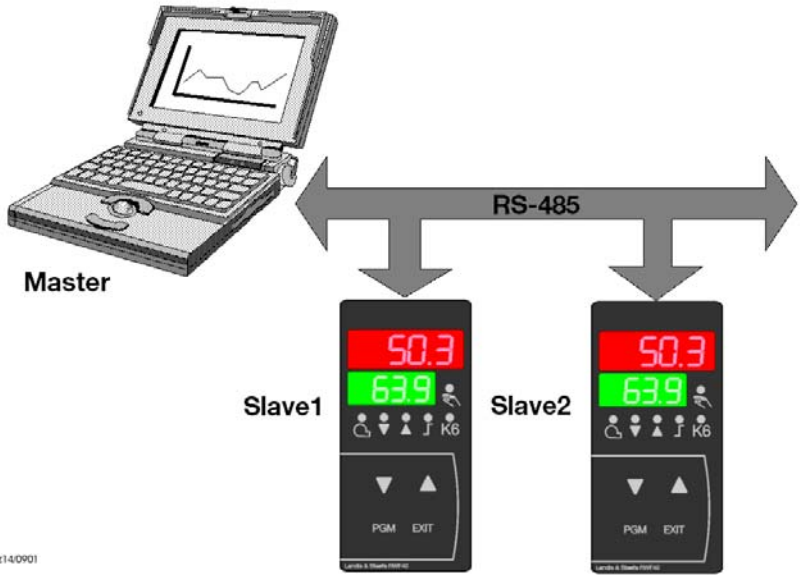
Interface RS-485 RWF40...

The RS-485 interface is used for integrating RWF40… controllers into data networks via MOD bus protocol.

Application examples:
- Process visualization
- Plant control
- Reporting

Master-slave principle

Communication between a PC (master) and a device (slave) via MOD bus is based on the master-slave principle in the form of data query / instruction – reply.



A master computer controls the exchange of data and can address up to 99 controllers via device addresses (slaves).

Transmission mode (RTU)

The transmission mode used is the RTU (remote terminal unit) mode. Data are transmitted in binary format (hexadecimal) with 8 bits.
The LSB (least significant bit) is transmitted first.
ASCII mode is not supported.

Data format

The data format describes the structure of the transmitted byte.

Data word	Parity bit	Stop bit ½ bit	Number of bits
8 bit	Not	1	9

Device address

The slaves' device addresses can be selected between 1 and 99.
Device address 0 is reserved.

A maximum of 31 slaves can be addressed via the RS-422 / RS-485 interface.

There are 2 choices of data exchange:

Query — Data query / instructions delivered by the master to a slave via the respective device address.
The addressed slave responds.

Broadcast — Master instructions to all slaves via device address 0.
The addressed slaves do not respond.
A data query with device address 0 does not make sense.
A certain setpoint can be transmitted to all slaves, for example.
In that case, correct adoption of the value by the slaves should be checked by subsequent setpoint readout.

Communication sequence

Both the start and end of a data block are characterized by transmission pauses. The maximum period of time that may elapse between 2 successive characters is 3 times the period of time required for the transmission of one character.
The character transmission time (period of time required for the transmission of 1 character) is dependent on the Baud rate and the type of data format.

Using a data format of 8 data bits, no parity bit and 1 stop bit, the character transmission time is calculated as follows:

Character transmission time [ms] = 1000 * 9 bits / Baud rate

Process

Data query by the master Transmission time = n characters * 1000 * x bits / Baud rate
Identification of end of data query 3 characters * 1000 * x bits / Baud rate
Handling of data query by the slave (≤ 250 ms)
Reply by the slave Transmission time = n characters * 1000 * x bits / Baud rate
Identification of end of reply 3 characters * 1000 * x bits / Baud rate

Example

Identification of the data query or end of the reply with a data format of 10 / 9 bits.

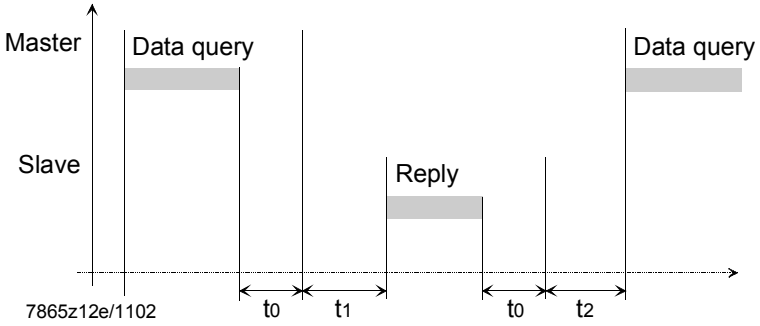
Waiting time = 3 characters * 1000 * x bits / Baud rate

Baud rate	**Data format** [bits]	**Waiting time** [ms]
9.600	9	2.813
19.200	9	1.406

Data query sequence

Time sequence

The time sequence of a data query looks as follows:



t0 Identification of end = 3 characters
(time is dependent on the Baud rate)

t1 This time is dependent on internal handling.
The maximum handling time is 250 ms

t2 This is the time required by the device to switch from the transmitting mode back to the receiving mode.
This time must be observed by the master before it makes a new data query. It must always be maintained, even if the new data query is sent to some other device.

$t2 \geq 20$ ms

Communication during the slave's internal handling time

The master is not allowed to make any data queries during the slave's internal handling time.
Data queries made during that period of time will be ignored by the slave.

Communication during the slave's response time

The master is not allowed to make any data queries during the slave's response time.
Data queries made during that period of time cause all data currently on the bus to become obsolete.

Structure of the data blocks

All data blocks use the same structure:

Data structure

Slave address	Function code	Data field	Checksum CRC16
1 byte	1 byte	x byte	2 bytes

Every data block contains 4 fields:

Slave address Device address of a certain slave

Function code Function selection (reading or writing words)

Data field Contains the following information:
- Word address
- Number of words
- Word value

Checksum Identification of transmission errors

Fault handling

Error codes

3 different error codes are used:

1 Invalid function
2 Invalid parameter address
8 Write access to parameter rejected

Reply in the event of fault

Slave address	Function XX OR 80 h	Error code	Checksum CRC16
1 byte	1 byte	1 byte	2 bytes

The function code is OR linked with 0 x 80, that is, the MSB (most significant bit) will be set to 1.

Example

Data query:

01	02	00	70	00	04	CRC16

Reply:

01	82	01	CRC16

Special cases

In the following cases, the slave does not reply:
- The checksum (CRC16) is wrong
- The instruction given by the master is incomplete or overdefined
- The number of words or bits to be read is zero

Checksum (CRC16)

The checksum (CRC16) is used to detect transmission errors.
If the evaluation reveals an error, the relevant device will not respond.

Calculation

```
CRC = 0xFFF
    CRC = CRC XOR ByteOfMessage
    For (1 to 8)
        CRC = SHR (CRC)
        if (flag to the right = 1)
            then                    else
            CRC = CRC XOR
            0xA001
while (not all ByteOfMessage edited)
```

The low byte of the checksum will be transmitted first.

Example

Data query:

Reading 2 words from address 6 (CRC16 = 0x24A0)

0B	03	00	06	00	02	A0	24
						CRC16	

Reply:

(CRC16 = 0x6105)

0B	03	04	00	00	42	C8	61	05
			Word 1		Word 2		CRC16	

The following functions for the device will be available:

Function number	**Function**
0x03 / 0x04	Reading n words (n ≤ 12)
0x06	Writing 1 word
0x10	Writing n words (n ≤ 2)

Reading n words

This function is used to read n words from a certain address.

Data query

Slave address	Function 0x03 or 0x04	Address of the first word	Number of words (max. 12)	Checksum CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Reply

Slave address	Function 0x03 or 0x04	Number of bytes read	Word value(s)	Checksum CRC16
1 byte	1 byte	1 byte	x byte(s)	2 bytes

Example

Reading the 2 setpoints of the controller
Word address = 0x0008 (setpoint SP1)

Data query:

0B	03	00	08	00	04	CRC16

Reply:

0B	03	08	0000	42C8	0000	4316	CRC16
			Setpoint 1 (100)		Setpoint 2 (150)		

Writing 1 word

With the “Wordwriting” function, the data blocks for instruction and reply are identical.

Instruction

Slave address	Function 0x06	Word address	Word value	Checksum CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Reply

Slave address	Function 0x06	Word address	Word value	Checksum CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Example

Write limit value limit comparator 1 (AL1) (= 275)
Word address = 0x000C

Instruction: (write the first part of the value)

0B	06	00	0C	80	00	CRC16

Reply (like instruction):

0B	06	00	0C	80	00	CRC16

Instruction: (write the second part of the value)

0B	06	00	0D	43	89	CRC16

Reply (like instruction):

0B	06	00	0D	43	89	CRC16

Writing n words

Instruction

Slave address	Function 0x10	Address of first word	Number of words	Number of bytes (max. 2)	Word value(s)	Check-sum CRC16
1 byte	1 byte	2 bytes	2 bytes	1 byte	x byte(s)	2 bytes

Reply

Slave address	Function 0x10	Address of first word	Number of words	Checksum CRC16
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Example

Write switch-on threshold (Hys1 = -10)
Word address = 0x0018

Instruction:

0B	10	00	18	00	02	04	00	00	C1	20	CRC16

Reply:

0B	10	00	18	00	02	CRC16

Data type “char“

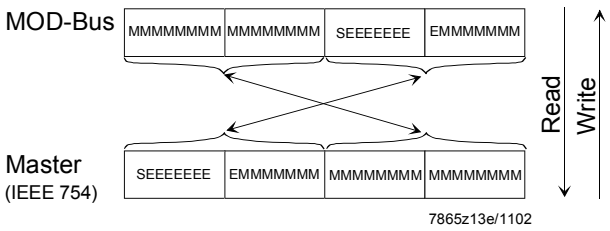
The high byte must be transmitted first.

Example: Configuration code C111: “9030“
MOD bus: 0B10 0024 00 02 04 0903

Data type “float“

The following explanations apply under the condition that the master works with the IEEE-754 format. Before transmitting a value, the bytes must be exchanged in a way that the order corresponds to the presentation for the MOD bus (see illustration below).

M-23 bit normalized mantissa
E-exponent (complement to base 2)
S-Sign-bit; 1 = negative, 0 = positive



Example:
Transmission of decimal value “550“:
MOD bus: 0x80, 0x00, 0x44, 0x09

Following is a description of all process values (variables) with their addresses, data type and type of access.

Where:

R / O Read only access
R / W Read and write access
float Float value (4 bytes / 2 words)
word Integer (2 bytes / 1 word)

The process values are subdivided into logic areas.

Address tables

Process data

Address	Data type	Access	Parameter		Value range	Default value
0x0000	float	R / O		Actual value E1		
0x0002	float	R / O		Actual value E2		
0x0004	float	R / O		Actual value E3		
0x0006	float	R / W		Current setpoint		
0x0008	float	R / W	SP1	First setpoint	SPL...SPH	0
0x000A	float	R / W	SP2 (=dSP)	Second setpoint	SPL...SPH	0

Parameter level

Address	Data type	Access	Parameter		Value range	Default value
0x000C	float	R / W	AL	Limit value limit comparator	-1999...9999	0
0x000E	float	R / W	Pb1	Proportional band	0.1...9999	10
0x0010	float	R / W	dt	Derivative action time	0...9999	80
0x0012	float	R / W	rt	Integral action time	0...9999	350
0x0014	float	R / W	db	Dead band (neutral zone)	0.0...100.0	1
0x0016	float	R / W	tt	Actuator running time	10...3000	15
0x0018	float	R / W	Hys1	Switch-on threshold	0...-199.9	-5
0x001A	float	R / W	Hys2	Switch-off threshold, bottom	0...Hys3	3
0x001C	float	R / W	Hys3	Switch-off threshold, top	0.0...999.9	5
0x001E	float	R / W	q	Reaction threshold	0.0...999.9	0
0x0020	float	R / W	H	Heating curve slope	0.0...4.0	1.0
0x0022	float	R / W	P	Parallel displacement room temperature	-90...90	0

Configuration level

Address	Data type	Access	Parameter		Value range	Default value
0x0024	char [4]	R / W	C111			9030
0x0026	char [4]	R / W	C112			0010
0x0028	char [4]	R / W	C113			0110
0x002A	char [4]	R / W	C000			0000
0x002C	float	R / W	SCL	Normalization start value: Input 1	-1999...9999	0
0x002E	float	R / W	SCH	Normalization end value: Input 1	-1999...9999	100
0x0030	float	R / W	SCL2	Normalization start value: Input 2	-1999...9999	0
0x0032	float	R / W	SCH2	Normalization end value: Input 2	-1999...9999	100
0x0034	float	R / W	SPL	Start value setpoint limitation	-1999...9999	0
0x0036	float	R / W	SPH	End value setpoint limitation	-1999...9999	100
0x0038	float	R / W	OFF1	Offset input 1	-1999...9999	0
0x003A	float	R / W	OFF2	Offset input 2	-1999...9999	0
0x003C	float	R / W	OFF3	Offset input 3	-1999...9999	0
0x003E	float	R / W	HYST	Hysteresis of limit comparator	0...9999	1
0x0040	float	R / W	df1	Filter time constant input 1	0.0...100.0	1.0
0x0042	float	R / W	dF3	Filter time constant input 3	0...1440	1278
0x0044	float	R / W	dtt	Bus detection timer	0...7200 *	30
0x0046	float	R / O	oLLo	Start value actual value limit	-1999...9999	-1999
0x0048	float	R / O	oLHi	End value actual value limit	-1999...9999	9999

* Timer = 0 means switched off
This parameter can only be changed via the management system

Device data

Address	Data type	Access	Parameter	Value range	Default value
0x0300	word [13]	R / O	Device data		
0x0300			char SWVersion [11+1] Software version		
0x0306			char VDNNr [13+1] VdN number		

Remote operation

Address	Data type	Access	Parameter		Value range	Default value
0x0400	float	R / O	TEMP	Actual value E3 (unfiltered)		
0x0500	word	R / W	REM	Activation remote operation	0...2 *	0
0x0501	word	R / W	ROFF	Controller OFF in REMOTE SETPOINT	0...1 **	0
0x0502	float	R / W	RHYS1	Switch-on threshold REMOTE	0...-1999	HYS1
0x0504	float	R / W	RHYS2	Switch-off threshold bottom REMOTE	0...RHYS3	HYS2
0x0506	float	R / W	RHYS3	Switch-off threshold top REMOTE	0...9999	HYS3
0x0508	float	R / W	SPR	Setpoint REMOTE	SPL...SPH	SP1
0x050A	word	R / W	RK1	Burner control remote operation	0...1	0
0x050B	word	R / W	RK2	Relay K2 remote operation	0...1	0
0x050C	word	R / W	RK3	Relay K3 remote operation	0...1	0
0x050D	word	R / W	RK6	Relay LK remote operation	0...1	0
0x050E	word	R / W	RSTEP	Step control remote operation	-100...100	0
0x050F	float	R / W	RY	Positioning output remote operation	0...100	0

* 0 = local
1 = remote setpoint
2 = fully remote

** 1 = controller OFF

Device state

Address	Data type	Access	Parameter
0x0200	word	R / O	Outputs and states

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

B8 Hysteresis limitation (for remote operation)
B9 Management system off (for remote operation)
B10 Self-optimization active
B11 Second setpoint active
B12 Measured value range crossing input 1
B13 Measured value range crossing input 2
B14 Measured value range crossing input 3
B15 Reserved

B0 Output 1 off
B1 Output 3 off
B2 Output 2 off
B3 Output 4 off

Address	Data type	Access	Parameter
0x0201	word	R / O	Binary signal and hardware identification

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0

B15 Reserved
B14 Interface present
B13 Analog output present

B0 Operating mode 2-stage active
B1 Manual operation active
B2 Binary input 1 closed
B3 Binary input 2 closed
B4 Thermostat function active
B5 First controller output active
B6 Second controller output active
B7 Limit comparator active

Description of operating modes

General

Parameter «RemoteStatus» is used to switch between the operating modes «LOCAL», «REMOTE SETPOINT» and «FULLY REMOTE». The change is always accomplished via the MOD bus.
In the event the master fails or communication is lost, the RWF40... will switch to operating mode «LOCAL». The time for detecting a failure is set via the interface.

RAM parameter for remote operation

Remote parameter		Default after «Power-up»
REM	Operating mode «LOCAL», «REMOTE SETPOINT» or «FULLY REMOTE»	= 0
SPR	Setpoint remote	= SP1
RHYS1	Switch-on threshold remote	= Hys1
RHYS2	Lower switch-off threshold remote	= Hys2
RHYS3	Upper switch-off treshold remote	= Hys3
ROFF	Controller ON (0) / OFF (1) in operating modes «REMOTE SETPOINT» and «FULLY REMOTE»	= 0 [1)]
RSTEP	Number of control cycles (opening / closing) (FULLY REMOTE)	= 0 [2)]
RK1	Release of burner (FULLY REMOTE)	= 0 [3)]
RK2	Controlling element opens (FULLY REMOTE)	= 0 [3)]
RK3	Controlling element closes (FULLY REMOTE)	= 0 [3)]
RK6	Value of «K6» in operating modes «SETPOINT REMOTE» and «FULLY REMOTE»	= 0
RY	Degree of modulation for the analog output (FULLY REMOTE) in %	= 0

[1)] Controller active
[2)] No travel command (K2 + K3 = deenergized)
[3)] When the operating mode changes (e.g. LOCAL → FULLY REMOTE), the relay information and the degree of modulation will be predefined, depending on the operating state of the plant.

Dtt	Bus detection timer (value will also be maintained after a power failure)

The remote parameters are stored in RAM and will no longer be available after a power failure.
After «Power-up», the default values will be used.

Operating mode «LOCAL»

The previous functions of the RWF40... are maintained (apart from memory usage). The RWF40... can be parameterized and uploaded via the MOD bus, whereby the outputs cannot be changed. After «Power-up», the RWF40... will normally assume operating mode «LOCAL».

Operating mode «REMOTE SETPOINT»

The RWF40... monitors cyclic bus communication via the «Dtt» parameter (bus detection timer). Operating mode «REMOTE SETPOINT» is active as long as the bus calls within the predefined period of time. If the time limit is crossed, the RWF40... will switch to operating mode «LOCAL» and continues to operate using the parameters of local operation.

Like in operating mode «LOCAL», the control functions of the RWF40... are maintained. With regard to setpoint and switching thresholds, only «RSP» and «RHYS1...RHYS3» are active. The setpoints (SP1 and SP2), the external setpoint, the weather-compensated setpoint, the analog / binary setpoint shift and the associated changeover functions are not available.

After the controller's «Power-up», setpoint «SP1» and switching thresholds «Hys1...Hys3» will be copied to RAM as remote parameters in a one-time operation. These remote parameters can then only be changed via the management system.

The control algorithm can be deactivated by the management system via parameter «ROFF=1». In that case, the RWF40... will switch the burner off and causes the controlling element to travel to the fully closed position. The controller terminates manual operation (analog safety shutdown).
Self-optimization is not possible in this operating mode.

The management system controls contact «RK6» (relay «K6»).

Operating mode «FULLY REMOTE»

The RWF40... monitors cyclic bus communication via the «Dtt» parameter (bus detection timer). Operating mode «FULLY REMOTE» is active as long as the bus calls within the predefined period of time. If the time limit is crossed, the RWF40... will switch to operating mode «LOCAL» and continues to operate using the parameters of local operation.

The management system switches the burner (RK1, relay «K1»), controls the actuator (RK2 and RK3, relays «K2 / K3»), or defines the degree of modulation in the case of an analog output, and controls contact «RK6» (relay «K6»).
Using parameter «ROFF=1», control of the burner and controlling element can be switched off by the management system. In that case, the RWF40... deactivates the burner and causes the controlling element to travel to the fully closed position.
Manual operation and self-optimization are not possible in this operating mode.

2-stage burner:
If, with a 2-stage burner, relay positions «RK2» and «RK3» are identical, the settings are «K2 = deenergized» and «K3 = energized» (closing).

The analog output is set as follows, depending on the relay positions «RK2» and «RK3»:
K2 = energized, K3 = deenergized → analog output = 10 V or 20 mA
K2 = deenergized, K3 = energized → analog output = 0 V or 0 / 4 mA

Setting the «RY» by the management system has no impact.

Mudulating burner

Modulating controller:
The management system predefines the value (degree of modulation) for the analog output via «RY».
Setting the «RK2» and «RK3» by the management system has no impact.
Both relays «K2» and «K3», are deenergized.

Floating step controller:
The management system controls the actuator («RK2» and «RK3», relays «K2» / «K3»).
Setting the «RY» by the management system has no impact. In that case, the analog output delivers 0 V or 0 / 4 mA.

The RWF40... always checks to ensure that «RK2» and «RK3» (opening / closing) are not activated simultaneously. In such a case, the response is «K2 = K3 = deenergized».
If both relay contacts change their position during the controller's sequence time, the output is «K2 = K3 = deenergized». This time contact interval («K2 = K3 = off» for one scanning time) is also permitted in 2-stage operation.

Control strategy for floating output with modulating burner operation

The remote relay commands «RK2» and «RK3» (relays «K2» / «K3») control the opening and closing travel of the controlling element. Using parameter «RSTEP», the management system predefines the required number of control cycles.
Output «K2» (opening) is controlled by a travel command and a positive number.
Output «K3» (closing) is controlled by a travel command and a negative number.
The number gives the number of RWF40... scanning cycles (210 ms) with which the output is controlled.
The travel command with number 0 deenergizes immediately «K2» and «K3».
If a new travel command is given before the control time has elapsed, the RWF40... ascertains the direction of rotation requested by the command. If the direction of rotation does not change, the control time will immediately be replaced by the new value. If the direction of rotation must be reversed, the controlled output will be dactivated and, for the next scanning cycle, the appropriate control time is used (time contact interval).
If, simultaneously with the control strategy for the floating output, outputs «K2» and «K3» (via «RK2» and «RK3») are directly set by the management system, the relay information from the control strategy and output information «K2» and «K3» have a logic «OR» connection. «RK2» and «RK3» (opening / closing) must never be energized simultaneously. In such a case, the response is «K2 = K3 = denergized».

Supervision of actual value by setpoint-dependent switching thresholds

In operating mode «FULLY REMOTE», the management system ensures burner control. The RWF40... monitors the actual value to make certain the switching hystereses will be observed.
If the actual value crosses the upper switch-off threshold, the management system will be locked (status flag, «Management system locked» can be read via the interface).
The management system is released again when the actual value returns to a level below the switch-on threshold.
If supervision of the actual value is not desired, the switching hystereses in the RWF40... must be set to the respective maximum value.
In operating mode «REMOTE SETPOINT», the control algorithm ensures this kind of supervision.