

MODBUS RTU transmission protocol

for digital electronic ballasts with RS-485 interface

The digital electronic ballasts of LT-ELEKTRONIK GERA GmbH support serial data transfer according to half duplex RS-485 standard. The signal level is 5V.

The implemented protocol is based on the MODBUS RTU standard.

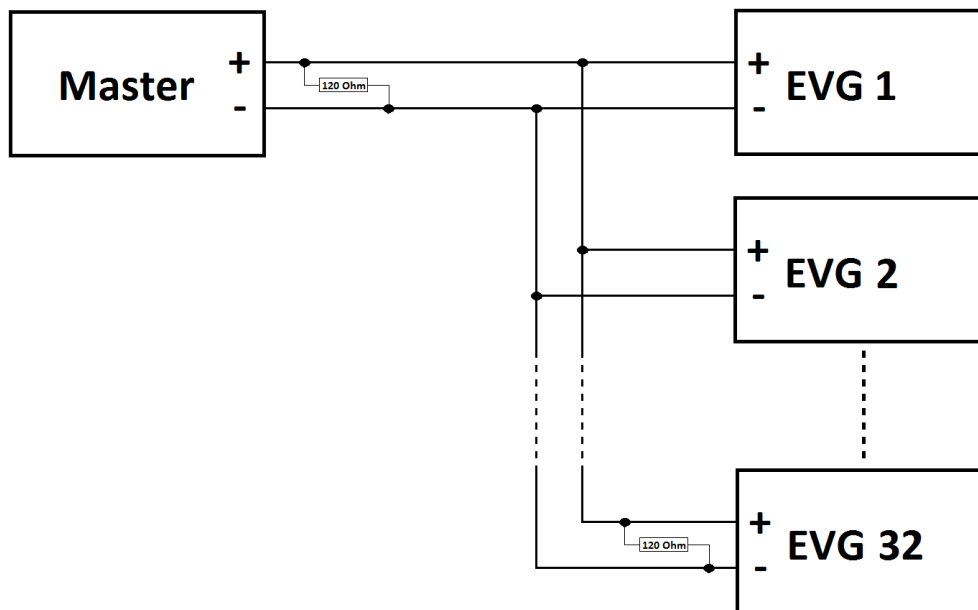
1. Communication parameters

Baud rate	9600
Date bit	8
Stop bit	1
Parity	none

2. Wiring

The RS-485 standard allows direct communication with up to 32 devices.

The ballasts must be connected as follows:



It is the use of a twisted pair cable recommended. Furthermore a bus termination should be used. This is done with a 120 Ohm resistor at both ends of the network (see connection diagram).

Please note:

Each device, which is integrated in the communication network must meet the following conditions:

- Unique address
- Identical baud rate and protocol unit (Date bit, Stop bit und 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

Each ballast in a network is assigned a unique unit address from 1 to 32. The address 0 can be used for communication to all devices – broadcast.

The ballast address can be set with the DIP switch on the top of the electronic ballast.

In the following table are all adjustable addressing shown:

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

3.2. Function code

The digital electronic ballast 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 register 4001-4014 have the data type word. MODBUS transmit the higher byte first followed by the lower byte.

Register	Address	Name	Description	Data type
1	0x00	Power	0 = ON (ballast works) 1 = OFF (ballast in standby)	Boolean
2	0x01	Dimm analog/digital	0 = Analog via 1-10 V input 1 = Digital via RS-485 interface	Boolean
3	0x02	RESET Operating time counter/Start counter	0 = Operating 1 = Set counter to 0	Boolean
4001	0x00	Ballast address	Displays the set ballast address (1 – 32)	Word
4002	0x01	Ballast type	1 = LT-UVC1x(40..150)W-C/D/M/I 0,8..1,5A 2 = LT-UVC1x(80..200)W-C/D/M/I 1,2..2,1A 3 = LT-UVC1x(80..200)W-C/D/M/I 1,8..2,9A 4 = LT-UVC1x(200..400)W-C/D/M/I 1,8..2,9A 5 = LT-UVC1x(200..400)W-C/D/M/I 3,2..4,8A 6 = LT-UVC1x480W-C/D/M/I 4,8A	Word
4003	0x02	Switch position	Displays the adjustment of lamp current (0 – 9)	Word
4004	0x03	State	1 = Ballast start 2 = Lamp preheating 3 = Ballast works 4 = Ballast waits for start 5 = Reserved 6 = Failure – Temperature 7 = Failure – Under voltage mains 8 = Failure – Over voltage mains 9 = Failure – Lamp voltage 10 = Failure – Over current 11 = Failure – Over current Preheating	Word
4005	0x04	Operating time counter - Minute	Displays the operating time in minutes (0 - 60 min.) - counter only works in state 3 -	Word
4006	0x05	Operating time counter - Hour	Displays the operating time in hours (0 - 65535 h) - counter only works in state 3 -	Word
4007	0x06	Start counter	Displays the number of lamp starts (0 - 65535)	Word
4008	0x07	Dimm actual value	Displays the current dimm value in % (0 – 100 %)	Word
4009	0x08	Dimm point value (Digital)	Displays the set dimm value via RS-485 interface in % (0 – 100 %) - does not reflect the dimm value of the analog input -	Word
4010	0x09	Dimm timer (delay)	Displays the time until the dimming is ready in seconds (after lamps ignition the dimm function is blocked for 5 min.)	Word
4011	0x0A	Ballast temperature	Displays the temperature of the ballast in °C (ballast switch off at approx. 80 °C) - does not reflect the temperature at the case(tc-point) -	Word
4012	0x0B	Main voltage	1 = Mains voltage under limit ($U_{\text{Netz}} < 187 \text{ V}$) 2 = Typical tolerance ($187 \text{ V} < U_{\text{Netz}} < 253 \text{ V}$) 3 = Mains voltage over limit ($U_{\text{Netz}} > 253 \text{ V}$)	Word
4013	0x0C	Lamp voltage	Displays the lamp voltage in V ($\pm 10\%$)	Word
4014	0x0D	Lamp current	Displays the lamp current in mA ($\pm 10\%$)	Word

Please note: All given addresses are physical addresses. In some programming environments logical addresses are used, meaning that all addresses described here must be increased by 1.

3.4. Checksum

The calculation of the checksum use every byte of the message and is always 2 byte. The Checksum transmit the lower byte first followed by the higher byte. This is compared with the transmission of data registers a reverse order.

The calculation algorithm is the CRC16 standard using the generator polynomial 0x8005 and the CRC start value 0xFFFFF.

4. Error control

If a transmission error detected, no acknowledgement is sent to the master and thus provoked a timeout. A transmission error means, the calculated checksum from the ballast does not match with the received. The same happens when a non-existent device is addressed.

If the electronic ballast detect another error, it returns an error message to the master.

Ballast address	Function code	Data	Checksum
0xXX	Function code + 0x80	Error code	CRC16

The ballast send the function code plus 0x80 back.

Following function codes are possible:

Error code	Description
0x01	Using an unsupported function code
0x02	Using an invalid memory address

5. Message-examples

5.1. Read Boolean variables FC01

Request from Master:

Ballast address	Function code	Startaddress	Number of coils	Checksum
0x01	0x01	0x0000	0x0003	0x7C0B

This command is requesting the ON/OFF status of discrete coils 1 to 3 from the ballast with address 1.

Response from Slave:

Ballast address	Function code	Number of data bytes	Data	Checksum
0x01	0x01	0x01	0x03	0x1189

The data 0x03 (0b00000011) from the ballast with address 1 will be analysed as follows:

Register	Address	Name	State	Description
1	0x01	Power	1 (ON)	Ballast in standby
2	0x02	Dimm analog/digital	1 (ON)	Digital via RS-485 interface
3	0x03	RESET Operating time counter/Start counter	0 (OFF)	Operating

5.2. Read Numeric variables FC03

Request from Master:

Ballast address	Function code	Startaddress	Number of Register	Checksum
0x0A	0x03	0x000D	0x0001	0x15C9

This command is requesting the content of analog output holding register 4014 from the ballast with address 10.

Response from Slave:

Ballast address	Function code	Number of data bytes	Data	Checksum
0x0A	0x03	0x02	0x05DC	0xBA8D

The data 0x05DC of the register 4014 from the ballast with address 10 will be analysed as follows:

Register	Address	Name	Value
4014	0x0D	Lamp current in mA	1500

5.3. Set Single Boolean variables FC05

Request from Master:

Ballast address	Function code	Data address	State	Checksum
0x03	0x05	0x0001	0xFF00	0xDC18

This command is writing the contents of discrete coil 2 to 1 (ON) in the ballast with address 3.

State	Description
0xFF00	1 (ON)
0x0000	0 (OFF)

Response from Slave:

Ballast address	Function code	Data address	Data	Checksum
0x03	0x05	0x0001	0xFF00	0xDC18

The normal response is an echo of the query, returned after the coil has been written.

5.4. Set Single Numeric variables FC06

Request from Master:

Ballast address	Function code	Data address	Data	Checksum
0x05	0x06	0x0008	0x0032	0x8859

This command is writing the content of analog output holding register 4009 to the ballast with address 5.

Register	Address	Description	Value
4009	0x08	Dimm point value (digital) in %	0x32 (50)

Response from Slave:

Ballast address	Function code	Address	Data	Checksum
0x05	0x06	0x0008	0x0032	0xD8859

The normal response is an echo of the query, returned after the coil has been written.

Please note: The address 0 can be used for communication to all devices – broadcast. This message is not acknowledged.