179	deactivate simulation mode of all device variables
190	read current loop output error value
191	write current loop output error value
194	read PV/current loop with sign or absolute
195	write PV/current loop with sign or absolute
200	read FLUXUS serial number
201	read FLUXUS firmware information
202	read HART timeserial number
203	read HART firmware version
230	clear totalizer
240	read error value delay
241	write error value delay
253	reset HART specific settings to factory default

The data types used in following tables are indicated as follows:

Tab. A.44: Data types

A	ASCII string (packed 4 characters per 3 bytes)
B	bit mapped flags
D	date (3 bytes: day, month, year 1900)
E	enum
F	floating point (4 bytes IEEE 754)
I	integer
P	packed ASCII

Tab. A.45: **Command 179**: deactivate simulation mode of all device variables
(resets all device variables to normal if one or more device variables are in simulation mode (see command 79)
One data byte (123) has to be written to the transmitter.)

request data bytes	**byte no.**		**data type**
	0	123	I
response data bytes	none		
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.46: **Command 190**: read current loop error output value
(reads the current loop output error value in mA)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...3	current loop output error value	F
response codes	0	no command specific errors	

Tab. A.47: **Command 191**: write current loop error output value
(writes the current loop output error value in mA)

request data bytes	**byte no.**		**data type**
	0...3	current loop output error value	F
response data bytes	**byte no.**		**data type**
	0...3	current loop output error value	F
response codes	0	no command specific errors	
	3	passed parameter too large	
	4	passed parameter too small	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.48: **Command 194**: read PV/current loop with sign or absolute
(reads whether the sign of the PV is to be considered for the current loop output
0 - with sign, 1 - absolute)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	PV/current loop with sign or absolute	I
response codes	0	no command specific errors	

Tab. A.49: **Command 195**: write PV/current loop with sign or absolute
(writes whether the sign of the PV is to be considered for the current loop output
0 - with sign, 1 - absolute)

request data bytes	**byte no.**		**data type**
	0	PV/current loop with sign or absolute	I
response data bytes	**byte no.**		**data type**
	0	PV/current loop with sign or absolute	I
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.50: **Command 200**: read FLUXUS serial number
(reads the FLUXUS serial number (16 ASCII characters))

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...15	FLUXUS serial number	A
response codes	0	no command specific errors	

Tab. A.51: **Command 201**: read FLUXUS firmware version
(reads the FLUXUS firmware version (16 ASCII characters))

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...15	FLUXUS firmware version	A
response codes	0	no command specific errors	

Tab. A.52: **Command 202**: read HART serial number
(reads the HART serial number (15 ASCII characters))

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0...14	HART serial number	A
response codes	0	no command specific errors	

Tab. A.53: **Command 203**: read HART firmware version
(reads the HART firmware version, the first byte represents the major and the second byte the sub version)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	HART major version	I
	1	HART sub version	I
response codes	0	no command specific errors	

Tab. A.54: **Command 230**: clear totalizer
(sets the totalizer value to zero. It is possible to choose the totalizer of a physical (A, B, C, D), virtual (Z, Y) or all channels(*) by setting the first data byte (channel ID). This first data byte has to be written with the ASCII value of the channel ID (example: channel A = 65 = 0x41).
The second byte represents the totalizer type. It is possible to reset only positive ('+'), only negative ('-') or both ('*') totalizers. As at the channel ID it is necessary to specify the ASCII value of '+' (43 = 0x2B), '-' (45 = 0x2D) or '*' (42 = 0x2A).)

request data bytes	**byte no.**		**data type**
	0	channel ID	I
	1	totalizer ID	I
response data bytes	none		
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.55: **Command 240**: read error value delay
(reads the timeout value, which determines how many seconds must past before the status of a device variable changes to poor accuracy and the current loop changes to the current loop output error value.)

request data bytes	none		
response data bytes	**byte no.**		**data type**
	0	error value delay	I
response codes	0	no command specific errors	

Tab. A.56: **Command 241**: write error value delay
(writes the timeout value, which determines how many seconds must past before the status of a device variable changes to poor accuracy and the current loop changes to the current loop output error value.)

request data bytes	**byte no.**		**data type**
	0	error value delay	I
response data bytes	**byte no.**		**data type**
	0	error value delay	I
response codes	0	no command specific errors	
	4	passed parameter too small	
	5	too few data bytes received	
	7	in write protect mode	

Tab. A.57: **Command 253**: reset HART specific settings to factory default
(resets the HART specific default settings. One data byte (1) has to be written to the device.)

request data bytes	**byte no.**		**data type**
	0	1	I
response data bytes	none		
response codes	0	no command specific errors	
	2	invalid selection	
	5	too few data bytes received	
	7	in write protect mode	

A.7 Device Variables and Units

FLUXUS flowmeters are multichannel/sensor devices:

- channel A, B, C, D → physical channels
- channel Z, Y → virtual/calculation channels

All device variables listed in table 5.1 are available over HART interface. Defaults are:

- primary process variable (PV) → volumetric flow rate (7)
- secondary process variable (SV) → volumetric flow rate, positive totalizer (8)
- tertiary process variable (TV) → sound speed (5)
- quaternary process variable (QV) → flow velocity (6)
- unit primary process variable → m^3/h (19)
- unit secondary process variable → m^3 (43)
- unit tertiary process variable → m/s (21)
- unit quaternary process variable → m/s (21)

The upper 3 bits of every device variable code represents the channel. The lower 5 bits represents the measuring value of the determined channel.

channel MSB	channel	channel LSB	MeasVal	MeasVal	MeasVal	MeasVal	MeasVal LSB

example: volumetric flow rate of channel B → device variable
code 39 = 0x27 = 00100111

Note!	Only the first 20 device variables of every channel except the totalizers are mapable to the PV (primary variable).

Tab. A.58: Device variables

device variable code	variable name	unit code	classification	
channel A				
0 (0x00)	temperature fluid - TFV	see Tab. A.67	temperature	64 - 0x40
1 (0x01)	temperature inlet - TIV	see Tab. A.67	temperature	64 - 0x40
2 (0x02)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
3 (0x03)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
4 (0x04)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
5 (0x05)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
6 (0x06)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
7 (0x07)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
8 (0x08)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
9 (0x09)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
10 (0x0A)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
11 (0x0B)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
12 (0x0C)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
13 (0x0D)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
14 (0x0E)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
15 (0x0F)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
16 (0x10)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
17 (0x11)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
18 (0x12)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
19 (0x13)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A
20 (0x14)	SNR (signal-to-noise ratio)	see Tab. A.68	not classified	0 - 0x00
21 (0x15)	SCNR (signal to clutter plus noise ratio)	see Tab. A.68	not classified	0 - 0x00
22 (0x16)	reserved			
23 (0x17)	reserved			
24 (0x18)	reserved			
25 (0x19)	reserved			
26 (0x1A)	reserved			
27 (0x1B)	reserved			
28 (0x1C)	reserved			
29 (0x1D)	reserved			
30 (0x1E)	reserved			
31 (0x1F)	reserved			

Tab. A.58: Device variables

device variable code	variable name	unit code	classification	
channel B				
32 (0x20)	temperature fluid - TFV	see Tab. A.67	temperature	64 - 0x40
33 (0x21)	temperature inlet - TIV	see Tab. A.67	temperature	64 - 0x40
34 (0x22)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
35 (0x23)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
36 (0x24)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
37 (0x25)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
38 (0x26)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
39 (0x27)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
40 (0x28)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
41 (0x29)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
42 (0x2A)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
43 (0x2B)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
44 (0x2C)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
45 (0x2D)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
46 (0x2E)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
47 (0x2F)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
48 (0x30)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
49 (0x31)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
50 (0x32)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
51 (0x33)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A
52 (0x34)	SNR (signal-to-noise ratio)	see Tab. A.68	not classified	0 - 0x00
53 (0x35)	SCNR (signal to clutter plus noise ratio)	see Tab. A.68	not classified	0 - 0x00
54 (0x36)	reserved			
55 (0x37)	reserved			
56 (0x38)	reserved			
57 (0x39)	reserved			
58 (0x3A)	reserved			
59 (0x3B)	reserved			
60 (0x3C)	reserved			
61 (0x3D)	reserved			
62 (0x3E)	reserved			
63 (0x3F)	reserved			

Tab. A.58: Device variables

device variable code	variable name	unit code	classification	
channel C				
64 (0x40)	temperature fluid - TFV	see Tab. A.67	temperature	64 - 0x40
65 (0x41)	temperature inlet - TIV	see Tab. A.67	temperature	64 - 0x40
66 (0x42)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
67 (0x43)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
68 (0x44)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
69 (0x45)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
70 (0x46)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
71 (0x47)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
72 (0x48)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
73 (0x49)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
74 (0x4A)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
75 (0x4B)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
76 (0x4C)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
77 (0x4D)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
78 (0x4E)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
79 (0x4F)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
80 (0x50)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
81 (0x51)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
82 (0x52)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
83 (0x53)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A
84 (0x54)	SNR (signal-to-noise ratio)	see Tab. A.68	not classified	0 - 0x00
85 (0x55)	SCNR (signal to clutter plus noise ratio)	see Tab. A.68	not classified	0 - 0x00
86 (0x56)	reserved			
87 (0x57)	reserved			
88 (0x58)	reserved			
89 (0x59)	reserved			
90 (0x5A)	reserved			
91 (0x5B)	reserved			
92 (0x5C)	reserved			
93 (0x5D)	reserved			
94 (0x5E)	reserved			
95 (0x5F)	reserved			

Tab. A.58: Device variables

device variable code	**variable name**	**unit code**	**classification**	
channel D				
96 (0x60)	temperature fluid - TFV	see Tab. A.67	temperature	64 - 0x40
97 (0x61)	temperature inlet - TIV	see Tab. A.67	temperature	64 - 0x40
98 (0x62)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
99 (0x63)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
100 (0x64)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
101 (0x65)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
102 (0x66)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
103 (0x67)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
104 (0x68)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
105 (0x69)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
106 (0x6A)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
107 (0x6B)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
108 (0x6C)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
109 (0x6D)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
110 (0x6E)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
111 (0x6F)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
112 (0x70)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
113 (0x71)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
114 (0x72)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
115 (0x73)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A
116 (0x74)	SNR (signal-to-noise ratio)	see Tab. A.68	not classified	0 - 0x00
117 (0x75)	SCNR (signal to clutter plus noise ratio)	see Tab. A.68	not classified	0 - 0x00
118 (0x76)	reserved			
119 (0x77)	reserved			
120 (0x78)	reserved			
121 (0x79)	reserved			
122 (0x7A)	reserved			
123 (0x7B)	reserved			
124 (0x7C)	reserved			
125 (0x7D)	reserved			
126 (0x7E)	reserved			
127 (0x7F)	reserved			

Tab. A.58: Device variables

device variable code	variable name	unit code	classification	
channel Z				
128 (0x80)	temperature fluid - TFV	see Tab. A.67	temperature	64 - 0x40
129 (0x81)	temperature inlet - TIV	see Tab. A.67	temperature	64 - 0x40
130 (0x82)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
131 (0x83)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
132 (0x84)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
133 (0x85)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
134 (0x86)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
135 (0x87)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
136 (0x88)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
137 (0x89)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
138 (0x8A)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
139 (0x8B)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
140 (0x8C)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
141 (0x8D)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
142 (0x8E)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
143 (0x8F)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
144 (0x90)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
145 (0x91)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
146 (0x92)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
147 (0x93)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A

Tab. A.58: Device variables

device variable code	variable name	unit code	classification	
channel Y				
160 (0xA0)	temperatur fluid - TFV	see Tab. A.67	temperature	64 - 0x40
161 (0xA1)	temperatur inlet - TIV	see Tab. A.67	temperature	64 - 0x40
162 (0xA2)	pressure fluid - PFV	see Tab. A.66	pressure	65 - 0x41
163 (0xA3)	pressure inlet - PIV	see Tab. A.66	pressure	65 - 0x41
164 (0xA4)	signal amplitude - SAV	see Tab. A.69	not classified	0 - 0x00
165 (0xA5)	sound speed - CFV	see Tab. A.63	velocity	67 - 0x43
166 (0xA6)	flow velocity - FMV	see Tab. A.63	velocity	67 - 0x43
167 (0xA7)	volumetric flow rate - VMV	see Tab. A.59	volumetric flow rate	66 - 0x42
168 (0xA8)	volumetric flow rate, positive totalizer - VQP	see Tab. A.60	volume	68 - 0x44
169 (0xA9)	volumetric flow rate, negative totalizer - VQN	see Tab. A.60	volume	68 - 0x44
170 (0xAA)	standardized volumetric flow rate (gas measurement) - NMV	see Tab. A.59	volumetric flow rate	66 - 0x42
171 (0xAB)	standardized volumetric flow rate, positive totalizer - NQP	see Tab. A.60	volume	68 - 0x44
172 (0xAC)	standardized volumetric flow rate, negative totalizer - NQN	see Tab. A.60	volume	68 - 0x44
173 (0xAD)	mass flow - MMV	see Tab. A.64	mass flow	72 - 0x48
174 (0xAE)	mass flow, positive totalizer - MQP	see Tab. A.61	mass	71 - 0x47
175 (0xAF)	mass flow, negative totalizer - MQN	see Tab. A.61	mass	71 - 0x47
176 (0xB0)	heat flow - HMV	see Tab. A.65	power	79 - 0x4F
177 (0xB1)	heat flow, positive totalizer - HQP	see Tab. A.62	energy	77 - 0x4D
178 (0xB2)	heat flow, negative totalizer - HQN	see Tab. A.62	energy	77 - 0x4D
179 (0xB3)	concentration - KMV	see Tab. A.69	concentration	90 - 0x5A

A.8 Unit Codes

Tab. A.59: Unit IDs - volumetric flow rate

unit of measurement	HART - unit ID
cubic meter per hour (m3/h)	19 - 0x13
cubic meter per day (m3/d)	29 - 0x1D
cubic meter per minute (m3/min)	131 - 0x83
cubic meter per second (m3/s)	28 - 0x1C
liter per hour (l/h)	138 - 0x8A
liter per minute (l/min)	17 - 0x11
liter per second (l/s)	24 - 0x18
mega US gallons per day (MDG)	23 - 0x17
US gallons per hour (USgph)	136 - 0x88
US gallons per minute (USgpm)	16 - 0x10
US gallons per second (USgps)	22 - 0x16
barrel per day (bbl/d)	135 - 0x87
barrel per hour (bbl/h)	134 - 0x86
barrel per minute (bbl/m)	133 - 0x85
barrel per second (bbl/s)	132 - 0x84
cubic feet per day (CFD)	27 - 1B
cubic feet per hour (CFH)	130 - 0x82
cubic feet per minute (CFM)	15 - 0x0F
cubic feet per second (CFS)	26 - 0x1A

Tab. A.60: Unit IDs - volume

unit of measurement	HART - unit ID
cubic meter (m3)	43 - 0x2B
hectoliter (hl)	236 - 0xEC
liter (l)	41 - 0x29
US gallons (USgal)	40 - 0x28
barrel (bbl)	46 - 0x2E

Tab. A.61: Unit IDs - mass

unit of measurement	HART - unit ID
kilogram (kg)	61 - 0x3D
gram (g)	60 - 0x3C
tons (t)	62 - 0x3E
pounds (lb)	63 - 0x3F

Tab. A.62: Unit IDs - heat quantity

unit of measurement	HART - unit ID
megawatt-hour (MWh)	240 - F0 (FLUXUS specific)
kilowatt-hour (kWh)	128 - 0x80
megaJoule (MJ)	164 - 0xA4
MBTU	241 - F1 (FLUXUS specific)

Tab. A.63: Unit IDs - velocity

unit of measurement	HART - unit ID
meter per second (m/s)	21 - 0x15
inch per second (in/s)	114 - 0x72
feet per second (in/s)	20 - 0x14

Tab. A.64: Unit IDs - mass flow

unit of measurement	HART - unit ID
kilogram per second (kg/s)	73 - 0x49
gram per second (g/s)	70 - 0x46
tons per day (t/d)	79 - 0x4F
tons per hour (t/h)	78 - 0x4E
kilogram per hour (kg/h)	75 - 0x4B
kilogram per minute (kg/min)	74 - 0x4A
US pound per day (lb/d)	83 - 0x53
US pound per hour (lb/h)	82 - 0x52
US pound per minute (lb/min)	81 - 0x51
US pound per second (lb/s)	80 - 0x50

Tab. A.65: Unit IDs - heat flow

unit of measurement	HART - unit ID
kilowatt (kW)	127 - 0x7F
MBTU per hour	243 - F3 (FLUXUS specific)

Tab. A.66: Unit IDs - pressure

unit of measurement	HART - unit ID
bar (bar)	7 - 0x07
millibar (mbar)	8 - 0x08
megapascal (MPa)	237 - 0xED
pounds per square inch (psi)	6 - 0x06
millimeter mercury column (mmHg)	5 - 0x05

Tab. A.67: Unit IDs - temperature

unit of measurement	HART - unit ID
degree Celsius (°C)	32 - 0x20
degree Fahrenheit (°F)	33 - 0x21

Tab. A.68: Unit IDs - signal strength

unit of measurement	HART - unit ID
decibel (dB)	244 - F4 (FLUXUS specific)

Tab. A.69: Unit IDs - no unit of measurement

unit of measurement	HART - unit ID
no unit	244251 - FB

A.9 Status Information

This chapter describes the different status information by the field device.

A.9.1 HART Specific Device Status

The first two bytes of every slave response message contains field device status information. The first byte is multiplexed and contains either the communication status (MSB set) or the response code (MSB not set) for a handled command from a master. The second byte contains

field device status information.

- Field device returns communication status byte (bit-mapped) if a communication error is detected.
- If no communication errors occur the field device returns a command dependent response code.
- If a communication error occur all bits of the second byte are zero. If not it contains the device status which represents the current state of the slave.

Tab. A.70: Communication errors

bit mask	definition
0x80	communication error - This bit indicates one of the following detected communication errors if it is set to 1.
0x40	vertical parity error - The parity of at least one received byte was incorrect.
0x20	overrun error - At least one byte in the receive buffer of the UART was overwritten before it was read.
0x10	framing error - The stop bit of at least one byte was not detected by the device.
0x08	longitudinal parity error - The checksum calculated by the device did not match the checksum byte at the end of the received message.
0x04	reserved - set to 0
0x02	buffer overflow - The received message was too long for the receive buffer of the device.
0x01	reserved - set to 0

The response codes indicate three classes of indications to the host. These are notifications, warnings and errors.

Tab. A.71: Response code classification

response code class	definition
notification	successfully command execution. The response code is 0.
warning	command was executed with a deviation as described with the response code (e.g., a value was set to its nearest legal value).
error	command was not executed successfully. The response code indicates the reason (e.g., the device is in write protect mode).

The following table shows information about the device status byte.

Tab. A.72: Device status

bit mask	definition
0x80	device malfunction - The device detected an error or failure.
0x40	configuration changed - A write or set commend which changed the device configuration was executed.
0x20	cold start - power has been removed or a device reset occured. The first executed command recognizes this status bit and it dispose the device to reset the staus bit.
0x10	more status Available - More status information is available which can be read via command 48.
0x08	loop current fixed - The loop current is being held at a fixed value and is not responding the PV.
0x04	loop current saturated - The loop current is beyond its upper or lower limit.
0x02	non-primary variable out of limits - A device variable other than the PV has reached operating limits.
0x01	primary variable out of limits - The PV is beyond the operating limit.

A.9.2 Additional Device Status

The field device doesn’t support an additional device status.

A.9.3 Device Variable Status

Every device variable has a status which can be read with HART command 9.

device variable states:

good → measuring value OK - no errors

poor Accuracy → measuring value is older than “error value delay” (see command 240 and 241)

bad → measuring value is unavailable or never set

A.9.4 Error Value Delay

The error value delay is the time interval after which the current loop output error value will be transmitted to the current loop in case no valid measured values are available. This delay can be read by command 240 and written by command 241. The default value is 10 seconds.