METER/ KTU5 / PTU5x

MODBUS protocol

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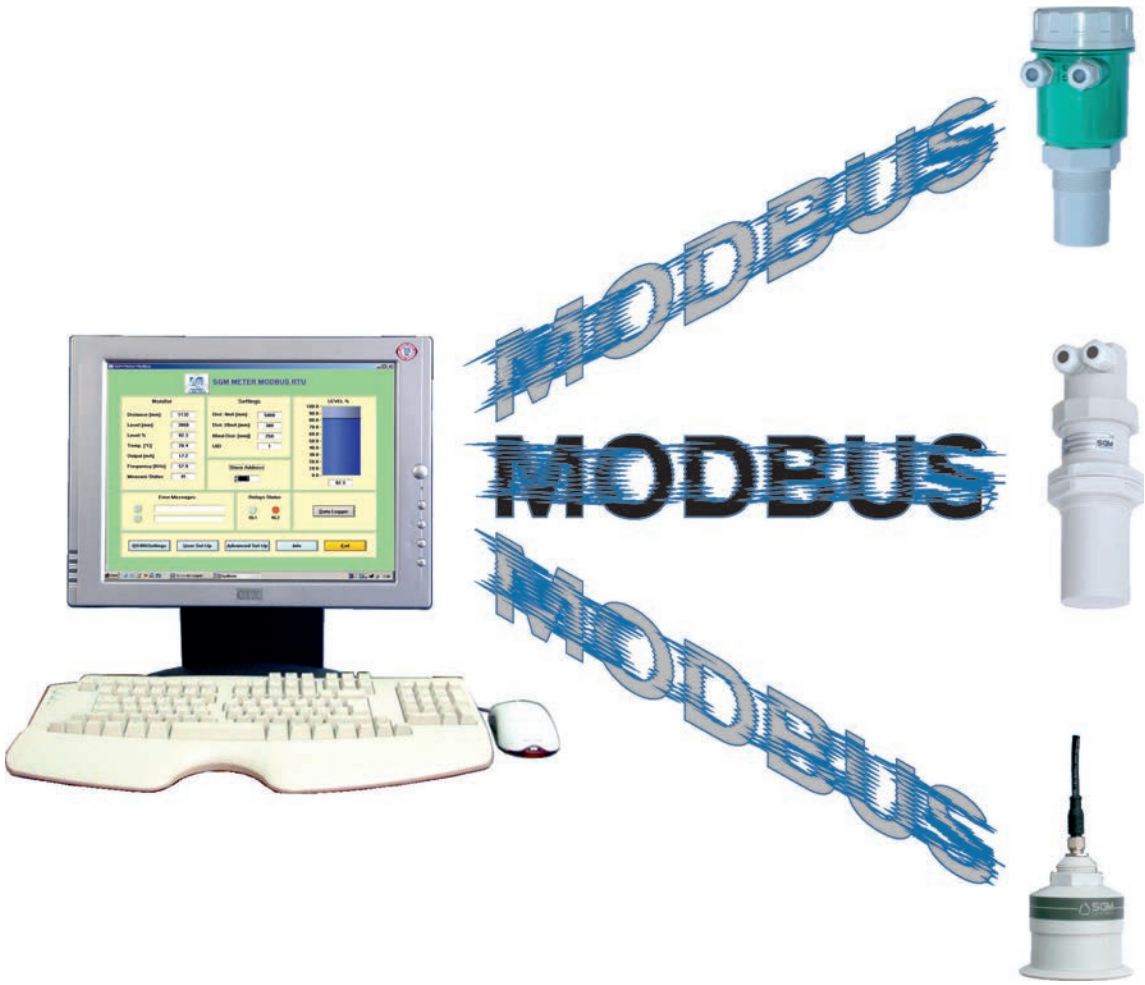


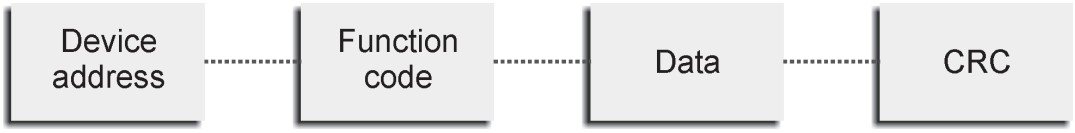
Introduction to MODBUS protocol

The METER, KTU5 and PTU5x level transmitters are able to support the MODBUS RTU communication protocol on 2 wires RS485 serial line.
With the MODBUS communication protocol you can read the level state on multiple online METER, KTU5 and PTU5x and check them through software,standards supervisory software provided by third parties or through interface with equipment such as MODBUS PLC terminals and data processing.
The MODBUS protocol is based on a Master-Slave architecture, where requests for interrogating are unidirectional and executed only by the master (usually a PC) to the Slave (transmitting METER, KTU5 and PTU5x). Indeed, if the Slave does not questioned by the Master, do not send any signal. The Slave when interviewed by the Master meet on predefined rules (defined by the MODBUS protocol) and not ever generate messages on its own initiative while remaining in the passive state pending Master request.
All slave devices must have a different address in order to be recognized by the Master, if not, the whole system may still have some problems during operation. RTU protocol is a binary code and is the most common, besides being fast, having a message length below by almost 50% compared to the ASCI protocol.To be able to converse with each other, the master and all slaves should have the same protocol (RTU / ASCII), speed, stop bits and parity.
For more information you can visit the official website: www.modbus.org.

1 MODBUS structure Protocol

The MODBUS protocol common structure that is independent of the communication type (serial, TCP/IP) is characterized by 2 communication fields which are: data and function code.
On serial line, however, the command string consists of 4 communication fields:

- Device address;
- Function code;
- Data;
- CRC.



1.1 SlaveAddress

The field address (SlaveAddress) serves to indicate what Slave is called by Master. The valid slave address can be between 1 and 128. Please, note that the Slaves must have different addresses. To communicate with a slave, the Master into the address field the value of the slave address, which in turn will use in the reply message. The values that the Master may enter inside the string are:

- 0 = address 0, or "Broadcasting", was sent to all slave who must not be answered;
- 1÷128 = free addresses for the Slave devices addressing;

1.2 FunctionCode

The function code used to indicate to the slave the request of the master, and then the operation type to be performed, if the slave could not make this request will send an error code.
The codes that can be sent must be between 1 and 83.
To determine which functions are manageable refer to maps on the next page.

1.3 Data

The data field contains data sent from master to slave, or sent in response from Slave to Master. The data fields are multiples of 16-bit registers (1WORD = 2byte, 1byte = 8bit). Each WORD is always transmitted from the most significant byte. Depending on how the Slave records are set, you can view or change values in sequence, and it's possible if the records in question are adjacent to each other

1.4 CRC

This field is used to verify the integrity of the received message. Is calculated and attached to the message by the transmitting station. The receiving station, as a first step, recalculate this field and compare it with that received. Is generated in two different ways if you use the ASCII mode (LRC Logitudinal Redundancy cheking) or, as in the case of METER/PTU5_, RTU (CRC Cyclic Redundancy Checking).

2 Introduction to MODBUS RTU

2.1 MODBUS RTU protocol

The MODBUS RTU protocol is faster than ASCII, and the string of communication consists of:

- T1 T2 T3 T4
- indirizzo dispositivo (1 byte)
- device address (1 byte)
- data (N x 2 byte; N = contiguous registers numbers to read or send)
- CRC (2 byte)
- T1 T2 T3 T4

“T1 T2 T3 T4”
indicates the time that must elapse before a subsequent communication to avoid collisions of messages, the overall structure of the byte is composed of:

- 1 start bit;
- 8 data bits (transmitted from the least significant bit);
- 1 parity bit + 1 stop bit, if there is no parity bit using 2 stop bits.

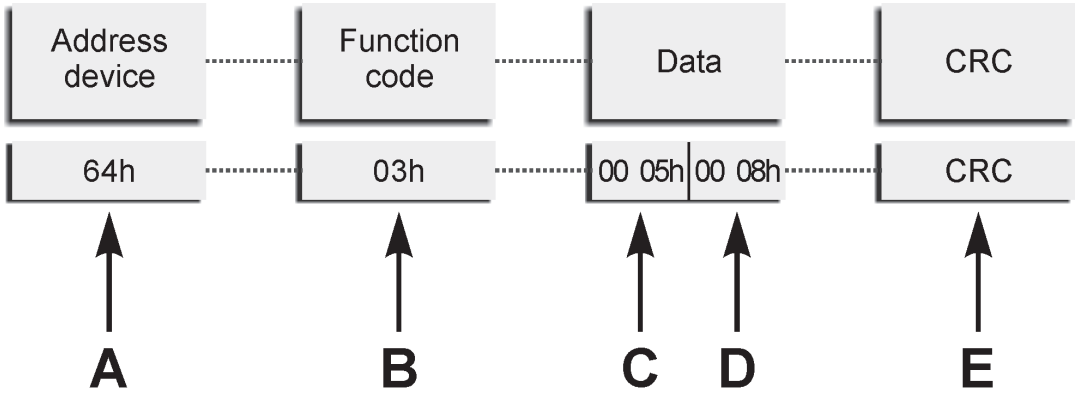
2.2 EXAMPLE

To better understand the MODBUS protocol operation, the following is an example of communication between MASTER and SLAVE:

- Master: PC;
- Slave: METER with decimal address 100 (hexadecimal 64h).

The request by the Master is to read 2 of the contiguous cells Slave to level% measure reading

2.2.1 REQUEST FROM THE MASTER



A. Address device 100 (64h)

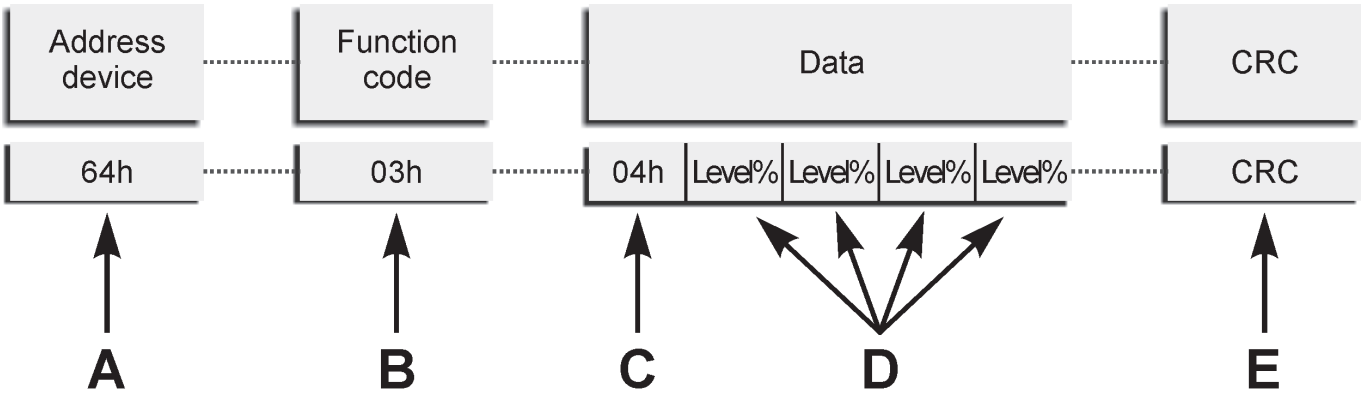
B. 03h (read holding registers) is the MODBUS value to indicate the reading of one or more consecutive registers

C. 05h indicates the first record read (according to tables given by the manufacturer of the product)

D. 08h indicates the reading of 4 contiguous registers

E. CRC

2.2.2 RESPONSE SLAVE (METER/PTU5_)



A. Slave address

B. function required by the Master

C. Data field No. byte

D. data required by the Master

E. CRC

Part of a METER/PTU5_ functions table, for complete tables refer to the following pages

PART OF METER MAPPINGS TABLE				
register address	**Dim. (WORD)**	**Description**	**Measure unit**	**Function**
02h	4	% level Measurement	%	03h

3 Mappings

To enable the "system integrator" to develop a levels management software, following the mapping is represented in the METER/KTU5/PTU5x series.

3.1 MODBUS possible functions

Modality: RTU

Parity: none (bit not sent)

Times: minimum waiting time between two successive transmissions: $\geq$ time of 1 character multiplied by 3.5

Read / write:

01, **02** – "read single inputs"
03, **04** – "read holding register"
05 – "write single coil"
06 – "write single register"

Error functions management (function code + 80h)

Diagnostics: unmanaged

Information Management: field data up to 100 bytes

METER MAPPINGS

Address Dec.	Address *Hex*	Dim. (WORD)	Description	Measure unit	Function	
01	*00*	1	Distance	mm	03h	
02	*01*	1	Level	mm	03h	
03	*02*	2	Level %	%	03h	
05	*04*	2	Temperature	°C	03h	
07	*06*	2	Analog output	mA	03h	
09	*08*	2	Pulse frequency output	kHz	03h	
11	*A*	1	0% calibration distance (4mA)	mA	03h	06h
12	*B*	1	100% calibration distance (20mA)	mA	03h	06h
15	*E*	1	Blind distance	mm	03h	06h
16	*F*	1	MAX gain TH		03h	06h
17	*10*	1	Frozen gain		03h	06h
23	*16*	1	Filter coefficent	s	03h	06h
25	*18*	1	UID		03h	06h
38	*25*	1	RL1 Setpoint delay (*)	s	03h	06h
40	*27*	1	RL2 Setpoint delay (*)	s	03h	06h
43	*2A*	1	Control pump delay (RL1)	s	03h	06h
44	*2B*	1	Medium		03h	06h
45	*2C*	1	RL1 alarm mode (*)		03h	06h

(*) - Available only for METER and KTU5

METER MAPPINGS						
1° register address		Dim. (WORD)	Description	Measure unit	Function	
Dec.	*Hex*					
46	*2D*	1	RL1 safety (*)		03h	06h
47	*2E*	1	RL1 alarm enable (*)		03h	06h
48	*2F*	1	RL2 alarm mode (*)		03h	06h
49	*30*	1	RL2 safety (*)		03h	06h
50	*31*	1	RL2 alarm enable (*)		03h	06h
51	*32*	1	Pump control mode (RL1) (*)		03h	06h
52	*33*	1	Pump control enable (RL1) (*)		03h	06h
53	*34*	1	Diagnostic alarm enable (RL2) (*)		03h	06h
54	*35*	1	Measure status		03h	
55	*36*	1	Temperature error message		03h	
56	*37*	1	Echo error message		03h	
57	*38*	1	Gain error message		03h	
58	*39*	1	Distance error message		03h	
59	*3A*	1	Analog output safe mode		03h	06h
60	*3B*	1	RL1 status (*)		03h	
61	*3C*	1	RL2 status (*)		03h	
66	*41*	1	F_WINDOW function value		03h	06h
70	*45*	1	RL1 setpoint (*)	%	03h	06h
71	*46*	1	RL2 Setpoint (*)	%	03h	06h
72	*47*	1	Pump control higher setpoint (RL1) (*)	mm	03h	06h
73	*48*	1	Pump control lower setpoint (RL1)	mm	03h	06h
74	*49*	1	Modbus RS485 Parity		03h	06h
75	*4A*	1	Modbus RS485 Baudrate		03h	06h

(*) - Available only for METER and KTU5

RECORDS CONTENT DESCRIPTION				
Ad. Dec.	**Ad. *Hex***	**Description**	**Reading**	**Writing**
01	*00*	Measured distance in mm from the METER /KTU5/PTU5x (16bit integer)	X	
02	*01*	Measured level in mm from the METER /KTU5/PTU5x (16bit integer)	X	
03	*02*	Measured level in % from the METER /KTU5/PTU5x (32bit integer)	X	
05	*04*	Measured Temperature in ° C by METER /KTU5/PTU5x inside digital sensor (32bit float)	X	
07	*06*	Analog Value in mA, calculated according to the level measured (32bit float)	X	
09	*08*	The echo output impulse frequency in KHz (32bit float)	X	
11	*A*	0% or 4mA calibration distance, in millimeters (16bit integer)	X	X
12	*B*	100% or 20mA calibration distance, in millimeters (16bit integer)	X	X
15	*E*	Blind distance is the distance, in mm, by which the sensor does not measure; default: sensor min. blind distance (integer 16bit)	X	X
16	*F*	MAX gain is the amplification coefficient value that the system should not exceed (default 255), passing generates an error message (integer 16bit)	X	X
17	*10*	Frozen gain is set when you need to block the gain value (1 ÷ 255) excluding automatic modulation, set to value 000, default 000 (integer 16bit)	X	X
23	*16*	Filter coefficient is the system damping value, is expressed in seconds (0 to 60s); default 10s (integer 8bit)	X	X
25	*18*	UID is the sequence number for sensor identification in a communication network, default 1 (integer 8bit)	X	X
38	*25*	RL1 setpoint delay, expressed in s, is the relay 1 intervention threshold delay time, default 0s (integer 8bit)	X	X
40	*27*	RL2 setpoint delay, expressed in s, is the relay 2 intervention threshold delay time, default 0s (integer 8bit)	X	X
43	*2A*	Control pump delay (RL1), expressed in s, is the relay 1 delay time intervention when it's set to pump control; default 0s (whole 8bit)	X	X
44	*2B*	Medium is used to select the surface type that reflects the sensor echo signal: 4 for liquids; 6 for solids ; 8 for liquid in the pipe (integer 8bit)	X	X
45	*2C*	RL1 alarm mode, serves to set the alarm type that is associated with the relay 1: 0 for the lowest level and 1 for the highest level (integer 8bit)	X	X
46	*2D*	RL1 safety was used to set the relay 1 status in non-alarm condition: 0 not normally energized, 1 normally energized (integer 8bit)	X	X
47	*2E*	RL1 alarm enable is used to enable the relay 1 alarm threshold: 0 disabled, 1 enabled (integer 8bit)	X	X

(*) - Available only for METER and KTU5

RECORDS CONTENT DESCRIPTION				
Ad. Dec.	**Ad. *Hex***	**Description**	**Reading**	**Writing**
48	*2F*	RL2 alarm mode, serves to set the alarm type that is associated with the relay 2: 0 for the lowest level and 1 for the highest level (integer 8bit)	X	X
49	*30*	RL2 safety was used to set the relay 2 status in non-alarm condition: 0 not normally energized, 1 normally energized (integer 8bit)	X	X
50	*31*	RL2 alarm enable is used to enable the relay 2 alarm threshold: 0 disabled, 1 enabled (integer 8bit)	X	X
51	*32*	Pump control mode (RL1) is used to set the relay 1 associated operating pump characteristic (filling or empty): 0 for empty and 1 for filling (integer 8bit)	X	X
52	*33*	Pump control enable (RL1) is used to enable the relay 1 pump control function: 0 disabled, 1 enabled (integer 8bit)	X	X
53	*34*	Diagnostic alarm enable (RL2) is designed to enable relay 1 diagnostic alarm reporting: 0 disabled, 1 enabled (integer 8bit)	X	X
54	*35*	Measure status indicates the echo input signal gain amplifier instantaneous level (0 to 255): lower the reading, better the echo signal reception (integer 16bit)	X	
55	*36*	Temperature error message indicates that the measured value is outside the range -30 ÷ +80 ° C: 0 normal, 1 abnormal condition (integer 8bit)	X	
56	*37*	Echo error message indicates the return echo signal receipt absence: 0 normal, 1 abnormal condition (integer 8bit)	X	
57	*38*	Gain error message indicates that the echo signal input instantaneous gain level (0 to 255) exceeds the MAX gain threshold (31) set: 0 normal, 1 abnormal condition (integer 8bit)	X	
58	*39*	Distance error message indicates that the measured distance is greater than 120% of the maximum distance calibration value: 0 normal, 1 abnormal condition (integer 8bit)	X	
59	*3A*	Analog output safe mode adjusts the output to a predetermined value in case of a general malfunctioning: 4 adjusts the output to 21.5mA; 6 adjusts the output 3.85mA; 8 disabled with maintenance of reading conducted (integer 8bit)	X	X
60	*3B*	RL1 status: 1 energized; 0 diseccitato (integer 8bit)	X	
61	*3C*	RL2 status: 1 energized; 0 diseccitato (integer 8bit)	X	
66	*41*	Is the consecutive echoes number to be detected so that the measure is considered valid, within a agitators filter band. If you don't set the agitators filtering, this parameter represents the static filter width increase/decrease rate	X	X
70	*45*	RL1 setpoint is the relay 1 threshold value and is expressed in % referring to the measured level range 0 to 100%, default 0% (integer 8bit)	X	X
71	*46*	RL2 setpoint is the relay 2 threshold value and is expressed in % referring to the measured level range 0 to 100%, default 0% (integer 8bit)	X	X
72	*47*	Pump control higher setpoint (RL1), expressed in%, is the higher threshold value of relay 1 when it's in pump control mode, default 0% (integer 8bit)	X	X

(*) - Available only for METER and KTU5

RECORDS CONTENT DESCRIPTION				
Ad. Dec.	**Ad. *Hex***	**Description**	**Reading**	**Writing**
73	*48*	Pump control lower setpoint (RL1), expressed in%, is the relay 1 lower threshold value of when it's in pump control mode, default 0% (integer 8bit)	**X**	**X**
74	*49*	MODBUS RS485 Parity	**X**	**X**
75	*4A*	MODBUS RS485 Baudrate	**X**	**X**

NOTES

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