

MODBUS RTU Transmission protocol for 1-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.

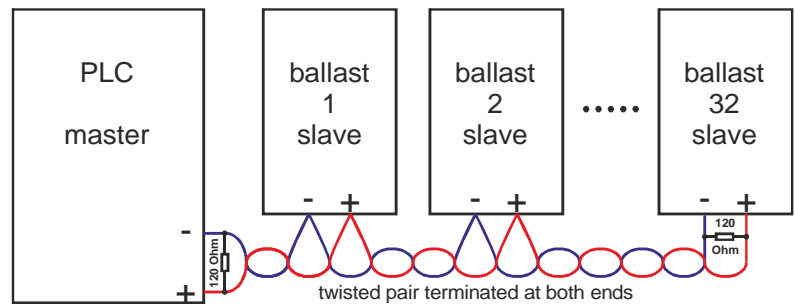
The implemented protocol is based on the industry standard MODBUS RTU.

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 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
06	set single numeric variables	4009

3.3 Data

The data in the registers 4001 to 4014 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	dimming analog/digital	0 = analog via 1-10 V port 1 = digital via RS485 interface	Boolean
3	0x02	RESET operation counter/ start counter	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 UVT 40-150W 0,8..1,5A 2 = EVG UVT 80-200W 1,2..2,1A 3 = EVG UVT 80-200W 1,8..2,9A 4 = EVG UVT 200-400W 1,8..2,9A 5 = EVG UVT 200-480W 3,2..4,8A 6 = EVG UVT 480W 4,8A <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	1 = start condition fulfilled 2 = pre heating 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 pre heating	word
4005	0x04	operation counter - minute	indicates the operation time in minutes (0 - 60 min.) - counter active only in status 3 -	word
4006	0x05	operation counter – hour	indicates the operation time in hours (0 - 65535 h) - counter active only in status 3 -	word
4007	0x06	start counter (On/Off-cycles)	indicates the number of lamp ignitions (0-65535)	Word
4008	0x07	dimming actual value	indicates the currently set dim value in % an (0-100 %)	word
4009	0x08	dimming setpoint value (digital)	indicates setpoint value in % set via RS485 interface (0 -100 %) - does not specify the analog value of the 1-10 V connector -	word
4010	0x09	dimming timer (delay)	indicates the duration up to the use of the dimming in s (after the lamp ignition the dimming is prevented for 5 minutes)	word
4011	0x0A	ballast temperature	indicates the internal ballast temperature in °C (ballast switches off at approx. 80 °C) - does not specify the case temperature at the t_c point -	word
4012	0x0B	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
4013	0x0C	lamp voltage	indicates the lamp voltage in V ($\pm 10\%$)	word
4014	0x0D	lamp current	indicates the lamp current in mA ($\pm 10\%$)	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 registers 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	dimming analog/digital	1	digital via RS485 interface
3	0x03	reset counters for operation hours and starts	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	0x05DC	0xBA8D

The data 0x05DC of the register 4014 of the electronic ballast with the address 10 are evaluated as follows:

register	address	designation	value
4014	0x0D	lamp current in mA	1500

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.

5.4 Set Single Numeric variables FC06

Reply from the slave:

ballast address	function code	address	data	checksum
0x05	0x06	0x0008	0x0032	0x8859

With this message, the master sets the register 4009 from the electronic ballast with the address 5 to 50.

register	address	designation	adjusted value
4009	0x08	dimming setpoint value (digital) in %	0x32 (50)

Reply from the slave:

ballast address	function code	address	data	checksum
0x05	0x06	0x0008	0x0032	0xD8859

The response of the electronic ballast with the address 5 is an acknowledgment that the action has been carried out.

Note: An action can be carried out simultaneously with ballast address 0 for all devices. This type of telegram is not acknowledged.