# RS-485 INTERFACE CONTROLLER

# EM-481


# OPERATING MANUAL

# TECHNICAL PASSPORT

***Quality Management System of 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 Operation Manual.
Store the Operating Manual throughout the service life of the device.

# CONTENTS

**ATTENTION! ALL REQUIREMENTS OF THIS OPERATION MANUAL ARE COMPULSORY TO BE MET!**

**WARNING! THE DEVICE TERMINALS AND INTERNAL COMPONENTS ARE UNDER POTENTIALLY LETHAL VOLTAGE.**
**TO ENSURE THE DEVICE SAFE OPERATION IT IS STRICTLY FORBIDDEN THE FOLLOWING:**

**–** TO CARRY OUT MOUNTING WORKS AND MAINTENANCE **WITHOUT DISCONNECTING THE DEVICE FROM THE MAINS;**

**– TO OPEN AND REPAIR THE DEVICE INDEPENDENTLY;**

**– TO OPERATE THE DEVICE WITH MECHANICAL DAMAGES OF THE HOUSING.**

**IT IS NOT ALLOWED WATER PENETRATION ON TERMINALS AND INTERNAL ELEMENTS OF THE DEVICE.**

**During operation and maintenance the regulatory document requirements must be met, namely:**
Regulations for Operation of Consumer Electrical Installations;
Safety Rules for Operation of Consumer Electrical Installations;
Occupational Safety in Operation of Electrical Installations;

Installation, adjustment and maintenance of the device must be performed by the skilled professionals having studied this Operating Manual.

The device is safe for use under keeping of the operating rules.

This Operating Manual is intended to familiarize you with the design, the requirements for safety, operation and maintenance procedures of the RS-485 interface controller EM-481 (hereinafter referred to as the "device", "EM-481").

***The device meets the requirements of the following:***

- EN 60947-1:2014, Low-voltage switchgear and controlgear; Part 1; General rules;
- EN 60947-6-2:2014, Low-voltage switchgear and controlgear; Part 6-2; Multiple function equipment; Control and protective switching devices (or equipment) (CPS);
- EN 55011:2014, Industrial, scientific and medical RF equipment; Electromagnetic interference characteristics; Limits and methods of measurement;
- IEC 61000-4-2:2008, Electromagnetic compatibility; Part 4-2; Testing and measurement techniques; Electrostatic discharge immunity test.

Harmful substances in amounts exceeding maximum permissible concentrations are not available.
The device versions are listed in Appendix A.

**Terms and abbreviations:**

- **10Base-T** is Ethernet standard for twisted pair communication with the speed of 10 Mbit/s;
- **100Base-T** is Ethernet standard for twisted pair communication with the speed of 100 Mbit/s;
- **8P8C/RJ45** is unified connector used for 10Base-T/100Base-T network connections;
- **Twisted pair** is the pair of insulated conductors inside the cable, which are twisted together to reduce the distortion of the transmitted signals;
- **Display** is OLED graphical led;
- **Indicator** is single LED indicator;
- **Client** is the device, which is addressing the other device (server) with the query to perform certain functions;
- **Packet** is a block of data to be transmitted between devices;
- **Server** is a unit, which performs specific functions upon query of other units;
- **ASCII** is standard character encoding table;
- **DHCP** – It is the protocol that allows network nodes automatically obtaining the parameters of TCP/IP (IP address);
- **Ethernet** is a standard for packet network communication and transmitting data between units (e.g., PCs);
- **FTP** is FTP protocol of file transfer according to TCP/IP standard;
- **GPRS** is technology of data packet transmission by mobile communication;
- **GSM** is the standard of digital mobile communication;
- **HTTP** is a protocol for transferring Web-pages and other data using "client-server" technology;
- **Internet** is the global routing system of units for storing and transferring data;
- **IP (protocol)** is routable protocol for transferring data by Ethernet. It is a part of TCP/IP and used for Internet;
- **IP (address)** is a node address, which is unique within a single network, operating via IP protocol;
- **IPv4** is four byte IP-address;
- **MAC (address)** – is the address used for device authentication during Ethernet transmissions. It is usually unique although qualified personnel can change it under certain circumstances;
- **MAC-48** is six byte MAC-address;
- **MODBUS** is the standard and protocol for packet communication using the "client-server" technology for industrial electronic units;
- **MODBUS RTU** is the communication protocol of the unit for bite wise transfer of the packet;
- **MODBUS ASCII** is communication protocol of the units for the transfer of packet in the form of ASCII-symbols;
- **MODBUS TCP** is the protocol for transferring Modbus packets using the TCP/IP standard;
- **RS-485/EIA-485** is network standard for communicating units using the twisted pair;
- **SMS** is standard and technology of transmitting the brief messages via mobile communication;
- **TCP/IP** is the standard and a set of protocols for packet transferring data via the networks with delivery verification;
- **WEB** is the system for accessing documents on the servers, used in the Internet;
- **WEB-page** is the document, file and resource, which is available on the Web-server;
- **WEB-browser** is client for accessing the WEB-pages, which is primarily using the HTTP protocol.

## 1. SERVICE

### 1.1. Device service

EM-481 provides data collection from connected MODBUS devices, data transfer to the server, data access (via MODBUS TCP or SMS text messages), event tracking and response to events (sending SMS notifications, recording values to MODBUS devices).

EM-481 provides:

- Flexible options of connection (via wire or wireless communication, automatic method selection of communicating with a server, automatic or manual selection of GSM provider and communication parameters, resetting of MAC-address and other Ethernet settings;

- Protection of access (password for setting mode, filter of IP-address for setting or connection to Modbus network, connection only to the selected server with automatic login, password for control via SMS);
- Different modes of data interchange via MODBUS network (RTU or ASCII, with checking of parity for even-odds or without checking, wide range of transmitting rate, adjustable delay);
- programming the collection of data, events, and action for events (see Appendix C);
- Service functions (real time clock, firmware updating option).

### 1.2. Controls, overall and mounting dimensions

**1.2.1.** Overall and mounting dimensions of EM-481 are shown in Fig. 1.1.

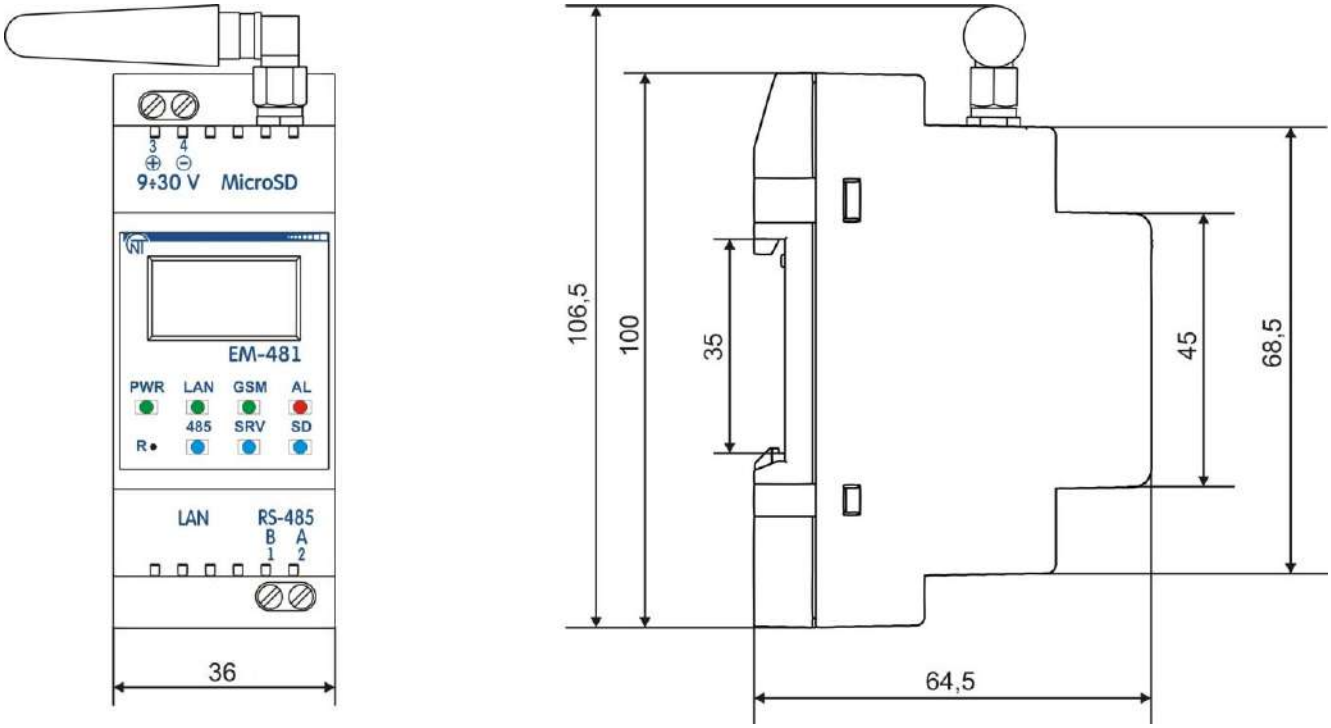
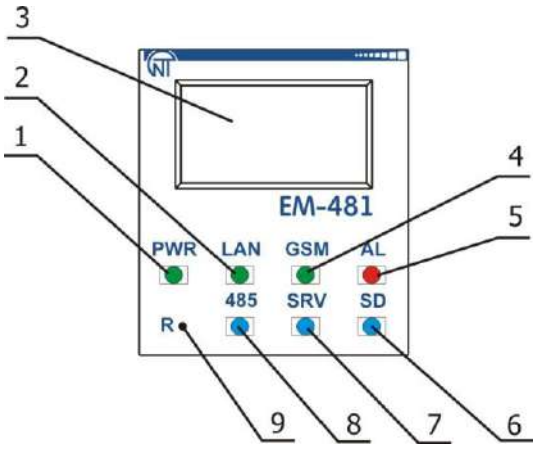



**Figure 1.1** – Overall and mounting dimensions of EM-481

**1.2.2.** Controls are shown in Fig. 1.2.




1 – **"PWR"** LED is on when there is supply voltage;
2 – **"LAN"** LED is on when connected to Ethernet network, it blinks while the data exchanging via the network;
3 – The display serves to display the state of the device, the connections, the load of the communication interfaces, and showing of warnings about detected faults;
4 – **"GSM"** LED is blinking every 3 sec. when there is connection via GSM network, it is blinking 3 times per second while data exchanging via GPRS;
5 – "**AL"** LED warns about the registration of the fault in the course of analysis of the received data;
6 – **"SD"** is on when there is a memory card in a special slot, it is blinking while the data exchanging to SD-card;
7 – **"SRV"** is on when there is a connection with a server for data collation, it is blinking while data exchanging with the server;
8 – **"485"** is on when waiting a respond from the device in Modbus network; it is blinking while data exchanging via Modbus network;
9 – **"R"** reset button (is located under the housing) is designed to restart the device or to reset the parameters.

**Figure 1.2** – Controls of EM-481

### 1.3. Operation conditions

The device is intended for operation in the following conditions:

- Ambient temperature: from minus 35 to +55 °C;
- Atmospheric pressure: from 84 to 106.7 kPa;
- Relative humidity (at temperature of +25 °C): 30 … 80 %.

**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.).

## 2. DELIVERY SET

The device delivery set is specified in Table 2.1.

**Table 2.1** – Device delivery set

| Description | QTY, pc |
|---|---|
| EM-481 | 1 |
| Cable for Ethernet connection | 1 |
| GSM antenna (SMA M connector, 50 Ohm)* | 1 |
| Memory card microSD (2 Gb) | 1 |
| Operation Manual; Technical Passport | 1 |
| Packing | 1 |
| **Note:** * other types of antennas are delivered in coordination with the buyer | |

## 3. TECHNICAL SPECIFICATIONS

The device technical specifications are given in Table 3.1.

**Table 3.1** – Technical Specifications

| Description | Value |
|---|---|
| DC rated supply voltage, V | 12 |
| Data exchange interface via wired network | 10Base-T/100Base-T |
| Supported Ethernet protocols | UDP, ARP, TCP |
| Data exchange interface via wireless network | GSM |
| Supported standards of wireless network | SMS, GPRS |
| Integrated servers | MODBUS TCP, HTTP |
| Maximum number of connections via Modbus TCP protocol | 4 |
| Data exchange interface via Modbus network | RS-485 |
| Supported protocols of Modbus network MODBUS via RS-485 | MODBUS RTU,<br>MODBUS ASCII |
| Transmission speed in the MODBUS network via RS-485, bit/s | 75 – 921600 |
| Maximal output voltage of driver RS-485, V | 3.3 |
| Short circuit output voltage of driver RS-485 (maximum), mA | 250 |
| Resistance of in-built terminator, Ohm | 70 – 1000 Ohm or disabled |
| The recommended number of connected devices in Modbus network:<br>– when the input current of receivers on RS-485 bus is no more than 0.125 mA;<br>– when the input current of receivers on RS-485 bus is no more than 1 mA; | <br>256 max.<br>32 max. |
| Readiness time when power is applied, no more than, s | 15* |
| The supply voltage at which the operability is maintained | 9 –30 |
| Power consumption (under load), W, not more than | 6 |
| Device service | Switchgear and controlgear |
| Rated operating condition | Continuous |
| Protection class rating | IP20 |
| Electric shock protection class | II |
| Climatic design version | UHL 3.1 |
| Permissible contamination level | II |
| Overvoltage category | II |
| Rated voltage of insulation, V | 450 |
| Rated impulse withstand voltage, kV | 2.5 |
| Conductor cross-section for connecting to terminals, mm² | 0.5-3 |
| Tightening torque of the terminal screws, N * m | 0.4 |
| Weight, kg, maximum | 0.400 |
| Overall dimensions (Fig. 1.1), H*B*L, mm<br>– with installed GSM antenna<br>– without GSM antenna | <br>64.5*106.5*36<br>64.5*100*36 |
| Installation (mounting) of the device is on standard 35 mm DIN-rail | |
| The device remains operational capability in any position in space | |
| Housing material - self-extinguishing plastic | |
| **Notes:** * Connections in Ethernet networks/Internet can take more time. | |

## 4. DEVICE DESCRIPTION

The device provides control for MODBUS devices in RS-485 network via Ethernet interfaces or GPRS, or via SMS. The device also allows reading data of devices by MODBUS. The processor supports connection to cloud-based data collection server via Ethernet network with a help of microchip of physical interface of Ethernet (or via GPRS with a help of in-built GSM-modem, if connection via Ethernet is not available).

In addition, the device can be connected to Ethernet via MODBUS TCP Protocol to exchange data with MODBUS devices, or with EM-481. The controller receives and processes SMS with a password and command read/write for Modbus devices.

When inserting a memory card the device reads the internal memory for operational logic - program for data collection and tracking of events. The program runs in the background mode.

The device stores the network settings, safety parameters, the logic of action, the collected data log in the built-in memory.

## 5. THE INTENDED USE

### 5.1. Preparation for operation

**5.1.1.** Preparation for connection:

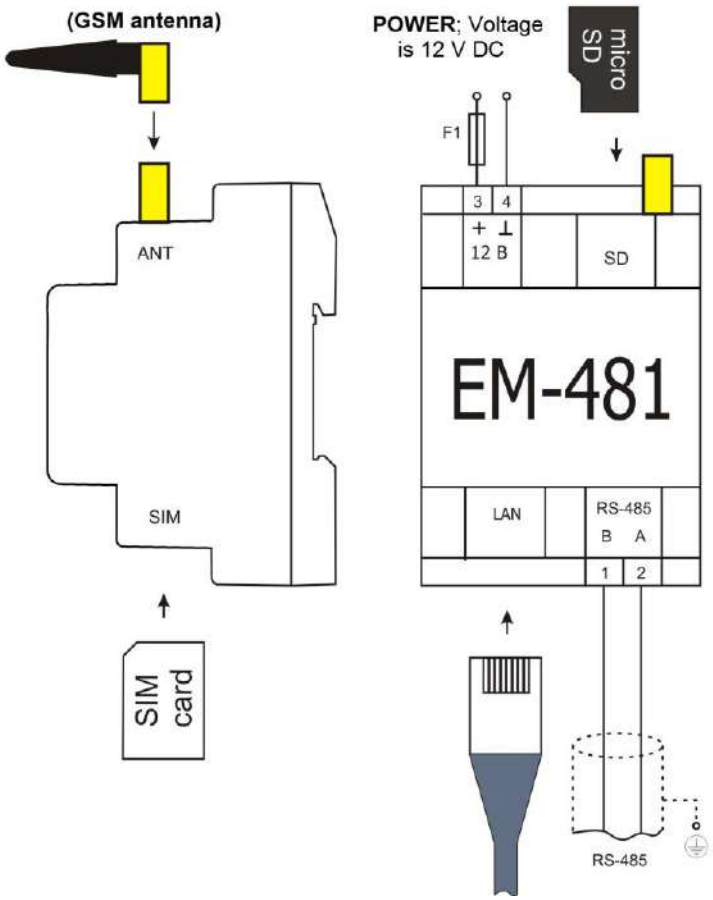
- Unpack the device (we recommend to keep the original packing for the entire warranty period of the device operation);
- Check the device for damage after transportation; in case of such damages detection, contact the supplier or the manufacturer;
- Carefully study the Operating Manual (**pay special attention to the connection diagram to power the device**);
- If you have any questions regarding the installation of the device, please contact the manufacturer by telephone number indicated at the end of this Operating Manual.

**5.1.2.** General

*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! ALL CONNECTIONS MUST BE PERFORMED WHEN THE DEVICE IS DE-ENERGIZED.**

**Error when performing the installation works may damage the device and connected devices.**




F1 – fuse (fuse element) for current of 2.5 A;
Contact “A” is designed for transmission of non-inverted signal;
Contact “B” is designed for transmission of inverted signal.

**Figure 5.1** – Connection Diagram of the device

To ensure the reliability of electrical connections you should use flexible (stranded) wires, the ends of which it is necessary to be striped of insulation for 5±0.5 mm and tightened with bootlaces. It is recommended to use the wire with cross-section of at least 1 $mm^2$.

- When connecting to the RS-485 bus, use twisted pair cable of category 1 or higher. It is recommended to use shielded cable; in this case it should be earthed.
- When connecting to Ethernet, use the cable supplied, or twisted pair cable of category 5e with 8P8C (RJ-45) lug.

Wires fastening should exclude mechanical damage, twisting and abrasion of the wire insulation.

**IT IS NOT ALLOWED TO LEAVE EXPOSED PORTIONS OF WIRE PROTRUDING BEYOND THE TERMINAL BLOCK.**

**For a reliable contact, tighten the terminal screws with the force indicated in Table 3.1.**

When reducing the tightening torque, the junction point is heated, the terminal block may be melted and wire can burn. If you increase the tightening torque, it is possible to have thread failure of the terminal block screws or the compression of the connected wire.

**To improve the performance of the device, it is recommended to install the fuse F1 (fuse element) or its equivalent in the EM-481 supply circuit for a current of no more than 2.5 A.**

**5.1.3.** Device connection

**5.1.3.1.** Connect the device as per Fig. 5.1.

**5.1.3.2.** Connect the connection cable to the MODBUS network to the "RS-485" connector and to the MODBUS network (or directly to the device with the RS-485 interface).

**5.1.3.3.** If the EM-481 is to connect to the Internet through wired communication, to local network or directly to computer, connect the Ethernet connection cable to the Ethernet connector and to the Ethernet network. The details of connection depending on the type of wire line are indicated in Appendix B.

**5.1.3.4.** Connect power to the "12 V" power connector.

**5.1.3.5.** If the EM-481 is to connect to the Internet through wireless communication, put SIM card of the telecom operator in the SIM slot, and connect the GSM antenna to the ANT connector (SMA F connector).

**5.2. Using the device**

**5.2.1.** General

After power is turned on, all indicators except **"LAN"** and **"GSM"** light up, and EM-481 performs initialization. After that, for 2 seconds indicators, except for the power indicator, go out, and the device proceeds to start of communication interfaces with networks. In this case, the display shows general information about the device (Fig. 5.2). The start can take up to 15 seconds, depending on settings and the connection quality.

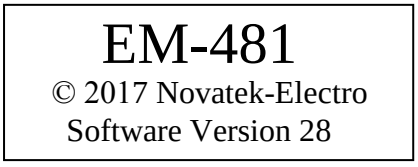



**Figure 5.2** – Displaying of general information about the device on the display

After this, the EM-481 goes on to setting connection with the server and querying MODBUS devices.

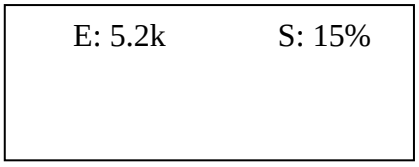
**ATTENTION! IF "AL" LED PERMANENTLY ON OR PERIODICALLY BLINKS AFTER EM-481 ENABLING IT MEANS THE DEVICE FAILURE.**

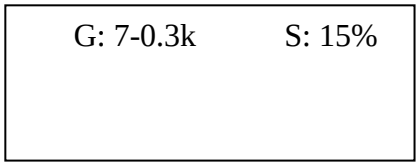
EM-481 provides and supports the connection to Ethernet/GSM networks.

If the **"LAN"** indicator lights up, the connection to the network is successful. The blinking **"LAN"** LED indicates the data is being transmitted through the network.

If the **"GSM"** indicator blinks every three seconds, the connection to the GSM network is set successfully. If the **"GSM"** indicator blinks three times per second, then the data is transmitted via GPRS.

The display shows the loads of I/O interfaces and GSM signal level, as shown in Fig. 5.4.




"E: 5.2k" – the transmission speed via Ethernet is 5.2 kB/s;
"G: 7-0.3k" – the GSM signal level is 70 % and the GPRS transmission rate is 0.3 kB/s;
"S: 15%" – the load of RS-485 is 15 %.

**Figure 5.3** – Displaying the status of connections on the display

**5.2.2.** Operation modes

**5.2.2.1.** Connection to the server

EM-481 provides and supports connection to the server specified in the settings. If **"SRV"** LED is on, it means that the connection to server has been done successfully. If **"SRV"** LED blinks, it means that there is data exchange with the server. The data exchange with server is made using one of two protocols: MODBUS TCP and modified MODBUS TCP.

**5.2.2.2.** Monitoring of devices connected via RS-485

The device inquires the MODBUS registers of devices connected via RS-485, upon queries from the server.

The MODBUS EM-481 registers can be specified in the server queries to read the current time, the EM-481 supply voltage, etc.

**5.2.2.3.** Access to MODBUS network using MODBUS TCP

EM-481 performs the function of Modbus gateway and waits for network connection via Modbus TCP protocol to port 502. The Modbus TCP connection port can be changed by the user. Connection to PC can be made by any programs - Modbus TCP clients. The client version for Windows software is available for download at the web-site of NOVATEK-ELECTRO Ltd (http://novatek-electro.com/en/software.html).

At inquiry for client connection to Modbus TCP port, EM-481 checks a list of available connections. If all connections are already engaged, the connection is cancelled otherwise the unit adds it into its internal list of service clients (no more than specified number of clients).

When connection with a client is set EM-481 waits for Modbus-inquiry from the client. In RS-485 slave mode, RS-485 requests from the MODBUS master are also accepted.

After receiving the query from the client, the device analyses the query and, depending on code of inquired function and actual rights of the client, processes or blocks it. In case of blocking the query EM-481 can generate and send to the client the specified by the user code of MODBUS exception (by default - code 1). The client's authority level is determined by the passwords entered after connection.

If the query is address to EM-481, the device does not re-direct it, but processes it and send the reply to the client.

In RS-485 master mode, queries to other devices are redirected to the MODBUS network, and a response is expected from the device in the MODBUS network, while the **"RS-485"** indicator lights up. If the data is received or the waiting time has expired, the **"RS-485"** indicator goes out.

In redirection mode to a remote server, if communication with remote MODBUS TCP server is set in Ethernet network, queries to other devices are also sent to this server, and a response is expected from it.

**Note: The respond is received from the first responding addressee; therefore, in the MODBUS network and among the addressees accessible via the remote MODBUS TCP server, there should not be devices with the same MODBUS addresses (identifiers).**

If the query could not be redirected (for example, in the RS-485 slave mode, if the connection to the remote MODBUS TCP server was terminated), the EM-481 can generate and send the MODBUS user-defined exclusion code to the client (default code is 10).

If there is no reply, EM-486 can generate and send to the client the specified by the user code of Modbus exception (by default - code 11).

If there is a respond received on the query, EM-486 sends it to the client who had sent this query.

**5.2.2.4.** Access to MODBUS network using SMS

If there is GSM-connection set, EM-481 receives incoming SMS. All incoming SMS begin with a password. If the password does not match the one specified in settings, SMS is not processed and the reply SMS is not being sent back. After the password through the space the command is indicated.

The command consists of the following:

- the access symbol ("R" for reading, "W" for writing);
- the address (identifier) of the device in the MODBUS network;
- the resource symbol ("H" for the most frequently used MODBUS registers for storing values, while using the MODBUS functions No.3 for reading or No.6 for writing, or "I" for the input registers, using MODBUS function No.4 for reading);
- the address of the resource (register).

For the writing function, additionally after the space, the value to be placed at the address is indicated. For example:

- SMS message "abc r1h100" will send a query to read register 100 of device 1 (if the password for reading using SMS is specified as "abc" in the settings);
- The SMS message "stanc12 w2h174 5000" is used to write the value 5000 to the register 174 of device 2 (if the password for writing using SMS is specified as "stanc12" in the settings).

If the command format is correct, the device generates a MODBUS query, which is further processed in the same way as requests from other clients (see 5.2.2.3).

For the correct respond to the query, the EM-481 generates a response SMS. Each SMS starts with a command accepted earlier from the user. After the command, the value of the register used in the command (both for reading

and writing) is indicated after a space. The presence of the value of the register in the SMS confirms the successful execution of the command. For example, SMS "r1h100 2200" means that the read command from device 1 has read the value 2200 of register 100.

If the response to the query is MODBUS exception code, the EM-481 generates SMS with exception message. **SMS begins with the command received earlier from the user**. After the command, the exclusion warning is indicated after a space. The warning consists of "EXC." line and the exception number. After the warning, text description of the exception with this number can be indicated after a space (standard exceptions to MODBUS are described in Table 5.2). For example, the message "r3h873 EXC.2 ILLEGAL DATA ADDRESS" means that for device 3 register with address 873 is not readable (or absent).

**Table 5.2** – The standard Modbus exception codes

| Code | Exception | Description |
|---|---|---|
| 1 | ILLEGAL FUNCTION | The received function code cannot be processed |
| 2 | ILLEGAL DATA ADDRESS | The data address specified in the query is not available |
| 3 | ILLEGAL DATA VALUE | The value contained in the query data field is invalid value |
| 4 | DEVICE FAILURE | Unrecoverable error has occurred when the addressee has tried to perform the requested action |
| 5 | ACKNOWLEDGE | The addressee accepted the request and processed it, but it takes a long time |
| 6 | DEVICE BUSY | The addressee is busy processing the command. The client can retry the message later |
| 8 | MEMORY PARITY ERROR | The parity error was detected when the addressee has tried to read the extended memory |
| 10 | GATEWAY PATHS NOT AVAILABLE | The gateway cannot redirect the query, since there is no path (connection) to the addressee |
| 11 | TARGET DEVICE FAILED TO RESPOND TO GATEWAY | The gateway did not receive a response to the forwarded query, because the addressee did not respond on time |

**5.2.2.5.** Data collection and event tracking

When action logic program is loaded into the internal memory, the device reads the specified registers (connected devices or EM-481) at a specified interval, then performs the specified conversions and evaluates the received data. As a result, the following actions can be performed: SMS sending, writing to the specified register (connected device or EM-481). The program is loaded into the internal memory from the memory card. The procedure for preparing and downloading the program into the device is described in Appendix C.

### 5.3. Configuration

**5.3.1.** General

The connection settings of EM-481 is made via **HTTP** protocol or via **Modbus TCP** protocol and serves for specifying the main parameters needed for the device operation: types of connected sensors, exchange parameters via RS-485, parameters of address in Ethernet network (if Ethernet is used) and server address to which EM-481 is connected automatically.

The adjustable parameters are described in items 5.3.2. The parameters remain saved after the power cut off.

EM-481 setting can be made by two methods:

- Via WEB-interface (it. 5.3.3);
- Via Modbus-interface (it. 5.3.4).

**ATTENTION! WHEN CHANGING EM-481PARAMETERS, THE VALUES MAY BE SET THAT INTERFERE OR BLOCK THE CONNECTIONS TO IT IN THE NETWORKS. IN THIS CASE, THE PARAMETERS SHOULD BE RESETTED TO THE FACTORY VALUES.**

Safely remove of the memory card, restarting the device or reset of settings to factory values is executed by means of the **"R"** button available through a hole on a front panel. The button is pressed by a thin subject.

***The reset of the device to factory settings:***

- press and hold the reset button **"R"** for not less than 8 seconds (after 2 seconds of holding the indicator **"AL"** will light on); after 8 seconds of holding the device will restart, the indicators will blink one time;
- then release the button **"R"**.

***To restart the device with saving of the user's settings:***

– press and hold the reset button **"R"** during time from 2 to 8 seconds;

– when **"AL"** indicator lights on, release the button **"R"**.

***To display information about connections or safely remove of the memory card:***

- press and release the reset button **"R"**, the display shows information about connections, the indicator "Memory SD" will go out. Remove the memory card, if necessary.

**5.3.2.** EM-481 parameters

The sets of parameters available via MODBUS protocol are provided in Table 5.3. The internal structure of all sets of parameters is similar to the structure of a set provided in Table 5.8, for exception of the initial address.

The format of parameters presentation in MODBUS registers is described in Table 5.4.

Parameters describing the device are given in Table 5.5.

The parameters of the device current mode are available for reading and writing and are provided in Table 5.6.

The parameters of current state are available only for reading and are described in Table 5.7.

The setting parameters are available only in the setting mode and are listed in Table 5.8.

**Table 5.3** – The sets of parameters available via Modbus protocol

| Set | Description | Access | Address |
|---|---|---|---|
| Changeable settings | The parameters listed in Table 5.8 that can be changed and activated as described in it. 5.3.3 and 5.3.4 | Only in mode of setting, reading or writing | 300 – 799, 5250 – 5499 |
| Active settings | The settings being used by the device at the moment | In any mode, only reading | 2300 – 2799, 5500 – 5749 |
| Saved settings | The set is saved regardless the power of the device and is used at starting | Only in mode of setting, only reading | 3300 – 3799, 5750 – 5999 |

**Table 5.4** – Format of parameters presentation in Modbus registers

| Parameter | Range of values | Description | Number of occupied registers |
|---|---|---|---|
| Number | 0 – 65535 | Whole number (16 bit) in standard range of Modbus register values | 1 |
| Number | 0 – 4294967295<br>In two registers,<br>Upper part – first | Whole number, which value can exceed the limit for Modbus register (65535) | 2 |
| Character string | In every register – number of 0 to 255 - ASCII character code or 0 (the end of string) | A set of values, each of which is equal to the code of one character in the ASCII encoding. If the string is shorter than the maximum length, the last character is placed code 0. | Max. length of string for this parameter |
| IP-address (IP-mask) | In every register – one byte (0–255) | Set of four byte of address IPv4, from left to right | 4 |
| MAC-address | In every register – one byte (0–255) | Set of six byte of address MAC-48, from left to right | 6 |

**Table 5.5** – Parameters describing the device

| Parameter | Description | Address |
|---|---|---|
| Device type | The code that defines the MODBUS product by the manufacturer (23 – EM-481) | 0 |
| Firmware version | Firmware version of embedded software | 1 |
| Check code | CRC32 of firmware of embedded software | 2–3 |

**Table 5.6** – Parameters of the current mode

| Parameter | Range of values | Initial volume | Description | Address |
|---|---|---|---|---|
| Entering password | String of characters | 0 | When entering a valid password, the client is given the appropriate permission (see registers 710 - 749).<br>When you enter an empty string, the client rights are reset to the rights level at the time of connection. | 100–119 |
| Control command | 0–40959, Writing in the configuration mode | 0 | 0: no activity;<br>1: “Restart” – EM-481 restart;<br>2: “Save” – save the changes of settings via MODBUS;<br>3: "Apply" - apply settings without restarting (only available for MODBUS and user parameters);<br>4: "Save and apply" - similarly to commands 2 and 3;<br>444: “Back to Factory Settings” - reset the settings to the factory settings;<br>9: “Cancel" - to read the saved settings;<br>35381: "Start setting the clock" - it allows access to the registers of clock setting;<br>35431: "Cancel setting the clock" - it closes the access to the registers of the clock setting without changing hours;<br>40959: "Clear the internal memory of the tasks" - to erase the program for logic of actions (when the memory card is inserted, it will automatically read again). | 120 |

**Table 5.7** – Parameters of current state

| Parameter | Description | | Address |
|---|---|---|---|
| Mode<br>(see details for reg. 122) | 0: User's mode;<br>1: Setting mode. | | 121 |
| Tabs of access | Bit 0 | The ability for the connected client to obtain the permission (with the help of a password) for queries of the functions of reading devices by RS-485:<br>0 - permission cannot be obtained;<br>1 - permission can be received by the password. | 122 |
| | Bit 1 | Permission for the connected client for queries of the functions of reading devices via RS-485:<br>0 - no permission;<br>1 - there is permission. | |
| | Bit 2 | The ability for the connected client to obtain the permission (with the help of a password) for queries of the functions of recording and controlling devices by RS-485:<br>0 - permission cannot be obtained;<br>1 - permission can be received by the password. | |
| | Bit 3 | Permission for the connected client for queries of the functions of recording and controlling devices via RS-485:<br>0 - no permission;<br>1 - there is permission. | |
| | Bit 4 | Ability for the connected client to obtain permission (with the help of a password) to access the EM-481 registers, except for the registers of version, password, mode and access tabs;<br>0 - permission cannot be obtained;<br>1 - the permission can be received by the password. | |
| | Bit 5 | Permission for the connected client to access the EM-481 registers, except for registers of version, password, mode and access tabs;<br>0 - no permission;<br>1 - there is permission. | |
| | Bit 6 | It is always as 1. | |
| | Bit 7 | Permission for the connected client to configure EM-481 (the same as register 121);<br>0 - no permission;<br>1 - there is permission. | |
| | Bit 8 | It is always as 0. | |
| | Bit 9 | 1 - the client has the right to connect<br>(it is always read as "1" after connection). | |
| | Bit 12 | Permission for the connected client to set the clock:<br>0 - no permission;<br>1 - there is permission. | |
| Time, min | Number of minutes since the moment of start-up | | 123–124 |
| Number of MODBUS TCP clients | Number of occupied connections of MODBUS TCP | | 125 |
| Limit of MODBUS TCP clients | Number of occupied connections of MODBUS TCP clients | | 126 |
| Load of RS-485, query/s | Total number of possible clients via MODBUS TCP | | 127 |
| Effective load of RS-485, query/s | Number of responds without errors via RS-485 per second. | | 128 |
| Load of RS-485 per second, % | Load of RS-485 for the last second considering the set rate of RS-485 and time of inactivity | | 129 |
| Load of RS-485 per minute, % | Load of RS-485 for the last minute | | 130 |
| Load of RS-485 for 5 minutes, % | Load of RS-485 for the last 5 minutes | | 131 |
| Load of MODBUS TCP, query/s | The number of queries received from clients via MODBUS TCP per second. | | 132 |
| Effective load of MODBUS TCP, query/s | Number of responds without errors being sent to the client via MODBUS TCP per second | | 133 |
| Load of GSM, kB/s | Load of GPRS channel with GSM being switched on | | 134 |
| Load of Ethernet, 100 kB/s | Load of wire channel with Ethernet being switched on | | 135 |

Table 5.7 Continued

| Parameter | Description | Address |
|---|---|---|
| Max. number of clients of MODBUS TCP | Maximal number of simultaneously connected clients via Modbus TCP - from the moment of start up | 136 |
| Max. load of MODBUS TCP, query/s | Maximal number of queries received per second from the clients via Modbus TCP - from the moment of start up | 137 |
| Max. load of RS-485, % | Maximal load of RS-485 for 5 minutes - from the moment of start up | 138 |
| Max. load of GSM, kB/s | Maximal load of GPRS - from the moment of start up | 139 |
| Current IP-address of Ethernet | IP-address, by which EM-481 device is accessible in Ethernet network* | 140 – 143 |
| Current MAC-address of Ethernet | MAC-address, by which EM-481 is detected in Ethernet network | 144 – 149 |
| Unused parameter | The parameter is reserved for compatibility and is equal to 0 | 150 – 164 |
| Time to connect to the data collection server | 0 - connection to the data collection server is set;<br>1 - connection to the data collection server is performed;<br>2 - 65534: the number of seconds before reconnecting;<br>65535: connection to the server is not used. | 165 |
| Number of programmed restarts | Number of restarts in accordance to the user setting - for total operational time | 166 |
| Number of critical errors | Number of noted errors (failures) causing the restart of the device - for total operational time | 167 |
| Total operation time, min | The number of minutes of operating time - for the total operational time | 168 – 169 |
| Current time | Number of seconds since 1st of January of specified year (see reg. 172) | 170 – 171 |
| Year of countdown | Year, since 1st of January which is taken for time counting | 172 |
| Time zone, min | Time zone, for the time count, number of minutes with sign as to UTC+00 | 173 |
| Temperature, °C | Temperature inside EM-481 | 174 |
| Power voltage, mV | Bus voltage of 12 V | 175 |
| Time before connection to remote server Modbus TCP | 0 - connection to the remote server is set;<br>1 - connecting to the remote server;<br>2 - 65534: the number of seconds before reconnecting;<br>65535: Connection to the Modbus TCP server is not used. | 176 |
| Interface of connection to remote server of Modbus TCP | 0 - the connection is not set;<br>1 - Ethernet connection is set;<br>2 - GPRS connection is set. | 177 |
| Unused parameter | The parameter is reserved for compatibility and is equal to 0 | 178 – 179 |
| IP-address of client 1** | IP-address of client, 0.0.0.0 – not connected | 180 – 183 |
| Port of client 1** | Port of client, 0 – not connected | 184 |
| IP-address of client 2** | IP-address of client, 0.0.0.0 – not connected | 185 – 188 |
| Port of client 2** | Port of client, 0 – not connected | 189 |
| IP-address of client 3** | IP-address of client, 0.0.0.0 – not connected | 190 – 193 |
| Port of client 3** | Port of client, 0 – not connected | 194 |
| IP-address of client 4** | IP-address of client, 0.0.0.0 – not connected | 195 – 198 |
| Port of client 4** | Port of client, 0 – not connected | 199 |
| Unused parameter | The parameter is reserved for compatibility and is equal to 0 | 200 – 209 |
| Year (current time) | Current year | 210 |
| Month (current time) | Current month | 211 |
| Day of the month (current time) | Current day of the month | 212 |
| Hour (current time) | Current hour | 213 |
| Minute (current time) | Current minute | 214 |
| Second (current time) | Current second | 215 |
| Day of week (current time) | Current day of week (1 - Monday) | 216 |
| Month (winter time) | Current month, excluding summer time | 217 |
| Day of the month (winter time) | Current day of the month, excluding summer time | 218 |
| Hour (winter time) | Current hour, excluding summer time | 219 |
| Unused parameter | The parameter is reserved for compatibility and is equal to 0 | 220 – 229 |
| Time of day, s | Number of seconds from midnight of the current day | 230 – 231 |
| Time of sunrise, s | 0–86399: Number of seconds from midnight to sunrise;<br>86400: Sunrise is not observed on this day | 232 – 233 |

Table 5.7 Continued

| Parameter | Description | Address |
|---|---|---|
| Sunset time, s | -1: Sunset is not observed on this day;<br>0–86399: Number of seconds from midnight to sunset; | 234 – 235 |
| Current IP-address of GSM** | IP-address obtained from GPRS* provider | 900 – 903 |
| GSM signal level, %** | Signal level and quality of radio communication with GSM provider | 915 |
| Interface to the data collection server** | 0 - the connection is not set;<br>1 - Ethernet connection is set;<br>2 - GPRS connection is set. | 1111 |
| User parameters of status | User parameters of status after starting take a value of 0. They can be used for storage and transmission to the server of tasks of values to be measured and calculated in the files, and noted events | 5000 – 5219 |
| User parameters of statistics | They store the value for the operating time of the built-in battery for the clock. They can be used in the task files for statistics gathering or saving state | 5220 – 5249 |

**Notes:**
* – IP-address of device in GSM network can be allocated dynamically. For the access to the device via GSM using its IP-address, please contact the manufacturer of the device;
** – content of registers is available only in the setting mode.

**Table 5.8** – Setting parameters

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| **Ethernet network** | | | | |
| Static IP-address | IP-address | 192.168.0.111 | If the dynamic addressing is switched off or not available, IP-address of the device in Ethernet network is equal to this value | 300 – 303 |
| Subnetwork mask | IP-mask | 255.255.255.0 | It is used only with static IP-address | 304 – 307 |
| Gateway | IP-address | 192.168.0.1 | It is used only together with static IP-address for communication with other networks, or as an address of DNS/DHCP servers | 308 – 311 |
| Switch on the dynamic addres-sing with a help of DHCP-server | 0 – 1 | 1 | 0 - for addressing in Ethernet, the specified values of the IP address, mask and gateway are used;<br>1 - the DHCP server of the network is used to determine the IP address, mask and gateway. If the server is unavailable, the static addressing values are used | 312 |
| Switch on the filter of IP-address of DHCP- server | 0 – 1 | 0 | It is used for dynamic addressing.<br>0 - the addressing data from the first responding DHCP server is received;<br>1 – the device receives addressing data only from DHCP-server with IP-address of the gateway | 313 |
| Switch on the use of DNS server with IP- address of gateway | 0 – 1 | 1 | It is used if DHCP is not available (switched off):<br>0: DNS of gateway is not used;<br>1: DNS of gateway is used for detecting the IP-address of server for data collection, if its address is set as host name | 314 |
| IP-address of DNS server | IP-address | 8.8.8.8 | It is used if DHCP is not available (switched off);<br>When the server of DNS gateway is used, it sets IP-address of additional DNS server | 315 –318 |
| IP-address of additional DNS server | IP-address | 0.0.0.0 | It is used if DHCP is not available (switched off);<br>It can set the IP-address of one more additional DNS server; 0.0.0.0 – it is not used; | 319 – 322 |
| Switch on MAC-address Ethernet set manually | 0 – 1 | 0 | 0 - unique value for each device is used as MAC address;<br>1 - manually set value is used for MAC address. | 323 |
| MAC-address Ethernet set manually | MAC-address | Unique value for each device | It is used when manual MAC-address is enabled to identify the device in Ethernet network. | 324 – 329 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| **GSM network** | | | | |
| PIN-code of SIM-card | 0–65535 | 65535 | 0 – 9999: this code is used for the SIM card if it demands the PIN code;<br>Other values: the code isn't used, SIM card and GSM are unavailable if the card demand a code. | 330 |
| Switch on the automatic detection of APN settings | 0 – 1 | 1 | 0 - GPRS connection is set according to manually specified parameters of APN;<br>1 - APN is automatically detected by the GSM provider, in accordance with the ICCID code of the SIM card. | 331 |
| Activate GPRS in roaming | 0 – 1 | 1 | 0: GPRS is blocked in roaming;<br>1: GPRS may be used in roaming; | 332 |
| Activate SMS messages sending in roaming | 0 – 1 | 0 | 0 – SMS messages cannot be sent (but can be received) in roaming;<br>1 – SMS messages can be received and sent in roaming; | 333 |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 334 – 351 |
| APN log-in of GPRS service | Character string | | Provided by the GSM service provider; up to 40 characters; | 352 – 391 |
| APN password of GPRS service | Character string | | Provided by the GSM service provider; up to 24 characters. | 392 – 415 |
| APN address of host | Character string | | Provided by the GSM service provider; up to 34 characters; there cannot be spaces in a string; | 416 – 449 |
| **MODBUS TCP clients** | | | | |
| Connection port via MODBUS TCP | 1 – 65535 | 502 | It is used for external connection to EM-481 for exchange via MODBUS TCP protocol. | 450 |
| Enable inactive clients replacement | 0 – 1 | 1 | 0: connection via Modbus TCP is supported regardless of time between queries from client;<br>1: if all connections via Modbus TCP are used, a new client inquiring for connection, can be connected instead of a client being inactive for a period which is more than set time | 451 |
| Max. response waiting time, s | 0 – 600 000 | 90 | It is used if the replacement of inactive clients is enabled. | 452 – 453 |
| Enable the queue for the last made MODBUS TCP connection | 0 – 1 | 0 | 0: connection via Modbus TCP is supported regardless of connection holding time;<br>1: If all connections via Modbus TCP are used, a new client inquiring for connection can be connected instead of the last connected client, if the time of connection holding on is more than the specified time | 454 |
| Max. time of last connection holding via Modbus TCP, ms | 0 – 600 000 | 60000 | It is used if the queue for the last connection via Modbus TCP is enabled | 455 – 456 |
| **MODBUS network** | | | | |
| Native Modbus-identifier of EM-481 | 0 – 247 | 111 | 0 - all queries are sent via MODBUS TCP to the MODBUS network, the device registers are unavailable by MODBUS TCP;<br>1-247 - the device responds MODBUS TCP queries with this MODBUS identifier without sending them to the MODBUS network. | 457 |
| Bit rate via RS-485, bit/sec | 75 – 921600 | 9600 | It is used in case of data exchange between the devices via RS-485, the same value for the devices on the same bus-bar | 458 – 459 |
| Activate selection of byte format when transmitting via RS- 485 | 0 – 1 | 1 | It is used in case of data exchange between the devices via RS-485, the same value for the devices on the same bus-bar.<br>0 – unused, byte is completed with 2 stop bits;<br>1 – Byte format is selected in register 461. | 460 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| Byte format when transmitting via RS-485 | 0 – 5 | 5 | It is used in case of data exchange between the devices via RS-485 only if byte format selection is activated.<br>The same value for the devices on the same bus-bar.<br>0 – “EVEN” – 1 parity bit and 1 stop bit;<br>1 – “ODD” – 1 parity bit and 1 stop bit;<br>2 – «0» (“SPACE”) – 1 zero bit and 1 stop bit;<br>3 – «1» (“MARK”) – 1 unit bit and 1 stop bit (similar to mode with two stop-bits);<br>4 – "ABSENT" - no parity bit, 1 stop bit;<br>5 – "AUTO-STOP" - no parity bit, 2 stop bits in the sent bytes, 1 stop bit in the received bytes (in such a case, devices with one and two stop bits may be connected simultaneously). | 461 |
| Waiting time for starting the MODBUS RTU response, ms | 0 – 60000 | 200 | It is used for transmissions via RS-485 in **RTU** mode. After transmission of query, if the first byte of the response was not received within this time interval, the waiting for the response is terminated. The response is always expected to be not less than the silence time between frames (the silence time depends on the transmission speed and is equal to the transmission time of 3.5 bytes, or 1.75 ms for speeds above 19200 bps). | 462 |
| Enable ASCII exchange mode in MODBUS network | 0 – 1 | 0 | Exchange mode via RS-485, the same value for all units on the same bus-bar.<br>0 – **RTU** exchange mode (format: 1 start bit, 8 data bits, 2 stop-bits, parity bit, and stop bit or only 1 stop bit - total from 10 to11 bits);<br>1 – **ASCII** exchange mode (format: 1 start bit, 7 data bits, 2 stop-bits or parity bit and stop bit - total is 10 bits). In this case, non-standard formats of byte 4 (without parity bit, 1 stop bit) and 5 (automatic stop bit compatibility) are inaccessible, format 3 (1 unit bit and 1 stop bit or 2 stop bits) is used instead. | 463 |
| Response time for subsequent Modbus ASCII character, ms | 0 – 60000 | 1000 | It is used in case of data transfer via RS-485 in **ASCII** mode. If you receive a response, if the next byte of the response was not received within this time interval, then the response waiting is stopped. Waiting is always not less than the transmission time of one character (depends on the transmission speed). | 464 |
| **Connecting to data collection server** | | | | |
| Mode of connection to the server for data collection | 0 – 4 | 1 | 0 – connection to server is not used;<br>1 – It sets and supports connection to the server through the specified port of the server connection (port on the server side) through any of the available interfaces;<br>2 – it is expected to connect from the server through the specified server connection port (port on the EM-481 side);<br>3 – similar to 1, but only via Ethernet;<br>4 – similar to 1, but only via GPRS. | 465 |
| Server connection port | 0 – 65535 | 20502 | The port to which the party is addressed, making connection between EM-481 and the server (see reg. 465). | 466 |
| Time of waiting for response from the server, s | 0 – 3600 | 120 | 0 – the server silence time is not limited;<br>1–3600 – max. time of server silence after which the connection will be stopped and must be remade again. | 467 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| Waiting time before reconnect-ting to the server, s | 0 – 30000 | 15 | It is used when connecting to the server (except mode "2"). After losing connection to the server, the reconnection will be performed after the specified waiting time. | 468 |
| Enable server address setting with a text string | 0 – 1 | 1 | It is used when connecting to the server (except mode "2"):<br>0 – connection is made to the server with fixed IP-address set in the registers 470 – 473;<br>1 – connection is made to the server with the name set in the registers 474–509. | 469 |
| IP-address of the server | IP-address | 0.0.0.0 | It is used when connecting to the server (except for mode "2"), if the server address setting is turned off with text string. IP address of the remote server with which the connection is supported. | 470 – 473 |
| Server address | Character string | modbus.overvis.com | It is used when connecting to the server (except for mode "2"), if the server address setting is turned on with text string. Address of the remote server with which the connection is supported.<br>The string of up to 36 characters can be indicated as address. This string should not have any spaces. | 474 –509 |
| **Protection** | | | | |
| Specified password for access to the mode of setting | Character string | 11111 | It is used to access the MODBUS TCP configuration mode. The string of 5 to 10 characters in length can be indicated as password. This string should not have any spaces. | 510 – 519 |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 520 – 529 |
| The specified password for recording permission using incoming SMS | Character string | gap | It is used to verify the authenticity of incoming SMS with request for record or with acknowledgment of the fault. The string of 3 to 10 characters in length can be indicated as password. This string should not have any spaces. | 530 – 539 |
| The specified password for reading permission using incoming SMS | Character string | gap | It is used to verify the authenticity of incoming SMS with request for reading or with acknowledgment of the fault. The string of 3 to 10 characters in length can be indicated as password. This string should not have any spaces. | 540 – 549 |
| The specified password for recording permission via MODBUS TCP in devices using RS-485 | Character string | | It is used to access devices connected to the EM-481, to request write or control functions that can change the status of these devices. The string to 10 characters in length can be indicated as password. This string should not have any spaces. | 550 – 559 |
| The specified password for reading permission via MODBUS TCP | Character string | | It is used to access devices connected to the EM-481, to request read functions, or to access the EM-481 registers, except for registers of version, password, mode and tabs. The string to 10 characters in length can be indicated as password. This string should not have any spaces. | 560 – 569 |
| Enable the protection mode against writing via SMS | 0 – 1 | 0 | 0 – Protection against recording is regulated with help of other parameters (password);<br>1 – Blocking of queries via SMS for function of writing. | 570 |
| Enable the protection mode against reading via SMS | 0 – 1 | 0 | 0 - Protection against reading is regulated with help of other parameters (password);<br>1 – Blocking of queries via SMS for function of reading. | 571 |
| Enable the protection mode against writing via MODBUS TCP | 0 – 1 | 0 | 0 – Protection against recording is regulated with help of other parameters (password) or deactivated;<br>1 - Blocking of any queries for functions, excepting functions of MODBUS 1, 2, 3, 4, 7, 17, 20. | 572 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| Enable the protection mode against reading via MODBUS TCP | 0 – 1 | 0 | 0 – Protection against reading is regulated with help of other parameters (password) or deactivated;<br>1 – Blocking of queries for functions of MODBUS 1, 2, 3, 4, 7, 17, 20, excepting reading using function 3 of registers of version, mode and tabs. | 573 |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 574 |
| **Miscellaneous** | | | | |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 575 – 629 |
| Enable automatic restart of the device | 0 – 1 | 1 | 0 - the periodic restart is disabled;<br>1 - the device is restarted after a specified period of time. | 630 |
| Restart time, min | 5 – 7200 | 120 | Used when automatic restart is enabled. | 631 |
| Enable restart mode automatically only when there are no connections | 0 – 1 | 1 | It is used when automatic restart is enabled:<br>0 - the device is restarted after a specified period of time since the start;<br>1 - the device is restarted after a specified period of time since the last transmission via Ethernet or GSM networks. | 632 |
| MODBUS exception code generated when access is denied | 0 – 255 | 1 | 0 - if the access to MODBUS registers is denied, the response to the client is not returned;<br>1 - 255 - if you deny access to the client who sent the request, this exception code is returned; | 633 |
| MODBUS exception code generated when there is no response | 0 – 255 | 11 | 0 - if there is no response from the addressee (Gateway Timeout), the response to the client is not returned;<br>1 - 255 - if there is no response from the request recipient, this exception code is returned to the client. | 634 |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 635 |
| MODBUS exception code generated if there is no connection to query addressee | 0 – 255 | 10 | 0 – If there is no connection to the query addressee (Gateway Path Unavailable), response is not returned to the client;<br>1 – 255 – if there is no connection to the query addressee, this exception code is returned to the client; | 636 |
| Enable RS-485 slave mode | 0 – 1 | 0 | 0 – Master mode: RS-485 is used to send queries;<br>1 – Slave mode: RS-485 is used to receive queries from additional client; | 637 |
| First MODBUS-identifier of RS-485 | 1 – 255 | 1 | Parameters define a range of MODBUS identifiers used for RS-485.<br>In the master mode the queries with addresses in this range (and also the broadcast ones with address 0) are sent via RS-485.<br>In the slave mode the queries with addresses in this range (and also the broadcast ones and the queries to EM-481 address) are received via RS-485. | 638 |
| Last MODBUS-identifier of RS-485 | 1 – 255 | 255 | | 639 |
| **Connection to remote server of MODBUS TCP** | | | | |
| IP-address of remote server | IP-address | 192.168.0.112 | It is used when enabling redirection of queries to MODBUS TCP remote server. IP-address of the remote server wherewith connection is maintained. | 640 – 643 |
| Port of the remote server connection | 0 – 65535 | 502 | It is used during redirection of queries to the remote server. The remote server port is for MODBUS TCP connection. | 644 |
| Time to wait for response from remote server, ms | 0 – 60000 | 1000 | It is used during redirection of queries to the remote server. After the query transfer, if the correct response failed to be received within this time interval, response waiting is stopped. | 645 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| Standby time to repeated connection to the remote server, ms | 0 – 240 | 20 | It is used during redirection of queries to the remote server. After connection with the server is lost, the repeated connection will be performed after preset standby time. | 646 |
| Remote server connection mode | 0 – 4 | 0 | 0 – MODBUS TCP remote server is not used;<br>1 – to connect to the server using Ethernet or GPRS, preferably via Ethernet;<br>2 – to connect to the server using Ethernet or GPRS, preferably via GPRS;<br>3 – to connect to the server only via Ethernet;<br>4 – to connect to the server only via GPRS; | 647 |
| First MODBUS-identifier of the remote server | 1 – 255 | 1 | It is used during redirection of queries to the remote server.<br>The parameters define the range of MODBUS identifiers used on the remote server.<br>Queries with addresses in this range (and also the broadcast ones with address 0) are sent to the remote MODBUS TCP server. | 648 |
| Last MODBUS-identifier of the remote server | 1 – 255 | 255 | | 649 |
| Parameter is not used | 0 | 0 | It is not used; it should be equal to 0 for compatibility. | 650 – 699 |
| **Automatic transition to daylight saving time** | | | | |
| Daylight saving time transition mode | 0 – 200 | 12 | 0 – automatic transition is not used (the gain can be set manually when setting the clock)<br>1 – Brazil 6 – Italy 11 – Turkey<br>2 – Great Britain 7 – Namibia 12 – Ukraine<br>3 – Germany 8 – Poland 13 – Finland<br>4 – Greece 9 – Portugal 14 – France<br>5 – Jordan 10 – USA<br>15 – according to preset days; | 700 |
| Preset month for transition to daylight saving time | 1 – 12 | 3 | It is used if you selected the automatic transition to daylight saving time on the specified days. The month when the clock will be set one hour ahead. | 701 |
| Preset week of the month for transition to daylight saving time | 1–10 | 10 | It is used if you selected the automatic transition to daylight saving time on the specified days. Week of the month when the clock will be set one hour ahead.<br>1–5 – week of the month, counting the part weeks;<br>other values – the last week of the month; | 702 |
| Preset day of the week for transition to daylight saving time | 1–7 | 7 | It is used if you selected the automatic transition to daylight saving time on the specified days. The day of the week when the clock will be set one hour ahead. | 703 |
| Preset hour for transition to daylight saving time | 0–22 | 2 | It is used if you selected the automatic transition to daylight saving time on the specified days. The hour of the day at which the clock will be set one hour ahead. | 704 |
| Preset month of revert to standard time | 1 – 12 | 10 | It is used if you selected the automatic transition to daylight saving time on the specified days. The month when the clock will be set one hour back. | 705 |
| Preset week of the month of revert to standard time | 1–10 | 10 | It is used if you selected the automatic transition to daylight saving time on the specified days. Week of the month when the clock will be set one hour back.<br>1–5 – week of the month, counting the part weeks;<br>other values – the last week of the month; | 706 |
| Preset day of the week of revert to standard time | 1–7 | 7 | It is used if you selected the automatic transition to daylight saving time on the specified days. The day of the week when the clock will be set one hour back. | 707 |
| Preset hour of revert to standard time | 1–23 | 3 | It is used if you selected the automatic transition to daylight saving time on the specified days. The hour of the day at which the clock will be set one hour back. | 708 |

Table 5.8 Continued

| Parameter | Range of values | Factory setting | Description | Address |
|---|---|---|---|---|
| **Calculation of sunrises and sunsets** | | | | |
| Sunny day | 0–3 | 1 | 0 – official;<br>1 – civil;<br>2 – marine;<br>3 – astronomical; | 709 |
| Latitude, degree | 0 – 89 | 46 | The absolute value of the latitude | 710 |
| Latitude, minute | 0 – 59 | 29 | | 711 |
| Latitude, second | 0 – 59 | 10 | | 712 |
| Longitude, degree | 0 – 179 | 30 | The absolute value of the longitude | 713 |
| Longitude, minute | 0 – 59 | 43 | | 714 |
| Longitude, second | 0 – 59 | 40 | | 715 |
| Quadrant | 0 – 3 | 0 | 0 – N latitude, E longitude;<br>1 – N latitude, W longitude;<br>2 – S latitude, E longitude;<br>3 – S latitude, W longitude; | 716 |
| **The connection to the server of NTP clock synchronization** | | | | |
| NTP server connection mode | 0 – 4 | 0 | 0 – clock synchronization with the server is not used;<br>1 – to connect to the servers using Ethernet or GPRS, preferably via Ethernet;<br>2 – to connect to the servers using Ethernet or GPRS, preferably via GPRS;<br>3 – to connect to the servers only via Ethernet;<br>4 – to connect to the servers only via GPRS;. | 717 |
| Time period of connection to NTP servers, h | 1 – 240 | 24 | It is used if you have enabled synchronization of clocks with the server clock. The time interval over which the server time is received. | 718 |
| Minimum shift of clock for synchronization, s | 1 – 180 | 2 | It is used if you have enabled synchronization of clocks with the server clock. The synchronization is performed after receiving the server time, if the difference between the clocks is no less than this value. | 719 |
| **User settings** | | | | |
| User's settings and stored values | 0 – 65535 | 0 | They can be used to store any identification data of the device or for adjusting the settings of task files operation. | 5250 – 5499 |
| **Setting the clock** | | | | |
| Adding daylight saving time, 15 min | -48 – +48 | | Current gain. It is set during manual transition to the daylight saving time, when selecting the automatic mode it will be adjusted within 5 minutes | 34817 |
| Adding time zone, ·15 min | -48 – +48 | 8 | It is used during synchronization of the clock with the server clock | 34818 |
| Second | 0–59 | | The time is to be set at the clock | 34819 |
| Minute | 0–59 | | | 34820 |
| Hour | 0–23 | | | 34821 |
| Day | 1–31 | | | 34822 |
| Month | 1–12 | | | 34823 |
| Year | 0–65534 | | | 34824 |
| Set the clock | 0–65535 | 0 | It is used to set the clock. When recording to this register with any value, the new clock settings in registers 34817-34824 will be set. | 34825 |
| * – registers for the clock setting is available only in the clock setting mode, see registers 120, 122 | | | | |

**5.3.3.** EM-481 configuring via WEB-interface

WEB-browser is used for setting via WEB-interface:

1) Write the IP-address of EM-481 in the address bar of the browser (to display the address on the display of the device, see it. 5.3.1) and select the transition to the specified address (the main page with the tab headings will be displayed for switching to other modes).

**If the browser is set to use the proxy server, the access to the device via local network shall be granted only after adding the IP-address into the exceptions list as indicated in the browser documentation.**

2) Select “Parameters” for setup of parameters. Password request shall appear before granting access to setup mode (factory setting 11111).
3) Enter password and press **ENTER**. If the password is correct, you shall be granted access to the setup mode. You will see the settings page. If the password is incorrect, the password request shall be displayed once again.
4) Settings on the settings page are grouped by types and are divided into tabs. Non-configurable settings and measurements are available in the tab "State". Settings on other tabs are listed in Table 5.8.
5) Click **SAVE** after making changes to the settings. This will check all the changed parameters. If no errors are detected, new parameters will be stored in the **EM-481** memory (new settings will take effect after the following application of settings or restart of the device). In case of any errors detected upon clicking the SAVE button, none of the parameters is saved, while the names of erroneous parameters are highlighted in red.
6) To apply the settings without restarting the device, you should click **"Apply"** at the bottom of the page. The entered settings will be checked. If the values of the parameters have not errors, the parameters will be stored in the memory of EM-481 and will come into force. Only parameters MODBUS, inputs and outputs can be applied without restarting.
7) To set the clock on the tab "Time", press **"Set"** button.
8) Click **"Restore defaults"** to restore the default value of parameters.
9) Click **"Reset"** to stop all connections and interrupt all receive/transmit operations, with the following restart of the device. In case of any changes to the parameters, either introduced or stored in the memory, these changes shall be implemented.

**If the addressing parameters in Ethernet network (MAC-address, IP- address) are modified and saved, the browser may not load the page after the restart of EM-481 by pressing the “Reset” button. This can happen as the browser continues to reply over the previous address. In this case, the connection should be made anew.**

10) Clicking the **“Exit”** button the will close the setup mode and a password request appears once again.

**5.3.4.** EM-481 configuring via MODBUS-interface

Setting via Modbus-interface shall be provided if the device is connected using the Modbus client, which is supporting the Modbus TCP protocol. The connection is established using its IP-address (for display of the address on the device display see the it. 5.3.1) with the indication of Modbus-identifier (factory setting – 111).

Write the password string into the password input register (see Table 5.6) before setting parameters. Factory set password - is 11111, i.e. write 49 - ASCII-code for one to record the factory set password to registers 100 - 104. If the password is correct, the mode register (see Table 5.7) takes the value of “1” - setup mode.

The instruction registers (see Table 5.7), as well as registers for the collection of Modbus customizable parameters (see Table 5.8) are available for writing in the setup mode. When the required value is written to the registers of customizable parameters, write 2 (instruction for **“Saving”**) in the instruction register. The accuracy of values for the stored parameters can be checked by comparing the collections of customizable parameters and saved parameters. If collections are the same, new values and settings shall be accepted and saved.

To apply the settings without restarting the device you should write into the parameter of the control command the value "4" - command **"Save and apply".** Only parameters MODBUS network, MODBUS remote server and user parameters can be applied without the device restarting. The correctness of the saved parameter values can be checked by comparing the sets of configurable parameters and current settings. If the sets match, then the new settings are accepted and saved.

To cancel the changes in the parameters before saving them, you should write the value of "9" command in the control command parameter - the **"Cancel"** command. In this case, the configurable parameters take the values of the saved ones.

To reset the saved parameters to the factory settings in the configuration mode, you should write the value of "444" command in the control command parameter - **"Reset to factory"**.

In order for all saved parameter values to take effect, the device must be restarted. Through the MODBUS interface, the restart is performed by writing to the parameter of the control command the value "1" - the command **"Restart"**.

To exit the setup mode, write 0 instead of any character in password input register. This will clear all the password input registers and instruction register (turn the values to 0).

## 6. MAINTENANCE

### 6.1. Safety precautions

**THE TERMINALS AND THE DEVICE INTERNAL ELEMENTS CONTAINS POTENTIALLY LETHAL VOLTAGE**
**DURING MAINTENANCE IT IS NECESSARY TO DISABLE THE DEVICE AND CONNECTED DEVICES FROM THE MAINS.**

6.2. Maintenance of the device must be performed by the skilled professionals.

6.3. Recommended frequency of maintenance is every **six months.**

**6.4. Maintenance Procedure:**

1) Check the connection reliability of the wires, if necessary, clamp with the force specified in Table 3.1;

2) Visually check the integrity of the housing, in case of detection of cracks and damages take the device out of service and send for repair;

3) If necessary, wipe the front panel and the housing of the device with cloth.

**Do not use abrasives and solvents for cleaning.**

## 7. SERVICE LIFE AND MANUFACTURER WARRANTY

**7.1.** The lifetime of the device is 10 years. Upon expiration of the service life, contact the manufacturer.

**7.2.** Shelf life is 3 years.

**7.3.** Warranty period of the device operation is 5 years from the date of sale.

During the warranty period of operation (in the case of failure of the device) the manufacturer is responsible for free repair of the device.

**ATTENTION! IF THE DEVICE HAS BEEN OPERATED IN VIOLATION OF THE REQUIREMENTS OF THIS OPERATION MANUAL, THE MANUFACTURER HAS THE RIGHT TO REFUSE IN WARRANTY SERVICE.**

**7.4.** Warranty service is performed at the place of purchase or by the manufacturer of the device.

**7.5.** Post-warranty service of the device is performed by the manufacturer at current rates.

**7.6.** Before sending for repair, the device should be packed in the original or other packing excluding mechanical damage.

**You are kindly requested, in case of the device return and transfer it to the warranty (post-warranty) service please indicate detailed reason for the return in the field of the claims data.**

## 8. 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 %. When transporting the device, you should protect it against mechanical damage.

## 9. ACCEPTANCE CERTIFICATE

EM-481 has been manufactured and accepted in accordance with the requirements of current technical documentation and classified as fit for operation.

Head of QCD _____

Date of manufacture _____

Seal

## 10. CLAIMS DATA

_____

_____

_____

_____

_____

_____

_____

_____

*The Company is grateful to you for the information about the quality of the device and suggestions for its operation.*

For all questions, please contact the manufacturer:
NOVATEK ELECTRO INDIA PVT. LTD.
C-30, Patparganj Industrial Area
Delhi - 110092, India
Tel.: +91 11 42143253, 43010600
Email: info@novatek-electro.in
www.novatek-electro.in

Date of sale_____

## Appendix A
## (mandatory)

### Versions and modifications

Firmware versions are listed in Table A.1.

**Table A.1** – Firmware versions

| Version | Date of issue | Remarks |
|---|---|---|
| 25 | 10.04.2017 | • Demo version |
| 26 | 27.04.2017 | • Improved operation in slave mode using RS-485 |
| 27 | 6.06.2017 | • Added support for statistical functions for variable ranges in task files |
| 28 | 30.06.2017 | • Improved GSM stability |

The device versions are specified in Table A.2.

**Table A.2** – The device versions

| Version | Date of issue | Remarks |
|---|---|---|
| 1 | 10.04.2017 | • First version |

**Appendix B**
**(recommended)**

## Connections

**ATTENTION! CONNECTING THE INCORRECTLY SET DEVICE TO THE DATA TRANSMITTING NETWORK CAN INFLUENCE THE COMMUNICATION BETWEEN THE OTHER DEVICES. CONNECTION OF DEVICE EM-481 TO ETHERNET NETWORK NEEDS MUTUAL PARITY OF CONNECTED DEVICES SETTINGS. AS A RULE, ALL CONNECTIONS TO THE NETWORK LINKING MORE THAN 2 DEVICES, SHOULD BE MADE BY QUALIFIED PERSONAL (NETWORK ADMIN).**

### 1. IP-addressing

When units are communicating over Ethernet network using TCP/IP protocol, every unit is using a set of IP-addressing settings to identify the sender and receiver of the data. The unit memory contains the personal and unique, within a single subnet, IP-address (four bytes are written as four integers, separated by dots, in the range of 0-255), subnet mask, which is the same for all units within the subnet (written similar to IP-address), and IP-address of the gateway, which is used to communicate with other networks. Proper communication between units of a subnet is possible under several conditions:

1) All units of a subnet have similar to mask. Most of small LANs are using 255.255.255.0 mask.
2) Mask starts with a group of bits set to “1”, followed by a group of bits turned to “0”.
3) All bits set to “1” in the mask are similar to for all the IP-addresses of units in subnet and indicate the subnet address. 192.168 is most frequently used address in LANs for the mask 255.255.255.0. The third byte may be used as a subnet number in a complex LAN. In smaller LANs, the third byte is usually equal to “0”.
4) A set of bits in IP-address of the unit, which is set to “0” in the mask, is unique to each unit within the same subnet.
5) In most cases, the unit like router, which is already communicating with other networks, is switched to the network. This unit often gets the following address 192.168.0.1, 192.168.0.100, or 192.168.0.101. In this case, other units in the network shall have this IP-address of the unit as the gateway address. This address is not necessary for communication between units in a subnet, and is only used to connect units of one subnet to units of other networks.

Factory addressing settings for EM-481 are listed in Table B.1.

**Table B.1** – Factory addressing settings for EM-481

| Parameter | Value |
|---|---|
| Addressing using DHCP | Yes |
| IP-address | 192.168.0.111 |
| Subnet mask | 255.255.255.0 |
| Gateway | 192.168.0.1 |

With the factory settings of the EM-481, two ways are possible for communicating with it via Ethernet:

a) The network uses a router or other DHCP server, which assigns IP addresses to new devices. In this case, it is sufficient to connect the EM-481 to the network, and after some time the obtained IP address is appeared on the display. The address "0.0.0.0" means that the desired value has not been received yet. The address is "192.168.0.111", obtained after 20-60 seconds after running EM-481, may mean that getting address from the DHCP server is failed and the device uses a static address;

b) The network is not able to use DHCP, or EM-481 is connected directly to the computer (or other device-client on the same subnet). In this case, EM-481 will switch to static addressing after some time (20-60 seconds) after starting. A client device should use a mask 255.255.255.0 as a mask and address starting with 192.168.0. The fourth byte of the address can take any value in the range from 1 to 254, except for 111. If the connection between EM-481 and a client unit is not provided directly but via a network with a number of units, the mentioned address cannot be equal to any of the addresses of other units on the subnet. If network has several units with the mask and the first three bytes of the IP- address, which are different from those specified in Table B.1, or the EM-481 factory IP-address is already taken, the configurable unit should be temporarily removed from the network to avoid addressing conflicts and establish a communication between this unit and EM-4816 directly. This will allow configuring the unit and EM-481 for direct communication or switching EM-481 to the network.

### 2. Configuring the client device to connect via Ethernet

The unit addressing is set according to documents and software it uses.

Below is an example of configuring the personal computer (PC) with Windows XP/7/8 to communicate directly with the EM-481 using factory settings.

Open the list of OS network connections to configure the network address in Windows. To do this, follow the steps below (mind the OS version).

***For OS of Windows XP***:

1) Log in as administrator;
2) Select Start-Control Panel;
3) If control panel items are divided into categories, select "Network and Internet Connections";
4) Go to "Network Connections".

***For OS of Windows 7/8:***

1) Log in as administrator;
2) Select Start-Control Panel;
3) If control panel items are divided into categories, select "Network and Internet";
4) Go to "Control Center Network and Sharing Center";
5) In the task bar (on the left), select "Change adapter settings".

Next, perform the following steps:

1) In the Connections window, select the desired connection via an adapter with the addressing that you want to change. Many computers have only one adapter and one connection, which will be displayed in this window. If the window shows several connections, select the connection you want, using the adapter name in the information on connection or contact your system administrator.
2) Click the icon of the connection with the right button, and select "Properties" in the drop-down menu. The Properties window opens (see Fig. B.1).

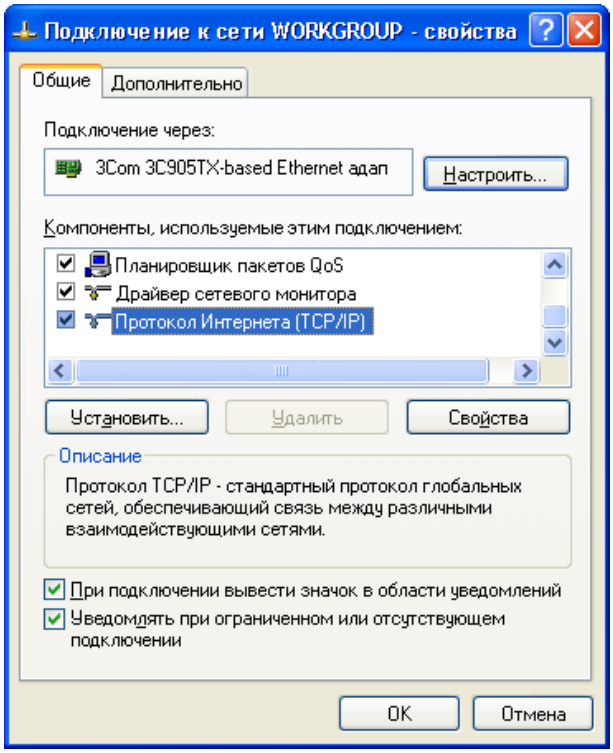



**Fig. B.1** – Connection properties window in Windows OS

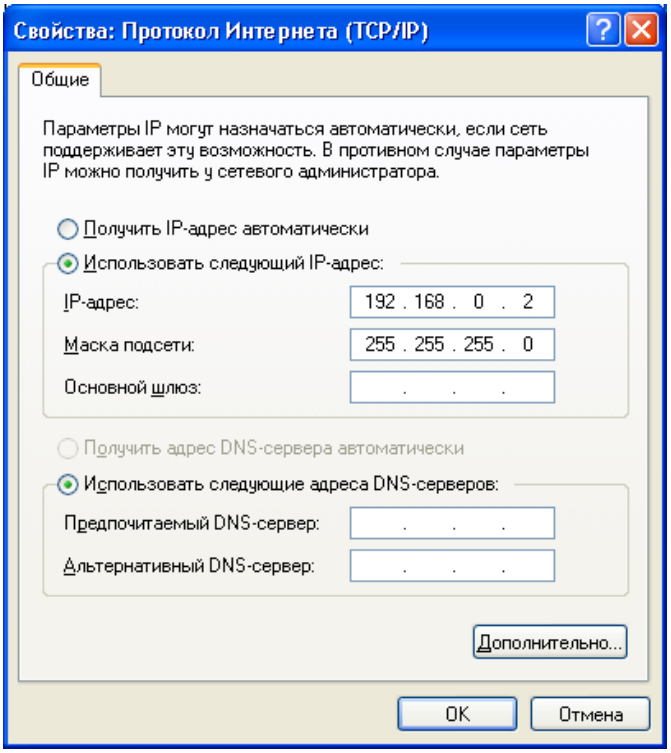



**Fig. B.2** – TCP/IP properties window in Windows OS

3) Select "Internet Protocol (TCP/IP)" from the list of connection components in the next window. Make sure that the component is enabled (flagged in the list). Click "Properties". The TCP/IP properties window opens (see Fig. B.2).
4) Select "Use the following IP- address".
5) Specify the address in the "IP- address" field within the range from 192.168.0.1 to 192.168.0.255 (except for 192.168.0.111, which is used by EM-481).
6) Specify "255.255.255.0" in the “Subnet Mask” field.
7) The fields "Default Gateway", "Preferred DNS-server", and "Alternative DNS- server" should be left blank.
8) Press "OK" to close the Protocol Settings window.
9) Press "OK" to close the Connections Settings window.
10) If prompted by the OS to restart the PC after closing the windows, answer yes.

**3. Connection to Internet via Ethernet**

**ATTENTION! THE USER IS STRONGLY RECOMMENDED TO CONNECT THE UNIT TO INTERNET UNDER THE SUPERVISION OF THE LAN SYSTEM ADMINISTRATOR AND/OR REPRESENTATIVE OF INTERNET SERVICE PROVIDER.**

Use the following guidelines to connect the unit to Internet via Ethernet:

- Acquire a dedicated line with a static IP-address from your Internet Service Provider (hereinafter referred to as ISP). If static IP is unavailable, a part of functions (direct connection via MODBUS TCP or via the WEB interface) can be unavailable from Internet, at the same time connection to the server can be used in active mode;

- Direct connection of the unit to the ISP cable is not recommended; in case of a router connection, the ISP cable is connected to the "Uplink" socket on the router (It is usually marked with color and has no numbers. The marking depends on the router manufacturer, see the router documentation). The straight-through (supplied) Ethernet cable is used for connecting EM-481 unit to the router. Set the router for Internet connection as per ISP recommendations. The router settings should also provide for the redirection of queries, which are coming to static IP-address provided by the ISP, to the unit IP-address (factory setting - 192.168.0.111). If for a dedicated line the static IP address is fixed in Internet, and direct access from Internet to the product FTP, HTTP, MODBUS TCP servers is required, then in settings it is required to specify ports of redirection - for a local IP address of a device on which there is a redirection, it is necessary to specify 80 (for access to the WEB INTERFACE), 502 (for access on MODBUS TCP). It will also necessary to disable DHCP in the settings of EM-481, or configuring the router for the provision of EM-481 via DHCP of always the same IP address;

- Verify if the Internet connection of EM-481 is protected by standard means (see below*)*;

- When referring the EM-481 unit via Internet, use IP-address provided by your ISP.

**4. GSM connection**

**ATTENTION! THE USER IS STRONGLY RECOMMENDED TO CONNECT THE UNIT TO INTERNET UNDER THE SUPERVISION OF REPRESENTATIVE OF MOBILE SERVICE PROVIDERS.**

**Make sure that your tariff plan includes providing GPRS service (for connection to Internet) and/or receiving and sending SMS messages (for control via SMS).**

To connect the EM-481 device via GSM, use the following recommendations:
- From GSM provider (hereinafter referred to as a provider) you should get a SIM-card;
- Insert the SIM-card in the device and connect the appropriate antenna to have a proper radio signal in the place of the EM-481 device location;
- After starting the device, make sure that SIM-card has a correctly identification - after the communication initialization, the indicator GSM keeps on blinking; if the indicator lights down, check the SIM-card, antenna and a level of GSM signal on the display of the device;
- If GPRS is used for Internet connection, make sure, that the provider and GPRS settings are correct via code of SIM-card - after GPRS initialization, the GSM indicator blinks 3 times per second; if the indicator is blinking less frequently than 1 time per a second, check the settings of APN and GPRS;
- In case of necessity, manually set the APN in accordance with the provider's recommendations.

**5. Protection of connection:**
- EM-481 has basic protection against unauthorized access via network;
- Access for writing and/or reading via Modbus TCP or via SMS can be deactivated in settings;
- The device settings can be changed remotely by entering the password (minimum 5 characters). Entering several incorrect passwords while trying to determine the correct one is blocked by the unit;
- Access passwords can be set for restriction of writing and/or reading via Modbus TCP or via SMS;
- When entering the password, all settings shall be only available to a given client using a given protocol. In case of no requests from the client over the long period, the access returns to locked mode*;*

**ATTENTION! DURING ANY CONNECTIONS EXCEPT FOR TRANSMITTING VIA GSM AND COMMUNICATION WITH SERVER VIA SPECIAL PROTOCOL EM-481, THE PASSWORDS ARE SENT IN NOT PROTECTED MODE; IN CASE OF CORRECT PASSWORD THE ACCESS OPENS IN NOT PROTECTED CONNECTION.**

- The unit protection system is not designed to counter malicious network attacks (especially those, which are not trying to get access to the unit but to block it instead);
- In case of complex and large networks (especially when providing access to the ET-481 via Internet), the users are recommended to separate the unit from unprotected networks with standard protective equipment (router, configured to filter the transmissions, Firewall, etc.).

**6. Connection to the server**

EM-481 has the mode of constant communication with the data collection and management server. For example Overvis system can be as a server (Internet-address: overvis.com).

*Overvis – it is a system for monitoring and remote control of technological processes. Overvis makes it possible to read the data and make control over the devices including EM-481, provided there is a connection with them, to save the data in the base, review the data in appropriate form, to receive alarm messages as SMS or e-mail.*

**EM-481 factory settings are prepared for connection to Overvis.**

Overvis system supports a special manner of identification which is used in EM-481. In addition the devices are verified by a unique MAC-address which is sent to the server at each connection session. The device registration for a user of the Overvis system is possible in two ways:

a) if the device has a sticker with a QR code - it is required to read the code and follow the link and follow the instructions of the server;

b) by specifying the activation code to a user account of Overvis. The code represents the number of 8 characters and is displayed on the display and on the status page of the WEB interface of the product after connecting to the server. When you enter code EM-481 is "attached" to a user account.

To connect a new device to the Overvis system using activation code you should:

- connect the EM-481 device to Internet via one of above mentioned methods;
- make sure (by information on the display or on the page of parameters of the unit WEB-interface state) that the connection to the server is made and the activation code is received;


**Fig. B.3** – Image of the activation code on the display

**If for a new device which is connected to Overvis system there is an information that the connection is activated, then for security reason you should press the button «Restart the activation» in the page bottom of WEB-interface state page - in order to delete the device from Overvis system. That guarantees that the EM-481 device will be used only by the authorized users.**

- Using the instruction on the site of Overvis system, connect to EM-481 with activation code; after activation during the connection to the server there will be shown on the unit display a message “activated”;

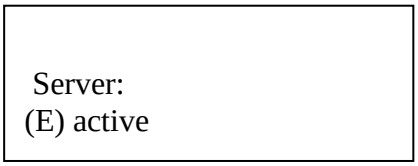



**Fig. B.4** – Image of activation state on the display

**FOR INFORMATION ABOUT EM-481 CONNECTION TO OTHER SERVERS, CONTACT THE DEVICE MANUFACTURER.**

# Appendix C
# (recommended)

## Operation logic programming

### 1. General

After running, EM-481 starts execution of the program for logic of action, if it was placed earlier in the built-in memory. If there is no program in the built-in memory, EM-481 searches for and checks the task files placed in the folder "**TASKS**" on the memory card, provided the card is formatted in the FAT or FAT32 format. The correctly discovered files are read in the built-in memory and form the logic program of actions. Such a reading runs once after startup or after installing a new memory card, only if the built-in memory does not contain the programs.

To clean the internal memory you should:

1) Enter EM-481 parameter setting via WEB interface (see Manual, it. 5.3.3);
2) Go to the tab "Files";
3) Press the button "Clear internal memory of tasks";
4) If the result of the reading the program is not displayed immediately in the tab "Files", refresh the page a few seconds later.

**Note: The program in the internal memory is deleted when updating the embedded software. If the memory card with the task files remains installed in the EM-481, the program will automatically read again after the update.**

The tab "Files" indicates the result of reading the folder "**TASKS**", including the number of discovered and read files. If during reading and verifying the program errors were detected, then it indicates the type of error, file and line number of the file error. If the program consisted of several files in the folder "**TASKS**", then the internal memory will read all files except those in which errors are detected. Therefore, during error correction you should compare the number of discovered and read files and if some were read, to clear again the internal memory to re-read the program.

Files can have arbitrary names and extensions and placed in subfolders of the folder "**TASKS**". Files placed directly in the folder TASKS, allow you to use MODBUS ID default in the text, equal to MODBUS ID of the product EM-481. Files placed in subfolders in the folder "T**ASKS**" with names from "1" to "247", allow to use the text MODBUS ID default name of the subfolder. Therefore, if the program logic is divided into tasks so that each is associated with its connected device, it is recommended that files relating only to EM-481, to be placed in the folder "**TASKS**" and files related to primarily the other device, to be put in a subfolder with the name of the MODBUS ID of this device. This allows you to change the list of managed devices by copying and renaming the subfolders, and create universal and portable files of the tasks.

### 2. Files of the tasks

File of tasks describes repeated after a specified time interval the set of actions for gathering, processing and comparing the data and special actions after fulfillment of the preset conditions according to the processing results.

The task file is divided into sections which in turn are divided into lines.

The section is part of the file that starts with "!" and the name of the section written in a row.

Correct example:

```
!META
* UPDATE 60
!PARAMS
...
```

Incorrect example:

```
META
* UPDATE 60
! PARAMS
...
```

If the section allows you to refer the lines in it, then all the lines of the section are numbered, otherwise instead of a number of the line will be put the sign "*". The format of the line is different in each section. The number and order of sections does not matter (sections can be interrupted and then be continued after one or more sections), if two rules are fulfilled:

1) If a section with numbered lines is found for the first time, the numbering starts with 0, otherwise, numbering continues from the previous section of the same name.

Correct example:

```
...

!VARS
0 VAL 0

!CONDS
0 VAREQVAL V0 0

!ACTS
0 ALARMON 1
1 ALARMOFF 1

!REACTS
* C0 ACT A0

!CONDS
1 NOT C0

!REACTS
* C1 ACT A1

...
```

Incorrect example:

```
...

!VARS
0 VAL 0

!CONDS
0 VAREQVAL V0 0

!ACTS
0 ALARMON 1
1 ALARMOFF 1

!REACTS
* C0 ACT A0

!CONDS
0 NOT C0

!REACTS
* C1 ACT A1

...
```

2) Link to next line should be below the line that is referenced.

Correct example:

```
...

!CONDS
0 VAREQVAL V0 0
1 NOT C0

...
```

Incorrect example:

```
...

!CONDS
0 NOT C1
1 VAREQVAL V0 0

...
```

The file should end with an empty line or a comment. The file should not have extra spaces, including at the end of lines. The file can contain comment lines that begin with **"#",** and are ignored when reading the file.

Correct example:

```
...

# This is a comment
!VARS
# number of seconds per minute
0 VAL 60
1 VAL 1

...
```

Incorrect example:

```
...

# This is a comment
!VARS
0 VAL 60   # number of sec. in min
 1 VAL 1

...
```

**Table C.1** – Sections assignment

| | |
|---|---|
| **META** | General information and the file run settings |
| **DEVICES** | MODBUS devices capabilities |
| **PARAMS** | Parameters, registers and bits of MODBUS devices, and type conversion |
| **VARS** | Variables, transformation of parameters and calculations |
| **PHONES** | Phone numbers to which SMS are sent |

| | |
|---|---|
| **STRS** | Texts of messages to send to SMS |
| **CONDS** | Comparison of variables, the conditions for performing actions |
| **ACTS** | Actions that can be performed |
| **REACTS** | Reactions that determine under what conditions the actions will be fulfilled |

### 2.1. META Section

It contains the general information about the file and settings for its execution, and is responsible for the particularities of the program cycle fulfillment (the so-called "updates"), including the frequency of updates. Lines in it do not have numbering, instead of index is "*". Each line has the following format:

```
* <modifier type> <argument>
```

The types of the arguments are the following:

- `<int>` - 32-bit signed integer
- `<uchar>` - 8-bit unsigned integer
- `<ushort>` - 16-bit unsigned integer

**Table C.2** – Types of modifiers

| | |
|---|---|
| **PROTOCOLVERSION** <int> | **Version of the file**: It prevents the processing of files with outdated firmware EM-481. The version described in this document is 6. |
| **UPDATE** <int> | **Frequency of the program cycle fulfillment (update rate) in seconds**: Every cycle has the reading of parameters, calculation of variables values, defining operation conditions and implementation of response to these conditions. The minimum value is 1 second.<br>By default, if a modifier is not specified, it equals to 60.. |
| **PARAMACTUAL** <ushort> | **Frequency of reading the parameters in seconds**: It allows optimizing the number of readings of parameters. At the moment of the updating the parameter it is checked how many seconds ago it was read last time, and if this time is not more than the value PARAMACTUAL, then upgrade option will not be read and the last read value of the parameter will be accepted as current one. Thus, if the total program consists of several files, reading the same parameters, the number of readings of these parameters and the excessive load on the communication channels can be reduced.<br>For the value 0 – with each update the parameter values will be read again.<br>By default, if a modifier is not specified, it equals to 0. |
| **PARAMRETRIES** <uchar> | **Number of times to repeat reading in case of error**: The value 0 for the programming cycle there will not be more than one attempt to read the parameter. For 1 – it will be made up to two attempts to read, etc. Calculations and reaction to conditions can be performed even without a successful reading of all parameters, if they have sufficient known data.<br>By default, if a modifier is not specified, it equals to 0. |
| **PARAMTIMEOUT** <int> | **Time of waiting for response to MODBUS query in milliseconds**: It is used if in the settings of EM-481 the total timeout MODBUS is more than frequency of update of this file, or if the exception code generation is disabled if no MODBUS response.<br>By default, if a modifier is not specified, it equals to 1000. |
| **PARAMLOADRATIO** <uchar> | **Maximum load of RS-485 channel, in percent**: After each query a delay is added, depending on the waiting time of the last response that allows other clients to send queries and receive responses. A value of 100 generates the minimum possible delays (it is not recommended). A value of 50 means a delay equal to the time of waiting for a response. A value of 25 means a delay of 3 times exceeding the response time.<br>By default, if a modifier is not specified, it equals to 25. |

Example:

```
!META
* PROTOCOLVERSION 6
* UPDATE 5
```

### 2.2. DEVICES Section

It contains the capabilities of MODBUS devices, the settings of not specified here devices will be treated the same as for the device with maximum features and functions. The lines in this section do not have numbering, instead of an index is “*”. Each line has the following format:

```
* <MODBUS ID of device> <record type> <argument 1> [argument 2]
```

MODBUS device ID: a number from 1 to 247. “0” – is the broadcast, it can be used to configure recording simultaneously to all devices that support the broadcasting (the argument 1 in this case is defined, but not used). "*" instead of the MODBUS ID means a device by default for this folder (EM-481, if the file is placed directly in the program folder, or device with the MODBUS ID of the name of the subfolder, if the file is placed in the subfolder named "1" to "247").

Lines with different types or arguments, but with the same MODBUS ID are not permitted. These lines being in different files in the folder of programs are also considered to be incorrect.

Arguments type: `<uchar>` – 8-bit unsigned integer.

**Table C.3** – Types of records

| | |
|---|---|
| **WRHANY** <uchar> <uchar> | **Device can write both as a function of 6 and function of 16 in the storage registers**. The first argument specifies how many registers can be read in one query; the second one determines how many you can record in a single query. |
| **WRHMULTIPLE** <uchar> <uchar> | **Device can write only using function 16 in the storage registers**. The first argument specifies how many registers can be read in one query; the second one determines how many you can record in a single query. |
| **WRHSINGLE** <uchar> | **Device can write only using function 6 in the single storage register**. The argument specifies how many registers can be read in one query. |
| **WRHDENIED** <uchar> | **Device can't write to the storage registers**. The argument specifies how many registers can be read in one query. |

Example:

```
!DEVICES
* * WRHANY 50 50
* 3 WRHSINGLE 4
```

### 2.3. PARAMS Section

It contains parameters, their addressing, and conversion between types (how they are used by the device). When reading the settings are always converted from the specified type to the default type for the program EM-481 (INT32 – 32-bit signed integer). When recording the inverse transform is performed. The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <MODBUS ID of device> <data type> <register table> <address>
```

Index: the sequential number of the line.

MODBUS ID of device: a number from 1 to 247. “0” – is the broadcast, it can be used for writing only. "*" instead of the MODBUS ID means a device by default for this folder (EM-481, if the file is placed directly in the program folder, or device with the MODBUS ID of the name of the subfolder, if the file is placed in the subfolder named "1" to "247").

Tables of registers:

- `H` - storage registers (most frequently used registers)
- `I` - input registers;
- `D` - digital inputs;
- `C` – tabs.

Address: a number from 0 to 65535.

**Table C.4** – Data types

| | |
|---|---|
| **UINT16** | **16-bit unsigned integer**. It occupies one register. |
| **INT16** | **16-bit signed integer.** |
| **INT16BLE** | **16-bit signed integer with reverse order of byte transfer.** |
| **INT32** | **32-bit signed integer**. It occupies 2 registers. |
| **INT32BLE** | **32-bit signed integer with reverse order of bytes.** |
| **INT32WLE** | **32-bit signed integer with reverse order of words.** |
| **BIT** | **1-bit value for the digital inputs and flags.** |
| **INT32BE** | **32-bit signed integer.** For compatibility, the analog to **INT32**. |
| **F32EP0R** | **32-bit rounded to an integer with floating point.** |
| **F32EP1R** | **32-bit with floating-point, multiplied by 10, rounded.** |
| **F32EP2R** | **32-bit with floating-point, multiplied by 100, rounded.** |
| **F32EP3R** | **32-bit with floating-point, multiplied by 1000, rounded.** |
| **F32BLEEP0R** | **32-bit with reverse order of bytes and floating-point.** |
| **F32BLEEP1R** | **32-bit with reverse order of bytes and floating-point *10.** |
| **F32BLEEP2R** | **32-bit with reverse order of bytes and floating-point *100.** |
| **F32BLEEP3R** | **32-bit with reverse order of bytes and floating-point *1000.** |
| **F32WLEEP0R** | **32-bit with reverse order of words and floating-point.** |
| **F32WLEEP1R** | **32-bit with reverse order of words and floating-point *10.** |
| **F32WLEEP2R** | **32-bit with reverse order of words and floating-point *100.** |
| **F32WLEEP3R** | **32-bit with reverse order of words and floating-point *1000.** |

Example:

```
!PARAMS
0 3 UINT16 H 240
```

### 2.4. VARS Section

It contains variables, processing the parameters and other calculations (e.g. the sum of the parameters). The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <source type> <argument 1> [argument 2]
```

Index: the sequential number of the line.

The types of the arguments:

- `<bit number>` - is the bit number of the parameter from 0 and above. For 16-bit parameters it is no more than 15. For 32-bit parameters it is not more than 31;
- `<int>` - 32-bit signed integer;
- `<param ref>` - parameter reference of format Pn, where n is index of the parameter;
- `<var ref>` - variable reference of format Vn, where n is index of the variable.

**Table C.5** – Types of sources

| | |
|---|---|
| **COPY** <var ref> | **Copy the variable.** |
| **VAL** <int> | **Set to the specified value.** |
| **PARAMVAL** <param ref> | **Copy the value of the parameter.** |
| **PARAMBIT** <param ref> <bit number> | **Copy one bit of the parameter value.** |
| **PARAMERC** <param ref> | **Copy the last error code of MODBUS parameter.** |
| **PARAMERN** <param ref> | **Copy the error counter of reading the parameter** (it is reset to 0 after successful reading, and is incremented by 1 after each update, for which read attempts of the parameter was terminated). |
| **VARADDVAR** <var ref> <var ref> | **Sum of two variables.** |
| **VARMULVAR** <var ref> <var ref> | **Product of two variables** |
| **VARSUBVAR** <var ref> <var ref> | **Difference of two variables** |
| **VARDIVVAR** <var ref> <var ref> | **Quotient of two variables (the remainder is discarded)** |
| **VARSMIN** <var ref> <var ref> | **The minimum of all variables in the specified range** |
| **VARSMINIDX** <var ref> <var ref> | **The number of the minimum variable in the specified range** |
| **VARSMAX** <var ref> <var ref> | **Maximum of all variables in the specified range** |
| **VARSMAXIDX** <var ref> <var ref> | **The number of the maximum variable in the specified range** |
| **VARSSUM** <var ref> <var ref> | **The sum of all variables in the specified range** |

Example:

```
!VARS
0 PARAMBIT P0 0
```

### 2.5. STRS Section

It contains the text used as message for actions. The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <text>
```

Index: the sequential number of the line.

Special sequences in the line text:

- `*U*` - MODBUS ID by default;
- `*<var ref>*` - variable reference, such as `*V2*`
- `**` - means a single character *

Example:

```
!STRS
0 *U* - awaria 21: korotkoe zamykanie TS2
```

### 2.6. PHONES Section

It contains texts that are used for addressing SMS. The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <text(phone number)>
```

Index: the sequential number of the line.

Example:

```
!PHONES
# Ivanoff - comment
0 0671234566
```

### 2.7. CONDS Section

It contains conditions that compare variables. The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <condition type> <argument 1> [argument 2]
```

Index: the sequential number of the line.

The types of the arguments:

- `<int>` - 32-bit signed integer;
- `<cond ref>` - reference to the condition of the format Cn, where n is the index of conditions;
- `<var ref>` - reference to the variable of format Vn, where n is the index of the variable;

**Table C.6** – Condition types

| **IF** <cond ref> | **Copy of the condition** |
|---|---|
| **NOT** <cond ref> | **Logical NOT**. The condition is satisfied, when the referred condition did not happen and vice versa. |
| **AND** <cond ref> <cond ref> | **Logical AND**. Condition is satisfied, when both refereed conditions happened. |
| **OR** <cond ref> <cond ref> | **Logical OR**. The condition is satisfied, when any referred conditions occurred. |
| **VAREQVAR** <var ref> <var ref> | **Comparison of two variables**. The condition is fulfilled, if they are equal. |
| **VAREQVAL** <var ref> <int> | **Comparison of a variable with a specified value**. The condition is fulfilled when a variable by reference is equal to the specified value. |
| **VARGRVAR** <var ref> <var ref> | **Comparison of two variables**. The condition is fulfilled when the first variable by reference is more than the second variable. |
| **VARGRVAL** <var ref> <int> | **Comparison of a variable with a specified value**. The condition is fulfilled when a variable by reference is more than the specified value. |
| **VARGEVAR** <var ref> <var ref> | **Comparison of two variables**. The condition is fulfilled when the first variable by reference is more or equal to the second variable. |
| **VARGEVAL** <var ref> <int> | **Comparison of a variable with a specified value**. The condition is fulfilled when a variable by reference is more or equal to the specified value. |

Example:

```
!CONDS
0 VAREQVAL V0 1
1 NOT C0
```

### 2.8. ACTS Section

It contains actions that can be performed (action is performed only by references from the section of the reactions **REACTS**, during the performance of the conditions indicated there). The lines in this section are in ascending order, starting from zero. Each line has the following format:

```
<index> <action type> <argument 1> [argument 2]
```

Index: the sequential number of the line.

The types of the arguments:

- `<int>` - 32-bit signed integer;
- `<alarm reason>` - is the number of reason of the alarm – when any of the alarms is enabled, red LED of alarm is on, so to turn off the indicator, each of them needs to be turned off;
- `<param ref>` - reference to the parameter of format Pn, where n is the index of the parameter;
- `<phone ref>` - reference to the phone of format Hn, where n is the index of the phone;
- `<str ref>` - reference to the line of format Cn, where n is the index of the line;
- `<var ref>` - reference to variable of format Vn, where n is the index of the variable.

**Table C.7** – Types of actions

| | |
|---|---|
| **ALARMON** <alarm reason> | **Turn on alarm LED**. Red LED alarm will be on to the action of ALARMOFF with the same number of <alarm reason>. |
| **ALARMOFF** <alarm reason> | **Turn off alarm LED** |
| **PARAMWRVAR** <param ref> <var ref> | **Record the parameter with the value of the variable** |
| **PARAMWRVAL** <param ref> <int> | **Record the parameter with the set value** |
| **SENDSMS** <phone ref> <str ref> | **Send SMS** |

Example:

```
!ACTS
0 SENDSMS H1 S0
1 PARAMWRVAL P0 31
```

### 2.9. REACTS Section

It contains the responses, a list of actions that must be performed under specified conditions. Lines do not have numbering, instead of an index is "*". Each line has the following format:

```
* <cond ref> <response type> <act ref>
```

The types of the arguments:

- `<cond ref>` - reference to the condition of the format Cn, where n is the index of the condition;
- `<act ref>` - reference to the action of format An, where n is the index of the action.

**Table C.8** – Types of responses

| | |
|---|---|
| <cond ref> **ACT** <act ref> | **Perform once**. If the condition occurred, but did not occur in the previous update, the action will be performed once |
| <cond ref> **REPEAT** <act ref> | **Perform each time**. Regardless of the previous state, the action will be executed. The action will be executed even, if the state conditions are not defined in this update due to reading errors, but this condition has already happened earlier |

Example:

```
!REACTS
* C0 ACT A0
* C1 REPEAT A1
```

## 3. Examples of programs

Below there are examples of finished programs, each consists of a single task file. To run the sample on the EM-481 it is necessary:

1) Create a text file (with the extension **".txt"**) and program text.
2) Put the file in the folder **"TASKS"**.
3) Put the prepared folder to the memory microSD card, formatted in FAT or FAT32.
4) Put the memory card in the EM-481.

### 3.1. Example 1

This example describes a program that in the event of fault of the device will send SMS with warning. In the text 3 – MODBUS ID of the device is OM-310; 240 – is the register address which is monitored for the fault.

```
#enabling relay 1 depending on bit 0 of register 240 of device 3

!META
#6th version of Protocol
*PROTOCOLVERSION 6
#program run will be fulfilled every 3 seconds
* UPDATE 3
#in case of error of the parameter reading, it will be read again 2 times
* PARAMRETRIES 2
```

```
#limit of response waiting for MODBUS query is 1000 msec = 1 sec
* PARAMTIMEOUT 1000
#after each query the delay is added, equal to the response waiting time,
#so the other clients can perform their queries
* PARAMLOADRATIO 50

!DEVICES
#EM-481 can read and record no less than 120 registers per one query
#note the second character * - it is MODBUS ID of the EM-481 device
* * WRHANY 120 120
#OM-310 has MODBUS ID equal to 3 and allows reading 4 registers per one query,
#but to record only one register per one query
* 3 WRHSINGLE 4

!PARAMS
#during each updating, it is required to read the storage register with address
240,
#from the device with MODBUS ID equal to 3
#UINT16 – means that the 16-bit value and unsigned one (it can't be less than 0)
0 3 UINT16 H 240

!VARS
#copy zero bit of the register 240
#now in the variable the parameter value is 240.0
0 PARAMBIT P0 0

!CONDS
#variable V0 is compared with 1, condition is met, if V0 = 1
0 VAREQVAL V0 1
#condition is met, if the previous condition is not fulfilled and vice versa
1 NOT C0

!STRS
#SMS text
0 OM-310 (3) – avaria

!PHONES
#below the phone to receive SMS can be specified
0 01234567

!ACTS
#send SMS
0 SENDSMS H0 S0

!REACTS
#if the condition C0 is met (if 240.0 = 1), then send one SMS
* C0 ACT A0

#END - comment at the end of the file for correct reading
```

### 3.2. Example 2

In this example, the program controls the hysteresis value on the second channel of the TR-101 device, depending on the temperature on the sensor of the first channel. In the text 16 – MODBUS ID of the device is TR-101; 4 - address of the channel temperature register 1; 47 is the address of register for the hysteresis of the second channel.

The program uses registers in the field of current user settings 5500-5749. Registers 5500 and 5501 are reserved for the values respectively of the lower and upper temperature limits and the registers 5502 and 5503 are for the hysteresis value to be set in TR-101 if achieving the temperature respectively the lower or upper limits. These registers are read-only. To change them, you should be in configuration mode (see it. 5.3.4), then write the desired values to addresses of the respective editable settings. These addresses are obtained by subtracting 250 from the address current value. Thus, temperature limits are recoded into the registers 5250 and 5251, and the hysteresis – 5252 and 5253. Then, in order for the changes to take effect, you need to give the commands "Save" and "Apply" (for example by writing 4 to the register 120).

```
!META
* PROTOCOLVERSION 6
#program will run every 20 seconds
* UPDATE 20

!DEVICES
* * WRHANY 120 120
#TP-101 has MODBUS ID as 16 and can read no less than 100 registers per a query,
#but to record by one register per one query
* 16 WRHSINGLE 100

!PARAMS
#INT16 – registers with sign, as the temperature can be less than 0
0 * INT16 H 5500
1 * INT16 H 5501
#UINT16 – as the hysteresis is no less than 0
2 * UINT16 H 5502
3 * UINT16 H 5503
4 16 INT16 H 4
5 16 UINT16 H 47

!VARS
#lower temperature limit
0 PARAMVAL P0
#upper temperature limit
1 PARAMVAL P1
#hysteresis for temperature below the lower limit
2 PARAMVAL P2
#hysteresis for temperature above the upper limit
3 PARAMVAL P3
#temperature value
4 PARAMVAL P4
#hysteresis value
5 PARAMVAL P5

!CONDS
#is the temperature higher than the upper limit?
0 VARGEVAR V4 V1
#is hysteresis set for the desired value for the upper limit?
1 VAREQVAR V5 V3
2 NOT C1
#if temperature is higher than limit, and hysteresis is not set to the desired
value
3 AND C0 C2
#is temperature below the lower limit?
4 VARGEVAR V0 V4
#is hysteresis set for the desired value for the lower limit?
5 VAREQVAR V5 V2
6 NOT C5
#if temperature is below the limit and hysteresis is not set to the desired value
7 AND C4 C6

!ACTS
#record to TP-101 the hysteresis for temperature above the upper limit
0 PARAMWRVAR P5 V3
#record to TP-101 the hysteresis for temperature below the lower limit
1 PARAMWRVAR P5 V2

!REACTS
* C3 REPEAT A0
* C7 REPEAT A1

#program is completed
```

## Appendix D
## (recommended)

## Updating of firmware

**1. General**

EM-481 uses the "EM481FW1.FUS", "EM481FW2.FUS" or "EM481FW3.FUS" files in the "UPGRADES" folder on the SD memory card formatted in FAT or FAT32 format to update the firmware (hereinafter software).

Updating one of these files can be done in the firmware update mode.

**2. Transmission of files to update EM-481**

To transfer the update files it is possible in two ways:

1) record files to SD card on a personal computer or other external device and put the card into the EM-481, then enter the update mode of the firmware, as shown in Table D.1;

2) if updating via WEB interface is permitted in the parameter settings, tab "Other" (see it. 5.3.3), go to the tab "Files", select the firmware file and click the button "Upload file". The file will be written to the folder "UPGRADES" with the name "EM481FW2.FUS". Then click "Program". The firmware update will be done automatically for 3-4 minutes.

**2. Update mode of firmware**

EM-481 can be set in mode of firmware updating after power supply and restart. The setting in that mode is made automatically (in case of updating failure) or manually (if the button **"R"** being pressed during startup). The procedure of entering in mode of updating is given in Table D.1.

**Table D.1** – Entering the mode of firmware updating

| No. | Step | "R" button | Display | Time | Remark |
|---|---|---|---|---|---|
| 1 | Initialization | Pressed | | 0.5 s | To cancel the updating, release **"R"** button during these steps |
| 2 | Stand-by | Pressed | | 1 s | |
| 3 | Notification about entering in mode of updating | Pressed | Entering upgrade mode | 5 s | |
| 4 | Offer to enter the mode of updating | Pressed | To enter upgrade mode - release button | 2 s | To enter the mode of software updating, release **"R"** button during this step |
| 5 | Protection against incidental pressing | Pressed | – | – | Holding the button pressed will cancel the firmware updating |

After manual entering in mode of updating, select the file of updating. The procedure for file selection is given in Table D.2. To cancel the updating, cut off the power supply of EM-481 or wait until automatic completion of updating mode.

**Table D.2** – Selection of updating file

| No. | Step | "R" button | Display | Time | Remark |
|---|---|---|---|---|---|
| 1 | Finding the available files | | Searching for upgrade files | (depends on the found files) | |
| 2 | Notification about entering in mode of updating | Released | Name and version of updating file | 5 s | To select a file, press and release **"R"** button at this step |
| 3 | Offering all files of updating | Released | – | (depends on the found files) | Repeat the step 2 for each file |
| 4 | Repeated offer | Released | – | (depends on time of step 4) | Repeat the steps 2-3 for 3 times |
| 5 | Protection against incidental entering in the mode of updating | Released | – | – | The file cancelation cause the escape from the mode of firmware updating |

At automatic entering into the mode of firmware updating or at manual selection of file, the updating is made from the file. The procedure of updating is described in Table D.3.

**Table D.3** – Updating of firmware

| No. | Step | "R" button | Display | Time | Remark |
|---|---|---|---|---|---|
| 1 | Start of firmware updating | – | ATTENTION! Firmware updating | 2 – 10 s | |
| 2 | Firmware updating | – | (performance line shows the process of updating) | (depends on the file of updating) | Time until the end of process of updating is shown on the display. |
| 3 | Updating is successfully completed | – | Updating is successfully completed! | 5 s | |
| 4 | Startup of firmware | – | – | – | |

The errors detected during the updating process are shown on the display. The possible errors during the updating of firmware are listed in Table D.4.

**ATTENTION! IF THERE ARE CRITICAL ERRORS DURING THE UPDATING MODE THE OPERATION OF THE EM-481 DEVICE IS NOT POSSIBLE.**

In this case the indication of a critical error is made during an hour, after that the EM-481 device automatically restarts. If an error is as a result of incidental event, the firmware will be restored from the file on the memory card.

**Table D.4** – Codes of warning in firmware updating mode

| Code | Warning | Actions | Remark |
|---|---|---|---|
| 2 | Firmware cannot be started | Initialization of mode of emergency updating:<br>Auto start of updating from the selected file or from the first available file (if any) | The warning is as a result of other error and is automatically corrected with the help of available files of software updating |
| 3 | Error while current process of firmware updating | Similar to No.2, but the file with an error has less priority | The error is automatically corrected with available files of updating |
| 4 | The files of updating are not available | Escape from the mode of updating, start of available firmware | EM-481 device can continue operation but for reprogramming the file of updating should be loaded in the folder «UPGRADES» on the device SD memory card |
| 5 | Emergency mode - firmware cannot be started | Waiting for manual restart of device or restart automatically in 1 hour | The error is a result of three-time entering in emergency mode as a result of other errors. The correct file of firmware updating should be loaded in the folder «UPGRADES» on the SD memory card. If the error is repeated, contact the manufacturer. |
| 6 | Emergency mode - error during the current firmware updating | Waiting for manual restart of device or restart automatically in 1 hour | The error is a result of three-time entering in emergency mode as a result of other errors. The correct file of firmware updating should be loaded in the folder «UPGRADES» on the SD memory card. If the error is repeated, contact the manufacturer. |
| 7 | Unrecoverable error - no available files of updating, the firmware cannot be started | Waiting for manual restart of device or restart automatically in 1 hour | The error is a result of three-time entering in emergency mode as a result of other errors. The correct file of firmware updating should be loaded in the folder «UPGRADES» on the SD memory card. If the error is repeated, contact the manufacturer. |