



Ser. Interface, Data Transfer

R 1300-2 / -3; The Microprocessor Controller

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2.0 Interface, general description

The microprocessor controlled controllers of the series **R1300-2 and R1300-3** are equipped with a serial interface. As a standard: RS-485 (half-duplex).

This allows up to 32 controllers (here called: slaves) to be monitored and controlled on a common bus (multipoint interface) by a higher level computer (here called: master).

The interface is electrically isolated by the rest of the device circuit.

The data transfer between the slave and master takes place with the aid of a defined protocol.

The communication is always controlled by the master.

The controller operates as a slave with its own address (1...255).

The address has to be programmed in the configuration level of the controller.

If there are transmission or other errors detected by the slave (controller), it doesn't accept this data.

The old parameter values are still valid.

All data are transferred in a hexadecimal, ASCII-coded format.

- Check criterias:
1. Only ASCII-Codes from 0...9 or A...F ?
Except for start and stop character?
 2. Data format (Parity) o.k. ?
 3. Check sum o.k. ?

RS-485 interface data:	Number of drivers/receivers:	32
	Transmission character:	symmetric
	Max. wire length:	1200 m

3.0 Interface Parameters

The following parameters have to be programmed in the configuration level of the controller:
See controller manual --> configuration level.

Adr	Unit address	1 255	(ex works: 1)
		The master addresses the slave at this address. Each slave has its own address. It is possible to address 32 slaves.	
For	Data format	7E1	7 data, even, 1 stop bit
		7o1	7 data, odd, 1 stop bit
		7E2	7 data, even, 2 stop bit
		7o2	7 data, odd, 2 stop bit
		7n2	7 data, none, 2 stop bit
		8E1	8 data, even, 1 stop bit
		8o1	8 data, odd, 1 stop bit
		8n1	8 data, none, 1 stop bit
		8n2	8 data, none, 2 stop bit
bAud	Baud rate	OFF; 0,3 ... 38,4 kBaud	(ex works: 9,6)
		The baud rate denotes the transmission rate at which one bit is transmitted.	

Start bit:

At the beginning of the transmission a start bit (log. 0) is transmitted. It's purpose is to inform the receiver of the start of a data word (synchronization of the data exchange).

Data bit:

The start bit is (starting with the least significant bit) followed by 7 or 8 data bit,.

Parity bit:

The next bit is the parity bit.

It is calculated from the check sum of all data bit and enables the receiver to recognize transmission errors.

EVEN - Parity: The number of the ones transmitted (including the parity bit) must be even.

ODD - Parity: The number of the ones transmitted (including the parity bit) must be odd.

NONE - Parity: There is no parity-bit calculated and transmitted.

Stop bit:

The transmission of a data word is concluded with 2 stop bit (log. 1). The purpose of this is to provide a minimum space between two immediatly consecutive data words.

EXAMPLE 1

Data format: (7E2) : 1 Start bit 7 Data bit Parity (EVEN) 2 Stop bit

Data word:		111 1100		
Transmission:	0	0011 111	1	1 1

EXAMPLE 2

Data format: (8o1) : 1 Start bit 8 Data bit Parity (ODD) 1 Stop bit

Data word:		1111 1100		
Transmission:	0	0011 1111	1	1

4.0 Data Transmission / Protokoll

All data (Hex-Byte) are transmitted in ASCII-format (text characters).

Permitted ASCII characters: 30H ... 39H, 41H ...46H,
0AH, 0DH

All other characters would be ignored.

E.g.: Hex-Byte **2FH** -> "2" in ASCII: 32H
"F" in ASCII: 46H

Two ASCII characters are thus required for each hex byte.

The only exceptions are:

the start character: (0AH = line feed, LF) and

the end character: (0DH = carriage return, CR).

The instruction or parameter transfer is executed in both directions by means of defined data blocks.

4.1 Terms

Start character:	Introduces transfer of a data block. All characters in front of the start character are ignored.	(1 ASCII)
Device adress:	designates a specific controller or instrument	(2 ASCII)
Constant:	30H, 31H (reserved dummy variable)	(2 ASCII)
Instruction code:	Tells the device (slave) what it must do	(2 ASCII)
Parameter code:	Designates each individual parameter that can be called in the device.	(2 ASCII)
Parameter group code:	Some parameters are combined to a group (E.g.: the feedback parameters P, I, D and the switching cycle time C). All this parameters can be set and called up with one instruction.	(2 ASCII)
Parameter value:	States the value of a parameter	(6 ASCII)
Responce:	Acknowledgement message of the device in response to a master instruction.	(2 ASCII)
Check sum:	The two's complement of the sum of all the hex bytes of a data block without the start and the end characters. Serves the purpose of recognizing transmission errors.	(2ASCII)
End character:	Concludes the transmission of a data block	(1 ASCII)

5.0 Instruction and Response

The master (computer) can issue the following instructions to the slave (controller):

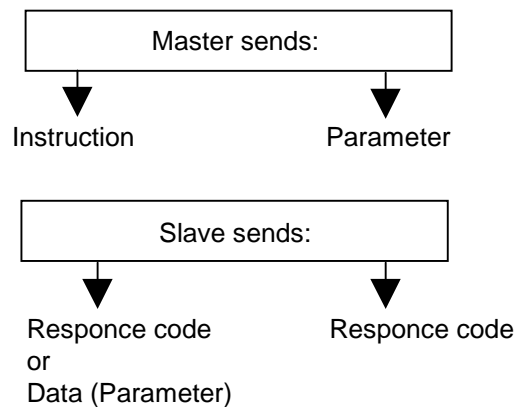
- | | |
|--|----------------------------------|
| a. Send parameter: | Instruction code 10 H (see 12.1) |
| b. Send parameter group: | Instruction code 15 H (see 12.2) |
| d. Accept parameter: | Instruction code 20 H (see 12.3) |
| e. Accept parameter and store with powerfail protection: | Instruction code 21 H (see 12.4) |
- Take care:
The EAROM / E² ROM permits max. 10.000 write cycles.

Provided, that the slave understood the instruction, it always responds by sending a complete data block.

The typical interval between master instruction and slave response (time-out) is 5...10 msec..

The slave repeats the received instruction code.

5.1 Instruction



5.2 Response (with error code)

- | | |
|------|--|
| 00 H | - acknowledge, no error (Instruction executed) |
| 01 H | - Parity error |
| 02 H | - Check sum error |
| 03 H | - Procedure error |
| 04 H | - Non-compliance with specified range |
| 05 H | - Constant not equal to „30H,30H“ or „30H,31H“ |
| 06 H | - The addressed parameter is a read-only parameter |
| FEH | - Error during writing into the powerfail storage |
| FFH | - General error |

6.0 Parameter Value

The parameter value comprises three data bytes:
2 data byte (mantissa), 1 data byte (exponent).

Examples:	Dec.	Hex.	Mantissa	Exp.	ASCII
Process value (°C):	215	00D7	00D7	00	30 30 44 37 30 30
Setpoint (°C):	230	00E6	00E6	00	30 30 45 36 30 30
Output ratio, "cooling" (%)	-16	FFF0	FFF0	00	46 46 46 30 30 30
Setpoint ramp (°C/min):	2,2	0016	0016	FF	30 30 31 36 46 46
The parameter value is calculated as follows: Dec.: 2,2 = 22 x 10 ⁻¹ Hex.: = 0016 (mantissa) = FF (exponent)					
Status word	1	0001	0001	00	30 30 30 31 30 30

Negative mantissas / negative exponents : Built binary two's complement.

7.0 Check Sum

The checksum is formed by subtracting the hex data of a data block (without start- and end characters) from 00H (two's complement of the sum). Carryovers are disregarded.

Example:

Device address = 14dec.:	0E	00 - 0E = F2
Constant:	01	F2 - 01 = F1
Instruction code:	10	F1 - 10 = E1
Parameter code:	10	E1 - 10 = D1
Parameter value:	00C8.00	D1 - 00 = D1 D1 - C8 = 09 09 - 00 = 09

Checksum: 09

8.0 Parameter Code

Parameter list	Mnem.	Parameter code		read write	Parameter group code
		Hex.	Dec.		
Device type:		01	01	r	
Process value group					01 H
Process value		10	16	r	
Process value offset	OFSt	18	24	r/w	
Sensor configuration	Sen	1A	26	r/w	
Dec.point (standard signal input)	rA.dP	1D	29	r/w	
Display range value, low	rA.Lo	1E	30	r/w	
Display range value, high	rA.Hi	1F	31	r/w	
Setpoint group					02H
Setpoint, actual		20	32	r	
Setpoint 1		21	33	r/w	
Setpoint 2	SP2	22	34	r/w	
Lower setpoint limitation	SP.Lo	2B	43	r/w	
Higher setpoint limitation	SP.Hi	2C	44	r/w	
Ramp, rising	SP↑	2D	45	r/w	
Ramp, falling	SP↓	2F	47	r/w	
Alarm group					03H
Alarm configuration 3	Co.A3	34	52	r/w	
Alarm configuration 2	Co.A2	35	53	r/w	
Alarm value 3	AL3	38	56	r/w	
Alarm value 2	AL2	39	57	r/w	
Parameter group 2-point (heating-off / cooling-off) or 3-point (heating-off-cooling) "heating"					04H
Proportional range, xp (P)	1 P	40	64	r/w	
Rate (derivative time), Tv (D)	1 d	41	65	r/w	
Reset time, Tn (I)	1 I	42	66	r/w	
Switching cycle time, heating	1 CY	43	67	r/w	
Dead band (only 3-point-contr.)	S h	46	70	r/w	
Control sensivity (Hystereses)	1 Sd	47	71	r/w	
Parameter group 3-point (heating-off-cooling) „cooling“					05H
Proportional range, xp (P)	2 P	50	80	r/w	
Rate (derivative time), Tv (D)	2 d	51	81	r/w	
Reset time, Tn (I)	2 I	52	82	r/w	
Switching cycle time, cooling	2 CY	53	83	r/w	
Control sensivity (Hystereses)	2 Sd	57	87	r/w	
Parameter group 3-point-step-controller					04H
Proportional range, xp (P)	P	40	64	r/w	
Motor setting time, ts (D)	tS	41	65	r/w	
Reset time, tn (I)	tn	42	66	r/w	
Dead band, neutral zone	Sh	46	70	r/w	
Control sensivity (Hystereses)	Sd	47	71	r/w	

Parameter list	Mnem.	Parameter code		read write	Parameter group code
		Hex.	Dec.		
Parameter group „control response ratio output“					06H
Output ratio, actual (cooling < 0 < heating)	Y	60	96	r	
Manual response ratio (mode "Hand")	Hand	62	98	r/w	
Output ratio limitation, OUT1	1 LY	64	100	r/w	
Output ratio limitation, OUT2	2 LY	69	105	r/w	
Start up output ratio	So.Y	6A	106	r/w	
Start up setpoint	So.SP	6B	107	r/w	
Hold up time	So.ti	6C	108	r/w	
Parameter group „status word“					
Status word 1		70	112	r	
Parameter group "process"					0AH
With this (single) instruction the following, actual parameters can be read out by the master.					
Process value		10	16	r	
Setpoint, actual		20	32	r	
Output ratio, actual	Y	60	96	r	
Status word 1		70	112	r	

9.0 Configuration Code

With the following parameters the device can be configured.
Instead of a parameter value a code number has to be send.

Parameter list		Mnem.	Parameter code		read
			Hex.	Dec.	write
9.1 Controller configuration		ConF	80H	128d	r/w
Code:	Display:	Action:			
0	2P h	2-point- or continous-controller „heating“			
1	2P c	2-point- or continous-controller „cooling“			
2	2Pnc	2-point- or continous-controller „cooling“, with nonlinear cooling action			
3	3P	3-point controller (heating-off-cooling)			
4	3Pnc	3-point controller (heating-off-cooling) with nonlinear cooling action			
5	3PSt	3-point-step controller action			
9.2 Configuration Output 1		Out1	81H	129	r/w
Code:	Display:	Action:			
0	rEL.	Out1 = Relay			
1	biSt.	bistable voltage output			
2	Co. 0	0 ... 20 mA, 0 ... 10 Vdc (only version R1300-2 or R1300-3)			
3	Co. 4	4 ... 20 mA, 2 ... 10 Vdc (only version R1300-2 or R1300-3)			
9.3 Configuration Output 2		Out2	82H	130	r/w
Code:	Display:	Action:			
0	rEL.	Out2 = Relay			
1	biSt.	bistable voltage output			
2	Co. 0	0 ... 20 mA, 0 ... 10 Vdc (only version R1300-2 or R1300-3)			
3	Co. 4	4 ... 20 mA, 2 ... 10 Vdc (only version R1300-2 or R1300-3)			
9.4 Sensor Configuration		Sen	1AH	26	r/w
Code:	Display:	Action:			
0	P1 °C	Pt 100, -50,0...100,0 °C			
1	P1 °F	Pt 100, -58,0...212,0 °F			
2	P2 °C	Pt 100, -90,0...205,0 °C			
3	P2 °F	Pt 100, -130...401 °F			
4	P4 °C	Pt 100, 0...400 °C (ex works)			
5	P4 °F	Pt 100, 32...752 °F			
6	P8 °C	Pt 100, 0...800 °C			
7	P8 °F	Pt 100, 32...1472 °F			
8	L4 °C	T/C Fe-CuNi (L), 0...400 °C			
9	L4 °F	T/C Fe-CuNi (L), 32...752 °F			
10	L8 °C	T/C Fe-CuNi (L), 0...800 °C			
11	L8 °F	T/C Fe-CuNi (L), 32...1472 °F			
12	J8 °C	T/C Fe-CuNi (J), 0...800 °C			
13	J8 °F	T/C Fe-CuNi (J), 32...1472 °F			
14	n1 °C	T/C NiCr-Ni (K), 0...1200 °C			
15	n1 °F	T/C NiCr-Ni (K), 32...2192 °F			
16	S1 °C	T/C Pt10Rh-Pt (S), 0...1600 °C			
17	S1 °F	T/C Pt10Rh-Pt (S), 32...2912 °F			
18	0 - 20	Current	0...20 mA		
19	4 - 20	Current	4...20 mA		
20	10 dc	Voltage	0...10 V dc		

Parameter list	Mnem.	Parameter code		read	write
		Hex.	Dec.		
9.5 Alarm Configuration 3	Co.A3	34H	52	r/w	
Alarm Configuration 2	Co.A2	35H	53	r/w	
Code:	Display:	Action:			
0	OFF	Alarm OFF, no alarm signalisation (ex works)			
1	1	Signal contact:	off-on		
2	2	Limit contact:	off-on		
3	3	Limit comparator:	off-on-off		
4	4	Signal contact:	on-off		
5	5	Limit contact:	on-off		
6	6	Limit comparator:	on-off-on		
7	7	Limit comp. with standby during start-up:	off-on-off		
9.6 Manual operation while sensor breakage					
		Hand	8BH	139	r/w
Code:	Display:	Action:			
0	OFF	No manual operation			
1	Auto	Automatic switch over to manual operation			
2	Man	Controller works as an actuator with the programmed percentage output ratio			
9.7 Switching behaviour of the outputs in case of sensor breakage					
		Co.Sb	8AH	138	r/w
					3-point step controller
Code:	Display:	Action:			
0	OFF	OUT1: off	OUT2: off	off: Relay not energized	
1	out2	off	on		
2	out1	on	off		
9.8 Adjustment lock (keyboard)LOC					
			85H	133	r/w
Code:	Display:	Action:			
0	OFF	no adjustment lock			
1	P C	Parameter- and Configuration levels locked			
2	n.SP1	All Parameters except setpoint 1 locked (not SP1)			
3	ALL	All Parameters locked			
9.9 Self tuning (auto tune)					
		Opt	88H	136	r/w
Code:	Display:	Action:			
0	OFF	Self tuning out of action			
1	on	Self tuning on request (one time)			
2	Auto	Self tuning automatically if the controller is switched on			
9.10 Manual output ratio while sensor breakage					
		Hand	8CH	140	r
					3-point step controller
Code:	Display:	Action:			
0	OFF	The unit works as a controller			
1	On	The unit works as an actuator			

10.0 Status Word 1

For monitoring and controlling is one status word available.
It has 8 bit.

Status word 1, Parameter code 70H

Reports alarm states ascertained by the controller.

7	6	5	4	3	2	1	0	:			
bit									bit 0 = 1	-> System error	
									bit 1 = 1	-> Sensor error	
									bit 2 = x	-> no function	
									bit 3 = 1	-> reset-control.	A reset was triggered during operation. The device automatically resets bit 3 = 0 if the status word 1 has been read once by the master.
									bit 4 = x	-> no function	
									bit 5 = 1	-> Alarm 3 „on“	
									bit 6 = 1	-> Alarm 2 „on“	
									bit 7 = 1	-> Setpoint ramp in operation	

11.0 Data Block Structure

11.1 Master sends „Instruction“, Instruction code: 10H, 15H

Start ----> **0A** ----> **xx xx** ----> **30 31** ----> **xx xx** ----> **xx xx** ----> **xx xx** ----> **0D** ----> End
Lf Device- Constant Instruction- Param.- Check- CR
adress code code sum

11.2 Master sends "Parameter", Instruction code: 20H, 21H

Start ----> **0A** ----> **xx xx** ----> **30 31** ----> **xx xx** ----> **xx xx** ---->
Lf Device- Constant Instruction- Param.-
adress code code

----> **xx xx xx xx xx xx** ----> **xx xx** ----> **0D** ----> End
Mantissa Exp. Check- CR
Parameter sum

11.3 Slave sends „Response“ to master:

Start ----> **0A** ----> **xx xx** ----> **30 31** ----> **xx xx** ----> **xx xx** ----> **xx xx** ----> **0D** ----> End
Lf Device- Constant Response- Response Check- CR
adress code code sum
Instruction- Error-
code code

11.4 Slave sends „Parameter“ or „Parameter group“ to master (Data transfer)

Start ----> **0A** ----> **xx xx** ----> **30 31** ----> **xx xx** ---->
Lf Device- Constant Response-
adress code
Instruction-code

----> **xx xx** ----> **xx xx xx xx xx xx** ---->
Param.- Mantissa Exp.
code 1 Parameter value 1

----> **xx xx** ----> **xx xx xx xx xx xx** ----> **xx xx** ----> **0D** ----> End
Param.- Mantissa Exp. Check- CR
code n Parameter value n sum

12.0 Typical Transmission Examples

12.1 Transmission example, Instruction code 10 H

The device No.(adress) 5 is called to send a parameter (process value, 10 H) to the master.

Master to device (slave):	Dec.	Hex		ASCII (Hex)
Start character				0A
Device adress:	5	05	-->	30 35
Constant:		01	-->	30 31
Instruction: Send parameter		10	-->	31 30
Parameter code (actual value):		10	-->	31 30
Check sum:		DA	-->	44 41
End character:				0D

Transmission to controller: 0A 30 35 30 31 31 30 31 30 44 41 0D

Device (slave) to master:	Dec.	Hex		ASCII
Start character				0A
Device adress:	5	05	-->	30 35
Constant:		01	-->	30 31
Send parameter (repeats instruction):		10	-->	31 30
Parameter code (process value):		10	-->	31 30
Parameter value:	225	00E1.00	-->	30 30 45 31 30 30
Check sum:		F9	-->	46 39
End character:				0D

Trnasmission to master: 0A 30 35 30 31 31 30 31 30 30 30 45 31 30 30 46 39 0D

12.2 Transmission example, Instruction code 15 H

The device No.12 should send the parameter group 0AH to the master.

Master to device (slave):	Dec.	Hex		ASCII (Hex)
Start character				0A
Device adress:	12	0C	-->	30 43
Constant:		01	-->	30 31
Instruction: Send parameter group		15	-->	31 35
Parameter group code (0AH):		0A	-->	30 41
Check sum:		D4	-->	44 34
End charakter:				0D

Transmission to device: 0A 30 43 30 31 31 35 30 41 44 34 0D

Device to master:	Dec.	Hex		ASCII
Start character				0A
Device adress:	12	0C	-->	30 43
Constant:		01	-->	30 31
Send parameter group (repeats instruction):		15	-->	31 35
1. Parameter code, process value:		10	-->	31 30
Parameter value	248	00F8.00	-->	30 30 46 38 30 30
2. Parameter code, actual setpoint:		20	-->	32 30
Parameter value	250	00FA.00	-->	30 30 46 41 30 30
3. Parameter code, actual output ratio:		60	-->	36 30
Parameter value	42	002A.00	-->	30 30 32 41 30 30
4. Parameter code, Status word 1:		70	-->	37 30
Parameter value	00	0000.00	-->	30 30 30 30 30 30
Check sum:		C2	-->	43 32
End character:				0D

Transmission to master:

0A 30 43 30 31 31 35 31 30 30 30 46 38 30 30 32 30 30 30 46 41 30 30
36 30 30 30 32 41 30 30 37 30 30 30 30 30 30 30 43 32 0D

12.3 Transmission example, Instruction code 20 H

The device No.27 gets the instruction:

"Take over the parameter 1 P (xp-heating, Parameter code: 40H) into the RAM.

Master to device (slave):	Dec.	Hex		ASCII
Start character:				0A
Device adress:	27	1B	-->	31 42
Constant:		01	-->	30 31
Instruction code:		20	-->	32 30
Parameter code (xp-heating):		40	-->	34 30
Parameter value:	5	0005.00	-->	30 30 30 35 30 30
Check sum:		7F		37 41
End character:				0D

Transmission to device: 0A 31 42 30 31 32 30 34 30 30 30 30 35 30 30 37 41 0D

Device to master:	Dec.	Hex		ASCII
Start character				0A
Device adress:	27	1B	-->	31 42
Constant:		01	-->	30 31
Instruction code (repeats instruction):		20	-->	32 30
Responce* (acknowledged) :		00	-->	30 30
Check sum:		C4	-->	43 34
End character:				0D

Transmission to master: 0A 31 42 30 31 32 30 30 30 43 34 0D

* If the device has understood the instruction issued by the master, it acknowledges with the response 00 H (acknowledge).

In the event of transmission or other errors, the device responds here with the appropriate error code.

12.4 Transmission example, Instruction code 21 H

The device No.2 gets the instruction:

"Take over the parameter SP1 (Setpoint 1, Parameter code: 21H) and store powerfail.

Master to device (slave):	Dec.	Hex	ASCII
Start character			0A
Device adress:	2	02	--> 30 32
Constant:		01	--> 30 31
Instruction code:		21	--> 32 31
Parameter code (Setpoint 1):		21	--> 32 31
Parameter value:	235	00EB.00	--> 30 30 45 42 30 30
Check sum:		D0	--> 44 30
End character:			0D

Transmission to device: 0A 30 32 30 31 32 31 32 31 30 30 45 42 30 30 44 30 0D

Device to master:	Dec.	Hex	ASCII
Start character			0A
Device adress:	2	02	--> 30 32
Constant:		01	--> 30 31
Instruction (repeats instruction) :		21	--> 32 31
Response * (acknowledged):		00	--> 30 30
Check sum:		DC	--> 44 43
End character:			0D

Transmission to master: 0A 30 32 30 31 32 31 30 30 44 43 0D

* If the device has understood the instruction issued by the master, it acknowledges with the response 00 H (acknowledge).

In the event of transmission or other errors, the device responds here with the appropriate error code.

13.0 Typical Error Messages

13.1 Procedure error; error message: 03 H

The device (slave or controller) reports „procedure error“ if unknown instruction or parameter codes or parameter group codes are stated.

Other error messages as follows:

1. The master wishes to edit an illegal alarm value.
Remedy: initially allow the alarm by means of the alarm configuration.
2. The slave (controller) is operating in the automatic mode (controller mode).
The master wishes to edit the manual response ratio (62H).
First switch over to mode „HAnd“.
3. The slave can't store the parameter „manual output ratio“ powerfail.
4. The slave (controller) is configured as a 2-point (heating-off) controller:
The master requests the „cooling“ parameters.
5. The slave (controller) is configured as a 3-point (heating-off-cooling) controller:
The master will trigger alarm AL2. AL2 is not available in this controller configuration.

13.2 Parameter is an only read parameter; error message: 06 H

The slave (controller) reports „parameter is only read parameter“ if a read parameter is to be edited via the master.

E. g.:

1. The master wishes to specify the response output ratio, although the slave is in the automatic mode (parameter 62H).
2. The master wishes to send status word 1 (parameter 70H) to the slave.
3. The master wishes to edit the actual value.
4. The master wishes to edit the current setpoint (parameter 20H). Edit SP1 or SP2.
5. 3-point-step controller configuration:
The master wishes to send a manual output ratio value when the slave is in „HAnd“-mode.

13.3 Non - compliance with specified range; error message: 04H :

The slave reports „non-compliance with specified range“ in the following instances:

1. Alarm configuration: Signal contact
The master wishes to edit +1100 (max. allowed: +999).
2. Configured measuring and controlling range: 0 ... 400°C.
The master wishes to edit 430°C.

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