

**The thruster remote control system
«КРПУ-1011»
User's Manual**

TABLE OF CONTENTS

INTRODUCTION	3
1 SYSTEM DESCRIPTION AND OPERATION.....	4
2 SCOPE OF DELIVERY	8
3 SYSTEM DESIGN AND OPERATION	10
4 DESCRIPTION AND OPERATION OF SYSTEM COMPONENTS.....	14
5 INSTALLATION OF SYSTEM DEVICES	34
6 CONNECTION	35
7 SETTING OF SYSTEM DEVICES.....	37
8 SYSTEM USE	38
9 MAINTENANCE	47
10 ROUTINE MAINTENANCE	49
11 FAILURES AND REMEDIAL ACTIONS	50
12 TRANSPORTATION AND STORAGE	52
13 RECYCLING	53
14 WARRANTY OBLIGATIONS.....	54
APPENDIX A OVERALL AND MOUNTING DIMENSIONS OF SYSTEM UNITS.....	55
APPENDIX B THE INTERNAL LOCATION AND PURPOSE OF THE TERMINAL BLOCKS..	59
APPENDIX C DESCRIPTION OF PRIMARY TECHNICAL PARAMETERS ENSURED WITH THE SYSTEM	67
APPENDIX D ALARMS AND INDICATION BLOCKS МЦУ И ПДУ	72
APPENDIX E FAULTS, CAUSES AND REMEDIS.....	75
APPENDIX F TABLE OF THE INTERFACE CONNECTIONS	79
APPENDIX G STANDARD TOOLS-AND-SPARES KIT.....	86
APPENDIX H MAINTENANCE DOCUMENTATION SET.....	87

INTRODUCTION

The present User's Manual (hereinafter referred as UM) covers the thruster remote control system with fixed pitch propeller КРПУ-1011 (hereinafter referred as the system). UM is intended to study operation principles and operation rules of the system, and contains the system devices description.

The system complies with Rules for Classification and Construction of Sea-Going Ships, 2015 for ships with automation sign AUT1 and Rules for the During Construction of Ships and Manufacture of Materials and Products for Ships, 2015.

It is mandatory to follow the current industry regulations and safety rules along with the instructions stipulated in this document.

Only competent personnel instructed with this document, qualified after having completed the special training and permitted for unassisted system maintenance shall be admitted to the system operation.

The equipment defects caused by negligence to the present UM requirements are not eligible for any claims to the Manufacturer.

1 SYSTEM DESCRIPTION AND OPERATION

1.1 SCOPE

The КРПУ-1011 thruster remote control system is intended to ensure local, remote and automatic control of the thruster (with fixed pitch propeller), and to provide the thruster operation information to the control stations and to external ship systems.

The thruster remote control system ensures operation under maritime conditions on ships with unlimited navigation area (UM). The climatic design and location category 5 as under GOST 15150 and RMRS Rules (Item 2.1 Part XV Volume 2, Rules of Classification and Construction of Sea-Going Ships, 2015).

The system ensures stable operation under the following operation conditions:

- at temperature minus 10 °C to plus 55 °C indoors (temperature minus 50°C to plus 70°C does not result in damage of the system elements and devices);
- at relative air humidity 75 ± 3 % and temperature plus 45 ± 2 °C or 80 ± 3 % at temperature plus 40 ± 2 °C, as well as at air relative humidity 95 ± 3 % at temperature plus 25 ± 2 °C;
- at vibrations with frequency 2 to 100Hz (2 to 13.2 Hz with movement amplitude ± 1 mm; 13.2 to 100 Hz with acceleration $\pm 0.7g$);
- at long-term heel up to 22.5°;
- at rolling 22.5° with period 8 ± 1 s;
- under electromagnetic and magnetic interferences, and magnetic field;
- at impacts with acceleration $\pm 5g$ with impact duration 10-15 ms and frequency 40 to 80 impacts per minute;
- at deviations from rated power supply according to Table 1.

Table 1 – Power voltage deviations from rated values

Parameter	Deviation from Rated Values		
	Long-term, %	Short-term	
		Values, %	Duration, s
AC	-10 to +6	± 20	1,5
Frequency	± 5	± 10	5

1.2 MAIN TECHNICAL CHARACTERISTICS

Main technical characteristics of the system are presented in Table 2 and Table 3.

Table 2 – Main technical characteristics of the thruster remote control system

Characteristic	Parameter			
Power voltage	<ul style="list-style-type: none">– main and standby feed line: 220 V 50/60 Hz (with automatic switching from one to another);– Independent operation mode up to 10 minutes (from standard power source, see Section 4.4)			
Integral protection	Power circuits: <ul style="list-style-type: none">– galvanic isolation (below 1,500 V) Interface inputs and outputs: <ul style="list-style-type: none">– galvanic isolation of power grid;– galvanic isolation as per groups (4 pcs), inside the groups are galvanic-coupled			
Number of ports *	Digital (interface) inputs/outputs: <ul style="list-style-type: none">– 2 x RS-422/232 (NMEA);– 4 x RS-422/485 (Modbus, Profibus, NMEA) with galvanic isolation from each other (both for signal and power circuits)			
	Analogue: <ul style="list-style-type: none">– 6 x входов (4..20 mA, нагрузка max 500 Ом);– 4 x выхода (4..20 mA, нагрузка max 500 Ом) with galvanic isolation from each other (both for signal and power circuits)			
	Discrete: Logic (discrete): <ul style="list-style-type: none">– 24 inputs, for dry contact signals (24VDC 0.5 W max), with galvanic isolation as per groups (4 pcs each) Relay: <ul style="list-style-type: none">– 40 outputs, dry contact type (30VDC max 5 A; 250VAC max 5 A)			
Number of remote control panels connected	<ul style="list-style-type: none">– up to 2 pcs (w/o multiplex switch use);– up to 6 pcs (with one multiplex switch use);– up to 16 pcs (if several multiplex switches are connected by cascade)			
Operational constraints				
Protection design	МЦУ	БП	МК	ПДУ
	IP44	IP44	IP22	IP22
Note: * – actual number of used ports is determined by Customer's Scope of Works				

Table 3– Technical characteristics of thruster remote control system devices

Characteristics	МЦУ	БП	МК	ПДУ
Power consumption, W	≤100	≤320	≤15	≤15
Weight, kg	≤30.5	≤16.0	≤3.7	≤1.2
Installation type	Hinged	Hinged, floor-mounted	Hinged	Into a notch (into a panel)

1.3 GENERAL TECHNICAL DATA

The system ensures the thruster control by setting signals (propeller rotation direction and speed) issuing to the thruster frequency converter, and monitors the current parameters of all thruster systems.

The system ensures:

a) interaction with the frequency converter using the following signal types:

1. digital of Modbus type (interface RS-485, TCP/IP);
2. analogue (current) 4..20 mA;
3. discrete: logic (24VDC), relay (30VDC or 250VAC);
4. other signals (upon agreement with the Customer);

b) thruster control:

1. from local control board of the system;
2. from remote control panels via local control board;
3. under commands from the external ship systems (Dynamic Positioning System (DP), Joystick System (JS), Autopilot System) via local control board;

c) communication with the external systems using ports in Table 2;

d) possibility of data communication about the thruster systems state to the following external ship systems:

1. Ship Monitoring System (SMS);
2. Emergency Alarm System (EA);
3. Dynamic Positioning System (DP) or Joystick System (JS);
4. Voyage Data Recorder (VDR);
5. Conning display or Navi Conning;
6. Autopilot System;
7. other systems and devices (if necessary);

e) thruster control under one of the following modes (as per priority descending order):

1. local (from local control board);
2. automatically (as per signals from the external ship systems);
3. remote (from ПДУ);

f) possibility to connect the maximum number of ПДУ (up to 6 pcs) (if one multiplex switch is used);

g) possibility to automate the following process operations:

1. soft start of the propeller motor;
2. speed control of the propeller motor;
3. rotation direction control of the propeller motor;
4. the propeller motor rpm monitoring and indication;
5. the propeller motor load monitoring and indication (power, current);
6. thruster shutdown;
7. thruster emergency shutdown;
8. monitoring of the technical parameters and state of the thruster systems with the appropriate information displaying with the system devices;
9. the propeller motor protection according to the monitored parameters (speed, bearings temperature, windings temperature, overload, overheating);
10. simultaneous-control lock with several systems and control devices;
11. additional operations specified in Delivery Scope of Works;

h) the current parameters displaying at local and remote control stations:

1. the propeller motor speed;
2. the propeller motor drive load;
3. propeller shaft rotation direction;
4. other emergency, warning and information signals see Appendix D;

i) signalling of following parameters:

1. thruster is ready to start;
2. thruster failure;
3. thruster in operation;
4. drive overload;
5. control system failure;
6. high oil temperature in the reduction gearbox;
7. low oil level in the pressurization tank;
8. fault of the main power grid;

k) (manual) acknowledgement of receipt of the alarm signals both from local control board and remote control panels;

l) registration and storage of data on alarms and failures, and its presentation in the Log of Errors in chronological order.

The system is power-supplied with the main ship feed line 220 V 50 Hz using the power supply unit supplied with the system kit.

Upon main grid loss the automatic switching to the standby feed line is ensured with concurrent warning alarm activation.

The system ensures fault-free operation from the standard delivered power supply (with battery) for 10 minutes after loss of the main and emergency power feed line.

The system installed at the object provides for the future upgrading.

Note: list of the interfacing systems, number of the control modes, hierarchy of the control priorities, list of process operations, list of displayed parameters, list of emitted and received signals are specified by the Customer in the Scope of Works, and shall be agreed with the Manufacturer and the Ship Designer. The appropriate information of the specific Project is given in Appendix C of the present UM for the delivered system.

2 SCOPE OF DELIVERY

КРПУ-1011 system scope of delivery shall include:

- | | |
|--|------------------|
| 1. КРПУ-1011 system | 1 set* |
| 2. Operational and technical documentation | 1 set** |
| 3. Spares set (base and/or on-board) | 0 or more pcs*** |

Notes:

1 * – composition of scope of delivery is determined by the Order List or selected by the Manufacturer (according to Customer's Scope of Works) from list specified in Section 2.1. Actual composition is specified in passport (or certificate) of the system.

2 ** – scope of the operation and technical documentation is delivered according to the list in Appendix H.

3 *** – the on-board and base Spares are selected from the list in Appendix G. Composition of Spares set is clarified upon ordering.

2.1 PRODUCT COMPOSITION

КРПУ-1011 system shall include the following units:

1	Local Control Board (МЩУ)	(ЦИУЛ.4683650.001)	1 pc. or more*
2	Multiplex Switch (МК)	(ЦИУЛ.468349.002)	0 pc. or more**
3	Remote Control Panel (ПДУ): ПДУ-Д *** ПДУ-К ***	(ЦИУЛ.421251.002) (ЦИУЛ.421251.002-01)	1 pc. or more**
4	Power Supply: 1. ББП-114-24 *** 2. ББП-114-24К ***	(ЦИУЛ.461524.001) (ЦИУЛ.461524.002)	0 pc. or more**
Notes: 1 * – per one frequency converter – one local control board; 2 ** – actually delivered number of each type devices is specified in certificate for the system; 3 *** – types of remote control panel and power supply are specified upon ordering			

КРПУ-1011 system structure is shown in Figure 1.

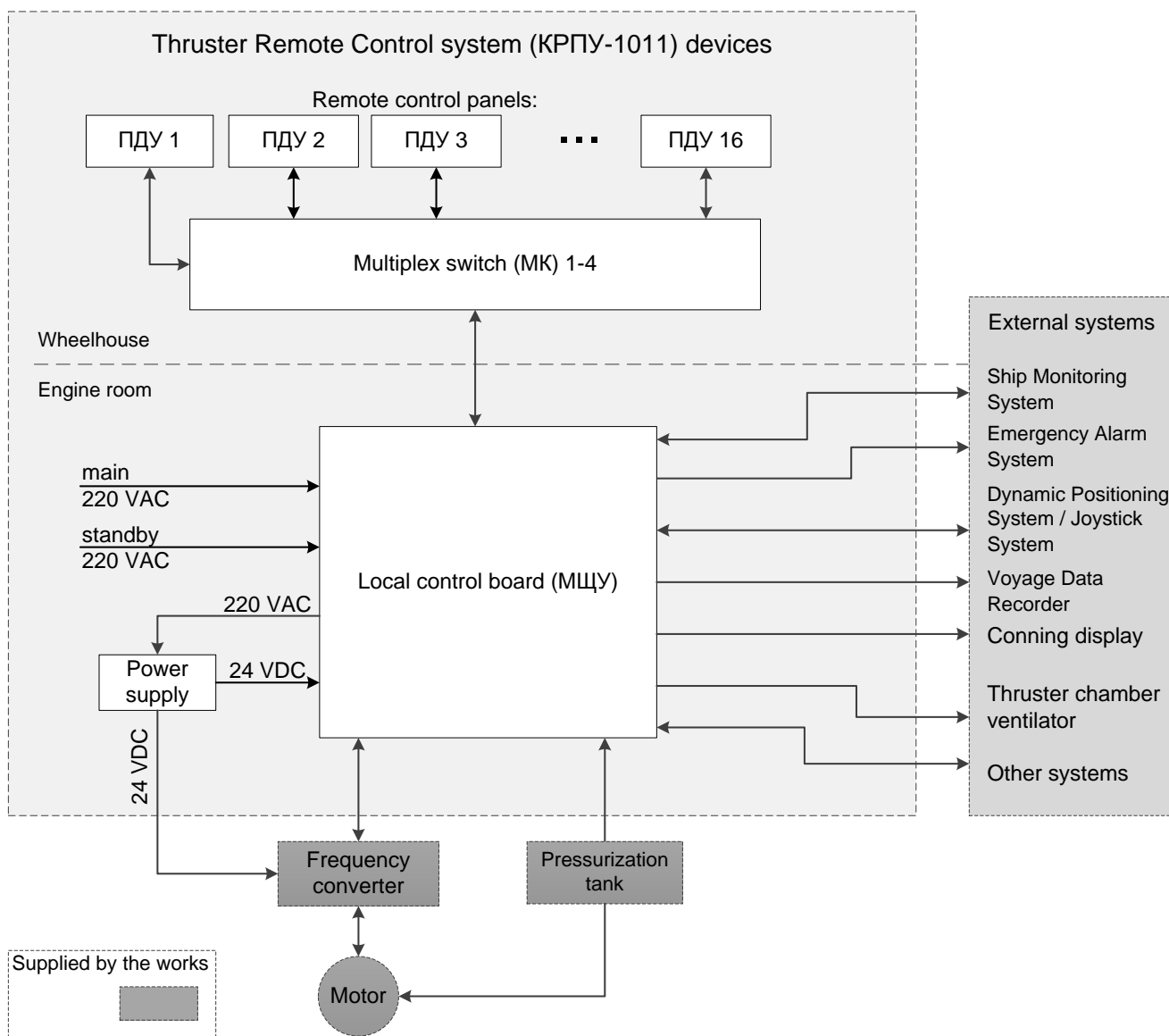


Figure 1 – КРПУ-1011 system structure

3 SYSTEM DESIGN AND OPERATION

KPPIY-1011 thruster remote control system is an aggregate of devices based on the local control board, connected via RS-422/485 network, and converting commands of the mechanical or automatic setting devices into the control signals for the frequency converter.

Additionally the thruster remote control system ensures continuous current data acquisition from all thruster systems (as per scope specified in the Scope of Works for system delivery) and displays these data in the Ship Control Panels, and transmits them to the external ship systems. The local control board controls the frequency converter according to the set algorithm (see Section 3.2).

Description and operation principle of the thruster remote control system components are given in Section 4.

3.1 SYSTEM OPERATION MODES

KPPIY-1011 system ensures operation under the following modes:

- a) service (special);
- b) operation (standard).

Service mode is intended for use by the Manufacturer's service engineer only to execute the following actions:

- 1. initial setting of the system devices;
- 2. adjustment of the system devices (upon the system commissioning and during maintenance);
- 3. extended troubleshooting;
- 4. scheduled works.

Operation mode is intended for the system purpose use. Under this mode the thruster control is performed without limitation from both local, and remote (or automatic) control stations (considering the set-points and algorithms).

The operation mode ensures:

- 1. on-line control;
- 2. monitoring of the operation parameters and modes;
- 3. initial troubleshooting.

Switching between the specified modes is performed with the appropriate software keys from local control board display module. Meanwhile switching to the service mode is performed with an input of the special service password.

3.2 ALGORITHM OF SYSTEM OPERATION

Under operation mode the system can be in one of the following states:

- 1. «Ready to start» (after power on or standard halt);
- 2. «In-operation» (on-line control of the frequency converter from local control board of remote control devices (systems));
- 3. «Emergency stop».

System operation under the specified states is performed in accordance with the algorithm shown in Figure 2.

The system ensures execution of the commands delivered from the controls or from the external systems, and selection of the current control station according to the diagram in Figure 3.

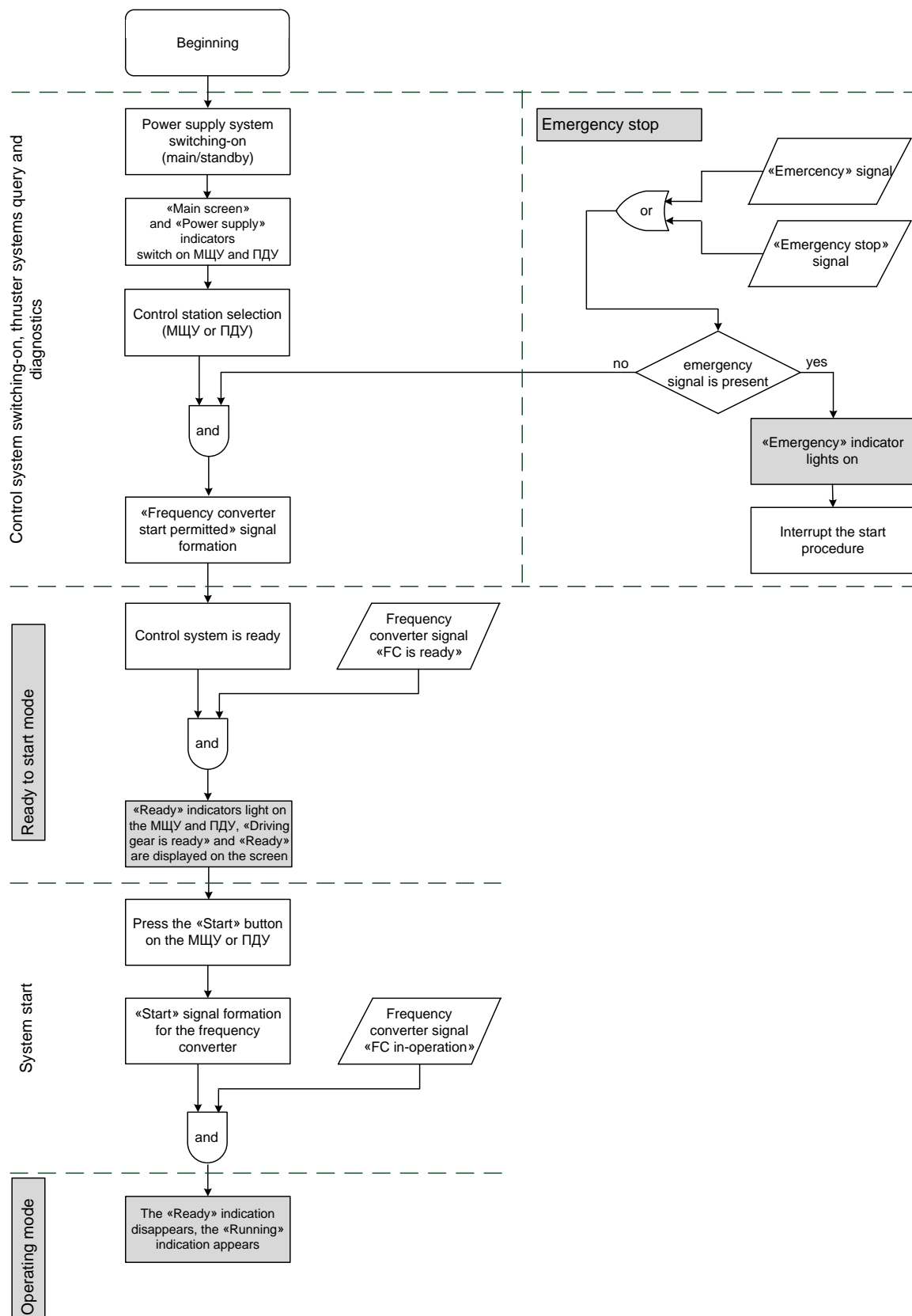


Figure 2 – System operation algorithm – block diagram

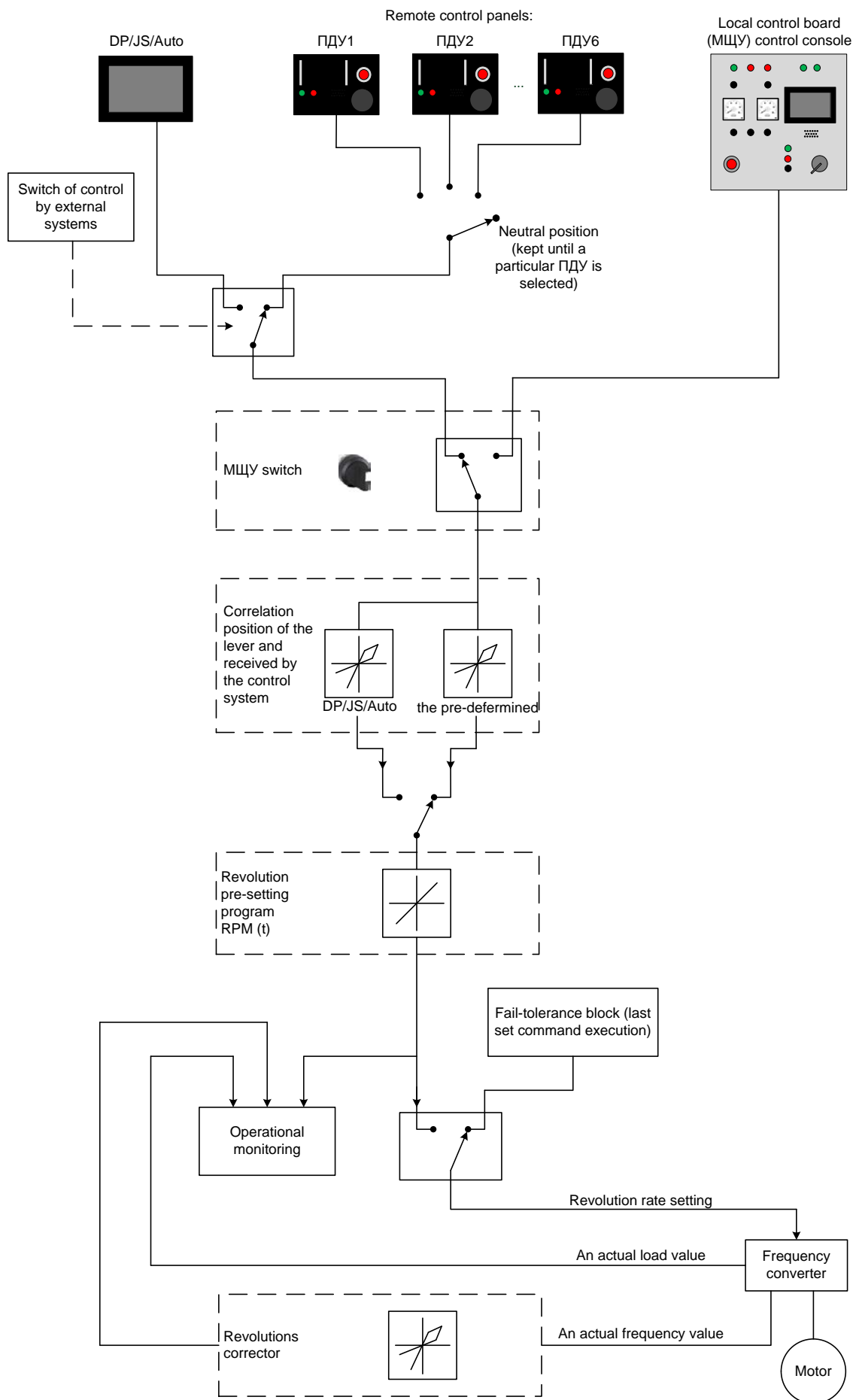


Figure 3 – Thruster control and speed monitoring – block diagram

4 DESCRIPTION AND OPERATION OF SYSTEM COMPONENTS

4.1 LOCAL CONTROL BOARD

The Local Control Board is metal cabinet with devices displaying current parameters, door mounted controls, packing glands for cables output, and it is main system device.

The local control board includes electronic modules for interaction with the system devices, the frequency converter, the thruster systems, the external control systems, and for current data acquisition, processing, displaying and transmission to the control stations and external ship systems.

Local control board block diagram is shown in Figure 4.

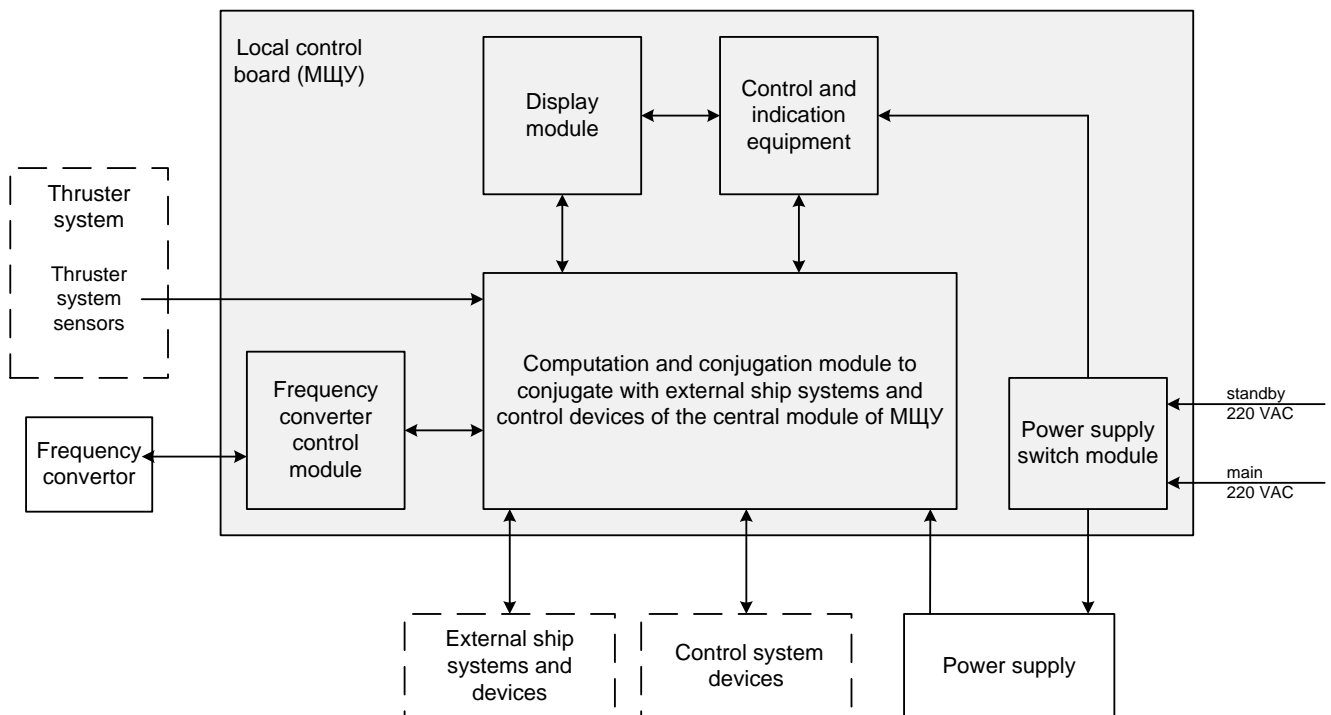


Figure 4 – local control board block diagram

Local control board ensures:

- the frequency converter control and parameters monitoring of the thruster systems;
- supply to the integral display modules of the information relating current parameters of the thruster and control system devices;
- system setting and testing;
- connection via digital communication lines of up to two remote control panels in case of direct connection, of up to six remote control panels if one multiplex switch is used, of up to 16 sixteen remote control panels if cascade connection of several multiplex switches is used;
- continuous connection with the ship systems: DP, JS, SMS, EA (Modbus protocol), NDR (NMEA 0183 protocol), conning display, and other systems and devices;
- control using local control board mechanical push-buttons or touchpad of the local control board display module;

- the thruster control switching to local or remote station;
- Indication of the thruster and thruster remote control system operation;
- alarms on failure of main or emergency power supply;
- acknowledgment of current alarm;
- redundancy of communication lines (simultaneous device connection via two independent communication lines);
- emergency shutdown (with a push-button) regardless of the station used for control;
- execution of the additional functions (upon agreement with the Manufacturer).

Local control board is equipped with a control station selection switch (remote or local), display module (with LCD and touchpad) and other control and indication elements. Local control board is shown in Figure 5.

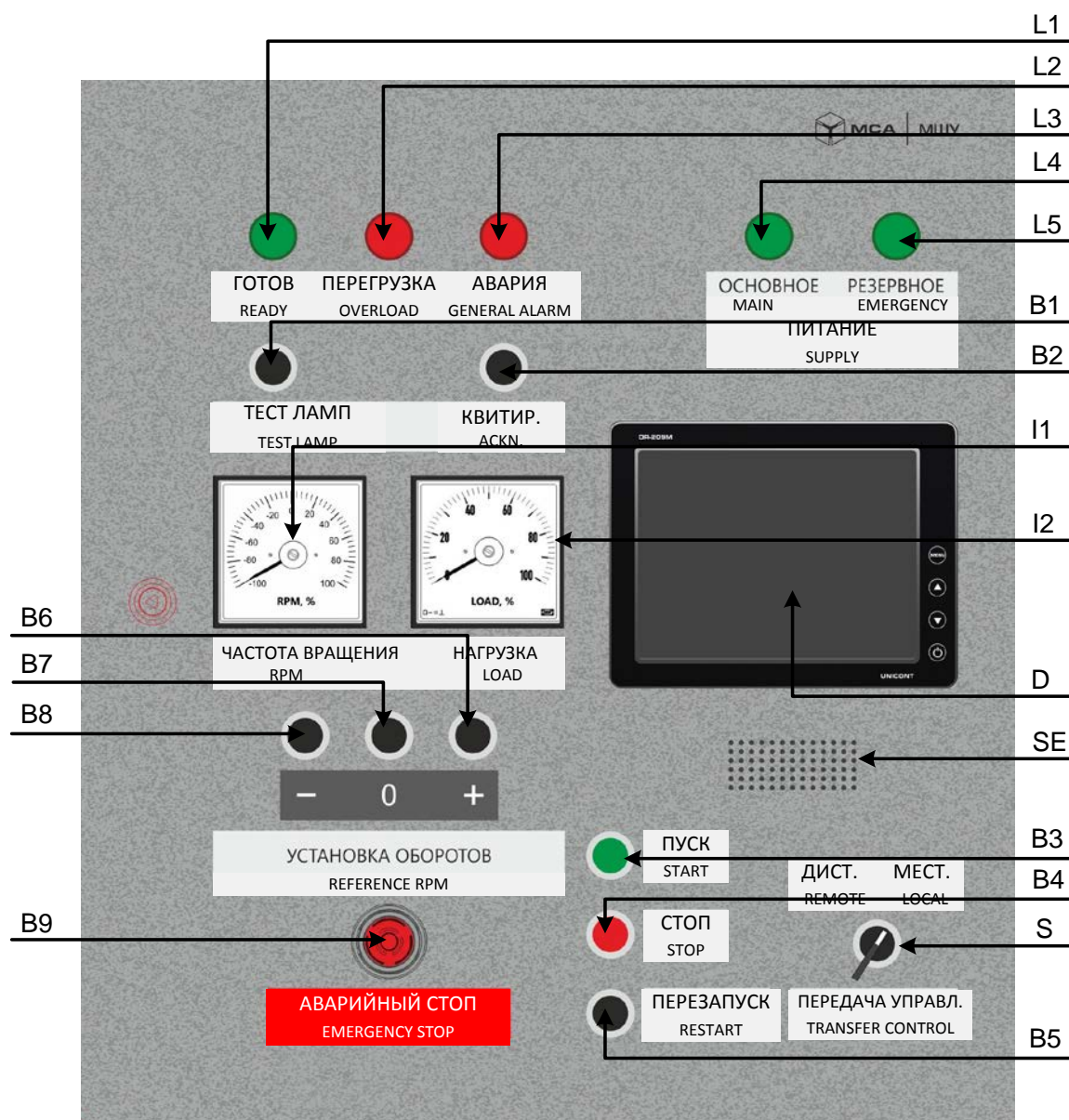


Figure 5 – Local control board

Controls and indicators purpose is described in Table 4.

Table 4 – Purpose of the local control board indicators and operating controls

Designation in Figure	Element Description and Type	Purpose
L1	Lamp « Ready »	Warning about thruster remote control system readiness for operation (including frequency converter); once the response about the frequency converter readiness is received, the lamp is permanently alight (under the standard operation mode)
L2	Lamp « Overload »	Warning: a) about drive overload exceeding set-point (by default >120%) – flashing mode; b) about overload time exceeding set-point (by default >5 s) – is permanently alight
L3	Lamp « General Alarm »	General alarm: a) failure signal was not acknowledged – flashing mode; b) failure signal was acknowledged – permanently alight; c) no alarm – OFF
L4	Lamp « Main supply »	Warning about main supply presence
L5	Lamp « Emergency supply »	Warning about emergency supply presence
B1	Push-button « Test Lamp »	Operation state testing of lamps and sound emitters; during testing for 1 second: a) all lamps are ON; b) sound signal is generated; c) screens backlighting is set to maximum; push-button is illuminated when pushed
B2	Push-button « Ackn. »	End-to-end acknowledgement (confirmation of alarm signal reception); the push-button is illuminated when pushed
I1	Pointer indicator « RPM »	Indication of actual rpm of the propeller shaft from -100% (portside) to 100% (starboard)
I2	Pointer indicator « Load »	Indication of motor drive power (actual load from the frequency converter)
D	Display module	Displaying of current parameters, troubleshooting, thruster remote control system setting and thruster control
SE	Sound emitter	Warning sound signals: a) periodic sound signal – presence of unacknowledged failure; b) short-term sound signal – standard user actions (mechanical or touch keys being pushed)
B3	Push-button « Start »	Motor start-up: a) start executing – flashing mode; b) successful start – permanently alight; c) no start – is OFF
S	Control mode switch « Transfer control »	Control modes switching: a) Local ; b) Remote
B4	Push-button « Stop »	Motor shutdown: a) shutdown executing – flashing mode; b) successful shutdown – permanently alight; c) no shutdown – is OFF
B5	Push-button « Restart »	Motor restart after emergency shutdown; push-button is illuminated when pushed

Designation in Figure	Element Description and Type	Purpose
B6	Push-button «+»	Increasing of propeller motor speed (each push causes acceleration by 5%); the push-button is illuminated when pushed
B7	Push-button «0»	Propeller motor speed setting to zero; the push-button is illuminated when pushed
B8	Push-button «-»	Decreasing of propeller motor speed (each push causes acceleration by 5%); the push-button is illuminated when pushed
B9	Push-button «Emergency stop»	Emergency stop

4.1.1 Local control board Display Module

Local control board is equipped with display module having LCD (8 inches) and touchpad of resistive type. The display module appearance is shown in Figure 6; controls are described in Table 5.

The display module ensures:

1. possibility to set the system (while commissioning);
2. fault diagnosis (via operation and service modes, see Section 11.3);
3. possibility to control the thruster through the touchpad (in case of remote control panel failure);
4. displaying of the current and service (under appropriate work mode) system information;
5. automatic start-up upon power supply to local control board.

The module operation and displayed screen are described in Sections 4.1.1.2 – 4.1.1.4.



Figure 6 – Display module appearance

Table 5 – Purpose of local control board display module controls and indicators

Designation in Figure	Element Description and Type	Purpose
B1	Push-button «Menu»	Switching to menu «Service»
B2	Push-button «▲»	Increasing of screen brightness
B3	Push-button «▼»	Decreasing of screen brightness
B4	Push-button «exit»	Exit from menu «Service»
B5	Push-button «⏻»	Device ON/OFF

Attention! The display module has resistive-type touchscreen (with surface tactile layer) and is intended for use with smooth blunt items only. Use of sharp items (pointing end of the pen or pencil) and rude mechanic effect are prohibited to prevent any touchscreen damage.

4.1.1.1 Information Screens of Display Modules

As the power supply is set to a local control board, there appears one of the following screens on the screen of the display module depending on position of the transfer control switch (see Figure 5 and Table 4), one of the two screens:

1. «Local control» screen, when the local control mode is selected (transfer control switch is in position «Local»), see Figure 7;
2. Main Screen, when the remote control mode is selected (transfer control switch is in position «Remote»), see Figure 8;

4.1.1.2 «Local Control» Screen of Display Module

«Local Control» screen contains the software keys for the frequency converter control and indicators of the current parameters of the system and thruster. The «Local Control» is shown in figure 7.

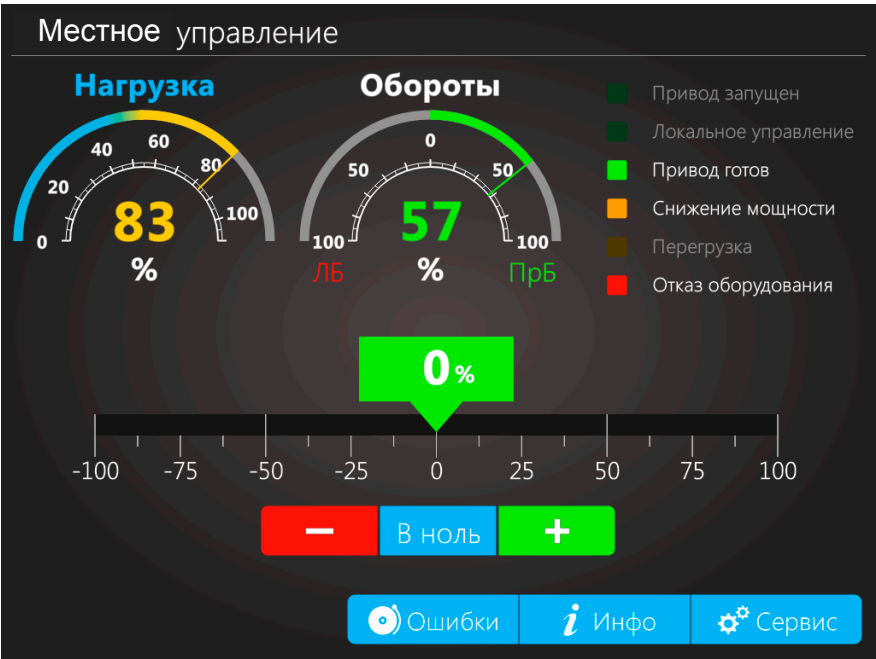


Figure 7 – «Local Control» screen of local control board display module

The screen contains the following operating controls and indicators:

Load	actual drive load is displayed in analogue and digital form
rpm	actual propeller shaft rpm are displayed in analogue and digital form
Drive started	informs about drive start
Local control	informs about the local control from drive
Drive is ready	informs about the system readiness for operation
Power decreasing	informs about start of the power limitation mode

Overload	informs about drive overload
Equipment failure	informs about reception of equipment fault signals
Scale «-100.. 0 ..100»	touch screen scale of rpm setting (range -100 % .. +100%) and set rpm indicator
«-», «To zero», «+»	group of rpm control software keys
Errors	button to refer to the error-display page and fault-reference messages (see Section 4.1.1.4.1)
Info	button to refer to the system Information page (see Section 4.1.1.4.2)
Service	key of switching to system settings menu (for service engineers only)

Current screen indicators can be at two states:

- active (indicators are ON) – upon signal reception;
- passive (indicators are OFF) – with no signal present.

4.1.1.3 Main Screen of the Display Module

Main Screen (see Figure 8) shows current system state, and active control station (ПДУ, СДП, МЩУ).



Figure 8 – Main Screen of local control board display module

The screen contains the following controls and indicators:

СДП	indication of the thruster control kept by Dynamic Positioning System (DynPos)
МЩУ	indication of the thruster control kept by the local control board
Пульт...	indication of the thruster control kept by the local control board (local control board name is set during initial system setting, and will be displayed instead of the text «Пульт»)

Alarm	alarm indication (to receive fault information press key «Errors») (see Appendix C, Appendix D)
Error	alarm indication (to receive fault information press key «Errors») (see Appendix C, Appendix D)
rpm	indication of actual propeller shaft rpm (in digital form)
RPM scale command	indication of the set rpm of the propeller shaft
RPM scale feedback	indication of the actual rpm of the propeller shaft
Load and load scale	indication of the actual drive load (motor relative power of maximum possible value set in thruster remote control system settings)
Drive ON	Indication of the drive work state (drive controls the motor)
Local control	indication of the frequency converter control from own control unit
Drive is ready	indication of the drive readiness for operation
Power decreasing	indication of the activated power limitation mode
Overload	indication of the drive overload
Equipment failure	equipment failure indication (for information on a particular failure occurred press the button «Failure») (for failure list see Section 11.1)
Lever	indication of the current position of the set lever (control knob) of the remote control panel considering program correction (adjustment)
Command rpm	indication of intermediate rpm set by offset correction program
Command to the propulsion motor	indication of rpm ordered by control program from frequency converter
Errors	button of switching to errors and fault messages page (see Section 4.1.1.4.1)
Info	button of switching to system information page (see Section 4.1.1.4.2)
Service	button of switching to system setting menu (see Section 4.1.1.4)

Current screen indicators can be in two states:

- active (indicators are ON) – upon signal reception;
- passive (indicators are OFF) – upon signal absence.

4.1.1.4 Soft Keys of Screens of local control board Display Module

At the bottom of the information screens «Main Screen» and «Local Control» of local control board display module have soft keys providing access to additional menu items (see Figure 9).

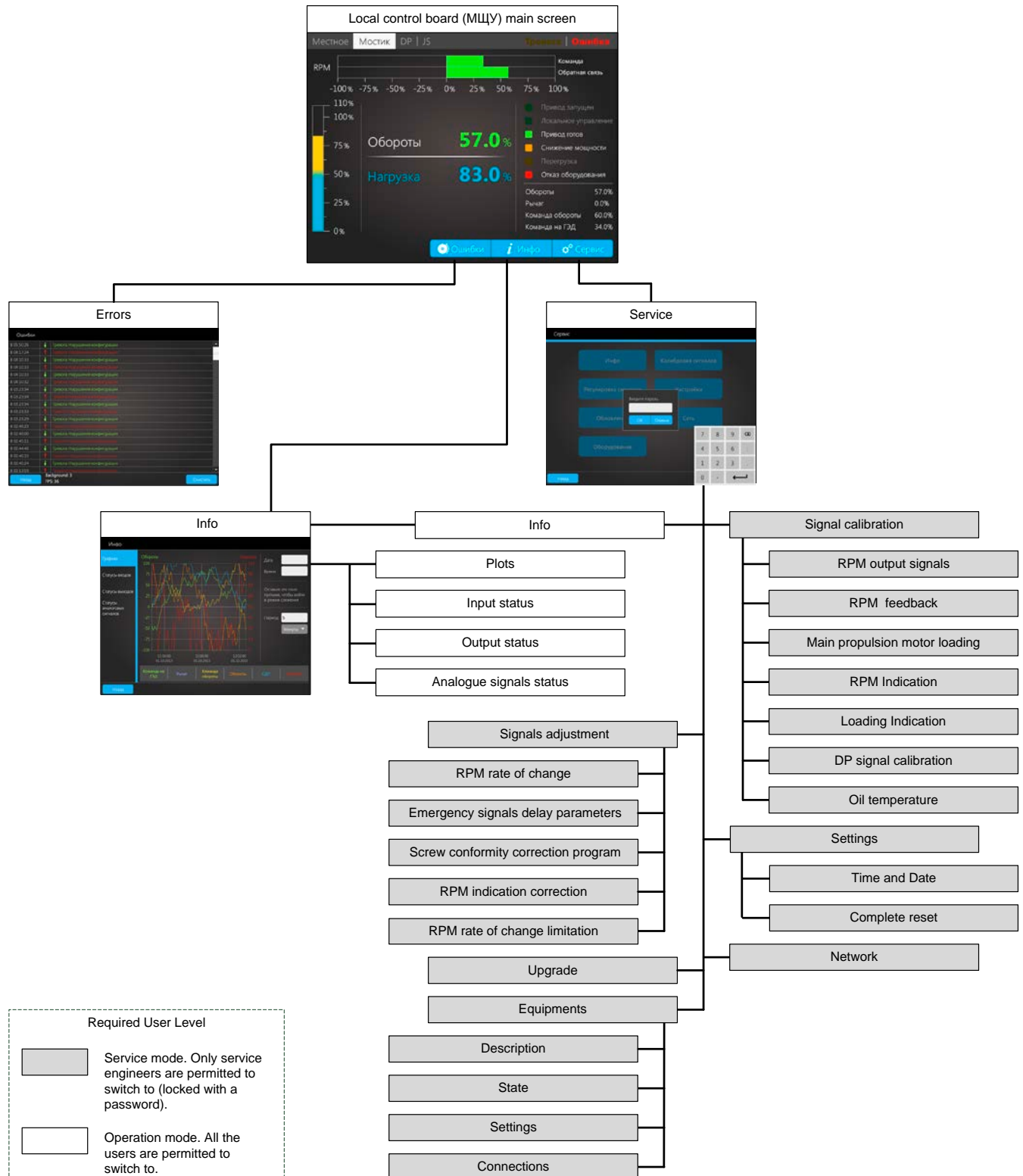
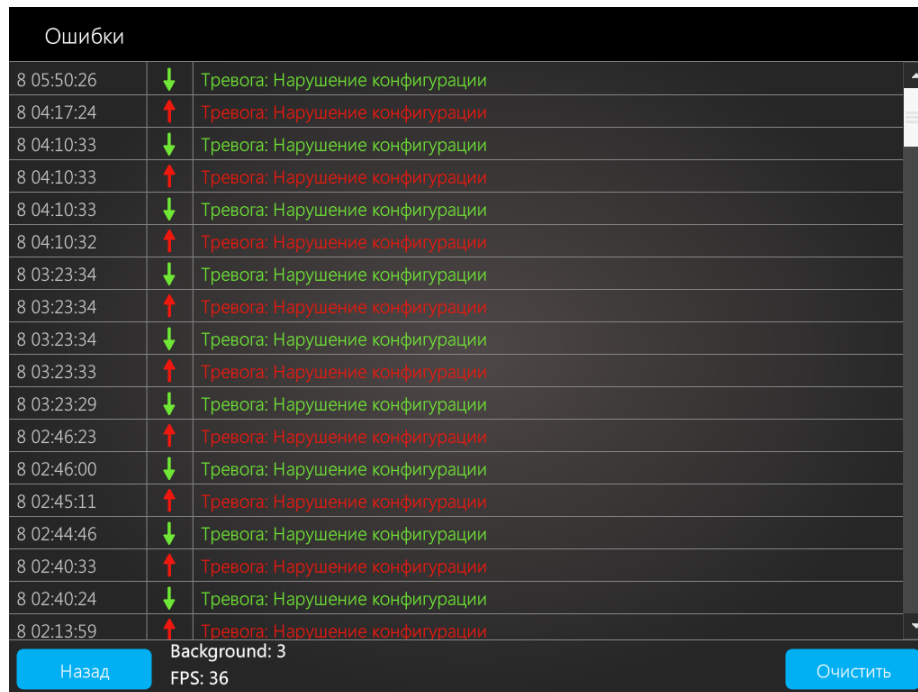


Figure 9 – Menu structure of the local control board display module

4.1.1.4.1 Tab «Errors»

Page «Errors» have logbook of alarms and accidents registered by the system (see Figure 10). The errors logbook stores in chronological order up to 20,000 records (for about last work hour of the system). The data are registered by the system just after power supply to local control board. After de-energizing the system stores the last 256 records of the registered failures.



Ошибки		
8 05:50:26	↓	Тревога: Нарушение конфигурации
8 04:17:24	↑	Тревога: Нарушение конфигурации
8 04:10:33	↓	Тревога: Нарушение конфигурации
8 04:10:33	↑	Тревога: Нарушение конфигурации
8 04:10:33	↓	Тревога: Нарушение конфигурации
8 04:10:32	↑	Тревога: Нарушение конфигурации
8 03:23:34	↓	Тревога: Нарушение конфигурации
8 03:23:34	↑	Тревога: Нарушение конфигурации
8 03:23:34	↓	Тревога: Нарушение конфигурации
8 03:23:33	↑	Тревога: Нарушение конфигурации
8 03:23:29	↓	Тревога: Нарушение конфигурации
8 02:46:23	↑	Тревога: Нарушение конфигурации
8 02:46:00	↓	Тревога: Нарушение конфигурации
8 02:45:11	↑	Тревога: Нарушение конфигурации
8 02:44:46	↓	Тревога: Нарушение конфигурации
8 02:40:33	↑	Тревога: Нарушение конфигурации
8 02:40:24	↓	Тревога: Нарушение конфигурации
8 02:13:59	↑	Тревога: Нарушение конфигурации

Назад Background: 3 FPS: 36 Очистить

Figure 10 – Information screen of the «Errors» page

«Errors» screen information is shown in form of the table with three columns:

Time of signal reception (in chronological order)	Signal actuality – green arrow down «↓» indicates that signal was discarded, red arrow up «↑» indicates that signal is active (continuing reception)	Signal name – message green colour – cleaned signal, red colour – signal is received
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The nether screen part has the following soft keys:

Back	switching to the previous page
Discard	discarding of the table containing failures information to default

4.1.1.4.2 Tab «Info»

If button «Info» is activated the new soft keys (tab-keys) will be accessible on the display module screen:

1. «**Diagrams**» – shows on screen the history of commands and feedback signals supplied to the frequency converter (see Figure 11).
1. «**Input Status**» – displays information about state of all digital inputs, and appropriate signals presence on them (see Figure 12).
1. «**Output Status**» – displays information about state of all digital outputs, and appropriate signals presence on them (see Figure 13).
1. «**Analogue Signals Status**» – displays information about state of all analogue inputs/outputs, and appropriate signals presence on them (see Figure 14).

1) Tab «Diagrams»

Current tab ensures displaying on the screen of the generated commands and feedback signals history in form of diagrams, and provides possibility of the system work analysis or current parameters monitoring.

The diagrams are plotted separately for each selected signal type. By pushing the soft keys it is possible to switch on or off the appropriate diagrams (as per each command or signal).

The diagrams are plotted using last 20,000 records (for about one hour).

Tab «Diagrams» is shown in Figure 11.



Figure 11 – Information screen of «Diagrams» page

White fields in right part of the screen, which activation results in displaying of the virtual keyboard or pop-down lists, provide the possibility of the necessary time intervals setting.

Date and time are set by service engineers in settings, and their keeping is ensured with the built-in battery of the display module.

The screen contains the following controls:

Date	date setting field (format: DD:MM:YY)
Time	setting window for reference time point used for review of the commands and feedback signals history (in format: HH:MM:SS)
Period	setting window for time interval within which the commands and feedback signals history is reviewed; the pop-down list provides selection of the necessary time units: seconds, minutes, hours
Command to propeller motor	key of command addition to the diagram
Command rpm	key of command addition to the diagram
Lever	key of command addition to the diagram
RPM indication	key of feedback signal addition to the diagram
DPS	key of command addition to the diagram
Load	key of feedback signal addition to the diagram
Back	key of switching to previous page

2) Tab «Input Status»

The current tab ensures state displaying of all local control board digital inputs, and presence on them of the appropriate signals, and is intended for failures diagnostics. The colour indicator activity can specify presence and type of the alarms or accident. Tab «Input Status» is shown in Figure 12.

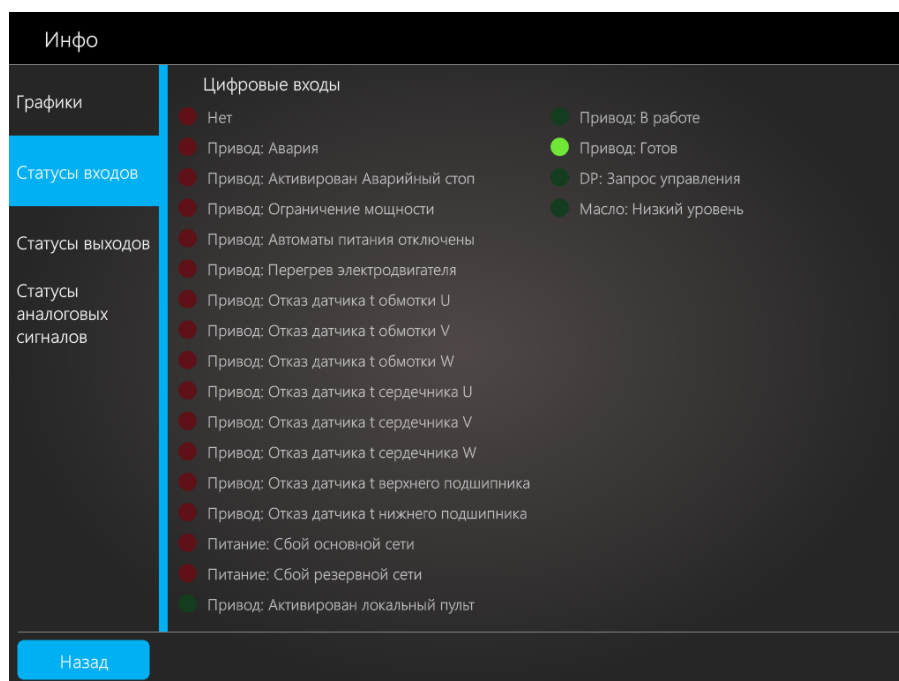


Figure 12 – Information screen of «Input Status» page

Depending on light alarm colour the signals are divided as follows:

- alarm – red;
- warning – yellow;
- Information (normal) – green.

Current screen indicators can be in two states:

- active (indicators are ON) – upon signal reception;
- passive (indicators are OFF) – upon signal absence.

The screen contains the following controls:

Back key to switch to the previous page

3) Tab «Output Status»

The current tab ensures state displaying of all local control board digital outputs, and presence on them of the appropriate signals, and is intended for failures diagnostics. The colour indicator activity can specify presence and type of the alarms or accident. Tab «Output Status» is shown in Figure 13.

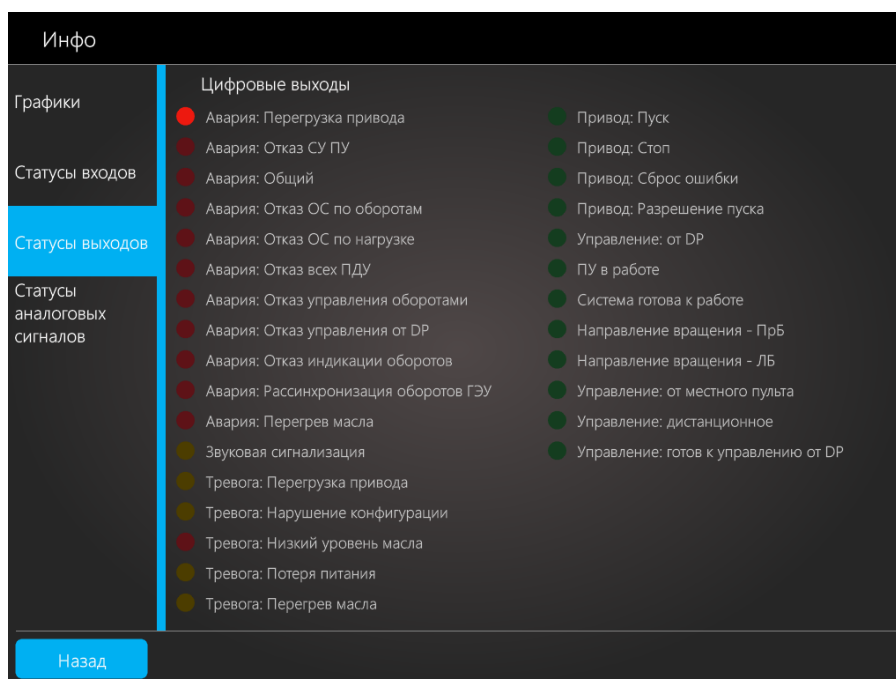


Figure 13 – Information screen of «Output Status» page

Depending on light alarm colour the signals are divided as follows:

- alarm – red;
- warning – yellow;
- Information (normal) – green.

Current screen indicators can be in two states:

- active (indicators are ON) – upon signal reception;
- passive (indicators are OFF) – upon signal absence.

The screen contains the following controls:

Back key of switching to previous page

4) Tab «Analogue Signals Status»

The current tab displays state of all local control board analogue inputs/outputs, and presence of them of the appropriate signals. Tab «Analogue Signals Status» is shown in Figure 14.

Инфо				
Графики	Аналоговые входы			
Статусы входов	Имя	Состояние	Аналоговое значение	Реальное значение
	Обороты ГЭУ (обратная связь)	Нет	12.00	-67.47
	Нагрузка на ГЭУ (обратная связь)	Нет	12.00	88.24
Статусы выходов	Задание оборотов от СДП	Нет	12.00	12.73
	Температура масла	Нет	12.00	0.00
Статусы аналоговых сигналов	Аналоговые выходы			
	Имя	Состояние	Аналоговое значение	Реальное значение
	Индикация оборотов ГЭУ	Нет	12.00	-67.47
	Индикация нагрузки на ГЭУ	Нет	12.00	88.24
	Задание оборотов ГЭУ	Нет	12.00	12.73
Назад				

Figure 14 – Information screen of «Analogue Signals Status» page

Page displays all analogue input and output signals, and important information of these signals:

Name	analogue signal name in the system
Status	current status of the analogue input or output (valid, invalid, no (signal absence))
Analogue value	signal input or output value in mA
Actual value	input or output value of signal in real units corresponding to associated parameter
Back	key of switching to previous page

4.2 MULTIPLEX SWITCH

The multiplex switch is a device used to receive signals from remote control panel and to retransmit them via main and stand-by channels to local control board.

Data communication between the multiplex switch and remote control panel is ensured via communication lines RS-422/485 using UNS protocol.

The multiplex switch ensures:

- data communication between local control board and remote control panel;
- power distribution to RCP;
- simultaneous connection of six RCPs;
- possibility of the cascade connection of additional multiplex switches (to extend the system and to increase number of RCPs (over six));

- assurance of communication signal lines redundancy (devices connection via several communication lines).

The multiplex switch appearance is shown in Figure 15.

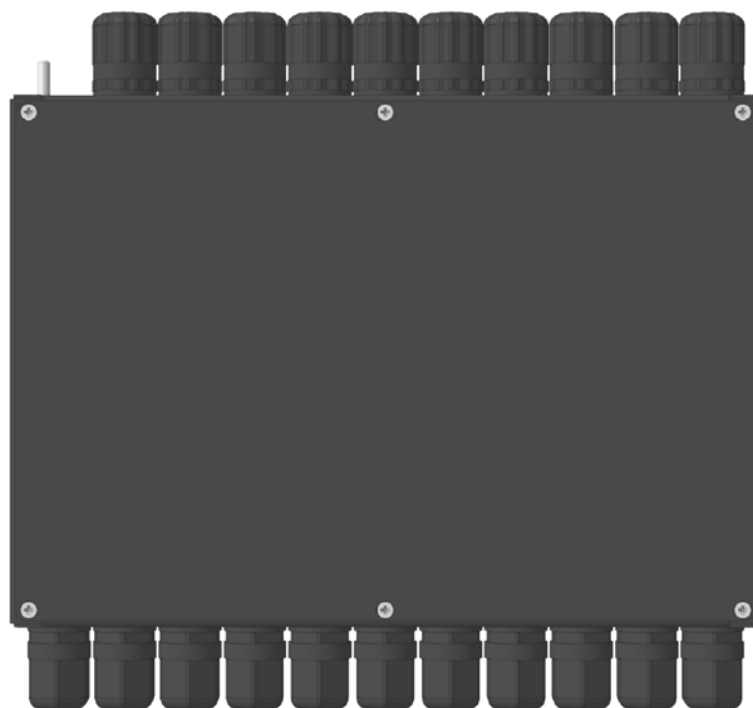


Figure 15 – Multiplex switch exterior view

4.3 REMOTE CONTROL PANEL

The remote control panel (hereinafter the RCP) is a device designed for the thruster control from navigation bridge and for thruster systems operation monitoring.

In the thruster remote control system the remote control panels are of two modifications:

- ПДУ-Д (with a joystick-type revolution and stop-orientation control level);
- ПДУ-К (with a knob-type revolution and stop-orientation control level);

Remote control panel of both modifications can be assigned in the system as:

- central control panel in the wheelhouse;
- side control panels in the wheelhouse (portside, starboard).

Remote control panel ensures:

- control transfer and accepting between remote control panels;
- information displaying about the thruster operation on built-in LCD;
- displaying of power supply presence, readiness for start-up and rotation (stop) direction of the thruster;
- the thruster systems start-up and shutdown;
- smooth and fine setting (adjustment) of the thruster rpm, and change of stop direction;
- alarm of control system and thruster failures (see Appendix D);

- acknowledgment of current alarm;
- emergency shutdown from any remote control panel regardless of what remote control panel is used for the thruster control;
- one remote control panel replacement by another one without re-setting (interchangeability);
- switching to service mode using input of special sign and password from the touchpad (by service engineers);
- brightness adjustment of push-buttons and LC screen.

Remote control panel is made in form of metal module with LC screen (4.3 inches) and touchpad, for installation in the control stand. On back side of the device the cable glands are installed.

Remote control panel has controls and indicators shown in Figure 16. They are described in Table 6.

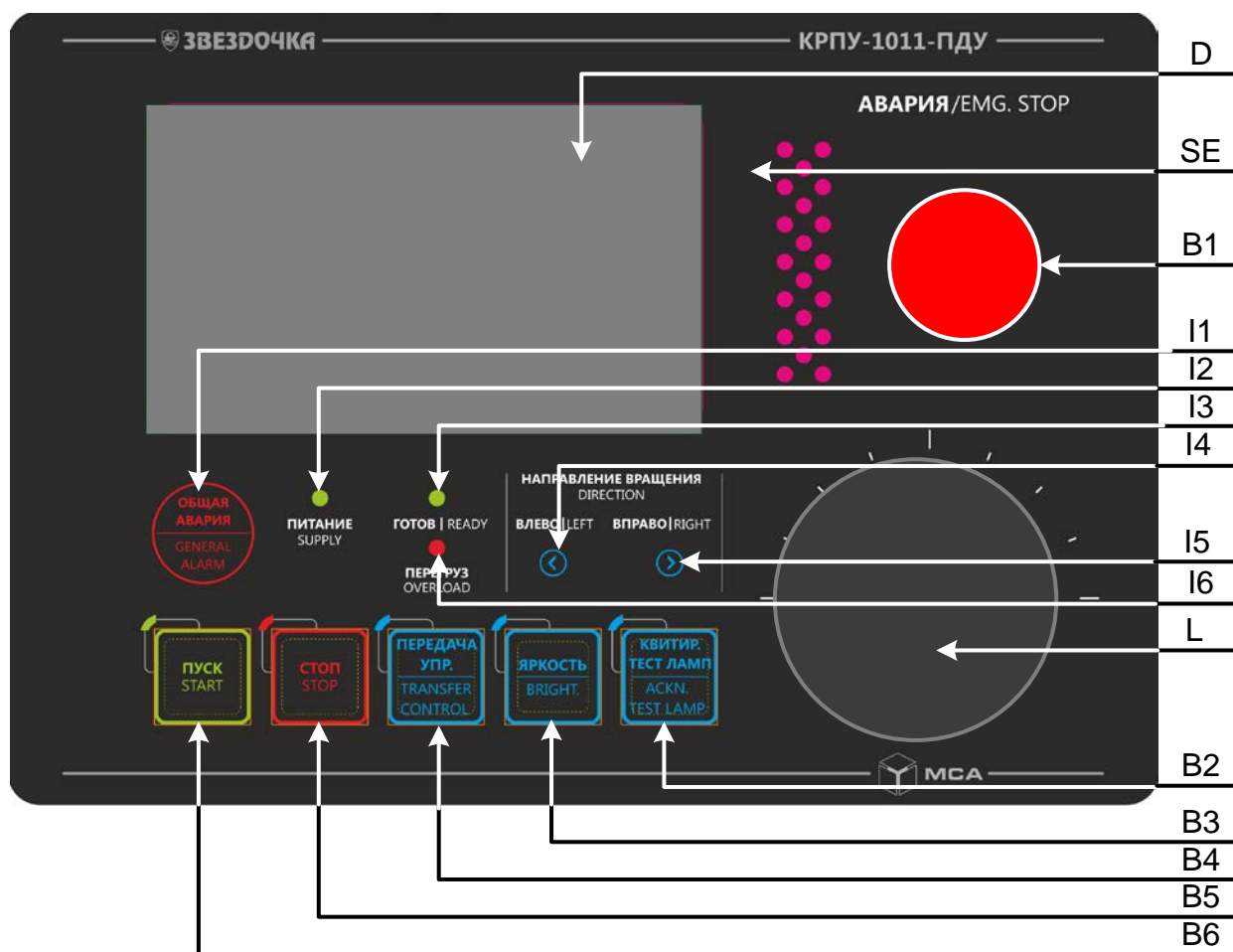



Figure 16 – Remote control panel exterior view

Table 6 – Purpose of the remote control panel controls and indicators

Designation in Figure	Controls or Indicator	Purpose of Controls and Indicators
D	LC screen	Displaying of current parameters, troubleshooting, control lever setting and thruster control
SE	Sound emitter	Warning sound signals: a) periodic sound signal – presence of an unacknowledged failure; b) short sound signal – standard user actions (mechanical or touch keys push) c) short sound signal – synchronization discrepancy of the current position of the remote control panel control lever with actual value of the propeller shaft rpm (> 5%); d) short repeated sound signal – control transfer from one remote control panel to another one
B1	Push-button « Emg. Stop »	Emergency stop
I1	Indicator « General Alarm »	General alarm: a) failure signal was not acknowledged – flashing mode; b) failure signal was acknowledged – permanently alight; c) no alarm – OFF
I2	Indicator « Supply »	Warning about power supply presence
I3	Indicator « Ready »	Warning about thruster remote control system readiness for operation (including frequency converter); after reply about the frequency converter readiness the lamp is continuously ON (under standard operation mode)
I4	Indicator «  »	Indicator of stop direction – to left
I5	Indicator «  »	Indicator of stop direction – to right
I6	Indicator « Overload »	Warning: a) about drive overload exceeding set-point (by default >120%) – flashing mode; b) about overload time exceeding set-point (by default >5 s) – permanently alight
L	Control lever (joystick or knob)	Propeller shaft rpm and direction of rotation control; change of the thruster traction direction: a) relocation completely onto the portside (-100%); b) zero (0%); c) relocation completely onto the starboard (100%);
B2	Push-button «Ackn./Test Lamp»	End-to-end acknowledgement (confirmation of alarm signal reception); Testing of lamps and sound emitters; the push-button is illuminated when pushed
B3	Push-button « Brightness »	Brightness adjustment of controls and monitoring devices, including LC screen; the button is illuminated when pushed

Designation on Figure	Controls or Indicator	Purpose of Controls and Indicators
B4	Key « Transfer Control » «Transfer/Receive Control»	Control transfer and accepting between remote control panels; a) current position of the control lever (joystick or knob) of selected remote control panel is not synchronized to the actual propeller shaft rpm – not active; b) control transfer is performed – flashing mode; c) received control – permanently alight; d) control from another station or system – is OFF
B5	Push-button « Stop »	Motor shutdown: a) shutdown executing – flashing mode; b) successful shutdown – permanently alight; c) no shutdown – is OFF
B6	Push-button « Start »	Motor start-up: a) start executing – flashing mode; b) successful start – permanently alight; c) no start – is OFF

4.3.1 Remote control panel Main Screen

As the power supply is connected, there is the main information frame displayed on the remote control panel, see Figure 17.




Figure 17 – Main information frame of remote control panel

The screen contains indicators displaying information about the current status of the system and active control panels:

Not ready	informs that thruster remote control system is not ready for operation
Ready	informs that thruster remote control system is ready for operation and waits for «Start» signal from operator
Start	informs that thruster remote control system waits signal about drive start-up
Run	informs about the frequency converter switching to operation mode
Stop	thruster remote control system waits signal about drive shutdown

Failure	indicates presence of the critical failures – emergencies impeding any further operation (failure of the thruster remote control system, of the thruster drive, failure: oil overheating, failure: overload)
Control from ...	informs about activated control panel: «Control from local control board », «Control from ...» (device No. or unique name assigned during initial setting is displayed); indicator colour changes: blue – control transfer, yellow – current panel was selected, green – another control panel was selected (not current)
Overload	informs about drive overload (at overload alarm – permanently alight, upon overload warning – flashes)
RPM	actual propeller shaft rpm is displayed in analogue and digital form
Load	actual drive load is displayed in analogue and digital form

Scale RPM has indicator of rpm set by the control lever – «». The indicator remains white if control is performed from another panel (not current), changes colour to green or red if current remote control panel is activated (to left of the centre – red, to right – green). Additionally through the indicator the position of remote control panel control lever is synchronised prior to control transfer.

The screen bottom part is used for text messages of alarms (red colour) and warnings (yellow colour).

4.4 POWER SUPPLY

Power supply is an uninterrupted power source (UPS) with built-in battery, it is intended to ensure power supply 24 V both under standard mode (upon external power presence), and under off-line mode (main and emergency power absence/loss).

The power supply ensures:

- system devices power supply from grid 220 V with voltage 24VDC generation;
- automatic switching to emergency power supply upon main grid power supply loss;
- automatic switching to power supply from built-in battery in case of main and emergency power grid loss, and system power supply for 10 minutes (for time of switching from main to emergency grid);
 - automatic battery charging while supplied from primary grid;
 - internal circuits and battery protection against short circuit and overload.

The device is made in form of a metal monoblock with cable packing glands (see drawing in Appendix A). The residual charge level of the built-in battery is displayed with the LED indicator installed on the face panel of the device. On the device side panel the power ON/OFF push-button is provided.

Maximum time of the power supply work from the battery at load 10 A is not less than 30 minutes.

Technical characteristics and work information of the device are included in the User Manual for the device.

5 INSTALLATION OF SYSTEM DEVICES

The system units location shall be selected considering the operation constraints (work temperature, protection class IP), the necessary information is in Section 1.1 and Section 1.2.

The system devices are installed in accordance with the overall and connecting drawings in Appendix A. Weight and installation type of the devices are in Table 3.

For easy wiring and device maintenance ensure free passage to the system devices and access to the detachable parts.

Local control board is installed in the engine room (in the thruster room) on wall, in vertical position only.

During local control board installation provide for place for the door free opening to position where door lock gear is activated (see drawings in Appendix A).

It is recommended to install the power supply in the direct vicinity of local control board to compensate wire losses.

The multiplex switch is installed in the wheelhouse on wall to reduce number of the connecting cables between a remote control panel and a local control board.

Remote control panel is installed in a notch of the control stand in the wheelhouse. During installation ensure free access to the controls and indication visibility at any angles.

The devices shall be installed in the room without possibility of steam, oil and corrosion liquids ingress in it.

Exclude possibility of the direct heating of the system units by other devices.

The devices with side openings for heat and air exchange shall not be installed by these sides against the walls.

6 CONNECTION

6.1 GENERAL

Local control board is the main system device of the thruster remote control system, where to the other system units are connected, as well as the thruster frequency converter and other sensors and actuators of the thruster systems are connected. To local control board, if necessary, circuits of the external ship automated control systems and other systems can be connected.

The system device tie-in to the Order Subject is made as per individual diagrams, delivered with the system for the appropriate project (see Appendix H).

Location and purpose of terminals of the system devices are in Appendix B.

6.2 INSTRUCTIONS ON DEVICES INSTALLATION

Prior to the installation also make sure that all connected power cables of the system are de-energized, and connected ship devices are switched off.

Cables entry to the devices shall be performed via standard connectors, notches and packing glands (depending of the device type) with further securing excluding their free sagging and pitch, for this the devices have the appropriate cable lock elements (see Appendix A).

6.2.1 Requirements for Cables

Cables used for inter-unit connections shall be of types and makes specified in the connection diagrams. Their analogues can be used. At that use the approved cables with braided screen only.

Cables that ought to keep operability against fire shall conform to the fire-resistant type specification.

6.2.2 Grounding requirements

All system devices shall be grounded. The casing grounding connection shall be performed by flexible with cross-section: at least 4mm² – for the devices with GND stud M5, and at least 6mm² – for the devices with GND studs M6. The protective GND circuit shall be integral.

The signal circuits shall be installed keeping the screen integrity.

6.3 REQUIREMENTS FOR POWER SOURCE

For the thruster remote control system the main and emergency power sources are provided with power sufficient for the system devices power supply.

The requirements for the power source are set according to the Customer's Scope of Work.

Note: the Manufacturer together with the system delivers UPS ensuring the system independent operation (without external power supply) for at least 10 minutes. The built-in battery charging and re-charging are performed automatically using the built-in charger.

6.4 FINAL ACTIVITIES

Prior to the first start-up the system shall be visually inspected by the authorized Manufacturer's representative.

Prior to the system equipment switching-on make sure that installation was made properly (wires and braids of all cables are reliably connected to terminals, installation cables are secured and tightened with glands, device casings are grounded) and in accordance with the delivered diagram.

After power supply to the system devices the following actions shall be executed:

- make sure that the system devices are ON (provided with power);
- set the system devices (made by service engineers);
- ensure functional check of the system (see Section 8.2).

7 SETTING OF SYSTEM DEVICES

During commissioning the system setting is implemented by the Manufacturer's representatives.

After commissioning the system setting is implemented by the Manufacturer's representatives or by Customer forces according to the Manufacturer's documentation while consulting the latter.

The following system devices are set:

- local control board (setting via the display module);
- remote control panel.

In general local control board ensures the following settings:

1. Calibration of input signals (analogue) received by local control board.
2. Calibration of output signals (analogue) generated by local control board.
3. Correction of propeller motor and control lever speed signals.
4. Adjustment of constraints of RPM change rate and alarm delays.
5. Date and time setting.
6. Individual equipment settings.

Menu structure of local control board display module is shown in Figure 9.

Remote control panels ensure control lever of the given remote control panel only.

Note: access to the settings menu of the abovementioned devices is possible after service password input only.

8 SYSTEM USE

Thruster remote control system preparation and functional check shall be performed while the thruster systems and machinery remain out of operation.

Prior to the thruster remote control system run make sure that:

- all thruster systems and machinery are ready;
- all ship switches ensuring thruster remote control system power supply are disconnected;
- all devices are at standard places, and reliably secured, fasteners have no mechanical damages;
- wiring is performed completely (all cables are secured and electrically insulated, cable braiding surfaces have no damages resulting in people electric shock, installation cables and glands are reliably secured).

Measure insulation resistance of thruster remote control system according to the instructions given in Section 9.1.

Make sure that the grid power corresponds to the total power consumed by the system devices (see Table 3).

Check compliance of parameters of main and emergency power sources with characteristics in Table 2. Different group cables Rules of Classification and Construction of Sea-Going Ships.

8.1 DEVICE SWITCHING-ON

For the system switching on make the following actions:

1. Supply power to the frequency converter and all thruster systems.
2. Switch on the thruster, and set remote control mode (according to User's Manual for the thruster).
3. Supply power to the thruster remote control system; switch the system power supply on.
4. As the power supply is connected the thruster remote control system switches to the operation mode and executes the following actions:
 - current connections check (grid scanning, obtaining of grid topology and equipment list, topology and equipment list confirmation);
 - the thruster remote control system query and then waiting for the signals of the thruster readiness for operation;
 - connected external ship systems and devices query, waiting for the signals of the operation readiness;
 - current controls position identification;
 - switching to the mode of the thruster readiness for the start-up after the registration of the signals permission for the thruster to start up;

- generating the signal which permits the frequency converter to start with a «Start» key push;
- information displayed on the indicators of the system devices after the motor had been started up and the load and speed status signal had been received;
- reception of control signals of the devices and remote control systems;
- generation of the control signals to the frequency converter and of other received signals to the external ship systems and devices.

Note: if necessary, the system can be switched to the service mode.

8.2 FUNCTIONAL CHECK

Operability of the thruster remote control system is determined by the following indication:

1. Indicators confirming power presence («**Supply**» on remote control panel, «**Main Supply**» or «**Emergency Supply**» on local control board).
2. Main information screens are displayed on local control board and remote control panel.
3. There are no sound alarms, light and text indication of alarms (composition and colour of text messages are in Appendix D).
4. The propeller shaft speed upon the system start-up is equal to zero.

The functional check of the light indicators and sound emitters is performed using key «**Test Lamp**» in local control board, and «**Ackn./Test Lamp**» in LCP. For this hold the key in pressed state for three seconds. During test all light indicators of the device are activated for 1 second, sound indicators generate short signal, also for 1 second the backlight of the integral LC screen is set to maximum brightness.

Attention! In case of failure terminate the start-up procedure, determine failure reason, repair in accordance with instructions in Appendix E and Manuals enclosed to the device that are not part of thruster remote control system.

The failed items or items with failed Instruments, indicators and/or control elements are prohibited for operation as part of the thruster remote control system.

8.3 SYSTEM PURPOSE USE

8.3.1 Thruster Control Modes Switching

In KРПУ-1011 system there is possibility of the thruster control under the following modes (according to priority descending):

- manual from local control board;
- remote automatic (external ship systems and remote automatic control devices (Autopilot, DPS, JS));
- remote manual from remote control panel.

Furthermore:

- if external automatic ship control systems are activated, the control from remote control panel is completely disabled until the automatic control mode is disconnected.
- the external ship control systems does not imply any independent system start-up, this shall be performed under the manual mode only, see Section 8.3.3

Block diagram with logic description of the system used along with the thruster control modes is shown in Figure 18.

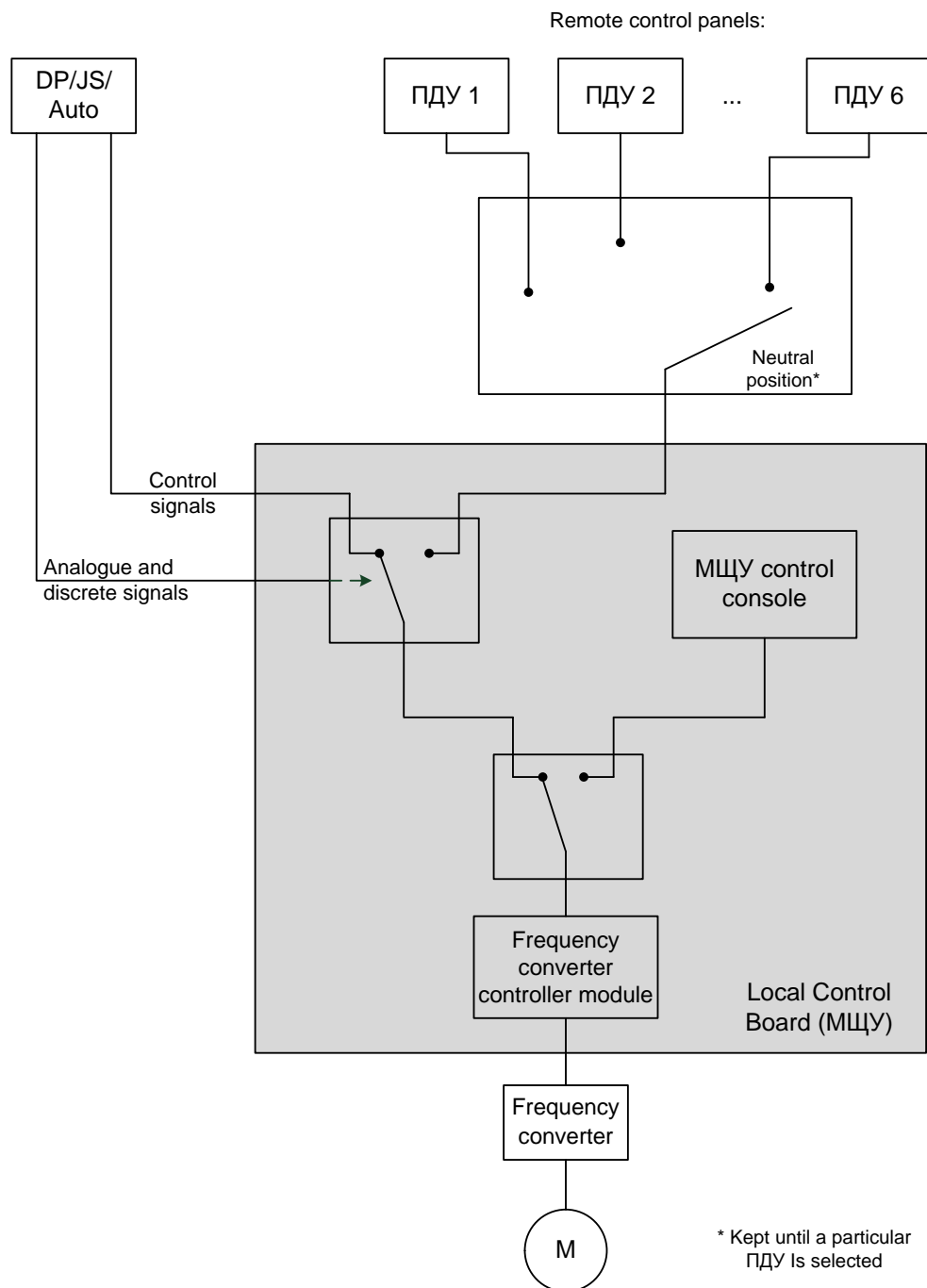


Figure 18 – Control block diagram

For the control modes switching the following sequence of actions is provided:

Transfer from local control to remote manual

1. Set switch «Transfer Control» on face panel of local control board (see figure 5) to position «Remote».
2. In all remote control panels short repeated sound signal, indication of keys «Transfer Control» is activated; «Transfer/Receive Control» switches to flashing mode.
3. Receive control on appropriate remote control panel (press key «Transfer Control» «Transfer/Receive Control» (if necessary synchronize position of knob and speed see 8.3.2)).
4. On local control board screen indication of the selected remote control panel – «Panel...» is ON. On other remote control panel displays message «Control from ...» (name of activated panel) is displayed.

Transfer from local control to remote automatic control

1. Set switch «Transfer Control» on face panel of local control board to position «Remote».
2. External systems and devices of ship automatic control automatically receive control from any remote control panel during operation.

Transfer from automatic remote to manual remote control

1. After having disabled the external systems and devices of the automatic remote vessel control, an intermittent repetitive signal emits at all remote control panels, the button indication «Transfer/Receive Control» turns into the flashing mode.
2. Within the set (while setting up the system) period of time you need to select a random remote control panel and take the control: press the button «Transfer/Receive Control» and, if necessary, to synchronize the position of the handle and rotation in accordance with clause 8.3.2.
3. If the reception of the control has not succeeded within the specified time, the control is automatically transferred to the last active remote control panel.

Transfer from automatic remote to or manual remote control to local control

1. To transfer to the local control set switch «Transfer Control» on face panel of local control board to position «Local».
2. Note: remote control switching to local control is impossible.
3. Main Screen of local control board display module switches to Local Control screen. In all remote control panels indicator «Control from local control board » are ON.

8.3.2 Control Transfer between remote control panels

Control Transfer between remote control panels

1. On current remote control panel press key «Transfer Control» «Transfer/Receive Control».
2. In all remote control panels button «Transfer Control» indication is ON Indicator «Transfer/Receive Control» switches to flashing mode, short repeated sound signal is activated.
3. Select any remote control panel.
4. Synchronize position of control lever with motor speed in LC screen («RPM»)*.
5. Press button «Transfer Control» «Transfer/Receive Control». Key indication of current remote control panel switches from flashing mode to continuous ON state, in other remote control panels is OFF. On local control board screen indication of the selected remote control panel – «Panel...» is ON (name of

activated panel).

Note: * – Upon attempt of remote control panel knob use without synchronization the system generates short repeated sound signal, and displays on remote control panel screen the message «Synchronize lever position with motor speed». Permitted synchronization discrepancy is 5%. For synchronization press key «Transfer Control» «Transfer/Receive Control» is inactive, control cannot be regained.

Possibility of simultaneous control from several control panels is excluded.

Attention! Upon power supply after de-energizing (scheduled works, long-term out of operation, system re-start, after emergency shutdown) thruster remote control system transfers control to the last control station keeping the last selected control mode.

8.3.3 Thruster Start-up

The thruster propeller motor is started (depending on position of control mode switch of local control board) with one of the following methods:

- «**START**» button push on the face panel of local control board – is control mode switch is in «Local» position;
- «**START**» button push on the remote control panel – if the control mode switch is in «Remote» position.

After button «Start» depression the frequency converter tries to start the propeller motor, and upon successful start-up informs the system about start-up by the appropriate control signal, then the thruster remote control system switches to the initial operation mode (mode «Run»), and current parameters of the system status are displayed in indicators.

Order of actions relating the thruster start-up is as follows:

- power supply;
- power indicators at the local control board and remote control panels are ON;
- screens switching on local control board (local or remote control) and on remote control panel;
- selection of the control station (local control board or remote control panels);
- indicator of active control station is ON;
- button «Start» depression at selected station (local control board or remote control panel*);
- signal «Start» generation for the frequency converter;
- signal «Frequency converter is ON» reception from the frequency converter.

Note: * – after control transfer to remote control panel all system remote control panels will be in mode waiting confirmation of remote control panel selection (activate remote control panel according to Section 8.3.2), and cannot ensure the thruster start-up and control.

8.3.4 Thruster Control through the Manual Mode

The thruster control through the manual mode is similar to control from both remote control panel (see Section 8.3.4.1), and from local control board (see Section 8.3.4.2)

8.3.4.1 Thruster Control from remote control panel (Manual Remote Control from remote control panel)

For the thruster control from remote control panel preliminarily switch the system to the «remote manual control from remote control panel» mode (procedure as per Section 8.3.4.1 for the given mode).

As the specified actions are executed it is possible to keep control from the current (active) remote control panel only.

For the thruster propeller motor start-up execute steps in Section 8.3.3.

For propellers speed and direction of rotation control use control lever (PDU-D) or knob (PDU-L) of remote control panel (see Figure 19 and Figure 20).

Setting of the required speed and stop is performed by smooth movement of the lever to the appropriate direction (left or right), and its position lock upon required speed achievement. At that, monitor current rpm on indicator of remote control panel screen.

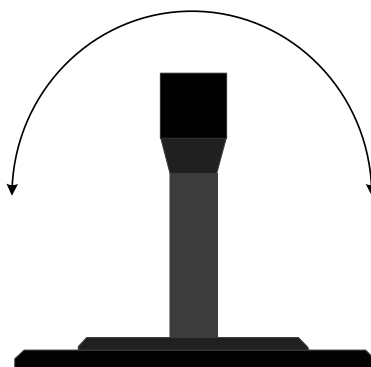


Figure 19 – Control scheme of lever (joystick) ПДУ-Д

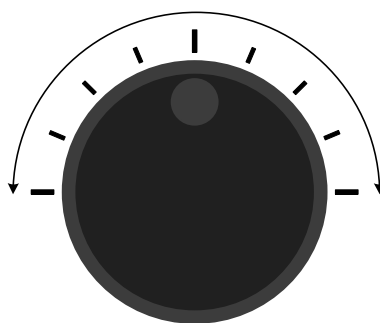


Figure 20 – Control scheme of knob ПДУ-К

While using the lever (knob) it is possible to change smoothly traction with complete reversing to portside (-100%), zero (0%) or completely to starboard (100%). Extreme positions of knobs correspond to maximum value (100%) of the propeller motor speed that is pre-set in the system settings. The direction of rotation of the propeller motor (stop) is changed to opposite direction via middle (zero) position of the knob. Knob scale interval is 25%.

Attention! To prevent emergencies avoid rapid movements of the remote control panel lever.

If it is necessary to transfer control from one remote control panel to another one (if there are several remote control panels) execute procedure in Section 8.3.2.

8.3.4.2 Thruster Control from local control board (Manual Control from local control board)

The necessity to use a local control board as a control device can occur in cases when no remote control seems possible. Such control method shall be permitted by steersman. The ship rotation direction and speed shall be set in accordance with the steersman commands.

The local control board has priority over the remote control devices, and at any time can regain control by the appropriate switch setting to position Local.

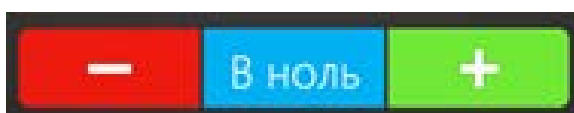
For propellers speed and direction of rotation control under the local control mode the following local control board controls shall be used:

1. Push-buttons «RPM» on local control board face panel:



- «-», «+» push-buttons for discrete rpm increasing / decreasing (change of current rpm by 5% with each push)
- «0» zero traction setting

2. Soft keys of local control board display module:



- «-», «+» soft keys for discrete rpm increasing / decreasing (change of current rpm by 5% with each push)
- «To zero» zero traction setting

3. Touch-sensitive scale of local control board display module:



- 100...100 rpm setting is performed by transposing the scale slider

8.3.5 Thruster Control by External Ship Systems

Switching to the automatic control mode (control from automatic ship control systems) is performed under automatic mode upon request (control signal reception by thruster remote control system) from the appropriate system (type of external control systems and devices, as well as

hierarchy of their priorities are specified in the Scope of Work). The control acceptance is performed just after the reply signal generation by thruster remote control system confirming readiness for external control.

The thruster control by the automatic control systems is terminated when the request for control by the appropriate system is annulled.

The control acceptance by the external control system can be performed only if the mode switch of local control board is set to position "Remote".

8.3.6 Shutdown

Standard shutdown of the thruster can be performed from both remote control panel (see 8.3.6.1), and from local control board (see 8.3.6.2).

8.3.6.1 Standard Shutdown from remote control panel

The standard shutdown from remote control panel is performed with running propeller motor by remote control panel «**Stop**» key push.

The standard shutdown from remote control panel can be performed only from remote control panel that is currently used for ship control.

8.3.6.2 Standard Shutdown from LCP

The standard shutdown from local control board is performed with «**Stop**» button push on the local control board face panel.

The standard shutdown from local control board is possible in any situation no matter which devices are being currently used for ship control.

8.3.6.3 Thruster Automatic Shutdown

The thruster remote control system ensures shutdown by steersman commands, and does not perform any thruster automatic shutdown without steersman's knowledge. Yet, some frequency converters contain standard algorithms providing the frequency converter shutdown (without steersman's knowledge), i.e. own protection system of the frequency converter is activated. Such shutdown occurs because of the necessity to protect the frequency converter and propeller motor against the emergency modes that can result in damages.

In similar situation the thruster remote control system will display (on remote control panel and local control board screens) the messages corresponding to the signals received from the frequency converter. If the current information from the remote control panel and the local control board does not clarify the reason for shutdown, then consult the documentation for the frequency converter.

The automatic shutdown algorithm and form of messages transmitted from the frequency converter to the thruster remote control system depend on the frequency converter type and shall be agreed while ordering.

8.3.6.4 Emergency Stop

The emergency shutdown is performed when urgent stop of the thruster operation occurs necessary.

Possibility of the emergency shutdown is provided from all control stations no matter which panel is used for control.

For the emergency shutdown press «**Emergency**» button at the remote control panel or «**Emergency stop**» at the local control board.

9 MAINTENANCE

During operation the system does not require adjustment and setting.

To keep the system devices in permanent readiness for operation according to the intended application the following types of maintenance are provided:

- Maintenance No. 1 (TO-1);
- Maintenance No. 2 (TO-2);
- Maintenance No. 3 (TO-3);
- In case of long-term out of operation;
- Inspections at navigation beginning and end.

The operation conditions during maintenance shall comply with Section 1.1.

TO-1 is performed after 30 days (1 month) after the system start-up and further on each 90 days of operation regardless of the number of system operation hours for this period.

During TO-1 the following routine works shall be performed as follows:

1. Disconnect thruster remote control system power supply.
2. Visually check the state of the grounding of the thruster remote control system units and cable braids.
3. Check reliable securing of the system devices, make sure that rubber glands are operable, and there are no mechanical damages of connectors, and tighten loose connections.
4. Make sure that terminals and screws are appropriately tightened. If necessary, tighten them.
5. Clean face side of local control board display module and remote control panel touchpads. At that use of hard cloth, paper, glass cleansers or chemicals is prohibited. During the displays cleaning exclude heavy pressing of the surface, and spray liquid directly on the screen.
6. Check operability of indicators and sound emitters using button «**Test Lamp**» in local control board and «**Ackn./Test Lamp**» in remote control panel (see Section 8.2).

TO-2 is performed at least after each 180 days (6 months) of operation regardless of the number of the system operation hours per this period.

During TO-2 and inspections at the navigation beginning and end the following works shall be performed as per the specified order:

1. TO-1.
2. Measure insulation resistance according to Section 9.1.
3. After elimination of all identified failures perform functional test of thruster remote control system according to Section 8.2.

TO-3 is performed at least once past each 360 days (12 months) of operation.

During TO-3 the following works shall be performed as per the specified order:

1. TO-1.
2. Replace damaged contacts and jumpers.
3. If necessary, replace damaged cables and wires.
4. Clean dust and dirt from external surfaces of devices.
5. Perform touch-up painting of paint chips of the external surfaces of units using fast-setting nitrocellulose enamels of the appropriate tint.
6. Clean device elements by the compressed air at pressure two atmospheres maximum.

7. Measure insulation resistance according to Section 9.1.

8. After repair of all identified failures perform functional test of thruster remote control system according to Section 8.2.

If thruster remote control system is out of operation for up to 180 days (6 months) or at the end of navigation the following works shall be performed as per specified order:

Switch all system devices off, except the power supply.

Check battery charge indicator on the power supply. If indicator shows less than 100%, then keep the power supply switched-on for up to 4 hours (until 100% charge). When charge gains 100% switch the power supply off.

If thruster remote control system is out of operation for the period exceeding 180 days (6 months) up to 360 days (12 months) the following works shall be performed according to the specified order:

Switch on the thruster remote control system equipment.

Perform TO-3.

Check battery charge indicator on the power supply. If necessary, recharge device.

Switch off the thruster remote control system equipment.

If thruster remote control system remains out of operation for a period exceeding 360 days (12 months) then it is recommended to dismount the system devices, and render them for conservation for the required period.

Prior to start of the system operation after long-term operational inactivity or at the beginning of navigation execute works according to the following order:

1) Switch on the thruster remote control system equipment.

2) Perform TO-3.

3) Check the battery charge indicator on the power supply. If necessary, recharge device.

4) Check operability of the power supply disconnecting the system devices from ship grids for 10 minutes. Battery shall ensure independent operation of the system. If necessary replace battery.

9.2 INSULATION RESISTANCE

Insulation electric resistance between the electrically disconnected circuits and between electric circuits and device housings shall be 20 MOhm under normal climate conditions.

In case of insulation resistance decreasing take measures to repair reasons of the insulation worsening.

10 ROUTINE MAINTENANCE

In case of a thruster remote control system equipment failure the repair shall be performed meeting the PEEK-91 and Safety Rules for installations with working voltage below 1000V by the personnel familiarized with the present User Manual and being qualified for electric equipment operation and maintenance.

10.1 GENERAL INSTRUCTIONS

For failure testing of the system devices use information provided by the system devices and information in Appendix E As for failures that cannot be identified call for Manufacturer's Technical Support Service.

Spares dismounting and installation shall be performed after thruster remote control system complete de-energizing, and accompanied by installation of the prohibitive posters on the switching devices, switches and knife switches, which closing results in voltage supply to the current conducting parts of thruster remote control system.

The maintenance personnel can repair as per scope including spares replacement from SPTA set (see Appendix G):

1. Fuses replacement. During blown fuses replacement check their correct installation to ensure proper electric contact, absence of local overheating and operation reliability.
2. Repair, replacement, disconnection and connection of all cables.
3. Push-buttons replacement.
4. Replacement of the double-throw switches.
5. Another repair upon agreement with the Manufacturer.

All other failures can be repaired by Manufacturer's specialists only.

At final phase of the current repair after all installations completion measure insulation resistance according to Section 9.1.

11 FAILURES AND REMEDIAL ACTIONS

11.1 FAILURE CRITERIA

Failure criteria of the thruster remote control system are:

1. Absence of thruster remote control system output signals to the ship control systems and to the thruster machinery from the appropriate thruster remote control system controls.
2. Incompliance between alarm or operation parameter indication of the machinery, sensors status, the thruster remote control system status and actual position (status).
3. Other faults of thruster remote control system operation requiring crew intervention for the operability restoration.

Critical faults are:

1. The thruster remote control system fault:
 - complete or partial fault of the system devices (remote control panel and local control board);
 - speed control circuit fault;
 - rpm feedback coupling fault;
 - synchronization discrepancy of the speed control;
 - temperature feedback coupling fault.
2. The thruster drive fault.
3. Gearbox oil overheating (temperature over set-point (by default $>70^{\circ}\text{C}$)).
4. Drive overload (over set-point (by default $>120\%$) for time period exceeding set time period (by default 5 s)).

Attention! Prior to the thruster re-start discard all critical faults.

The remedial actions are described in Appendix D.

11.2 ALARM AND INDICATION

Light and sound alarms, as well as the messages on the screens are provided in the following system devices:

- Local Control Board;
- Remote Control Panel.

In КРПУ-1011 control system the following signalling is provided:

- alarms (red messages), requires prompt elimination;
- warning (yellow messages), informs of faults present, does not require prompt elimination;
- current (green messages), informs of the normal operation of the object or process progress.

Upon alarm reception the system ensures:

- activation of the periodic sound signal (upon presence of unacknowledged signals);

- activation of red indicators in device panels («Alarm», «General Alarm», «Overload») (upon presence of unacknowledged signals – flashing mode, after acknowledge – continuously ON);
- text messages provision (red colour) on device screens.

Upon warning signal reception the system ensures:

- activation of the periodic sound signal (upon presence of unacknowledged signals);
- text messages provision (yellow colour) on device screens.

Furthermore the thruster remote control system ensures the current indication of normal states:

- green indicators of the appropriate system operation modes are ON;
- information text messages provision (green colour) on device screens;
- short sound signal with key pushes through the work with touchpads;
- short repeated sound signal through the control transfer from one remote control panel to another one;
- short sound signal upon absence of the synchronization of the remote control panel control lever position and motor speed (upon attempt of control transfer).

Types of messages and indication colours are specified in Appendix D.

11.3 CHARACTERISTIC FAULTS AND REMEDIAL ACTIONS

Main information about thruster remote control system faults is displayed on remote control panel and local control board screens.

Possible reasons of main faults and their remedial actions are specified in Appendix E.

Extended testing of the thruster remote control system КРПУ-1011 is performed by the Manufacturer or his authorized persons.

12 TRANSPORTATION AND STORAGE

The system devices shall be transported in the Manufacturer's shipping packages with closed transportation means.

Types of device packages:

- by road and railroad transport with closed means (boxcars, universal containers);
- by air transport (in tight and heated aircraft compartments);
- by sea (in dry service compartments).

The devices transportation shall be performed in accordance with rules of shipment for each type of transport.

During handling and transportation strictly follow the requirements of warnings on crates, exclude jerks and impacts that can affect the devices integrity and operability.

The packed devices shall be reliably secured within the transportation means.

The devices shall be stored in a packed form in rooms complying with the storage conditions 3 (Ж3) according to GOST 15150. Dust, oil, moisture and corrosion admixtures content in air shall not exceed rates specified in GOST 12.1.005-88 for work zones of the industrial rooms.

Unpack devices after storage in warehouse or transportation at temperature below +10° only in heated rooms, preliminary hold them in packed state for 12 hours under normal climatic conditions.

13 RECYCLING

New item package, item parts damaged during its operation, and item with expired life shall not be recycled as common domestic wastes, as they contain raw-materials and materials suitable for re-use.

Decommissioned and unused item parts shall be delivered to special wastes gathering centre licenced by the local authorities. Also you can deliver the equipment with expired life to the Manufacturer for further item recycling.

The proper recycling of the item components excludes possible negative ecological and health consequences, and restoration of the item components yields significant saving of energy and resources.

The item during service life and upon its expiration is not dangerous for life, health, and environment.

This item is recycled according to the regulations applied for the electronic devices. (Federal Law dated 24.06.98 No. 89-FZ «About Industrial and Domestic Wastes», with amendments dated 30.12.2008 No. 309-FZ).



Products marked with a sign of a crossed recycle bin shall be recycled separately from common domestic wastes.

14 WARRANTY OBLIGATIONS

The Manufacturer guarantees to the Buyer that equipment procured by the Buyer was manufactured in accordance with the documentation approved by the Manufacturer, was tested and inspected by Company specialists, was assumed as suitable for operation, and shipped to the Buyer in operable state.

The Manufacturer during warranty period free of charge repair the equipment defects by its repair or replacement. The device provided for replacement can be both new, and restored, but in any case the Manufacturer guarantees that its characteristics will be at least the same then of the replaced device.

The warranty period for the Manufacturer delivered equipment is 24 (twenty four) months, unless another time period is not specified by the delivery contract.

The warranty obligations are valid since equipment shipment to the Buyer, and upon 100% payment.

During the warranty period the owner has the right for free of charge repair or separate unit replacement, if the failure is due to the Manufacturer's fault.

The warranty repair is performed upon presence of the Manufacturer's factory label on the device with readable serial number and number of the present User Manual.

The Manufacturer is not responsible and is excused from warranty obligations:

1. Upon expiration of the warranty period.
2. Upon failure to meet the rules and conditions of operation, transportation, storage and installation of the device.
3. In case of loss of device market condition or housing integrity, and due to other reasons out of Manufacturer control.
4. In case of use of home-made electric devices.
5. Upon attempt of repair by the person who is not Manufacturer's authorised representative.

If the owner losses the present user Manual or factory label with serial number, their copies are not issued by the Manufacturer, and the owner losses the right for free of charge repair during the warranty period.

Upon expiration of the warranty obligations the Manufacturer supports the device failures repair at the expense of the owner.

Note: In case of the warranty repair the device dismounting and delivery to the Manufacturer's service centre are performed at the expense of the owner.

The Manufacturer web-site (<http://www.unicont.com>) in Section: "Support/Warranty Obligations" one can find:

- form for claims;
- complete text of warranty obligations;
- detailed procedure of warranty services provision.

Address and contacts of Manufacture's service centre:

SPC Morsvyazavtomatika LLC
192174, Russia, Saint-Petersburg, ul. Kibalchicha, 26E.
phone: + 7 (812) 602-02-64, 8 800 100 6719
fax: +7 (812) 362 76 36
e-mail: <mailto:service@unicont.com>

APPENDIX A

OVERALL AND MOUNTING DIMENSIONS OF SYSTEM UNITS

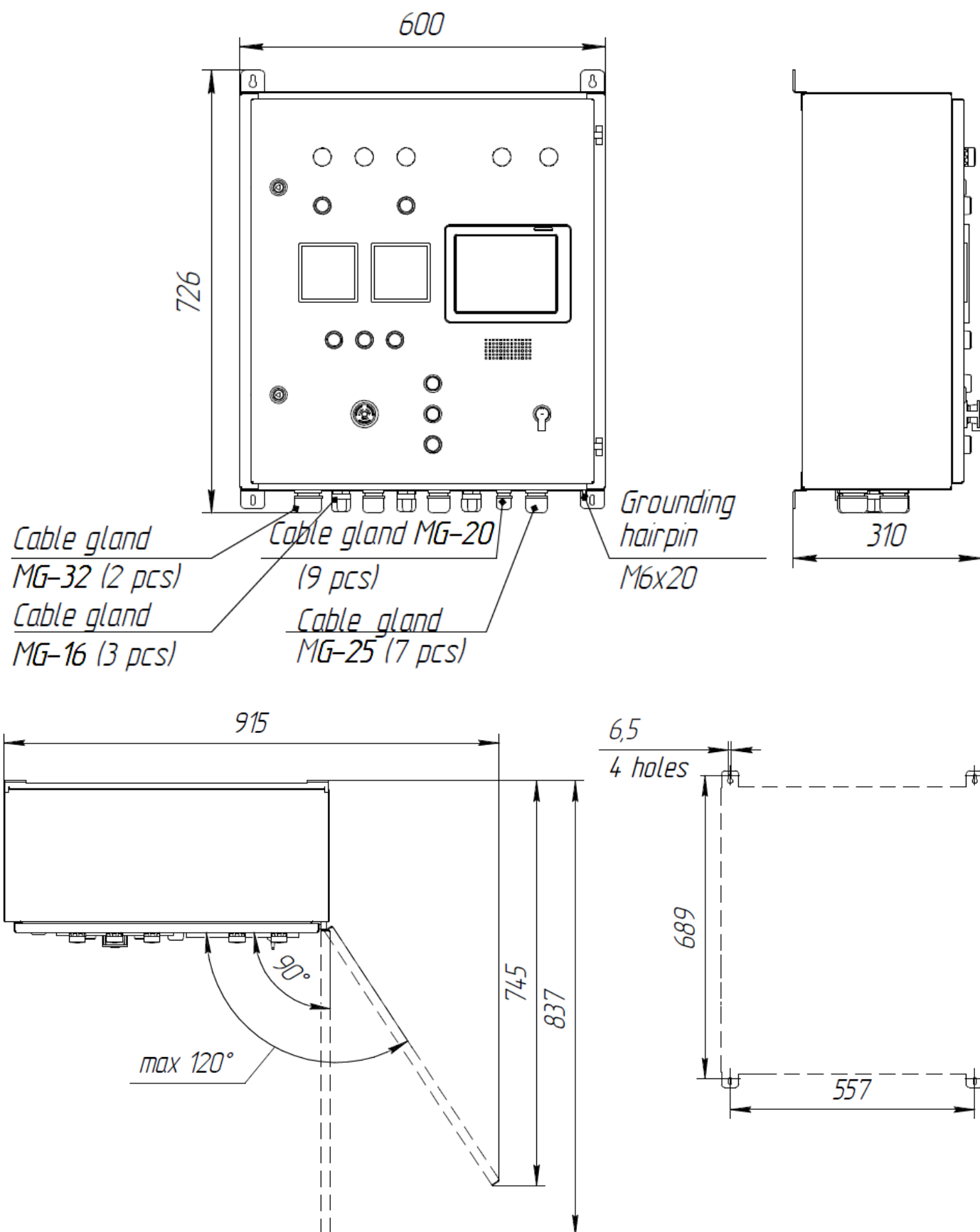


Figure 21 – Local Control Board [МЦУ]

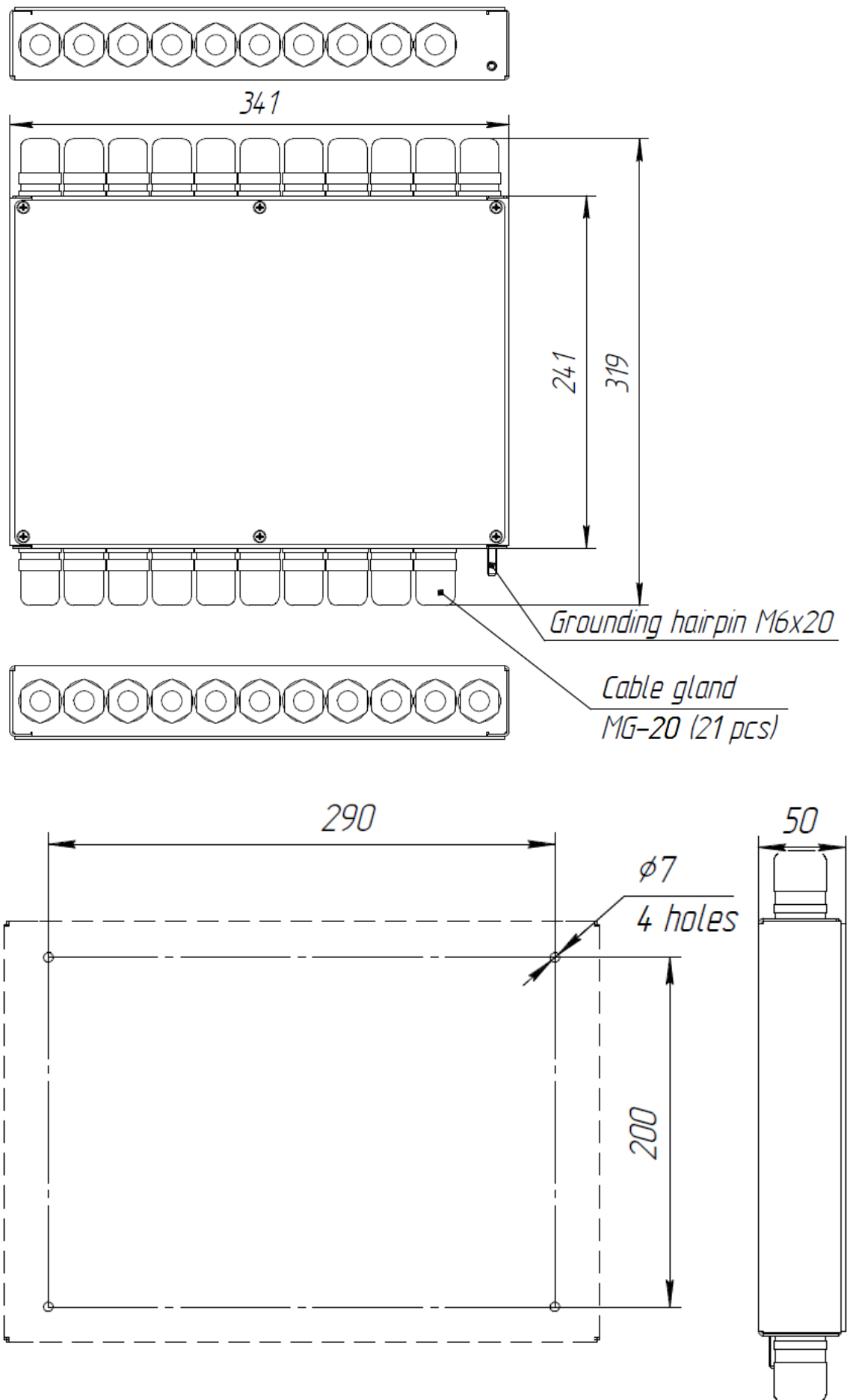


Figure 22 – Multiplex Switch

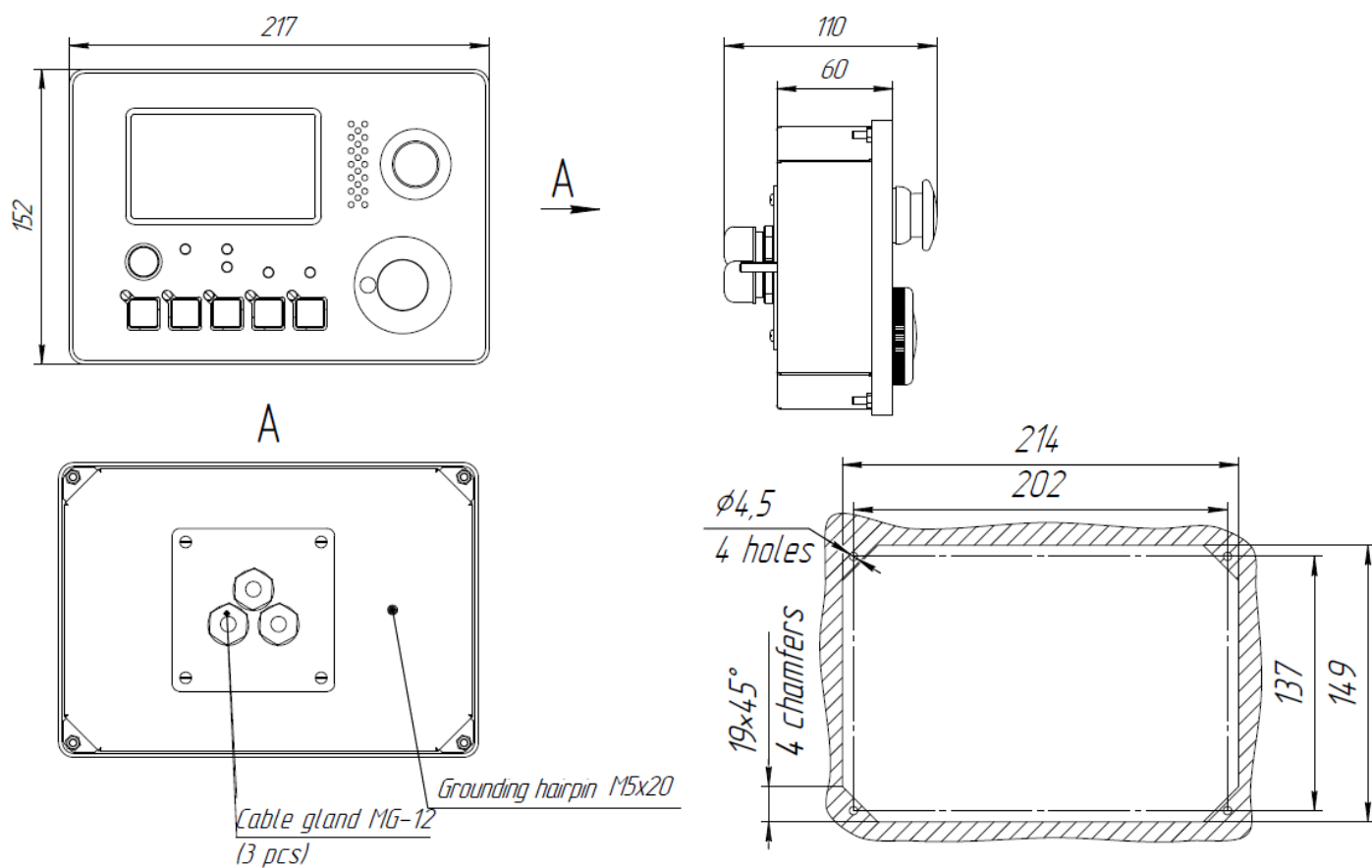


Figure 23 – Remote Control Panel ПДУ-К

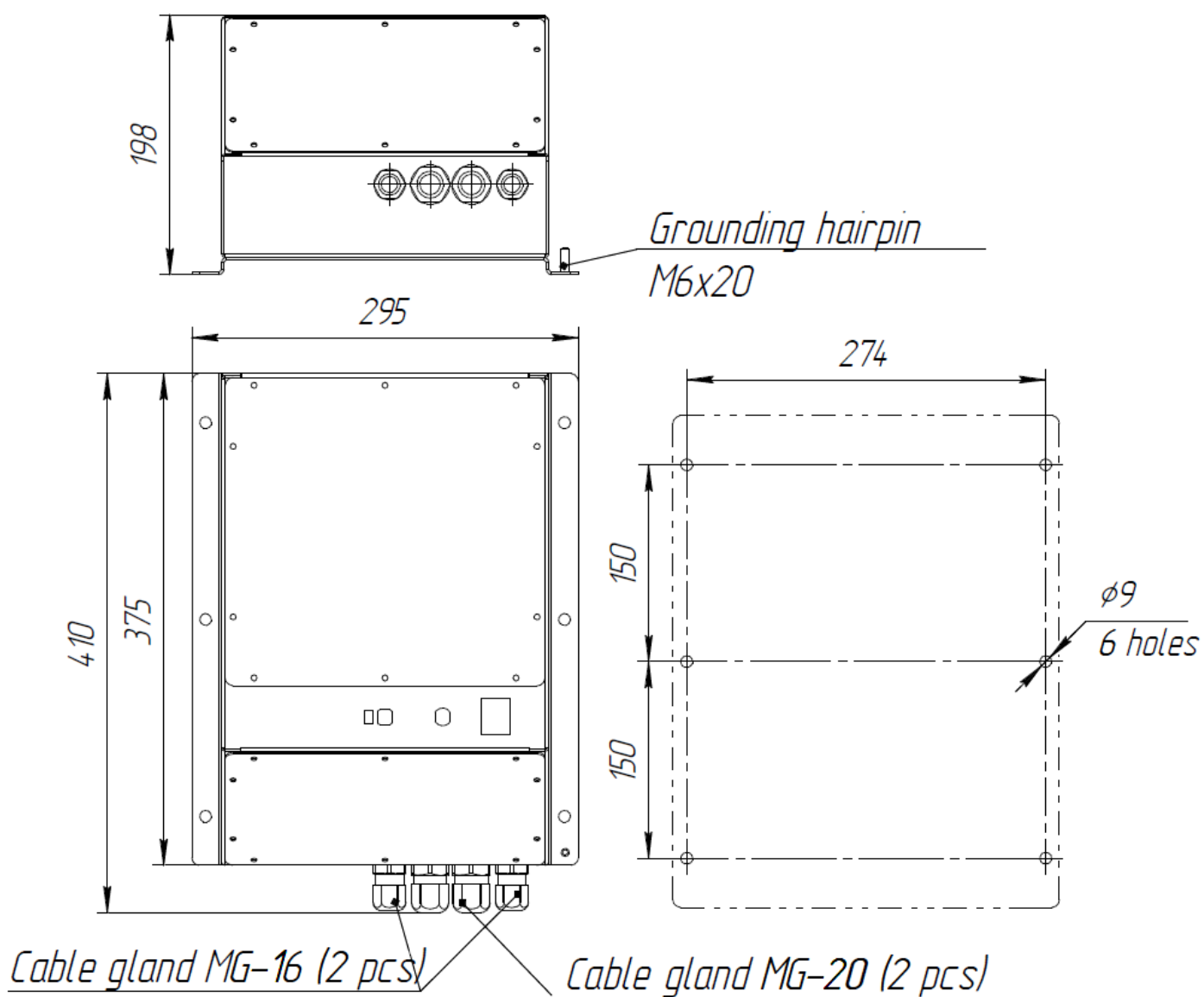


Figure 24 – Power Supply

APPENDIX B

THE INTERNAL LOCATION AND PURPOSE OF THE TERMINAL BLOCKS

B.1 The internal location and purpose of the terminal blocks in the local control block [МЦУ]

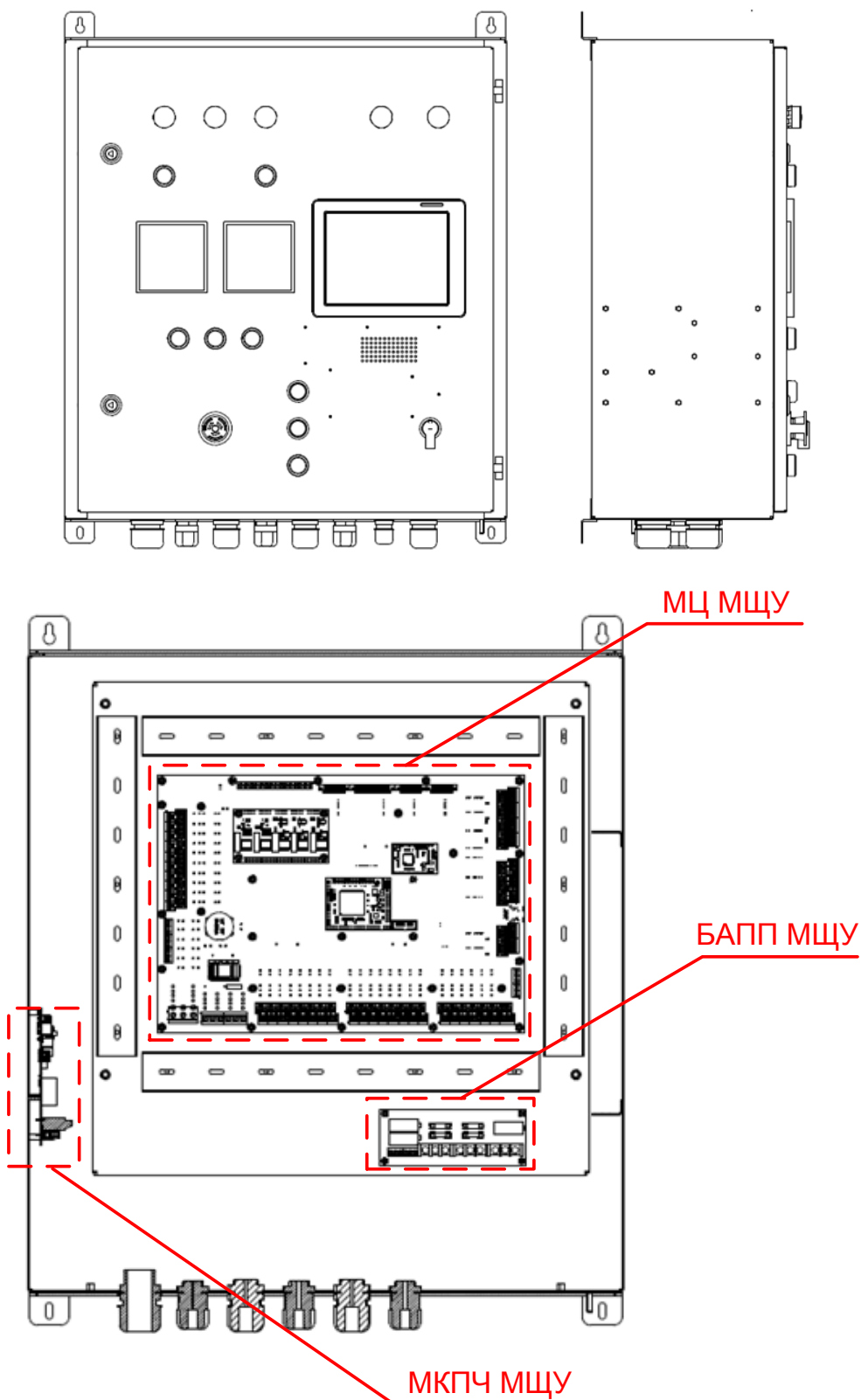


Figure 25 – The internal arrangement of the blocks of the local control board [МЦУ]

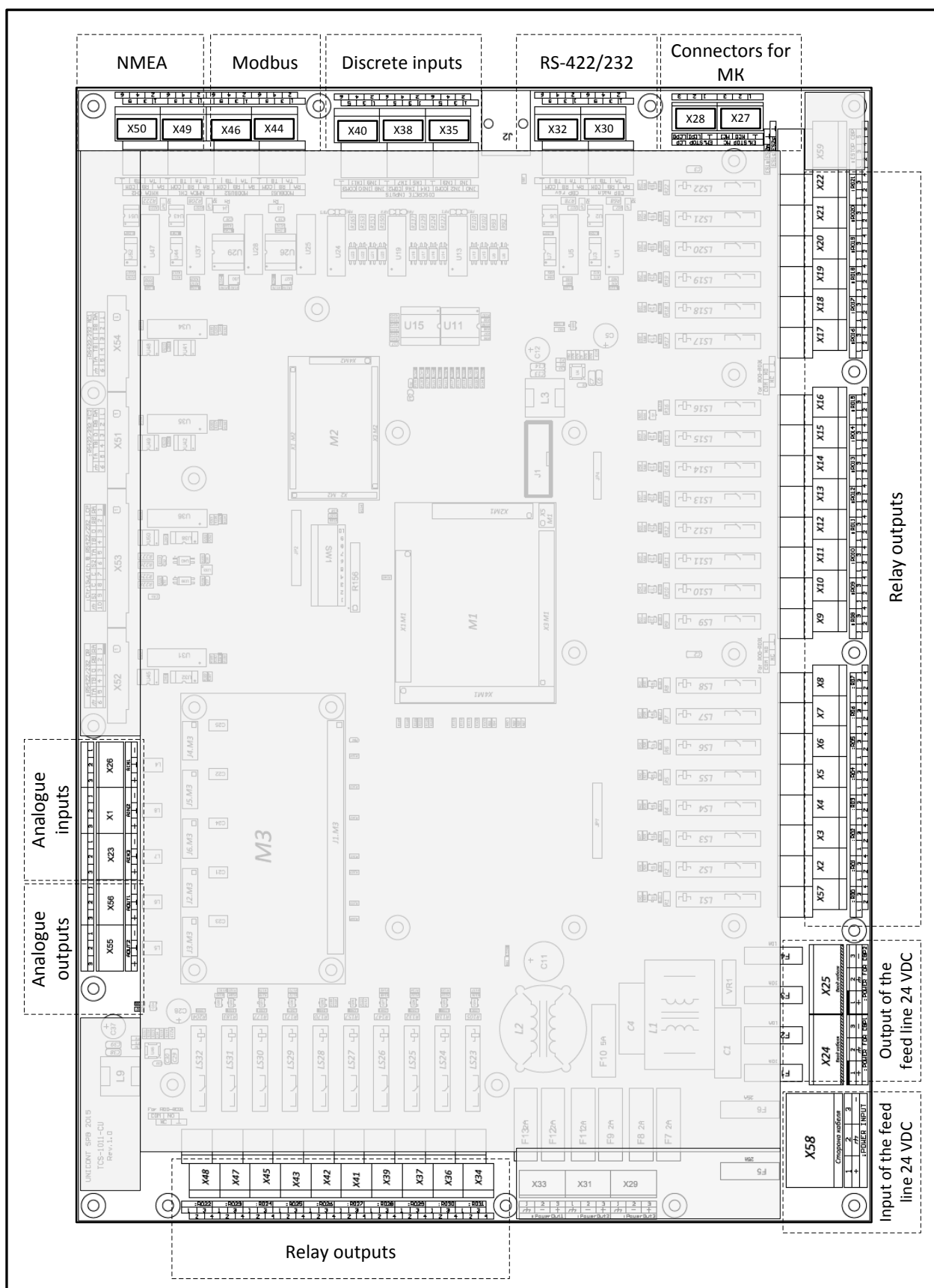
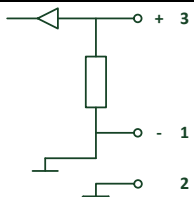
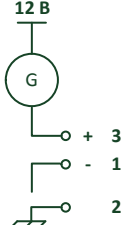
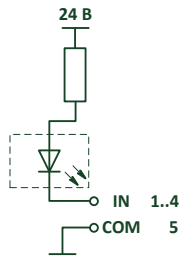
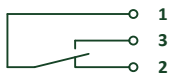


Figure 26 – The location and purpose of the terminal blocks in the central module of the local control board [МЛ МЦУ]

Table 7 – The function of the terminal blocks in the central module of the local control board [МЛ МЦУ]

Terminal Type	Terminal, socket		Signal specification	Description
Modbus ports (RS-422/485/232)	X44, X46	1 RxA 3 RxB 5 COM 2 TxA 4 TxB 6 ⊥		Communication with external ship systems
NMEA ports (RS-422/485/232)	X49, X50	1 RxA 3 RxB 5 COM 2 TxA 4 TxB 6 ⊥		Communication with external ship systems
RS-422/485/232 ports	X30, X32	1 RxA 3 RxB 5 COM 2 TxA 4 TxB 6 ⊥		Communication with external ship systems
Connectors for MK	X27, X28	1 ⊥ 2 ES 3 ES		Emergency stop
Analogue inputs	X1(X58), X23(X57), X26(X59)	3 + 2 ⊥ 1 -		Analogue: 4-20 mA, input impedance 200 Ω
Analogue outputs	X55, X56	3 + 2 ⊥ 1 -		Analogue: 4-20 mA, load max 500 Ω
Discrete inputs	X35, X38, X40	1 IN 3 IN 5 COM 2 IN 4 IN 6 ⊥		Discrete: 24 VDC 0,5 W max
Input of the feed line	X58	1 + 2 ⊥ 3 -		24 VDC
Output of the feed line	X24, X25	1 + 2 ⊥ 3 -		24 VDC for MK
Relay outputs	X2-X22, X57, X34, X36, X37, X39, X41-X43, X45, X47, X48	1 COM 3 NO 2 NC 4 ⊥		Relay: 30 VDC max 5 A; 250 VAC max 5 A

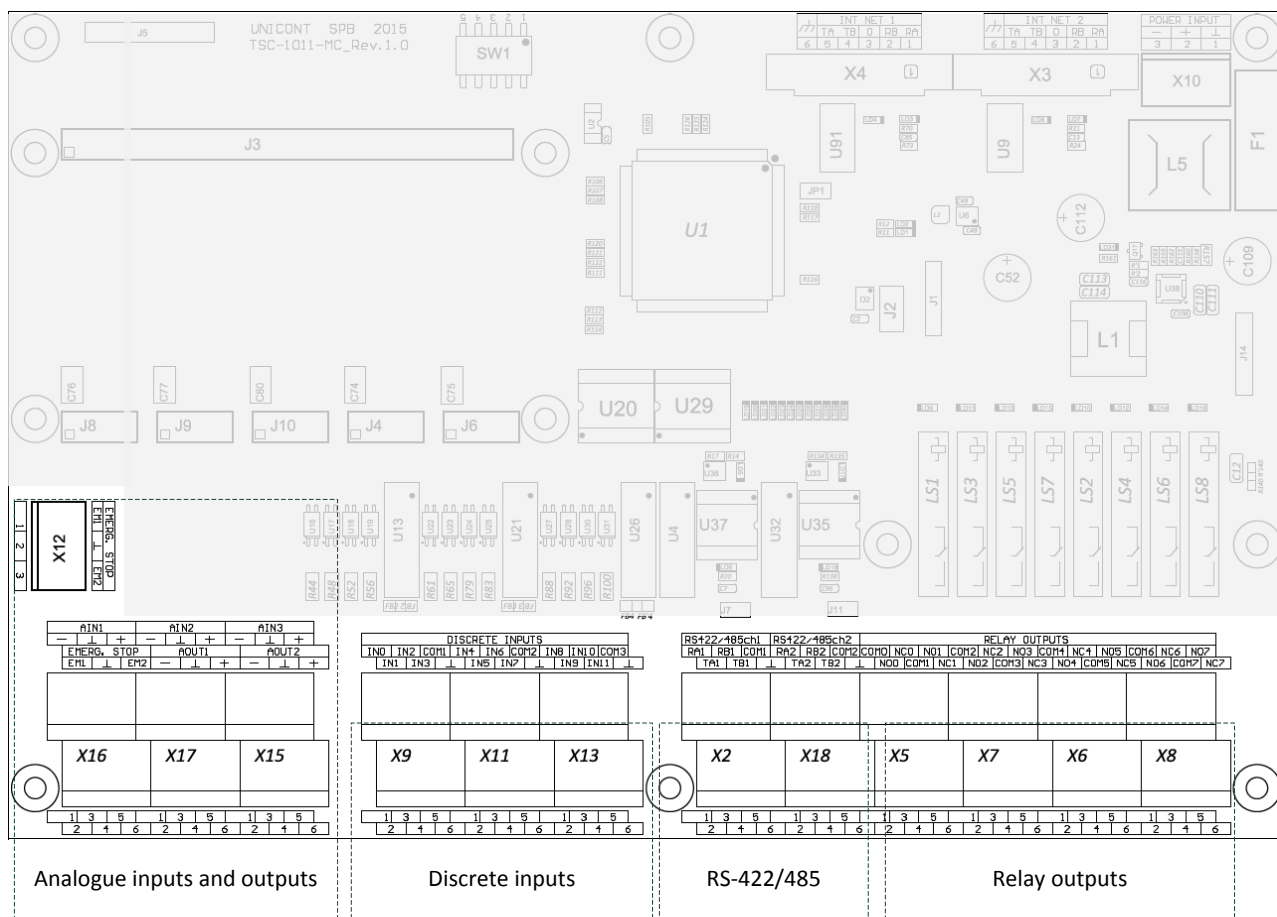
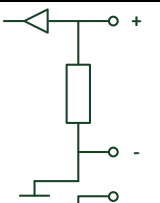
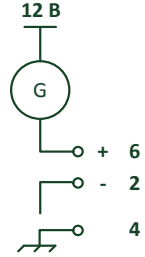
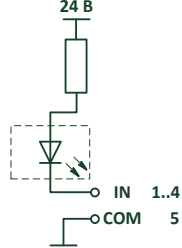
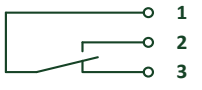


Figure 27 – The location and purpose of the terminal blocks of the frequency converter controller module of the local control board [МКПЧ МЦУ]

Table 8 – The purpose of the terminal blocks of the frequency converter controller module of the local control board [МКПЧ МЦУ]

Type	Terminal	Signal specification	Description
RS-422/485/232	X2, X18	1 RxA 3 RxB 5 COM 2 TxA 4 TxB 6 ⊥	Communication with external ship systems
Emergency stop	X12	1 ES 2 ⊥ 3 ES	Emergency stop
Emergency stop	X16	2 ES 4 ⊥ 6 ES	Emergency stop
Analogue inputs	X16-X17	1 - 3 ⊥ 5 + 	Analogue: 4-20 mA, input impedance 200 Ω

Type	Terminal		Signal specification	Description
Analogue outputs	X15, X17	2 - 4 ⊥ 6 +		Analogue: 4-20 mA, load max 500 Ω
Discrete inputs	X9, X11, X13	1 IN 3 IN 5 COM 2 IN 4 IN 6 ⊥		Discrete: 24 VDC 0,5 W max
Relay outputs	X5-X8	1 COM 3 NC 5 NO 2 NO 4 COM 6 NC		Relay: 30 VDC max 5 A; 250 VAC max 5 A

B.2 The internal location and purpose of the terminal blocks in the multiplex switch [MK]

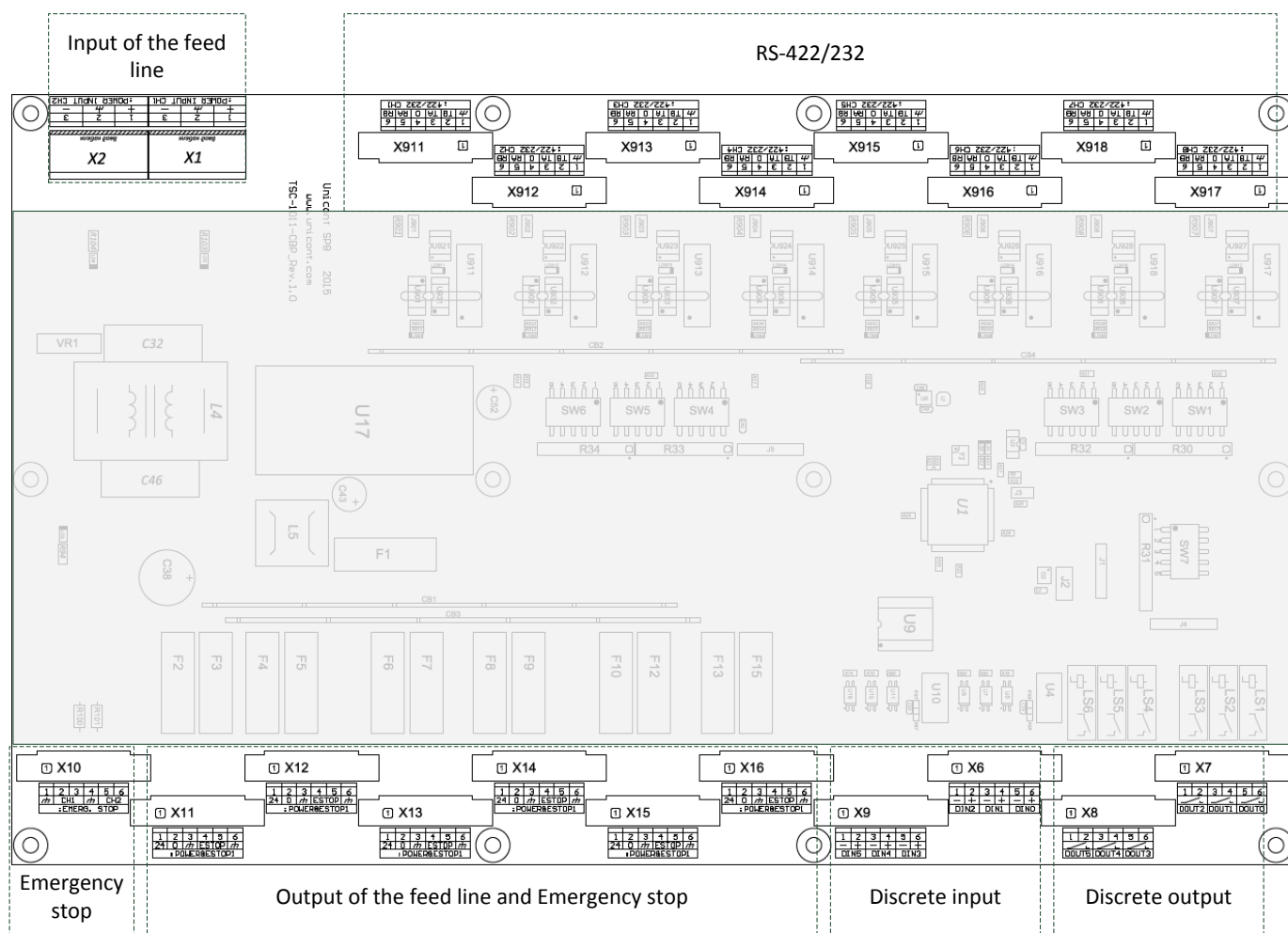






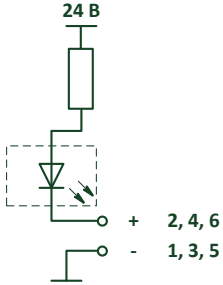


Figure 28 – The location and purpose of the terminal blocks in the multiplex switch [MK]

Table 9 – The purpose of the terminal blocks in the multiplex switch [MK]

Type	Terminal	Signal specification	Description
Input of the feed line	X1, X2	1 + 2 ⊥ 3 -	Feed line 24 VDC
Output of the feed line	X11-X16	1 24 2 0 3 ⊥	Feed line 24 VDC
Emergency stop	X11-X16	4 ES 5 ES 6 ⊥	Emergency stop
Emergency stop	X10	1 ⊥ 2 ES1 3 ES6 4 ⊥ 5 ES1 6 ES6	Emergency stop
RS-422/485/232	X911-X918	1 ⊥ 2 TxB 3 TxA 4 0 5 RxA 6 RxB	Communication with the local control board [МЦУ] and the remote control panel [ПДУ]

Socket Type	Terminal, socket		Signal specification	Description
Discrete outputs	X7, X8	1  2  3  4  5  6 		Discrete: 30 VDC max 5 A; 250 VAC max 5 A
Discrete inputs	X6, X9	1 - 2 + 3 - 4 + 5 - 6 +		Discrete: 24 VDC 0,5 W max

B.3 The internal location and purpose of the terminal blocks of the remote control panel [ПДУ]

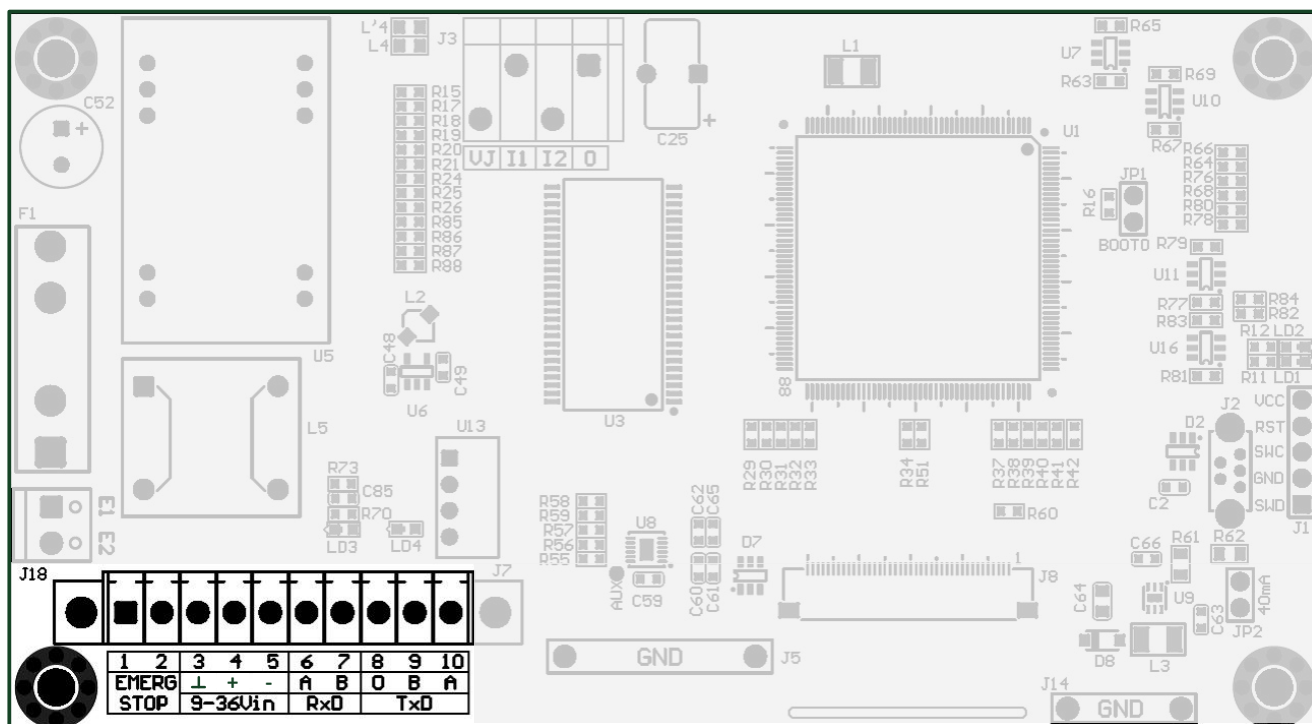


Figure 29 – The location and purpose of the terminal block of the remote control panel [ПДУ]

Table 10 – The purpose of the terminal block of the remote control panel [ПДУ]

Socket Type	Terminal, socket		Signal specification	Description
Emergency stop	J7	1 ES 2 ES		Emergency stop
Input of the feed line	J7	3 ⊥ 4 + 5 -		Feed line 24 VDC
RS-422/485	J7	6 Rx A 7 Rx B 8 0 9 Tx B 10 Tx A		Data exchange

APPENDIX C

DESCRIPTION OF PRIMARY TECHNICAL PARAMETERS ENSURED WITH THE SYSTEM

The list of technical parameters for coordination with the system and ship manufacturers:

- 1) The list of signals that enable communication with the frequency converter.
- 2) Thruster control post along with the priority hierarchy.
- 3) The list of external ship systems to interface with the thruster remote control system.
- 4) The list of signals that enable interaction with external ship systems.
- 5) The list of technological operations performed.
- 6) The list of displayed parameters.
- 7) Emergency, warning and current alarms at the local- and remote-control stations.

1) The list of signals that enable communication with the frequency converter:

Signal source	The recipient of the signal	Signal designation
TR CS	TC1	Electric motor revolutions presetting
TR CS	TC1	Start
TR CS	TC1	Stop
TR CS	TC1	Acknowledgement of receipt
TR CS	TC1	Emergency stop
TR CS	TC1	Start permission
TC1	TR CS	Frequency converter is ready
TC1	TR CS	Velocity response
TC1	TR CS	Load response
TC1	TR CS	In-operation
TC1	TR CS	Failure
TC1	TR CS	Emergency

2) Posts of thrusters control, in descending priority order:

- Local control board (МЩУ);
- Dynamic Positioning System (СДП);
- Remote control panels (ПДУ).

3) The list of external ship systems to interface with the thruster remote control system:

Navi Conning;
 Voyage Data Recorder (VDR);
 Dynamic Positioning System (DP);
 Power management system (PMS).

4) The list of signals that enable interaction with external ship systems:

Signal source	The recipient of the signal	Signal designation
Navi Conning		
TR CS	Navi Conning	The actual rotation sense and revolution rate
TR CS	Navi Conning	Frequency converter load (%)
Voyage Data Recorder (VDR)		
TR CS	VDR	Extended fault code
TR CS	VDR	The actual rotation sense and revolution rate
TR CS	VDR	Rotation sense and revolution rate reference signal
TR CS	VDR	Frequency converter load (%)
Dynamic Positioning System (DPS)		
CS	DPS	Control transfer readiness
DPS	CS	Control transfer request
CS	DPS	SDP-affirmed control
DPS	CS	Thruster revolutions presetting
CS	DPS	Response (propeller screw revolutions)
Power management system (PMS) [CY C3C]		
TR CS	PS1	Switch main power distribution unit 1 on [ГЩ1]
TR CS	PS1	Switch main power distribution unit 1 off [ГЩ1]
PS1	TR CS	Ready for remote operation
PS1	TR CS	Emergency protective interruption has responded
PS1	TR CS	Emergency interrupter has responded and got blocked
PS1	TR CS	Interrupter is on and circuited
TR CS	PS2	Switch main power distribution unit 2 on [ГЩ2]
TR CS	PS2	Switch main power distribution unit 2 off [ГЩ1]
PS2	TR CS	Ready for remote operation
PS2	TR CS	Emergency protective interruption has responded
PS2	TR CS	Emergency interrupter has responded and got blocked
PS2	TR CS	Interrupter is on and circuited
Pressurization tank		
Tank	TR CS	Low oil level

5) The list of technological operations performed:

Control station emergency stop

Concurrent multiple-station control block

Transmission of the information preliminarily concerted with the ship project designer to the external ship systems and devices

Thruster remote control

Thruster-chamber ventilator start
 Main propulsion motor protection under controlled parameters
 Indication (projection) of the specified parameters
 Main propulsion motor driving gear power control and indication
 Main propulsion motor revolution rate control and indication
 Technical parameters and state control of the thruster remote control system
 Local thruster control
 Thruster halt
 Main propulsion motor soft start
 Operation hours counting (motorhours)
 Operation/failure signaling
 Main propulsion motor revolution sense control, reverse
 Main propulsion motor revolution rate control

6) The list of displayed parameters:

Number of operation hours
 Main propulsion motor power
 Main propulsion motor driving gear load
 Propeller screw revolution sense
 Driving gear overload
 Propeller screw revolution rate
 Reduction gear oil temperature
 The state of the motor coil temperature sensor
 The state of the motor bearings temperature sensor
 The state of the motor core temperature sensor
 Pressurization tank oil level
 Main propulsion motor revolution rate

7) Alarms, warning and current signaling:

Type of signaling	Message
Alarms	Failure (driving gear)
	Emergency halt activated
	Low oil level
	General emergency
	Equipment failure (remote control panels overall failure)
	Oil temperature sensor failure
	Thruster driving gear failure
	Revolution indication failure
	Load feedback coupling failure

Type of signaling	Message
	Revolution feedback coupling failure
	Temperature feedback coupling failure
	Thruster remote control system failure
	Revolutions control failure
	DPS-control failure
	Oil overheating (the oil temperature exceeds the set point (>70 °C))
	Driving gear overloading (failure) exceeding the set point (>120%) with duration exceeding the set stretch (>5 s)
	Electric motor overheating
	Revolutionary synchronization discrepancy of the electrical propulsion installation
Warning	Circuit breakers are switched off
	Configuration disturbance
	Low oil level
	Power limitation
	Top bearing t-sensor failure
	Bottom bearing t-sensor failure
	U-coil t-sensor failure
	V-coil t-sensor failure
	W-coil t-sensor failure
	U-core t-sensor failure
	V-core t-sensor failure
	W-core t-sensor failure
	Oil overheating (oil temperature exceeded (>55 °C))
	Overload (driving gear overload (warning) with duration less than the set stretch (<5 s))
	Power supply failure
	Supergrid system failure
	Standby power system failure
Current (informative)	In-operation
	Ready
	Local control
	Revolution sense - starboard
	Revolution sense - portside
	Halted
	Driving gear is started
	Driving gear is ready
	Driving gear: Start

Type of signaling	Message
	Driving gear: Stop
	Driving gear: Failure discard
	Driving gear: Confirmed to start
	Thruster in-operation
	System is ready to operate
	Control: Ready for DPS-control
	Control: Remote
	Control: DPS-control
	Control: Local console control
	Controlled by <...designation...>

APPENDIX D

ALARMS AND INDICATION BLOCKS МЦУ И ПДУ

Table 11 – The composition of the signaling messages and color of indication

Light indication displayed on the local control board / remote control panel	Message format in the "Info" section on the local control board / remote control panel screens	Indicators on the local control board / remote control panel screens	Message / indicator color	Acoustic signal
Alarm signaling				
"Emergency" lamp	Failure (driving gear)	-	red	+
"Emergency" lamp	Emergency halt activated	-	red	+
"Emergency" lamp	Low oil level	-	red	+
"Emergency" lamp	General emergency	-	red	+
"Emergency" lamp	-	Equipment failure (remote control panels overall failure)	red	+
"Emergency" lamp	Thruster driving gear failure	-	red	+
"Emergency" lamp	Revolution indication failure	-	red	+
"Emergency" lamp	Load feedback coupling failure	-	red	+
"Emergency" lamp	Revolution feedback coupling failure	-	red	+
"Emergency" lamp	Temperature feedback coupling failure	-	red	+
"Emergency" lamp	Thruster remote control system failure	-	red	+
"Emergency" lamp	Revolution control failure	-	red	+
"Emergency" lamp	DPS-control failure	-	red	+
"Emergency" lamp	Oil overheating (the oil temperature exceeds the set point (>70 °C))	-	red	+
"Overload" lamp (constantly alight)	-	Overloading (driving gear overloading exceeding the set point)	red	+
"Emergency" lamp	Electric motor overheating	-	red	+
"Emergency" lamp	Revolutionary	-	red	+

Light indication displayed on the local control board / remote control panel	Message format in the "Info" section on the local control board / remote control panel screens	Indicators on the local control board / remote control panel screens	Message / indicator color	Acoustic signal
lamp	synchronization discrepancy of the electrical propulsion installation			
Warning signaling				
-	Circuit breakers are switched off	-	yellow	+
-	Configuration disturbance	-	yellow	+
-	-	Power limitation	yellow	+
-	Top bearing t-sensor failure	-	yellow	+
-	Bottom bearing t-sensor failure	-	yellow	+
-	U-coil t-sensor failure	-	yellow	+
-	V-coil t-sensor failure	-	yellow	+
-	W-coil t-sensor failure	-	yellow	+
-	U-core t-sensor failure	-	yellow	+
-	V-core t-sensor failure	-	yellow	+
-	W-core t-sensor failure	-	yellow	+
-	Oil overheating (high oil temperature (>55 °C))	-	yellow	+
"Overloading" lamp (flashing)	Overload (driving gear overload (warning) with duration less than the set stretch (<5 s))	-	yellow	+
-	Power supply failure	-	yellow	+
-	Supergrid system failure	-	yellow	+
-	Standby power system failure	-	yellow	+
Current (informative) signaling				
"Ready" lamps	-	МЦУ screen indicator: "Local control"	green	-
"Ready" lamps	-	МЦУ screen indicator: "Driving gear started"	green	-
"Ready" lamps	-	МЦУ screen indicator: "Driving gear ready"	green	-
"Ready" lamps	Driving gear: Start	-	green	-
"Ready" lamps	Driving gear: Halt	-	green	-
"Ready" lamps	Driving gear: Fault discard	-	green	-

Light indication displayed on the local control board / remote control panel	Message format in the "Info" section on the local control board / remote control panel screens	Indicators on the local control board / remote control panel screens	Message / indicator color	Acoustic signal
"Ready" lamps	Driving gear: Affirmed to start	-	green	-
"Ready" lamps	Control: by DPS	-	green	-
"Ready" lamps	Thruster in-operation	-	green	-
"Ready" lamps	The system is ready to operate	-	green	-
"Ready" lamps	Revolution sense - starboard	-	green	-
"Ready" lamps	Revolution sense - portside	-	green	-
"Ready" lamps	Управление: от местного пульта Control: by a local console	-	green	-
"Ready" lamps	Управление: дистанционное Control: remote	-	green	-
"Ready" lamps	Control: ready for DPS—control	-	green	-
"Ready" lamps	-	Remote control panel's screen indication: "In-operation"	green	-
"Ready" lamps	-	Remote control panel's screen indication: «Ready»	green	-
-	-	Remote control panel's screen indication:: «Halted»	green	-
"Ready" lamps	-	Remote control panel's screen indication: «Controlled by <...designation...> »	green	-

APPENDIX E

FAULTS, CAUSES AND REMEDIS

Table 12 – Generalized (versatile) emergency alarms

Failure	Probable Cause	Repair method
Emergency halt	A failure occurred demands an instant electric motor halt; inadvertently “Emergency halt” button pushed on the local control board or “Emergency” button pushed on any remote control panel.	Find and eliminate the cause of the electric motor failure; check whether all the emergency halt buttons are released; release the inadvertently pushed button.
General failure	Thruster failure; frequency converter failure; driving gear failure; thruster remote control system failure; system configuration disturbance	Consult the messages displayed with the remote control panels and the local control board to find the cause of the failure; if possible, eliminate the cause of the failure.
Power supply failure	Supergrid or/and standby power cable rupture; connection loss	Find and eliminate the cause of the failure
(Driving gear) failure	Driving gear overload; driving gear overheating	Find and eliminate the cause of the failure
Electric motor overheating	Electric motor revolution rate exceeded; excessive thrust [axial] bearing temperature; temperature sensors failure; water flow impeded in the tunnel; motor overloading.	Find and eliminate the cause of the failure
Thruster remote control system failure	All remote control panels and local control boards are switched off; revolution control circuits failure; revolution feedback coupling failure; revolution control synchronization discrepancy; temperature feedback coupling failure	Launch emergency diagnostics and eliminate the cause of the failure
Thruster driving gear failure	Thruster external signal	Find and eliminate the cause of the failure
Configuration disturbance	Electrical network topology modified	Launch emergency diagnostics and eliminate the cause of the failure

Table 13 – Thruster remote control system failure

Failure	Probable Cause	Repair Method
Load feedback coupling failure (electric motor load)	Feedback coupling line failure, connection loss	Find and eliminate the cause of the failure
Revolutions feedback coupling failure (of electric motor)	Feedback coupling line failure, connection loss	Find and eliminate the cause of the failure
Temperature feedback coupling failure	Feedback coupling line failure, connection loss	Find and eliminate the cause of the failure
Supergrid failure	Supergrid power supply failure	Find and eliminate the cause of the failure
Standby power system failure	Standby power supply system failure	Find and eliminate the cause of the failure
DPS—control failure	Connection line failure, connection loss, short-circuit fault, DP failure	Find and eliminate the cause of the failure
Revolution control failure	Connection line failure, connection loss, short-circuit fault	Find and eliminate the cause of the failure
Revolution indication failure	Connection line failure, connection loss, short-circuit fault	Find and eliminate the cause of the failure
Configuration disturbance	Connection line failure, connection loss, system devices failure	Find and eliminate the cause of the failure
Remote control panels overall failure	Connection line failure	Find and eliminate the cause of the failure
“Panel” indicator is inactive on the “Main screen” of the display module of the local control board	Connection line failure	Find and eliminate the cause of the failure

Table 14 – Technical failures

Failure	Probable Cause	Repair Method
Circuit breakers are switched off	Frequency converter input signal	Check the state of the circuit breakers, eliminate the causes of the failure
Power limitation	Electric motor failure	Find and eliminate the cause of the failure
Electric motor overheating	Electric motor failure	Find and eliminate the cause of the failure
Revolutionary synchronization discrepancy of the electrical propulsion installation	Connection line rupture, predetermined and actual revolution rate value discrepancy	Find and eliminate the cause of the failure
Oil overheating (the oil temperature exceeds the set point (>70 °C))	High oil temperature in the reduction gear, temperature sensor failure	Find and eliminate the cause of the oil overheating in the reduction gear, check and replace, if necessary, the temperature sensor
Oil overheating (high oil temperature (>55 °C))	High oil temperature in the reduction gear, temperature sensor failure	Find and eliminate the cause of the oil overheating in the reduction gear, check and replace, if necessary, the temperature sensor
Driving gear overloading (failure) exceeding the set point (>120%) with duration exceeding the set stretch (>5 s)	Critical high, continuous driving gear loading, motion impediment	Reduce the driving gear load; eliminate the motion impediment
Driving gear overload (warning) exceeding the set point (>120%) with duration less than the set stretch (<5 s))	High driving gear loading, motion impediment	Reduce the driving gear load; eliminate the motion impediment
Low oil level	Oil level in the pressurization tank is lower than the emergency signaling level; sensor failure	Check the oil level; if necessary, refill with oil to the level necessary; verify the sensor
U-<phase>-coil t-sensor failure	U-<phase>-coil t-sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
V-<phase>-coil t-sensor failure	V-<phase>-coil t-sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
W-<phase>-coil t-sensor failure	W-<phase>-coil t-sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
U-<phase>-core t-sensor failure	U-<phase>-core t-sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit

Failure	Probable Cause	Repair Method
V-<phase>-core t-sensor failure	V-<phase>-core temperature sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
W-<phase>-core t-sensor failure	W-<phase>-core temperature sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
Top bearing t-sensor failure	Top bearing temperature sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
Bottom bearing t-sensor failure	Bottom bearing temperature sensor failure; control circuit rupture	Find and eliminate the cause of the failure, check the control circuit
Indicator/button lights not	Indicator/button failure	Test lamps with "Test lamps" button on the local control board or with "Acknowledgement/Test lamps" on the remote control panel; if necessary, replace the button/indicator.
The main screen boots not	Power supply circuit failure; local control board module is switched off	Check the power supply connection; retry to switch the display module on.

APPENDIX F

TABLE OF THE INTERFACE CONNECTIONS

Table 15 – Multiplex switch and remote control panel (portside) connections table

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Remote control panel (portside)
Control signal reception	RS-422/485	X917	1 Earth 2 TB 3 TA 5 RA 6 RB	↔	J7	8 GNDi 7 RB 6 RA 10 TA 9 TB	RS-422/485	Control signal transmission
Remote control panel power supply		X16	3 Earth 1 +24 2 -24	→	J7	3 Earth 4 +24 5 -24		Feed line
Emergency halt signal reception	RS-422/485	X16	4 ES1 5 ES2 6 Earth	←	J7	1 ES1 2 ES2		Emergency halt signal emission

Table 16 – Multiplex switch and remote control panel (central) connections table

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Remote control panel (central)
Control signal reception	RS-422/485	X918	1 Earth 2 TB 3 TA 5 RA 6 RB	↔	J7	8 GNDi 7 RB 6 RA 10 TA 9 TB	RS-422/485	Control signal transmission
Remote control panel power supply		X15	3 Earth 1 +24 2 -24	→	J7	3 Earth 4 +24 5 -24		Feed line
Emergency halt signal reception	RS-422/485	X15	4 ES1 5 ES2 6 Earth	←	J7	1 ES1 2 ES2		Emergency halt signal emission

Table 17 – Multiplex switch and remote control panel (starboard) connections table

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Remote control panel (starboard)
Control signal reception	RS-422/485	X916	1 Earth 2 TB 3 TA 5 RA 6 RB	↔	J7	8 GNDi 7 RB 6 RA 10 TA 9 TB	RS-422/485	Control signal transmission
Remote control panel power supply		X14	3 Earth 1 +24 2 -24	→	J7	3 Earth 4 +24 5 -24		Feed line
Emergency halt signal reception	RS-422/485	X14	4 ES1 5 ES2 6 Earth	←	J7	1 ES1 2 ES2		Emergency halt signal emission

Table 18 – Multiplex switch and remote control panel (stern) connections table

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Remote control panel (stern)
Control signal	RS-422/485	X915	1 Earth 2 TB	↔	J7	8 GNDi 7 RB	RS-422/485	Control signal

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Remote control panel (stern)
reception			3 TA 5 RA 6 RB			6 RA 10 TA 9 TB		transmission
Remote control panel power supply		X13	3 Earth 1 +24 2 -24	→	J7	3 Earth 4 +24 5 -24		-
Emergency halt signal reception	RS-422/485	X13	4 ES1 5 ES2 6 Earth	←	J7	1 ES1 2 ES2		Emergency halt signal emission

Table 19 –Table of connections of the multiplex switch and the central module of the local control board

Multiplex switch	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Central module of the local control board
Control signal reception and transmission	RS-422/485	X911	1 Earth 2 TB 3 TA 4 GNDi 5 RA 6 RB	↔	X30	6 Earth 3 RB 1 RA 5 GNDi 2 TA 4 TB		Control signal reception and transmission
Multiplex switch power supply		X1	1 +24 2 Earth 3 -24	←	X24	1 +24 2 Earth 3 -24		-
Emergency halt signal emission		X10	1 Earth 2 ES1 3 ES2	→	X59	6 Earth 2 ES1 4 TS2		Emergency halt signal emission
Control signal reception and transmission	RS-422/485	X912	1 Earth 2 TB 3 TA 4 GNDi 5 RA 6 RB	↔	X32	6 Earth 3 RB 1 RA 5 GNDi 2 TA 4 TB		Control signal transmission
Multiplex switch power supply		X2	1 +24 2 Earth 3 -24	←	X25	1 +24 2 Earth 3 -24		-
Emergency halt signal emission		X10	4 Earth 5 ES1 6 ES2	→	X59	5 Earth 1 ES1 3 ES2		Emergency halt signal emission

Table 20 – Table of connections of the frequency converter controller module of the local control board and the frequency controller

Frequency converter controller module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Frequency converter
Rotation sense and revolution rate reference signal	Analogue 4-20mA, load max 500 Ω; 6mA: -100%; 12mA: 0%; 18mA: 100%	X17	2 - 4 Earth 6 +	→	-	-		Additionally to the frequency converter (supplied by manufacturer)

Frequency converter controller module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Frequency converter
Frequency converter start	Digital 30 VDC max 5A; 250 VAC max 5A	X5	1 COM 2 NO	→	-	-		Additionally to the frequency converter (supplied by manufacturer)
Frequency converter stop	Digital 30 VDC max 5A; 250 VAC max 5A	X5	4 COM 5 NO	→	-	-		Additionally to the frequency converter (supplied by manufacturer)
Emergency halt activated	Discrete 24 VDC 0,5 W max	X9	2 IN 5 COM	←	-	-		Emergency halt
Power limitation mode activated	Discrete 24 VDC 0,5 W max	X9	3 IN 5 COM	←	-	-		
Frequency converter in-operation	Discrete 24 VDC 0,5 W max	X11	3 IN 5 COM	←	-	-		
Driving gear emergency	Discrete 24 VDC 0,5 W max	X9	1 IN 5 COM	←	-	-		
Admission to start the frequency converter	Digital 30 VDC max 5A; 250 VAC max 5A	X7	4 COM 5 NO	→	-	-		Additionally to the frequency converter (supplied by manufacturer)
Emergency circuit breakers are switched off	Discrete 24 VDC 0,5 W max	X9	4 IN 5 COM	←	-	-		
Electric motor overheating	Discrete 24 VDC 0,5 W max	X11	1 IN 5 COM	←	-	-		
A local frequency-converter control console activated	Discrete 24 VDC 0,5 W max	X11	2 IN 5 COM	←	-	-		
Frequency converter is ready	Discrete 24 VDC 0,5 W max	X11	4 IN 5 COM	←	-	-		
Rotation sense and revolution rate feedback coupling	Analogue 4-20mA, input impedance 200 Ω; 6mA: -100%; 12mA: 0%; 18mA: 100%	X16	1 - 3 Earth 5 +	←	-	-		
Load feedback coupling	Analogue 4-20mA, input impedance 200 Ω; 4mA: 0%; 20mA: 100%	X17	1 - 3 Earth 5 +	←	-	-		

Frequency converter controller module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Frequency converter
Fault discard	Digital 30 VDC max 5A; 250 VAC max 5A	X7	1 COM 2 NO	→	-	-		Additionally to the frequency converter (supplied by manufacturer)
Automatic frequency converter emergency halt	Digital 30 VDC max 5A; 250 VAC max 5A	X6	1 COM 2 NO	←	-	-		
	Discrete 24 VDC 0,5 W max	X13	1 IN8 5 COM3		-	-		

Table 21 – Table of connections of the central module of the local control board and the voyage data recorder

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Voyage data recorder (VDR)
System is ready for operation	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Thruster in operation	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Driving gear overloading exceeding the set point (>120%) with duration exceeding the set stretch (>5 s)	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Local control	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Remote control	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Rotation sense and revolution rate feedback coupling	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Screw propeller rotation sense (portside)	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Screw propeller rotation sense (starboard)	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Voyage data recorder (VDR)
Rotation sense and revolution rate reference signal at the frequency converter	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
Emergency halt activated	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)
General emergency signal	NMEA 0183	X49	2 TA 4 TB 6 Earth	→	-	-		Additionally to the VDR (supplied by manufacturer)

Table 22 – Table of connections of the central module of the local control board and the dynamic positioning system

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Dynamic positioning system (DP)
Rotation sense and revolution rate reference signal	Analogue 4-20mA, input impedance 200 Ω 6mA: -100%; 12mA: 0%; 18mA: 100%	X26	1 - 2 Earth 3 +	←	-	-		Rotation sense and revolution rate reference signal emission
DP-control transfer request	Discrete 24 VDC 0,5 W max	X40	1 IN 8 5 COM 3	←	-	-		
	Discrete 24 VDC 0,5 W max	X40	2 IN 9 3 IN 10 4 IN 11 6 Earth					
		X56	1 - 2 Earth 3 +					

Table 23 – Table of connections of the central module of the local control board and NAVI CONNING (NC)

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal description	NC
	NMEA 0183	X50	2 TA 4 TB 6 ⊥	→	-	-		Additionally to NC (supplied by manufacturer)

Table 24 – Table of connections of the central module of the local control board and the pressurization tank

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Pressurization tank
"Low oil level" signal reception	Discrete 24 VDC 0,5 W max	X38	1 IN 5 COMIN	←	-	-		"Low oil level" signal emission

Table 25 – Table of connections of the central module of the local control board and the main power distribution unit 1

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	VDR
		X17	1 COM 3 NO 4 Earth		-	-		Additionally to the main power distribution unit 1
		X18	1 COM 3 NO 4 Earth		-	-		Additionally to the main power distribution unit 1
		X35	1 IN0 2 IN1 3 IN2 4 IN3 5 COM 6 Earth		-	-		Additionally to the main power distribution unit 1

Table 26 – Table of connections of the central module of the local control board and the main power distribution unit 2

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	VDR
		X19	1 COM 3 NO 4 Earth		-	-		Additionally to the main power distribution unit 1
		X20	1 COM 3 NO 4 Earth		-	-		Additionally to the main power distribution unit 1
		X38	1 IN0 2 IN1 3 IN2 4 IN3 5 COM 6 Earth		-	-		Additionally to the main power distribution unit 1

Table 27 –Table of connections of the automatic power supply switch of the local control board and the power supply unit

Automatic power supply switch of the local control board	Signal description	Socket, input/output		Signal direction	Socket, input/output		Signal type	Power supply unit
Power supply		J2	1 220B 2 220B 3 Earth	→		1 220B 2 220B 3 Earth	J7	Power supply

Table 28 – Table of connections of the central module of the local control board and the power supply unit

Central module of the local control board	Signal type	Socket, input/output		Signal direction	Socket, input/output		Signal type	Power supply unit
Power supply to the central module of the local control board		X58	1 +24 2 Earth 3 -24	←		1 +24 Earth 2 -24	J5	Power supply to the central module of the local control board

APPENDIX G

STANDARD TOOLS-AND-SPARES KIT

Table 29 – Standard tools-and-spares kit

Spare part name	Quantity in the kit (number of items)	Notes
Emergency halt button	2	
A set of buttons with illumination, color: red	1	
A set of buttons with illumination, color: green	1	
A set of buttons without illumination, color: black	1	
A set of fuses, 10A	1	
A set of fuses, 20A	1	
A set of fuses, 25A	1	
A set of fuses, 2A	1	5x20mm
A set of fuses, 5A	1	5x20mm
Remote control panel (ПДУ)*	0 or more	
Off—on (binary) switch	1	
Note: * – conventionally supplied according to the preliminary request of the customer (not included in the standard kit)		

APPENDIX H

MAINTENANCE DOCUMENTATION SET

Table 30 – Maintenance documentation set

Title	Designation	Notes
Operating instructions manual	ЦИУЛ.421455.001 РЭ	One per object
Electrical circuit network of КРПУ-1011 system	ЦИУЛ.421455.001 Э4	* One per object
Electrical circuit network of КРПУ-1011 system	ЦИУЛ.421455.001 Э5	* One per object
Logbook	ЦИУЛ.421455.001 ФО	* One per object
Standard tools-and-spares kit register	ЦИУЛ.421455.001 ЗИ	** One per object
The Register's Certificate	—	*** One per object
Notes: 1 * – developed (if necessary) according to the requirements specifications for the subsequent conjugation of the system with the object and thereafter supplied to the ship project designing enterprise; 2 ** – supplied along with order of the tools-and-spares kit; 3*** – supplied while ordering; 4 – supplementary documentation (with relation to a particular project) may be supplied at the discretion of the manufacturer; 5 – The number of copies shall be preliminarily agreed with the customer.		