



# GfG Instrumentation

Worldwide Manufacturer of Gas Detection Solutions

Transmitter Series

# EC 28 Modbus Implementation

## Annex to Operation Manual





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## General

The EC 28 supports digital communication via **MODBUS over Serial Line (MoSL)**. The MODBUS functionality refers to the mandatory requirement for conditionally MODBUS compliance according to [MoSL] and adheres to the definitions of the MODBUS Application Protocol Specification [MAPS].

## Interface

RS485 (Multipoint)

- Bus connection of master and slaves
- Two wires as twisted pair (terminal connection)
- Via two wires of the shielded supply line; e.g. LIYCY 4x0.75mm<sup>2</sup> (terminal connection)

## Bus design

The maximum length of the cable must not exceed 1000m (specification limit RS485), maximum 30 EC28 plus a master can be connected.

Essential for the voltage design is the supply of the connected units; the cross section of the cable depends on the following parameters:

- Number and model of transmitter (current consumption)
- Line length (voltage loss at line resistance)
- Quality of supply voltage  
(24V + 10%, -15% as per EN50160 or regulated DC voltage 24V +/- 1%)

Levels are determined via the master of the bus; the bus is to be terminated with 120Ω at both ends. In doing so, you may order the EC28 with terminal resistor.

Several examples are shown in the section, "Standard bus design".

## Communication Parameter

Device Addresses: 1-247 (selectable, only slave mode)

Unicast and Broadcast operation possible

Transmission rate: 9600 Baud or 19200 Baud

Date format: 1 Start bit

8 Data bits

1 Even parity bit with 1 Stop bit (8E1)

or no parity bit with 2 Stop bits (8N2)

Transmission mode: RTU (Remote Terminal Unit) as per [MoSL].

Settings are made in the EC28 service menu.

## Protocol Implementation

### Function Codes

The following functions are implemented in the EC 28 according to the tables mentioned below (for protocol specification see [MAPS]):

- Diagnostics (08)
- Read Exception Status (07)
- Read Input Registers (04)
- Write Multiple Registers (16)
- Read Holding Registers (03)

The start addresses are indicated both in pure hexadecimal form and in PLC notation.

Note: MODBUS stipulates access on data with a length of 1 bit or 16 bit. Distinction is made between “Read-Only” and “Read-Write” data.

<b>Discrete Input</b>	Single bit	Read-Only
<b>Coil</b>	Single bit	Read-Write
<b>Input Register</b>	16-bit word	Read-Only
<b>Holding Register</b>	16-bit word	Read-Write

The address of the 1-Bit data is done bit by bit, and of the 16-Bit data 16-bit by 16-bit – for “Read-Only” and “Read-Write” independently from each other.

Applicable for MODBUS-Register is big-Endian (High Byte or MSB first).

### Extended Function Codes

If requested, the safety of communication can be increased. For clear frame identification of a slave response, a master can insert two additional bytes in its request frame before the CRC field or at the end of the data field of the protocol data unit, to place identification criteria for this frame. These two bytes will then be placed together in the relevant response frame of the slave.

To make use of this extension, the above mentioned function codes have to be provided with an offset of 64. This results in the following extended function code calls:

- Diagnostics (72)
- Read Exception Status (71)
- Read Input Registers (68)
- Write Multiple Registers (80)
- Read Holding Registers (67)

## Description of Function Codes

### Diagnostics (08/72)

Is only supports in Unicast mode.

#### Request

Sub-function	Data Field	Meaning	Note
0x0000	Any	Request loop-back	
.....			not supported
0x000A	0x0000	Reset of diagnosis counter	Counter are not protected from overflow
0x000B	0x0000	Bus message counter	
0x000C	0x0000	Bus communication error counter	
0x000D	0x0000	Slave exception error counter	
0x000E	0x0000	Slave message counter	
0x000F	0x0000	Slave no response counter	
0x0010	0x0000	Slave negative acknowledge counter	
0x0011	0x0000	Slave busy counter	
0x0012	0x0000	Bus character overrun counter	
.....			not supported

### Read Exception Status (07/71)

Is only supported in Unicast mode.

#### Response

Bit-Nr.		Parameter		Meaning	Note
7	MSB	Value	MSB	Fault Code/Number	Response example 01011101: Cal.-Err. Nr. 2 at zeropoint setting
6					
5			LSB		
4		Group	MSB	01: System error (Sys Err X 10: Sensor error (Sens. Err. X; Change Sens. 11: Detection error (ADU-Err. X, Scal. Err., Cal.-Err.)	
3			LSB		
2		Status	MSB	000: System or Sensor error 001: Start of device  010: Check sensor loop (Check gas; Check Scal.) 011: Detection mode 100: Service menu  101: Zeropoint (ZERO) 110: Calibration (SPAN) 111: Code entry active	
1					
0	LSB		LSB		

<b>Read Input Registers (04/68)</b>					
Is only supported in Unicast mode.					
<b>Request</b>					
<b>Start Address</b>	<b>Number of requestable registers</b>	<b>Register-type (16 Bit)</b>	<b>Parameter</b>	<b>Note</b>	
0x0000 (30001)	2	unsigned	Device serial number (High)	8 digit (4 + 4)	<u>Not allowed</u> (exception: Response with Code 01) during • Start of device • System error • Code entry
		unsigned	Device serial number (Low)		
0x0010 (30017)	2	unsigned	Software version	Example 2 3: version 2.3	
		unsigned			
0x0020 (30033)	4	unsigned	Device name	String: Two ASCII bytes per register	
		unsigned			
		unsigned			
		unsigned			
0x0100 (30257)	6	unsigned	MK type	Example 39707: MK 397-07	<u>Not allowed</u> (exception: Response with Code 01) during • Start of device • System/Sensor error • Code entry
0x0101 (30258)	5	unsigned	MK serial number		
0x0102 (30259)	4	unsigned	Current status of sensor hour meter	Number of sensor's operational hours	
0x0103 (30260)	3	unsigned	Maximum allowed sensor hours		
0x0104 (30261)	2	unsigned	Sensor operational status	1: In operation 2: allowed operational time elapsed (qualifying period) 3: allowed operational time elapsed	
0x0105 (30262)	1	signed	Sensor temperature	°C x 10	
0x0200 (30513)	10	unsigned	Gas	Gas number in GfG gas table	
0x0201 (30514)	9	unsigned	Unit of gas	1: ppm 2: Vol% 3: %LEL 4: ppb 5: µg/m3 6: mg/m3 7: %	<u>Not allowed</u> (exception: Response with Code 01) during • Start of device • Autocal • Service menu • System/Sensor error • Code entry
0x0202 (30515)	8	signed	Scaling factor	-3: 0.001 -2: 0.01 -1: 0.1 0: 1 +1: 10 +2: 100 +3: 1000	

0x0203(30516)	7	signed	Current detection value	Referred to scaling factor	<u>Not</u> allowed(exception: Response with Code 01) during • Start of device • Autocal • Service menu • System/Sensor error • Code entry
0x0204(30517)	6	signed	Detection range start		
0x0205(30518)	5	signed	Current full scale deflection		
0x0206(30519)	4	signed	Maximum full scale deflection		
0x0207(30520)	3	signed	Resolution		
0x0208(30521)	2	signed	Zero band	If turned off, the 0 (see <i>Read Coils</i> )	
0x0209(30522)	1	signed	Current detection value	Standardized to 0-1000 (range start up to current full scale deflection)	



**Write Multiple Registers (16/80)**

Is supported in Unicast and Broadcast mode. (Response is omitted in Broadcast mode.)

**Request**

Start Address	Number of transferable registers	Number of bytes	Register type (16 bit)	Parameter	Note
0x1000 (44097)	2	4	signed	Scaling factor	-3: 0.001 -2: 0.01 -1: 0.1 0: 1 +1: 10 +2: 100 +3: 1000
			signed	Current detection range	Referred to scaling factor
0x1100 (44353)	2	4	signed	Scaling factor	-3: 0.001 -2: 0.01 -1: 0.1 0: 1 +1: 10 +2: 100 +3: 1000
			signed	Calibration gas concentration	Referred to scaling factor
0x1200 (44609)	6	12	unsigned	System time Year	Example 2005
0x1203 (44612)			3	6	unsigned
	unsigned	Day			Example 24
	unsigned	Hour			Example 14
	unsigned	Minute			Example 37
			unsigned	Second	Example 51
0x1300 (44865)	1	2	unsigned	Timeout in milliseconds	If after this time a request could not be started, Exception Response is sent with Code 06. (Supply status 2000 ms) <b>ATTENTION:</b> This value must be lower than the Response Timeout of the Bus-Master!

Not allowed (exception: Response with Code 01) during

- Start of device
- Autocal
- Service Menu
- System/Sensor error
- Code entry

Not allowed (exception: Response with Code 01) during

- Start of device
- Autocal
- Service Menu
- System/Sensor error
- Code entry

Not allowed During start of device (exception: Response with Code 01)

Not allowed during

- Start of device
- System/Sensor error
- Code entry (exception: Response with Code 01)

### Read Holding Registers (03/67)

Request is only supported in Unicast mode.

#### Request

Start Address	Maximum requestable registers	Register-type (16 Bit)	Parameter	Note	
0x1000 (44097)	2	signed	Scaling factor	-3: 0.001 -2: 0.01 -1: 0.1 0: 1 +1: 10 +2: 100 +3: 1000	<u>Not allowed during</u> <ul style="list-style-type: none"> <li>• Start of device</li> <li>• Service Menu</li> <li>• System/Sensor error</li> <li>• Code entry (exception: Response with Code 01)</li> </ul>
0x1001 (44098)	1	signed	Current detection range	Referred to scaling factor	
0x1100 (44353)	2	signed	Scaling factor	-3: 0.001 -2: 0.01 -1: 0.1 0: 1 +1: 10 +2: 100 +3: 1000	<u>Not allowed during</u> <ul style="list-style-type: none"> <li>• Start of device</li> <li>• Service Menu</li> <li>• System/Sensor error</li> <li>• Code entry (exception: Response with Code 01)</li> </ul>
0x1101 (44354)	1	signed	Calibration gas concentration	Referred to scaling factor	
Start Address	Number of requestable registers	Register-type (16 Bit)	Parameter	Note	
0x1200 (44609)	6	unsigned	System time Year	Example 2005	<u>Not allowed during</u> start of device Exception Response with Code 04 for non-existing time module (exception: Response with Code 01)
0x1203 (44612)		unsigned	Month	Example 12	
		unsigned	Day	Example 24	
		unsigned	Hour	Example 14	
		unsigned	Minute	Example 37	
		unsigned	Second	Example 51	
0x1300 (44865)	1	unsigned	Timeout in milliseconds	If after this time a request could not be started, Exception Response is sent with Code 06. (Supply status 2000 ms) <b>ATTENTION:</b> This value must be lower than the Response Timeout of the Bus-Master!	<u>Not allowed during</u> <ul style="list-style-type: none"> <li>• Start of device</li> <li>• System/Sensor error</li> <li>• Code entry (exception: Response with Code 01)</li> </ul>

## Exception Response

The following Exception Codes are implemented in the device within the menu exception responses according to their definition as per [MAPS] and in relation to the relevant function codes:

- Illegal Function (01)
- Illegal Data Address (02)
- Illegal Data Value (03)
- Slave Device Failure (04)
- Acknowledge (05)
- Slave Device Busy (06)

## Standard bus design and voltage supply

### 1. General bus design with master and terminal resistor

Wiring is to be done with shielded min.  $4 \times 0.75 \text{mm}^2$  (e.g. LIYCY  $4 \times 0.75 \text{mm}^2$ ).

There are two ways of voltage supply:

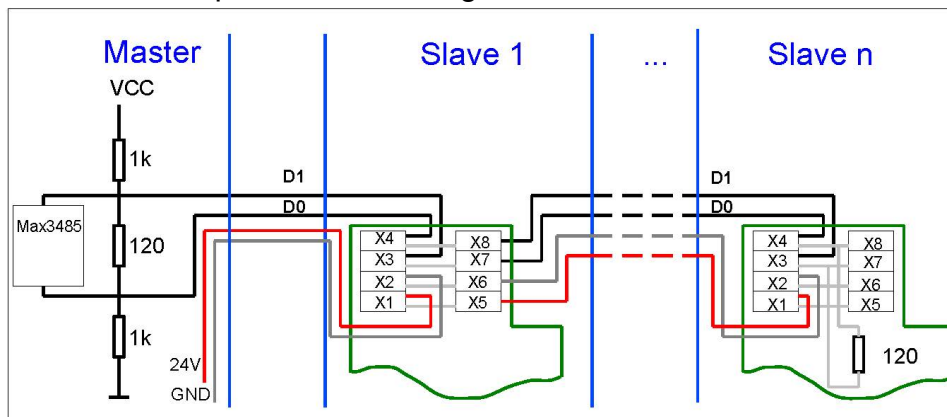
- Central voltage supply:  
Two wires of the 4-wire line are used for bus communication; the other two are for the voltage supply which is to be looped through from the master to all EC28 transmitters.
- De-central voltage supply:  
The transmitters are grouped and supplied from several power sources.

Due to the rather low data transmission rate you do not need a TP line.

The master (of the controller) and the last transmitter on the bus line require a  $120\Omega$  terminal resistor to prevent reflexions. The two  $1\text{k}\Omega$  resistors define the potentials during transmission breaks.

#### a.) Central voltage supply (from master)

Because of the different EC28 models and the different quality of supply voltages we can only give a short review of possible bus designs.



**Number of transmitters at typical line lengths and cross sections**

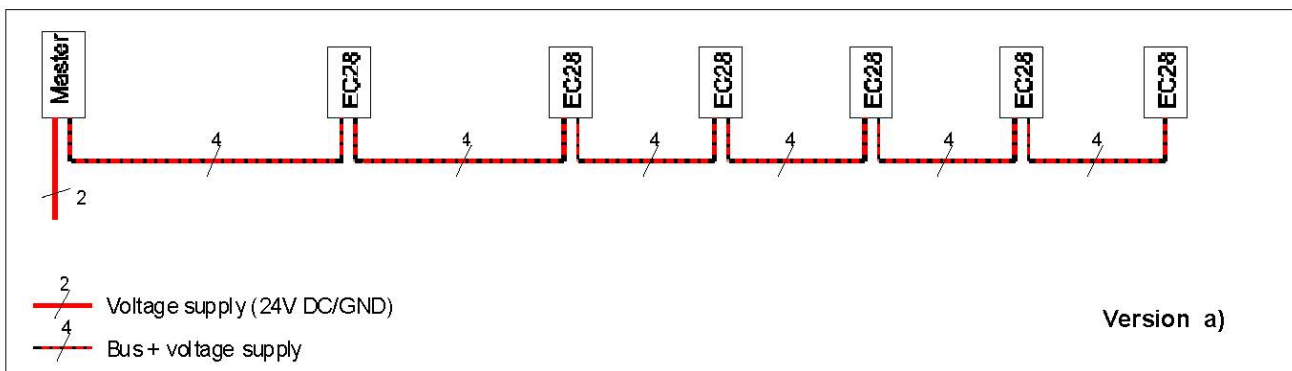
	24V (-15%, +10%)							
	100m		200m		500m		1000m	
Line to control panel *2	50m		100m		250m		500m	
Cross section per wire in mm <sup>2</sup> *1	0.75	1.5	0.75	1.5	0.75	1.5	0.75	1.5
Number of EC28 DAB	9	19	4	9	1	3	-	1
Number of EC28 DB	13	26	6	13	2	5	1	2
Number of EC28 D	22	30	11	22	4	8	2	4

	24V (+/- 1%)							
	100m		200m		500m		1000m	
Line to control panel *2	50m		100m		250m		500m	
Cross section per wire in mm <sup>2</sup> *1	0.75	1.5	0.75	1.5	0.75	1.5	0.75	1.5
Number of EC28 DAB	22	30	11	22	4	9	2	4
Number of EC28 DB	30	30	16	30	6	12	3	6
Number of EC28 D	30	30	26	30	10	21	5	10

\*1) used line e.g.: LIYCY 4x0.75mm<sup>2</sup> resp. LIYCY 4x1.5mm<sup>2</sup>

\*2) For calculation it is assumed that the transmitters disperse over the second half of the bus, i.e. the existing line from the control panel to the first transmitter represents 50% of the total length.

As you can see from the above, this version is rather useful for those EC28 models which have a low current consumption (EC28 B or EC28 DB). For all other models (EC28 DB, EC28 DAB) you may go for the possibilities described under b). In general all combinations have to be connected individually. Particularly essential for the total number of transmitters to be connected is the position of each transmitter on the bus line (line length to master/power source).

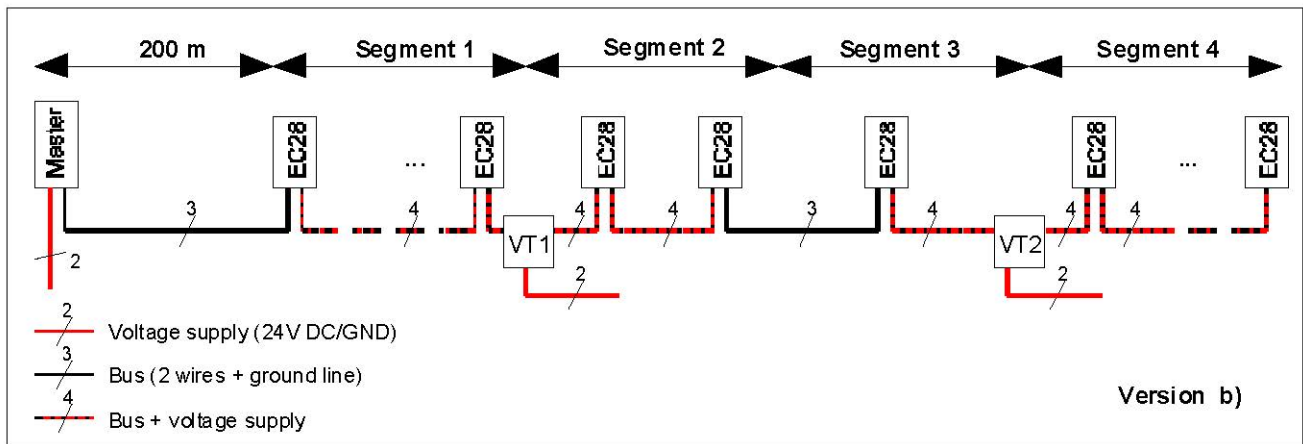


**b.) Decentral voltage supply (grouping)**

Select the decentral voltage supply to operate the maximum number of EC28 transmitters on the max. bus length, which are subject to higher current consumption (EC28 DB and EC28 DAB). This requires a 24V DC= source close to the planned bus line.

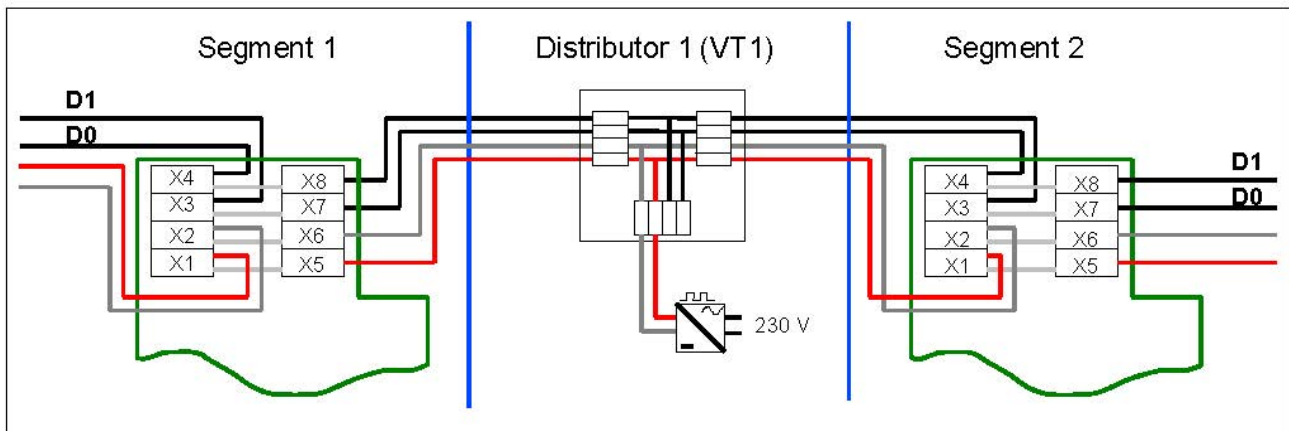
Only two suitable voltages supplies allow to separate a 1000m bus into four segments of 200m each, considering an additional 200m line from the control panel (master) to the first transmitter.

This results in the above chart for 200m, concerning the number of transmitters per segment (the total quantity of 30 units, however, must not be exceeded).

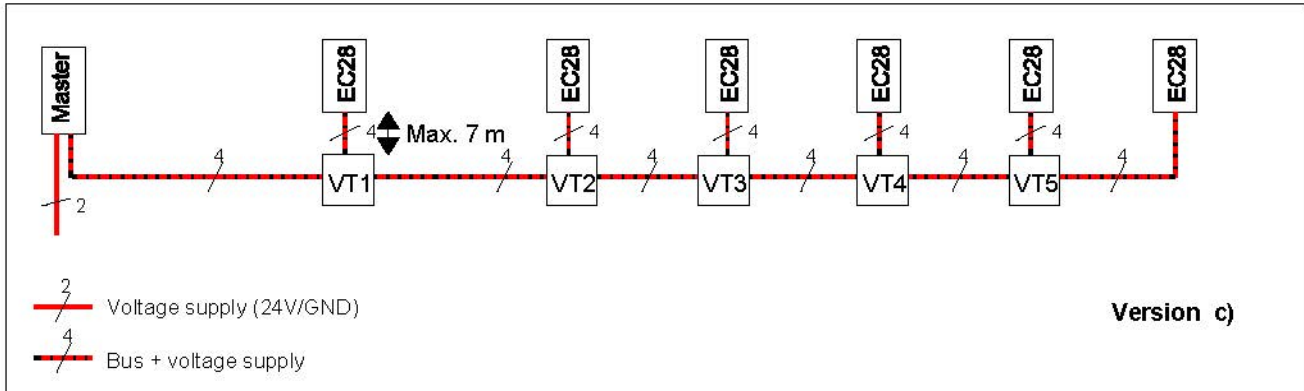


It is possible to provide and power even a long bus line with 30 EC28 DAB transmitters. These commonly supplied transmitters can also be grouped in local and/or functional blocks. In regard to data transmitters, the bus topology can be used without shunt. The transmitters are connected in groups to power sources through distribution boxes (VT).

**c.) Special forms of bus topology**



In general, version a) transmitter can also be designed this way with crosspoints. The length of the transmission lines from distributor (VT) to EC28 should not exceed 7m. The disadvantage of this bus design is the considerably increased number of terminals but it may be advantageous under certain conditions for specific environments.



## References

[MoSL] MODBUS over Serial Line – Specification & Implementation Guide V1.0;  
<http://www.modbus.org>

[MAPS] MODBUS Application Protocol Specification V1.1; <http://www.modbus.org>



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