

## THE MODBUS PROTOCOL HANDLING FOR PDU-4xx-P

Transmission parameters: 1 start bit, 8 data bits, 1 or 2 stop bit (2 bits are send, 1 and 2 bits are accepted when receive), no parity control  
Baud rate: selectable from: 1200 to 115200 bits/second  
Transmission protocol: MODBUS RTU compatible

The device parameters and display value are available via RS-485 interface, as HOLDING-type registers (numeric values are given in U2 code) of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single registers) or 10h (group of the registers) accordingly to Modbus RTU specification. Maximum group size for 03h and 10h functions can not exceeds 16 registers (for single frame).



The device interprets the broadcast messages, but then do not sends the answers.

### LIST OF REGISTERS

<b>Register</b>	<b>Write</b>	<b>Range</b>	<b>Register description</b>
01h	No	-999 ÷ 9999	Measurement value (no decimal point)
02h	No	0h, A0h, 60h	The status of the current measurement; <b>0h</b> - data valid; <b>A0h</b> - top border of the measurement range is exceeded; <b>60h</b> - bottom border of the measurement range is exceeded;
03h	Yes	0 ÷ 3	"Pnt" parameter in "InPt" menu (decimal point position) <b>0</b> - " 0"; <b>1</b> - " 0.0"; <b>2</b> - " 0.00"; <b>3</b> - "0.000"
04h	Yes	see descr.	State of the relays and alarm LED (binary format) (1 - on, 0 - off): <b>00000000 000edcba</b> <b>a</b> - relay R1; <b>b</b> - relay R2; <b>c</b> - relay R3; <b>d</b> - relay R2; <b>e</b> - alarm LED; If written, only <b>a</b> , <b>b</b> , <b>c</b> , <b>d</b> bits are important (others are ignored) these bits allows user to control the relays via RS-485 interface

<b>Register</b>	<b>Write</b>	<b>Range</b>	<b>Register description</b>
05h <sup>1</sup>	Yes	0h ÷ 1800h	State of current output, expressed in 1/256 mA units – it means that high byte express integer part, and low byte fractional part of desired output current.
06h	No	-999 ÷ 9999	Peak (drop) value (no decimal point)
10h	Yes	0 ÷ 5	“ <b>tyPE</b> ” parameter in “ <b>InPt</b> ” menu (nominal input range). <b>0</b> - 0-20 mA range; <b>1</b> - 4-20 mA range; <b>2</b> - 0-10 V range; <b>3</b> - 2-10 V range; <b>4</b> - 0-5 V range; <b>5</b> - 1-5 V range
11h	Yes	0 ÷ 3	“ <b>CHAR</b> ” parameter in “ <b>InPt</b> ” menu (characteristic type) <b>0</b> - linear ; <b>1</b> - square; <b>2</b> - square root; <b>3</b> - user defined
12h	Yes	0 ÷ 5	“ <b>FILT</b> ” parameter in “ <b>InPt</b> ” menu (measurement filtering rate)
13h	Yes	0 ÷ 3	“ <b>Pnt</b> ” parameter in “ <b>InPt</b> ” menu (the copy of 03h register, decimal point position) <b>0</b> - “ <b>0</b> ”; <b>1</b> - “ <b>0.0</b> ”; <b>2</b> - “ <b>0.00</b> ”; <b>3</b> - “ <b>0.000</b> ”
14h	Yes	-999 ÷ 9999	“ <b>Lo C</b> ” parameter in “ <b>InPt</b> ” menu, no decimal point included
15h	Yes	-999 ÷ 9999	“ <b>Hi C</b> ” parameter in “ <b>InPt</b> ” menu, no decimal point included
16h	Yes	0 ÷ 999	“ <b>Lo r</b> ” parameter in “ <b>InPt</b> ” menu, in 0.1%
17h	Yes	0 ÷ 199	“ <b>Hi r</b> ” parameter in “ <b>InPt</b> ” menu, in 0.1%
20h <sup>2</sup>	Yes	0 ÷ 199	Device address
21h	No	20F0h	Device identification code (ID)
22h <sup>3</sup>	Yes	0 ÷ 7	“ <b>bAud</b> ” parameter in “ <b>rS</b> ” menu (baud rate); <b>0</b> - 1200 baud; <b>1</b> - 2400 baud; <b>2</b> - 4800 baud; <b>3</b> - 9600 baud; <b>4</b> - 19200 baud; <b>5</b> - 38400 baud; <b>6</b> - 57600 baud; <b>7</b> - 115200 baud
23h <sup>4</sup>	Yes	0 ÷ 1	“ <b>mbAc</b> ” parameter in “ <b>rS</b> ” menu (permission to write registers via RS-485 interface); <b>0</b> - write denied ; <b>1</b> - write allowed
24h	Yes	see descr.	Parameters of “ <b>SECU</b> ” menu (binary format (0 - „ <b>oFF</b> ”, 1 - „ <b>on</b> ”): <b>bit 0</b> - “ <b>A r1</b> ” parameter; <b>bit 1</b> - “ <b>A r2</b> ” parameter <b>bit 2</b> - “ <b>A r3</b> ” parameter; <b>bit 3</b> - “ <b>A r4</b> ” parameter
25h	Yes	0 ÷ 5	“ <b>rESP</b> ” parameter in “ <b>rS</b> ” menu (additional response delay); <b>0</b> - no additional delay; <b>1</b> - “ <b>10c</b> ” option; <b>2</b> - “ <b>20c</b> ” option; <b>3</b> - “ <b>50c</b> ” option; <b>4</b> - “ <b>100c</b> ” option; <b>5</b> - “ <b>200c</b> ” option;
27h	Yes	0 ÷ 99	“ <b>mbtO</b> ” parameter in “ <b>rS</b> ” menu (maximum delay between received frames); <b>0</b> - no delay checking; <b>1 ÷ 99</b> - maximum delay expressed in seconds
28h	Yes	0 ÷ 1	“ <b>AL</b> ” parameter in “ <b>bEEP</b> ” menu: <b>0</b> - off; <b>1</b> - on
29h	Yes	0 ÷ 1	“ <b>R1</b> ” parameter in “ <b>bEEP</b> ” menu: <b>0</b> - off; <b>1</b> - on
2Ah	Yes	0 ÷ 1	“ <b>R2</b> ” parameter in “ <b>bEEP</b> ” menu: <b>0</b> - off; <b>1</b> - on
2Bh	Yes	0 ÷ 1	“ <b>R3</b> ” parameter in “ <b>bEEP</b> ” menu: <b>0</b> - off; <b>1</b> - on
2Ch	Yes	0 ÷ 1	“ <b>R4</b> ” parameter in “ <b>bEEP</b> ” menu: <b>0</b> - off; <b>1</b> - on
2Dh	Yes	1 ÷ 8	“ <b>bri</b> ” parameter (display brightness); <b>1</b> - the lowest brightness; <b>8</b> - the highest brightness

<b>Register</b>	<b>Write</b>	<b>Range</b>	<b>Register description</b>
2Fh	Yes	0 ÷ 1	“ <b>Edit</b> ” parameter (numerical parameters edit mode); <b>0</b> - „ <b>dig</b> ” mode; <b>1</b> - „ <b>SLid</b> ” mode
30h	Yes	-999 ÷ 9999	“ <b>SEtP</b> ” parameter in “ <b>rEL1</b> ” menu, no decimal point included
31h	Yes	-999 ÷ 999	“ <b>HySt</b> ” parameter in “ <b>rEL1</b> ” menu, no decimal point included
32h	Yes	0 ÷ 3	“ <b>modE</b> ” parameter in “ <b>rEL1</b> ” menu: <b>0</b> - “ <b>noAC</b> ” mode; <b>1</b> - “ <b>on</b> ” mode; <b>2</b> - “ <b>oFF</b> ” mode; <b>3</b> - “ <b>in</b> ” mode; <b>4</b> - “ <b>out</b> ” mode; <b>5</b> - “ <b>modb</b> ” mode
33h	Yes	0 ÷ 999	“ <b>t on</b> ” parameter in “ <b>rEL1</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 35h)
34h	Yes	0 ÷ 999	“ <b>toFF</b> ” parameter in “ <b>rEL1</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 35h)
35h	Yes	0 ÷ 1	“ <b>unit</b> ” parameter in “ <b>rEL1</b> ” menu: <b>0</b> - seconds; <b>1</b> - minutes
36h	Yes	0 ÷ 2	“ <b>AL</b> ” parameter in “ <b>rEL1</b> ” menu: <b>0</b> - no changes; <b>1</b> - on; <b>2</b> - off
37h	Yes	-999 ÷ 9999	“ <b>SEt2</b> ” parameter in “ <b>rEL2</b> ” menu, no decimal point included
38h	Yes	-999 ÷ 9999	“ <b>SEtP</b> ” parameter in “ <b>rEL2</b> ” menu, no decimal point included
39h	Yes	-999 ÷ 999	“ <b>HySt</b> ” parameter in “ <b>rEL2</b> ” menu, no decimal point included
3Ah	Yes	0 ÷ 3	“ <b>modE</b> ” parameter in “ <b>rEL2</b> ” menu: <b>0</b> - “ <b>noAC</b> ” mode; <b>1</b> - “ <b>on</b> ” mode; <b>2</b> - “ <b>oFF</b> ” mode; <b>3</b> - “ <b>in</b> ” mode; <b>4</b> - “ <b>out</b> ” mode; <b>5</b> - “ <b>modb</b> ” mode
3Bh	Yes	0 ÷ 999	“ <b>t on</b> ” parameter in “ <b>rEL2</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 3Dh)
3Ch	Yes	0 ÷ 999	“ <b>toFF</b> ” parameter in “ <b>rEL2</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 3Dh)
3Dh	Yes	0 ÷ 1	“ <b>unit</b> ” parameter in “ <b>rEL2</b> ” menu: <b>0</b> - seconds; <b>1</b> - minutes
3Eh	Yes	0 ÷ 2	“ <b>AL</b> ” parameter in “ <b>rEL2</b> ” menu: <b>0</b> - no changes; <b>1</b> - on; <b>2</b> - off
3Fh	Yes	-999 ÷ 9999	“ <b>SEt2</b> ” parameter in “ <b>rEL2</b> ” menu, no decimal point included
40h	Yes	-999 ÷ 9999	“ <b>SEtP</b> ” parameter in “ <b>rEL3</b> ” menu, no decimal point included
41h	Yes	-999 ÷ 999	“ <b>HySt</b> ” parameter in “ <b>rEL3</b> ” menu, no decimal point included
42h	Yes	0 ÷ 3	“ <b>modE</b> ” parameter in “ <b>rEL3</b> ” menu: <b>0</b> - “ <b>noAC</b> ” mode; <b>1</b> - “ <b>on</b> ” mode; <b>2</b> - “ <b>oFF</b> ” mode; <b>3</b> - “ <b>in</b> ” mode; <b>4</b> - “ <b>out</b> ” mode; <b>5</b> - “ <b>modb</b> ” mode
43h	Yes	0 ÷ 999	“ <b>t on</b> ” parameter in “ <b>rEL3</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 45h)
44h	Yes	0 ÷ 999	“ <b>toFF</b> ” parameter in “ <b>rEL3</b> ” menu, expressed in tenth of seconds or tenth of minutes depend on “ <b>unit</b> ” parameter - register no. 45h)
45h	Yes	0 ÷ 1	“ <b>unit</b> ” parameter in “ <b>rEL3</b> ” menu: <b>0</b> - seconds; <b>1</b> - minutes
46h	Yes	0 ÷ 2	“ <b>AL</b> ” parameter in “ <b>rEL3</b> ” menu: <b>0</b> - no changes; <b>1</b> - on; <b>2</b> - off

<b>Register</b>	<b>Write</b>	<b>Range</b>	<b>Register description</b>
47h	Yes	-999 ÷ 9999	“SEt2” parameter in “rEL3” menu, no decimal point included
48h	Yes	-999 ÷ 9999	“SEtP” parameter in “rEL4” menu, no decimal point included
49h	Yes	-999 ÷ 999	“HySt” parameter in “rEL4” menu, no decimal point included
4Ah	Yes	0 ÷ 3	“modE” parameter in “rEL4” menu: 0 - “noAC” mode; 1 - “on” mode; 2 - “oFF” mode; 3 - “in” mode; 4 - “out” mode; 5 - “modb” mode
4Bh	Yes	0 ÷ 999	“t on” parameter in “rEL4” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 4Dh)
4Ch	Yes	0 ÷ 999	“toFF” parameter in “rEL4” menu, expressed in tenth of seconds or tenth of minutes depend on “unit” parameter - register no. 4Dh)
4Dh	Yes	0 ÷ 1	“unit” parameter in “rEL4” menu: 0 - seconds; 1 - minutes
4Eh	Yes	0 ÷ 2	“AL” parameter in “rEL4” menu: 0 - no changes; 1 - on; 2 - off
4Fh	Yes	-999 ÷ 9999	“SEt2” parameter in “rEL4” menu, no decimal point included
50h	Yes	0 ÷ 1	“modE” parameter in “HOLD” menu (type of detected changes): 0 - peaks; 1 - drops
51h	Yes	0 ÷ 9999	“PEA” parameter in “HOLD” menu (minimum detectable change, no decimal point included)
52h	Yes	0 ÷ 199	“timE” parameter in “HOLD” menu, maximum peaks' (or drops') display time expressed in seconds
53h	Yes	0 ÷ 1	“HdiS” parameter in “HOLD” menu: 0 - “rEAL” mode ; 1 - “HOLD” mode
54h	Yes	0 ÷ 1	“H r1” parameter in “HOLD” menu : 0 - “rEAL” mode ; 1 - “HOLD” mode
55h	Yes	0 ÷ 1	“H r2” parameter in “HOLD” menu: 0 - “rEAL” mode ; 1 - “HOLD” mode
56h	Yes	0 ÷ 1	“H r3” parameter in “HOLD” menu: 0 - “rEAL” mode ; 1 - “HOLD” mode
57h	Yes	0 ÷ 1	“H r4” parameter in “HOLD” menu: 0 - “rEAL” mode ; 1 - “HOLD” mode
58h	Yes	0 ÷ 1	“HOuT” parameter in “HOLD” menu: 0 - “rEAL” mode ; 1 - “HOLD” mode
70h <sup>5</sup>	Yes	-999 ÷ 1999	The value of „X” coordinate of point <b>no. 1</b> of the user defined characteristic, expressed in 0.1%
71h <sup>5</sup>	Yes	-999 ÷ 9999	The value of „Y” coordinate of point <b>no. 1</b> of the user defined characteristic, no decimal point included
72h <sup>5</sup> ÷ 95h <sup>5</sup>			Further pairs of „X” - „Y” coordinates of points <b>no. 2 ÷ 19</b> of the user defined characteristic
96h <sup>5</sup>	Yes	-999 ÷ 1999	The value of „X” coordinate of point <b>no. 20</b> of the user defined characteristic, expressed in 0.1%

<b>Register</b>	<b>Write</b>	<b>Range</b>	<b>Register description</b>
97h <sup>5</sup>	Yes	-999 ÷ 9999	The value of „Y” coordinate of point <b>no. 20</b> of the user defined characteristic, no decimal point included
A0h <sup>1</sup>	Yes	0 ÷ 2	“ <b>Omod</b> ” parameter in “ <b>OUTP</b> ” menu (current output mode) <b>0</b> - current output disabled; <b>1</b> - current output enabled with 0÷20mA mode; <b>2</b> - current output enabled with 4÷20mA mode; <b>3</b> - current output controlled via RS-485 interface
A1h <sup>1</sup>	Yes	-999 ÷ 9999	“ <b>OUTL</b> ” parameter in “ <b>OUTP</b> ” menu, no decimal point included
A2h <sup>1</sup>	Yes	-999 ÷ 9999	“ <b>OUTH</b> ” parameter in “ <b>OUTP</b> ” menu, no decimal point included
A3h <sup>1</sup>	Yes	0 ÷ 499	“ <b>Lo r</b> ” parameter in “ <b>OUTP</b> ” menu, expressed in 0.1%
A4h <sup>1</sup>	Yes	0 ÷ 99	“ <b>Hi r</b> ” parameter in “ <b>OUTP</b> ” menu, expressed in 0.1%
A5h <sup>1</sup>	Yes	0 ÷ 3	“ <b>AL</b> ” parameter in “ <b>OUTP</b> ” menu (current output value on critical exception): <b>0</b> - no change; <b>1</b> - 22.1 mA; <b>2</b> - 3.4 mA; <b>3</b> - 0 mA

- 1 - these registers are active only if device is equipped with active current output
- 2 - after writing to register no 20h the device responds with an “old” address in the message.
- 3 - after writing to register no 22h the device responds with the new baud rate.
- 4 - the value of the “**mbAc**” parameter is also connected to write to this register, so it is possible to block a writes, but impossible to unblock writes via RS-485 interface, The unblocking of the writes is possible from menu level only.
- 5 - the pairs of „X -Y” coordinates may be defined for any free point. The pair is “free” (it means that particular point is not defined) if „X” coordinate of this point is equal 8000h. After writing both X and Y coordinate the point is defined and used in calculation of result. The coordinates of any point can be changed at any time.

### **TRANSMISSION ERRORS DESCRIPTION**

If an error occurs while write or read of single register, then the device sends an error code according to Modbus RTU specifications (example message no 1).

Error codes:

- 01h** - illegal function (only functions 03h, 06h and 10h are available),
- 02h** - illegal register address
- 03h** - illegal data value
- 08h** - no write permission ( see: “**mbAc**” parameter)
- A0h** - exceed of upper border of input range
- 60h** - exceed of lower border of input range

A0h and 60h codes can appear only during reg. 01h is reading by 03h function (read of a single register).

### **EXAMPLES OF QUERY/ANSWER FRAMES**

Examples apply for device with address 1. All values are represent hexadecimal.

#### **Field description:**

- ADDR** Device address on modbus network
- FUNC** Function code
- REG H,L** Starting address (address of first register to read/write, Hi and Lo byte)
- COUNT H,L** No. of registers to read/write (Hi and Lo byte)

**BYTE C**            Data byte count in answer frame  
**DATA H,L**        Data byte (Hi and Lo byte)  
**CRC L,H**         CRC error check (Hi and Lo byte)

**1. Read of the displayed value (measurement), SRP-94 device address = 01h:**

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	01	D5	CA

a) The answer (we assume that the measure result is not out of range):

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	00	FF	F8	04

DATA H, L - displayed value = 255, no decimal point.  
 Decimal point position can be read from reg. 03h.

b) The answer (if an error occur):

ADDR	FUNC	ERROR	CRC L,H	
01	83	60	41	18

ERROR - error code = 60h, bottom border of the measurement range is exceeded

**2. Read of device ID code**

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	21	00	01	D4	00

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	20	F0	A1	C0

DATA - identification code (20F0h)

**3. Change of the device address from 1 to 2 (write to reg. 20h)**

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

DATA H - 0  
 DATA L - new device address (2)

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

**4. Change of baud rate of all devices connected to the net (BROADCAST message).**

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
00	06	00	22	00	04	29	D2

DATA H - 0

DATA L - 4, new baud rate 19200 baud



Device do not reply to BROADCAST-type messages.

**5. Read of the registers 1, 2 and 3 in one message (example of reading a number of registries in one frame):**

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	01	00	03	54	0B

COUNT L - the count of being read registers (max.16)

The answer:

ADDR	FUNC	BYTE C	DATA H1,L1		DATA H2,L2		DATA H3,L3		CRC L,H	
01	03	06	00	0A	00	00	00	01	78	B4

DATA H1, L1 - reg. 01h (10 - displayed value "1.0"),

DATA H2, L2 - reg. 02h (0 - no errors),,

DATA H3, L3 - reg. 03h (1 - decimal point position " 0.0").