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Modbus protocol of the P4000 Particles probe

(Version 01G)



Ver	Modification
V01A	Initial Version
V01B	RTU & ASCII
V01C	Registers update
V01D	Registers update
V01E	Communication characteristics update
V01F	Add of on/off commands of particles sensor
V01G	on/off command frame correction

Modbus Protocol

The Modbus protocol allows a master unit to access up to 255 slaves units connected on a single bus. Each slave is assigned an address that distinguishes it from other slaves connected to the bus.

Transactions can be only initiated by the master and are of two types:

- Question / answer → One slave is addressed
- Broadcast / no answer → All slaves are addressed, but they shall not reply.

Characteristics used for communication with Modbus protocol:

Characteristics	ASCII (7-bit)	RTU (8 bits)
coding System	hexadecimal (utilisation of ASCII printable characters (0-9, A-F))	Binary
Number of bits par character :		10
start bits	1	1
data bits (least significant first)	7	8
parity (optional)	1 (1-bit sent for even or odd parity, no bits for no parity)	No parity
stop bits	1 or 2	1
Error Checking	LRC (Longitudinal Redundancy Check)	CRC16
Baud rate	1200	9600

Characteristics of communication used by the E4000 probe in Master mode: Speed: 1200 baud.

In the rest of document, regarding the transmitted data, you will find the following information:

$$x = x\text{-CHAR-BIT}$$

This information indicates the size of the data transmitted in ASCII and RTU mode (x data ASCII = y BIT RTU). For example, 2-CHAR = 8 BITS means that in the ASCII frame, the information is coded on 2 bytes in RTU mode, the information is encoded in 8 BITS.

Error Checking LRC (Longitudinal Redundancy Check)

The error control used in ASCII mode is the RSC. The error control consists of a binary number transmitted as two ASCII characters representing a hexadecimal encoding. The characters ':', CR, LF, and any other non-ASCII character are ignored in computing the RSC.

Address	02		0000 0010
Function	01		0000 0001
Start Add H.O.	00		0000 0000
Start Add L.O.	00		0000 0000
Quantity of Pts	00		0000 0000
	08		0000 1000
		Sum	0000 1011
		Complement at 1	1111 0100
		+1	0000 0001
Error Check	F5	Complement at 2	1111 0101

ASCII Raster

ASCII transmission mode is initiated by issuing a ':' character which indicates the beginning of the plot and characters carriage return and end of line (CR LF) to indicate the end. The end of line character (LF) is also used as a synchronization character that indicates that the transmitting station is ready to receive a new frame.

MASTER

BEGIN FRAME	ADDRESS	FUNCTION	DATA	ERROR CHECK	EOF	READY TO RECEIVE
:	2-CHAR = 8-BITS	2-CHAR = 8BITS	N X 4-CHAR N X 16-BITS	2-CHAR = 8-BITS	CR	LF

SLAVE

BEGIN FRAME	ADDRESS	FUNCTION	NUMBER OF DATA OCTETS = 2*N	DATA	ERROR CHECK	EOF	READY TO RECEIVE
:	2-CHAR = 8-BITS	2-CHAR = 8BITS	2-CHAR = 8BITS	N X 4-CHAR N X 16-BITS	2-CHAR = 8-BITS	CR	LF

RTU Raster

RTU mode transmission is in binary. Termination of the frame is determined by a time of silence of about 3.5 bytes (in our case about 30ms)

MASTER

ADDRESS	FUNCTION	DATA	ERROR CHECK
8-BITS	8BITS	N X 16-BITS	CRC 16 BITS

SLAVE

ADDRESS	FUNCTION	NUMBER OF DATA BYTES	DATA	ERROR CHECK
8-BITS	8BITS	8BITS	N X 16-BITS	CRC 16 16 BITS

Address field

The address field follows the first frame and consists of two ASCII characters.

Each slave must have a unique address and will only answer to queries that contained his address. When a slave reply, the address field of the slave shall inform the master about the origin of the response. In broadcast mode, the address used and 0. In this case, all slaves interpret the request, but don't respond.

Addresses are divided into 31 groups of 255 slaves as follows:

GROUP ADDRESS	LOCAL ADDRESS
2-CHAR = 8-BIT	2-CHAR = 8-BIT

The group addresses will only be used by repeaters. The slave receiver will only read the local address.

Field Function "Function"

The function code tells the recipient slave which function to address.

CODE	MEANING	ACTION
01	READ COIL STATUS	Obtains current status, (ON/OFF), of a group of logic coils.
02	READ INPUT STATUS	Obtains current status, (ON/OFF), of a group of discrete inputs.
03	READ HOLDING REGISTER	Obtains current binary value in one or more holding registers.
04	READ INPUT REGISTER	Obtains current binary value in one or more input registers.
05	FORCE SINGLE COIL	Force logic coil to a state of ON or OFF.
06	PRESET SINGLE REGISTER	Place a specific binary value into a holding register.

15	WRITE MULTIPLE COILS	Force a group of logic coils to a defined state.
16	PRESET MULTIPLE REGISTERS	Place specific binary values into a group of holding registers.

Field Number of data

This field contains a number indicating the number of bytes in the Data fields.

Data Field: "Data Field"

Data field contains informations necessary for the slave to process the command sent by the master, or contains information that is sent in response by the slave to the master.

Request from the master:

INPUT MODE : Function = 4

FIRST REGISTER	NUMBER OF REGISTERS TO READ
4-CHAR = 16-BIT	4-CHAR = 16-BIT

Request from master:

HOLDING MODE: Function = 6

REGISTER'S ADDRESS	VALUE TO WRITE IN
4-CHAR = 16-BIT	4-CHAR = 16-BIT

ACTION:

Order sent to E4000 probe: The address of the first register is 0

Response to master: function = 4

REGISTER #1 : Slave status	REGISTER #2 : Gas	REGISTER #3 : Particle weight < 1µm	REGISTER #4 : Particle weight < 2.5µm	REGISTER #5 : Particle weight < 10µm
4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS

REGISTER #6 : PM1 count	REGISTER #7 : PM2.5 count	REGISTER #8 : PM10 count	REGISTER #9 : Software version	REGISTER #10 : Sensor Command
4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS	4-CHAR = 16-BITS

The register #10 is only available in RTU version sensors starting from software release #108.

Description of read-only records:

SLAVE STATUS: Register #1 (address 0)

- 00 OK
- 01 Optic needs to be cleaned
- 02 Low voltage
- 03 Saturation
- 04 TBD
- 05 TBD
- 06 Preheating
- 07 Sensor Off
- 08 TBD

GAS: Register #2 (address 1) (Particles for P4000)

- 4-CHAR (16-BITS):
- 00 CO

01 O2
 02 O3
 03 H2
 04 CH4
 05 PARTICLES
 06 RADON
 07 H2S
 0A NO2
 0E EC
 0F CO2 (code used to define E4000 probe that also handle VOC)

Particle weight < 1µm (en µg/m³): Register #3 (address 2)

4-CHAR (16-BITS):

16 bits unsigned

Particle weight < 2.5µm (en µg/m³): Register #4 (address 3)

4-CHAR (16-BITS):

16 bits unsigned

Particle weight < 10µm (en µg/m³): Register # 5 (address 4)

4-CHAR (16-BITS):

16 bits unsigned

PM1 count per CBM: Register # 6 (address 5)

4-CHAR (16-BITS):

Particles count in thousands

PM2.5 count per CBM: Register # 7 (address 6)

4-CHAR (16-BITS):

Particles count in thousands

PM10 count per CBM: Register # 8 (address 7)

4-CHAR (16-BITS):

Particles count in thousands

Software version: Register # 9 (address 8)

4-CHAR (16-BITS)

Sensor command: Register # 10 (address 9)

This register is only available on RTU version sensors starting from software release #108.

4-CHAR (16-BITS)

ON/OFF Sensor Command

ON Value = 0xFF00

OFF Value = 0x00FF

Example of sending an ON command:

ADDRESS	FUNCTION	DATA		CRC 16
0x01	0x06	0x0009	0xFF00	0x1838

Example of sending an OFF command:

ADDRESS	FUNCTION	DATA		CRC 16
0x01	0x06	0x0009	0x00FF	0x1988