

## DIGITAL INPUT/OUTPUT MODULE

### OB-216

## OPERATING MANUAL



Quality Management System of the device designing and production complies with the requirements of ISO 9001:2015

Dear Customer,

Novatek-Electro Ltd. Company thanks you for purchasing our products. You will be able to use properly the device after carefully studying the Operating Manual.

Keep the Operating Manual throughout the service life of the device.

### PURPOSE

Digital input/output module OB-216 (hereinafter referred to as the Device or OB-216) can be used as:

- remote DC voltage meter (0 - 10 V);
- remote meter of direct current (0 - 20 mA);
- remote temperature meter when connecting an analog sensor NTC (10KB), PTC 1000 or PT 1000;
- remote temperature or humidity meter when connecting a digital sensor D18B20, DHT21, DHT22 or AM2301;
- counter of impulses with saving the result in memory.

OB-216 provides:

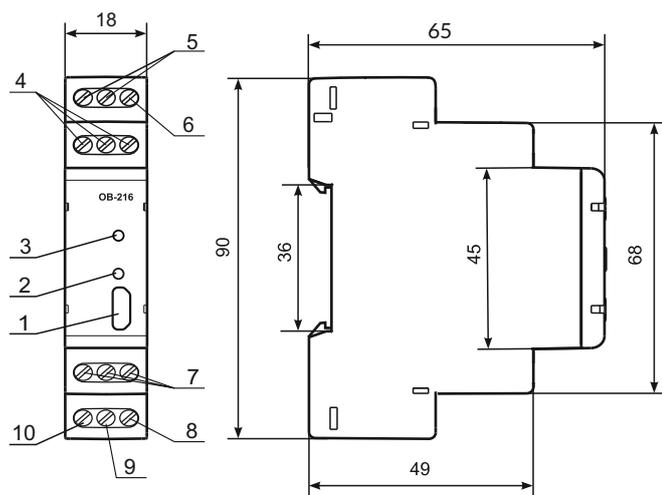
- monitoring the state (closed / open) of the contact at the input of the «dry contact» type;
- issue of an analog signal (0 - 10 V, 0 - 20 mA) at the analog output.

RS-485 or USB interfaces provide control over the ModBus protocol of devices connected to the analog output (Figure 1, pos. 9, 10), reading sensor readings, setting device parameters. The control is carried out using the program "Control Panel OB-215/OB-216" or other software supporting the MODBUS protocol.

Power supply of the device and data exchange are indicated by indicators on the front panel (Fig. 1, pos. 2, 3).

The overall and mounting dimensions and controls of OB-216 are shown in Figure 1.

*Note - temperature sensors are not included in the delivery set.*



- 1 - micro-USB connector;
- 2 - data exchange indicator;
- 3 - power supply indicator;
- 4 - terminals for RS-485 connection;
- 5 - terminals for power supply;
- 6 - terminal for restarting the device;
- 7 - terminals for connecting sensors;
- 8 - terminal "ground" of the analog output;
- 9 - current terminal 0 - 20 mA analog output;
- 10 - voltage terminal 0 - 10 V analog output.

Figure 1

### TERMS AND ABBREVIATIONS

- **ModBus** - standard, packet communication protocol based on "client-server" technology for industrial electronic devices;
- **ModBus RTU** - device communication protocol, through which the packet is transmitted byte by byte;
- **ModBus ASCII** - device communication protocol through which a packet is transmitted in the form of ASCII characters;
- **RS-485/EIA-485** - network standard for communication of devices via twisted pair;
- **Twisted pair** - a pair of insulated conductors in a cable, twisted together to reduce distortion of transmitted signals;
- **W/R** - write/read;
- **Indicator** - a single LED indicator;
- **R** - reading.

### OPERATION CONDITIONS

The device is intended for operation in the following conditions:

- Ambient temperature: from minus 35 to +45 °C;
- Atmospheric pressure: from 84 to 106.7 kPa;
- Relative humidity (at temperature of +25 °C): 30 ...80 %.

*If the temperature of the device after transportation or storage differs from the ambient temperature at which it is supposed to be operated, then before connecting to the mains keep the device under the operating conditions within two hours (because of condensation may be on the device elements).*

ATTENTION! The device is not intended for operation in the following conditions:

- Significant vibration and shocks;
- High humidity;
- Aggressive environment with content in the air of acids, alkalis, etc., as well as severe contaminations (grease, oil, dust, etc.).

### TECHNICAL SPECIFICATIONS

#### MAIN TECHNICAL CHARACTERISTICS

DC supply voltage	10 - 30 V
Number of connected sensors	1
DC voltage measurement error in the range 0 - 10 V	≤ 1%
DC current measurement error in the range of 0 - 20 mA	≤ 1%
Temperature measuring range (NTC 10KB)	-25...+125 °C
Temperature measuring range (PTC 1000)	-50...+120 °C
Temperature measuring range (PT 1000)	-50...+250 °C
Maximum pulse frequency in the «Pulse counter/Logic input» mode	200 Hz
Maximum pulse frequency in the «Voltage/current pulse counter» mode	10 Hz
Maximum voltage supplied to the input «IO1», «IO2»	no more supply voltage
Number of outputs	1
Output voltage range	0 - 10 V
Output voltage error	0.5 %
Output current range	0 - 20 mA
Output current error	0.5 %
Ready time	≤ 2 s
Maximum power consumption	≤ 1 W
Communication interfaces	RS (EIA/TIA)-485, USB
Data exchange protocol ModBus	RTU/ASCII
Nominal operating mode	long lasting
Climatic performance	NF 3.1
Device protection degree	IP 20
Permissible degree of pollution	II
Electric shock protection class	III
Cross-section of conductors for connection	0.5 - 3.0 mm <sup>2</sup>
Screw tightening torque	0.4 N*m
Weight	≤ 0.07 kg
Overall dimensions, HxBxL	90x65x18 mm

The device meets the requirements of the following:  
EN 60947-1; EN 60947-6-2; EN 55011; EN 61000-4-2

Installation (mounting) - DIN rail 35 mm

The device maintains its performance at any position in space

Body material - self-extinguishing plastic

Harmful substances in amounts exceeding maximum permissible concentrations are not available

## OB-216 SETTINGS

Parameter	Value range	Factory value	Type	W/R	Address (DEC)
<b>Measurement of discrete signals:</b>					
0 - impulse counter (discrete signal);					
1 - logical input					
<b>Measurement of analog signals:</b>					
2 - voltage measurement;					
3 - current measurement					
<b>Temperature measurement:</b>					
4 - NTC sensor (10KB);	0...6, 8, 11-12	1	UINT	W/R	100
5 - PTC 1000 sensor;					
6 - PT 1000 sensor					
<b>Additional:</b>					
8 - digital sensor (1-Wire)*;					
11 - pulse counter (voltage);					
12 - pulse counter (current)					
<b>Connectable digital sensor:</b>					
0 - DS18B20 (1-Wire);					
1 - DHT11 (1-Wire);	0...3	0	UINT	W/R	101
2 - DHT21/AM2301 (1-Wire);					
3 - DHT22 (1-Wire)					
<b>Temperature correction</b>					
	-99...99	0	INT	W/R	102
<b>Working parameter*:</b> 0 - temperature;					
1 - humidity					
<b>Upper threshold</b>					
	-32767...32767	250	UINT	W/R	104
<b>Lower threshold</b>					
	-32767...32767	0	UINT	W/R	105
<b>Settings for the pulse counter</b>					
<b>Pulse counter mode:</b>					
0 - counter on the leading edge of the pulse;					
1 - counter on the trailing edge of the pulse;					
2 - counter on both pulse edges					
<b>Contact debouncing delay**</b>					
	1...250	10	UINT	W/R	107
<b>Number of pulses per counting unit***</b>					
	1...65534	8000	UINT	W/R	108
<b>Data transfer settings</b>					
<b>RS-485:</b> 0 - ModBus RTU; 1 - ModBus ASCII					
	0...1	0	UINT	W/R	109
<b>ModBus UID</b>					
	1...247	28	UINT	W/R	110
<b>Exchange rate:</b> 0 - 1200; 1 - 2400;					
2 - 4800; 3 - 9600; 4 - 14400; 5 - 19200;					
6 - 38400; 7 - 57600; 8 - 115200					
<b>Parity and stop bits control:</b>					
0 - no, 2 stop bits; 1 - even, 1 stop bit;					
2 - odd, 1 stop bit					
<b>Selecting an interface for data transmission:</b> 0 - automatically; 1 - RS-485; 2 - USB					
	0...2	0	UINT	W/R	113
<b>Password protection ModBus****:</b>					
0 - disabled; 1 - enabled					
	0...1	0	UINT	W/R	116
<b>ModBus password value</b>					
	A-Z,a-z,0-9	admin	STRING	W/R	117-124
<b>Measured value conversion settings</b>					
<b>Measured value conversion:</b>					
0 - conversion is disabled;					
1 - conversion is enabled					
	0...1	0	UINT	W/R	130
<b>Minimum input value</b>					
	0...2000	0	UINT	W/R	131
<b>Maximum input value</b>					
	0...2000	1000	UINT	W/R	132
<b>Minimum converted value</b>					
	-32767...32767	0	INT	W/R	133
<b>Maximum converted value</b>					
	-32767...32767	1000	INT	W/R	134
<b>Settings for analog output</b>					
<b>Analog output control:</b>					
0 - control is disabled;					
1 - automatic control of voltage output;					
2 - automatic control of current output;					
3 - manual control of voltage output;					
4 - manual control of current output					
	0...4	0	UINT	W/R	150
<b>Register for writing value in manual mode of analog output control</b>					
	0...2000	0	UINT	W/R	151
<b>Converting the manual control value to an analog signal:</b>					
0 - conversion is disabled;					
1 - conversion is enabled					
	0...1	0	UINT	W/R	152
<b>Minimum input value</b>					
	-500...2500	0	INT	W/R	153
<b>Maximum input value</b>					
	-500...2500	1000	INT	W/R	154

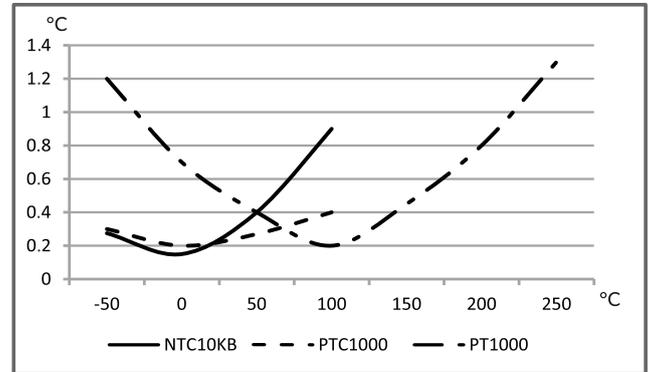
-2-

Minimum converted analog value	0...2000	0	UINT	W/R	155
Maximum converted analog value	0...2000	1000	UINT	W/R	156

**NOTES:**

- \* Used parameter of the selected digital sensor (address 101).
- \*\* Delay in milliseconds used to suppress contact bounce in the «Pulse counter» and «Logic input/pulse relay» modes.
- \*\*\* Used only if pulse counter is enabled. The «Value» column indicates the number of pulses at the input, after the registration of which the counter is increased by one. Writing to memory is performed at intervals of 1 minute.
- \*\*\*\* If «ModBus password protection» is enabled (address 116 value «1»), then to access the recording functions, must be write the correct password value to addresses 51-58

### TEMPERATURE MEASUREMENT ERROR WHEN USING ANALOG SENSORS



### CONNECTING DEVICE

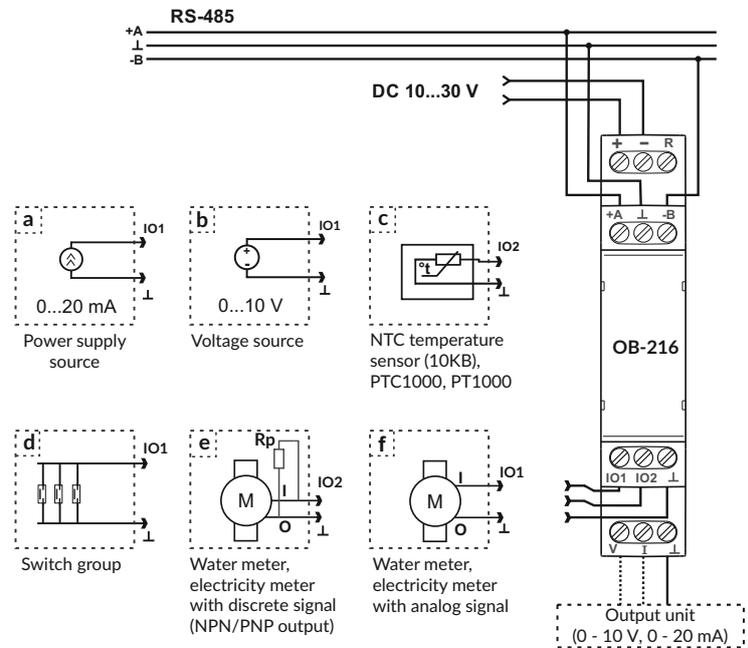


Figure 2

**All connections must be made with the de-energized device!**

An error during installation work can damage the unit and appliances connected to it.

For reliable contact, it is necessary to tighten the terminal block screws with force of 0.4 N\*m.

When the tightening torque is reduced, the junction may heat up, the terminal block may melt and the wire may catch fire. With an increase in the tightening torque, it is possible that the threads of the terminal block screws are broken or the wire to be connected is pinched.

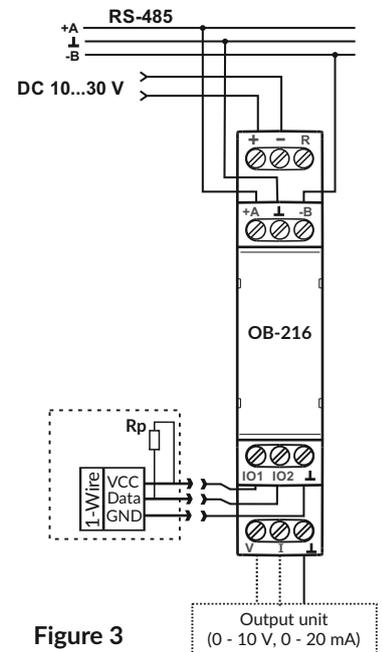


Figure 3

1. **Connect the device** in accordance with Figure 2 (when using the device in the mode of measuring analog and discrete signals) or in accordance with Figure 3 (when using the device with digital sensors) and check the correct connection. To connect the device to the ModBus network, use a twisted pair cable of Cat.1 category or higher.

**Note** - contact «A» for transmitting non-inverted signal, contact «B» - for inverted signal.

**ATTENTION!** The power supply unit of the device must be galvanically isolated from the main energy supply system.

2. Turn on the power supply to the device.

## USE OF DEVICE

After power is applied, the indicator « $\phi$ » flashes for 1.5 s, then the indicators « $\phi$ » and «RS-485» (Fig. 1, pos. 2, 3). After 0.5 s, the «RS-485» indicator goes out. During data exchange, the «RS-485» flashes, otherwise the indicator does not light up.

To configure the device, use the program «Control Panel OB-215/OB-216» (available at web-site <https://novatek-electro.com/en/software.html>) or other software compatible with the ModBus RTU/ASCII. The program connects to the device via USB or RS-485 interface.

When connecting the device via the USB interface, you need to download the NOVATEK USB-SERIAL Driver located at web-site <https://novatek-electro.com/en/drivers-and-utilities.html> and install it on your PC. At the factory setting, the device automatically switches to the USB interface.

### Notes:

- USB cable not included in delivery set.
- when changing the OB-216 settings, they must be saved into memory by a command written to the ModBus register («Command register», address 50, value «18220»). After that, the device will save the settings, automatically restart, and then work with the new settings.

## DEVICE OPERATION

### PULSE COUNTER (DISCRETE SIGNAL)

Connect an external device according to Figure 2 (e). Configure the device for operation in the pulse counter mode for counting discrete signals («OB-216 setting», address 100, value 0). In the register (address 106) to select the pulse detection algorithm.

In this mode, the device counts the number of pulses at the «IO2» (input with a duration not less than the value specified in the «OB-216 settings», address 107, the value is specified in ms) and saves the data into memory with a frequency of 1 minute. If the device was switched off before 1 minute has elapsed, the last stored value will be restored when switched on.

Upon reaching the value indicated in the register (address 108), the counter is incremented by one («Additional registers», address 4:5).

To configure the initial value of the pulse counter, write the required value into the register («Additional registers», address 4:5). Then the counter will count pulses from the entered value.

When changing the value in the register (address 108), all stored pulse counter values will be deleted.

**Note:** if the external device has a PNP type output, for correct operation of the OB-216, it is necessary to connect an external resistor (nominal from 1 k $\Omega$  to 5.1 k $\Omega$ ) in accordance with Figure 2 (e).

### IMPULSE COUNTER (BY VOLTAGE)

Connect an external device according to Figure 2 (f). Configure OB-216 to operate in the pulse counter mode for counting voltage pulses («OB-216 settings», address 100, value 11). In register (address 106) select the pulse detection algorithm. In registers (addresses 104, 105) specify the upper and lower voltage thresholds at which the pulse will be counted.

In this mode, the device counts the number of voltage pulses in accordance with the set thresholds. If the voltage value changes within the upper and lower thresholds, the device will not register these pulses. The number of impulses is saved to memory every minute. If the device was switched off before 1 minute has elapsed,

the last stored value will be restored when switched on.

Upon reaching the value indicated in the register (address 108), the counter is incremented by one («Additional registers», address 4:5).

To configure the initial value of the pulse counter, write the required value into the register («Additional registers», address 4:5). Then the counter will add pulses to the initial value.

When changing the value in the register (address 108), all stored pulse counter values will be deleted.

### IMPULSE COUNTER (BY CURRENT)

Connect an external device according to Figure 2 (f). Configure OB-216 to operate in the impulse counter mode for counting current impulses («Device settings», address 100, value 12). In register (address 106) select the impulse detection algorithm. In registers (addresses 104, 105) specify the upper and lower current thresholds at which the impulse will be recorded.

In this mode, the device counts the number of current impulses in accordance with the set thresholds. If the current value changes within the upper and lower thresholds, the device will not register these impulses. The number of impulses is saved to memory every minute. If the device was switched off before 1 minute has elapsed, the last stored value will be restored when switched on.

Upon reaching the value indicated in the register (address 108), the counter is incremented by one («Additional registers», address 4:5).

To configure the initial value of the impulse counter, write the required value into the register («Additional registers», address 4:5). Then the counter will add pulses to the initial value.

When changing the value in the register (address 108), all stored impulse counter values will be deleted.

### LOGIC INPUT

Connect the device according to Figure 2 (d). Configure it for operation in the «Logic input» («OB-216 settings», address 100, value 1).

When the logical state at the «IO2» terminal (Fig. 1, item 7) changes to a low level, the device will set bit 18 («Additional registers», address 2:3) equal to 1.

When the logical state at the «IO2» terminal (Fig. 1, pos. 7) changes to a high level, the device will set bit 18 («Additional registers», address 2:3) equal to 0.

### VOLTAGE MEASUREMENT

Connect the device according to Figure 2(b). Configure it to operate in the «Voltage measurement» («OB-216 settings», address 100, value 2). The register («Additional registers», address 6) will display the voltage measured at the «IO1» (Fig. 1, pos. 7).

If it is necessary for the device to indicate overvoltage (under voltage), it is necessary to set the response thresholds («OB-216 settings», addresses 104, 105). To set the thresholds, write down the values in address 104 - upper threshold and address 105 - lower threshold. When the voltage value is exceeded (decreased), the corresponding bit will be set to «1» (bit 20 - voltage value above the upper threshold, bit 21 - voltage value below the lower threshold) («Additional registers», address 2:3).

#### **Voltage measurement with value conversion**

To convert the measured voltage to another value, turn on the conversion («OB-216 setting», address 130, value 1) and set the conversion ranges (addresses 131 - 134).

For example, the measured voltage needs to be converted to bars with the following sensor parameters: a voltage range of 0.5 V to 8 V corresponds to a pressure of 1 bar to 25 bar. Configuring the conversion ranges: minimum input value (address 131, value 50 corresponds to 0.5 V), maximum input value (address 132, value 800 corresponds to 8 V), minimum converted value (address 133, value 1 corresponds to 1 bar), maximum converted value (address 134, value 25 corresponds to 25 bar).

The converted value will be output to a register («Additional registers», address 16).

### **Voltage measurement with analog current output**

To output the measured voltage to the analog current output, select the analog current output by writing to the register (address 150) the value 2 - current output control (Fig. 1, pos. 9).

For example, to convert a measured voltage in the 1 V to 10 V range to a current (4 mA to 20 mA range), the conversion ranges must be set.

To set the ranges, write down the minimum value of the input voltage (100 = 1 V) into the register (address 153), and into the register (address 154) write down the maximum value of the input voltage (1000 = 10 V). In the register (address 155) write the minimum value of the output current (400 = 4 mA), in the register (address 156) - the maximum value of the output current (2000 = 20 mA).

The converted analog value will be output to a register («Additional registers», address 17).

### **Voltage measurement with analog voltage output**

To output the measured voltage to the analog voltage output, select the analog voltage output by writing to the register (address 150) the value 1 - voltage output control (Fig. 1, pos. 10).

For example, to convert a measured voltage in the 1 V to 10 V range to a voltage (0 V to 5 V range), the conversion ranges must be set.

To set the ranges, write down the minimum value of the input voltage (100 = 1 V) into the register (address 153), and into the register (address 154) write down the maximum value of the input voltage (1000 = 10 V). In the register (address 155) write the minimum value of the output voltage (0 = 0 V), in the register (address 156) - the maximum value of the output voltage (500 = 5 V).

The converted analog value will be output to a register («Additional registers», address 17).

### **Output voltage to analog output in manual mode**

To output voltage to the analog output in manual mode, select the analog voltage output by writing the value 3 to the register (address 150) - manual control of the voltage output (Fig. 1, pos. 10). To convert a manually set value, turn on the conversion of the output value by writing the value «1» to the register (address 152) and the required ranges in the corresponding registers (addresses 153-156).

When the value «500», is written to the register (address 151), a voltage with a level equal to 5.00 V will appear at the output of the analog voltage (Fig. 1, pos. 10) (when the conversion of the output value is disabled).

## **CURRENT MEASUREMENT**

Connect the device according to Figure 2 (a). Configure it for operation in the «Current measurement» mode («OB-216 settings», address 100, value 3). The register («Additional registers», address 6) will display the value of the current measured at the «IO1» terminal (Fig. 1, pos. 7).

If it is necessary for the device to indicate an excess (decrease) in current, it is necessary to set the response thresholds («OB-216 settings», addresses 104, 105).

To set the thresholds, write down the values in address 104 - high threshold and address 105 - low threshold. When the current value is exceeded (decreased), the corresponding bit will be set to «1» (bit 22 - the current value is above the upper threshold, bit 23 - the current value is below the lower threshold) («Additional registers», address 2:3).

### **Current measurement with value conversion**

To convert the measured current into another value, turn on the conversion («OB-216 settings», address 130, value 1) and set the conversion ranges (addresses 131 - 134).

For example, the measured current needs to be converted to bars with the following sensor parameters: a current range of 4.5 mA to 20 mA corresponds to a pressure of 1 bar to 25 bar. Configuring the conversion ranges: minimum input value (address 131, value 450 corresponds to 4.5 mA), maximum input value (address 132, value 2000 corresponds to 20 mA), minimum converted value (address 133, value 1 corresponds to 1 bar), maximum converted value (address 134, value 25 corresponds to 25 bar).

The converted value will be output to a register («Additional registers», address 16).

### **Current measurement with output to analog current output**

To output the measured current to the analog current output, select the analog current output by writing to the register (address 150) the value 2 - current output control (Fig. 1, item 9).

For example, to convert the measured current, in the range from 0 mA to 10 mA, to current (range from 4 mA to 20 mA), adjust the conversion ranges.

To set the ranges, write the minimum value of the input current (0 = 0 mA) into the register (address 153), and into the register (address 154) - the maximum value of the input current (1000 = 10 mA). In the register (address 155) write the minimum value of the output current (400 = 4 mA), in the register (address 156) - the maximum value of the output current (2000 = 20 mA).

### **Current measurement with analog voltage output**

To output the measured current to the analog output, select the analog voltage output by writing the value 1 to the register (address 150) - voltage output control (Fig. 1, pos. 10).

For example, to convert the measured current, in the range from 0 mA to 20 mA, to voltage (range from 0 V to 5 V), the conversion ranges must be set. To set the ranges, write the minimum value of the input current (0 = 0 mA) to the register (address 153), and the maximum value of the input current (2000 = 20 mA) to the register (address 154). In the register (address 155) write the minimum value of the output voltage (0 = 0 V), in the register (address 156) - the maximum value of the output voltage (500 = 5 V).

### **Current output to analog output in manual mode**

To output the current to the analog output in manual mode, select the analog current output by writing the value 4 to the register (address 150) - manual control of the current output (Fig. 1, item 9).

To convert a manually set value, turn on the conversion of the output value by writing the value «1» to the register (address 152) and the required ranges in the corresponding registers (addresses 153 - 156).

When the value «500» is written to the register (address 151), a current with a level equal to 5.00 mA will appear at the analog current output (Fig. 1, pos. 9) (when the conversion of the output value is disabled).

## **TEMPERATURE MEASUREMENT**

Connect the device according to Figure 2 (c). Configure it for operation in the «Temperature measurement» («OB-216 settings», address 100, value 4, 5, 6). If it is necessary for the device to react to an excess (decrease) of temperature, set the response thresholds («OB-216 settings», addresses 104, 105). To set the thresholds, write down the values to address 104 - upper threshold and address 105 - lower threshold. When the temperature value is exceeded (decreased), the corresponding bit will be set to «1» («Additional registers», address 2:3, bits 24, 25).

If it is required to correct the temperature measured by the sensor, enter the correction temperature into register 102 (OB-216 settings). Value input format: 55 = 5.5 °C.

In this mode, the device measures the temperature using a thermistor. The measured temperature value can be read at address 6 (Additional registers).

Temperature values are displayed with an accuracy of tenths of a degree Celsius (1234 = 123.4 °C; 123 = 12.3 °C).

### **Temperature measurement with analogue output**

To output the measured temperature to the analog output, select the analog voltage output by writing in the register (address 150) the value «1» (control of the voltage output, Fig. 1, item 10) or value «2» (control of the current output, Fig. 1, item 9) and set up the conversion range registers (addresses 153 - 156).

## **CONNECTING DIGITAL SENSORS**

The device supports digital (single) sensors specified in the «OB-216 settings» (address 101).

The measured values of the digital sensor can be read at addresses 11 - 12, «Additional registers» (depending on which values the sensor measures). Interrogation period of digital sensors - 3 s.

If it is required to correct the temperature measured by a digital sensor, it is necessary to enter the correction temperature into register 102 (OB-216 Settings).

If it is necessary for the device to react to the excess (decrease) of the operating parameter, it is necessary to select the operating parameter («OB-216 settings», address 103), and set the response thresholds (addresses 104, 105). When the value of the operating parameter is exceeded (decreased), the corresponding bit will be set to «1» (excess (decrease) of temperature - bit 24, bit 25 («Additional registers», address 2:3), excess (decrease) of humidity - bit 26, bit 27 (address 2:3)).

Temperature values are displayed with an accuracy of tenths of a degree Celsius (1234 = 123.4 °C; 123 = 12.3 °C).

Moisture values are displayed with an accuracy of tenths of a percent (800 = 80.0%).

**Note:** when connecting sensors via the 1-Wire interface, it is necessary to install an external resistor to pull up the «Data» line to the power supply, with a nominal value of 2 kΩ to 5.1 kΩ.

### Connection of digital sensors with output to analog output

To output the operating parameter of the digital sensor («OB-216 settings», address 103) to the analog output, select the analog voltage output by writing the value «1» to the register (address 150) (voltage output control, Fig. 1, pos. 10) or value «2» (current output control, Fig. 1, pos. 9) and set the registers of the conversion ranges (addresses 153 - 156).

## RESTARTING THE DEVICE AND RESETTING TO THE FACTORY SETTINGS

If you need to restart the device, close and hold contacts «R» and «-» for 3 seconds (Fig. 1).

If it is required to restore the factory settings of the device, it is necessary to close and hold contacts «R» and «-» (Fig. 1) for more than 10 seconds. After 10 seconds, the device will automatically restore factory settings and reboot.

Also, the above actions can be performed through the command register by writing the corresponding command into it («Command register», address 50).

## WORK WITH RS (EIA/TIA)-485 AND USB INTERFACE VIA MODBUS PROTOCOL

### CONFIGURING THE DEVICE FOR USB OPERATION

If the register (address 113) contains the value «0» (automatic selection of the interface), the device will automatically switch to work with USB, if OB-216 is connected to the PC via a USB cable. Otherwise, the device works with the RS-485 interface.

To work only with the RS-485 interface, it is necessary to write the value «1», to the register (address 113); with this setting, the device will not switch to work with USB when the cable is connected.

To work only with the USB interface, it is necessary to write the value «2», to the register (address 113), with this setting the device will work only with the USB interface, and access to the device via RS-485 will be prohibited.

### WORK WITH THE RS INTERFACE (EIA/TIA)-485

OB-216 allows data exchange with external devices via the RS (EIA/TIA)-485 serial interface via the ModBus protocol with a limited set of commands (the list of supported functions is given in the table below).

When building a network, the master-slave organization principle is used, where OB-216 acts as a slave. Only one master and several slaves can be present on the network. A personal computer or a programmable logic controller acts as a master node.

With this organization, only the master node can act as the initiator of exchange cycles.

Host requests are individual (addressed to a specific device).

OB-216 transmits in response to individual requests from the master.

If errors are detected in receiving requests, or if it is impossible to

execute the received command, OB-216, as a response, generates an error message.

The addresses (in decimal) of the command registers and their purpose are shown in the «List of Supported Functions».

Addresses (in decimal) of additional registers and their purpose are given in the «Command Register».

### List of supported features

Function (hex)	Appointment	Note
0x03	Reading one or more registers	Maximum 50
0x06	Writing one value to a register	----
0x08	Communication diagnostics	----

### Command register

Name	Description	W/R	Address (DEC)
Command register	Command codes: 18220 – write settings to flash memory; 18263 – load settings from flash memory; 42228 – device restart; 41672 – reset to factory settings; 61989 – reset the impulse counter (this will clear all values stored in the flash memory)	W/R	50
Entering ModBus password (8 ASCII characters)	Set the correct password to access the recording functions (default value is "admin"). To disable recording functions, set any value other than a password. Allowed characters: A-Z; a-z; 0-9.	W/R	51 – 58

**Notes:**

- W/R – type of access to the register write/read;
- an address like "50" means a 16 bit value (UINT);
- address like "51 – 58" mean a range of 8 bit values

### Additional registers

Name	Description	W/R	Address (DEC)
Identifier	Device ID (value 28)	R	0
Firmware version	12	R	1
Status register	bit 0 0 – impulse counter (discrete) disabled; 1 – pulse counter (discrete) enabled	R	2:3
	bit 1 0 – counter on the leading edge of the pulse is disabled; 1 – counter on the leading edge of the pulse is on		
	bit 2 0 – counter on the trailing edge of the pulse is disabled; 1 – counter on the trailing edge of the pulse is on		
	bit 3 0 – counter on both pulse edges is disabled; 1 – counter on both pulse edges is on		
	bit 4 0 – logical input disabled; 1 – logical input is enabled		
	bit 5 0 – voltage measurement is disabled; 1 – voltage measurement is on		
	bit 6 0 – current measurement is disabled; 1 – current measurement is on		
	bit 7 0 – measurement by the NTC (10KB) sensor is disabled; 1 – measurement by NTC (10KB) sensor is enabled		
	bit 8 0 – measurement by PTC1000 sensor is disabled; 1 – measurement by PTC1000 sensor is enabled		
	bit 9 0 – measurement by PT1000 sensor is disabled; 1 – measurement by PT1000 sensor is on		
	bit 10 0 – impulse counter (by voltage) is disabled; 1 – impulse counter (voltage) enabled		

Name	Description	W/R	Address (DEC)			
Status register	bit 11 0 - impulse counter (by current) is disabled; 1 - pulse counter (current) is on	R	2:3			
	bit 12 0 - measurement by DS18B20 sensor is disabled; 1 - measurement by DS18B20 sensor is enabled					
	bit 13 0 - measurement by DHT11 sensor is disabled; 1 - measurement by DHT11 sensor is enabled					
	bit 14 0 - measurement by DHT21 sensor is disabled; 1 - measurement by DHT21 sensor is enabled					
	bit 15 0 - measurement by DHT22 sensor is disabled; 1 - measurement by DHT22 sensor is enabled					
	bit 16 0 - automatic control of voltage output is on; 1 - automatic control of current output enabled					
	bit 17 0 - manual control of voltage output is enabled; 1 - manual control of current output enabled					
	bit 18 0 - «IO2» input is open; 1 - «IO2» input is closed					
	bit 19 0 - exchange via RS-485 is enabled; 1 - sharing via USB is enabled					
	bit 20 0 - there is no overvoltage; 1 - there is overvoltage					
	bit 21 0 - there is no decrease in voltage; 1 - there is decrease in voltage					
	bit 22 0 - there is no overcurrent; 1 - there is overcurrent					
	bit 23 0 - there is no current reduction; 1 - there is current reduction					
	bit 24 0 - there is no temperature rise; 1 - there is temperature rise					
	bit 25 0 - there is no temperature drop; 1 - there is temperature drop					
	bit 26 0 - there is no excess humidity; 1 - there is excess of humidity					
	bit 27 0 - there is no moisture reduction; 1 - there is moisture reduction					
	bit 28 0 - value conversion is disabled; 1 - value conversion is enabled					
	bit 29 0 - device settings are saved; 1 - device settings are not saved					
	bit 30 0 - the device is calibrated; 1 - the device is not calibrated					
	bit 31 0 - conversion of the value into an analog signal is disabled; 1 - conversion of a value into an analog signal is enabled					
	Impulse counter			----	W/R	4:5
	Measured value *			----	R	6
	Temperature (x0.1°C)			----	R	11
	Humidity (x0.1%)			----	R	12
	Converted value **			----	R	16
	Converted analog value ***			----	R	17

**Note:**  
- address of the form «1» means the value of 16 bits (INT);  
- address of the form «2:3» means 32 bit value (ULONG);  
\* Measured value from analog sensors (voltage, current, temperature);  
\*\* Converted value of the measured value in accordance with the settings in the registers (addresses 131 - 134);  
\*\*\* The measured value converted into an analog signal at the output in accordance with the settings in the registers (addresses 153 - 156)

## MESSAGE FORMATS

The exchange protocol has well-defined message formats. Compliance with the formats ensures the correctness and stability of the

network.

### Byte format

OB-216 is configured to work with one of two data byte formats: with parity control (Figure 4) and without parity control (Figure 5). In the mode of operation with parity control, the type of control is also indicated: by parity (Even), or by oddness (Odd). Data bits are transmitted with the least significant bits first.

By default (at manufacture) the device is configured to operate without parity control and with two stop bits.

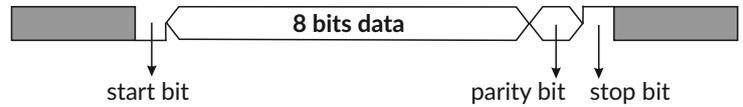


Figure 4 - Byte format with parity control

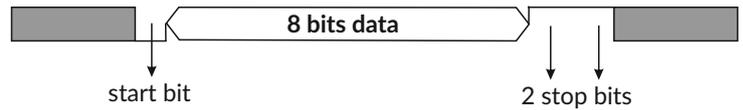


Figure 5 - Byte format without parity control (2 stop bits)

Bytes are transmitted at speeds of 1200, 2400, 4800, 9600, 14400 and 19200 bps. By default, during manufacture, the device is configured to operate at 9600 bps.

**Note** - for ModBus RTU mode, 8 data bits are transmitted, and for ModBus ASCII mode, 7 data bits are transmitted.

### Frame format

Frame length cannot exceed 256 bytes for ModBus RTU and 513 bytes for ModBus ASCII.

In the ModBus RTU mode, the start and end of the frame is monitored using silence intervals of at least 3.5 bytes in length. The frame must be transmitted as a continuous stream of bytes. The correctness of the frame is additionally controlled by checking the CRC checksum.

The address field takes up one byte. Slave addresses range from 1 to 247.

Figure 6 shows the RTU frame format.

silence interval	Address	Function code	Data	CRC checksum	silence interval
>3.5 bytes	1 byte	1 byte	up to 252 bytes	2 bytes	>3.5 bytes

Figure 6 - RTU frame format

In the ModBus ASCII mode, control of the start and end of the block is carried out using special characters (the symbol ':' 0x3A) - for the beginning of the frame; symbols ('CRLF' 0x0D0x0A) - for the end of the frame). The frame must be transmitted as a continuous stream of bytes. The correctness of the frame is additionally checked by checking the LRC checksum.

The address field is two bytes long. Slave addresses range from 1 to 247.

Figure 7 shows the ASCII frame format.

silence interval	Address	Function code	Data	LRC checksum	CRLF
>3.5 bytes	2 bytes	2 bytes	up to 504 bytes	2 bytes	2 bytes

Figure 7 - ASCII frame format

**Note** - in ModBus ASCII mode, each data byte is encoded with two bytes of ASCII code (for example: 1 byte of data 0x25 is encoded with two bytes of ASCII code 0x32 and 0x35).

## CHECKSUM GENERATION AND VERIFICATION

The transmitting device generates a checksum for all bytes of the transmitted message. OB-216 similarly generates a checksum for all bytes of the received message and compares it with the checksum received from the transmitting device. If the generated and received checksums do not match, an error message is generated.

### CRC checksum generation

The checksum in the message is transmitted by the least significant byte first and is a cyclic check code based on the irreducible polynomial 0xA001.

The subroutine for generating the CRC checksum in C:

```

1: uint16_t GenerateCRC(uint8_t *pSendRecvBuf, uint16_t uCount)
2: {
3:     cons uint16_t Polynom = 0xA001;
4:     uint16_t crc = 0xFFFF;
5:     uint16_t i;
6:     uint8_t byte;
7:     for(i=0; i<(uCount-2); i++){
8:         crc = crc ^ pSendRecvBuf[i];
9:         for(byte=0; byte<8; byte++){
10:            if((crc & 0x0001) == 0){
11:                crc = crc >> 1;
12:            }else{
13:                crc = crc >> 1;
14:                crc = crc ^ Polynom;
15:            }
16:        }
17:    }
18:    return crc;
19: }
    
```

### LRC checksum generation

The checksum in the message is transmitted by the most significant byte first and is a longitudinal redundancy check.

Subroutine for generating the LRC checksum in C:

```

1: uint8_t GenerateLRC(uint8_t *pSendRecvBuf, uint16_t uCount)
2: {
3:     uint8_t lrc = 0x00;
4:     uint16_t i;
5:     for(i=0; i<(uCount-1); i++){
6:         lrc = (lrc + pSendRecvBuf[i]) & 0xFF;
7:     }
8:     lrc = ((lrc ^ 0xFF) + 2) & 0xFF;
9:     return lrc;
10: }
    
```

## COMMAND SYSTEM

### Function 0x03 - Reading a group of registers

Function 0x03 reads the contents of OB-216 registers. The master's request contains the address of the start register as well as the number of words to read.

The OB-216 response contains the number of bytes to be returned and the requested data. The number of returned registers is limited to 50. If the number of registers in the request exceeds 50 (100 bytes), the response is not split into frames.

An example of a request and response in ModBus RTU is shown in Figure 8.

Request

Address	Function	Init. address HB	Init. address LB	QTY of words HB	QTY of words LB	CRC LB	CRC HB
01h	03h	00h	A0h	00h	02h	C4h	29h

Response - register value 00A0h = 1000 (FLOAT)

Address	Function	QTY of bytes	HW HB data	HW LB data	LW HB data	LW LB data	CRC LB	CRC HB
01h	03h	04h	44h	7Ah	00h	00h	CFh	1Ah

Figure 8 - An example of a request and response of the function 0x03 - reading a group of registers

### Function 0x06 - Write Register

Function 0x06 writes to one register OB-216. The master's request contains the register address and data to write.

The device response matches the master's request and contains the register address and set data. An example of a request and response in ModBus RTU mode is shown in Figure 9.

Request - register 00A0h = 1000 (INT)

Address	Function	Init. address HB	Init. address LB	QTY of words HB	QTY of words LB	CRC LB	CRC HB
01h	06h	00h	A0h	03h	E8h	89h	56h

Response

Address	Function	Init. address HB	Init. address LB	QTY of words HB	QTY of words LB	CRC LB	CRC HB
01h	06h	00h	A0h	03h	E8h	89h	56h

Figure 9 - Example of request and response of function 0x06 - register setting

### Function 0x08 - Communication Diagnostics

Subfunction 0x00 - returns the received data, the response is identical to the request.

An example of a request and response is shown in Figure 10.

Request

Address	Function	Subuction HB	Subuction LB	HB data	LB data	CRC LB	CRC HB
01h	08h	00h	00h	00h	02h	61h	CAh

Response

Address	Function	Subuction HB	Subuction LB	HB data	LB data	CRC LB	CRC HB
01h	08h	00h	00h	00h	02h	61h	CAh

Figure 10 - Example of request and response of function 0x08 - communication diagnostics

## MODBUS ERROR CODES

Error code	Name	Comments
0x01	ILLEGAL FUNCTION	Invalid function number
0x02	ILLEGAL DATA ADDRESS	Invalid address
0x03	ILLEGAL DATA VALUE	Incorrect data
0x04	SERVER DEVICE FAILURE	Controller hardware failure
0x05	ACKNOWLEDGE	Data not ready
0x06	SERVER DEVICE BUSY	System busy
0x08	MEMORY PARITY ERROR	Memory error

## SECURITY MEASURES

Disconnect the device from the mains supply during installation and maintenance.

Do not try to open and repair the device yourself.

Do not use the device with mechanical damage to the case.

Do not allow water to enter the terminals and internal elements of the device.

Observe the following requirements during operation and maintenance:

- «Rules for the technical operation of consumer electrical installations»,
- «Safety rules for the operation of electrical installations of consumers»,
- «Labor protection during the operation of electrical installations».

## TRANSPORTATION AND STORAGE

The device in the original package is permitted to be transported and stored at the temperature from minus 45 to +60 °C and relative humidity of no more than 80 %, not in aggressive environment.

## MAINTENANCE PROCEDURE

Recommended frequency of maintenance is every six months.

Maintenance Procedure:

- 1) check the connection reliability of the wires, if necessary, clamp with the force 0.4 N\*m;
- 2) visually check the integrity of the housing;

