NIVELCO

MultiCONT

Description of the USER RS485 protocol for MultiCONT

3rd editon

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1. INTRODUCTION

The **USER RS485 interface** of the MultiCONT provides the possibility of serial data transfer to the central process control computer or PLC. Using HART over MODBUS or HART over HART communication protocol there is a remote programming possibility of the connected transmitters to change the identification and operational parameters. This case the MultiCONT acts as a bridge in the communication. Moreover it is possible to query the following values:

- Measurement values of the transmitters
- System configuration (MultiCONT settings, relays, current outputs, number of universal interface modules and its settings)
- Relays and current outputs assigned to the transmitters
- Error list

2. TECHNICAL DATA

Serial data format		9600 BAUD, 8bit data, ODD parity, 1 STOP bit
Input resistance (K1 open)		20 kΩ
Built-in terminal resistor		120 Ω 0.9 W
Input current	U_{IN}=12V	max. 1 mA
	U_{IN}=–7V	max. –0.8 mA
Input ESD Impulse Protection		I_{max} (8/20 μs)=400 A W_{max}=1.5 J (2 ms), 8kV ESD
DC galvanic isolation		500 V_{RMS}
Communication protocol (selectable from menu)		**HART 5** or **MODBUS RTU**
Connection cable		**STP** (**S**hielded **T**wisted **P**air)

3. OPERATION

3.1 ELECTRICAL LAYOUT

The RS485 interface converts the TTL-level asymmetric (unbalanced) full duplex serial signals of the MultiCONT to standard RS485 symmetric (balanced) half-duplex signals. Terminate the „A" and „B" cables of the interface with the 120 Ω resistor enabled by the K1 switch.

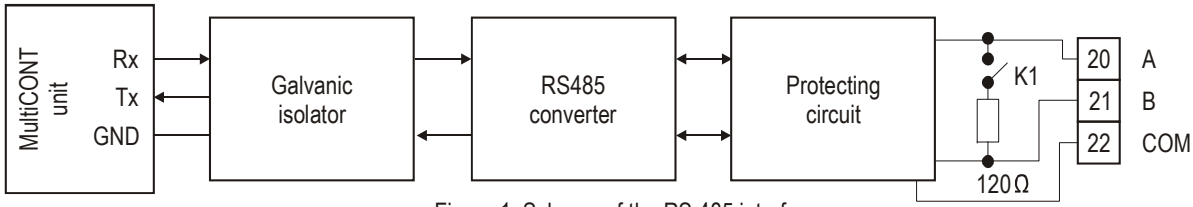


Figure 1: Scheme of the RS 485 interface

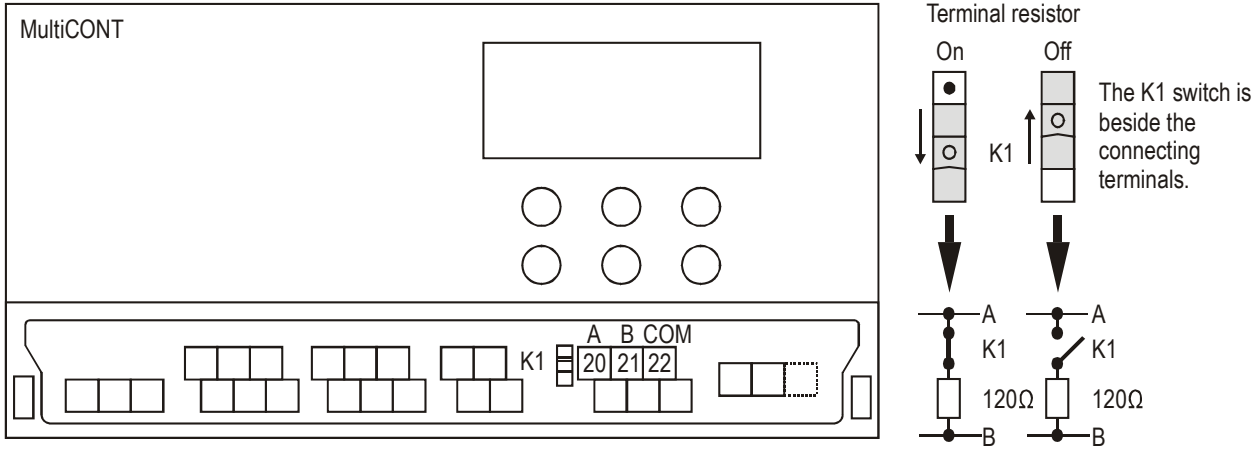


Figure 2: Position of the connection terminals and K1 switch

3.2 CONNECTING MULTICONT PROGRAMMING UNITS VIA RS485 INTERFACE

MultiCONT units can be arranged in a network via the RS485 interface. This way a very simple, cost-effective 2-wire STP network can be set up. When setting up the network, the instructions for building a computer network should be taken into consideration (chapter 3.3.)

3.3 RECOMMENDATIONS FOR BUILDING A NETWORK

The most important thing is that the communication line should be closed on both ends with terminal resistors and only at the two farthest points. The value of the resistor depends on the wave impedance of the used cable. The interface has a 120Ω terminal resistor, so the cable should be chosen considering this impedance value.

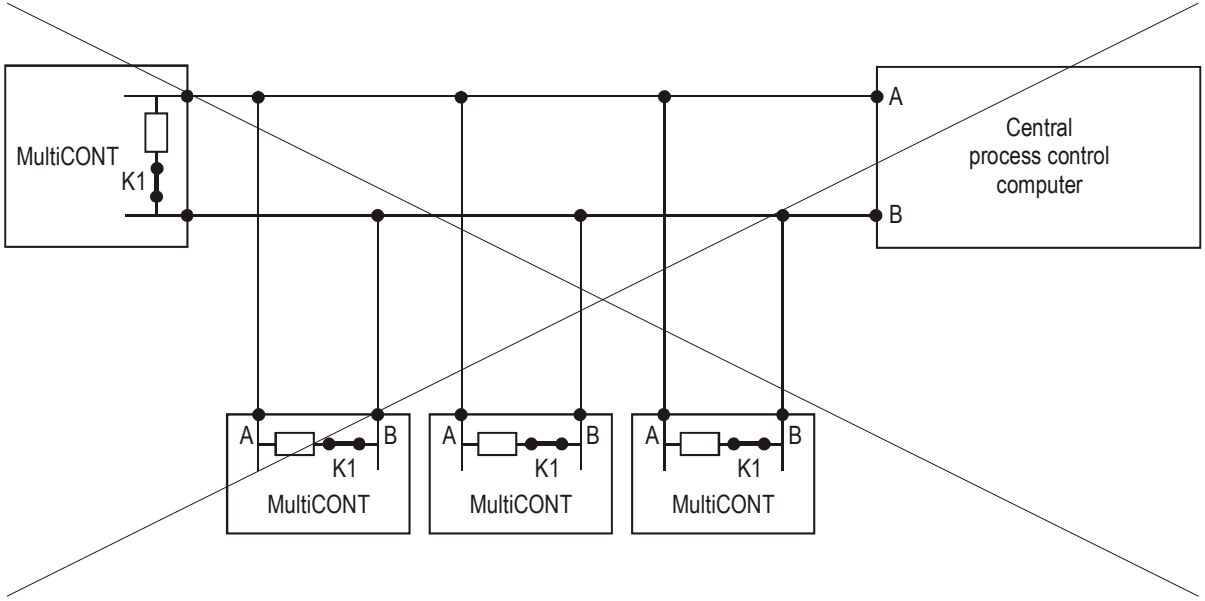


Figure 3: Example of an incorrect network

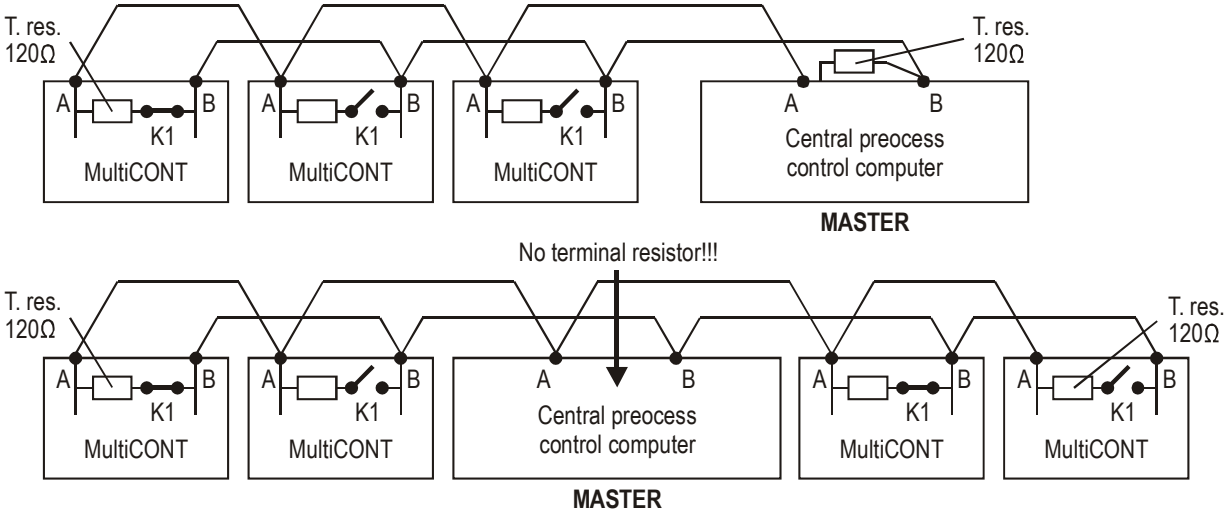


Figure 4: Examples of correct networks

Incorrect configuration is where there are more than 2 terminal resistors or they are not on the (2) farthest points of the line. (Fig.3). In such cases, especially when using too long connection cable, data transfer errors may occur. The MultiCONT units should be connected one by one on the cable (Fig. 4). Star topology is not allowed!

The max. cable length is 1000 m but In this case always use **STP** (**S**hielded **T**wisted **P**air) cable. Cable capacitance must be less than 100 pF/m. **Shielding must be grounded only at one point to the ground of the central process controller computer.** Shielding must be connected to the COM terminal.

MultiCONT units connected in a network should have distinct addresses (1…31) see „Main menu" / "MultiCONT config" / "HART"/"Short address" in the USER'S AND PROGRAMMING MANUAL. There can be only one **master** (process control computer, PLC) in a system.

Note:

If a system is installed in an environment with heavy electromagnetic disturbances it is possible that the internal protection of the interface is insufficient to withstand the voltage impulses. Only those types of (over voltage or lightning) protection can be used on the A-B terminals of the interface that don't affect data transfer process. This means that it should not cause a change in the transfer characteristics in the –7…+12V voltage range (with regards to the COM terminal). As a result, we recommend the use of STP cable when transferring data over long distances.

3.4 APPLICATION EXAMPLE

The „network" consists of the following devices:

- Central process control computer
- 3 pcs of **PR_-1_A** or **PR_-1_B** type **MultiCONT**

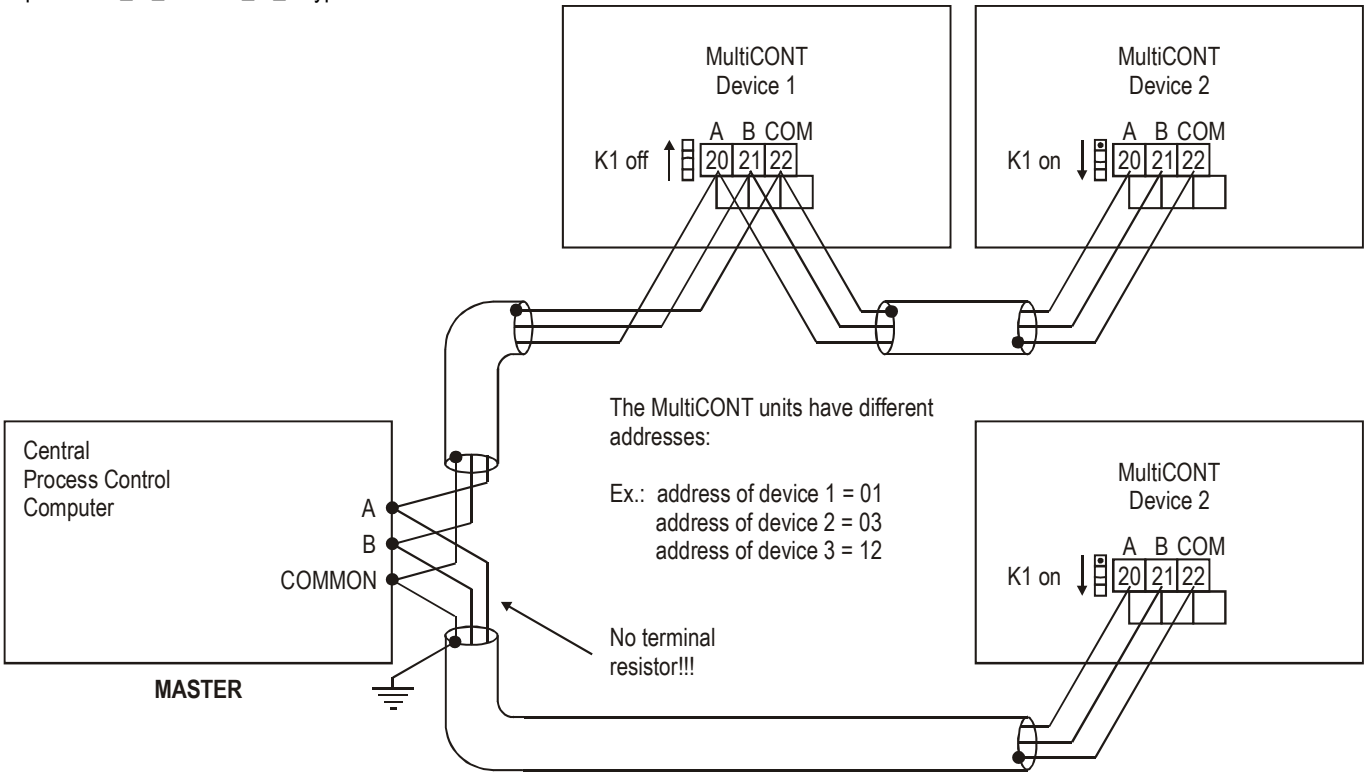


Figure 5: system structure mentioned in the example

4. DATA TRANSFER

Data transfer in the network established between the MultiCONT controllers and the central process control computer is in accordance with the protocol described in chapters 6 and 7. Data transfer is initiated by the **MASTER** (only one MASTER can be in the system). Each MultiCONT has its own address (1…31), see: “Main menu” / ”MultiCONT config” / ”HART” / ”Polling address” menu point in the USER’S AND PROGRAMMING MANUAL. The process control computer (MASTER) uses these addresses when initiating the communication with the MultiCONT units.

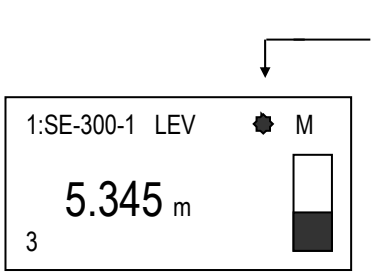
Properties of the serial data transfer:

Data transfer speed (BAUDRATE)	9600
Data length	8 bit
Parity	none, even, odd
Number of stop bits	1 or 2

The central process control computer sends a command to the MultiCONT unit and then waits for a response.
The length of the response varies, so for content description see: chapter 6. (HART) and 7. (MODBUS). To ensure data transfer reliability every command and response is equipped with either a **CRC** code (MODBUS) or an **FCS** checksum (HART) which enable error detection. If there is no response from the MultiCONT the causes may be the following:

- Broken cable (When the system is turned off, using an Ohm-meter 60Ω can be measured between points A and B at the terminal of any device)
- points A and B are inverted (does not damage the device)
- the address of the device has changed
- Due to noise on the data transfer line the MultiCONT is unable to interpret the relevant command and does not respond, or the central process control computer cannot interpret the response. In such cases the commands should be repeated. It is also useful to check the grounding of the cable shielding. Shielding that is not grounded (or grounded at multiple points) may generate noise on the line!
- terminal resistors are not present or connected at wrong points.
- there are multiple MASTER units in the system and they jam each others communication

MultiCONT flashes a " * " character when interpreting a relevant command and this helps in discovering errors.



5. DATA TYPES

The following data types can be found in the responses:

5.1. String
This is a sequence of ASCII characters ending in 00h
e.g.: string = aba123
byte-sequence: 41h 42h 61h 31h 32h 33h 00h

5.2. **Packed:** Packed string (HART protocol)
In string variables the 8 bit ASCII characters are packed into 6 bits (4pcs. of 8 bit character fit into 3 bytes) as shown below:

Packed ASCII character set				
	0 1 2 3	4 5 6 7	8 9 A B	C D E F
0	@ A B C	D E F G	H I J K	L M N O
1	P Q R S	T U V W	X Y Z [	\ ] ^ _
2	SP ! „ #	$ % & ’	( ) * +	, - . /
3	0 1 2 3	4 5 6 7	8 9 : ;	< = > ?

e.g.: P-58 in compressed format

Byte N								Byte N+1								Byte N+2							
0	1	0	0	0	0	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	0	0	0
P								-								5							
8																							

In HEX format: 42h ddh f8h

5.3. **Float:** Floating point number

An IEEE 754 standard 4 byte long single precision floating point number

Byte N								Byte N+1								Byte N+2								Byte N+3							
S	E (8 bits exhibitor)								M (23 bits base)																						

S= sign of the mantissa: 0=positive 1=negative

Calculation: $(-1)^{S}*2^{(E-127)}*1.M$

5.4. **Unsigned:** unsigned integer

Binary description of an integer number that may be:

- unsigned 8: 1 byte integer (0…255)
  eg.: 151 (unsigned 8) = 1001 0111 (97h)
- unsigned 16: 2 byte integer (0…65 535)
  eg.: 5751 (unsigned 16)= 0001 0110 0111 0111 (1677h) the two bytes in H L sequence
- unsigned 24: 3 bytes integer (0…16 777 215)
- unsigned 32: 4 bytes integer

5.5. **Bit:** 1bit information encoded in bytes

1= TRUE

0= FALSE

- Bit 16: 16 1bit information encoded in 2 bytes
- Bit 32: 32 1bit information encoded in 4 bytes

5.6. **Date:** Date encoded in 3 bytes

Byte N								Byte N+1								Byte N+2							
day								month								year =1900+y							
0	0	0	d	d	d	d	d	0	0	0	0	m	m	m	m	y	y	y	y	y	y	y	y

5.7. **Time:** Time encoded in 3 bytes

Byte N								Byte N+1								Byte N+2							
hour								minute								second							
0	0	0	h	h	h	h	h	0	0	m	m	m	m	m	m	0	0	s	s	s	s	s	s

5.8. **LongAddr:** Long address in 5 bytes

Byte N	Byte N+1	Byte N+2	Byte N+3	Byte N+4
Manufact. ID (MID)	Type ID (TID)	Device ID (DID)		

For a NIVELCO device: **Manufacturer ID**= 151 (97h)

6. DESCRIPTION OF THE HART PROTOCOL

Setting: Main menu/MultiCONT config/USER RS484/HART prot.

Communication is in accordance with the standard commands of **HART 5**. These commands can be:

- universal: COMMAND 0, 12, 13 and 16
- device specific: COMMAND 241, 242

Timing:

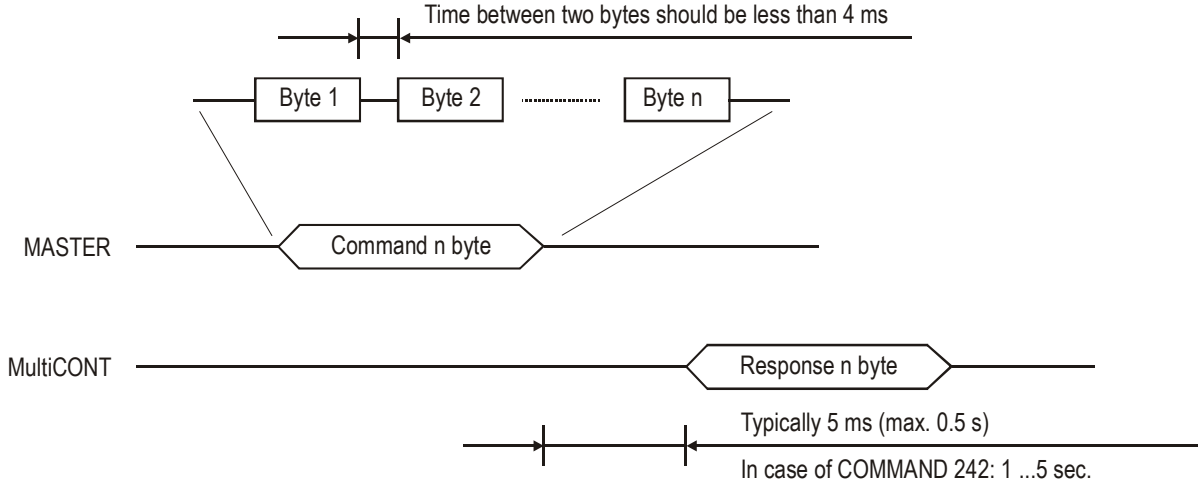
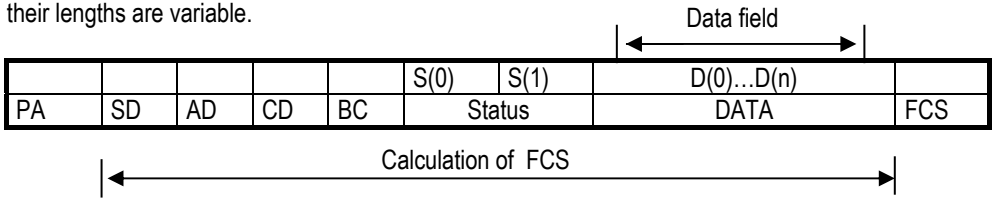


Figure 6.: Timing

6.1 COMMAND STRUCTURE

There are two types of commands depending on whether the access direction is MASTER→MultiCONT or MultiCONT→MASTER and their lengths are variable.



PA: Preamble: with a length of 6 bytes: 6x 1111 1111 (ffh) bitstream

SD: Start byte: shows the direction of the communication and addressing mode

MASTER→MultiCONT	Short address:	0000 0010 (02h)
	Long address:	1000 0010 (82h)
MultiCONT→MASTER	Short address:	0000 0110 (06h)
	Long address:	1000 0110 (86h)

AD: Address field: its length may be short (1 byte) or long (5 byte).

Short address: 100x xxxx (80h+ xxh), where x (0..31) is the Short address of the MultiCONT (see: „Main menu"/"MultiCONT config"/"HART"/"Short address")

eg.: if the Short address (Polling address)=13 then AD=1000 1101 (8dh)

Long address: 5 byte

1 MID= Manufacturer ID for NIVELCO instruments: 151 (97h)

2 TID= Device type ID MultiCONT 40 (28h)

3..5 DID= Device ID different for each MultiCONT

Direction of communication	Short address		Long address	
	SD	AD	SD	AD (5 byte)
MASTER→MultiCONT	02h	80h+xxh	82h	MID-TID-DID
MultiCONT→MASTER	06h	80h+xxh	86h	MID-TID-DID

CD: HART command code: 1 byte

BC: No. of bytes in Status and DATA fields. Length: 1 byte

Status: no status for MASTER→MultiCONT transfer
2 bytes long status - S(0) and S(1) - always present for MultiCONT→MASTER transfer
See: 6.1.1.

DATA: Data field, byte notation D(0)…D(n) , n=BC-1

FCS: Control Sum (Frame Check Sequence), length: 1 byte. Resulting by "XOR"-ing the bytes.

E.g.: MASTER uses the "COMMAND 0" universal command to query MultiCONT to get its identifiers (Read unique identifier)
Short address of the MultiCONT = 0 (00h). Bytes are coded hexadecimally.

MASTER→MultiCONT: ffh ffh ffh ffh ffh ffh 02h 80h 00h 00h 82h
A possible MultiCONT response:

ffh ffh ffh ffh ffh ffh 06h 80h 00h 0eh 00h 00h feh 97h 28h 05h 05h 01h 00h 01h 00h 34h 56h 78h d3h

- Manufacturer ID:	151 (97h)
- Device type ID:	40 (28h)
- Min. preamble number (Number of preamble requests):	5
- Universal command code (HART version)	5 (HART 5)
- Actual MultiCONT command set version (Device specific command version):	1
- HW version:	1
- SW version:	0
- MultiCONT flag (Device function flag):	0
- MultiCONT ID (Device ID):	345678h

The long address of the MultiCONT can be structured from the response: 97h 28h 34h 56h 78h

6.1.1 STATUS BYTES

The response of the MultiCONT always contains the S(0) and S(1) status bytes. S(0) is the result of the command processing. S(1) is always 0.

Status S(0)	
Value of S(0)	Error description
00	No error
02	COMMAND 241: sub-command code (CSD) error (see: 6.2.) or COMMAND 241: Index value error
05	Insufficient data in command
64	Command is uninterpretable for MultiCONT

In case of an error S(0)≠0 and the response does not contain a DATA field, only the 2 status bytes:.

					S(0) ≠0	S(1)=0	
PA	SD	AD	CD	BC=2	Status		FCS

6.2 COMMANDS

HART commands for communication with MultiCONT:

HART command (CD)	Sub-comm. (CSD)	Description
0	-	Read MultiCONT unique ID
12	-	Read MultiCONT message
13	-	Read MultiCONT TAG, descriptor, date
16	-	Read final assembly number
241	0	Read Transmitter PV (with time), percent, current
	1	Read transmitter PV, SV, TV, QV (all with time)
	2	Read NIVELCO Transmitter data
	3	Read some Transmitter Command 0 data
	4	Read Transmitter TAG, descriptor, date
	5	Read Transmitter Message
	200	Read MultiCONT Registers
	201	Read Error block
	210	Read Relay ID, TAG
	211	Read Relay setup, status
	212	Read Relay work time, switching number
	215	Read Current Output ID, TAG
	216	Read Current Output setup, status
	220	Read Universal interface module ID, TAG
	225	Read one binding
242	-	Remote programming of transmitters (HART over HART)

6.2.1 COMMAND 0 READ MULTICONT UNIQUE ID

MASTER→MultiCONT:
Contents of PA, SD and AD fields. See 6.1. Command structure

PA	SD	AD	CD=0	BC=0	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=0	BC=14 (0eh)	Status S(0) and S(1)	DATA D(0)..D(11)	FCS

See 6.1.1. for contents of the status bytes

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0	254 (feh)	Unsigned 8	Does not change
1	MultiCONT Manufacturer ID	Unsigned 8	Always 151 (97h)
2	Device type ID	Unsigned 8	Always 40 (28h)
3	Number of preamble requests	Unsigned 8	See 6.1. Command structure
4	HART version	Unsigned 8	5 = HART 5 standard
5	Device specific command version	Unsigned 8	
6	SW version	Unsigned 8	
7	HW version	Unsigned 8	For present: SW type
8	Device function flags	Unsigned 8	presently: 0
9…11	MultiCONT Device ID	Unsigned 24	In order of H..L

6.2.2 COMMAND 12 READ MULTICONT MESSAGE

MASTER→MultiCONT:
Contents of PA, SD and AD fields: see 6.1. Command structure

PA	SD	AD	CD=12 (0ch)	BC=0	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=12 (0ch)	BC=26 (1ah)	Status S(0) and S(1)	DATA D(0)..D(23)	FCS

See 6.1.1. for contents of the status bytes.

Content of the DATA field: the 32 character MultiCONT message expanded to 24 bytes

Byte ser. No.	Description	Data type	Comment
0…23	MultiCONT Message	Packed	Default: „MultiCONT PROCESS CONTROLLER”

6.2.3 COMMAND 13 READ MULTICONT TAG, DESCRIPTOR, DATE

MASTER→MultiCONT:
Contents of PA, SD and AD fields: see 6.1. Command structure

PA	SD	AD	CD=13 (0dh)	BC=0	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=13 (0dh)	BC=23 (17h)	Status S(0) and S(1)	DATA D(0)..D(20)	FCS

See 6.1.1. for contents of the status bytes.
Contents of the DATA field: 8 character MultiCONT TAG packed into 6 bytes
16 character MultiCONT descriptor packed into 12 bytes
Date coded in 3 bytes

Byte ser. No.	Description	Data type	Comments
0…5	MultiCONT TAG	Packed	Default: „P-200”
6…17	MultiCONT descriptor	Packed	Default: ”MultiCONT P-200”
18…20	Date	Date	

6.2.4 COMMAND 16 *READ FINAL ASSEMBLY NUMBER*

MASTER→MultiCONT:
Contents of PA, SD and AD fields: see 6.1. Command structure

PA	SD	AD	CD=16 (10h)	BC=0	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=16 (10h)	BC=5 (05h)	Status S(0) and S(1)	DATA D(0)..D(2)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field: MultiCONT Device ID in 3 bytes

Byte ser. No.	Description	Data type	Comment
0…2	MultiCONT Device ID	Unsigned 24	Different for each MultiCONT

6.2.5 COMMAND 241

COMMAND 241 is a command group. Code of „Sub-command" (**CSD**) should be specified in DATA field. The response should always contain the 4 byte long MultiCONT status.

6.2.5.1 CSD 0 (SUB-COMMAND 0) READ TRANSMITTER PV (WITH TIME), PERCENT, CURRENT

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Code of the Sub-command (**CSD**) is given in the first byte of the DATA field. Second byte of the DATA field (**INDEX**) contains the list number of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=0 (00h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=36 (24h)	Status S(0) and S(1)	DATA D(0)..D(33)	FCS

See 6.1.1. for contents of the status bytes.
Contents of the DATA field:

Byte ser. No.	Description	Data type	Comments
0…3	MultiCONT status	Bit32	
4	**CSD:** code of sub-command	Unsigned 8	CSD=0
5	**Index**: list No. of transmitter	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	Bit31…16 error bits See. User manual of the transmitters Bit15…0 state bits For service purposes
15	Code of the dimension of the primary variable (PV) of the transmitter	Unsigned 8	See: Table 1
16…19	Primary variable (PV) of the transmitter	Float	
20…22	Date of the transmitter's PV last update	Date	
23…25	Time of the transmitter's PV last update	Time	
26…29	Tank content in % („Sensor range")	Float	
30..33	Output current of the transmitters	Float	

Table 1. Dimension codes:

Code	Dimension	Code	Dimension	Code	Dimension	Code	Dimension
0	-	40	gal	80	lb/s	133	bbl/min
1	inH20@68°F	41	L	81	lb/min	134	bbl/h
2	inHg@0°C	42	Impgal	82	lb/d	135	bbl/d
3	ftH20@68°F	43	m^3	83	lb/d	136	gal/h
4	mmH20@68°F	44	ft	84	STon/min	137	Impgal/s
5	mmHg@0°C	45	m	85	STon/h	138	L/h
6	psi	46	bbl	86	STon/d	139	ppm
7	bar	47	in	87	LTon/h	140	
8	mbar	48	cm	88	LTon/d	141	HJ/h
9	g/cm^2	49	mm	89		142	
10	kg/cm^2	50	min	90		143	deg
11	Pa	51	s	91	g/cm^3	144	rad
12	kPa	52	h	92	kg/cm^3	145	inH20@60°F
13	torr	53	d	93	lb/gal	146	
14	atm	54		94	lb/ft^3	147	
15	Ft^3	55		95	g/mL	148	
16	min	56	uS	96	kg/L	149	Vol
17	L/min	57	%	97	g/L	150	
18	Impgal/min	58	V	98	lb/in^3	151	
19	M^3/h	59	pH	99	$STon/yd^3$	152	ft^3/lb
20	ft/s	60	g	100	yd^3	153	pF
21	m/s	61	kg	111	ft^3	154	mL/L
22	gal/s	62	MetTon	112	in^3	155	uL/L
23	Mgal/d	63	lb	113	in/s	163	kohm
24	L/s	64	STon	114	in/s	164	MJ
25	ML/d	65	LTon	115	in/min	235	gal/d
26	ft^3/s	66	mS/cm	116	ft/min	237	Mpa
27	ft^3/d	67	uS/cm	117	deg/s	238	inH20&4°C
28	m^3/s	68	N	118	rev/s	239	mmH20@4°C

29	m^3/d	69		119	rev/m	240	L/d
30	Impgal/h	70	g/s	120	m/h	241	kg/dm^3
31	Impgal/d	71	g/min	124	bbl liq	242	Ms
32	°C	72	g/h	125	ounce	243	ft/h
33	°F	73	kg/s	126		244	DB
34	°R	74	kg/min	127	kW		
35	Kelvin	75	kg/h	128	kWh		
36	mV	76	kg/d	129	hp		
37	ohm	77	MetTon/min	130	ft^3/h		
38	Hz	78	MetTon/h	131	m^3/min		
39	mA	79	MetTon/d	132	bbl/s		

6.2.5.2 CSD 1 (SUB-COMMAND 1) READ TRANSMITTER PV, SV, TV, QV (ALL WITH TIME)

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure

Index: list No. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=1 (01h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=61 (3dh)	Status S(0) and S(1)	DATA D(0)..D(58)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=1
5	**Index** : List No. of the transmitter	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	
15	Code of the dimension of the PV of the transmitter	Unsigned 8	See: Table 1
16…19	Primary variable (PV) of the transmitter	Float	
20…22	Date of the transmitter's PV last update	Date	
23…25	Time of the transmitter's PV last update	Time	
26	Code of the dimension of the secondary variable (SV) of the transmitter	Unsigned 8	See: Table 1
27…30	Secondary variable (SV) of the transmitter	Float	
31…33	Date of the transmitter's SV last update	Date	
34…36	Time of the transmitter's SV last update	Time	
37	Code of the dimension of the tertiary variable (TV) of the transmitter	Unsigned 8	See: Table 1
38…41	Tertiary variable (TV) of the transmitter	Float	
42…44	Date of the transmitter's TV last update	Date	
45…47	Time of the transmitter's TV last update	Time	
48	Code of the dimension of the quaternary variable (QV) of the transmitter	Unsigned 8	See.: Table 1
49…52	Quaternary variable (QV) of the transmitter	Float	
53…55	Date of the transmitter's QV last update	Date	
56…58	Time of the transmitter's QV last update	Time	

6.2.5.3 CSD 2 (SUB-COMMAND 2) READ NIVELCO TRANSMITTER DATA

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List No. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=2 (02h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=35 (23h)	Status S(0) and S(1)	DATA D(0)..D(32)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comments
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=2
5	**Index**: list no. of the transmitter in the list	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	
15	Code of the dimension of the LEVEL of the transmitter	Unsigned 8	See: Table 1
16…19	LEVEL value	Float	
20…23	LEVEL in % („Sensor range”)	Float	
24	TOT dimension	Unsigned 8	See: Table 1
25…28	TOT1 value	Unsigned 32	
29…32	TOT2 value	Unsigned 32	

6.2.5.4 CSD 3 (SUB-COMMENT 3) READ SOME TRANSMITTER COMMAND 0 DATA

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=3	CSD=3 (03h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=21 (15h)	Status S(0) and S(1)	DATA D(0)..D(18)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comments
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=3
5	**Index**: list no. of the transmitter	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	
15	Code of the HART standard	Unsigned 8	5 = HART 5 standard
16	Code of the HART command set	Unsigned 8	
17	SW version of the transmitter	Unsigned 8	
18	HW version of the transmitter	Unsigned 8	

6.2.5.5 CSD 4 (SUB-COMMAND 4) READ TRANSMITTER TAG, DESCRIPTOR, DATE

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=4 (04h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=38 (15h)	Status S(0) and S(1)	DATA D(0)..D(35)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=4
5	**Index**: List no. of the transmitter	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	
15…20	Short TAG of the transmitter	Packed	
21…32	Transmitter specific command version	Packed	
33…35	Transmitter date	Packed	

6.2.5.6 CSD 5 (SUB-COMMAND 5) READ TRANSMITTER MESSAGE

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=5 (05h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=41 (29h)	Status S(0) és S(1)	DATA D(0)..D(38)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=5
5	**Index:** List no. of the transmitter	Unsigned 8	Index=0…Dn-1 (see: 6.2.5.7.)
6…10	Long address of the transmitter	LongAddr	
11…14	Transmitter status	Bit32	
15…38	Transmitter message	Packed	

6.2.5.7 CSD 200 (SUB-COMMAND 200) READ MULTICONT REGISTERS

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the transmitter.

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=200 (c8h)	Index=0	FCS

If Index≠0 the response will contain an Index error!!!

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=14 (0fh)	Status S(0) and S(1)	DATA D(0)..D(12)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=200
5	Index	Unsigned 8	always 0
6	No. of bindings	Unsigned 8	Kn
7	Sum of internal and external relays	Unsigned 8	Rn
8	Sum of internal and external current outputs	Unsigned 8	Cn
9	Number of inputs	Unsigned 8	
10	No. of extension modules	Unsigned 8	Bn
11	No. of transmitters	Unsigned 8	Dn
12	Error table length	Unsigned 8	En

6.2.5.8 CSD 201 (SUB-COMMAND 201) READ ERROR BLOCK

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the error (0..En-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=201 (c9h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=14 (0eh)	Status S(0) and S(1)	DATA D(0)..D(11)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=201
5	**Index**: List no. of the error	Unsigned 8	Index=0…En-1 (see: 6.2.5.7.)
6…10	Long address of the faulty device	LongAddr	
11	Code of the error type	Unsigned 8	See : MultiCONT User's and programming manual

6.2.5.9 CSD 210 (SUB-COMMAND 210) READ RELAY ID, TAG

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the relay (0..Rn-1).

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=210 (d2h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=25 (19h)	Status S(0) and S(1)	DATA D(0)..D(22)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=210
5	**Index**: List no. of the relay	Unsigned 8	Index=0…Rn-1 (see: 6.2.5.7.)
6	Relay state register	Unsigned 8	See: Relay state reg. bit assignment
7…11	Long address of the relay	LongAddr	
12…16	Long address of the relay parent	LongAddr	
17..22	Relay Short TAG	Packed	8 character packed in 6 bytes

Relay state register bit assignment							
B7	B6	B5	B4	B3	B2	B1	B0
Relay state: 0=ON 1=OFF	0=Test ON 1=Test OFF	0=output RP1, RP2 and RP3 1=output test (as B6)	0=inactive (OFF) 1=active	0=Invert OFF 1=Invert ON	0	0	0

6.2.5.10 CSD 211 (SUB-COMMAND 211) READ RELAY SETUP, STATE

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure

Index: List no. of the relay (0..Rn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=211 (d3h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=24 (18h)	Status S(0) and S(1)	DATA D(0)..D(21)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=211
5	**Index**: List no. of the relay	Unsigned 8	Index=0…Rn-1 (see: 6.2.5.7.)
6	Relay state register	Unsigned 8	
7	Relay operating mode	Unsigned 8	0= Hyst. 1= Alarm 2= Alarm K 3= Window 4= Window D 5= Error 6= Pulse F 7= TOT1 8= Alt. S (see: User's and programming manual: „Main menu"/„Relays"/"Programming"/"Function")
8…11	RP1 relay parameter	Float	
12…15	RP2 relay parameter	Float	
16…17	RP3 relay parameter	Unsigned 16	
18…21	Relay source	Float	The value of the relay state is calculated from this

6.2.5.11 CSD 212 (SUB-COMMAND 212) READ RELAY WORKTIME, SWITCHING NUMBER

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the relay (0..Rn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=212 (d4h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=23 (17h)	Status S(0) and S(1)	DATA D(0)..D(20)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=212
5	**Index**: List no. of the relay	Unsigned 8	Index=0…Rn-1 (see: 6.2.5.7.)
6	Relay state register	Unsigned 8	
7…10	Relay worktime	Unsigned 32	In 100 ms resolution
11…14	Relay switching number	Unsigned 32	No. of relay state changes
15…18	Relay TOT2	Unsigned 32	
19…20	Relay TOT2 PULSE	Unsigned 16	

6.2.5.12 CSD 215 (SUB-COMMAND 215) READ CURRENT OUTPUT ID, TAG

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of current outputs (0..Cn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=215 (d7h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=25 (19h)	Status S(0) and S(1)	DATA D(0)..D(22)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=215
5	**Index**: List no. of the current outputs	Unsigned 8	Index=0…Cn-1 (see: 6.2.5.7.)
6	current output state register	Unsigned 8	See: current outputs. state reg. bit assignment
7…11	Long address of the current outputs.	LongAddr	
12…16	Long address of the current output parent	LongAddr	
17..22	current outputs. short TAG	Packed	8 character packed in 6 bytes

Current output state register bit assignment							
B7	B6	B5	B4	B3	B2	B1	B0
		0=output as CP1, CP2 and CP3 1=output test current	0=inactive (output 0mA) 1=active				

6.2.5.13 CSD 216 (SUB-COMMAND 216) READ CURRENT OUTPUT SETUP, STATE

MASTER→MultiCONT:
Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the current outputs (0..Cn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=216 (d8h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=28 (1ch)	Status S(0) and S(1)	DATA D(0)..D(25)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comments
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-comment	Unsigned 8	CSD=216
5	**Index**: List no. of the current output	Unsigned 8	Index=0…Cn-1 (see: 6.2.5.7.)
6	current output status	Unsigned 8	
7	current output operating mode	Unsigned 8	0=Quantity 1=Error current 3.6 mA 2=Error current 22 mA
8…11	CP1 current output. parameter	Float	
12…15	CP2 current output. parameter	Float	
16…17	CP3 current output. parameter	Unsigned 16	
18…21	current output. source	Float	the value the output current is calculated from
22…25	current output. actual output [mA]	Float	

6.2.5.14 CSD 220 (SUB-COMMAND 220) READ INTERFACE MODULE ID, TAG

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure
Index: List no. of the universal interface module (UIM) (0..Bn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=220 (dch)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=20 (14h)	Status S(0) and S(1)	DATA D(0)..D(17)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

Byte ser. No.	Description	Data type	Comment
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=220
5	**Index**: List no. of the UIM	Unsigned 8	Index=0…Bn-1 (see: 6.2.5.7.)
6	UIM status	Unsigned 8	
7…11	Long address of the UIM	LongAddr	
12..17	UIM Short TAG	Packed	8 character packed in 6 bytes

6.2.5.15 CSD 225 (SUB-COMMAND 225) READ ONE BINDING

When a relay or current output is assigned to a device it is called a binding.

MASTER→MultiCONT:

Contents of PA, SD and AD fields: see 6.1. Command structure

Index: List no. of the binding (0..Kn-1)

PA	SD	AD	CD=241 (f1h)	BC=2	CSD=225 (e1h)	Index	FCS

MultiCONT→MASTER (response)

PA	SD	AD	CD=241 (f1h)	BC=19 (13h)	Status S(0) and S(1)	DATA D(0)..D(16)	FCS

See 6.1.1. for contents of the status bytes.

Contents of the DATA field:

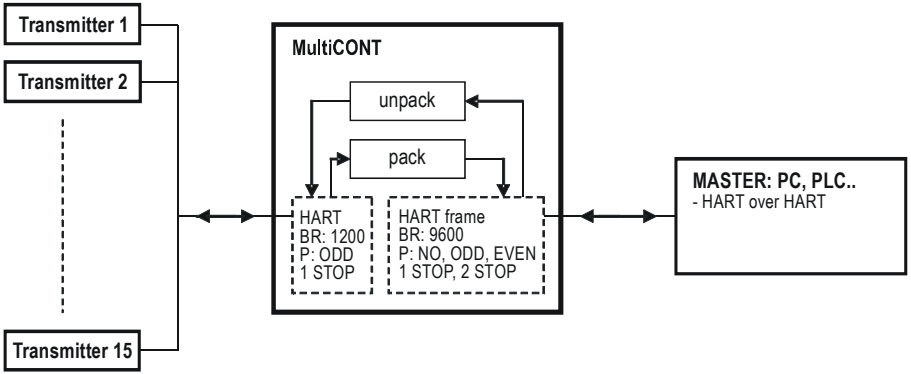
Byte ser. No.	Description	Data type	Comments
0…3	MultiCONT status	Bit32	
4	**CSD:** code of the sub-command	Unsigned 8	CSD=225
5	**Index**: List no. of the binding	Unsigned 8	Index=0…Kn-1 (see: 6.2.5.7.)
6…10	Long address of the device	LongAddr	Long address of the device that a relay, current output. or input is assigned to.
11…15	Long address of the module	LongAddr	Relay or current output
16	Binding mode	Unsigned 8	See: Mode register bit assignment

Mode register bit assignment					
B7…B5	B4	B3	B2	B1	B0
000	Source: 000=PV 001=SV 010=TV 011=QV			00=assigned with positive sign 01= assigned with negative sign 1x= assigned averaged	

6.2.6 COMMAND 242 REMOTE PROGRAMMING OF THE TRANSMITTERS (HART OVER HART)

Knowing the HART commands of the transmitters, with the help of USER RS485 interface of MultiCONT process controller (this case MultiCONT acts as a bridge) there is a possibility to perform remote programming of the connected transmitters. This can be done the following way:

- the MASTER inserts the HART frame to the data field of the HART frame, which is sent by the MultiCONT to the transmitters
- the MultiCONT „unpack" the HART frame and sent to the transmitter
- the MultiCONT „pack" the HART answer of the transmitter and send it to the MASTER in the data field of the HART frame in accordance to the following drawing



At ideal case the process is took only 1…2 seconds (if there is no error and no need to repeat on each side). If the commands should be repeated, the process can be up to 5 seconds.

HART Master → MultiCONT HART frame

HART frame												
PRE	0x82	MultiCONT Long ADDR					CMD 242	BCNT= BCNTx+3	DEVn	CMDx	BCNTx	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL							

DEVn= list number of the transmitter (0..Dn-1)
Since the communication between the MultiCONT and the transmitters uses the long address, the frame is added with the long address of the transmitter.

MultiCONT → DEV HART frame

HART frame									
PRE	0x82	DEV Long ADDR					CMDx	BCNTx	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL				

Response:
DEV HART frame → MultiCONT

HART frame									
PRE	0x86	Long address (DEV Long ADDR)					CMDx	BCNTy	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL				

Encapsulation of the transmitter's response frame:
MultiCONT → HART Master

HART frame												
PRE	0x82	MultiCONT Long ADDR					CMD 242	BCNT= BCNTy+3	DEVn	CMDx	BCNTy	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL							

DEVn= DEV list number of the transmitter (0..Dn-1)

Example:

Reading P04 parameter (max. measurement distance) of SE-380 ultrasonic transmitter

- MultiCONT long address: 97h 28h DB8AC0h (FACT-ID,T-ID and D-ID in order), which can be read with COMMAND0 with the short address
- DEVn: 0 so the transmitter has the first position in the DEV list
- Parameters of the transmitters can be read with the COMMAND131 device specific HART address, and its parameter number is to be entered in the data field in 1 byte (P04= 4 parameter).

See: HART communication description of the transmitters

Master >> MultiCONT:

FF FF FF FF FF	**82**	**97 28 DB 8A C0**	**F2**	**04**	**00**	**83**	**01**	**04**	**DC**
preamble	start byte	MultiCONT long address	CMD=242	BCNT	DEVn	CMDx=131	BCNTx	P04	CHK

The grayed fields are encapsulated added to the DEV long address.

MultiCONT >> DEV(SE-380):

FF FF FF FF FF	**82**	**97 03 02 00 21**	**83**	**01**	**04**	**B3**
preamble	start byte	DEV long address	CMDx=131	BCNTx	P04	CHK

DEV >> MultiCONT:

FF FF FF FF FF	**86**	**97 03 02 00 21**	**83**	**0D**	**00**	**08**	**00 00**
preamble	start byte	DEV long address	CMDx=131	BCNTy	S(0)	S(1)	DEV err

43 05	**04**	**04**	**2D**	**3F E8 F5 C3**	**3D**
DEV status	P04	Attr	P04 dimension	P04 value	CHK

The grayed fields are encapsulated added to the list number of the transmitter and sent to the MASTER

MultiCONT >> MASTER:

FF FF FF FF FF	**86**	**97 28 DB 8A C0**	**F2**	**10**	**00**	**83**	**0D**
preamble	start byte	MultiCONT long address	CMDx=242	BCNT=BCNTy+3	DEVn	CMDx=131	BCNTy

00	**08**	**00 00**	**43 05**	**04**	**04**	**2D**	**3F E8 F5 C3**	**46**
S(0)	S(1)	DEV err	DEV status	P04	Attr	P04 dimension	P04 value	CHK

In the response: P04=1.82 m

7. MODBUS RTU PROTOCOL

Setting: Main menu/MultiCONT config./USER RS484/MODBUS prot.

Data transfer uses RTU mode. Messages do not contain preamble bytes. Data transfer happens with binary coding. Querying is always initiated by the controller (Host, Master) by sending a Modbus Frame and the MultiCONT responds to it. End of a message (Frame) is indicated by a 4 ms (transmission time of 3.5 bytes) pause on the line. Time between the bytes that form a message can not exceed 1.7 ms (transmission time of 1.5 byte)

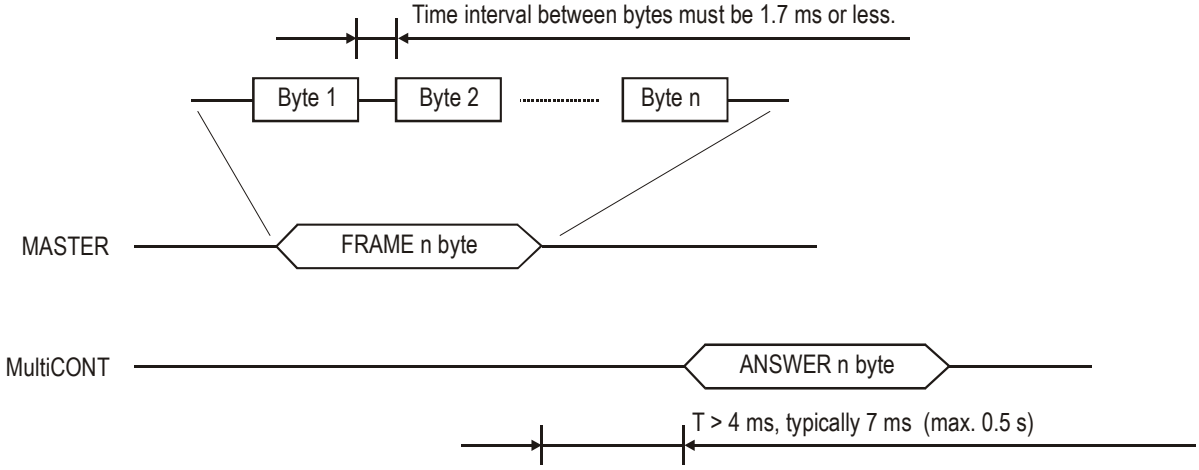


Figure 7.: Timing

Command structure:

Query: MASTER→MultiCONT:

ADDR	FNC	START		QUANTITY		CRC	
		HI	LO	HI	LO	HI	LO

ADDR: MultiCONT address 1…31 (see: „Main menu"/"MultiCONT config."/"HART"/"Short address")
("0" Slave address is reserved for communication (Broadcast) with all devices simultaneously on the system bus. Slaves do not respond in this case)

START: starting address of the queried bit or data field

QUANTITY: no. of bits or 16 bit variables, **QUANTITY**>0

CRC: block parity or Control Sum (CRC - Cyclical Redundancy Checking)

Specific functions of MultiCONT:

Function code (FNC)	Function	Comment
01	Read bit variables	state of devices, relays and curr. outputs (Active or not) and relay states (energised or not) can be queried
03	Read variables (registers)	Different tables and table elements can be queried. See: 7.2.
08	Checking of bindings	See: 7.3.
17h	Read / write of multiple variables (registers)	Remote programming of transmitters (HART over MODBUS)

Response: MultiCONT→MASTER

Response if no error:

ADDR	FNC	BCNT	DATA bytes B(0)…B(BCNT-1)	CRC

BCNT: no. of DATA bytes in the response
When reading bit variables (FNC=01): BCNT=QUANTITY/8 if no residue.
In case of a residue: BCNT= QUANTITY/8+1

When reading variables (FNC=03): BCNT=2*QUANTITY

Response on error:

FNC sent back = FNC received + 0x80

ADDR	FNC=0x8x	Error code	CRC	
			HI	LO

Error code	Error description
1	MultiCONT can not interpret the command
2	Bad START value
3	Bad QUANTITY value (QUANTITY=0, QUANTITY or START+QUANTITY is beyond the end of the table)
4	INDEX error
5	Other error during receive or conversion
6	FNC = 17h: error during HART communication

7.1 READING BIT VARIABLES (FNC=01H)

Query: MASTER→MultiCONT:

ADDR	FNC=0x01	START		QUANTITY		CRC	
		HI	LO	HI	LO	HI	LO

Bit (field) description	START	Comment
Active/inactive device	00 00h+N	N=0…Dn-1, where Dn is no. of HART devices, 1=active If a device is inactive it appears in the device list but MultiCONT does not query it!!
Active/inactive relay	00 10h+N	N=0…Rn-1, where Rn is no. of the relays 1=active 0=inactive, relay always is in de-energised state
Relay state	00 50h+N	N=0…Rn-1, where Rn is no. of the relays 1=ON, energised state 0=OFF, de-energised state
Active/inactive curr. output	00 90h+N	N=0…Cn-1, where Cn is no. of the curr. outputs., 1=active When inactive the output current is < 0.1mA

START: starting address of the bit (field)
QUANTITY: no. of queried bits, **QUANTITY** > 0

Response: **MultiCONT→MASTER**

ADDR	FNC=0x01	BCNT	DATA bytes B(0)…B(BCNT-1)	CRC

BCNT: BCNT=QUANTITY/8 if no remainder.
In case of a remainder: BCNT=QUANTITY/8+1

Example 1: Querying of relay states (R4…R23, 20 pcs) placed in positions 5.. 24 in the relay list

No. of bit	159..74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51..0
No. of relay		24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5			
Content	x…x	1	1	0	1	0	0	1	1	0	1	1	1	1	1	0	0	0	1	0	1	x	x	x..x

DB2								DB1								DB0							
0	0	0	0	1	1	0	1	0	0	1	1	0	1	1	1	1	1	0	0	0	1	0	1

MultiCONT address:1
Index: 4
Start: 0050h + 0004=0054h
Quantity: 0014h
BCNT= 3 (20/8=2.5)

Query		Response	
Byte description	Hex	Byte description	Hex
MultiCONT address	01h	MultiCONT address	01h
Function code (FNC)	01h	Function code (FNC)	01h
Start address HI	00h	No. of bytes (BCNT)	03h
Start address LO	54h	DB0 (Bit61…Bit54)	c5h
Quantity HI	00h	DB1 (Bit69…Bit62)	37h
Quantity LO	14h	DB2 (Bit73…Bit70)	0dh
CRC HI	7dh	CRC HO	
CRC LO	d5h	CRC LO	

Upper 4 digit position of the third data byte = 0

7.2 READING TABLES, VARIABLES (FNC=03H)

Query: MASTER→MultiCONT:

ADDR	FNC=0x03	START		QUANTITY		CRC	
		HI	LO	HI	LO	HI	LO

Tables	START	Comment
0=System variables	00 00h	
1=Error table	10 00h+N*0040h	N=0…En-1, where En is no. the error log entries
2=Bindings table	20 00h+N*00040h	N=0…Kn-1, where Kn is no. of the binding
3=Curr. output table	30 00h+(N*0040h)	N=0…Cn-1, where Cn no. of curr. outputs
4=Relay table	40 00h+(N*0040h)	N=0…Rn-1, where Rn is no. of relays
5=Interface module table	50 00h+(N*0040h)	N=0…Bn-1, where Bn is no. of UIMs
6=Device table	60 00h+(N*0040h)	N=0…Dn-1, where Dn is no. of HART devices
7=Remote query of the transmitters HART over MODBUS	70 00h+(N*0040h)	N=0…Dn-1, where Dn is the number of HART devices

START: starting address of the data(field)
QUANTITY: No. of queried 16 bit data, **QUANTITY**>0
N= INDEX
Response: MultiCONT→MASTER

ADDR	FNC=0x03	BCNT	DATA bytes B(0)…B(BCNT-1)	CRC	
				HI	LO

BCNT= 2 x QUANTITY

Example: Reading RP3=123 parameter of the 3rd relay in the relay list (serial number of the 1st and 3rd relay is 0 and 2)
MultiCONT address: 1
Index: 2
Start: 4011h + 0080h=4091h
Quantity: 0001h (RP3 is unsigned 16, i.e. 2 bytes)

Query		Response	
Byte description	Hex	Byte description	Hex
MultiCONT address	01h	MultiCONT address	01h
Function code (FNC)	03h	Function code (FNC)	03h
Start address HI	40h	No. of bytes (BCNT)	02h
Start address LO	91h	RP3 HI	00h
Quantity HI	00h	RP3 LO	7bh
Quantity LO	01h	CRC HI	f8h
CRC HI	c0h	CRC LO	67h
CRC LO	27h		

IMPORTANT! The device does not check if START points to the beginning of the 4 or more byte variables. It does not generate an error message and sends the incomplete variable!!!

7.2.1 TABLE OF SYSTEM VARIABLES:

Query: MASTER→MultiCONT:

ADDR	**FNC=0x03**	**START**		**QUANTITY**		**CRC**	
		HI=00h	LO=00h…30h	HI=00h	LO=01h…31h	HI	LO

Addr.	Description	Data type	Comment
0000h	MultiCONT long address	LongAddr*	
0003h	MultiCONT TAG	String*	8 characters with 00h at the end
0008h	MultiCONT type	String*	10 characters with 00h at the end (see: User's and programming manual / order code)
000eh	MultiCONT status	Bit 32	Unused, Value = 0
0010h	MultiCONT short address	Unsigned 16	0…31 (polling)
0011h	MultiCONT Software version	Unsigned 16	
0012h	No. of HART devices (**Dn**)	Unsigned 16	No. of (active or inactive) HART devices in the device list.
0013h	No. of possible HART devices	Unsigned 16	see: User's and programming manual / order code

0014h	Sum of internal and external relays (**Rn**)	Unsigned 16	
0015h	No. of internal relays	Unsigned 16	
0016h	No. of possible relays	Unsigned 16	Sum of possible internal or external relays
0017h	Sum of internal and external curr. outputs (**Cn**)	Unsigned 16	
0018h	No. of internal curr. outputs	Unsigned 16	
0019h	No. of possible curr. outputs	Unsigned 16	Sum of possible internal or external curr. outputs
001ah	No. of interface modules (**Bn**)	Unsigned 16	A module can be: relay, curr. output, combined
001bh	No. of possible interface modules	Unsigned 16	
001ch	No. of bindings (**Kn**).	Unsigned 16	When a relay or current output is assigned to a device it is called a binding. (max. 100)
001dh	No. of errors logged (**En**)	Unsigned 16	
001eh	No. of N485 interface module	Unsigned 16	If PE_-1__ then = 0 (not expandable) If PR_-1__ then = 1 (expandable)
001fh	MultiCONT Date	Date*	4 bytes in 00h, day, month, year sequence
0021h	MultiCONT Time	Time*	4 bytes in 00h, hour, minute, sec sequence
0023h	MultiCONT worktime	Unsigned 32	Working time in 100 ms precision
0025h	MultiCONT switching number	Unsigned 16	No. of times the unit was switched on-off after the first installation
0026h	Retrial count	Unsigned 16	No. of retrial during transmitter's querying if there is no answer
0027h	Cycle count	Unsigned 16	No. of transmitter's querying cycles before MultiCONT sends "Response error"
0028h	Cycle time	Unsigned 16	Elapsed time between two HART commands in 100 ms increments within transmitter's querying cycle
0029h	MultiCONT temperature	Float	
002bh	MultiCONT max temperature	Float	
002dh	MultiCONT min temperature	Float	
002fh	CS of MultiCONT software	Unsigned 16	
0030h	MultiCONT display mode	Unsigned 16	

*For data types with odd number of bytes the value of the most significant byte = 0

7.2.2 ERROR TABLE:

An error may have different causes: MultiCONT internal error (e.g. Programming error); during communication with a HART device (e.g. Response error), or device error (e.g. Sensor error). The error log entry contains the long address of the faulty device or module and the error code.

Query: MASTER→MultiCONT:

ADDR	FNC=0x03	START	QUANTITY		CRC	
		1000h+N*0040h+00..03h	HI=00h	LO=01h…04h	HI	LO

N=0…En-1, where En is No. of error log entries (see: address 001dh of the system variables table)

Addr.	Description	Data type	Comment
1000h	Long address of the error source	LongAddr*	MultiCONT, long addr. of faulty device or module
1003h	Error code	Unsigned 16	See: MultiCONT User's and programming manual / 6. Error codes

*For data types with odd number of bytes the value of the most significant byte = 0

7.2.3 BINDINGS TABLE

When a relay or current output is assigned to a device it is called a binding. (there can be max. 100 bindings)

Query: MASTER→MultiCONT:

ADDR	FNC=0x03	START	QUANTITY		CRC	
		2000h+N*0040h+00..06h	HI=00h	LO=01h…07h	HI	LO

N=0…Kn-1, where Kn is no. of bindings (see: address 001ch of the system variables table)

Addr.	Description	Data type	Comment
2000h	Long address of HART device	LongAddr*	Long address of the device that a relay, curr. gen. output or input is assigned to.
2003h	Module long address	LongAddr*	Relay or current generator
2006h	Mode	Bit16	See: Mode register bit assignment

*For data types with odd number of bytes the value of the most significant byte = 0

Mode register bit assignment					
B15…B5	B4	B3	B2	B1	B0
00000000 000	Source: 000=PV 001=SV 010=TV 011=QV			00= assigned with positive sign 01= assigned with negative sign 1x= assigned averaged	

7.2.4 CURRENT OUTPUT TABLE:

ADDR	FNC=0x03	START	QUANTITY		CRC	
		3000h+N*0040h+00..13h	HI=00h	LO=01h…14h	HI	LO

N=0…Cn-1, where Cn is No. of current outputs (see: address 0017h of system variables table)

Addr.	Description	Data type	Comment
3000h	Long address of current output	LongAddr*	
3003h	Long address of curr. output parent	LongAddr*	
3006h	Current output TAG	String	8 characters with 00h at the end
300bh	Current output operating mode	Unsigned 16	0=Quantity 1=Error current 3.6 mA 2=Error current 22 mA
300ch	Status register	Bit 16	* see: Status register bit assignment
300dh	Parameter CP1	Float	
300fh	Parameter CP2	Float	
3011h	Parameter CP3	Unsigned 16	
3012h	Actual output current [mA]	Float	
3014h	Source value	Float	The value the output current is calculated from.

Status register bit assignment						
B15…B6	B5	B4	B3	B2	B1	B0
00000000 00	0=output as CP1, CP2 and CP3 1=output test current	0=inactive (output 0 mA) 1=active	0	0	0	0

7.2.5 RELAY TABLE:

Query: MASTER→MultiCONT:

ADDR	FNC=0x03	START	QUANTITY		CRC	
		4000h+N*0040h+00..16h	HI=00h	LO=01h…17h	HI	LO

N=0…Rn-1, where Rn is No. of relays (see: address 0014h of system variables table)

Addr.	Description	Data type	Comment
4000h	Long address of the relay	LongAddr*	
4003h	Long address of the relay parent	LongAddr*	
4006h	Relay TAG	String	8 characters with 0 at the end
400bh	Relay operating mode	Unsigned 16	0= Hyst. 1= Alarm 2= Alarm K 3= Window 4= Window D 5= Error 6= Impulse F 7= TOT1 8= Alt. S (see: User's and programming manual: „Main menu"/„Relays"/"Programming"/"Function")
400ch	Status	Unsigned 16	* see: Status register bit assignment
400dh	Parameter RP1	Float	
400fh	Parameter RP2	Float	
4011h	Parameter RP3	Unsigned 16	
4012h	Worktime	Unsigned 32	In 100 ms precision
4014h	Switching number	Unsigned 32	No. of relay state changes
4016h	Source value	Float	The value the relay state is calculated from

State register bit assignment						
B15…B8	B7	B6	B5	B4	B3	B2..B0
00000000	Relay state: 0=OFF 1=ON	0=Test ON 1=Test OFF	0=output as RP1, RP2 and RP3 1=output test	0=inactive 1=active	0=Invert OFF 1=Invert ON	000

7.2.6 INTERFACE MODULE TABLE:

Every module (Universal Interface Module) has a long address and a TAG (ID). There are 2 units (SLOT) in a module. These slots can be either a relay or a current output. If there is only one unit in a module it is always in SLOT1. These units (relays and current outputs) have their own long addresses and TAGs.

Query: MASTER→MultiCONT:

ADDR	**FNC=0x03**	**START**	**QUANTITY**		**CRC**	
		5000h+N*0040h+00..08h	HI=00h	LO=01h…09h	HI	LO

N=0…Bn-1, where Bn is No. of interface modules (see: address 001ah of system variables table)

Module (UIM) Long address (parent)	Manuf. ID	Type ID	Device ID
	151	50	xxxxxx 0

Unit1 (SLOT1) Long address	Manuf. ID	Type ID	Device ID
	151	51=relay 52=current output 53=input	xxxxxx 1

Unit2 (SLOT2) Long address	Manuf. ID	Type ID	Device ID
	151	51=relay 52=current output 53=input	xxxxxx 2

Address	Description	Data type	Comment
5000h	Long address of the module	LongAddr*	
5003h	Module TAG	String	8 characters with 0 at the end
5008h	Interface module status	Unsigned 16	

*For data types with odd number of bytes the value of the most significant byte = 0

7.2.7 HART DEVICE TABLE:

Query: MASTER→MultiCONT:

ADDR	**FNC=03h**	**START**	**QUANTITY**		**CRC**	
		6000h+N*0040h+00..33h	HI=00h	LO=01h…34h	HI	LO

N=0…Dn-1, where Dn is No. of HART devices (see: address 0012h of system variables table)

Byte number	Description	Data type	Comment
6000h	Long address of the device	LongAddr*	
6003h	ID of the device (TAG)	String	8 characters + 0 at the end
6008h	Device error	Bit 16	
6009h	Device warning	Bit 16	
600ah	PV unit	Unsigned 16	See: Table 1
600bh	PV (primary variable)	Float	
600dh	Date of the transmitter's PV refresh	Date	
600fh	Time of the transmitter's PV refresh	Time	
6011h	SV unit	Unsigned 16	See: Table 1
6012h	SV (secondary variable)	Float	
6014h	Date of the transmitter's SV refresh	Date	
6016h	Time of the transmitter's SV refresh	Time	
6018h	TV unit	Unsigned 16	See: Table 1
6019h	TV (tertiary variable)	Float	

601bh	Date of the transmitter's TV refresh	Date	
601dh	Time of the transmitter's TV refresh	Time	
601fh	QV unit	Unsigned 16	See: Table 1
6020h	QV (quaternary variable)	Float	
6022h	Date of the transmitter's QV refresh	Date	
6024h	Time of the transmitter's QV refresh	Time	
6026h	Device output current [mA]	Float	
6028h	Level % („Sensor Range")	Float	
602ah	TOT unit	Unsigned 16	See: Table 1
602bh	TOT1	Unsigned 32	
602dh	TOT2	Unsigned 32	
602fh	HART statistics [%]	Float	Receive/transmission in %
6031h	Device HW version	Unsigned 16	
6032h	Device SW version	Unsigned 16	
6033h	HART command set	Unsigned 16	

*For data types with odd number of bytes the value of the most significant byte = 0

7.3 CHECKING OF BINDINGS (FNC=08H)

This function tests the data transfer between Master and Slave. Only 00 00h Sub-Function can be used that sends back data like an „echo".

Response: MASTER→MultiCONT:

ADDR	**FNC=08h**	Sub-Function		Arbitrary Byte1	Arbitrary Byte2	CRC HI	CRC LO
		00h	00h				

Response:

ADDR	**FNC=08h**	00h	00h	Arbitrary Byte1	Arbitrary Byte2	CRC HI	CRC LO

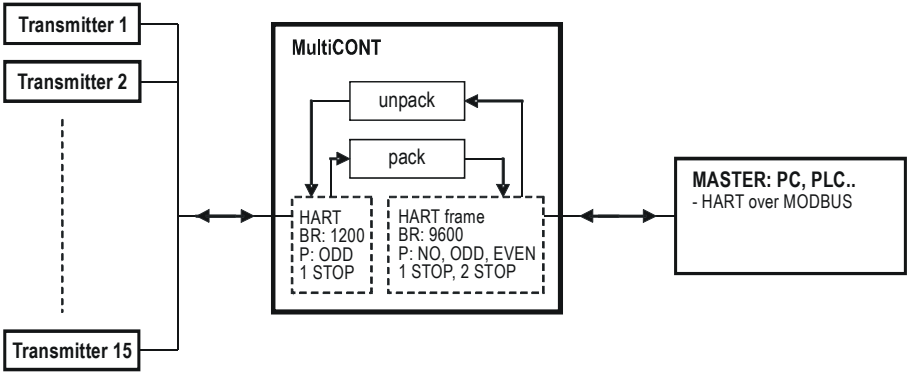
7.4 REMOTE PROGRAMMING OF THE TRANSMITTERS (FNC=17H) – HART OVER MODBUS –

Knowing the Knowing the HART commands of the transmitters, with the help of USER RS485 interface of MultiCONT process controller (this case MultiCONT acts as a bridge) there is a possibility to perform remote programming of the connected transmitters. This can be done the following way:

Detailed description of the remote programming can be found in „USER RS485 protocol for MultiCONT“ programming manual

Request: MASTER→MultiCONT:

- the MASTER inserts the HART frame to the data field of the MODBUS frame, which is sent by the MultiCONT to the transmitters
- the MultiCONT „unpack” the HART frame and sent to the transmitter
- the MultiCONT „pack” the HART answer of the transmitter and send it o the MASTER in the data field of the MODBUS frame in accordance to the following drawing



Query: MASTER →MultiCONT (MODBUS protocol)

ADDR	FNC=17h	Read				Write						CRC	
		START		QUANTITY		START		QUANTITY		BCNT	DATAFIELD		
		HI	LO	HI	LO	HI	LO	HI	LO			HI	LO

Read-Write/Start = 7000h +N*0040h, N=0..Dn-1, where Dn is the list number of the transmitter

The content of **Read / QUANTITY** field is depending on the length of the response HART frame.
If the response HART frame is consists from **Nr byte**, the **Read / QUANTITY=Nr/2.**
In case of odd **Nr** the **Read / QUANTITY=Nr/2 +1,** and in the response the content of the last padding byte complementing to even is 00h.

The **Write/QUANTITY** is depending on the length of the packed HART frame, if its length is **Nw**, then **Write/QUANTITY=Nw/2.** In case of odd **Nw** the **Write / QUANTITY=Nw/2 +1,** the content of the last padding byte complementing to even is 00h. **Write/BCNT= (Write / QUANTITY)*2**.

The **DATAFIELD** contains a HART frame, where the list number of the transmitter should be entered instead of the long address.

The following frame is sent by the MultiCONT which contains the long address:

MultiCONT → DEV HART frame

HART frame										
PRE	0x82	DEV Long ADDR					CMDx	BCNTx	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL				

DEV HART frame → MultiCONT

HART frame										
PRE	0x86	Long address (DEV Long ADDR)					CMDx	BCNTy	Data field	CHK
		FACT-ID	T-ID	D-IDH	D-IDM	D-IDL				

Answer: MultiCONT→MASTER (MODBUS protocol)

ADDR	FNC=17h	BCNT	DATAFIELD	CRC	
				HI	LO

BCNT= Read/QUANTITY * 2
DATAFIELD contains the HART response of the transmitter, with the list number of the transmitter in the long address field.

Example:

Reading P04 parameter (max measurement distance) of SE-380 ultrasonic transmitter
- MultiCONT address=1
- third in the DEV list N=2
- Parameters of the transmitters can be read with the COMMAND131, and its parameter number is to be entered in the data field in 1 byte (P04= 4 parameter).

See: HART communication description of the transmitters

Master >> MultiCONT:

01	17	70 80	00 08	70 80	00 02	04	83 01 04	00	4D 08
MultiCONT address	FNC	Read / START	Read / QUANTITY	Write / START	Write / QUANTITY	BCNT	Data field	Padding byte complementing to even	CHK

The grayed fields are encapsulated added to the DEV long address.

MultiCONT >> DEV(SE-380):

FF FF FF FF FF	82	97 03 02 00 21	83	01	04	B3
preamble	start byte	DEV long address	CMDx=131	BCNTx	P04	CHK

DEV >> MultiCONT:

FF FF FF FF FF	86	97 03 02 00 21	83	0D	00	08	00 00
preamble	start byte	DEV long address	CMDx=131	BCNTy	S(0)	S(1)	DEV err

43 05	04	04	2D	3F E8 F5 C3	3D
DEV status	P04	Attr	P04 dimension	P04 value	CHK

The grayed fields are encapsulated added to the list number of the transmitter and sent in the MODBUS frame to the MASTER.

MultiCONT >> MASTER:

01	17	10	83 0D 00 08 00 00 43 05 04 04 2D 3F E8 F5 C3	00	BC 13
MultiCONT address	FNC	BCNT	Data field (the response HART frame without long address)	Padding byte complementing to even	CHK

In the response: P04=1.82 m

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