engineering center
energoservice

Remote terminal unit ENCS-3m

Manual

ENCS.403500.001. Rev. 10.2023

Table of contents

Introduction **4**

Glossary **7**

1 Description **8**

1.1 Purpose 8
1.2 ENCS-3m...-1, ENCS-3m...-2 10
1.3 ENCS-3m...-3, ENCS-3m...-4, ENCS-3m...-5 12
1.4 Design and dimensions 13

2 Specifications **16**

2.1 Operating conditions 16
2.2 Power supply 16
2.3 Interfaces 17
2.4 GT-module 20
2.5 Reliability indicators 22
2.6 Electromagnetic compatibility and isolation 22

3 Data collection and processing **26**

3.1 General Information 26
3.2 IEC 60870-5-101/104 26
3.3 Modbus RTU/TCP 27
3.4 IEC 61850 8-1 (GOOSE) 27
3.5 IEC 61850 8-1 (MMS) 27
3.6 IEC 60870-5-103 28
3.7 SNMP 28
3.8 SPA-Bus 28
3.9 SPODES 29
3.10 Electricity meters 30
3.11 Transducers 30
3.12 Relay protection and automation devices 31
3.13 I/O modules 31
3.14 Time synchronization 31
3.15 Automatic control 32
3.16 Additional calculation parameters 32

4 Data transfer **34**

4.1 IEC 60870-5-101/104 34
4.2 IEC 61850 8-1 (GOOSE, MMS) 35
4.3 Modbus RTU/TCP 36
4.4 Remote control 36
4.5 Parameter quality attributes 37
4.6 Storage of retrospective measurements and states 37
4.7 Manual input and locking values 38

5 Functionality **40**

5.1 Event logs 40
5.2 Configuring the RTU 42

5.3 Redundancy 43
5.4 "End-to-end channel" mode 47
5.5 Port forwarding (NAT) 49
5.6 Time synchronization 49
6 Package content 51
7 Operation 52
7.1 Limitations 52
7.2 General Instructions 52
7.3 Connecting to interfaces 53
7.4 Data exchange with external devices 54
8 RTU setup 57
8.1 Firmware update 57
8.2 Configuration of ENCS-3m 58
8.3 Finding a device on the local network 59
8.4 Reset settings to default values 60
9 Maintenance 62
9.1 General instructions 62
9.2 Safety 62
9.3 Maintenance procedure 62
9.4 Service Center 64
10 Transportation and storage 65
11 Packaging 66
12 Warranty 67
13 Statement of spare parts 68
Appendix A. Agreements sheet on the compatibility of a telemechanical system based on RTU ENCS-3m in accordance with IEC 60870-5-101-2006 / IEC 60870-5-104-2004 69
Appendix B: Modbus Protocol 83
Appendix C: Simple Network Management Protocol (SNMP) 86
Appendix D: IEC 61850 protocol 87

Introduction

This operating manual of ENCS-3m remote terminal unit (RTU) is intended to familiarize the consumer with the technical characteristics, functions and provide the information necessary for the proper operation of RTU. The manual contains technical data, description of operation, instructions for installation and use, maintenance, packaging, transportation and storage, as well as diagrams for connecting the RTU to power supply circuits and digital interfaces.-

Attention! This manual applies only to ENCS-3m hardware version 4.0 and higher (**2018** year of release and newer).

Read the manual before using RTU.

The terms used in this manual complies with GOST 26.005.82.

Target group

This manual is intended for personnel involved in the design, installation and commissioning of devices.

Scope

The manual applies to ENCS-3m hardware version 4.0 and higher (serial number with 1713) and software version 30.15.2 8 (for hw 4) or 1.5.9 (for hw 5).

Support

If you have any questions related to the RTU, please contact the technical support service of Engineering Center Energoservice:

Official website:	http://www.enip2.ru/en
Telephone:	+7 (8182) 65-75-65
Email:	enip2@ens.ru

Differences between hardware versions of ENCS-3m

Symbol	ENCS-3m...-1 ENCS-3m...-2	ENCS-3m...-1 ENCS-3m...-2	ENCS-3m...-1 ENCS-3m...-2	ENCS-3m...-3 ENCS-3m...-4 ENCS-3m...-5
Hardware Version (hw)	**4.0**	**4.1**	**4.2, 4.3**	**5**
Firmware Version	30.15.28	30.15.28	30.15.28	1.5.9
Optical Interfaces	-	-	-	2 x SM or MM
CAN Redundancy	+	+	+	-
PRP/RSTP Redundancy	-	-	+	+
Nonvolatile event logs	-	+	+	+
PTPv2 Synchronization	-	-	+	-
GPS/GLONASS Synchronization	Optional	Optional	Optional	-
2G/3G	Optional	Optional	Optional	-
Available for ordering	-	-	+	+
Notes	Serial number from 1713		Serial number from 6930 (06.2022 and newer)	

Note: Use the RTU only as directed in this manual.
Installation and maintenance of the RTU is carried out only by qualified and trained personnel.
The RTU should be saved from impacts.
Connect the RTU only to a power supply with a voltage corresponding to that indicated on the label.

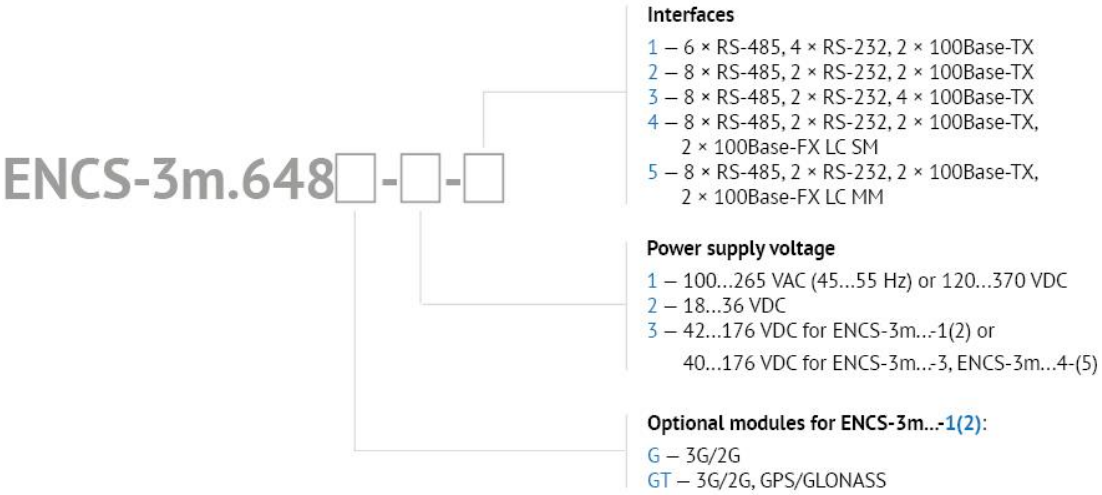
Attention! The software is constantly being improved and supplemented with new functional settings of the RTU. The manufacturer reserves the right to make changes and improvements to the software without notifying consumers.

Changes in legend

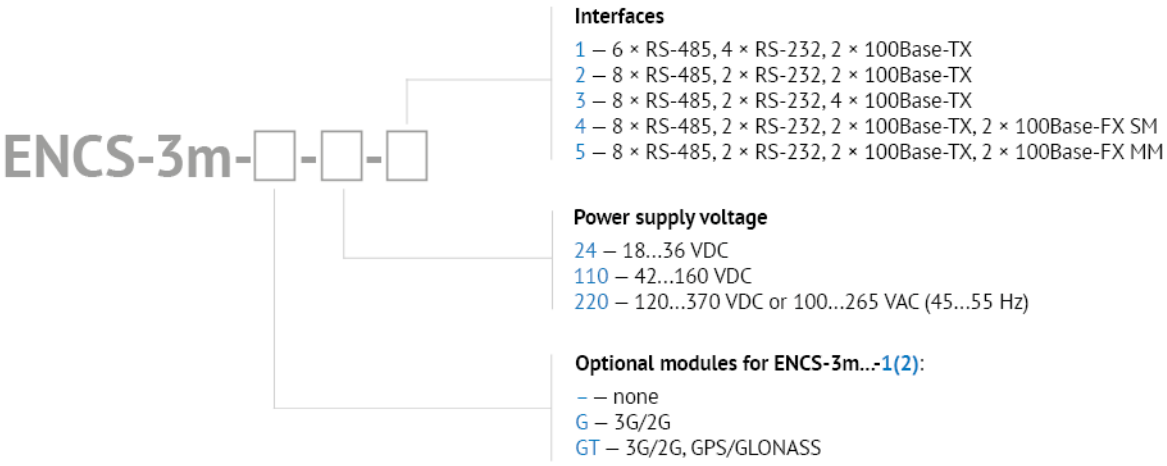
From 02.2023, the symbols of RTU ENCS-3m has changed, while the functions of the device, technical and operational characteristics have remained the same. Correspondence of the old and new symbols:

Until 02.2023	Actual symbols
ENCS-3m.648-1-2	ENCS-3m-220-2
ENCS-3м.648GT-2-1	ENCS-3м-24-1GT
ENCS-3m.648-3-3	ENCS-3m-11 0-3

The symbols until 02.2023:



The current symbols:



Glossary

- GLONASS – Global Navigation Satellite System;
- MMT – multifunctional measuring transducer;
- PC – personal computer;
- RTU – remote terminal unit;
- GOOSE (Generic Object Oriented Substation Event) is a transmission protocol according to IEC 61850 8-1 standard;
- GPS (Global Positioning System) is a satellite navigation system that measures distance, time and determines the location in the WGS 84 worldwide coordinate system;
- LC– small form factor fiber-optic connector;
- MM – multi-mode optical fiber;
- PRP – Parallel Redundancy Protocol;
- RS-TCP – "end-to-end channel" mode;
- SM – single-mode optical fiber;
- UTC - Universal Coordinated Time.
- LAN – local area network
- DI – digital input
- DO – digital output
- AI – analog input
- COT – cause of transmission
- IOA – information object address

1 Description

1.1 Purpose

1.1.1 RTU ENCS-3m is designed to work as part of systems for collecting and transmitting telemetry information at power facilities of various levels. The system for collecting and transmitting information based on the RTU is a geographically distributed system. At the field (lower) level devices that provide telemetry (MMT, electricity meters, etc.), remote alarm and control (relay protection and automation devices and bay controllers, discrete signal output modules, etc.) are located. The devices are combined into and LAN and RS-485 networks.

1.1.2 The RTU performs the following functions:

- data collection (discrete and analog signals) from lower-level devices: MMT, electricity meters, relay protection and automation devices and bay controllers, discrete and analog signal input/output modules, data acquisition devices, etc.;

- data transmission to a higher level in accordance with IEC 608705101, IEC 60870-5-104, --Modbus RTU/TCP and optionally IEC 61850;

- receiving remote control commands from a higher level and transmitting them to devices at a lower level;

- reception of precise time signals from GLONASS/GPS systems (optional) or synchronization via SNTP v4, IEC 60870-5-101, IEC 60870-5-104 and PTPv 2 protocols (only in hw 4.2 and higher versions) with subsequent synchronization of lower-level devices via standard or proprietary protocols.

1.1.3 RTU is not a measurement instrument. Performing the functions of collecting and transmitting telemetry, the RTU does not affect the metrological characteristics of the measuring channels.

1.1.4 The RTU is designed to transmit data via digital communication channels. When using low-speed data links, the requirement of an optimal ratio between the data rate and the amount of data transmitted must be met.

Wired (cable and overhead, multiplex and non-multiplex) channels, high-frequency channels over overhead lines and distribution networks, radio and radio relay communication channels, GSM/3G-network, satellite communications can also be used as communication channels.

Information can be transmitted simultaneously via several independent communication channels. The RTU is interfaced with channeling equipment using RS-232/RS-485 (IEC 60870-5-101, Modbus RTU) and Ethernet (IEC 60870-5-104, IEC 61850, Modbus TCP) interfaces.

1.1.5 It is allowed to use RTU at facilities without permanent personnel on duty.

1.1.6 ENCS-3m is based on a microcontroller with firmware specially developed for it.

1.1.7 RTU symbols:

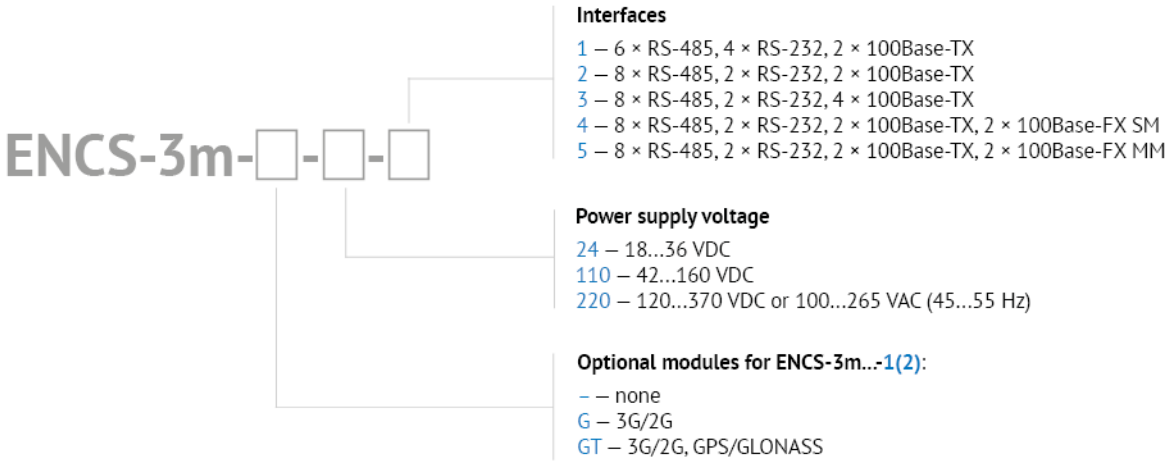


Figure 1.1. Symbol

1.2 ENCS-3m...-1, ENCS-3m...-2

1.2.1 The appearance of modifications is shown on Fig. Figure 1.2:

Figure 1.2. Appearance of ENCS-3m hw 4.1 (left) and ENCS-3m hw 4.2 (right)

Note: From 06.2022, devices of these modifications are available with an updated hardware version (4.2 and higher). The main differences from previous versions: LAN ports are located on the top panel of the device, the CAN port has been moved to the bottom panel, PRP, RSTP, PTPv2 protocols are supported.

1.2.3 The front panel contains device name, the marking of interfaces, power terminals, LED indicators, as well as the serial number, date of manufacture and QR code to access the device page with a detailed description. There are interfaces in the form of RJ45 connectors, a complete modification of the device, serial number, date of issue, hardware platform version, supply voltage type, information about factory settings of Ethernet interfaces on the top panel.

1.2.4 The power is connected to the RTU using the screw terminals in the lower left corner. If there is power, the LED above the inscription "POWER" lights up.

1.2.5 The protective ground is connected to the terminal indicated by the symbol: ⏚

1.2.6 Available interfaces:

- RS-485 – 6 or 8 pcs.
- RS-232 – 4 or 2 pcs.

- Ethernet 100 Mbit/s – 2 pcs.

1.2.7 Modifications ENCS-3m-...G (GT) has a SIM card slot on the rear of the device (the card is inserted with the cut forward and contacts towards the "SIM" label) and a USB port connector (Mini-B connector type) for configuring the GT module (see Fig. 1.3), as well as connectors for GSM/3G and GPS/GLONASS antennas on the top panel.

Figure 1.3. The rear side of the ENCS-3m modification-...GT

1.2.8 LED indicators description is given in Table 1.1:

Table 1.1. Description LEDs

LED	Description
Power	power supply status
LAN-1	data exchange via LAN-1 interface
LAN-2	data exchange via LAN-2 interface
COM 1...10	data exchange via COM-1... COM-10 interfaces
M1	communication between the main board and the GT module board
M2	lit constantly - the device is ready; lit with a change of color - data exchange with slave RTU during parallel operation; flashing (often) - data exchange with the master RTU during parallel operation; flashing once per second - operation of firmware bootloader

1.3 ENCS-3m...-3, ENCS-3m...-4, ENCS-3m...-5

1.3.1 The appearance of the modifications is shown in Fig. 1.4:

Figure 1.4. Appearance of ENCS-3m-220-3 (left) and ENCS-3m-220-4(5) (right)

1.3.2 The front panel contains device name, the marking of interfaces, power terminals, LED indicators, as well as the serial number, date of manufacture and QR code to access the device page with a detailed description. There are interfaces in the form of RJ45 connectors, a complete modification of the device, serial number, date of issue, hardware platform version, supply voltage type, information about factory settings of Ethernet interfaces on the top panel.

1.3.3 The power is connected to the RTU using the screw terminals in the lower left corner. If there is power, the LED under the symbol ⏻ lights up.

1.3.4 The protective ground is connected to the terminal indicated by the symbol: ⏚

1.3.5 Available interfaces:

- RS-485 – 8 pcs.
- RS-232 – 2 pcs.
- Ethernet – 4 pcs.

1.3.6 LED indicators description is given in Table 1.2:

Table 1.2. Description of the operation of LEDs

LED	Description
⏻	power supply status
LAN-1... 4	data exchange via the LAN-1... LAN-4 interfaces
COM-1...10	data exchange via the COM-1... COM-10 interfaces

1.4 Design and dimensions

1.4.1 The RTU is supplied for use on panels or in telemetry cabinets.

1.4.2 The RTU is mounted on a DIN rail. It is necessary to provide power to the RTU in accordance with the marking, as well as surge protection of all interfaces.

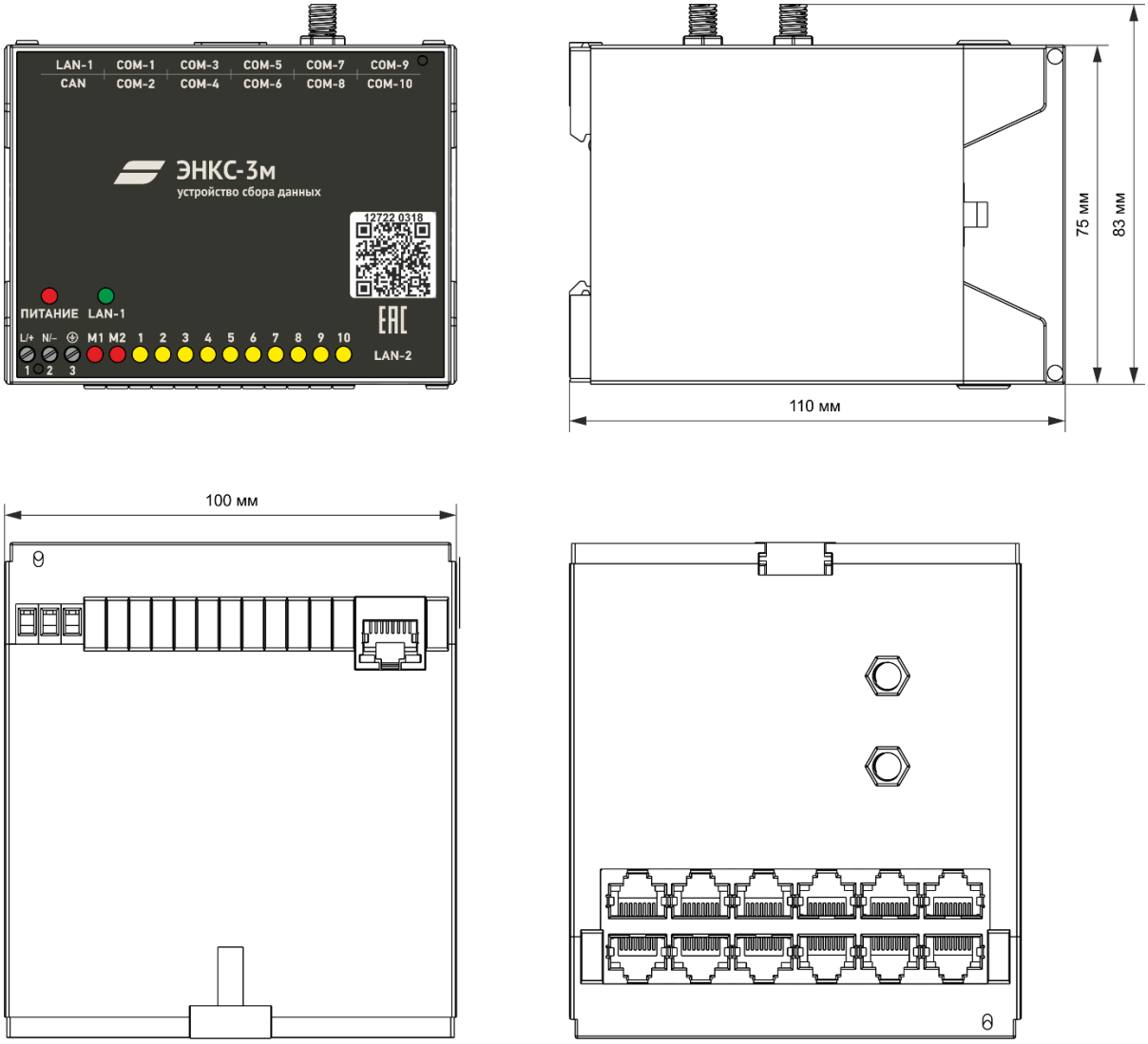


Figure 1.5. Overall dimensions of ENCS-3m-... 1GT, ENCS-3m-... 2GT

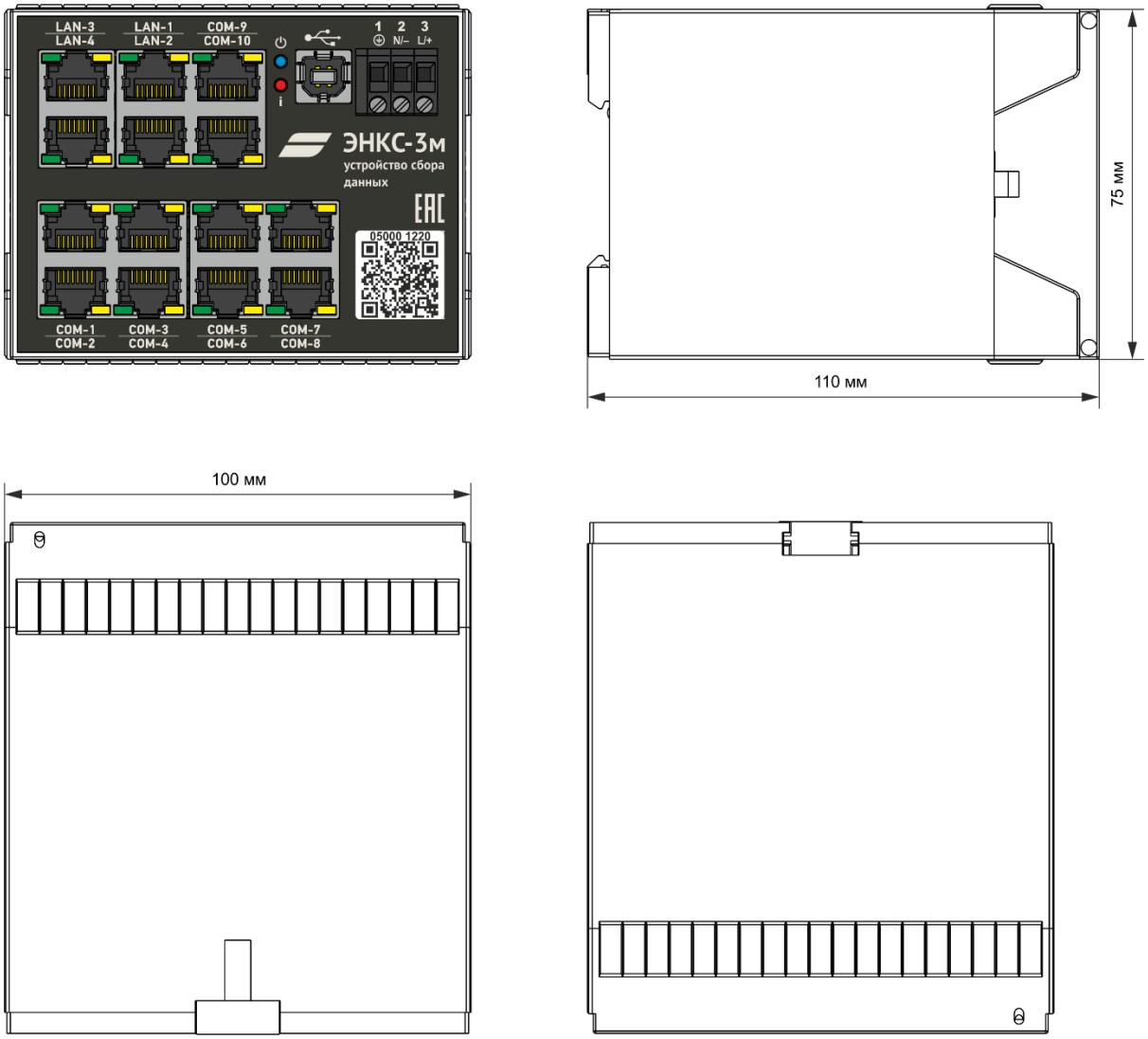


Figure 1.6. Overall dimensions of ENCS-3m-...-3

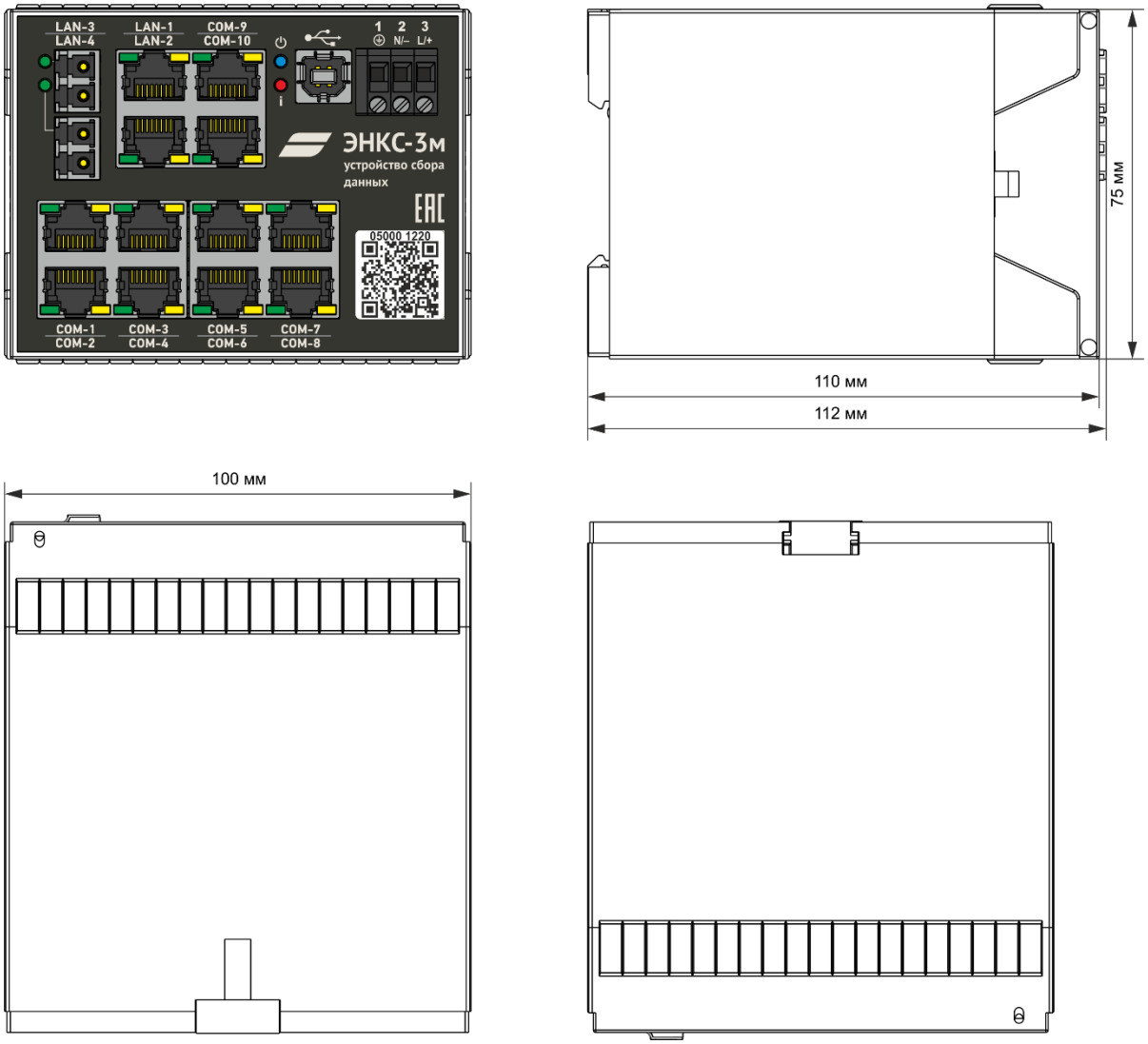


Figure 1.7. Overall dimensions of ENCS-3m-...-4, ENCS-3m-...-5

1.4.3 The overall dimensions and weight of the devices are given in Table. .3

Table 1.3. Overall dimensions and weight of devices

Modification	Overall dimensions (H x W x D), mm	Net weight, kg, not more than	Gross weight, kg, not more than	Note
ENCS-3m-...-1 ENCS-3m-...-2	76 × 100 × 110	0,5	1,0	IP40, 35 mm DIN rail mounting
ENCS-3м-...-1GT ENCS-3м-...-2GT	83 × 100 × 110			
ENCS-3m-...-3	76 × 100 × 110			
ENCS-3m-...-4 ENCS-3m-...-5	76 × 100 × 112			

2 Specifications

2.1 Operating conditions

2.1.1 The rated operating conditions of RTU are given in Table. 2.1

Table 2.1. Rated operating conditions

Parameter	Value
Operating Temperature Range	from -40 to +70°C
Relative humidity	up to 95% at 35°C
Atmospheric pressure	65-107 kPa (487-803 mmHg)

2.1.2 The maximum height above sea level for the operation is 3500 meters.

2.1.3 RTU should be installed in telemetry cabinets with a degree of protection:

- indoors – not worse than IP21;
- outdoors - not worse than IP55.

2.1.4 Normal operating conditions of RTU are given in Table. 2.2

Table 2.2. Normal operating conditions

Parameter	Meaning
Ambient temperature	from 15 to 25°C
Relative humidity	up to 95%
Atmospheric pressure	65-106.7 kPa (487.5-800 mmHg))

2.2 Power supply

2.2.1 Power supply characteristics are given in Table Table 2.

Table 2.3. Power supply

Parameter	ENCS-3m-220-...	ENCS-3м-**24**-...	ENCS-3m-110-...
Rated voltage	230 VAC, 50 Hz or 220 VDC	24 VDC	110 VDC
Input voltage range	100...265 VAC (45... 55Hz) or 120... 370 VDC,	18... 36 VDC,	ENCS-3m-110-1(2): 42...176 VDC, ENCS-3m-110-3(4/5): 40...160 VDC,
Power consumption	no more than 10 VA		

2.2.2 Power input of ENCS-3m-220-... is universal (both AC and DC voltage can be supplied).

Power input of ENCS-3m-220-... is unipolar (the device will work when a DC voltage of both direct and reverse polarity is connected).

2.2.3 On the power input of modifications ENCS-3m-24-... and ENCS-3m-110-... only direct polarity voltage should be supplied.

2.3 Interfaces

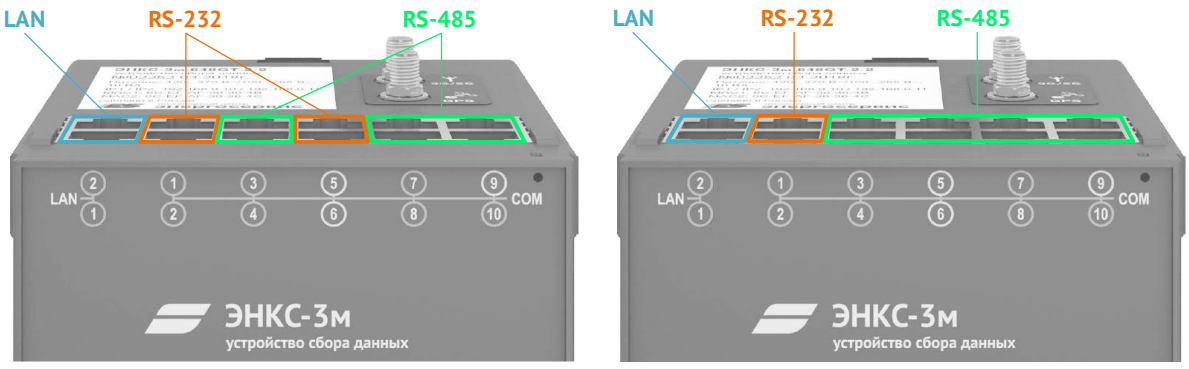
2.3.1 The RTU has RJ45 interface sockets: serial (COM) and network (LAN) ports. The interfaces are designed to poll lower-level devices and to connect to higher level data transmission channels. The list of interfaces, depending on the modification, is given in Table. 2.4

Table 2.4. RTU Interfaces

Interface	ENCS-3m-...-1	ENCS-3m-...-2	ENCS-3m-...-3	ENCS-3m-...-4(5)
COM-1	*RS-232*	*RS-232*	RS-485	RS-485
COM-2	*RS-232*	*RS-232*	RS-485	RS-485
COM-3	RS-485	RS-485	RS-485*	RS-485*
COM-4	RS-485	RS-485	RS-485*	RS-485*
COM-5	*RS-232**	RS-485*	RS-485	RS-485
COM-6	*RS-232**	RS-485*	RS-485	RS-485
COM-7	RS-485	RS-485	*RS-232*	*RS-232*
COM-8	RS-485	RS-485	*RS-232**	*RS-232**
COM-9	RS-485*	RS-485*	RS-485	RS-485
COM-10	RS-485	RS-485	RS-485	RS-485
LAN-1	100BASE-TX	100BASE-TX	100BASE-TX	100BASE-TX
LAN-2	100BASE-TX	100BASE-TX	100BASE-TX	100BASE-TX
LAN-3	-	-	100BASE-TX	100BASE-FX
LAN-4	-	-	100BASE-TX	100BASE-FX
CAN	For redundancy of two ENCS-3m		-	
USB	Mini-B to configure and update the built-in modem		Type-B for configuring and updating the RTU	

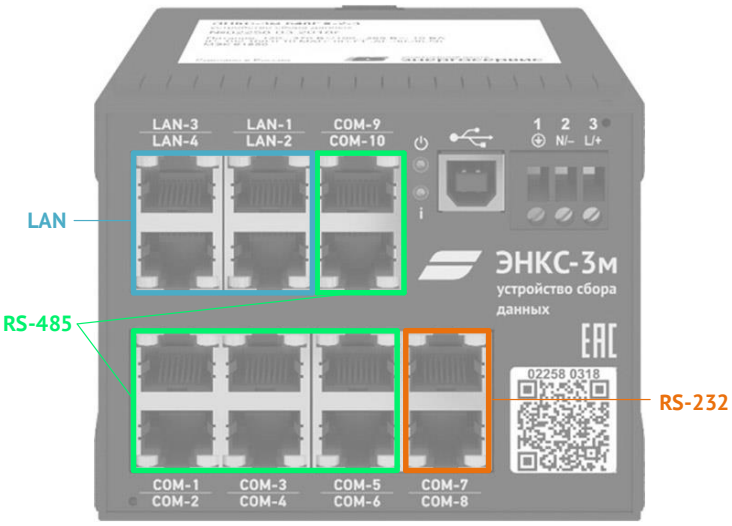
* interface can operate at speeds from 100 to 115200 baud; in other cases, the exchange rate is 2400 ... 115200 baud.

2.3.2 Fig. 2.1 and fig. 2.2 show mapping schemes used since 2020 in the ENCS-3m, where each UART is designated as COM-1...COM-10, regardless of the type of its interface (RS-232 or RS-485).



ЭНКС-3м..-1 ЭНКС-3м..-2

Figure 2.1. Correspondence of ENCS-3m interfaces (hw 4.2)



ЭНКС-3м..-3(4/5)

Figure 2.2. Correspondence of ENCS-3m interfaces (hw 5)

2.3.3 In fig. 2.3 previous designations of serial interfaces RS-485-1...-8 for ENCS-3m are given. Interfaces with the ability to operate at speeds of 100 ... 115200 baud are emphasized.

COM-1	COM-3	COM-5	COM-7	COM-9
232-2	485-8	485-6	485-4	485-2
232-1	485-7	485-5	485-3	485-1
COM-2	COM-4	COM-6	COM-8	COM-10

hw 4

LAN-3	LAN-1	485-7	COM-9
LAN-4	LAN-2	485-8	COM-10

COM-1	COM-3	COM-5	COM-7
485-1	485-3	485-5	232-1
485-2	485-4	485-6	232-2
COM-2	COM-4	COM-6	COM-8

hw 5

Figure 2.3. Correspondence of the current designations of serial interfaces ENCS-3m and the previous one

Ethernet ports modes

2.3.4 Modifications ENCS-3m ...-1 (2) hw 4.0 and hw 4.1 have two independent Ethernet ports, each with its own MAC and IP address. Data transfer between ports is not available.

2.3.5 Modifications ENCS-3m ...-1 (2) hw 4.2 and later have two Ethernet ports that operate in one of the following modes:

- Same network – both ports have the same common IP address, PRP or RSTP redundancy modes are available;
- Two networks – each port has its own IP and MAC addresses.

2.3.6 Modifications of ENCS-3m ...-3 (4/5) have four Ethernet ports that operate in one of the following modes:

- One network – all 4 ports have one common IP address, PRP or RSTP redundancy modes are available;
- Two networks - an odd pair of ports has one pair of IP and MAC addresses; an even pair has another one. No data is transmitted between pairs of ports. Each pair can operate in PRP mode. The first pair can work in RSTP mode. Both must be physically separated.
- Three networks – an odd pair of ports has one pair of IP and MAC addresses; an even pair has one MAC address and different IP addresses. No data is transmitted between the three port groups. The two ports can operate in switch, PRP, or RSTP mode. All three networks must be physically separated.

For available configuration options, see Fig. 2.4

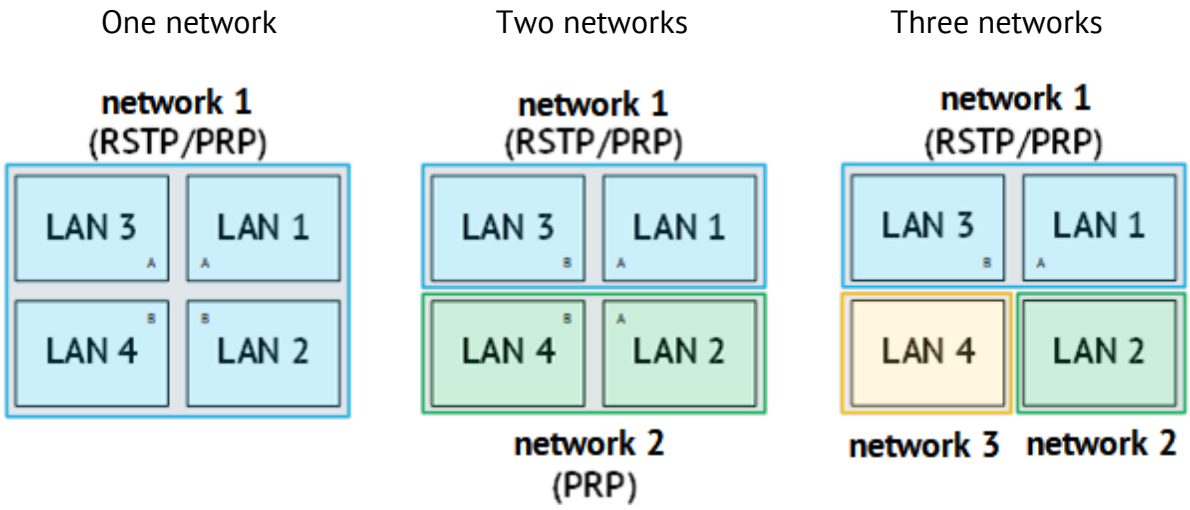
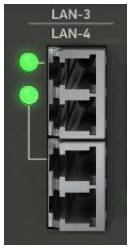


Figure 2.4. Modes of operation of Ethernet ports in ENCS-3m-...-3 (4/5)

In two- and three-network mode, interfaces must be connected to networks isolated from each other.

2.3.7 In the ENCS-3m-...-4 (5) modification, two 100BASEFX Ethernet optical interfaces are installed.



ENCS-3m-...-4	**ENCS-3m-...-5**
LC connector; single-mode; 9/125 µm wavelength - 1310 nm; cable length up to 15 km; UPC polish	LC connector; multi-mode; 62.5/125 µm and 50/125 µm; wavelength - 1300 nm; cable length up to 2 km; UPC polish

Radiation belongs to class 1 (lasers and laser systems of very low power, not able to create a radiation level dangerous to the human eye) in accordance with the EN60825-1 standard.

In the mode of two and three networks, when configuring, it is specified in which mode the optical interfaces will work: RSTP/PRP redundancy (fig. 2.5 on the left) or data transmission over two independent channels (Fig. 2.5 on the right).

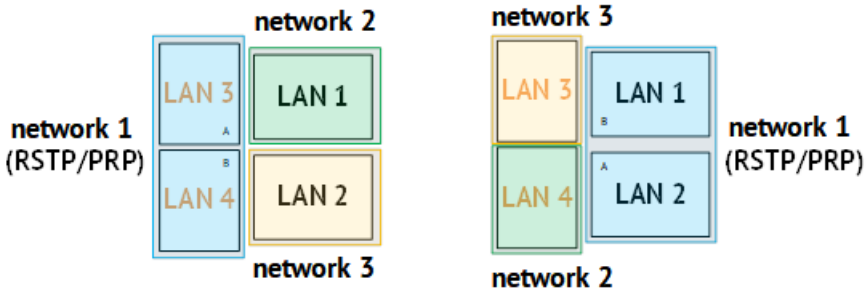


Figure 2.5. Options for the operation of Ethernet ports in ENCS-3m...-4/5 for 3 networks

2.3.8 For all modifications of ENCS-3m, the range of IP addresses, with which it is possible to work through one interface, is determined by the specified value mask in ENCS-3m. For example, a mask of 255.255.252.0 for an interface with an IP address of 192.168.0.X means that the device will "directly" exchange packets with other devices on the network whose IP address is set within the range 192.168.0.1 - 192.168.3.254 inclusive. If ENCS-3M initiates the sending of packets (establishing a TCP connection, sending data requests, etc.) outside the subnet defined by the settings of the IP address and its mask, then such packets will be forwarded to the default gateway.

Figure 2.6. LAN-1 (Ethernet) interface settings in ENCS-3m by default

2.4 GT-module

2.4.1 Optionally, the ENCS-3m-...-1 and ENCS-3m-...-2 modifications can be equipped with built-in G or GT modules, where **G** is the ability to transmit data over cellular networks, **T** is the ability to obtain precise time from GLONASS / GPS satellite systems. The module can be configured via the USB port on the back of the device.

2.4.2 The characteristics of the navigation module (**T** in the symbols) are given in Table. 2.5

Table 2.5. Characteristics of the navigation module

Parameter	Value
Supported navigation systems	Main - GLONASS Standby – GPS
Frequency of reception	1575… 1602 MHz
Antenna	3.3 V, output impedance 50 ohms, SMA connector, omnidirectional

2.4.3 The characteristics of the modem (**G** in the symbols) are given in Table. 2.6

Table 2.6. Characteristics of the built-in modem

Parameter	Value
Cellular network support	2G/3G
Communication standards	GSM/GPRS/EDGE/UMTS/HSPA+
SMS sending	Unavailable
Number of SIM cards	1
Authorization type	No/PAP/CHAP

2.4.4 To control registration in the mobile network, ENCS-3m provides the following mechanisms:

- ping – the RTU sends ICMP requests to the specified IP address at specified intervals. If there are no responses, the modem reboots and re-registers with the network.
- Data transfer - if there is no data exchange over the mobile network for the specified time (by default 20 minutes), the RTU reboots the built-in modem.

2.4.5 To provide a mobile communication channel between the data collection center and the controlled facility, the following conditions must be met:

- The data collection center server must be Internet-facing or have access to the private virtual network of the private APN (TCP port 2404).
- The RTU is located in the coverage area of mobile networks, the packet data transmission service is available;
- The SIM card installed in the RTU has a fixed (static) IP address. Dynamic addressing of the SIM card also can be used.

2.4.6 To diagnose the modem (operating time, connection status, signal strength, etc.), the "ENCS Configurator" software, section "Monitoring" is used.

2.5 Reliability indicators

2.5.1 In terms of reliability, the RTU corresponds to group 1 in accordance with GOST 26.205-88, which provides for work without interruption and installation of the device in hard-to-reach places;

- average time between failures of at least 100,000 hours under normal operating conditions;
- the average recovery time of the device is no more than 1 hour;
- the time of readiness of the RTU for operation when the power is turned on is not more than 1 minute;
- the total average service life of the device is at least 25 years;
- the coefficient of technical use is not less than 0.97;
- the mode of operation of the RTU is continuous.

2.5.2 According to the reliability of the transmission of information for each function (digital inputs, analog inputs, commands), the device belongs to the 1st category according to GOST 26.205-88:

- the probability of transformation of digital inputs information is not higher than 10^{-8};
- the probability of failure to transmit the sent command (when repeating the transmission up to five times) is no more than 10^{-10};
- the probability of false signals of remote control, remote alarm, measurement is not more than 10^{-12}.

2.5.3 The time of retransmission of remote commands from a higher to a lower level does not exceed 1 s.

The time of collection, processing and transfer of digital inputs does not exceed 1 s, if requirements given in section 7.4 are met.

2.5.4 A hardware watchdog timer is used to prevent the firmware (RTU firmware) from freezing.

2.5.5 When designing, it is recommended to lay spare parts at the rate of 1 RTU per 100 pieces.

2.6 Electromagnetic compatibility and isolation

2.6.1 RTU meets the requirements for electromagnetic compatibility regulated by the standards GOST R 51317.6.5-2006 and STO 56947007-29.240.044-2010 and specified in Table 2.7.7

When testing for immunity to the influence of electromagnetic interference, the normal functioning of the RTU should be considered the performance of all established functions without any deterioration in the quality of functioning.

Table 2.7. Electromagnetic compatibility compliance

№	Methods and types of tests	Magnitude of impacts on RTU ports						
		24 VDC	220 VDC	220 VAC	RS-485 RS-232	Ethernet	Housing	Ground
1	GOST 30804.4.2-2013 Electrostatic discharges directly to the housing with intervals between pulses of 10 s "contact discharge" "air discharge"	-	-	-	-	-	 ±6 kV ±8 kV acc. to A	-
2	GOST 30804.4.3-2013 Radio frequency electromagnetic field (80-1000) MHz (800-960) MHz (1400-3000) MHz	-	-	-	-	-	 10 V/m 10 V/m 10 V/m acc. to A	-
3	GOST R 30804.4.4-2013 Nanosecond impulse interference	±4 kV	±4 kV	±4 kV	±2 kV(C)	±2 kV (C)	-	±4 kV (C)
		acc. to A						
4	GOST R 51317.4.5-99 High-energy microsecond pulse interference «wire-to-wire» «wire-to-ground»	 ±1 kV ±2 kV	 ±1 kV ±2 kV	 ±2 kV ±4 kV	 ±2 kV (S)	 ±2 kV (S)	-	-
		acc. to A						
5	GOST R 51317.4.6-99 Conducted interference from 0.15 MHz to 80 MHz	10 V	10 V	10 V	10 V (S)	10 V (S)	-	10 V
		acc. to A						
6	GOST 30804.4.11-2013 Failures, interruptions, changes in power supply voltage: - failures (residual voltage, duration); - voltage interruptions; - voltage surges	-	-	 70% U_n, 1000 ms; 40% U_n, 1000 ms acc. to A 0% U_n, 100 ms; acc. to A 0% U_n, 1000 ms acc. to B [1)] 120% U_n 2000 ms acc. to A	-	-	-	-
7	IEC 61000-4-12-2016 Ringing wave «wire-to-wire» «wire-to-ground»	 ±2 kV ±4 kV	 ±2 kV ±4 kV	 ±2 kV ±4 kV	 ±1 kV (S)	 ±0.5 kV(S)	-	-
		acc. to A						
8	GOST 30804.4.13-2013 Distortion of the sinusoidal power supply voltage	-	-	Class 3 acc. to A	-	-	-	-
9	GOST R 51317.4.14-2006 Voltage fluctuations in the AC power supply network	-	-	±12% U_n, T/t=5/1 c, acc. to A	-	-	-	-
10	GOST R 51317.4.16-2000 Low-frequency conducted interference Short-term 50 Hz Continuous 50 Hz	 100 V 10 V	 300 V 30 V	 300 V 30 V	 300 V 30 V	 300 V 30 V	-	-
		acc. to A						
11	GOST R 51317.4.17-2000 DC Supply Voltage Ripple	10% U_n acc. to A	10% U_n acc. to A	-	-	-	-	-
12	ГОСТ IEC 61000-4-18-2016 Damped oscillatory wave						-	-

№	Methods and types of tests	Magnitude of impacts on RTU ports						
		24 VDC	220 VDC	220 VAC	RS-485 RS-232	Ethernet	Housing	Ground
	«wire-to-wire» «wire-to-ground»	±1 kV ±2.5 kV	±1 kV ±2.5 kV	±1 kV ±2.5 kV	±2.5 kV (S)	±1 kV (S)		
		acc. to A						
13	GOST R 51317.4.28-2000 Changing the frequency of the AC power supply	-	-	±15% 1 s acc. to A	-	-	-	-
14	IEC 61000-4-29-2016 Failures, interruptions, changes in power supply voltage - failures (residual voltage, duration); - interruptions (duration); - changes	 70% U_n, 1000 ms; 40% U_n, 100 ms; acc. to A 0% U_n, 100 ms acc. to A 0% U_n, 500 ms acc. to A (80-115)% U_n, 10 s acc. to A	 70% U_n, 1000 ms; 40% U_n, 100 ms; acc. to A 0% U_n, 100 ms acc. to A 0% U_n, 500 ms acc. to B[2)] (80-115)% U_n, 10 s acc. to A	-	-	-	-	-
15	GOST R 50648-94 Magnetic fields of power frequency in three mutually perpendicular planes: - protractedly - short-term 3 s	-	-	-	-	-	 100 A/m 1000 A/m acc. to A	-
16	GOST R 50649-94 Pulsed magnetic fields in three mutually perpendicular planes	-	-	-	-	-	1000 A/m acc. to A	-
17	GOST R 50652-94 Damped pulsed magnetic field in three mutually perpendicular planes	-	-	-	-	-	100 A/m acc. to A	-
18	GOST 30804.3.2-2013 Emission of harmonic components of current into the power supply network	-	-	Class A	-	-	-	-
19	GOST 30804.3.3-2013 Voltage fluctuations and flicker caused in the power supply network	-	-	P_{ST}<1, P_{LT}<0,65	-	-	-	-
20	GOST 30805.22-2013 Emission of industrial radio interference. Interference voltage at the network terminals in the frequency band 0.15-30 MHz Interference field strength in the frequency band 30-1000 MHz	 Class A	 Class A	 Class A	-	-	 Class A	-

Abbreviations:
(C) – interference is supplied through electromagnetic clamps;
(S) – interference is applied to the cable shield;
24 VDC, 220 VDC, 220 VAC – DC and AC power ports;
acc. to A - meets the A functioning quality criteria, normal functioning;
acc. to B – meets the B functioning quality criteria, temporary deterioration in the quality of functioning or termination of established functions with subsequent restoration without operator intervention

Notes:
[1)] Interruption of the AC power supply voltage with a duration of 1000 ms causes the device to be turned off and then restored without operator intervention;
[2)] Interruption of DC power supply voltage with a duration of 500 ms causes the device to be turned off and then restored without operator intervention, to ensure t the A functioning quality criteria, it is necessary to use a capacitor attachment.

2.6.2 The insulation resistance between each independent circuit (galvanically unconnected to other circuits) and the housing connected to all other independent RTU circuits is not less than 100 MΩ at DC voltage of 500 V.

2.6.3 Insulation of the RTU under operating conditions of use withstands for 1 minute the action of the test voltage of alternating current with a frequency of 50 Hz, the rms value of which:

- between the power port pins connected together (L/+, N/- pins) and the housing:
  - 2.0 kV (for modifications of ENCS-3m-220-... and ENCS-3m-110-...);
  - 0.5 kV (for modifications of ENCS-3m-24-...).

3 Data collection and processing

3.1 General Information

3.1.1 RTU ENCS-3m supports polling of devices capable of data exchange via Modbus RTU/TCP, IEC 60870-101/103/104, IEC 61850 GOOSE and optionally IEC 61850 MMS, as well as proprietary protocols of a number of devices listed below. The total number of polled devices may not exceed 240.

Note: For ENCS-3m hw 4, the total number of devices polled using the IEC 61850 MMS, IEC 60870-5-104, Modbus TCP (RTU over TCP) protocols and transmission channels to a higher level cannot exceed 64. For ENCS-3m hw 5, the total number of devices polled using the IEC 61850 MMS, IEC 60870-5-104, Modbus TCP (RTU over TCP) protocols and transmission channels to a higher level cannot exceed 48.

3.1.2 The maximum number of parameters processed from one device is given in Table. 3.1:

Table 3.1. Maximum number of parameters from one device

Protocol	DI	AI	DO	Entry in the register
IEC 60870-101	4096	8128	256	-
IEC 60870-103	64	64	256	-
IEC 60870-104	4096	8128	256	-
МЭК 61850 GOOSE	64	64	-	-
МЭК 61850 MMS	64	64	256	-
Modbus RTU	64	64	256	256
Modbus TCP (RTU over TCP)	64	64	256	256
SNMP	-	64	-	-
SPA-Bus	64	64	-	-

In total, ENCS-3m can process 4096 DI, 8182 AI, 256 DO, 256 recording commands.

3.1.3 For the requested parameters, the data type (discrete or analog value), the format of analog data (int16, int32, float), and the scale factor are indicated.

3.2 IEC 60870-5-101/104

3.2.1 Supported parameter types:

- DI (frame types: 1, 3, 7, 30, 31, 33);
- Integral and current measurements (frame types: 9, 11, 13, 15, 34, 35, 36, 37);
- Remote control (commands: 45, 46);
- Polling command (command 100: general polling of the station, query of groups);
- Counter polling command (command 101);
- Clock synchronization command (command 103).

3.2.2 Available settings:

- Address range: 1... 65535;
- Link layer address length: 1 or 2;
- ASDU address length: 1 or 2;
- COT length: 1 or 2;
- IOA length: 2 or 3.

3.2.3 Remote commands are relayed with the same parameters with which the command came to ENCS-3m from a higher level, including the type of command and holding time.

If the higher level sends a command to the RTU via Modbus or IEC 61850 protocols, the polling device must be able to receive commands without prior selection (Direct control function in ENIP-2 and ENMV-1). The holding time is set during setup.

3.3 Modbus RTU/TCP

ENCS-3m supports data acquisition via Modbus RTU, Modbus TCP and Modbus RTU over TCP protocols.

Supported parameters:

Data type	Reading Functions	Recording Functions
Discrete data	01, 02, 03, 04	05, 06
Analog data, one register Int16	03, 04	06
Analogue data, dual registers Int32, float	03, 04	-

For analog data, choice of byte order in the register is available when configuring.

For remote control, the relay addresses of on and off commands, as well as the output hold time, are set.

3.4 IEC 61850 8-1 (GOOSE)

ENCS-3m supports subscribing to GOOSE messages within the IEC 61850 8-1 standard.

Supported data types in GOOSE messages: Boolean, Quality, Timestamp, SPS, DPC, INT32, Float.

3.5 IEC 61850 8-1 (MMS)

Optionally, ENCS-3m supports subscribing to reports and sending remote control commands within the IEC 61850 8-1 standard.

Parameter	Supported values
The data type in the report	Boolean, Quality, Timestamp, SPS, DPC, INT32, Float

The data type to control	SPC, BSC
Control model	direct control, SBOes
Datasets	Only predefined
Optional fields	All
Conditions for running a report	All

Note: It is not recommended to use the IEC 61850 protocol to collect data from devices at the facilities of Rosseti, because the functionality of the MMS client in ENCS-3m is not confirmed by the corresponding certificate.

3.6 IEC 60870-5-103

ENCS-3m implements link (FT1.2) and application layer in accordance with IEC 60870-5-103-2005.

At the application level, ENCS-3m receives the following ASDUs:

- For digital inputs:
  - <1> – a message with a timestamp;
  - <2> – a message with a timestamp with relative time;
- For measurements:
  - <3> – measured values, set of type 1;
  - <4> – measured values with a timestamp and relative time;
  - <9> – measured values, set of type 2.

ASDU in the direction of control:

- <6> – Time synchronization;
- <7> – Initialization of the general polling;
- <20> – General command.

With remote control, the parameters of the ON/OFF command are determined in the command from a higher level.

3.7 SNMP

ENCS-3m provides measurements collection via SNMP v1 and v2c. Supported data types: INTEGER and COUNTER.

3.8 SPA-Bus

ENCS-3m supports device polling via the SPA-Bus protocol. Single-position and dual-position DI, AI reading and clock sync command are available.

3.9 SPODES

ENCS-3m supports polling of devices using the SPODES protocol. The list of supported parameters is given in Table. 3.2

Table 3.2. Data collection using the SPODES protocol

Designation	Parameter	OBIS code
Ia	Phase A current	1.0.31.7.0.255
Ib	Phase B current	1.0.51.7.0.255
Ic	Phase C current	1.0.71.7.0.255
Ua	Phase A voltage	1.0.32.7.0.255
Ub	Phase B voltage	1.0.52.7.0.255
Uc	Phase voltage C	1.0.72.7.0.255
Uab	Line AB voltage	1.0.124.7.0.255 (2nd version of SPODES) 1.0.12.7.1.255 (3rd version of SPODES)
Ubc	Line BC voltage	1.0.125.7.0.255 (2nd version of SPODES) 1.0.12.7.2.255 (3rd version of SPODES)
Uca	Line CA voltage	1.0.126.7.0.255 (2nd version of SPODES) 1.0.12.7.3.255 (3rd version of SPODES)
cos a	Phase A power factor	1.0.33.7.0.255
cos b	Phase B power factor	1.0.53.7.0.255
cos c	Phase C power factor	1.0.73.7.0.255
cos avg	Average power factor	1.0.13.7.0.255
f	Network Frequency	1.0.14.7.0.255
S	Total Power	1.0.9.7.0.255
His	Total Phase A power	1.0.29.7.0.255
Sb	Total Phase B power	1.0.49.7.0.255
Sc	Total Phase C Power	1.0.69.7.0.255
P	Active power	1.0.1.7.0.255
Well, i'm	Phase A active power	1.0.21.7.0.255
Pb	Phase B active power	1.0.41.7.0.255
Pc	Phase C active power	1.0.61.7.0.255
Q	Reactive power	1.0.3.7.0.255
Qa	Phase A reactive power	1.0.23.7.0.255
Qb	Phase B reactive power	1.0.43.7.0.255
Qc	Phase C reactive power	1.0.63.7.0.255
W·h+	Active energy, import	1.0.1.8.0.255
W·h-	Active energy, export	1.0.2.8.0.255
var·h+	Reactive energy, import	1.0.3.8.0.255
where·h-	Reactive energy, export	1.0.4.8.0.255

3.10 Electricity meters

ENCS-3m supports receiving telemechanical information from meters: currents, voltages, powers, frequency, etc., as well as the total accumulated energy. The list of supported devices is shown in table 3.3:

Table 3.3. Electricity meters

Options	Mercury		NZIF	Elster	Gran	Energomera	
	23X	20X	СЭТ4ТМ.02	A1800*	CC-301	CE6850M	CE-30X
Ua, Ub, Uc	+	+	+	+	+	+	+
Uab, Ubc, Uca			+			+	
U_L avg.				+			
Ia, Ib, Ic	+	+	+	+	+	+	+
I average				+			
Pa, Pb, Pc,	+		+	+	+	+	+
P total	+	+	+	+	+		
Qa, Qb, Qc,	+		+	+	+	+	+
Q total	+	+	+	+	+		
Sa, Sb, Sc	+		+	+		+	
S total	+	+	+	+			
F	+	+	+	+	+	+	+
Cos a, Cos b, Cos c	+		+	+	+	+	+
Cos average	+	+	+	+			+
Wh+, Wh-, varh+, varh-	+	+	+	+	+	+	+

* - A1800 (Elster Metronics) are supported only by the ANSI protocol.

Logs, power profiles and other information related to electric power control systems are not available in the RTU. ENCS-3m can provide a direct communication channel from the Ethernet network to the RS-485 bus (see p. 5.4)

3.11 Transducers

To poll modern measurement transducers, standard communication protocols IEC 60870-101/104, GOOSE, MMS, Modbus are used. To poll outdated versions of transducers, there is support for some series of devices given in Table 3.4

Table 3.4. Micom measuring transducers and relay protection and automation device

Parameters	ENIP-2 (FT3)*	AET	PC6806-03 PC6806-07	Micom P231
Ua, Ub, Uc	+	+	+	+
U average phase	+		+	+
Uab, Ubc, Uca	+	+		+
U average line	+		+	+
Ia, Ib, Ic	+	+	+	+
I average	+		+	+
In				+
Pa, Pb, Pc, P total	+	+	+	+
Qa, Qb, Qc, Q total	+	+	+	+
Sa, Sb, Sc	+	+		+
S total		+		+

Parameters	ENIP-2 (FT3)*	AET	PC6806-03 PC6806-07	Micom P231
F	+	+	+	+
Cos a, Cos b, Cos c	+			+
Cos average	+			+
Power Angle				+
Angles AB, BC, CA				+
Wh+, Wh-, varh+, varh-	+		+	+
DI	1... 8		1... 8	
DO	2		1	
Time Synchronization	+	+	+	+

* - polling of outdated versions of ENIP-2 without USB.

3.12 Relay protection and automation devices

To collect data from relay protection devices, IEC 60870-101/103/104, GOOSE, MMS protocols are used.

Often you can find Modbus protocol is used for these devices. Due to the lack of popular standard functions in the Modbus specification, such as time synchronization, etc., separate support is provided for different types of terminals (see Table 3.5). The request for other parameters, such as DI, AI and in some cases DO, are implemented in ENCS-3m by a standard Modbus device.

Table 3.5. Relay protection and automation devices.

Device	Supported parameters
BZP-1/2/3	Status of protection, DI, measurements, remote control
Altei-BZP/UZT/OZT	Status of protection, DI, measurements, remote control
ABB Emax/Tmax	Switch position, measurements
Sirius	Remote control
Orion-RTZ	Remote control
Sepam	Time Synchronization
BMRZ	Time Synchronization
BEMN	Time Synchronization

3.13 I/O modules

Table 3.6. I/O modules, other devices.

Device	Supported parameters
ENMV (FT3)*	DI1... 24, DO1, DO2
MC1201	DO1 ... 3
MC1202	DI1... 8
MC1210	Analog input
MC1218	Temperature 1...4
MC1220	Autotransformer switch position number
Scoreboard T54, PM54	Temperature, time transfer

* - polling of outdated versions of ENMV-1 without USB.

3.14 Time synchronization

ENCS-3m transmits precise time signals within the IEC 60870-5-101/104 protocols, SNTP, as well as factory protocols for devices with the frequency indicated in Table. 3.7

Table 3.7. Synchronization of polling devices

Device	Frequency of transmission of precise time signals
IEC 60870-5-101/104 (command 103)	2 times per minute at the 15th and 45th second
МЭК 60870-5-103 (ASDU 6)	
Relay protection and automation terminals: Sepam**,** BMRZ, BEMN	
Electricity meters: Mercury 23X**,** SET-4TM**,** A1800*, SS-301, CE6850M, CE30X	twice an hour (between 10 a.m. and 8 p.m. and from 40 to 50 minutes)
Relay protection and automation terminals: BZP-1/2/3, Sirius, Altei-BZP/UZT/OZT, DRP-100	
SNTP	depends on the settings of the device you are syncing

* Additionally, when setting up ENCS-3m, you can check the *Commercial accounting* checkbox, then the A1800 internal clock will be synchronized once a day for no more than 4 seconds.

The transmission of synchronization commands is carried out provided that the ENCS-3m clock is synchronized with the source of precise time. If its own synchronization is lost, ENCS-3m stops issuing synchronization commands to the polled devices after 30 minutes.

3.15 Automatic control

3.15.1 ENCS-3m supports automatic sending of remote control commands to polled devices when the specified conditions are met (the trigger can be a logical expression, DI, setpoint, etc.). All settings are made using the ENCS Configurator software.

3.15.2 For the Modbus devices being polled, it is also possible to automatically send a write command to the register (function 06).

3.16 Additional calculation parameters

3.16.1 In ENCS-3m, logical expressions are available for configuration, the data sources for which can be any discrete signals of the device: DI, DO commands, AI, setpoints, as well as other logical expressions.

The result of the logical expression can be transmitted via any supported protocol to a higher level in the form of a DI or used as a control command for the polled device.

3.16.2 Boolean and temporal operations are available for Boolean expressions:

- AND;
- OR;
- NOT;
- XOR;

- Nonvolatile RS-trigger (RS-FF);
- Pulse;
- Expansion of the minimum pulse;
- Pulse increasing;
- Delay.

There can be up to 64 elements in one logical expression.

3.16.3 Logical expressions can be used to perform software operational locks, automatic switching (ATS), control of various systems, etc. Expression settings are carried out using the graphical interface in the ENCS Configurator software:

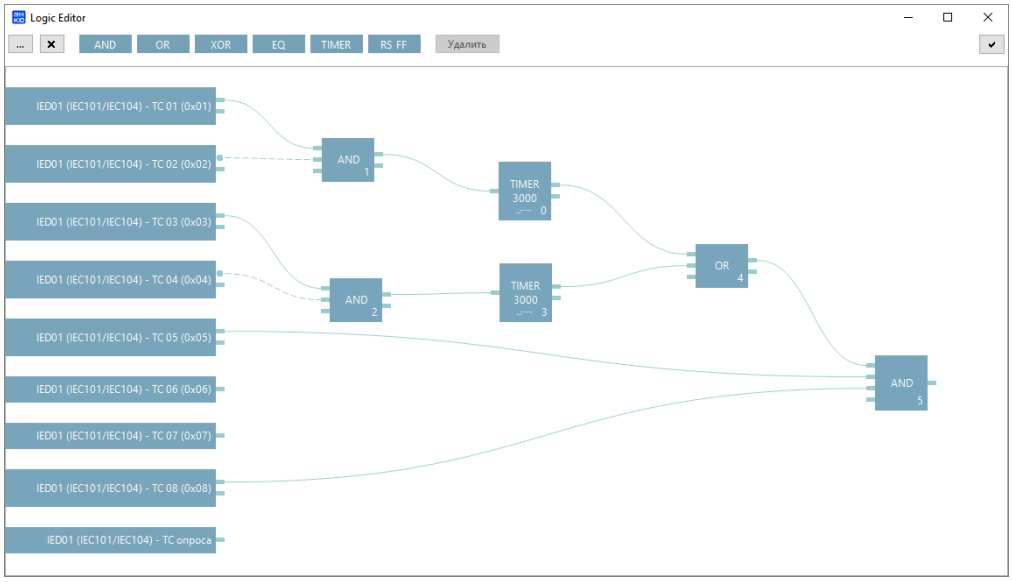


Figure 3.1. Setting up logical expressions in the ENCS Configurator software.

3.16.4 In ENCS-3m, additional calculation of parameters is available using the measurements according to the formula:

$$y = k\left(\sum x\right) + b,$$

where:

y – calculated value;

k – the scale factor;

x – measured value;

b – a constant.

4 Data transfer

4.1 IEC 60870-5-101/104

4.1.1 For data transmission ENCS-3m, a link (FT1.2) and application layer is implemented in accordance with IEC 60870-5-101-2006 and IEC 60870-5-104-2004.

At the application layer, the following commands are implemented:

- remote control – commands 45, 46;
- record setpoints – command 49;
- time synchronization – command 103;
- general poll – command 100;
- energy request – command 101;

The following data types are supported for data transfer:

- when transferring DI - 1, 3, 7, 30, 31, 33;
- when transferring AI current values - 9, 11, 13, 34, 35, 36;
- when transferring AI integral values - 15, 37;

The following causes of transmission are supported - 1, 2, 3, 5, 6, 7, 8, 9, 10, 20-36, 37-41, 47, and the P/N bit is triggered in COT if necessary.

At the link layer (FT1.2), an address length of one or two bytes is supported. At the application layer, the COT length is one or two bytes, the general ASDU address is one or two bytes, and the information object address is two or three bytes. COT option 2-2-3 should be used for IEC 60870-5-104-2004 or IEC 60870-5-101-2006 channels, which are then "converted" into a protocol in accordance with IEC 60870-5-104-2004.

4.1.2 Sporadic algorithm

The sporadic mode of data transfer implies the transfer of a parameter under certain conditions: a change in the value of a parameter goes beyond the redistribution of a predetermined value (setpoint or aperture). The value of the permissible deviation can be set in both absolute and relative values (as a percentage of the last transmitted value). Two boundaries can also be set, at the intersection of which the parameter is queued for transmission. This mode is convenient to use to control the voltage when it is necessary to transfer the parameter when it goes beyond certain limits.

For discrete signals, a supersporadic algorithm is available - priority guaranteed transmission of all changed states using a non-volatile archive.

4.1.3 Periodic algorithm

In this mode, telemetry is transmitted to a higher level at specified intervals (minimum - 1 minute, multiplicity - 1 minute).

4.1.4 Background scan

Background scanning has a lower priority in parameter transfer compared to sporadic and periodic algorithms. Data is sent only when buffers are available for transmission in accordance with IEC 60870-5-101-2006 (IEC 60870-5-104-2004).

The transmission of AI by background algorithm occurs whenever the parameter or its quality attributes change.

The transmission of DI by background algorithm occurs periodically with a pre-configured interval (at least 1 minute, multiplicity - 1 minute) or when the quality attributes change.

4.2 IEC 61850 8-1 (GOOSE, MMS)

4.2.1 ENCS-3m optionally supports data transmission via IEC 61850 Rev. 1.0 or 2.0 protocol.

4.2.2 ENCS-3M acts as an MMS server and supports:

- configurable logical devices (up to 16);
- configurable logicадl nodes (up to 256)
- customizable datasets (up to 64, each with up to 128 parameters)
- management functions;
- publication of GOOSE messages (up to 32);
- subscription to GOOSE messages (up to 240);
- buffered and unbuffered reports (up to 64).

4.2.3 Binding of measurements to the nodes of the IEC 61850 model is carried out using the ENCS Configurator software.

The 61850 model is customizable and may contain the nodes listed in 4.1:

Table 4.1. List of supported logical nodes

Code	Group	Logical node	Description
L	System Logical Nodes	LLN0	Logical node 0
		LPHD	Physical device settings
C	Management	CILO	Locking the control of switchgears
		CSWI	Switch control
G	General Purpose Nodes	GGIO	Common Data I/O
M	Metering & Measurement	MMTR	Three-phase network energy
		MMXN	Parameters of a single-phase network

Code	Group	Logical node	Description
		MMXU	Parameters of a three-phase network
		MSQI	Sequences and imbalances
P	Security features	PTOC	Overcurrent protection
		PTRC	Conditions for disabling when protections are triggered
R	Security-related features	RBRF	Breaker failure
T	Instrument transformer	TCTR	Current transformer
		TVTR	Voltage transformer
X	Switching devices	XCBR	Circuit breaker (switching device with the ability to turn off short-circuit currents)
		XSWI	Switch (switching device without the ability to turn off short-circuit currents)
With	Other equipment	ZAXN	Auxiliary network
		STRUGGLE	Accumulator

4.2.4 The ENCS-3m certificate of compliance with the requirements of IEC 61850 Rev. 2.0 is available at: IEC 61850 Certificate Level A.

4.3 Modbus RTU/TCP

ENCS-3m allows you to transmit data via Modbus TCP/RTU protocols.

Supported features:

- h01 read coil (for alarm);
- h02 read input status (for DI polling);
- h03 read holding registers (for measurments); two- and four-byte data available;
- h05 write single coil (for remote control);
- h06 write single holding register (to write to register).

4.4 Remote control

4.4.1 ENCS-3m supports receiving remote control commands using the following protocols:

- IEC 60870-5-104/104: Single command <45>, Double command <46>, Set point command <49> (last one can be relayed to h06 function for Modbus devices);
- Modbus RTU/TCP: Force single coil (h05), Write single holding register (h06);
- IEC 61850: direct-with-normal-security, sbo-with-normal-security, direct-with-enhanced-security, sbo-with-enhanced-security.

4.4.2 ENCS-3m supports the remote control software key. To configure it, you need to add a virtual device "Remote control key", set the priority for each channel. Sending any control commands to the polled devices will be blocked until control is captured. By default, the

key is in the released position, and you must send a key management command to capture it. After that, it is allowed to carry out telecontrol operations.

The current position of the key is transmitted in the form of DI for each channel and AI, which indicates the current priority of the key. Key capture can only be done by a high-priority channel.

4.4.3 For each channel, a full remote control prohibition is available, as well as a partial prohibition at selected addresses.

4.5 Parameter quality attributes

4.5.1 Quality attributes are assigned to each parameter when transmitted via IEC 60870-5-101/104, IEC 61850 and SNMP protocols.

4.5.2 In the absence of communication with the polled device, all parameters related to it are set to signs of negative quality.

4.5.3 For IEC 60870-5-101/104:

- SB bit – set if the operator has manually entered the value (see p 4.7);
- BL bit– set if the parameter was blocked by the operator (see p. 4.7;
- OV bit – set for AI if the parameter value is out of the set limits (set in the group settings);
- IV bit – set in the event that when turning on ENCS-3m, the polled device did not respond to the data request (with the exception of devices polled via IEC-101/104, for which, in the absence of communication, data is not transmitted to a higher level);
- NT bit – set when the device stops responding.

4.5.4 In the absence of synchronization of the ENCS-3m clock, the timestamps of parameters are marked as invalid.

4.5.5 The quality attributes of the parameters of devices polled using IEC 60870-101/104 protocols are relayed unchanged.

4.6 Storage of retrospective measurements and states

4.6.1 When the state of polled device DI changes, the new value of DI is stored in non-volatile memory with the time stamp assigned by the device or ENCS-3m, and quality attributes. The maximum DI log contains 400 entries, and when overflowing, the oldest events will be overwritten. In IEC 60870-5-101/104 protocols, when requested by the 100th

command of the 16th group, the entire available retrospective of the DI will be transmitted.

4.6.2 For each channel configured for IEC 60870-5-101/104 protocol, it is possible to enable the recording of AI and DI archives in volatile memory. At least 1000 of the last values intended for issuance according to a sporadic algorithm are recorded in the archive. In case of loss of connection with the higher level and subsequent recovery, all the accumulated data of the DI and AI archives will be transferred to the client.

If the archives are full, new data is written instead of the oldest records.

When the power of the device is turned off, the archives are reset.

4.7 Manual input and locking values

4.7.1 RTU ENCS-3m supports manual input and locking of TS and TI values. Manual input and locking are performed by the operator according to IEC 60870-101/104 protocol using the following commands:

- 150 – input/locking of a single-position DI;
- 151 – input /locking of a two-position DI;
- 152 – input/locking of tap position;
- 153 – input/locking of scaled AI;
- 154 – input/locking of normalized AI;
- 155 – input/locking of AI in floating-point format.

4.7.2 Each parameter is set to the corresponding quality bit: BL - when blocked, SB - when manually entered.

If the SB flag is set without the BL flag, the value transmitted by the ENCS-3m device will correspond to the manually entered value, until the first receipt of the real value from the polled device. After the real value is received, the SB flag is automatically cleared.

If the BL flag is set without the SB flag, the value transmitted by the ENCS-3m device will correspond to the value of the parameter before blocking, the receipt of real values from the polled device is blocked. The BL flag is reset at the operator's command.

If the SB and BL flags are set at the same time, the value transmitted by the ENCS-3m device will correspond to the manually entered value, the receipt of real values from the polled device is blocked. The BL flag is reset at the operator's command, after which the SB flag is stored until the first receipt of the real value.

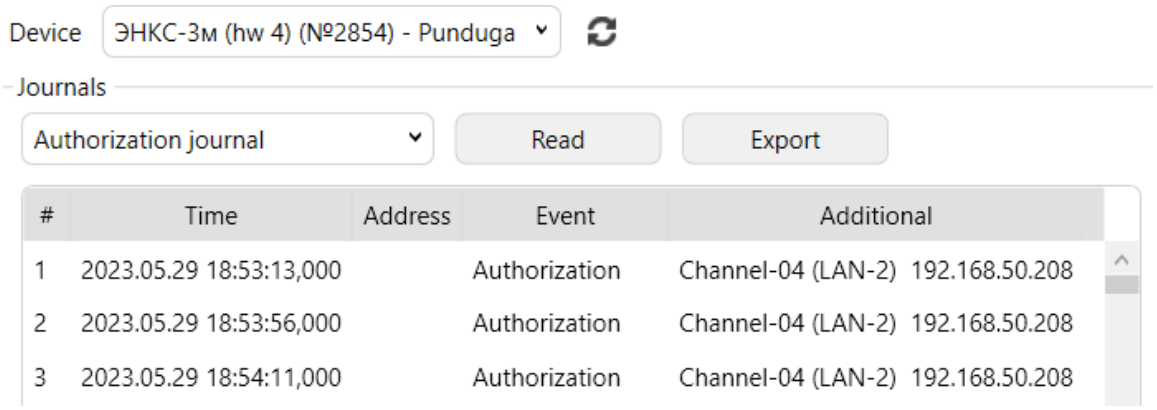
4.7.3 For ENCS-3m hw 4.1 and higher, the blocking and manual input signs are stored in non-volatile memory. After the device reboots, the value and quality attributes of the parameter do not change.

5 Functionality

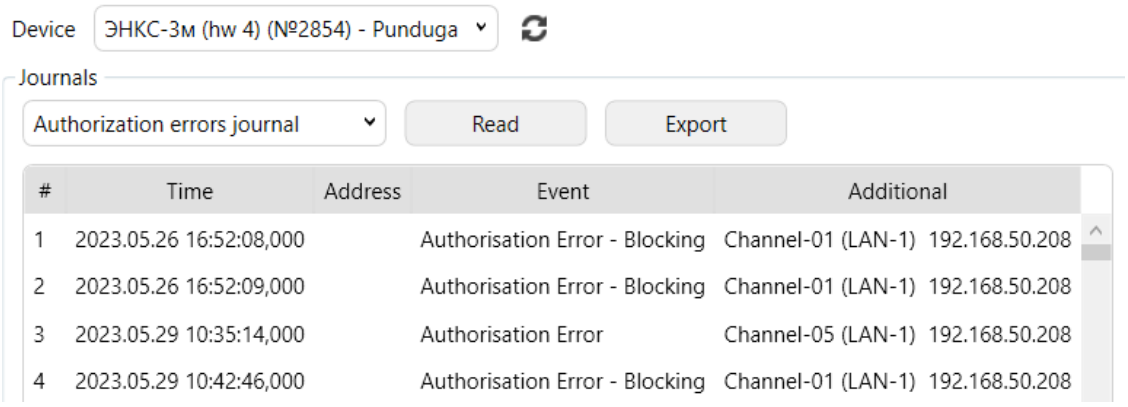
5.1 Event logs

5.1.1 RTU ENCS-3m hardware version 4.1 and higher keep the following logs in the built-in non-volatile memory:

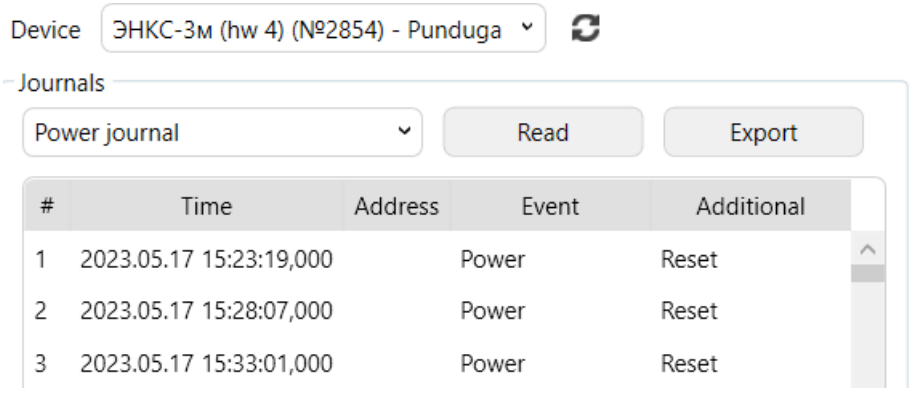
- Authorization journal – authorization events with channel used to connect and client's IP address indication. The log size is 100 events.



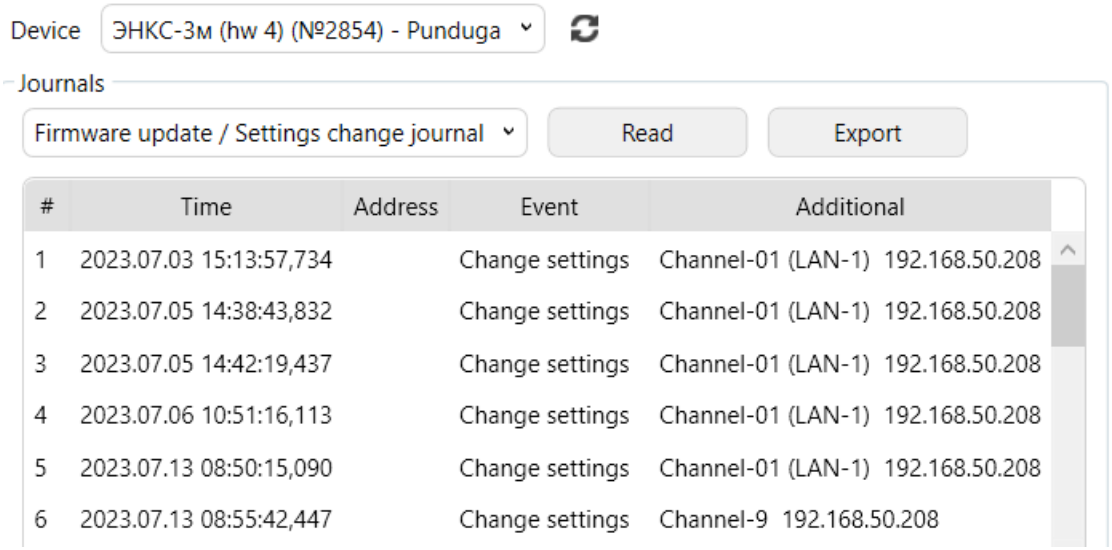
- Authorization errors journal– authorization attempts with an incorrect password with channel used to connect and client's IP address. The log size is 100 events.



- Power journal – power on, power, and reset events. The log size is 100 events.



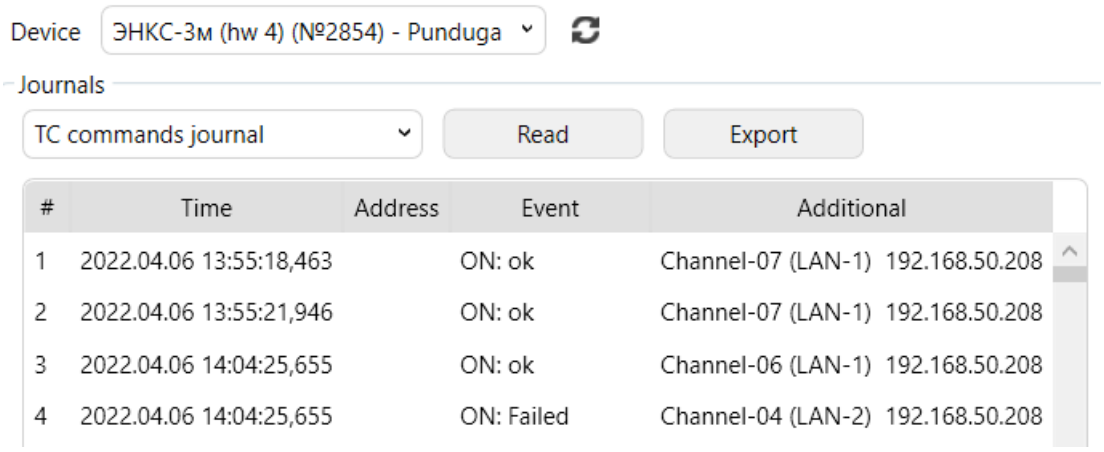
- Firmware update / Settings change journal - contains events of firmware update, indicating the new version, as well as the settings change events with change source, the channel used to connect, and the client's IP address indication. The log size is 20 events.



#	Time	Address	Event	Additional
1	2023.07.03 15:13:57,734		Change settings	Channel-01 (LAN-1) 192.168.50.208
2	2023.07.05 14:38:43,832		Change settings	Channel-01 (LAN-1) 192.168.50.208
3	2023.07.05 14:42:19,437		Change settings	Channel-01 (LAN-1) 192.168.50.208
4	2023.07.06 10:51:16,113		Change settings	Channel-01 (LAN-1) 192.168.50.208
5	2023.07.13 08:50:15,090		Change settings	Channel-01 (LAN-1) 192.168.50.208
6	2023.07.13 08:55:42,447		Change settings	Channel-9 192.168.50.208

- TC commands journal - contains list of all remote control commands that ENCS-3m sends to the polled devices. For each record, the following is indicated:
  - command: ON/OFF,
  - duration (for commands in IEC 60870-101/104 protocols),
  - execution result: success or error,
  - device: the device to which the command was sent;
  - device address: the address of device to which the command was sent;
  - channel: the channel through which the command was received;
  - address: the address on the channel where the command was received;
  - client IP address: The address from which the command was received.

  The log size is 1000 events.



- Cleaning journals journal – logs clearing events. Deleting log entries is only available to the manufacturer. The log size is 100 events.

5.1.2 Events are written to the logs cyclically, when the log is full, the oldest entries are erased.

5.1.3 Each record is assigned a timestamp. For authorization, authorization errors, power journals, the timestamp accuracy is 1 second. For other journals - 1 ms.

5.2 Configuring the RTU

5.2.1 The configuration of the RTU is stored in non-volatile memory.

5.2.2 Configuration is carried out using the ENCS Configurator software: https://enip2.ru/software/encs3mconfigurator.zip

The software supports the following methods of connecting to the RTU:

- via any RS-232/485 interface according to the IEC 60870-5-101 protocol;
- via any Ethernet interface using the IEC 60870-5-104 protocol;
- via USB interface (only for hw 5).

5.2.3 For more information about setting up the device, see the description of the ENCS Configurator software: https://enip2.ru/documentation/po_encs.403500.001.pdf

5.3 Redundancy

5.3.1 To increase the reliability of the ENCS-3m device, redundancy is available.

5.3.2 Duplication of ENCS-3m

With such a redundancy scheme, two independent ENCS-3m are used (communication with each polled device is organized via two RS-485, or via Ethernet), each ENCS-3m operates independently of the other. Similar data sets from both devices are transmitted to the higher levels at the same time.

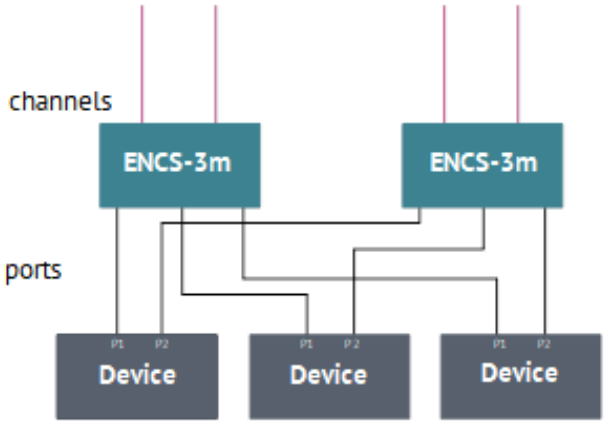


Figure 5.1. Duplication of ENCS-3m.

5.3.3 ENCS-3m redundancy via CAN

This redundancy option is applicable for two RTU modifications of ENCS-3m ... 1 (2) and allows you to always have only one -ENCS-3m out of two in constant operation. The first one (Master) polls devices and transmits parameters to a higher level. The second one (Slave) is in standby mode and is always ready to switch to normal operation when certain conditions occur. As a result of this redundancy scheme, higher levels receive only one set of data at a time. On the CAN bus, the DI archive is constantly synchronized, as well as the time synchronization.

A prerequisite for this type of redundancy is the connection of two RTU via CAN. To connect via CAN, follow the instructions in Table 7.1

During setup a priority is set for each RTU: Primary or Secondary. If the devices are set to different priorities, the main device will be in operation by default, if the exchange is disturbed by ports or channels, it will switch to the backup, then every 30 seconds polling will switch to the main device to check the communication status. If the devices have the same priorities, switching will occur only if the connection is broken.

Switching conditions:

- Channel checking

When setting up for each of the channels, you can specify the required type of redundancy (AND/OR):

– "OR" redundancy: Switching to the second ENCS-3m will occur if there is no TCP connection on all selected channels;

– Redundancy "AND": Switching to the second ENCS-3m will occur if there is no TCP connection on at least one channel.

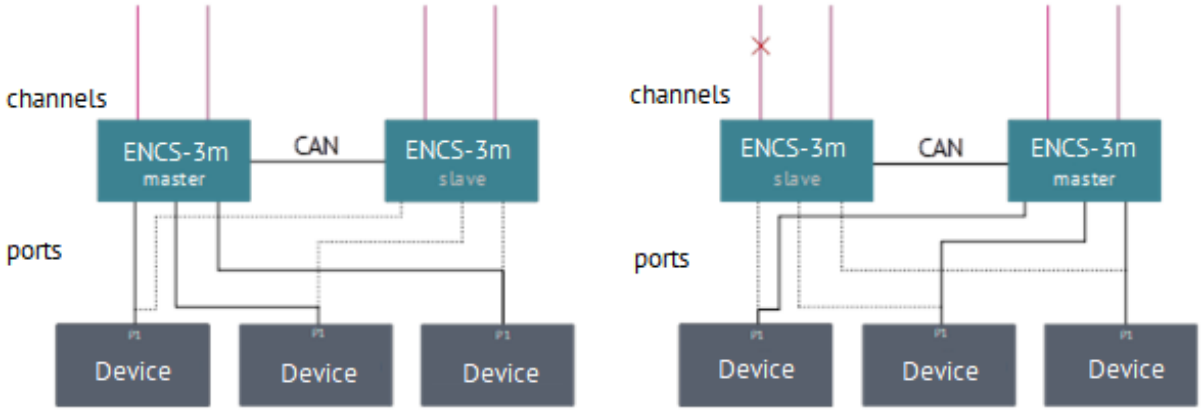


Figure 5.2. Channel checking.

For a device in Slave mode, it is possible to disable individual channels, in which case the RTU does not establish a TCP connection and does not check the connection status. A configurable channel recovery timeout is available from 0 to 120 seconds. During this time, the transition to a backup device will not be made.

- Port checking

If, when adding the polled device, you check the ENCS-3m redundancy checkbox, then this device will participate in the redundancy algorithm. In the event that **all** devices marked with these checkboxes stop responding, switching to the second ENCS-3m will occur.

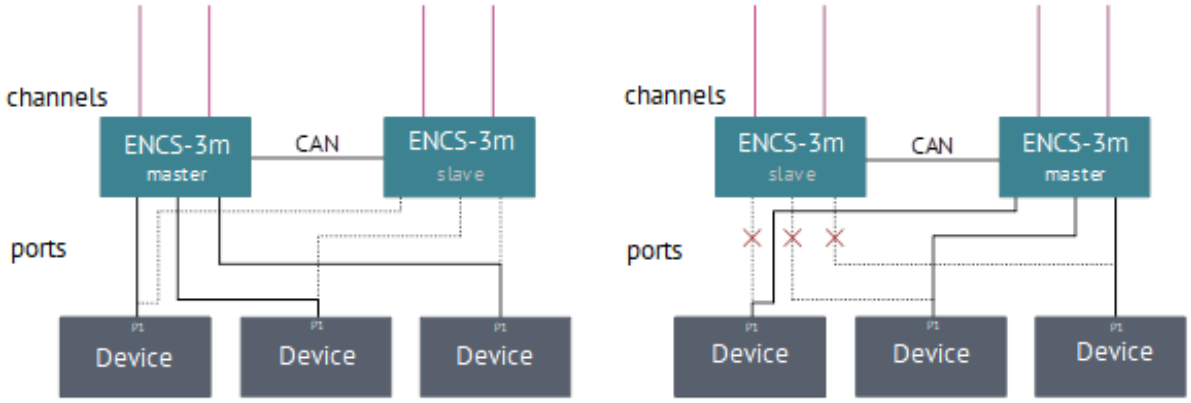


Figure 5.3. Port check.

- Verification of the duplicate ENCS-3m

If the channel check condition is not met on the RTU in Slave mode, switching will not occur. In the case when the RTU channels in Slave mode are disabled, this check is not performed. If the port check condition is not met on the ENCS-3m, both ENCS-3m will operate alternately at intervals of 30 seconds. ENCS-3m resets all its current TCP connections when it enters Slave mode.

In case of a violation of the communication between the RTU via CAN, both ENCS-3m will switch to the Master mode, and the circuit will switch to a state similar to the duplicated redundancy scheme.

Figure 5.4. Algorithm for checking conditions

5.3.4 RSTP redundancy

ENCS-3M supports ring RSTP (IEEE 802.1D-2004) redundancy.

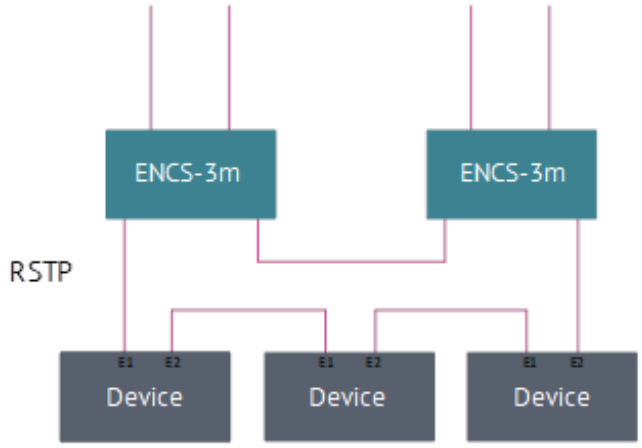


Figure 5.5. Connection of interrogated devices according to the RSTP scheme.

5.3.5 PRP redundancy

ENCS-3M supports parallel seamless PRP (IEC 62439-3) redundancy.

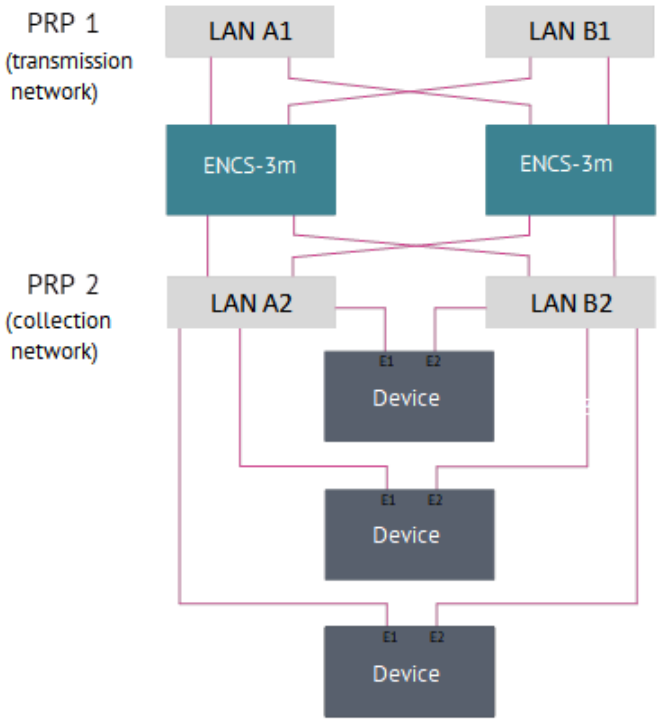
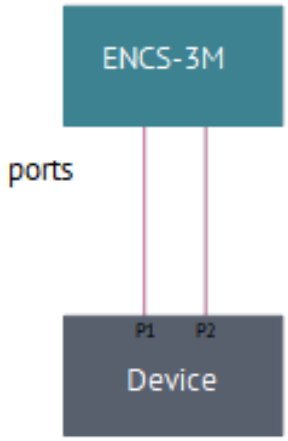


Figure 5.6. Connection of polled devices according to the PRP scheme

5.3.6 Redundancy of polling devices

Device redundancy allows you to poll one device over different communication interfaces. When configuring ENCS-3m for each polled device, the connection parameters and the requested parameters are indicated. To add an alternative interface, you need to specify the backup connection parameters in the backup settings; The list of passed parameters remains the same.

ENCS-3m polls the device simultaneously via two interfaces. If there is no response from the main device for several polling cycles, a switch to the backup device occurs.



5.4 "End-to-end channel" mode

5.4.1 "End-to-end channel" mode (RS-TCP) is the exchange of information between a higher level and devices connected to the RS-485/232 RTU port using a TCP connection. The exchange process consists of encapsulating the data passing through the RS-485/232 port into a TCP connection without any processing-.

5.4.2 Through the "end-to-end channel" it is possible to directly connect to the polled devices alternately, for example, to configure them, read logs, waveforms, etc.

5.4.3 At the higher level, you should use software that allows you to receive and transmit encapsulated data (RS-485 over TCP). Since the exchange takes place at the speeds typical of serial interfaces, with an actual Ethernet connection, the software used must correctly handle the delay that occurs when receiving responses to requests.

5.4.4 When you open an "end-to-end channel" to a serial port, the polling of all devices on this port stops, the parameters become unreliable. Polling of other devices and transmission channels are not affected. The "end-to-end channel" closes when the TCP connection is closed or automatically after 30 seconds of no exchange. After that, the polling of devices on the port is restored.

5.4.5 To configure the RTU to work in this mode in the "ENCS Configurator" software, in the "Channels" tab, you must specify the interface through which the "end-to-end channel" will be available, select the "RS-TCP" protocol, specify the IP address of the allowed client and the start address of the TCP port for connection.

The "Interfaces" tab will display the TCP port for each serial interface:

	COM-10	COM-9	COM-8	COM-7	COM-6	COM-5
Baudrate, baud	19200	19200	19200	19200	19200	19200
Parity	None	None	Even	Even	Even	Even
Stop bits	1	1	1	1	1	1
Data bits Stop bits	8	8	8	8	8	8
End delay	3	3	3	3	3	3
Minimum packet length, byte	5	5	5	5	5	5
Increase timeout:	☐	☐	☐	☐	☐	☐
intersymbol interval, ms	0	0	0	0	0	0
number of intervals	0	0	0	0	0	0
TCP-port for RS-TCP	LAN-1 - 4001 LAN-2 - 4000	LAN-1 - 4002 LAN-2 - 4001	LAN-1 - 4003 LAN-2 - 4002	LAN-1 - 4004 LAN-2 - 4003	LAN-1 - 4005 LAN-2 - 4004	LAN-1 - 4006 LAN-2 - 4005

Figure 5.7 – Interfaces tab

With this setting, to open an "end-to-end channel" to the COM-8 interface, you must connect to IP LAN-1 TCP port 4003.

5.4.6 Among the devices manufactured by Energoservice, ENIP-2, ESM, and ENMV devices support configuring in this mode. For example, to configure ENIP-2 transducers polled via COM-8, in the ES Configurator software, you must specify the appropriate connection method, as well as set the necessary network parameters.

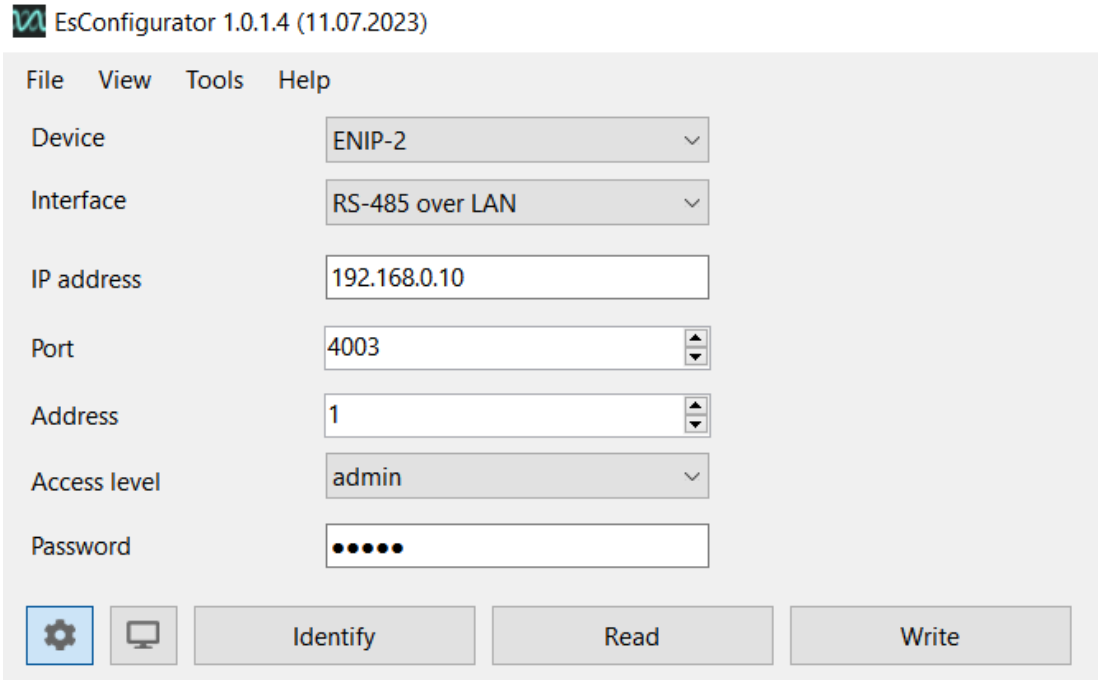


Figure 5.8. An example of setting up a connection to ENIP-2 using an "end-to-end channel"

5.5 Port forwarding (NAT)

5.5.1 ENCS-3m has the ability to configure TCP and UDP port forwarding between different networks. A maximum of 4 forwarding rules for TCP and 4 rules for UDP are supported. The configuration is carried out using the ENCS Configurator software.

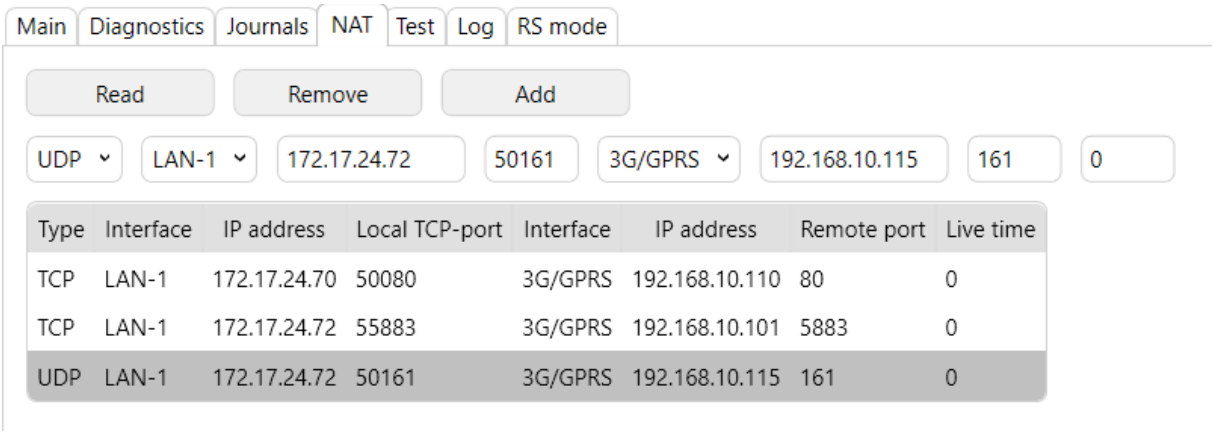


Figure 5.9. Example of setting forwarding rules

5.5.2 Changing the forwarding rules is available online without rebooting the device.

5.6 Time synchronization

5.6.1 The ENCS-3m device supports the reception of precise time signals and synchronization of the built-in clock from the sources indicated in Table 5.1:

Table 5.1

Source	Accuracy, ms	Notes
Built-in GLONASS/GPS receiver	1	Only for ENCS-3M-...-GT
Command 103 in accordance with IEC 60870-5-101-2006, IEC 60870-5-104-2004	5	
SNTP server	10	Primary and backup servers can be configured
PTPv2	1	Only for HW 4.2 and above
CAN bus	5	For slave when using CAN redundancy

5.6.2 In the absence of external synchronization, the deviation of the time of the internal clock ENCS-3m does not exceed ±0.4 s / day.

5.6.3 If the satellite signal is lost, when the synchronization method from the internal receiver is used, the device automatically switches to the synchronization mode from higher-level devices. The algorithm for selecting the source of precise time is shown in Fig. 5.10

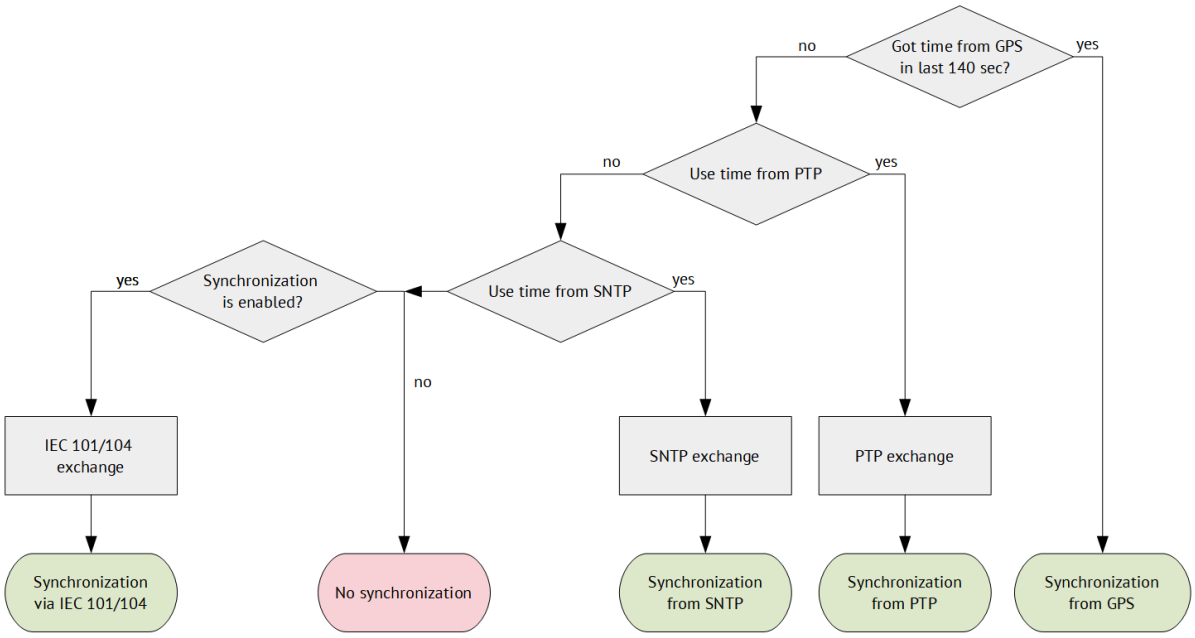


Figure 5.10. Algorithm for synchronizing the internal clock in ENCS-3m

Viewing the current synchronization source is available in the "ENCS Configurator" software, the "SNMP Diagnostics" menu:

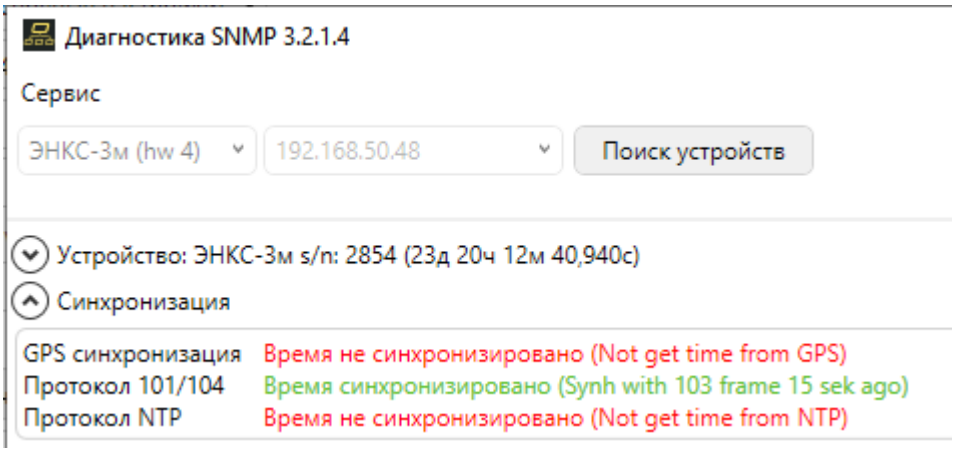


Figure 5.11. Sync diagnostics

6 Package content

Remote terminal unit ENCS-3m	1
ENCS.403500.001PC	1
Mini-USB to USB cable, 1 m (only for ENCS-3m-...-GT)	1

The necessary documentation, as well as software updates, are always available on the website:

https://www.enip2.ru/en

7 Operation

7.1 Limitations

RTU can be used for its intended purpose without any restrictions.

Commissioning of the device is carried out only after installation and commissioning, which must be carried out by specialized organizations that have the right to perform these works.

Installation and commissioning of the device in full must be carried out by the customer in accordance with the requirements of the operational documentation.

The device must be serviced by specially trained personnel in accordance with the requirements of operational documentation.

The location of the RTU during operation should provide free access to the RTU, as well as the possibility of placing devices for maintenance; convenient external cable connection.

Installation and repair work with the device are allowed to be carried out only when the voltage is completely removed. A poster "Do not turn on - people are working" should be posted next to it.

Ensuring fire safety of the room in which the device is installed - in accordance with GOST 12.1004-91.

7.2 General Instructions

Near the installed RTU, it is not allowed to carry out locksmith work that can lead to the ingress of small particles into the body.

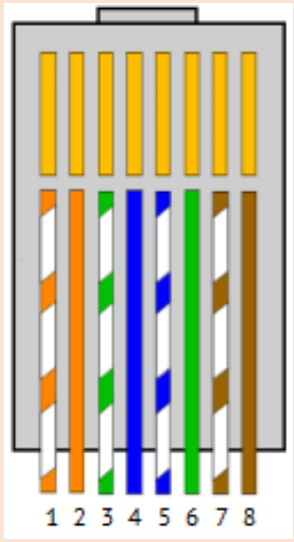
All installation and operation work should be carried out in compliance with the current rules that ensure the safe maintenance and operation of electrical installations. Installation must be carried out by personnel with appropriate qualifications.

- The device is mounted on a 35 mm DIN rail using the built-in mount.
- Power supply circuits are allowed to be connected with wires with a cross section of no more than 2.5 mm^2.

7.3 Connecting to interfaces

To connect to interfaces, follow the instructions in.1:

Table 7.1

Interface	Signal/Contact		Device (RJ45)
RS-485	A (data+)	7	
	B (data-)	8	
	GND	5	
RS-232	Rx	3	
	Tx	4	
	GND	5	
LAN	TX+ (Transmit Data+)	1	
	TX- (Transmit Data-)	2	
	RX+ (Receive Data+)	3	
	RX- (Receive Data-)	6	
CAN	GND	2	
	CAN L	3	
	GND	5	
	CAN H	6	

Note: To protect RS-485 interfaces, it is recommended to use ESP-485-X surge protection devices, where X is the number of channels (ESP-485 is available for one or two channels).

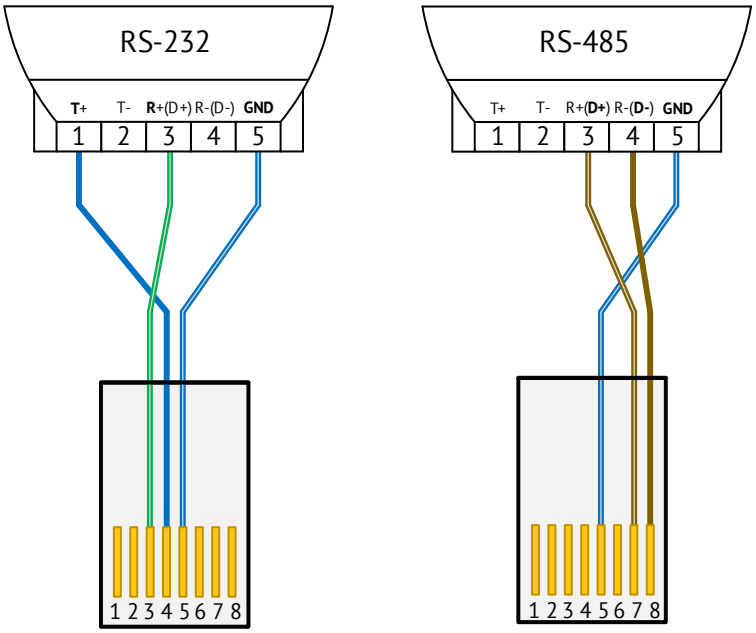


Figure 7.1. Patch cord pinout for connection to ENCS-3m via Moxa Uport 1150 converter

7.3.1 ENCS-3M implements "copper" Fast Ethernet interfaces in accordance with the 100BASE-TX (IEEE 802.3u) specification. To connect the device to the network, it is recommended to use twisted pair Cat 5e. Two pairs of conductors are used for communication, a distance of up to 100 m.

7.3.2 Modifications of ENCS-3m-...-4 (5) have optical Ethernet ports (see p. 2.3.7 of this manual).

7.3.3 ENCS-3m implements optically isolated serial two-wire RS-485 (2-Wire) interfaces. ENCS-3m, ENIP-2, ENMV-1 do not have built-in pull-up and terminating resistors for existing RS485 interfaces.

Recommendations for the organization of lines for a 2-wire RS-485 interface:

- The cable shield should be connected to the PE protective ground at one point, for example, on the side of ENCS-3m.
- To prevent the signal from being reflected from the end of the communication line, it is recommended to install 120 Ω (0.25 W) termination resistors at the line ends.
- If, when the above conditions are met, the polling of devices on the line remains unstable, it is necessary to use pull-up resistors. One pulls the line "A (data +)" to the ground, and the second - the line "B (data-)" to 5 V. The resistance of the resistors is 450 ... 650 ohms (the more devices on the line, the greater resistance of resistors). A resistor is installed only in one place, as a rule, this is the beginning or middle of the line. These requirements can be explicitly indicated in the documentation for the device being polled.

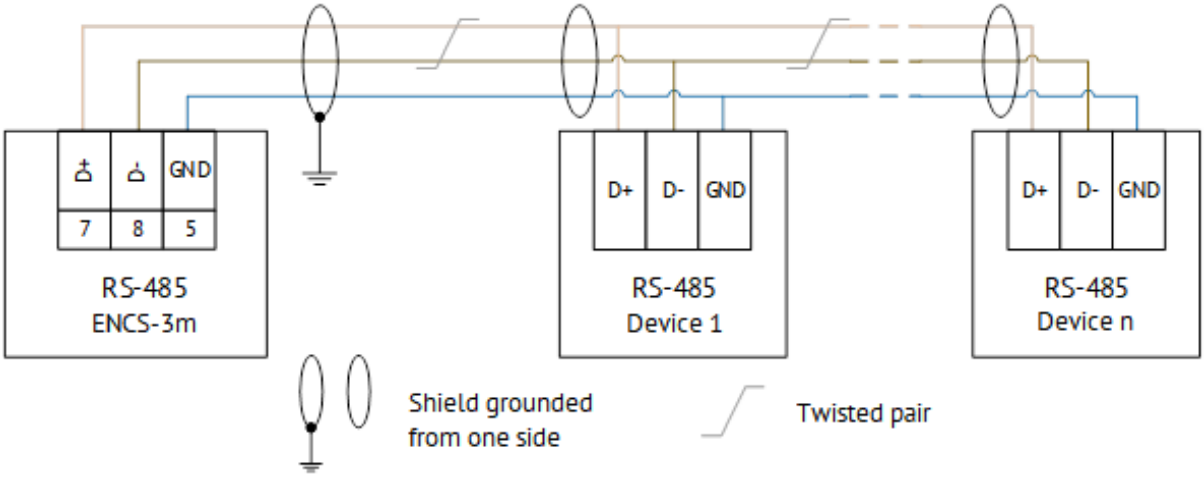


Figure 7.2. Connecting devices via RS-485

7.4 Data exchange with external devices

RTU ENCS-3m provides continuous polling of devices connected to ports, and data transmission to a higher level through channels. RS-232, RS485 interfaces can be used as ports for data acquisition or channels for transmission to a higher level. Ethernet and GSM/3G network interfaces can be used simultaneously as for collection and for transfer.

The maximum number of downstream devices that can be connected via one interface is indicated in Table. 7.2 In total, the RTU supports the polling of no more than 240 devices,

while the amount of transmitted data should not exceed 8192 AI, 4096 DI, 2048 DO, 256 setpoints.

Table 7.2

Interface	Maximum number of devices
RS-232	1
RS-485	31 without repeaters, 240 with repeaters
Ethernet: (IEC 60870-5-101 over UDP; GOOSE subscription, SNMP)	240
Ethernet: (IEC 60870-5-104, Modbus TCP, IEC 61850 MMS)	64 minus the number of channels (for HW 4) 48 minus the number of channels (for HW 5)
In total, across all interfaces	240

It is allowed to connect different types of devices with the same or similar (Modbus-like) protocols to one RS-485 port. It is not recommended to connect devices polled using the Modbus and IEC 60870-5-101 protocols to the same port.

To poll all devices on the port with a frequency of no more than 1 s, no more than 10 devices should be connected at 9600 baud rate, no more than 20 devices at 19200 baud rate.

The time of data transfer from the device to ENCS-3m depends on the polling interface, exchange rate, volume of parameters, protocol, type of device and other influences. The approximate Modbus polling cycle time of one device is given in Table. 7.3.

Table 7.3.

Number of parameters	**Modbus polling cycle time, ms** 9600 bps	19200 bps
10 registers	60	35
20 registers	80	50
30 registers	105	65
40 registers	125	80

RTU ENCS-3m supports 16 data transmission channels to a higher level, which can be organized by interfaces:

- RS-232 and RS-485 – up to 10 channels (the number of channels is equal to the number of interfaces);

- Ethernet/GSM/3G – up to 16 channels (with 16 channels – the maximum number for all interfaces). A separate channel is not required for data transmission via SNMP v1 and GOOSE protocols;

Each of the 16 channels is individually configured: the interface on which the connection should be made is determined - GSM / 3G, Ethernet, RS-232, RS-485. For a TCP connection, specify the type of connection - client or server; protocol – IEC 60870-5-104,

Modbus TCP, IEC 61850; IP address (client/server), port, and other parameters are specified. For UARTs, port speed, parity, protocol (IEC 60870-5-101 or Modbus RTU, etc.) are specified.

The support of exchange protocols in accordance with IEC 60870-5-104 and IEC 60870-5-101 implemented in the ENCS-3m RTU provides data exchange between the ENCS-3m RTU and the data collection center. It uses periodic, sporadic methods of data transmission, as well as background scanning and response to general polling commands.

Server Mode

If ENCS-3m channel is configured as a server, then ENCS-3m on this socket waits for the client to connect. The IP address of the allowed client and the TCP port are configured. After the client connects (TCP session is established), the exchange begins using the protocol selected for this channel. If the TCP session is broken, ENCS-3m waits for the session to be restored.

If the IP address field of the allowed client is 255.255.255.255, then you can connect from any IP address.

Client Mode

If the ENCS-3m channel is configured as a client, then ENCS-3m initializes the connection with the IP address of the remote server specified in the settings on this socket. After the remote server opens a connection (establishes a TCP session), ENCS-3m is ready for exchange using the protocol selected for this channel. In case of termination of the TCP session, ENCS-3m provides session recovery.

In client mode, you must specify the IP address of the server and the port to which you want to connect. In addition, if you need to use routing to different subnets, then up to 16 TCP packet routing rules can be installed in ENCS-3m, including the interface name, network IP address, network mask and gateway address.

8 RTU setup

Maintenance of RTU ENCS-3m is carried out using a PC (desktop or laptop), equipped with COM or Ethernet ports, with the Windows operating system (version 7 or newer) with an installed software package consisting of:

- Software "ENCS Configurator" – ENCS-3m configuration software (setting the parameters of the RTU interfaces, determining the addressing, composition and algorithms of data transmission; polling the RTU);
- Software "ES BootLoader" – a program for RTU firmware update;
- Software "ES Find IP" – a program to detect the device in local network.

The auxiliary equipment: a power cable, a network cable - a patch cord for connecting the RTU to an Ethernet network, a test bench with an installed measuring transducer (ENIP-2 or others), sensors to display the DO states and devices to simulate the DI states.

8.1 Firmware update

Attention! Before using the device, it is recommended to download the latest firmware version from the official website and upload it to the device using the ES BootLoader software.

The latest versions of software and firmware can be downloaded from our website in the "Support" section: https://enip2.ru/en/support/

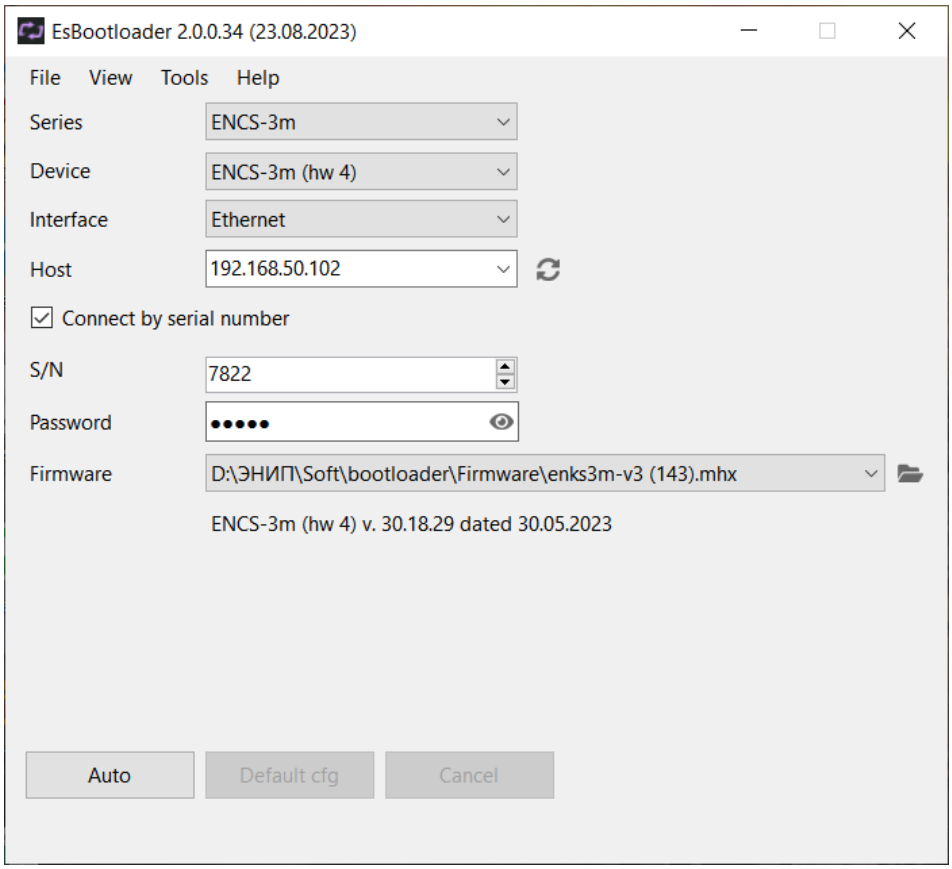


Figure 8.1. RTU ENCS-3m firmware update using the software "ES BootLoader".

Firmware update step-by-step instructions:

- Establish a connection to device via Ethernet (USB for hw5) or RS-232 port.
- In the "ES Bootloader" software, select Series - ENCS-3m, device - ENCS-3m of the desired version, interface - COM or Ethernet (USB);

  – To connect via a serial port, determine the serial port number in the connection settings. The speed can be left 19200, address 0;

  – To connect via Ethernet, specify the IP address of the device, or its serial number (in this case, the device will be temporarily assigned the IP address specified in the IP field).

- In the "Firmware" field, open the file with the latest firmware for the selected device (see Fig. 8.1) or select "Download Latest Firmware" to automatically download the latest version.
- To start firmware update in automatic mode, click the "Update" button. The procedure for erasing the current firmware from the device, writing a new one, and checking the recorded firmware will begin. If, after pressing the "Update" button, update process does not start (this does not apply to the Ethernet connection), remove and then reapply power to the device.

The GT module firmware update is carried out similarly via USB, located on the rear panel of the device.

8.2 Configuration of ENCS-3m

The configuration of the RTU is carried out using the ENCS Configurator software. The description of the configurator is given in the ENCS Configurator software manual.

Attention! The connection by the configurator is carried out through one of the configured channels of ENCS3m. In the channel settings, the IEC 104 protocol (-IEC101) must be specified, the mode is server, the IP address is 255.255.255.255 (means that the connection is allowed from any IP address) or the IP address of the computer from which the connection will be made, "Configuration" is activated. See. fig. 8.2
In the absence of such a channel, configuration is impossible!

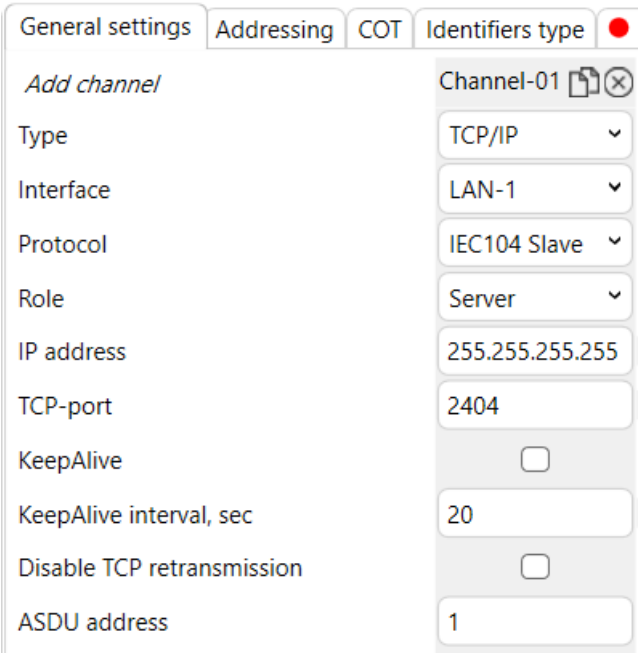


Figure 8.2. Channel setup for device configuring

Attention! Reading and writing configuration work with a limitation - at the same time, these operations are possible only for one channel. These operations become available on another channel only 3 minutes after the configuration is completed (Read or Write).
This restriction is introduced to exclude the possibility of changing the configuration (and even simply reading it) on different channels at the same time.

By default, configuration is available via RS-232-1 or Ethernet. Parameters for connection:

RS-232: 19200e1, МЭК 60870-5-101, ASDU 1;

LAN-1: 192.168.0.10:2404, МЭК 60870-5-104, ASDU 1;

LAN-2: 192.168.0.11:2404, МЭК 60870-5-104, ASDU 1.

If it is necessary to configure devices with default settings located in the same local network, you need first change the IP addresses using the «ES Find IP» software (p. 8.3) to address of subnet in which the computer with the configurator is located.

For a detailed description of all settings, see the ENCS Configurator Software manual.

8.3 Finding a device on the local network

The utility "ES Find IP" is used to detect devices manufactured by Energoservice located in the local network.

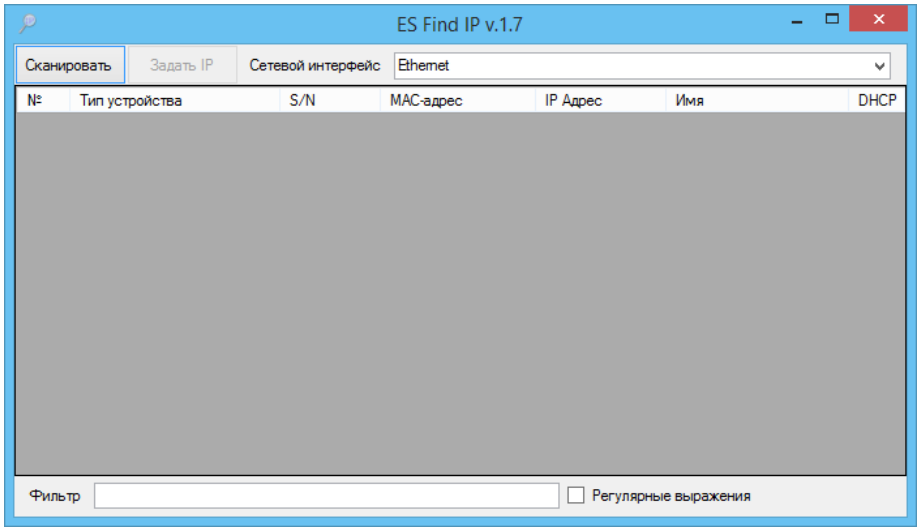


Figure 8.3. ES Find IP software.

To start, you need to run the ESFindIP.exe. Next, you need to click the "Scan" button, after which all devices detected in the local network will be displayed.

To change the IP address of the device, you must right-click on the line with the device and select "Set IP" in the context menu (see fig. 8.4).

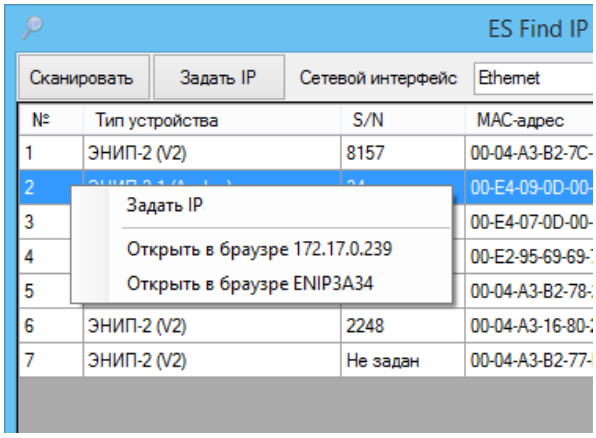


Figure 8.4. ES Find IP software.

In the "Filter" field, you can enter a criterion for searching for any of the fields.

Attention! The current version of the ENCS-3m RTU does not assume the presence of a web server, so the menu items "Open in browser ..." in the "ES Find IP" software: should be ignored.

8.4 Reset settings to default values

To reset the device settings to default values, you need to use a PC with the ES Bootloader utility installed. Connect the device to PC via RS-232 port, run the ES BootLoader software, set the connection parameters, click the

Default button. If no confirmation message appears within 15 seconds, you need to power off and then power on the device.

Default interface settings:

RS-232, RS-485 – 19200 bps, 8e1;

LAN 1: IP 192.168.0.10, DHCP client – disabled;

LAN 2: IP 192.168.0.11, DHCP client – disabled;

login: admin, password: admin.

9 Maintenance

9.1 General instructions

Operational supervision of the operation of the device must be carried out by persons to whom this equipment is assigned.

ENCS-3m devices must not be opened during operation. Violation of the integrity of the warranty sticker relieves the manufacturer of warranty obligations.

All malfunctions that occur during operation are eliminated by the manufacturer.

9.2 Safety

Maintenance work must be carried out by qualified personnel.

Personnel servicing ENCS-3m devices should be guided by this manual, as well as labor protection regulations.

9.3 Maintenance procedure

Microprocessor devices manufactured by Energoservice do not require additional maintenance during operation under normal conditions. However, in accordance with the existing regulatory documents, standards for the operation of remote control systems, periodic and unscheduled inspections and equipment inspections are possible.

9.3.1 Firmware update

Most of the released devices have the ability to update the firmware. It is recommended that you upgrade at the next scheduled maintenance.

The description of the firmware update process is contained in clause 8.1

It is recommended to subscribe to the periodic newsletter on enip2.ru, for prompt information about the firmware update of the devices being released.

9.3.2 Repair

If the device is defective or damaged, you must:

- Dismount the device;
- Draw up a fault report, indicating the signs of a malfunction of the device, the contact details of the person who diagnosed the malfunction.
- Pack the device securely to eliminate the possibility of damage during transportation.

- Send the device together with the fault report and a cover letter containing the address and full name of the contact person for the return of the repaired devices.
- Install the device from the spare parts to replace the faulty one, after loading the configuration from the archive into it.

The address and details for sending can be clarified with technical support or in the sales department.

9.3.3 Equipment Inspection

The following procedure for on-site inspection of equipment is recommended:

- check the operation of existing indicators;
- check the condition of the case, make sure there is no mechanical damage;
- check the condition of fasteners and external circuits;

9.3.4 Preventative maintenance

The list of works that can be included, at the discretion of the operating organization, in the list of planned works:

- Checking the availability of the necessary set of technical, software and operational documentation.
- Checking for up-to-date versions of technological software used to configure and diagnose devices.
- Copy the current configuration.
- Comparison of the current configuration of the device with the one in the archive.
- If necessary, update the firmware of devices and record used firmware versions
- If necessary, test backup copies of settings for operability.
- Scheduled change of passwords for access to devices.
- Checking the correct functioning of the devices:
  - the validity of received and transmitted information, fallback (for devices and systems for collecting and transmitting data);
- Filling out routine maintenance documentation.

9.4 Service Center

Contact information of Energoservice service center:

- Address: 163046, Arkhangelsk, Kotlasskaya str., 26.
- Phone: +7 (8182) 65-75-65.
- E-mail: sales@ens.ru.
- Working hours: Monday-Friday, 9:00-18:00.

The service center performs maintenance, repair and replacement of equipment manufactured by Energoservice, as well as trains operating and repair personnel.

The service center performs the following operations:

- Provides post-warranty service.
- It has an emergency reserve of spare parts agreed with the operating organization.
- Sends service center specialists to facilities that have problems with installed equipment within 72 hours (time and place are preliminarily agreed with the applicant).
- Supplies any spare parts, repairs and/or replacements of any unit of equipment within 20 years from the date of expiration of the warranty period.
- Ensures the delivery time of spare parts for equipment from the moment of signing the contract is not more than 6 months.

10 Transportation and storage

The conditions for transporting devices must comply with the requirements of GOST 26.205-88 and GOST R 52931-2008.

Transportation of packaged devices is allowed by the following transport: road, rail, air - in heated sealed compartments, river and sea - in the holds of ships.

The method of placing the devices in the package on vehicle must ensure their stable position, exclude the possibility of collisions with each other, as well as with the walls of vehicles.

During handling and transportation, the requirements of the manipulation marks on the container must be strictly observed.

When transported in conditions of negative temperatures, the devices must be kept for at least one day under normal conditions before re-opening.

The device and its components in the shipping container withstand a temperature of -50...+70 ° C at a maximum rate of temperature change of 20°C/h, exposure to relative humidity (95+3) % at a temperature of plus 35°C.

Transport containers and packaging for devices sent to the regions of the Far North and equivalent areas according to Table 1 of GOST 15846.

Devices must be stored in packaging that ensures preservation in storage conditions 1 according to GOST 15150-69.

In places where devices are stored in the ambient air, acidic, alkaline and other aggressive impurities, and conductive dust should be free.

The components of the devices in the shipping container during storage are allowed to be stored in no more than two rows.

11 Packaging

RTU are supplied in individual and transport containers.

The package contains 1 set of RTU, specified in section 6. Typical dimensions of individual packaging:

- 125x125x175 mm.

The number of RTU stacked in shipping containers, overall dimensions, net and gross weight - depending on the order. Typical shipping containers:

- corrugated box with dimensions of 375x350x250 mm, accommodating 12 individual packages of 125x125x175 mm;
- corrugated box with dimensions of 345x255x135 mm, accommodating 4 individual packages of 125x125x175 mm.

12 Warranty

The manufacturer guarantees the compliance of the product with the requirements of specifications under the conditions of use, storage, transportation and installation. The warranty period **is 60 months** from the date of delivery. The manufacturer undertakes to repair the product free of charge during the warranty period, subject to the consumer's compliance with the operating conditions. The manufacturer is not responsible for damage to the product due to improper storage, transportation and operation, as well as for unauthorized changes made by the consumer to the hardware and software of the product.

13 Statement of spare parts

Spare parts, tools, accessories and materials (SPTA) are not supplied with this product.

Appendix A. Agreements sheet on the compatibility of a telemechanical system based on RTU ENCS-3m in accordance with IEC 60870-5-101-2006 / IEC 60870-5-104-2004.

This sheet represents a set of parameters and variables from which a subset can be selected for the implementation of a specific telecontrol system based on the RTU ENKS-3m in accordance with IEC 60870-5-101-2006 (IEC 60870-5-104-2004).

For a number of parameters, only one value per system is allowed. Other parameters, such as the set of data and functions used in control and monitor directions, allow you to define a set or subsets suitable for use in a given facility. At the stage of setting up the exchange of telemetry information, it is necessary that the selected parameters be matched between ENCS-3m and equipment from other manufacturers.

Accepted designations:

☐ - The function or ASDU is not used.

☒ - The function or ASDU is used as specified in this standard (default).

R - The function or ASDU is used in the opposite direction only.

B - The function or ASDU is used in both directions.

The possible choice (empty, X, R, or B) is defined for each item or parameter. A black rectangle indicates that the option cannot be selected in this standard.

1. System or device

(A system-specific parameter; indicates the identification of a system or device by marking one of the following rectangles with an "X")

IEC 60870-5-101-2006	IEC 60870-5-104-2004
☐ Definition of the system. ☒ Definition of the monitoring station (Master-Master). ☒ Definition of the monitored station (Slave-Slave).	☐ Definition of the system. ☐ Definition of the monitoring station (Master-Master). ☐ Definition of the monitored station (Slave-Slave).

2. Network configuration

IEC 60870-5-101-2006			
☒	Point-to-point	☒	Bus
☒	Radial point-to-point	☒	Multipoint radial

IEC 60870-5-104-2004			
■	~~Point-to-point~~	■	~~Bus~~
■	~~Radial point-to-point~~	■	~~Multipoint radial~~

3. Physical layer

(Network-specific parameter; all interfaces and data rates used are marked with an "X")

Baud rates (control direction)

IEC 60870-5-101-2006					
Single-ended exchange circuits V.24/V.28 standard		Single-ended V.24/V.28 swap chains recommended at speeds greater than 1200 bps		Symmetrical X.24/X.27 exchange chains	
☒	100 bps	☒	2400 bps	☐	2400 bps
☒	200 bps	☒	4800 bps	☐	4800 bps
☒	300 bps	☒	9600 bps	☐	9600 bps
☒	600 bps	☒	19200 bps	☐	19200 bps
☒	1200 bps	☒	38400 bps	☐	38400 bps
		☒	57600 bps	☐	56000 bps
		☒	115200 bps	☐	64000 bps

IEC 60870-5-104-2004					
Single-ended exchange circuits V.24/V.28 standard		Single-ended V.24/V.28 swap chains recommended at speeds greater than 1200 bps		Symmetrical X.24/X.27 exchange chains	
■	~~100 bps~~	■	~~2400 bps~~	■	~~2400 bps~~
■	~~200 bps~~	■	~~4800 bps~~	■	~~4800 bps~~
■	~~300 bps~~	■	~~9600 bps~~	■	~~9600 bps~~
■	~~600 bps~~			■	~~9200 bps~~
■	~~1200 bps~~				
				■	~~38400 bps~~
				■	~~56000 bps~~
				■	~~64000 bps~~

Baud rates (monitor direction)

IEC 60870-5-101-2006		
Single-ended exchange circuits V.24/V.28 standard	Single-ended V.24/V.28 swap chains recommended at speeds greater than 1200 bps	Symmetrical X.24/X.27 exchange chains
☒ 100 bps	☒ 2400 bps	☐ 2400 bps
☒ 200 bps	☒ 4800 bps	☐ 4800 bps
☒ 300 bps	☒ 9600 bps	☐ 9600 bps
☒ 600 bps	☒ 19200 bps	☐ 19200 bps
☒ 1200 bps	☒ 38400 bps	☐ 38400 bps
	☒ 57600 bps	☐ 56000 bps
	☒ 115200 bps	☐ 64000 bps

IEC 60870-5-104-2004		
Single-ended exchange circuits V.24/V.28 standard	Single-ended V.24/V.28 swap chains recommended at speeds greater than 1200 bps	Symmetrical X.24/X.27 exchange chains
~~■ 100 bps~~	~~■ 2400 bps~~	~~■ 2400 bps~~ ~~■ 38400 bps~~
~~■ 200 bps~~	~~■ 4800 bps~~	~~■ 4800 bps~~ ~~■ 56000 bps~~
~~■ 300 bps~~	~~■ 9600 bps~~	~~■ 9600 bps~~ ~~■ 64000 bps~~
~~■ 600 bps~~		~~■ 9200 bps~~
~~■ 1200 bps~~		

Connection parameters (when using asynchronous communication channels)

IEC 60870-5-101-2006
8 – Number of data bits (5,6,7,8)
1 – Number of stop bits (1, 2)
☐ – Parity is None
☒ – Parity is Even
☐ – Parity is Odd

IEC 60870-5-104-2004
~~– Number of data bits (5,6,7,8)~~
~~– Number of stop bits (1, 2)~~
~~☐ – Parity is absent (None)~~
~~☐ – Parity control (Even)~~
~~☐ – Odd control (Odd)~~

4. Data Link Layer

(A network-specific parameter; all options used are marked with an X.) Specify the maximum frame length. If a non-standard assignment is used for Class 2 messages in unbalanced transmission, then specify Type ID (or Type Identifiers) and COT (cause of transmission) of all messages assigned to Class 2.

IEC 60870-5-101-2006

This standard uses only the FT 1.2 frame format, control symbol 1, and a fixed time-out interval.

Transmission on the channel	Link layer address field
☐ Balanced transmission ☒ Unbalanced transmission	
Frame length 255Maximum length L (number of bytes) (in the direction of management) 255Maximum length L (number of bytes) (in the direction of control) 5 repetitions– Either the time during which repetitions are allowed (Trp) or, the number of repetitions	☐ Absent (balanced gear only) ☒ One byte ☐ Two bytes ☐ Structured ☒ Flat 1–254 Range of Channel Address Values

When using an unbalanced link layer, the following ASDU types are returned for Class 2 (low priority) messages with COT:

☐ The standard ASDU assignment to Class 2 messages is used as follows

TYPE ID	Cause of transmission

☒ The ASDU special assignment to Class 2 messages is used as follows

TYPE ID	Cause of transmission

~~Note: When responding to a Class 2 data poll, the monitored station may send Class 1 data in response if no Class 2 data is available.~~

IEC 60870-5-104-2004

This standard uses only the FT 1.2 frame format, control symbol 1, and a fixed time-out interval.

Transmission on the channel	Link layer address field
■ ~~Balanced transmission~~ ■ ~~Unbalanced transmission~~	■ ~~Absent (balanced gear only)~~ ■ ~~One byte~~ ■ ~~Two bytes~~ ■ ~~Structured~~ ■ ~~Flat~~
Frame length ■ ~~Maximum length L (number of bytes)~~	

When using an unbalanced link layer, the following ASDU types are returned for Class 2 (low priority) messages with COT:

■ The standard ASDU assignment to Class 2 messages is used as follows

TYPE ID	Cause of transmission

■ The ASDU special assignment to Class 2 messages is used as follows

TYPE ID	Cause of transmission

5. Application Layer

Application data transmission mode

Mode 1 (low byte first) is used, as defined in 4.10 of GOST R IEC 870-5-4.

General address: ASDU

(A system-specific parameter; all options used are marked with an X.)

IEC 60870-5-101-2006	IEC 60870-5-104-2004
☒ One byte ☒ Two bytes	■ ~~One byte~~ ■ Two bytes

Information object address

(A system-specific parameter; all options used are marked with an X.)

IEC 60870-5-101-2006			
☐	One byte	☒	Structured
☒	Two bytes	☒	Unstructured
☒	Three bytes		

IEC 60870-5-104-2004			
■	One byte	☐	Structured
■	Two bytes	B	Unstructured
X	Three bytes		

Cause of transmission

(A system-specific parameter; all variants used are marked with an X.)

IEC 60870-5-101-2006			
☒	One byte	☒	Two bytes (with source address)

IEC 60870-5-104-2004			
■	~~One byte~~	☒	Two bytes (with source address)

If the source address is not used, it is set to 0.

IEC 60870-5-104-2004
APDU Length (A system-specific setting that sets the maximum length of the APDU in the system.) The maximum length of the APDU is 253 (default). The maximum length can be reduced for the system. The maximum length of the APDU for systems.

Selection of standard ASDU

Information about the process in monitoring direction

The value of the identifier and the **COT**

(A parameter specific to the station).

IEC 60870-5-104-2004																	
TYPE ID		Cause of transmission															
		1	2	3	4	5	6	7	8	9	10	11	12	13	20-36	37-41	44-47
<1>	M_SP_NA_1		X												X		
<2>	M_SP_TA_1																
<3>	M_DP_NA_1		X	X											X		
<4>	M_DP_TA_1																
<5>	M_ST_NA_1		X	X											X		
<6>	M_ST_TA_1																
<7>	M_BO_NA_1																
<8>	M_BO_TA_1																
<9>	M_ME_NA_1	X	X	X											X		
<10>	M_ME_TA_1																
<11>	M_ME_NB_1	X	X	X											X		
<12>	M_ME_TB_1																
<13>	M_ME_NC_1	X	X	X											X		
<14>	M_ME_TC_1																
<15>	M_IT_NA_1			X												X	
<16>	M_IT_TA_1																
<17>	M_EP_TA_1																
<18>	M_EP_TB_1																
<19>	M_EP_TC_1																
<20>	M_PS_NA_1																
<21>	M_ME_ND_1																
<30>	M_SP_TB_1			X													
<31>	M_DP_TB_1			X													
<32>	M_ST_TB_1			X													
<33>	M_BO_TB_1																
<34>	M_ME_TD_1			X													
<35>	M_ME_TE_1			X													
<36>	M_ME_TF_1			X													
<37>	M_IT_TB_1			X													
<38>	M_EP_TD_1																
<39>	M_IT_TB_1																
<40>	M_EP_TD_1																
<45>	C_SC_NA_1						R	R	R	R	R						R
<46>	C_DC_NA_1						R	R	R	R	R						R
<47>	C_RC_NA_1																
<48>	C_SE_NA_1																
<49>	C_SE_NB_1																
<50>	C_SE_NC_1																

<51>	C_BO_NA_1																
<70>	M_EI_NA_1																
<100>	C_IC_NA_1						R	R	R	R	R						
<101>	C_CI_NA_1						R	R			R						
<102>	C_RD_NA_1					R											R
<103>	C_CS_NA_1						R	R									R
<104>	C_TS_NA_1																
<105>	C_RP_NA_1																
<106>	C_CD_NA_1																
<110>	P_ME_NA_1																
<111>	P_ME_NB_1																
<112>	P_ME_NC_1																
<113>	P_AC_NA_1																
<120>	F_FR_NA_1																
<121>	F_SR_NA_1																
<122>	F_SC_NA_1																
<123>	F_LS_NA_1																
<124>	F_AF_NA_1																
<125>	F_CG_NA_1																
<126>	F_DR_TA_1																

Designations:

Gray rectangles: No option required.

Black rectangle: An option not permitted in this standard.

Empty rectangle: No function or ASDU is used.

Type Identifier/Cause of transmission Marking:

X - used only in the standard direction;

R - used only in the opposite direction;

B - used in both directions.

IEC 60870-5-101-2006																	
TYPE ID		Cause of transmission															
		1	2	3	4	5	6	7	8	9	10	11	12	13	20-36	37-41	44-47
<1>	M_SP_NA_1		X			X						X	X		X		
<2>	M_SP_TA_1																
<3>	M_DP_NA_1		X	X		X						X	X		X		
<4>	M_DP_TA_1																
<5>	M_ST_NA_1		X	X		X						X	X		X		
<6>	M_ST_TA_1																
<7>	M_BO_NA_1		X	X		X									X		
<8>	M_BO_TA_1																
<9>	M_ME_NA_1	X	X	X		X									X		
<10>	M_ME_TA_1																
<11>	M_ME_NB_1	X	X	X		X									X		

<12>	M_ME_TB_1																
<13>	M_ME_NC_1	X	X	X		X									X		
<14>	M_ME_TC_1																
<15>	M_IT_NA_1			X												X	
<16>	M_IT_TA_1																
<17>	M_EP_TA_1																
<18>	M_EP_TB_1																
<19>	M_EP_TC_1																
<20>	M_PS_NA_1																
<21>	M_ME_ND_1																
<30>	M_SP_TB_1			X		X						X	X				
<31>	M_DP_TB_1			X		X						X	X				
<32>	M_ST_TB_1			X		X						X	X				
<33>	M_BO_TB_1			X		X											
<34>	M_ME_TD_1			X		X											
<35>	M_ME_TE_1			X		X											
<36>	M_ME_TF_1			X		X											
<37>	M_IT_TB_1			X												X	
<38>	M_EP_TD_1																
<39>	M_IT_TB_1																
<40>	M_EP_TD_1																
<45>	C_SC_NA_1						R	R	R	R	R						R
<46>	C_DC_NA_1						R	R	R	R	R						R
<47>	C_RC_NA_1																
<48>	C_SE_NA_1																
<49>	C_SE_NB_1																
<50>	C_SE_NC_1																
<51>	C_BO_NA_1																
<70>	M_EI_NA_1																
<100>	C_IC_NA_1						R	R	R	R	R						
<101>	C_CI_NA_1						R	R			R						
<102>	C_RD_NA_1																
<103>	C_CS_NA_1						R	R									R
<104>	C_TS_NA_1																
<105>	C_RP_NA_1																
<106>	C_CD_NA_1																
<110>	P_ME_NA_1																
<111>	P_ME_NB_1																
<112>	P_ME_NC_1																
<113>	P_AC_NA_1																
<120>	F_FR_NA_1																
<121>	F_SR_NA_1																
<122>	F_SC_NA_1																
<123>	F_LS_NA_1																
<124>	F_AF_NA_1																
<125>	F_CG_NA_1																
<126>	F_DR_TA_1																

6. Main application functions

Station initialization

☐ Remote initialization

Cyclic data transmission

☒ Cyclic data transmission

Reading procedure

☐ Reading procedure

Sporadic transmission

☒ Sporadic transmission

Duplicated transmission of information objects with a sporadic COT

(A parameter specific to the station; each type of information is marked with an X, if both types – Type ID without a timestamp and the corresponding Type ID with a timestamp – are issued in response to a single sporadic change in the monitored object).

The following type identifiers, caused by a single change in the state of the information object, can be transmitted sequentially. Individual addresses of information objects for which duplicate transmission is possible are defined in the project documentation.

☐ Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1,

M_PS_NA_1

☐ Double-point information M_DP_NA_1, M_DP TA 1, M_DP_TB_1

☐ Step position information M_ST_NA_1, M_ST_TA_1, M_ST_TB_1

☐ Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1, M_BO_TB_1 (if specified for a project)

☐ Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1, M_ME_TD_1

☐ Measured value, scaled value M_ME_NB_1, M_ME_TB_1, M_ME_TE_1

☐ Measured value, short floating-point number M_ME_NC_1, M_ME_TC_1, M_ME_TF_1

Station interrogation

☒ – Common

☐ – Group 1	☐ – Group 7	☐ – Group 13
☐ – Group 2	☐ – Group 8	☐ – Group 14
☐ – Group 3	☐ – Group 9	☐ – Group 15
☐ – Group 4	☐ – Group 10	☐ – Group 16
☐ – Group 5	☐ – Group 11	☐ – IOA of each group should be given in a separate table
☐ – Group 6	☐ – Group 12	

Time synchronization

☒ – Time synchronization

Command transmission

☒ Direct command transmission

☐ Direct set point command transmission

☒ Select and execute command

☒ Select and execute set point command

☐ C_SE ACTTERM used

☐ No additional definition

☒ Short pulse (duration 1 sec.)

☒ Long pulse (duration 2 sec.)

☒ Persistent output

Transmission of integrated totals

☐ Mode A: local freeze with spontaneous transmission

☐ Mode B: local freeze with counter interrogation

☐ Mode C: freeze and transmit by counter interrogation commands

☐ Mode D: freeze by counter-interrogation command, frozen values reported spontaneously

☐ Counter read

☐ Counter freeze without reset

☐ Counter freeze with reset

☐ Counter reset

R – Time synchronization

☐ Request counter group 1

☐ Request counter group 2

☐ Request counter group 3

☐ Request counter group 4

Parameter loading

☐ Threshold value

☐ Smoothing factor

☐ Low limit for transmission of measured value

☐ High limit for transmission of measured

Parameter activation

☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

☐ Test procedure

File transfer

File transfer in monitor direction

☐ Transparent file

☐ Transmission of disturbance data of protection equipment

☐ Transmission of sequences of events

☐ Transmission of sequences of recorded analogue values

File transfer in control direction

☐ Transparent file

Background scan

☒ Background scan

Background scan – приоритет передачи самый низкий.

Типы срабатывания фонового сканирования:

- периодически с признаком «фоновое сканирование» (период передачи настраивается отдельно от периодов передачи по периодическому алгоритму)

- спорадически – любое изменение параметра влечет его передачу с признаком «фоновое сканирование»

- при изменении актуальности – изменение бита IV NT (если они включены в настройках) у параметра влечет его передачу с признаком «фоновое сканирование».

Acquisition of transmission delay

IEC 60870-5-101-2006	IEC 60870-5-104-2004
☐ Acquisition of transmission delay	■ ~~Acquisition of transmission delay~~

Further only for IEC 60870-5-104-2004:

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30 s	Time-out of connection establishment	
t_1	15 s	Time-out of send or test APDUs	15
t_2	10 s	Time-out for acknowledges in case of no data messages t2 < t1	10
t_3	20 s	Time-out for sending test frames in case of a long idle state	20

Maximum range for all timeouts: 1 s to 255 s, accuracy 1 s..

Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w):

Parameter	Default value	Remarks
K	12 APDU	Maximum difference receive sequence number to send state variable
W	8 APDU	Latest acknowledge after receiving w I format APDUs

Port number

Parameter	Value	Remarks
Номер порта	2404	Configurable

Appendix B: Modbus Protocol

General information

This appendix describes an implementation of Modbus protocol (Modbus is a trademark owned by Schneider Electric) used for data exchange between ENCS-3m and interrogated devices.

To get familiar with basics of Modbus protocol, please download the "Modicon Modbus Protocol Reference Guide" from the www.modbus.org website.

Modbus RTU

When using RTU mode, each byte of message contains two 4-bit hexadecimal numbers. Each message is transmitted in a continuous stream.

The format of each byte in RTU mode is:

- Encoding system: 8-bit binary, hexadecimal 0 - 9, A - F
- Two hexadecimal digits are contained in each 8-bit byte of message.

Bit assignment:

- 1 starting bit
- 8 bits of data, the least significant bit first
- 1 bit of parity; no parity bit
- 1 stop bit if there is parity; 2 stop bits if there is no parity
- Checksum: Cyclical Redundancy Check (CRC)

Content of message

The message begins with a silence interval equal to a transmission time of 3.5 characters at a given network rate. The first field is the device address.

The last transmitted character is also followed by a silence interval of at least 3.5 characters. A new message should start no earlier than this interval.

Thus, if a new message starts before the interval of 3.5 characters, the receiving device will perceive it as a continuation of previous message. In this case, an error is set, as there will be a mismatch of checksums.

Start	Address	Function	Data	CRC	The end
T1-T2-T3-T4	8 bits	8 bits	N x 8 bits	16 bit	T1-T2-T3-T4

Supported function codes

h01 read coil;

h02 read input status;

h03 read holding registers;

h04 read input registers (only in the direction of polled devices);

h05 write single coil;

h06 write single holding register;

Modbus request:

For read functions

Address	Function code	Starting address	Number of parameters	Checksum
1 byte	1 byte	2 bytes	2 bytes	2 bytes

For write functions

Address	Function code	Parameter address	Parameter status	Checksum
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Address – the slave address of the polled device; set by the manufacturer or when setting up the device, takes values from 1 to 254.

Team - one of the commands supported by the ENCS-3m RTU;

Start address (parameter address) - the address of the device parameter, takes a value from 0 to 65535 (hFFFF). When configuring ENCS-3m, the parameter address is always specified in decimal format. Parameter addressing in the device documentation can be specified in several ways, see below for an example of some of accepted addresses:

The parameter address in device description	Transformation	Address specified in ENCS-3m
15 (decimal)	-	15
0x02 (1-byte hex)	h02 = 2	2
011B (2-byte hex)	h011B = 283	283
416396 (logical address)	Discard the first digit, subtract 1 from the remaining number. The first digit in the logical address indicates the command by which the specified registers/discretes should be queried: 0XXXXX – function code 0x01 1XXXXX – function code 0x02 3XXXXX – function code 0x04 4XXXXX – function code 0x03	16395 Request the value of register with the specified physical address by function code 0x03, read the storage registers (Read Holding Registers).

Number of parameters – the number of parameters requested; for example, if you request three parameters with the start address 02, the response will be the values stored in the addresses 02, 03, 04.

Parameter value – used when sending telecontrol commands, takes the values hFF00 (enable) or h0000 (disable);

Checksum is a standard checksum for the protocol (CRC-16-IBM).

Appendix C: Simple Network Management Protocol (SNMP)

Within the SNMP v1 protocol, ENCS-3m supports the transfer of the following Management Information Base (MIB) (file *.mib for ENCS-3m is available at the link):

MIB object	Description	Meaning
SysDescr.0	Device name	Intelligent electronic device ENCS-3M
SysUpTime.0	Opening hours	XX hours, XX minutes, XX.XX seconds
SysContact.0	Contact details	www.enip2.ru, ed@ens.ru, +7 (818-2) 64-60-00
SysName.0	Device modification, serial number, firmware version	ENCS-3M(v2) s/n, f/w
IfNumber.0	Number of interfaces	15
IfTable.0:	Table of interface statistics:	
IfIndex.X	Interface Number	
ifDescr.X	Description	
ifInOctets.X	Bytes accepted	
ifOutOctets.X	Bytes sent	
diagSerialNumers.0	Serial number	s/n
diagFirmware.0	Firmware version	f/w
diagGPSsynh.0	Status of communication with GNSS satellites	
diagChanneNumber.0	Number of channels	16
diagChannelTable.0:	Channel diagnostics table:	
diagChannelIndex.X	Channel index	
diagChannelString.X	Description	
diagChannelInOctets.X	Bytes accepted	
diagChannelOutOctets.X	Bytes sent	
diagChannelLocalIP.X	IP Address	
diagChannelLocalPort.X	TCP port	
diagChannelRemoteIP.X	Client IP address	
diagChannelRemotePort.X	Client TCP port	
diagChannelState.X	Link Status	
diagSynh103.0	Time of last synchronization via IEC-101/104 protocols	
diagNTPsynh.0	Time of last SNTP synchronization	
numAllTC.0	Total number of events	
tcTable.0:	RTU events table	
tcIndex.X	Event index	
tcAdrRTU1.X	RTU Address	
tcParameter.X	Event state	
numAllTCopr.0	The total number of diagnostic events	
tcOprTable.0:	RTU diag. events table	
tcOprIndex.X	Diag. event index	
tcOprAdrRTU1.X	RTU Address	
tcOprParameter.X	Diag. event status	
tcOprTime.X	Last modified time	
tiTable.0:	RTU measurements table	
tiIndex.X	Measurement index	
tiAdrRTU1.X	RTU Address	
tiParameter.. X	Measured value	
tiTime.X	Last modified time	
modemState.0	GPRS connection status	
myGPRS-IP.0	IP address of the SIM card	

Appendix D: IEC 61850 protocol

Attention! Protocol support is provided as additional option ES61850.encs3 at the order. In the future, you can purchase and activate protocol support on-site.

Table D.1.1 – Basic provisions on compliance

		Client/ subscriber	Server/ publisher	Value/ comments
Client-server roles				
B11	**Server** side (of TWO-PARTY APPLICATION-ASSOCIATION)		●	
B12	**Client** side of (TWO-PARTY APPLICATION-ASSOCIATION)	●		
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used	●	●	
B22	SCSM: IEC 61850-9-1 used			
B23	SCSM: IEC 61850-9-2 used			
B24	SCSM: other			
Generic substation event model (GSE)				
B31	**Publisher** side		●	
B32	**Subscriber** side	●		
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			

● – supported services

Table E.1.2 – Provisions on compliance with ACSI models

		Client/ subscriber	Server/ publisher	Value/ comments
If Server side (B11) supported				
M1	**Logical device**		●	
M2	**Logical node**		●	
M3	**Data**		●	
M4	**Data set**		●	
M5	**Substitution**			
M6	**Setting group control**			
	Reporting			
M7	**Buffered report control**			
M7-1	sequence-number			
M7-2	report-time-stamp			
M7-3	reason-for-inclusion			
M7-4	data-set-name			
M7-5	data-reference			
M7-6	buffer-overflow			

		Client/ subscriber	Server/ publisher	Value/ comments
M7-7	entryID			
	conf_revision			
M7-8	BufTm			
M7-9	IntgPd			
M7-10	GIVE			
M8	**Unbuffered report control**		●	
M8-1	sequence-number		●	
M8-2	report-time-stamp		●	
M8-3	reason-for-inclusion		●	
M8-4	data-set-name		●	
M8-5	data-reference		●	
	conf_revision		●	
M8-6	BufTm		●	BufTm = 0
M8-7	IntgPd		●	
M8-8	GIVE		●	
	Logging			
M9	**Log control**			
M9-1	IntgPd			
M10	**Log**			
M11	**Control**			
If GSE (B31/B32) is supported				
	GOOSE			
M12-1	entryID			
M12-2	DataRefInc			
M13	**GSSE**			
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
M16	**Time**			
M17	**File Transfer**			

● – supported services

Table E.1.3 – ACSI Service Compliance Provisions

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
Server (Clause 6)					
S1	Server Directory	TP		●	
Application association (Clause 7)					
S2	Associate		●	●	
S3	Abort			●	
S4	Release			●	

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
Logical device (Clause 8)					
S5	LogicalDeviceDirectory	TP		●	
Logical node (Clause 9)					
S6	LogicalNodeDirectory	TP		●	
S7	GetAllDataValues	TP		●	
Data (Clause 10)					
S8	GetDataValues	TP		●	
S9	SetDataValues	TP	●	●	
S10	GetDataDirectory	TP		●	
S11	GetDataDefinition	TP		●	
Data set (Clause 11)					
S12	GetDataSetValues	TP		●	
S13	SetDataSetValues	TP		●	
S14	CreateDataSet	TP		●	
S15	DeleteDataSet	TP		●	
S16	GetDataSetDirectory	TP		●	
Substitution (Clause 12)					
S17	SetDataValues	TP			
Setting group control (Clause 13)					
S18	SelectActiveSG	TP			
S19	SelectEditSG	TP			
S20	SetSGValues	TP			
S21	ConfirmEditSGValues	TP			
S22	GetSGValues	TP			
S23	GetSGCBValues	TP			
Reporting (Clause 14)					
Buffered report control block (BRCB)					
S24	Report	TP			
S24-1	data-change (dchg)				
S24-2	qchg-change (qchg)				
S24-3	Data Update (DUPD)				
S25	GetBRCBValues	TP			
S26	SetBRCBValues	TP			
Unbuffered report control block (URCB)					
S27	Report	TP	●	●	
S27-1	data-change (dchg)			●	
S27-2	qchg-change (qchg)			●	
S27-3	Data Update (DUPD)				

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
S28	GetURCBValues	TP		●	
S29	SetURCBValues	TP		●	

Logging (Clause 14)					
Log control block					
S30	GetLCBValues	TP			
S31	SetLCBValues	TP			
Log					
S32	QueryLogByTime	TP			
S33	QueryLogAfter	TP			
S34	GetLogStatusValues	TP			

Generic substation event model (GSE) (14.3.5.3.4)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MSEC		●	
S36	GetGoReference	TP			
S37	GetGOOSEElementNumber	TP			
S38	GetGoCBValues	TP		●	
S39	SetGoCBValues	TP		●	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MSEC			
S41	GetGsReference	TP			
S42	GetGSSEElementNumber	TP			
S43	GetGsCBValues	TP			
S44	SetGsCBValues	TP			

Transmission of sampled value model (SVC) (Clause 16)					
Multicast SVC					
S45	SendMSVMessage	MC			
S46	GetMSVCBValues	TP			
S47	SetMSVCBValues	TP			
Unicast SVC					
S48	SendUSVMessage	TP			
S49	GetUSVCBValues	TP			
S50	SetUSVCBValues	TP			

Control (17.5.1)					
S51	Select	TP		●	
S52	SelectWithValue	TP	●	●	
S53	Cancel	TP		●	
S54	Operate	TP	●	●	
S55	CommandTermination	TP		●	
S56	TimeActivated-Operate	TP			

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
File transfer (Clause 20)					
S57	GetFile	TP			
S58	SetFile	TP			
S59	DeleteFile	TP			
S60	GetFileAttributeValues	TP			
Time (Clause 18)					
T1	Time resolution of internal clock	TP		1 ms	
T2	Time accuracy of internal clock	TP		1 ms	
T3	Supported TimeStamp resolution	TP		1 ms	

- – supported services

Attention! The availability of protocol support is determined when ordering the device (optional ES61850.encs3). In the future, you can purchase activation and activate on-site support for the protocol.

Table E.1.1 – Basic provisions on compliance

		Client/ subscriber	Server/ publisher	Value/ comments
Client-server roles				
B11	**Server** side (of TWO-PARTY APPLICATION-ASSOCIATION)		●	
B12	**Client** side of (TWO-PARTY APPLICATION-ASSOCIATION)	●		
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used	●	●	
B22	SCSM: IEC 61850-9-1 used			
B23	SCSM: IEC 61850-9-2 used			
B24	SCSM: other			
Generic substation event model (GSE)				
B31	**Publisher** side		●	
B32	**Subscriber** side	●		
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			

● – supported services

Table E.1.2 – Provisions on compliance with ACSI models

		Client/ subscriber	Server/ publisher	Value/ comments
If Server side (B11) supported				
M1	**Logical device**		●	
M2	**Logical node**		●	
M3	**Data**		●	
M4	**Data set**		●	
M5	**Substitution**			
M6	**Setting group control**			
	Reporting			
M7	**Buffered report control**			
M7-1	sequence-number			
M7-2	report-time-stamp			
M7-3	reason-for-inclusion			
M7-4	data-set-name			
M7-5	data-reference			
M7-6	buffer-overflow			

		Client/ subscriber	Server/ publisher	Value/ comments
M7-7	entryID			
	conf_revision			
M7-8	BufTm			
M7-9	IntgPd			
M7-10	GIVE			
M8	**Unbuffered report control**		●	
M8-1	sequence-number		●	
M8-2	report-time-stamp		●	
M8-3	reason-for-inclusion		●	
M8-4	data-set-name		●	
M8-5	data-reference		●	
	conf_revision		●	
M8-6	BufTm		●	BufTm = 0
M8-7	IntgPd		●	
M8-8	GIVE		●	
	Logging			
M9	**Log control**			
M9-1	IntgPd			
M10	**Log**			
M11	**Control**			
If GSE (B31/B32) is supported				
	GOOSE			
M12-1	entryID			
M12-2	DataRefInc			
M13	**GSSE**			
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
M16	**Time**			
M17	**File Transfer**			

● – supported services

Table E.1.3 – ACSI Service Compliance Provisions

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
Server (Clause 6)					
S1	Server Directory	HCMC		●	
Application association (Clause 7)					
S2	Associate		●	●	
S3	Abort			●	
S4	Release			●	

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
Logical device (Clause 8)					
S5	LogicalDeviceDirectory	HCMC		●	
Logical node (Clause 9)					
S6	LogicalNodeDirectory	HCMC		●	
S7	GetAllDataValues	HCMC		●	
Data (Clause 10)					
S8	GetDataValues	HCMC		●	
S9	SetDataValues	HCMC	●	●	
S10	GetDataDirectory	HCMC		●	
S11	GetDataDefinition	HCMC		●	
Data set (Clause 11)					
S12	GetDataSetValues	HCMC		●	
S13	SetDataSetValues	HCMC		●	
S14	CreateDataSet	HCMC		●	
S15	DeleteDataSet	HCMC		●	
S16	GetDataSetDirectory	HCMC		●	
Substitution (Clause 12)					
S17	SetDataValues	HCMC			
Setting group control (Clause 13)					
S18	SelectActiveSG	HCMC			
S19	SelectEditSG	HCMC			
S20	SetSGValues	HCMC			
S21	ConfirmEditSGValues	HCMC			
S22	GetSGValues	HCMC			
S23	GetSGCBValues	HCMC			
Reporting (Clause 14)					
Buffered report control block (BRCB)					
S24	Report	HCMC			
S24-1	data-change (dchg)				
S24-2	qchg-change (qchg)				
S24-3	data-update (dupd)				
S25	GetBRCBValues	HCMC			
S26	SetBRCBValues	HCMC			
Unbuffered report control block (URCB)					
S27	Report	HCMC	●	●	
S27-1	data-change (dchg)			●	
S27-2	qchg-change (qchg)			●	
S27-3	data-update (dupd)				

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
S28	GetURCBValues	HCMC		●	
S29	SetURCBValues	HCMC		●	

Logging (Clause 14)					
Log control block					
S30	GetLCBValues	HCMC			
S31	SetLCBValues	HCMC			
Log					
S32	QueryLogByTime	HCMC			
S33	QueryLogAfter	HCMC			
S34	GetLogStatusValues	HCMC			

Generic substation event model (GSE) (14.3.5.3.4)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MSEC		●	
S36	GetGoReference	HCMC			
S37	GetGOOSEElementNumber	HCMC			
S38	GetGoCBValues	HCMC		●	
S39	SetGoCBValues	HCMC		●	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MSEC			
S41	GetGsReference	HCMC			
S42	GetGSSEElementNumber	HCMC			
S43	GetGsCBValues	HCMC			
S44	SetGsCBValues	HCMC			

Transmission of sampled value model (SVC) (Clause 16)					
Multicast SVC					
S45	SendMSVMessage	MC			
S46	GetMSVCBValues	HCMC			
S47	SetMSVCBValues	HCMC			
Unicast SVC					
S48	SendUSVMessage	HCMC			
S49	GetUSVCBValues	HCMC			
S50	SetUSVCBValues	HCMC			

Control (17.5.1)					
S51	Select	HCMC		●	
S52	SelectWithValue	HCMC	●	●	
S53	Cancel	HCMC		●	
S54	Operate	HCMC	●	●	
S55	CommandTermination	HCMC		●	
S56	TimeActivated-Operate	HCMC			

Services		AA: TP/MC	Client/ subscriber	Server/ publisher	Comments
File transfer (Clause 20)					
S57	GetFile	HCMC			
S58	SetFile	HCMC			
S59	DeleteFile	HCMC			
S60	GetFileAttributeValues	HCMC			
Time (Clause 18)					
T1	Time resolution of internal clock	HCMC		1 ms	
T2	Time accuracy of internal clock	HCMC		1 ms	
T3	Supported TimeStamp resolution	HCMC		1 ms	

- – supported services