

MODBUS RTU Transmission protocol for 2-flamed digital ballasts with RS485 interface

The digital electronic ballasts from UVT Speziallampen GmbH support the serial data transmission according to the half-duplex RS-485 standard. The signal level is 5V.

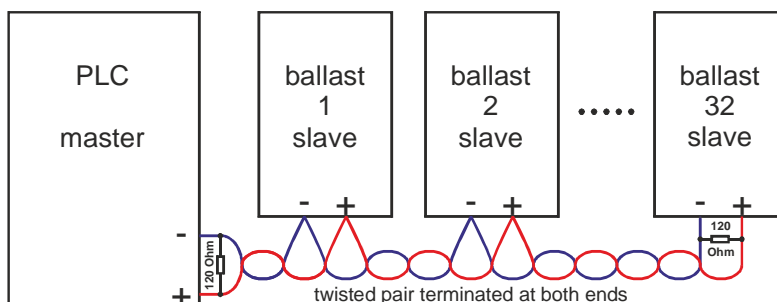
The implemented protocol is based on the industry standard MODBUS RTU.

1. Communication parameters

baud rate	9600
data bits	8
stop bit	1
parity	no

2. Connection

The RS-485 standard allows direct communication with up to 32 devices (64 lamps) via an interface. To enable correct communication, the devices must be connected as shown. By using a twisted pair cable, the network is insensitive to EMC interference. It is mandatory to use a bus topology with a 120 Ohm termination resistor at each end of the network (see connection diagram).



Note: Any device connected to the communication network must meet the following requirements:

- unique address
- identical baud rate and protocol unit (data bits, stop bits and parity)

3. General protocol structure

ballast address	function code	data	checksum
1 Byte	1 Byte	n x 1 Byte	2 Byte

3.1 Ballast address

The ballast address specifies which device is to be addressed or which device responds. Addresses from 1 to 32 are allowed. Address 0 can be used for messages to all devices (broadcast). In a network, each address can only be assigned once.

Addressing is carried out via the DIP switch on the top of the electronic ballast. The DIP switches are based on the binary system, which means that they can only display the values 0 and 1. Due to the reservation of the address 0 for the broadcast (message to all devices), the binary setting 0 (zero) corresponds to the address 1. The following table shows all addressable settings:

ballast address		adjustment of DIP switch					ballast address		adjustment of DIP switch				
physical address	logical address	1 2 ⁰ =1	2 2 ¹ =2	3 2 ² =4	4 2 ³ =8	5 2 ⁴ =16	physical address	logical address	1 2 ⁰ =1	2 2 ¹ =2	3 2 ² =4	4 2 ³ =8	5 2 ⁴ =16
1	0	0	0	0	0	0	17	16	0	0	0	0	1
2	1	1	0	0	0	0	18	17	1	0	0	0	1
3	2	0	1	0	0	0	19	18	0	1	0	0	1
4	3	1	1	0	0	0	20	19	1	1	0	0	1
5	4	0	0	1	0	0	21	20	0	0	1	0	1
6	5	1	0	1	0	0	22	21	1	0	1	0	1
7	6	0	1	1	0	0	23	22	0	1	1	0	1
8	7	1	1	1	0	0	24	23	1	1	1	0	1
9	8	0	0	0	1	0	25	24	0	0	0	1	1
10	9	1	0	0	1	0	26	25	1	0	0	1	1
11	10	0	1	0	1	0	27	26	0	1	0	1	1
12	11	1	1	0	1	0	28	27	1	1	0	1	1
13	12	0	0	1	1	0	29	28	0	0	1	1	1
14	13	1	0	1	1	0	30	29	1	0	1	1	1
15	14	0	1	1	1	0	31	30	0	1	1	1	1
16	15	1	1	1	1	0	32	31	1	1	1	1	1

3.2 Function code

The digital electronic ballasts support the following function codes:

function code	MODBUS function	register
01	read Boolean variables	1 - 3
03	read numeric variables	4001 - 4014
05	set single Boolean variables	1 - 3

3.3 Data

The data in the registers 4001 to 4017 have the data type word. According to the MODBUS specification, a high-byte, followed by the low-byte, is always transferred first for a register.

register	address	designation	signification	data typ
1	0x00	ballast On/Off	0 = ballast in operation 1 = ballast in standby	Boolean
2	0x01	RESET operation counter and start counter lamp 1	0 = in operation 1 = reset to 0	Boolean
3	0x02	RESET operation counter and start counter lamp 2	0 = in operation 1 = reset to 0	Boolean
4001	0x00	ballast address	indicates the set ballast address at the DIP switches (1-32)	word
4002	0x01	ballast type	1 = EVG-UVC 2x 30-80W 0.35 ... 0.8 A 2 = EVG-UVC 2x 30-80W 0.8 ... 1,5 A 3 = EVG-UVC 2x 60-100W 0.35 ... 0.65 A 4 = EVG-UVC 2x 80-125W 0.8 ... 1,5 A 5 = EVG-UVC 2x 100-200W 1.2 ... 2.1 A 6 = EVG-UVC 2x 150-320W 1.5 ... 2.1 A 7 = EVG-UVC 2x 100-200W 1.8 ... 2,9 A <i>(will be extended)</i>	word
4003	0x02	rotation switch position	indicates set switch position for lamp current/lamp type (0-9)	word
4004	0x03	status lamp 1	1 = start condition fulfilled 2 = preheating 3 = lamp in operation 4 = start condition not fulfilled 5 = reserved 6 = fault – temperature 7 = fault – supply voltage limit undercut 8 = fault – supply voltage limit exceeded 9 = fault – lamp voltage 10 = fault – overcurrent in operation 11 = fault – overcurrent while preheating	word
4005	0x04	status lamp 2	1 = start condition fulfilled 2 = preheating 3 = lamp in operation 4 = start condition not fulfilled 5 = reserved 6 = fault – temperature 7 = fault – supply voltage limit undercut 8 = fault – supply voltage limit exceeded 9 = fault – lamp voltage 10 = fault – overcurrent in operation 11 = fault – overcurrent while preheating	word
4006	0x05	operation counter lamp 1 - minute	indicates the operation time in minutes (0 - 60 min.) <i>- counter active only in status 3 -</i>	word
4007	0x06	operation counter lamp 1 - hour	indicates the operation time in hours (0 - 65535 h) <i>- counter active only in status 3 -</i>	word
4008	0x07	operation counter lamp 2 - minute	indicates the operation time in minutes (0 - 60 min.) <i>- counter active only in status 3 -</i>	word
4009	0x08	operation counter lamp 2 - hour	indicates the operation time in hours (0 - 65535 h) <i>- counter active only in status 3 -</i>	word
4010	0x09	start counter lamp 1 - On/Off-cycles	indicates the number of lamp ignitions (0-65535)	Word
4011	0x0A	start counter lamp 2 - On/Off-cycles	indicates the number of lamp ignitions (0-65535)	Word
4012	0x0B	ballast temperature	indicates the internal ballast temperature in °C (ballast switches off at approx. 80 °C) <i>- does not specify the case temperature at the t_c point -</i>	word
4013	0x0C	supply voltage	1 = too low (U _{net} < 187 V) 2 = within the allowed tolerance range (187 V < U _{net} < 253 V) 3 = too high (U _{net} > 253 V)	word
4014	0x0D	lamp voltage lamp 1	indicates the lamp voltage in V (±10%)	word
4015	0x0E	lamp voltage lamp 2	indicates the lamp voltage in V (±10%)	word
4016	0x0F	lamp current lamp 1	indicates the lamp current in mA (±10%)	word
4017	0x10	lamp current lamp 2	indicates the lamp current in mA (±10%)	word

Note: All specified addresses are physical addresses. In some programming environments, logical addresses are used, that means all addresses described here must be increased by 1.

3.4 Checksum

The checksum is calculated over all characters of the message and is always 2 bytes long. The low byte is then transferred to penultimate, the high byte at the last position of the telegram.

Note: This is an inverse order compared to the transfer of data registers. The calculation algorithm corresponds to the CRC16 standard using the generator polynomial 0x8005 and the CRC start value 0xFFFF.

4. Error handling

In the event of a transmission error, if the checksum calculated by the ballast does not match the received one, no acknowledgment is sent to the master and thus a timeout is provoked. This occurs when a non-existing device is addressed.

If the electronic ballast detects another fault, it transmits a corresponding error message to the master.

ballast address	function code	data	checksum
0xXX	function code + 0x80	error code	CRC16

The function code received by the ballast is sent back. However, the most significant bit is set to indicate an error. The following error codes may occur:

error code	meaning
0x01	use of an unsupported function code
0x02	use an invalid memory address

5. Communication samples

5.1 Read Boolean variables FC01

Inquiry from the master:

ballast address	function code	start address	number of registers	checksum
0x01	0x01	0x0000	0x0003	0x7C0B

With this message, the master queries register 1 to 3 from the electronic ballast with the address 1.

Reply from the slave:

ballast address	function code	number of bytes	data	checksum
0x01	0x01	0x01	0x03	0x1189

The data 0x03 (0b00000011) of the electronic ballast with address 1 are evaluated as follows:

register	address	designation	state	description
1	0x01	ballast on/off	1	ballast in standby
2	0x02	reset counters for operation hours and starts lamp 1	0	counter in operation
3	0x03	reset counters for operation hours and starts lamp 2	0	counter in operation

5.2 Read Numeric variables FC03

Inquiry from the master:

ballast address	function code	start address	number of registers	checksum
0x0A	0x03	0x000D	0x0001	0x15C9

With this message, the master requests the register 4014 from the electronic ballast with the address 10.

Reply from the slave:

ballast address	function code	number of bytes	data	checksum
0x0A	0x03	0x02	0x0096	0xBA8D

The data 0x0096 of the register 4014 of the electronic ballast with the address 10 are evaluated as follows:

Register	address	designation	value
4014	0x0D	lamp voltage in V	150

5.3 Set Single Boolean variables FC05

Inquiry from the master:

ballast address	function code	address	state	checksum
0x03	0x05	0x0001	0xFF00	0xDC18

With this message, the master sets the register 2 of the electronic ballast with the address 3 to 1 (on).

state	description
0xFF00	1 (on)
0x0000	0 (off)

Reply from the slave:

ballast address	function code	address	data	checksum
0x03	0x05	0x0001	0xFF00	0xDC18

The response of the electronic ballast with the address 3 is an acknowledgment that the action has been carried out.