APPROVED
КШЮЕ.421451.001РЭ–УЛ

421000

ГБ05

«STRUNA»

Measuring system

Maintenance manual

КШЮЕ.421451.001РЭ

2009

Content

1 System description and operation 4
1.1 System purpose. 4
1.2 Specifications 4
1.3 System Structure 9
1.4 Design and operation 10
1.5 Components arrangement and operation 13
1.6 Explosion-proof provision. 46
1.7 Measuring means, Tools and materials: 48
1.8 Labelling and sealing 48
1.9 Package 49
2 Intended use 50
2.1 Operational limits 50
2.2 Safety measures at installation and operation. 50
2.3 Preparation of the system to operation 50
2.4 System operation 50
3 System maintenance 51
3.1 General guidance 51
3.2 Safety measures 51
3.3 Maintenance service regulations 51
4 The system maintenance 52
4.1 General notice 52
4.2 Safety measures 52
4.3 Fault-finding and fault removal means 52
5 Storage 53
6 Transportation 53
7 Utilization 53
Appendix A Typical sub ranges of density measurements and densimeter setting levels 54
Appendix B List of reference documents 55

The present maintenance manual is intended for study of operation principle, design and specifications of «STRUNA» measuring system (hereinafter referred to as System). The manual contains instructions for correct and safe service (operation according to the purpose, maintenance, storage, transportation) and can be applied to systems' modifications КШЮЕ.421451.001 for КШЮЕ.421451.001-15.

There are such abbreviations in the manual:

AI – Acoustic Insert;
ATI – Acoustic and Temperature Insert;
AWL – water level alarm;
CB – commutation junction box;
CC – control channel;
CD – computing Device;
CFL – corrosive and food liquids;
CM – control module;
ComM – Commutation module;
CU – Computing unit;
DM – Distributing module;
DSC – density-sensing channel;
ED – Engineering documents;
GFS –gas-filling station;
IB – Interface block;
ISC – Intrinsically safe circuit;
IU – Indicating unit;
JB – Joint box;
LHG – Liquefied Hydrocarbon Gases;
LSC – Level-sensing Channel;
MM – Microchip module;
MP – Measuring procedure;
PC – personal computer;
PP – petroleum products;
PPR – Primary Parameter Reorganizing Sensor;
PrS – Pressure Sensor
PS – petrol station;
PSC – pressure-sensing channel;
PSD – petroleum storage depot;
PSU – Power Supply Unit;
PTM – Pressure-Transducer Module;
ROM – read-only memory;
SHC – Spark-hazardous circuit;
SU – sensor unit;
SUDM – sensor unit for density measurement;
SUDMA – sensor unit for density measurements and alarm;
SULTDM – sensor unit for level, temperature and density measurements;
SULTM – sensor unit for level and temperature measurements;
SULTMA – sensor unit for level, temperature measurements and alarm unit;
SULTMW – sensor unit for level and temperature measurement of water;
SUW – sensor unit for water;
TBC - Terminal-block connector;
TC – tank calibration;
TS – temperature sensor;
TSC – Temperature-sensing channel;
WLAC – bottom Water level alarm channel;
WLS – water level sensor;
WLSC – bottom water level sensing channel.

1 System description and operation

1.1 System purpose.

1.1.1 The system is intended for measuring of level, temperature, density, pressure, volume and weight of liquids in tanks, including explosive hazardous, for estimations and process operations, and also for level measurements and indicating of bottom water existence.

1.1.2 The system is to be applied within explosive hazardous areas inside and outside buildings and facilities according to the explosion protection marking based on GOST R51330.13-99 (IEC 60079-14-96), ch. 7.3 of “Electrical installation design regulations” (PUE) and other regulations that define the operation of electrical equipment in explosion hazardous areas connected to the electrical devices installed out of the hazardous area by a intrinsically-safe circuit. For example: PS, GFS, PSD, chemical and food plants. The measuring equipment is also used for tank calibration as standard means of 2nd category measurements in line with the State accuracy chart for liquid level measuring devices according to GOST 8.477-82.

1.1.3 The system complies with requirements to explosion safe equipment subgroup IIB of "*i*a" standard intrinsically-safe circuit protection type in line with GOST R 51330.0-99 and GOST R 51330.10-99.

1.1.4 System operation conditions:

a) temperature and ambient air humidity resistance is based on GOST 12997-84 for PPR, PrS and JB in C2 design (high temperature level +55°C), and for CD, CM and IU in B1 design.

b) the requirements of protection from penetration of water, dust and other foreign particles comply with GOST 14254-96 for PPR, PrS and JB in IP54 design and for CD, CM and IU in IP20 design.

1.2 Specifications

1.2.1 Options of PPR design are given in chart 1.1

1.2.2 LSC metrological performance:

а) ranges of level measurement for various options of PPR are given in chart 1.2;

б) ranges of permissible absolute accuracy of level measurement are given in chart 1.3;

в) the setting time from the moment of level measuring is no more than 10 sec.

Chart 1.1

PPR Designation	Measured parameters						PrS Installation on PPR Flange	Comments
	Level	Temperature	Density: Surface Densimeter	Density: Immersion Densimeter	Bottom Water Level	Bottom Water Alarm		
КШЮЕ.407533.001	+	+	-	-	-	+	-	For PS without a densimeter
КШЮЕ.407533.001-01	+	+	+	-	-	+	-	For PS with a densimeter. One flange.
КШЮЕ.407533.001-02	+	+	-	+	-	+	-	
КШЮЕ.407533.001-03	+	+	-	+	-	+	-	For PS with a densimeter Two flanges. L < 2000mm
КШЮЕ.407533.001-04	+	+	-	+	-	+	-	For PS with a densimeter Two flanges. L > 2000mm
from КШЮЕ.407533.002 till -05	+	+	-	+	+	-	-	For PSD.
КШЮЕ.407533.003	+	+	-	-	-	-	+	For GFS (single-shell tanks) without a densimeter
КШЮЕ.407533.003-01	+	+	-	-	-	-	+	For GFS (double-shell tanks) without a densimeter
КШЮЕ.407533.003-02	+	+	-	+	-	-	+	For GFS (single-shell tanks) with a densimeter Two flanges. L < 2000mm
КШЮЕ.407533.003-03	+	+	-	+	-	-	+	For GFS (double-shell tanks) with a densimeter Two flanges. L < 2000mm
КШЮЕ.407533.003-04	+	+	-	+	-	-	+	For GFS (single-shell tanks) with a densimeter. One flange.
КШЮЕ.407533.003-05	+	+	-	+	-	-	+	For GFS (single-shell tanks) with a densimeter. Two flanges. L > 2000mm
КШЮЕ.407533.003-06	+	+	-	+	-	-	+	For GFS (double-shell tanks)) with a densimeter Two flanges. L > 2000mm
КШЮЕ.407533.003-07	+	+	-	-	-	-	+	For GFS (single-shell tanks) without a densimeter and with an assembly casing.
КШЮЕ.407533.003-08	+	+	-	+	-	-	+	For GFS (single-shell tanks) with a densimeter and an assembly casing. Two flanges. L < 2000mm
КШЮЕ.407533.003-09	+	+	-	+	-	-	+	For GFS (single-shell tanks) with a densimeter an assembly casing. Two flanges. L > 2000mm
КШЮЕ.407533.004	+	+	-	-	-	-	-	For TC up to 4000mm.
КШЮЕ.407533.004-01	+	+	-	-	-	-	-	For TC up to 9000mm.
КШЮЕ.407533.005	+	+	-	-	-	-	-	For CFL without a densimeter.
КШЮЕ.407533.005-01	+	+	-	+	-	-	-	For CFL with a densimeter.
КШЮЕ.407533.006	+	+	-	-	-	-	-	Control device

Comments

1 PPR КШПОЕ.407533.002, -01…-05 may not be supplied with a densimeter and WLS on the Customer's request.

2 L – length of connection wire between PPR and CB (in PS) or PPR and SUDM (in GFS).

Chart 1.2

PPR Designation	Range of level measurements, mm
КШПОЕ.407533.001	160 …4000
КШПОЕ.407533.001-01	200 …4000
from КШПОЕ.407533.001-02 till -04	120 …4000
from КШПОЕ.407533.002 till -05	150 …18000
from КШПОЕ.407533.003 till -09	200 …4000
КШПОЕ.407533.004	10 …4000
КШПОЕ.407533.004-01	10 …9000
КШПОЕ.407533.005	120 …4000
КШПОЕ.407533.005-01	
КШПОЕ.407533.006	80 …400

Chart 1.3

PPR Designation	Limits of permissible absolute accuracy of level measurement, mm.
from КШПОЕ.407533.001 till - 04	±1.0
from КШПОЕ.407533.003 till - 09	
from КШПОЕ.407533.004 till - 01	
from КШПОЕ.407533.005 till - 01	
КШПОЕ.407533.006	
from КШПОЕ.407533.002 till - 05	±1.0 (measurement range: 150…4000mm)
	±2.0 (measurement range: over 4000mm)

Comments – limits of accuracy are provided on the condition no liquid getting in/out and no liquid surface surging.

1.2.3 TSC metrological performance:

a) temperature measurements range is from minus 40°C to +55°C;

b) limits of permissible absolute accuracy of temperature measurements are:

- ±0.5°C after yield and repair;

- ±0.5°C or ±1.0°C at the periodical maintenance checking depending on the measurement means used as a standard;

c) setting time from the moment of changing temperature no more than 2 hours.

1.2.4 DSC metrological performance:

a) measurements from 450 kg /m^3 to 1500 kg /m^3 with subranges of measurements lower than 100 kg /m^3;

Comments - standard sub ranges of density measurements and installation levels are given in Appendix A.

b) Limits of permissible absolute accuracy of density measurements are:

- ±1.5 kg/m^3 for surface densimeters;

- ±1 kg/m^3 after yield and repair for immersion densimeters, ±1kg/ m^3 or ±1.5kg/m^3 at the periodical testing during operation depending on the measurement means used as a standard;

c) Setting time from the moment of changing density that is no more than:

1) 10 sec. if storing liquid temperature in tank is the same as taking-in liquid temperature;

2) 10 min. if storing liquid temperature in tank is different from taking-in liquid temperature (EXCEPT density values normalized to +15°C or +20°C and average density values for surface densimeters)

3) 2 hours if storing liquid temperature in tank is different from taking-in liquid temperature (FOR density values normalized to +15°C or +20°C and average density values for surface density measuring devices)

1.2.5 WLAC metrological performances:

a) alarm level of bottom water is 25 mm;

b) limits of permissible absolute accuracy for alarm level of bottom water equal to ±2mm;

c) setting time from the moment of bottom water level changing is no more than 10 sec.

1.2.6 WLSC metrological performances:

a) the range of bottom water level measurements is between 80 and 300mm;

b) limits of permissible absolute accuracy of level measurement of bottom water equal to ±2mm;

c) Setting time from the moment of bottom water level changing is no more than 10 sec.

1.2.7 PSC metrological performances:

a) range of density measurement between 0 and 1.6 MPa;

b) limits of permissible absolute accuracy of temperature measurement is ±1%;

c) setting time from the moment of pressure changing is no more than 10 sec.

1.2.8 The limit of permissible absolute accuracy of tank-storing liquid mass measurements equals to ±0.4...1.0%;

Comments – actual accuracy value and minimum residue liquid (in storage mode) and taking-in liquid volume (or releasing liquid) are determined in accordance with MP and the calibration chart of tanks. MP is developed for the dedicated type of liquids according to GOST R8.563-96 (for oil and PP according to GOST R 8.563-96). Charts in the system are to be entered in line with КШЮЕ.421451.001И1 instruction.

1.2.9 Features of system connecting lines:

- length of connecting line (intrinsically-safe circuit) between PPR, PrS, JB and CD is no more 1200m. The recommended type of wire МКЭШ5×0.35 in line with GOST 10348-80;
- length of connecting line between CD and IU is no more than 20m;
- length of connecting line between CD and IU is no more than 1200m;
- electric features are described in section 1.6.

1.2.10 The System provides control of AC ~220 V power circuits and of DC circuits. Maximum number of control channels is 64. Types of control channels are the following:

a) for AC ~220 V circuit with switching current from 0.1 to 0.5A (AC 0.5 type);
b) for AC ~220 V circuit with switching current from 0.01 to 0.1A (AC 0.1 type);
c) for DC 27 V circuit with switching current is up to 0.5A (DC 0.5 type).

1.2.11 The system provides output of measured data for:

a) IU (Interfacing rules for operator are described in Operator's Manuals: КШЮЕ.421451.001РО1 and КШЮЕ.421451.001РО3);

b) PC in accordance with data exchange protocol "Кедр 2.1" (described in КШЮЕ.421451.001ПО);

c) PC with the installed «STRUNA measuring system» program (Interfacing rules for operator are described in Operator's Manual КШЮЕ.421451.001РОП) or «ARM STRUNA» program.

Comments – Connection to PC may be arranged on 1200m-link length through serial ports RS-232, RS-485 or USB connection socket.

1.2.12 The system fulfils the requirements of Fire Safety Regulations (NPB 111-98) providing:

a) control of filling of a tank with liquid;
b) control of liquid leak from a tank.

1.2.13 The system provides reduction of measured density to standard conditions by temperature of +15°C or +20°C.

1.2.14 Power supply is provided from AC 220^{+22}_{-33} V / 50±1 Hz single-phase circuit. The current consumption does not exceed 0.6 A.

1.2.15 SU of PPR is a hermetically sealed unit in relation to the measurement media. It is designed for test pressure of 0.2 MPa (~2 kg/sm^2)

1.2.16 SU of PPR is immersed in a tank containing LHG. SU is hermetically sealed in design pressure equal to 2.5 MPa. (~25 kg/sm^2).

Comments - Operating pressure does not exceed 1.6 MPa (~16 kg/sm^2).

1.2.17 System mass is within the range from 25 to 980 kg depending on the assembly type.

1.2.18 Overall and installation dimensions of system devices are described in КШЮЕ.421451.001ИМ Manual for Installation, Commissioning and Adjustment.

1.2.19 Average service life is 12 years if the operating conditions are strictly followed.

1.2.20 Average mean time between failures is 100000 h with confidence probability 0.8.

1.2.21 The system complies with electric-safety requirements of GOST 12.2.007.0-75:

– PPR, PrS, JB and IU are related to III category of safety requirements;
– CD and CM are related to I category of safety requirements.

Grounding joint design and grounding signs are in line with GOST 21130-75.

1.3 System Structure

1.3.1 The System contains:

a) devices in accordance with chart 1.4 (depending on system configuration);

b) PrS КШЮЕ.406233.001-01 (up to 9 devices connected to CD) or КШЮЕ.406233.001-02 (one device connected to PPR);

c) IU КШЮЕ.467846.001 quantity: 1;

d) CM КШЮЕ.468332.001 for AC power circuit control with voltage of ~220V or of DC circuits (up to 8 devices);

e) RS-232, RS-485 converters, USB;

f) JB КШЮЕ.408845.002 (a device for a PrS group);

g) cables:

- КШЮЕ.685661.022 (to provide a connection between CU and PC, at distance less than 100 m, for RS-232);
- КШЮЕ.685661.022 -02 (to provide a connection between CU and CM);
- КШЮЕ.685661.015 (to provide a connection between CU and CM);
- КШЮЕ.685661.022 -03 (to provide a connection between CMs);
- КШЮЕ.685661.037 (to provide a connection between CD and PPR for a tank calibration);

h) «STRUNA measuring system» application;

k) «ARM STRUNA» application;

m)«Бия-С» fire and security public speaking module, model 1 in line with TU 4372-017-00226827-97;

n) The maintenance documentation in line with the list of Maintenance documents КШЮЕ.421451.001ВЭ.

Chart 1.4

System Designation	CD Designation	Total number of PPRs and PrSs groups
КШЮЕ.421451.001	КШЮЕ.467444.001	16
КШЮЕ.421451.001- 01	КШЮЕ.467444.001- 02	1
КШЮЕ.421451.001- 02	КШЮЕ.467444.001- 02	2
КШЮЕ.421451.001- 03	КШЮЕ.467444.001- 03	3
КШЮЕ.421451.001- 04	КШЮЕ.467444.001- 04	4
КШЮЕ.421451.001- 05	КШЮЕ.467444.001- 05	5
КШЮЕ.421451.001- 06	КШЮЕ.467444.001- 06	6
КШЮЕ.421451.001- 07	КШЮЕ.467444.001- 07	7
КШЮЕ.421451.001- 08	КШЮЕ.467444.001- 08	8
КШЮЕ.421451.001- 09	КШЮЕ.467444.001- 09	9
КШЮЕ.421451.001- 10	КШЮЕ.467444.001- 10	10
КШЮЕ.421451.001- 11	КШЮЕ.467444.001- 11	11
КШЮЕ.421451.001- 12	КШЮЕ.467444.001- 12	12
КШЮЕ.421451.001- 13	КШЮЕ.467444.001- 13	13
КШЮЕ.421451.001- 14	КШЮЕ.467444.001- 14	14
КШЮЕ.421451.001- 15	КШЮЕ.467444.001- 15	15

Comments – PrS group consists of up to 9 PrSs connected to CU port through JB. PPR isn't connected to the CU port. Single PrS can be joined to a PPR controller without using a JB.

1.4 Design and operation

1.4.1 Structure of the System is given in fig. 1.4.1.1…1.4.1.4.

1.4.2 A structural arrangement of channels is given in fig. 1.4.1.1 … 1.4.1.3. PPR, CU and IU (PC can be used instead of IU with «STRUNA measuring system» or «ARM STRUNA» application) form measuring channels: LSC, DSC, TSC, WLAC, WLSC.

PrS, JB, CD and IU (PC can be used instead of IU with «STRUNA measuring system» or «ARM STRUNA» application) form measuring channels: DSC.

PPR renders primary information on liquid level, density, temperature, and bottom water existence and level.

PrS renders primary information on liquid pressure. JB unites PrS group for plugging to CD.

CD is used for receiving and processing of information from PPR and PrS, and displaying it on IU and PC.

1.4.3 Interfaces options of System-to-PC connection through various interfaces are indicated in figure 1.4.1.4.

1.4.4 Structure of channel control

CD and CM form control channels.

CM provides switching of AC 220V / 50 Hz power circuits and DC circuits by CD control signals depending on parameters threshold values.

Switching of power circuits provides activation of pumps and light and sound alarm.

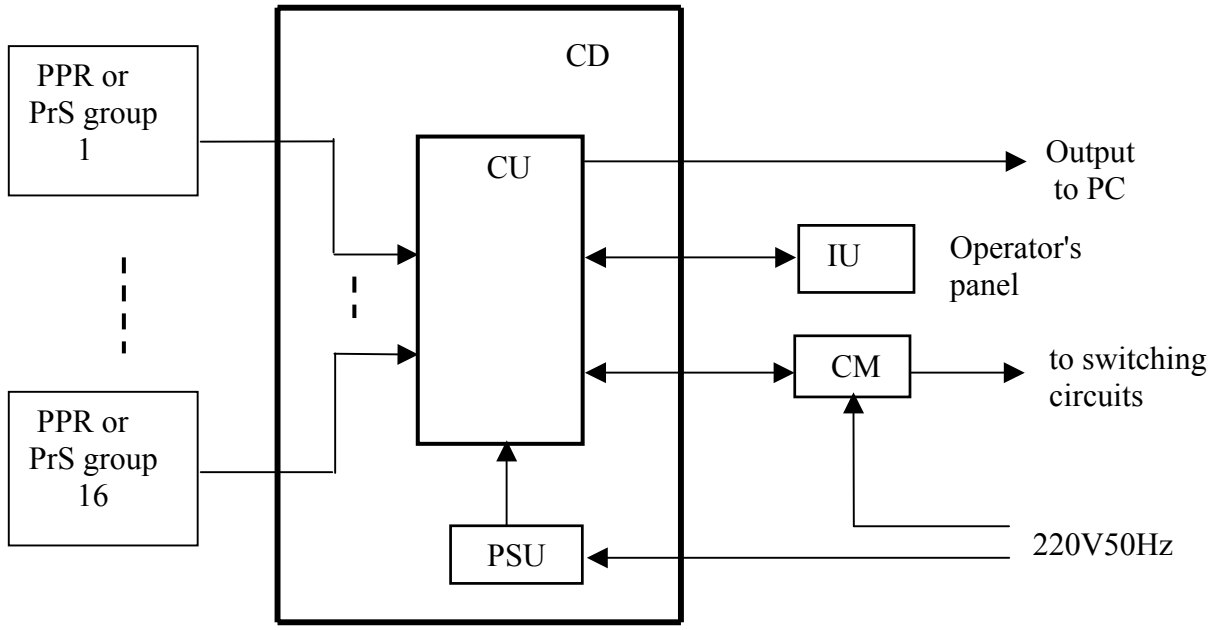


FIgure 1.4.1.1 - Structural system scheme.

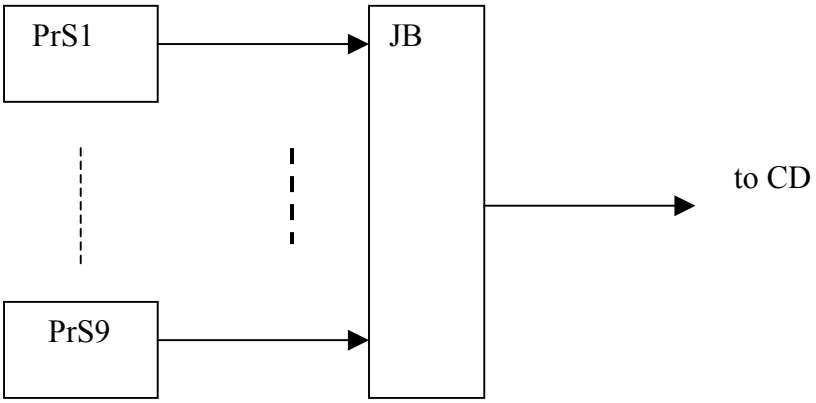


Figure 1.4.1.2 - Connection of PrS group

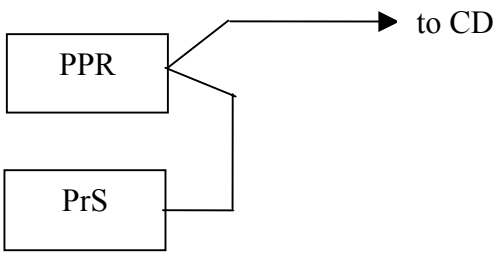
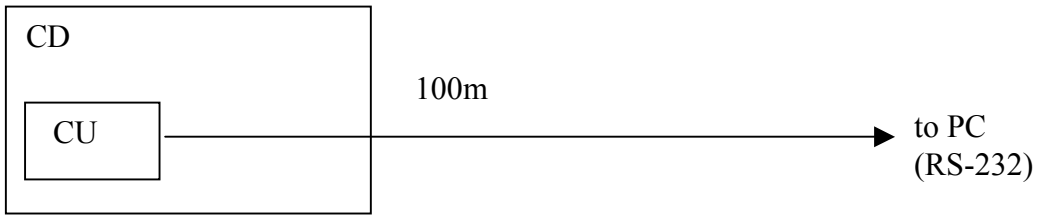
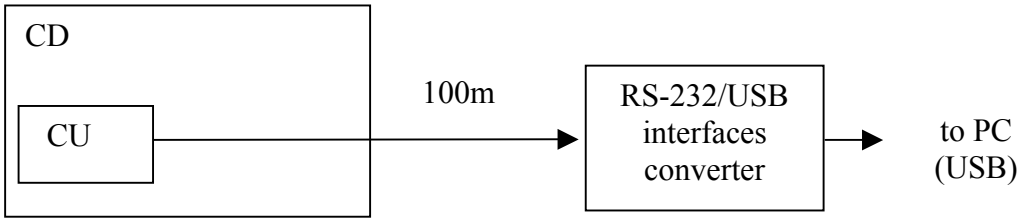


Figure 1.4.1.3 - Connection of single PrS to PPR

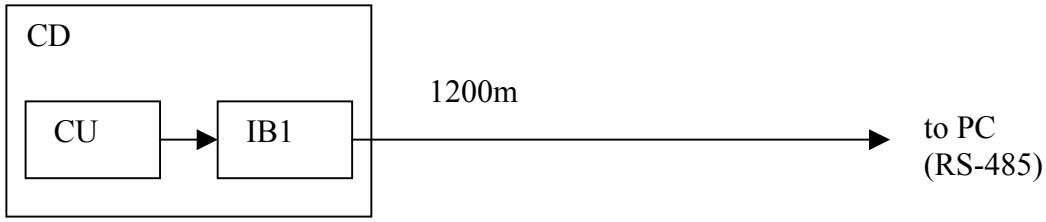
1) RS-232 interface with the link length no more than 100 m.



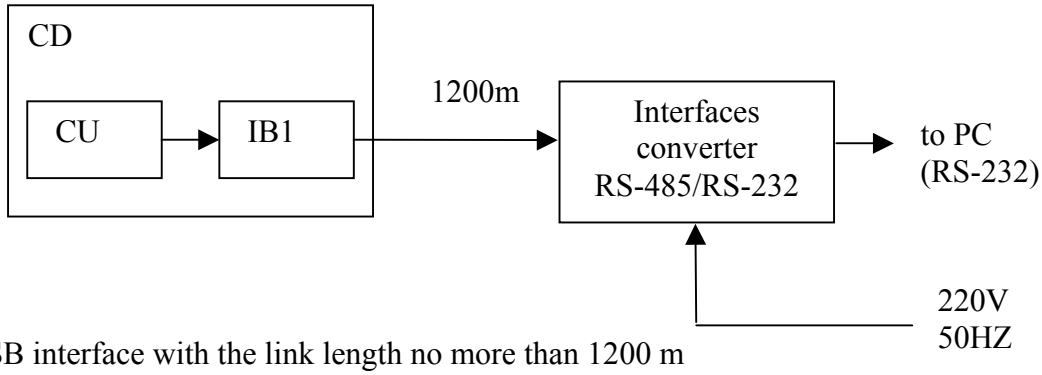
2) USB interface using the link length no more than 100 m



3) RS-485 interface with the link length no more than 1200 m



4) RS-232 interface with the link length no more than 1200 m



5) USB interface with the link length no more than 1200 m

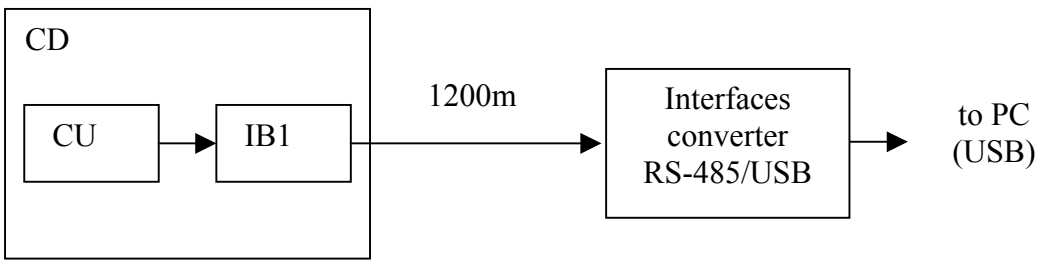


Figure 1.4.1.4 – Options of System-to-PC interfaces

1.5 Components arrangement and operation

1.5.1 Design and operation of the external device

1.5.1.1 PPR converters in PS

PPR optional designs of PS are shown on fig. 1.5.1.1.1 … 1.5.1.1.5.

PPR КШИОЕ.407533.001-01 (figure 1.5.1.1.2) with a surface densimeter consists of Controller 1 and SULTMA 2. SULTMA consists of tube 3 and ATI 4 both made of non-magnetic material. The tube is an ATI protector. Internal parts of ATI are: TS 5, fixed magnet (marker) 6, signal pick-up coil 7, magnetostrictive wire (string) 9, damper 10 made of elastic material that absorbes a reflected ultrasonic wave.

The controller is connected to the center of the System by cable 11.

Water level alarm 12 is installed on the lower side of tube.

Traveling elements with magnets 13, 14 (floats of level and density) at the operating slide along the tube surface and get into position along the tube depending on liquid level and density. The range of floats travel is between upper limit ring 15 and lower limit ring 16.

PPR is mounted to tank by flange 17. PPR travels vertically in tank by guide 18 tightened with flange 17. Grounding bus 8 connects flange 17 with controller 1.

Level and density liquid measurements are based on the ultrasonic wave distributing period in magnitostrictive wire. Transmitting speed of ultrasonic wave is virtually independent of density and humidity. The temperature influence is automatically compensated by a special time interval processing algorithm of ultrasound distribution.

Ultrasonic pulse is produced inside a magnitostrictive conductor (waveguide).

At the interaction of DC magnetic field created by the current impulse in the conductor and the field of constant magnets the crystal structure of the waveguide is deformed thus a mechanical wave is created and spreaded with ultrasonic speed.

Ultrasonic pulses that appear at the markers and floats locations spread into both directions from transducer wire.

Ultrasonic pulses in the upper part of the transducer wire are transformed into electric pulse by signal pick-up coil and are then absorbed by damper.

Time interval between moment of ultrasonic pulse generation and receipt of the signal is proportional to the measuring distance.

While density changes the immersion depth of a level float changes insignificantly but the immersion depth of a density float changes considerably thus distance between magnetic floats changes in proportion to the density.

The range of level measuring is defined by the distance between a fixed magnet and the signal pick-up coil.

Temperature is measured by integrated quartz sensors that output a digital code.

AWL operation is based on the conductometric principle. When water level reaches to limit of switching AWL the sensor's resistance considerably reduces and AWL output is transferred into a corresponding digital code.

PPR КШИОЕ.407533.001 (figure 1.5.1.1.1) without a densimeter differs from shown in figure 1.5.1.1.2, as density float 14 is not included.

PPR КШИОЕ.407533.001-02 (figure 1.5.1.1.3) with immersion densimeters for mounting on a flange consists of controller 1, SULTM and SUDMA. The controller is restrained with SULTM by joining unit 19. SUDMA is connected to a controller by a flexible cable with a connector. The cable is protected from external influences by flexible pipe 8, which is fixed in both sides by clips 14, 15. SUDMA is joined to flange 18 with guide 20. Flange 18 is mounted on a tank. The flange is used as a

support for installing flange 17 with guide 21. Flange 17 is mounted on SULTM. Clip 16 serves for fixing ground bus 13 to SUDMA. The controller is also connected to SULTM and SUDMA by ground busses 12 and 13.

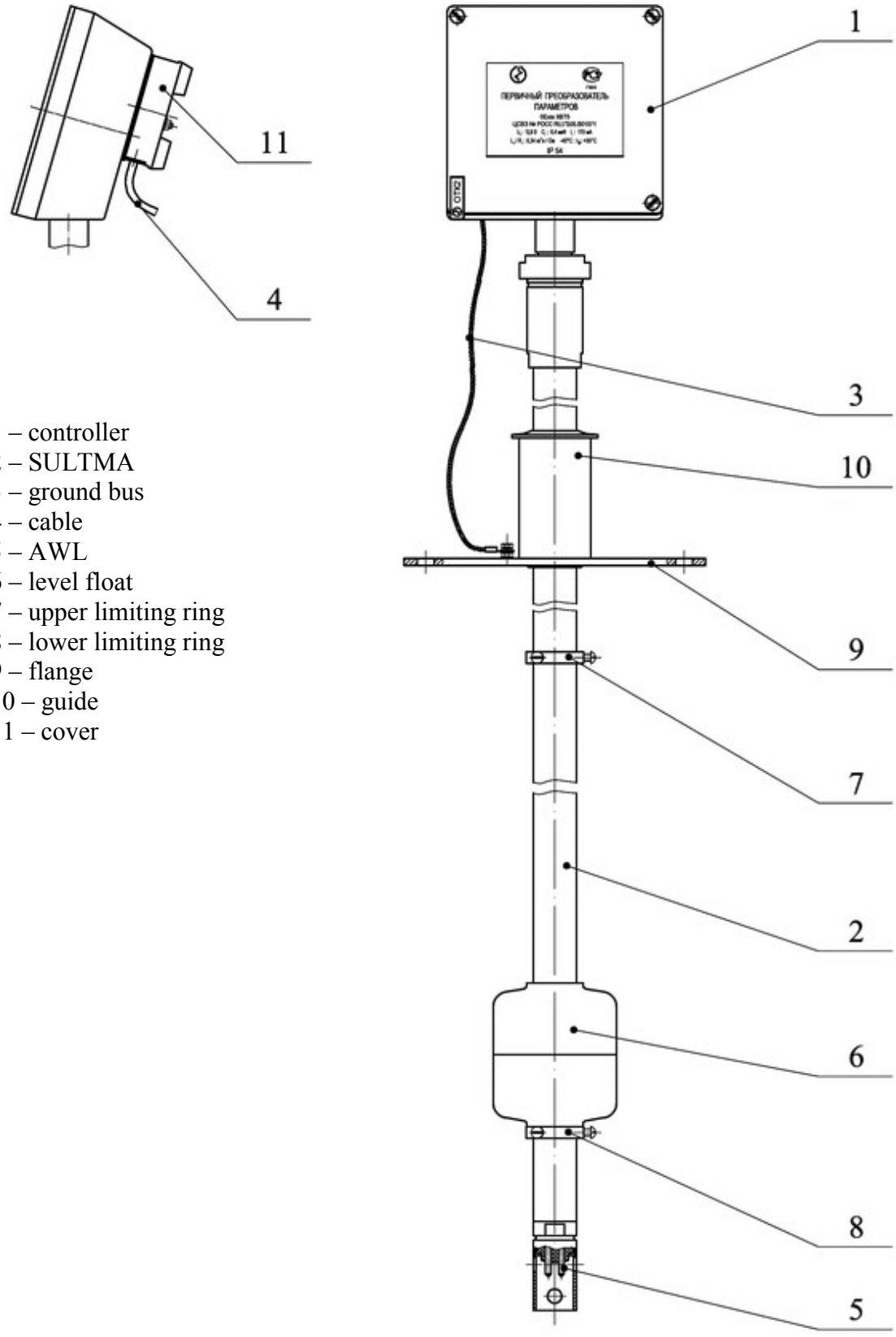
SULTM provides level and temperature measuring (operation principle is detailed in par.1.5.1.1). The range of level is determined by upper 6 and lower 7 limit rings that limit the level float 4 travel.

Density float 9 is mounted on SUDMA and is connected with balancing chains 10 to rings of circuit 11 and also to AWL. The installation of two floats is shown in figure 1.5.1.1.3. Maximum number of floats is four. SUDMA inner structure is similar to SULTM only without TSs.

The density changes result in the change of the pushing-out force that affects the density float and is balanced by chains masses thus the float mass varies. The float travel is proportional to density change. The process of density float travel measuring is similar to level float travel measuring (par.1.5.1.1).

PPR КШНОЕ.407533.001-03 (figure 1.5.1.1.4) with immersion densimeters is intended for installation on two straddled flanges with 23 cable length no more than 2 000mm.

PPR КШНОЕ.407533.001-04 (figure 1.5.1.1.5) with immersion densimeters is intended for installation on two straddled flanges with 23 cable length in the range from 2 000mm to 10 000 mm.



1 – controller
2 – SULTMA
3 – ground bus
4 – cable
5 – AWL
6 – level float
7 – upper limiting ring
8 – lower limiting ring
9 – flange
10 – guide
11 – cover

Figure 1.5.1.1.1 – PPR КШИОЕ.407533.001

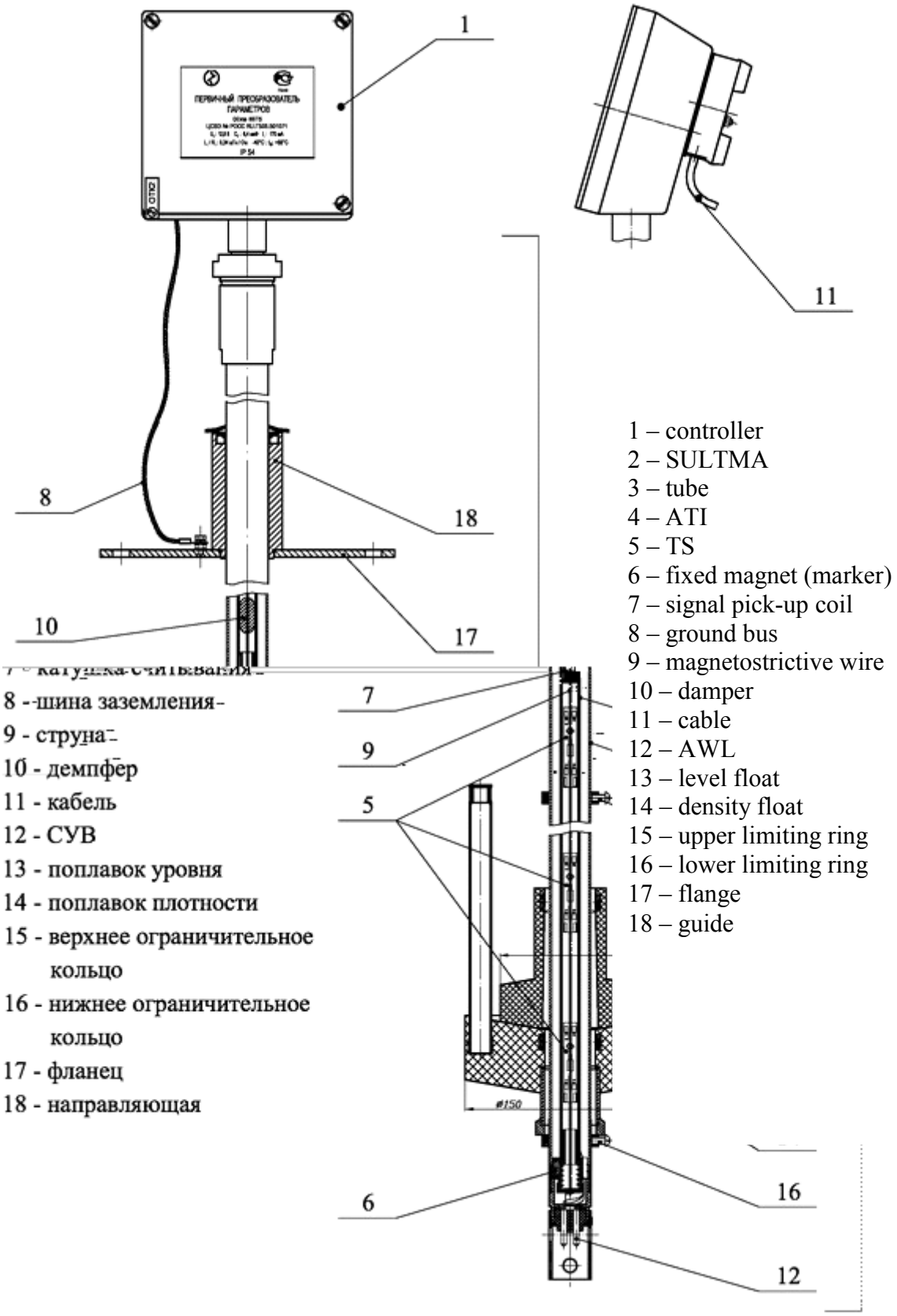
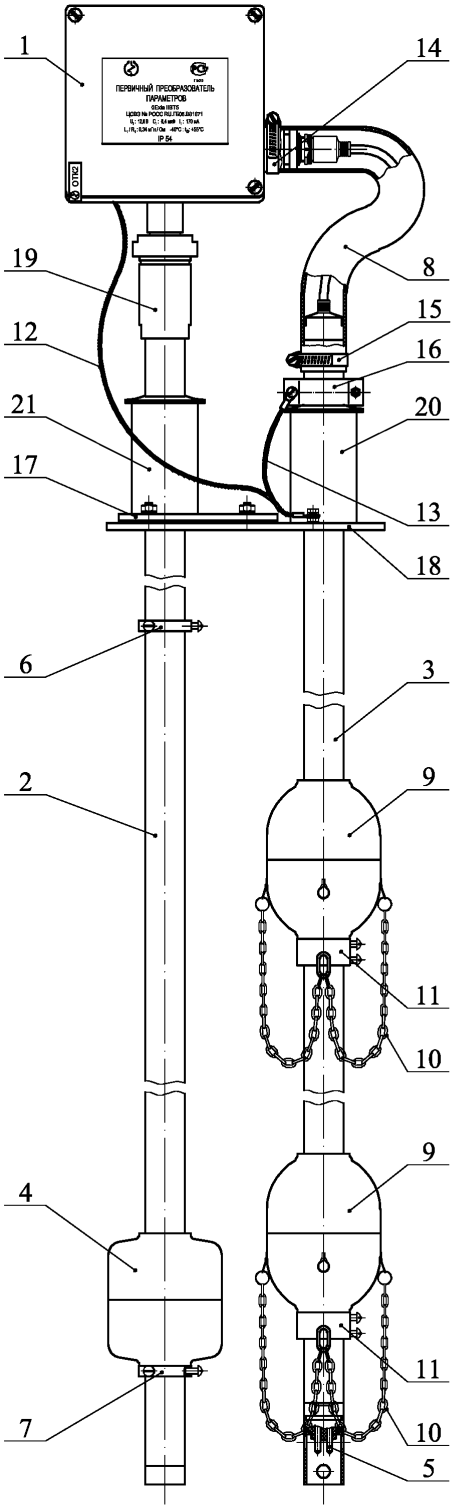
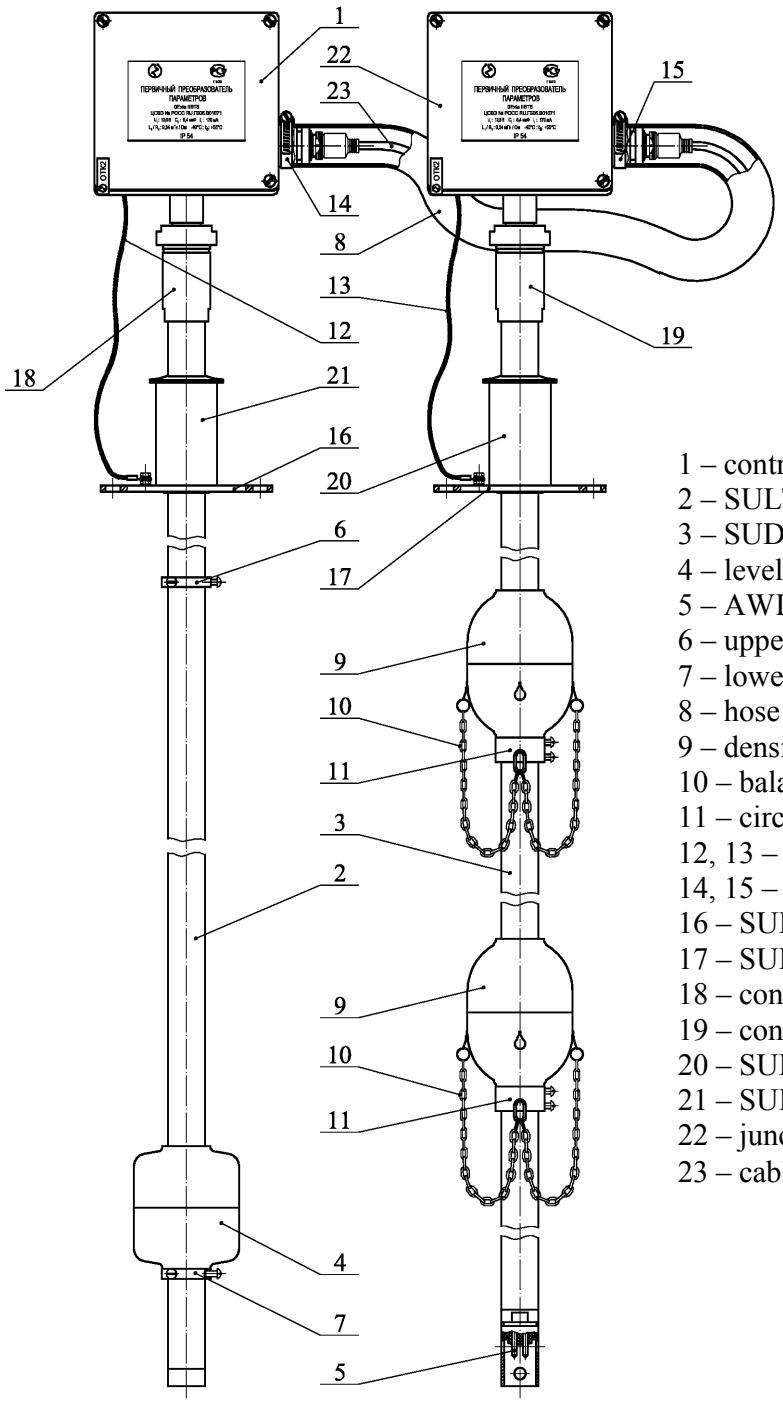


Figure 1.5.1.1.2 – ППП КШЮЕ.407533.001-01



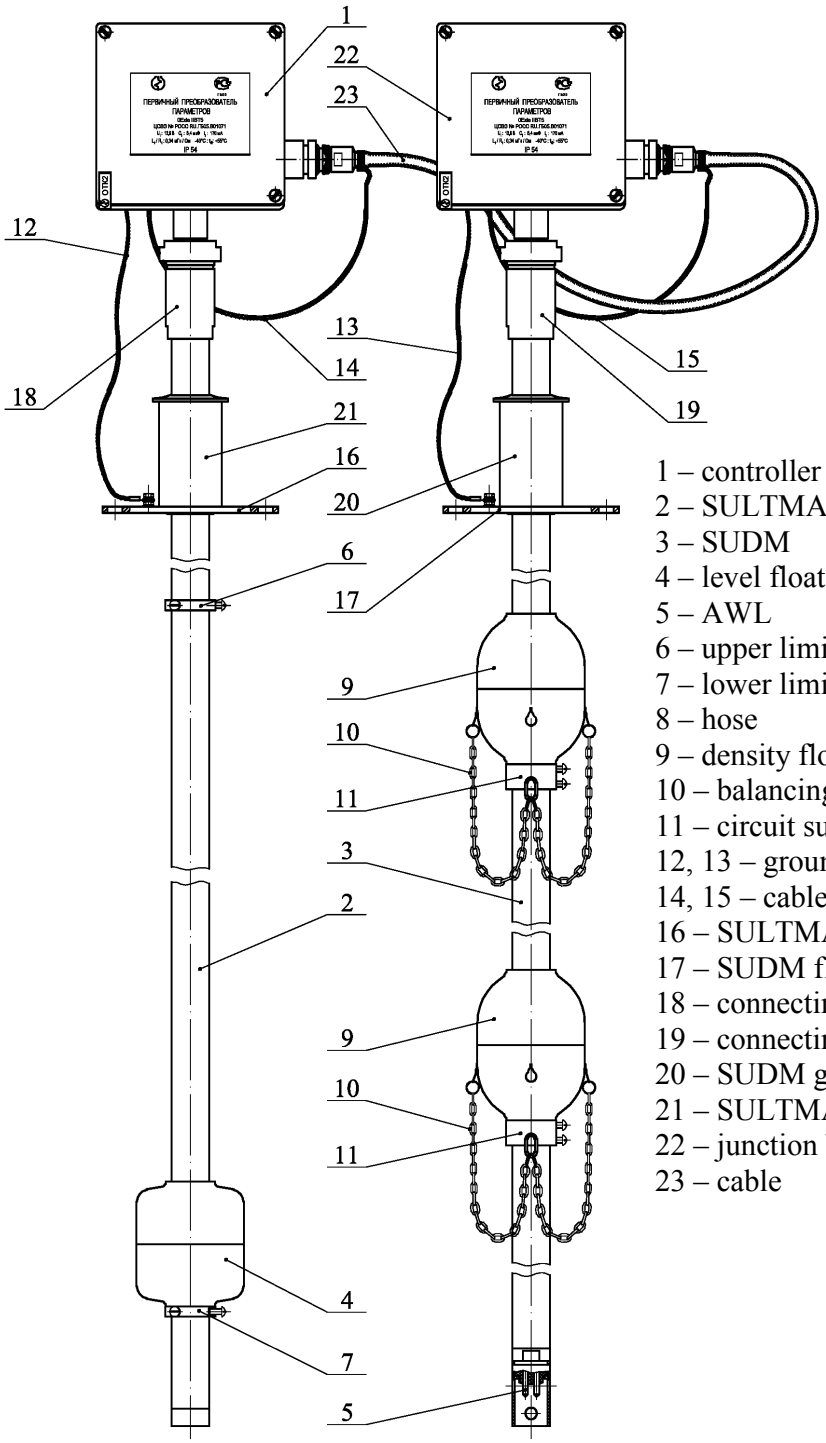
1 – controller
2 – SULTM
3 – SUDMA
4 – level float
5 – AWL
6 – upper limiting ring
7 – lower limiting ring
8 – hose
9 – density float
10 – balancing chains
11 – circuit suspend ring
12, 13 – ground bus
14, 15 – clamp
16 – clamp for ground bus
17 – SULTM flange
18 – SUDMA flange
19 – connecting unit of controller and SULTM
20, 21 – guide

Figure 1.5.1.1.3 – PPR КШЮЕ.407533.001-02



1 – controller
2 – SULTM
3 – SUDMA
4 – level float
5 – AWL
6 – upper limiting ring
7 – lower limiting ring
8 – hose
9 – density float
10 – balancing chain
11 – circuit suspend ring
12, 13 – ground bus
14, 15 – clamp
16 – SULTM flange
17 – SUDMA flange
18 – connecting unit of controller with SULTM
19 – connecting unit of CB with SUDMA
20 – SUDMA guide
21 – SULTM guide
22 – junction box CB
23 – cable

Figure 1.5.1.1.4 – PPR КШИЮЕ.407533.001-03.
Cable 23 length is no more than 2 000 mm.



1 – controller
2 – SULTMA
3 – SUDM
4 – level float
5 – AWL
6 – upper limiting ring
7 – lower limiting ring
8 – hose
9 – density float
10 – balancing chain
11 – circuit suspend ring
12, 13 – ground bus
14, 15 – cable ground bus
16 – SULTMA flange
17 – SUDM flange
18 – connecting unit of controller with SULTMA
19 – connecting unit of CB with SUDM
20 – SUDM guide
21 – SULTMA guide
22 – junction box CB
23 – cable

Figure 1.5.1.1.5 – PPR КШЮЕ.407533.001-04.
Cable 23 length from 2 000 mm to 10 000 mm.

1.5.1.2 PPR of PSD converters

PPR КШПОЕ.407533.002, -01…-05 with 23 cable length no more than 2 000 mm is shown in figure 1.5.1.2.1. PPR with 23 cable length over 2 000 mm is shown in figure 1.5.1.2.2. Both devices with immersion densimeters consist of controller 1, SU1 2, SU2 3, JB2 3 and cable 13.

SU1 2 consists of SULTMs 5, 6 interconnected by coupling units 7 and are linked with a controller by spacer 17. SU1 2 is fixed to a tank by flange 8 and guide 9. The flange and the controller are also interconnected by ground bus 10. Level floats are sliding along SULTM tubes 11. Their travel is limited by rings 12 position.

Internal design of SULTM and operating principles of level and temperature measurements are similar to the description in par. 1.5.1.1. SULTM maximum number is four.

SU2 3 consists of SULTDMs 14,15 and SUW 16 interconnected by coupling units 7 and CB. The parts are separated by spacer 18. SU2 is fixed to a tank by flange 19 with guide 20. The flange is also connected with CB by ground bus 21. SULTDM differs from SULTM by availability of density floats 22, balancing chains 23 and chain suspension rings 24 for density measurement. Principle of density measurement is described in par.1.5.1.3. Maximum number of SULTDM is three.

SUW 16 is located in the lowest side of SU2 3. The level float 25 is sliding along SULTM tube in between limiting rings 12. Float 25 locates at battery line between petroleum product and bottom water. Level measurement principles of bottom water are similar to description in par. 1.5.1.1.

The controller switched in measuring mode inquirs SULTM and SULTD signals at the certain algorithm. The controller defines sensor unit in which level float 11 is not in contact with limit rings. The sensors unit is the main unit for measurements.

Densimeters and SWL are optional devices.

PPR options are defined by a number of various sensor sections that are included in SU1 and SU2. The number depends on maximum liquid level.

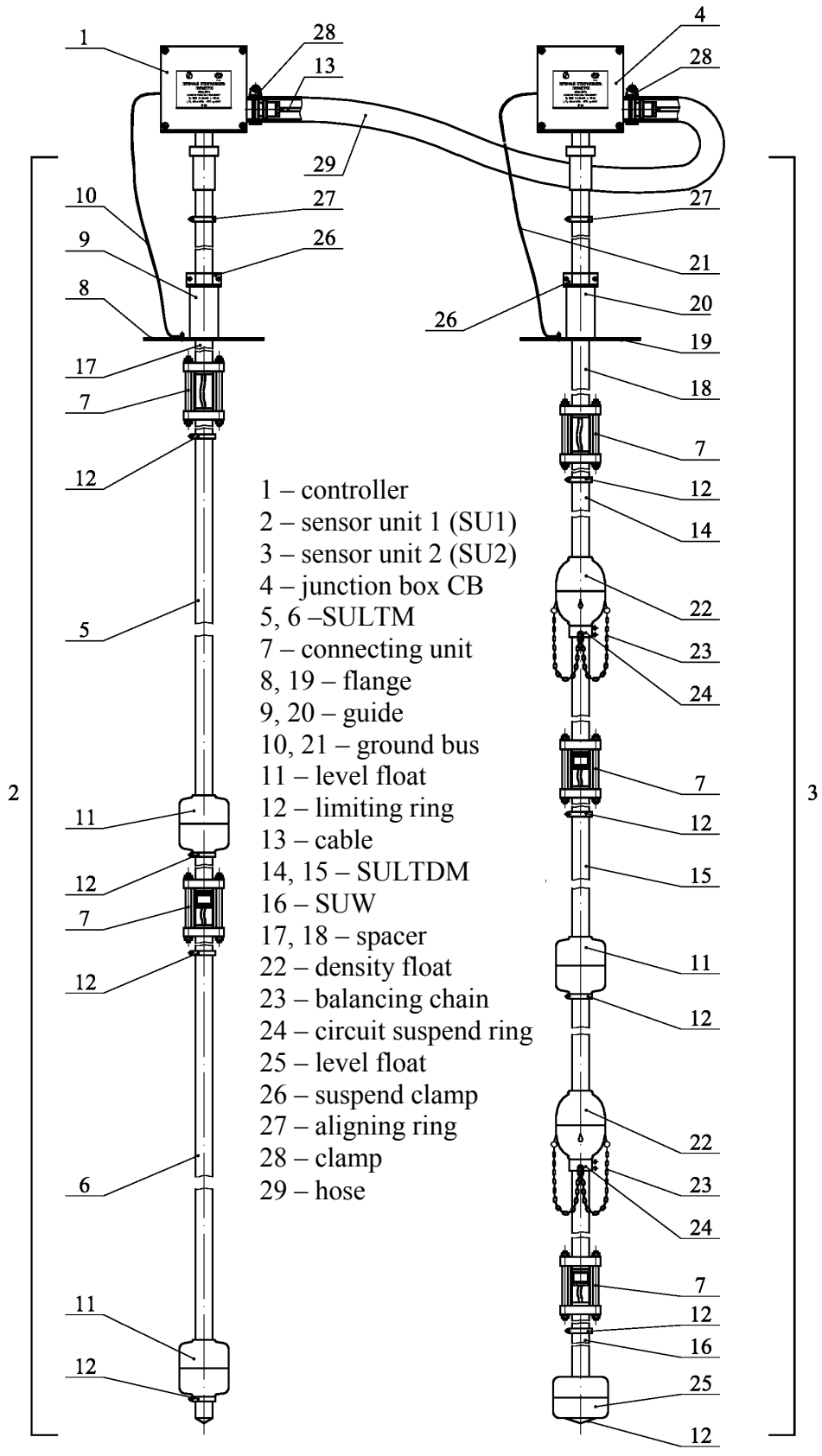


Figure 1.5.1.2.1 – PPR КШЮЕ.407533.002, -01…-05
Cable 13 length is no more than 2000 mm.

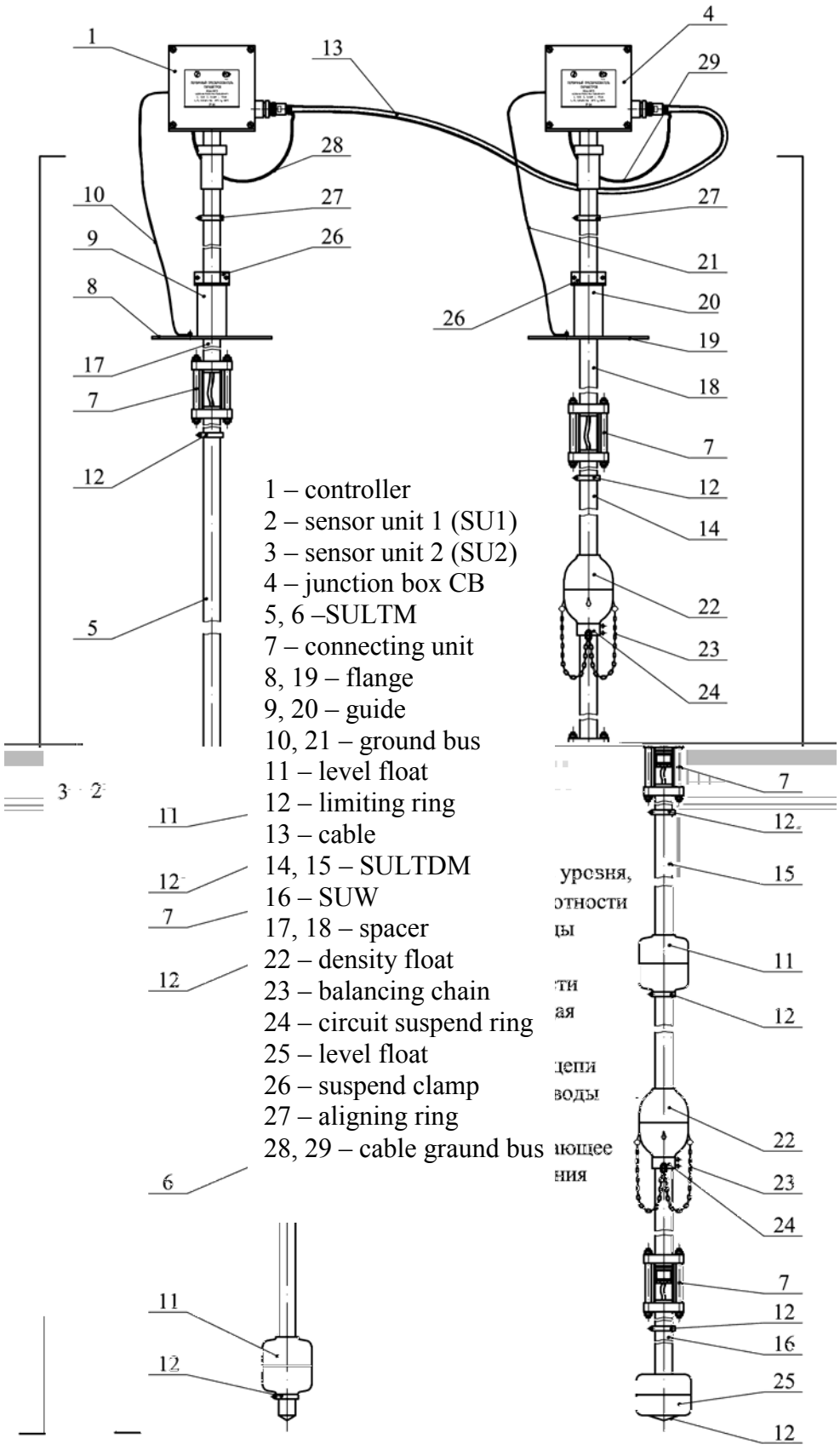


Figure 1.5.1.2.2 – PPR КШЮЕ.407533.002, -01…-05
Cable 13 length from 2000 mm to 10 000 mm.

1.5.1.3 PPR converters in GFS

PPR in GFS are divided in two groups: PPR for single-shell tanks (shown in fig. 1.5.1.3.1, 1.5.1.3.3, 1.5.1.3.5, 1.5.1.3.6, 1.5.1.3.8, 1.5.1.3.9, 1.5.1.3.10), PPR for double-shell tank (shown in fig. 1.5.1.3.2, 1.5.1.3.4, 1.5.1.3.7).

PPR can be equipped with immersion densimeters (up to four pieces).

PrSs may be installed on PPR flanges for measuring pressure inside the tank. PrS is connected with PPR in parallel thus it is not neccessary to have a separate cable for PrS.

Some PPRs for single-shell tanks (КШИОЕ.407533.003 - 07, - 08, - 09) differ by availability of protection casing installation with PPR tubes as an internal unit. Such structure allows doing routine maintenance of tubes without depressurization.

PPR for double-shell tanks differ from the single-shell ones by the fact that PPR pipes and flanges are double-shell.

Common principles of liquid level, density and temperature measurement are described in par. 1.5.1.1 and the pressure measurement in par. 1.5.1.7.

1.5.1.4 PPR converters for TC

PPR КШИОЕ.407533.004 (figure 1.5.1.4.1) is intended for tanks calibration filled up to 4 000mm. It consists of controller 1 and SULTM 2. PPR is mounted on a tank by flange 3 with guide 4. The controller and flange 3 are joined by ground bus 5. Level float 6 travels along SULTM tube. Upper point of traveling is limited by limiting ring 7. Lower part of SULTM tube ends with tipper 8 fixing low float position. Level and density measurement principles are desribed in par. 1.5.1.1. PPR main feature is a special level float form of level 6 that allows to measure the lowest measurement range limit equal to 10 mm.

PPR КШИОЕ.407533.004-01 (figure 1.5.1.4.2) is intended for calibration of tank filled up to 9 000mm level. PPR consists of controller 1, SULTM 2,3, JB 4, cable 5. SULTM 2 and controller 1 are tightly joined together and installed on a tank by flange 6 with guide 7 and fixation 8. Level float 9 travels along SULTM tube; float travel is limited by ring 10 in the top, and cap 11 in the bottom. Flange 6 is connected with a controller by ground bus 12.

SULTM 3 and CB 4 are connected by joining unit 13 with spacer 14. Spacer 14 and flange 15 with guide 16 are joined together for the installation on a tank. CB 4 and flange 15 are joined by ground bus 12. Level float 9 travels along SULTM tube 3; float travel is limited by ring 10 at the top and cap 11 in the bottom.

Level and temperature measurement principles for SULTM 2, 3 are similar to par. 1.5.1.1.

The level measurement in range from 10 mm to 9 000 mm is done the following way: at the level measurement from 10 mm to 4 500 mm the level is changed by SULTM 3, when float reachs ring 10, the controller is switched to SULTM 2 and begins measurement in range from 4 500 mm till 9 000 mm. SULTM 2 is put in the certain position from SULTM 3 for the right measurement by fixation 8.

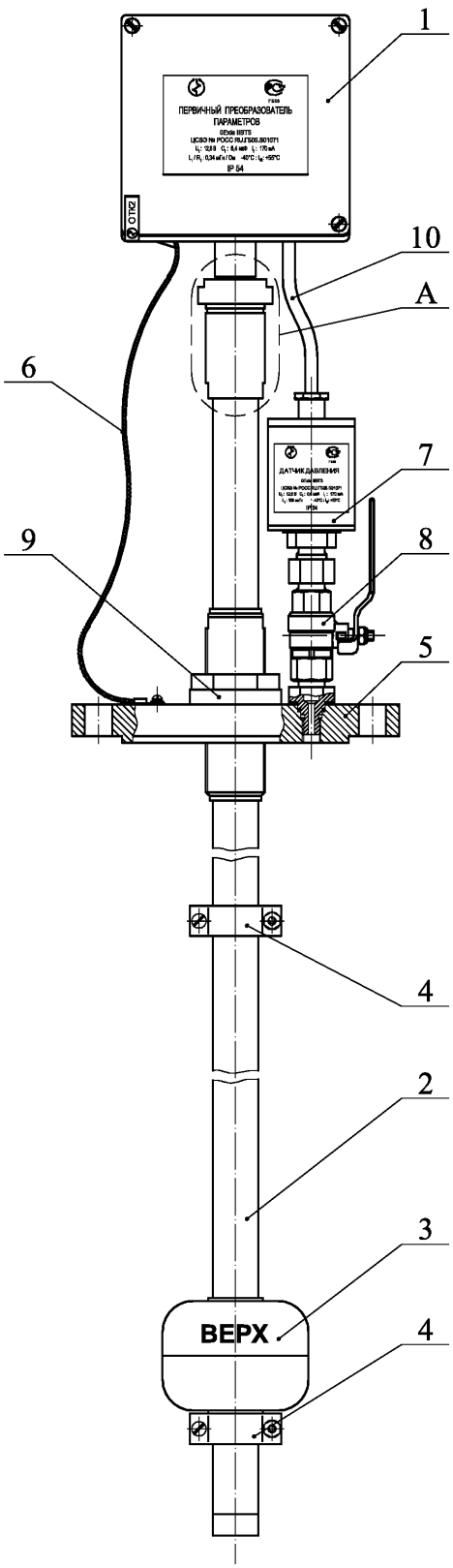
1.5.1.5 PPR converter for CFL

PPR is intended for use in food and corrosion liquid. The device is sanitary certificated. Parts of PPR are made of stainless steel 12X18H10T.

PPR КШИОЕ.407533.005 (figure 1.5.1.5.1) is not equiped with densimeters and AWL. Fluoroplastic is used in sealing units.

PPR КШИОЕ.407533.005-01 contains immersion densimeters.

Level, density and temperature measurment principles are described in par. 1.5.1.1.



1 – controller
2 – SULTM
3 – level float
4 – limiting clamp
5 – flange
6 – ground bus
7 – PrS
8 – shut-off valve
9 – lock-nut
10 – cable
A – connecting unit of controller and SULTM

Figure 1.5.1.3.1 – PPR КШЮЕ.407533.003

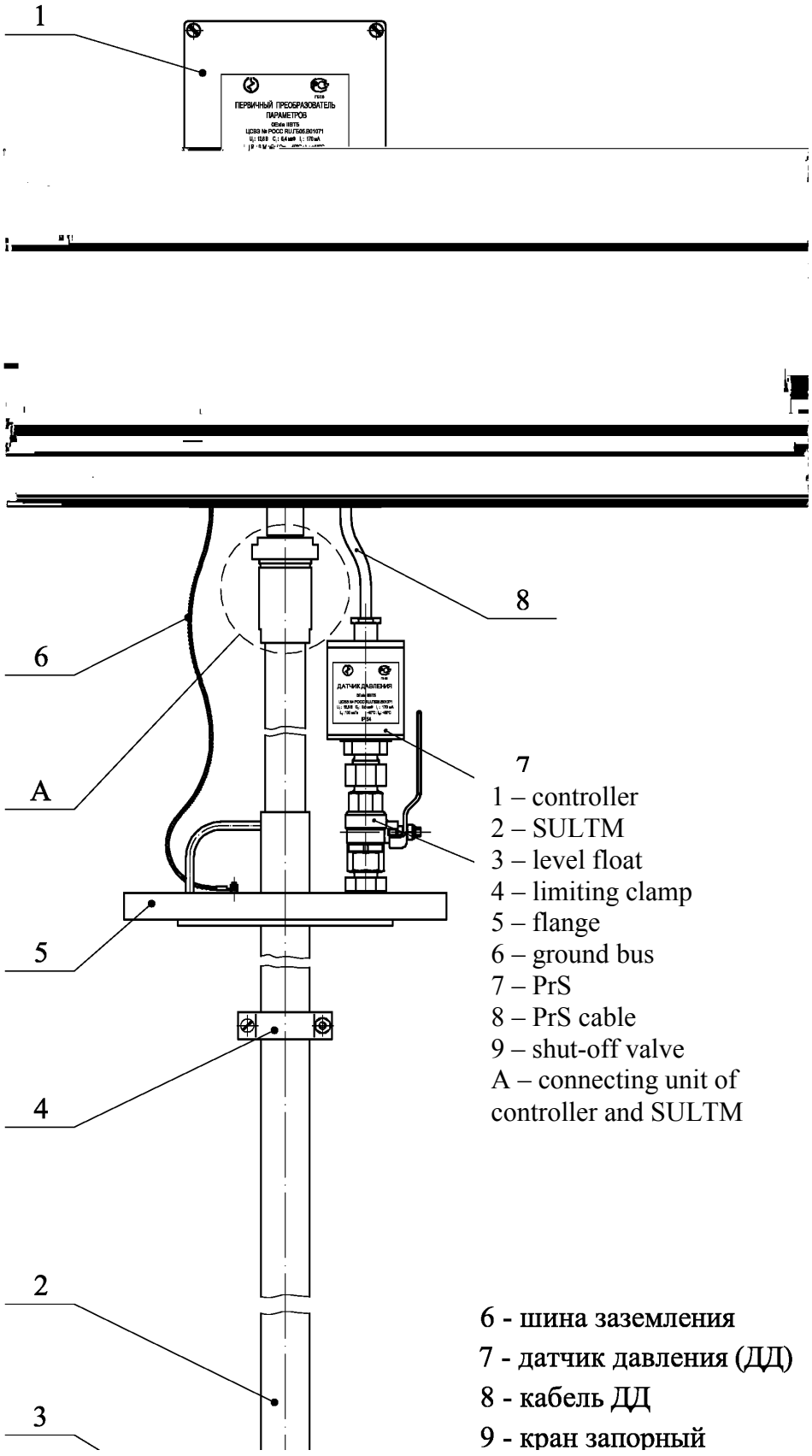
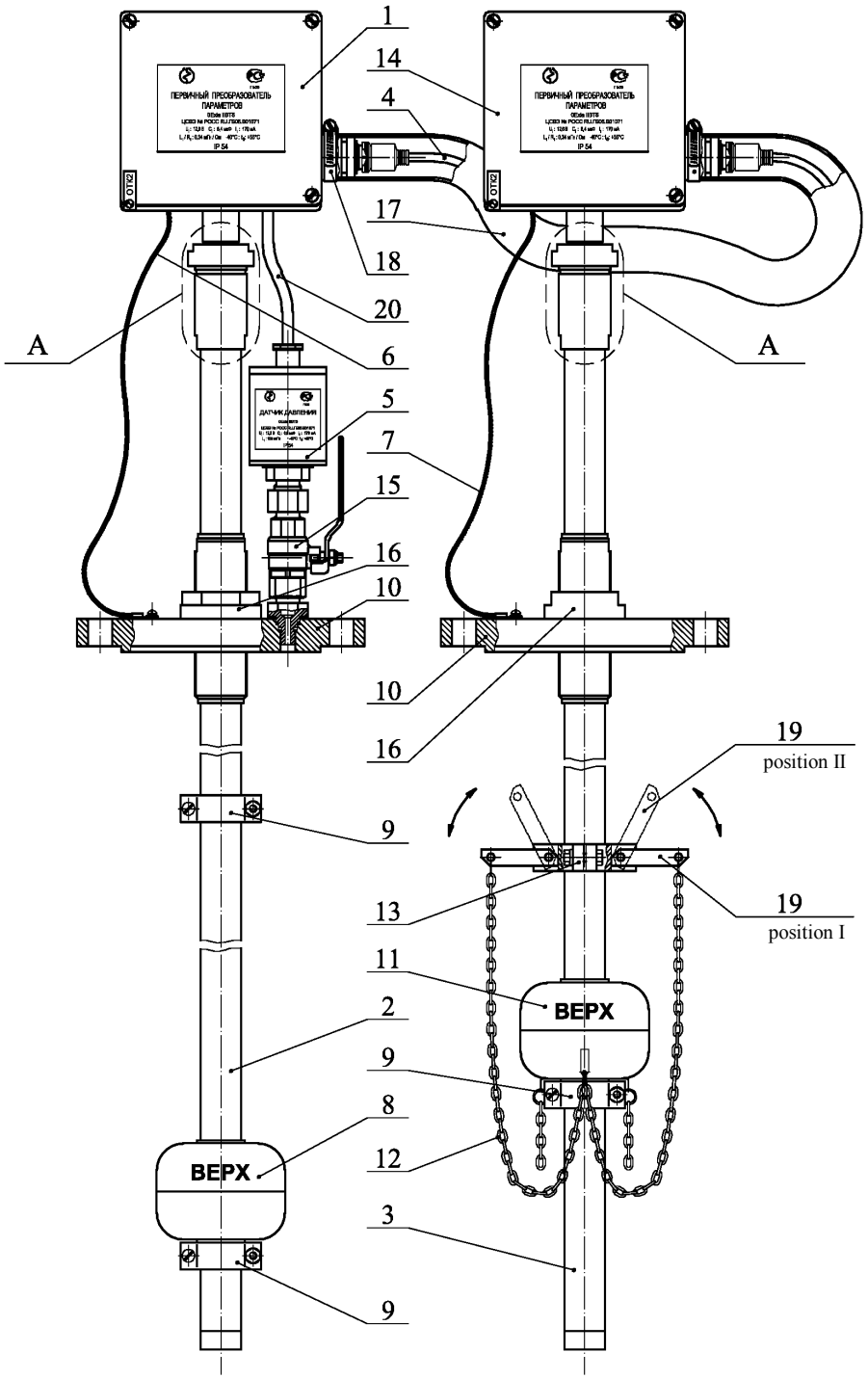


Figure 1.5.1.3.2 – PPR КШЮЕ.407533.003-01



1 – controller
2 – SULTM
3 – SUDM
4 – cable
5 – PrS
6, 7 – ground bus
8 – level float
9 – limiting clamp
10 – flange
11 – density float
12 – balancing chains
13 – chain fixing unit
14 – CB
15 – shut-off valve
16 – lock-nut
17 – hose
18 – clamp
19 – board
20 – PrS cable
A – connecting unit of controller and SULTM (CB and SUDM as well)

Figure 1.5.1.3.3 – PPR КШЮЕ.407533.003-02.
Cable 4 length is no more than 2000 mm.

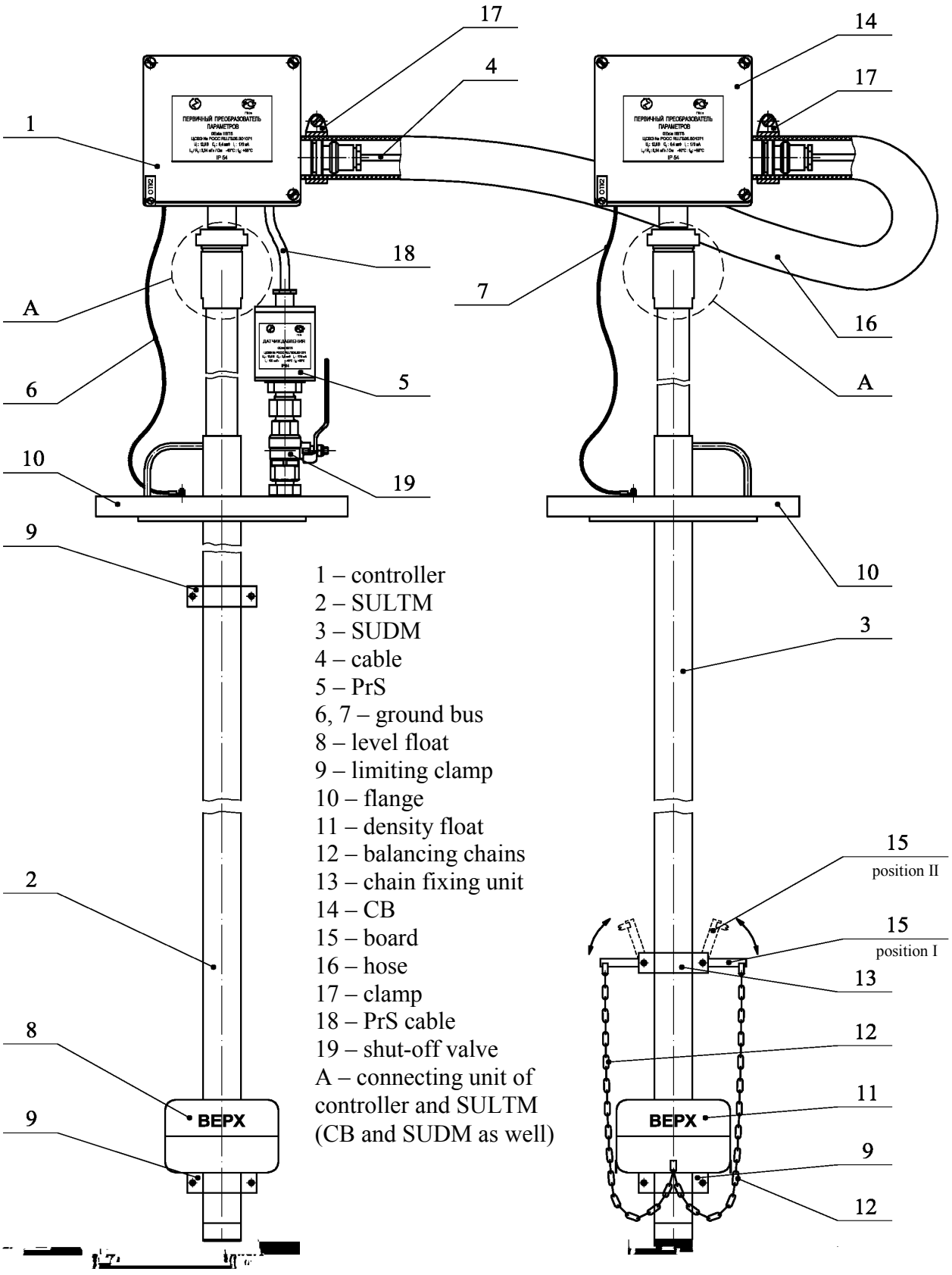
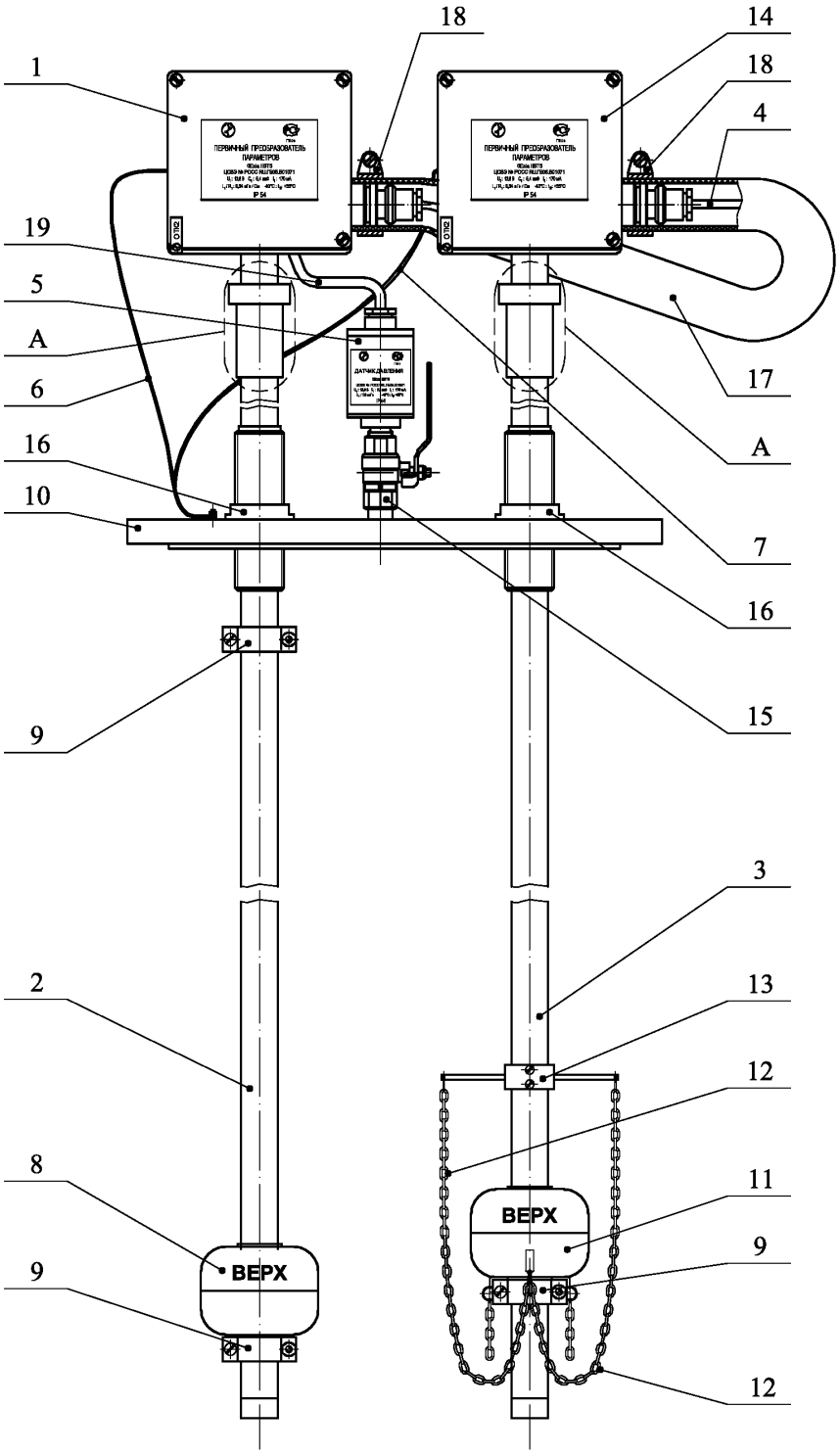
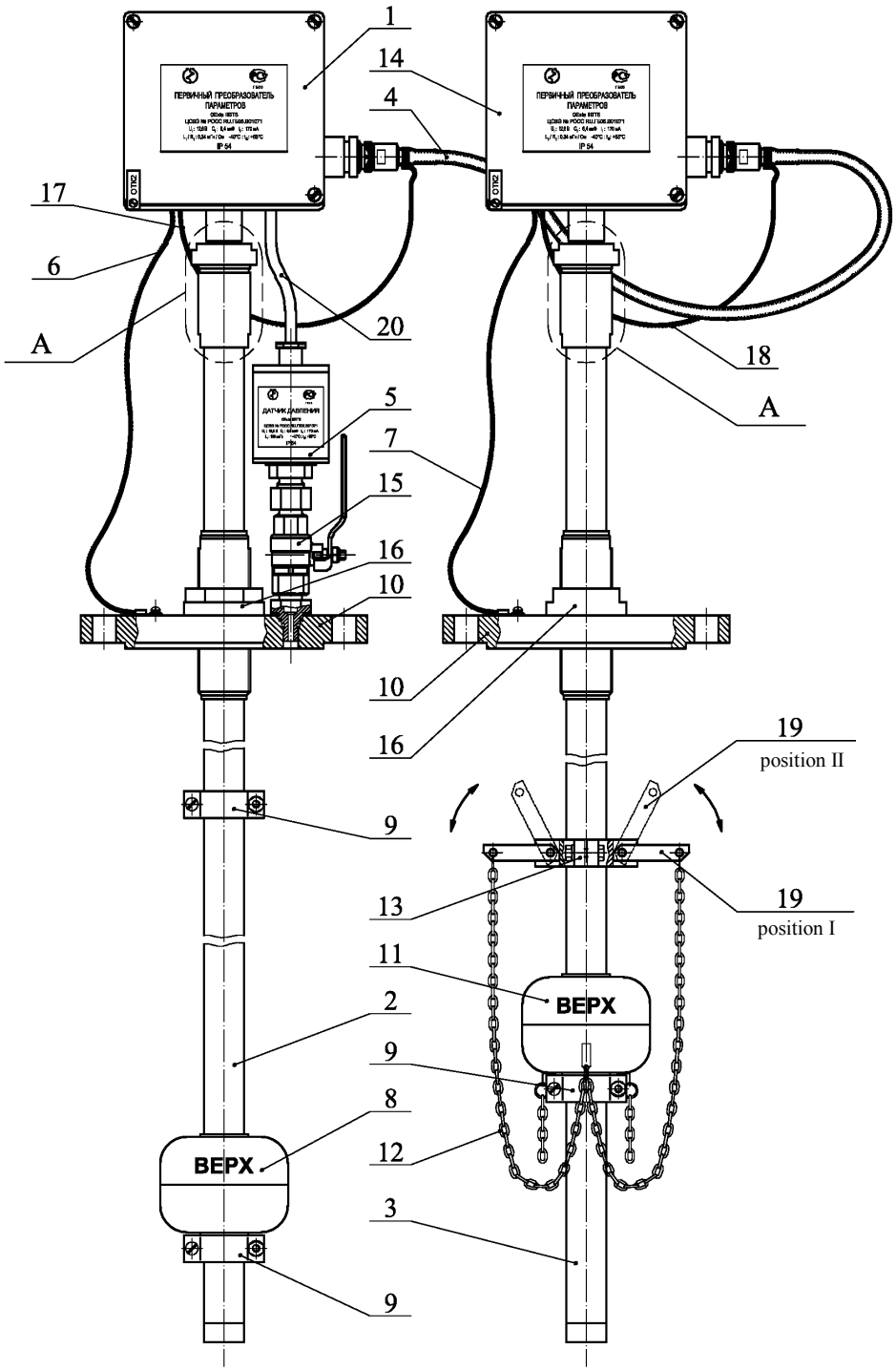


Figure 1.5.1.3.4 – PPR КШЮЕ.407533.003-03
Cable 4 length is no more than 2000 mm.



1 – controller
2 – SULTM
3 – SUDM
4 – cable
5 – PrS
6, 7 – ground bus
8 – level float
9 – limiting clamp
10 – flange
11 – density float
12 – balancing chains
13 – chain fixing unit (for convenience it is turned on 90°)
14 – CB
15 – shut-off valve
16 – lock-nut
17 – hose
18 – clamp
19 – PrS cable
A – connecting unit of controller and SULTM (CB and SUDM as well)

Figure 1.5.1.3.5 – PPR КШИОЕ.407533.003-04



1 – controller
2 – SULTM
3 – SUDM
4 – cable
5 – PrS
6, 7 – ground bus
8 – level float
9 – limiting clamp
10 – flange
11 – density float
12 – balancing chains
13 – chain fixing unit
14 – CB
15 – shut-off valve
16 – lock-nut
17, 18 – cable ground bus
19 – board
20 – PrS cable
A – connecting unit of controller and SULTM (CB and SUDM as well)

Figure 1.5.1.3.6 – PPR КШИОЕ.407533.003-05.
Cable 4 length from 2 000 mm to 10 000 mm.

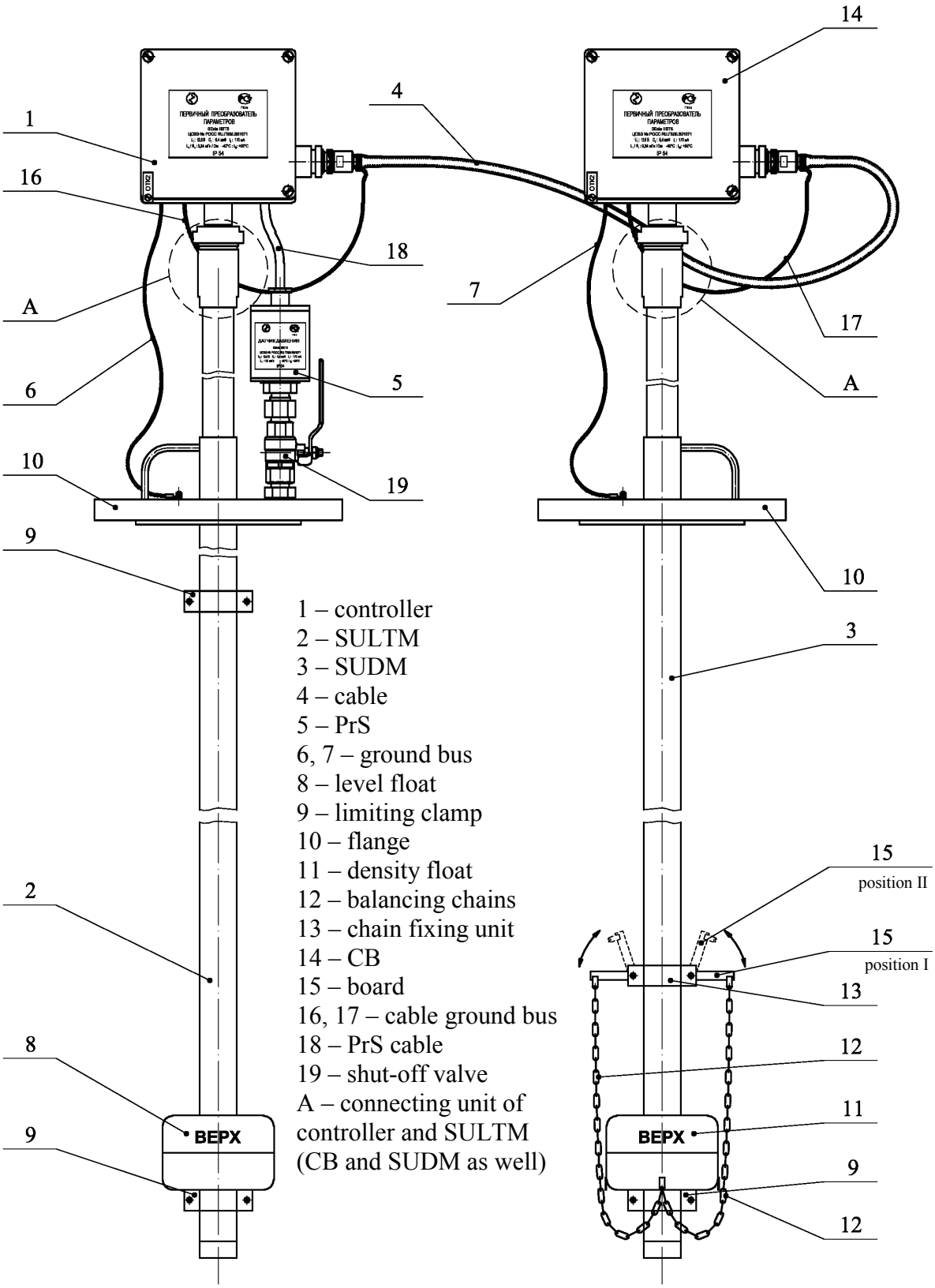
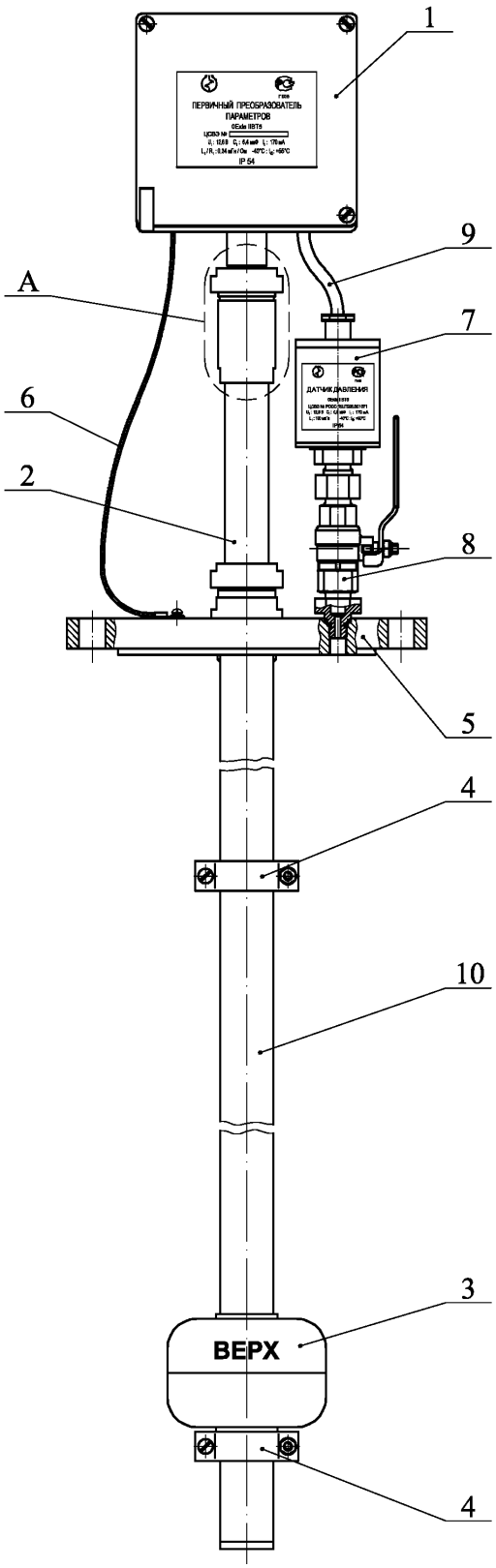
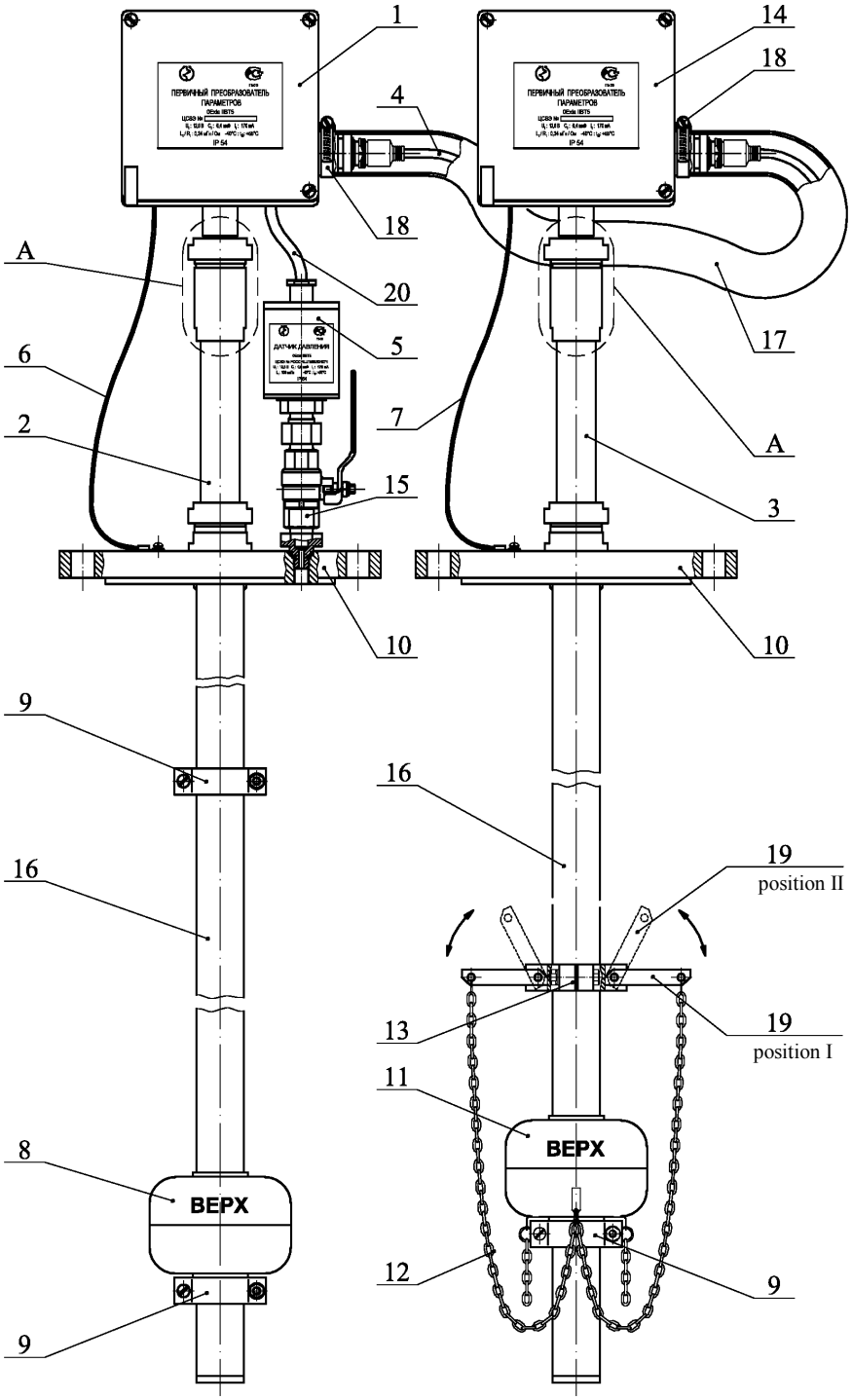


Figure 1.5.1.3.7– PPR КШЮЕ.407533.003-06
Cable 4 length from 2 000 mm to 10 000 mm.



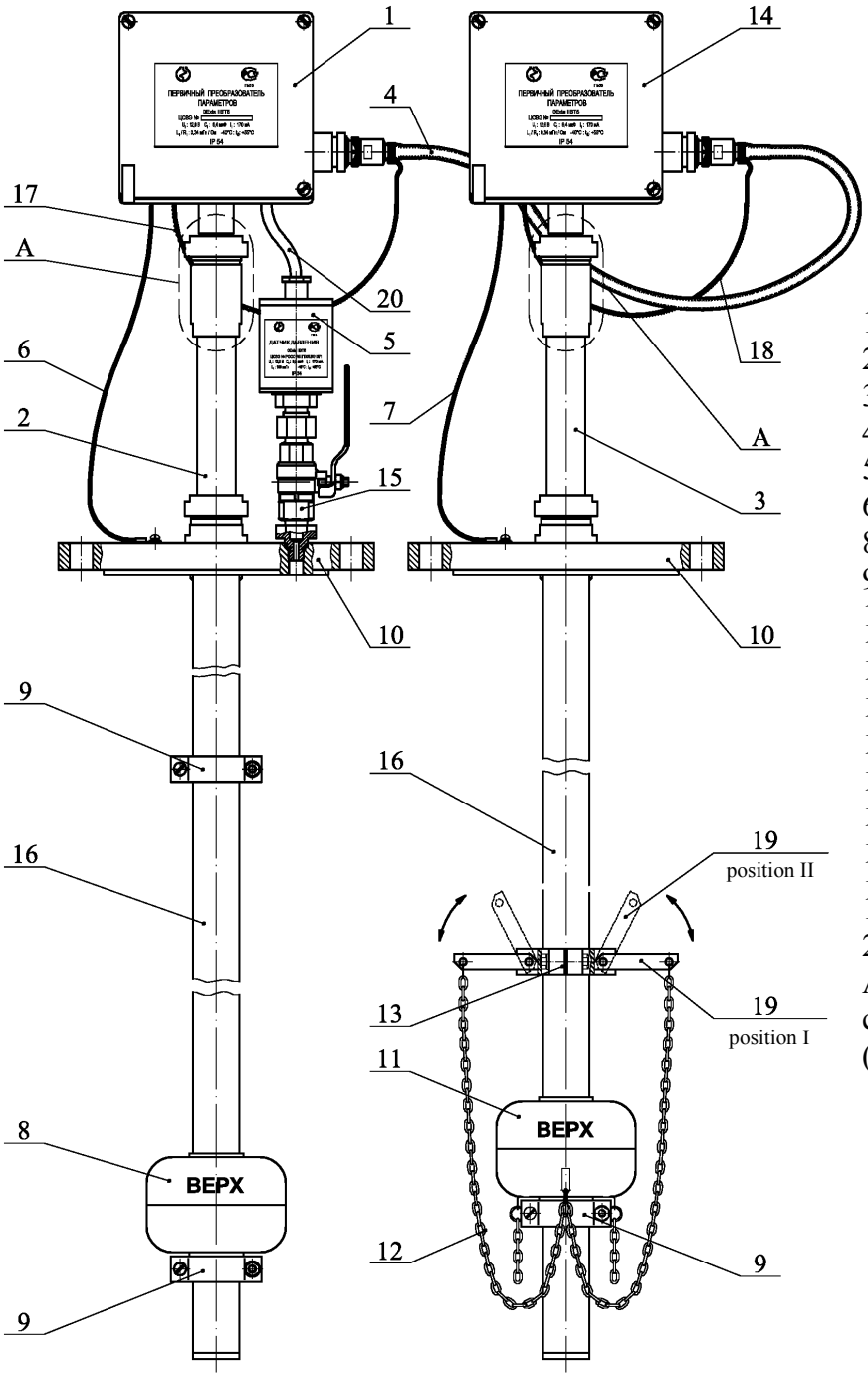
1 – controller
2 – SULTM
3 – level float
4 – limiting clamp
5 – flange
6 – ground bus
7 – PrS
8 – shut-off valve
9 – cable
10 – protective casing
A – connecting unit of controller and SULTM

Figure 1.5.1.3.8 – PPR КШЮЕ.407533.003-07



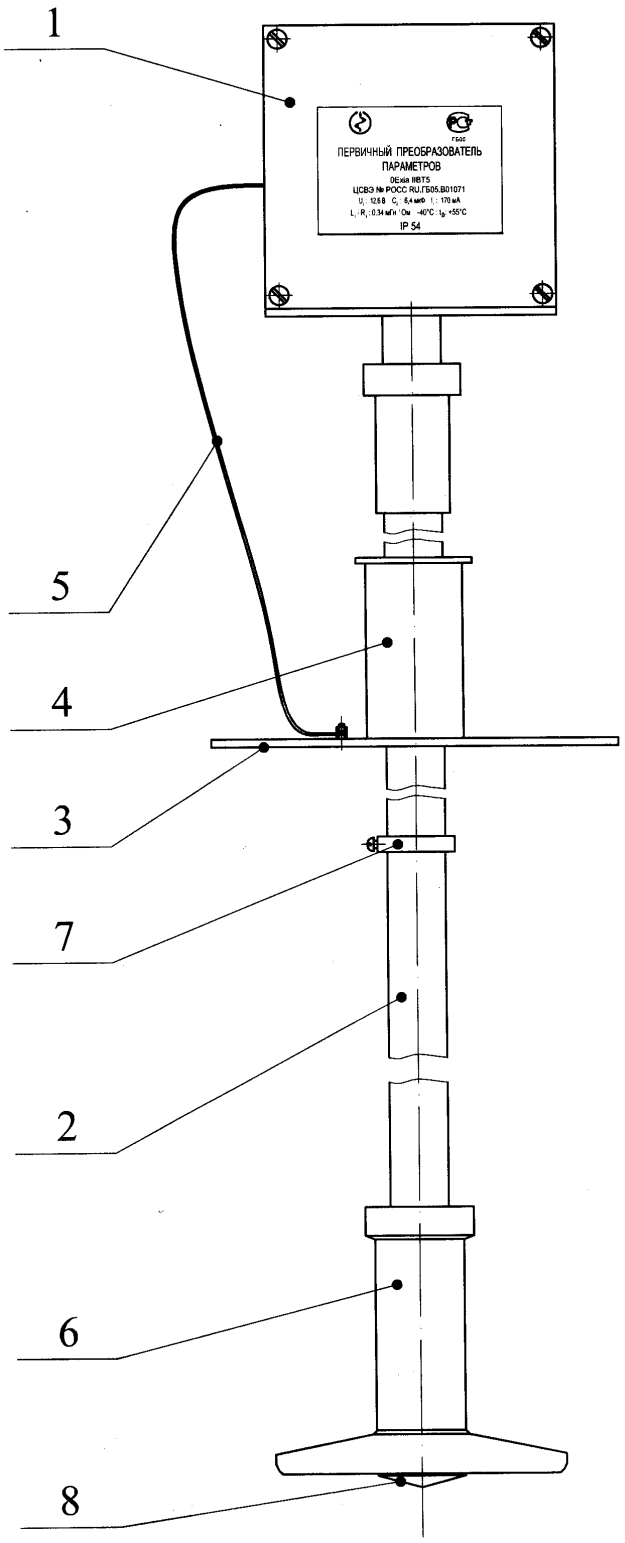
1 – controller
2 – SULTM
3 – SUDM
4 – cable
5 – PrS
6, 7 – ground bus
8 – level float
9 – limiting clamp
10 – flange
11 – density float
12 – balancing chains
13 – chain fixing unit
14 – CB
15 – shut-off valve
16 – protective casing
17 – hose
18 – clamp
19 – board
20 – PrS cable
A – connecting unit of controller and SULTM (CB and SUDM as well)

Figure 1.5.1.3.9 – PPR КШИОЕ.407533.003-08
Cable 4 length is no more than 2 000 mm.



1 – controller
2 – SULTM
3 – SUDM
4 – cable
5 – PrS
6, 7 – ground bus
8 – level float
9 – limiting clamp
10 – flange
11 – density float
12 – balancing chains
13 – chain fixing unit
14 – CB
15 – shut-off valve
16 – protective casing
17, 18 – cable ground bus
19 – board
20 – PrS cable
A – connecting unit of controller and SULTM (CB and SUDM as well)

Figure 1.5.1.3.10 – PPR КШЮЕ.407533.003-09.
Cable 4 length from 2 000 mm to 10 000 mm.



1 – controller

2 – SULTM

3 – flange

4 – guide

5 – ground bus

6 – level float

7 – limiting ring

8 – tip

Figure 1.5.1.4.1 – PPR КШИОЕ.407533.004

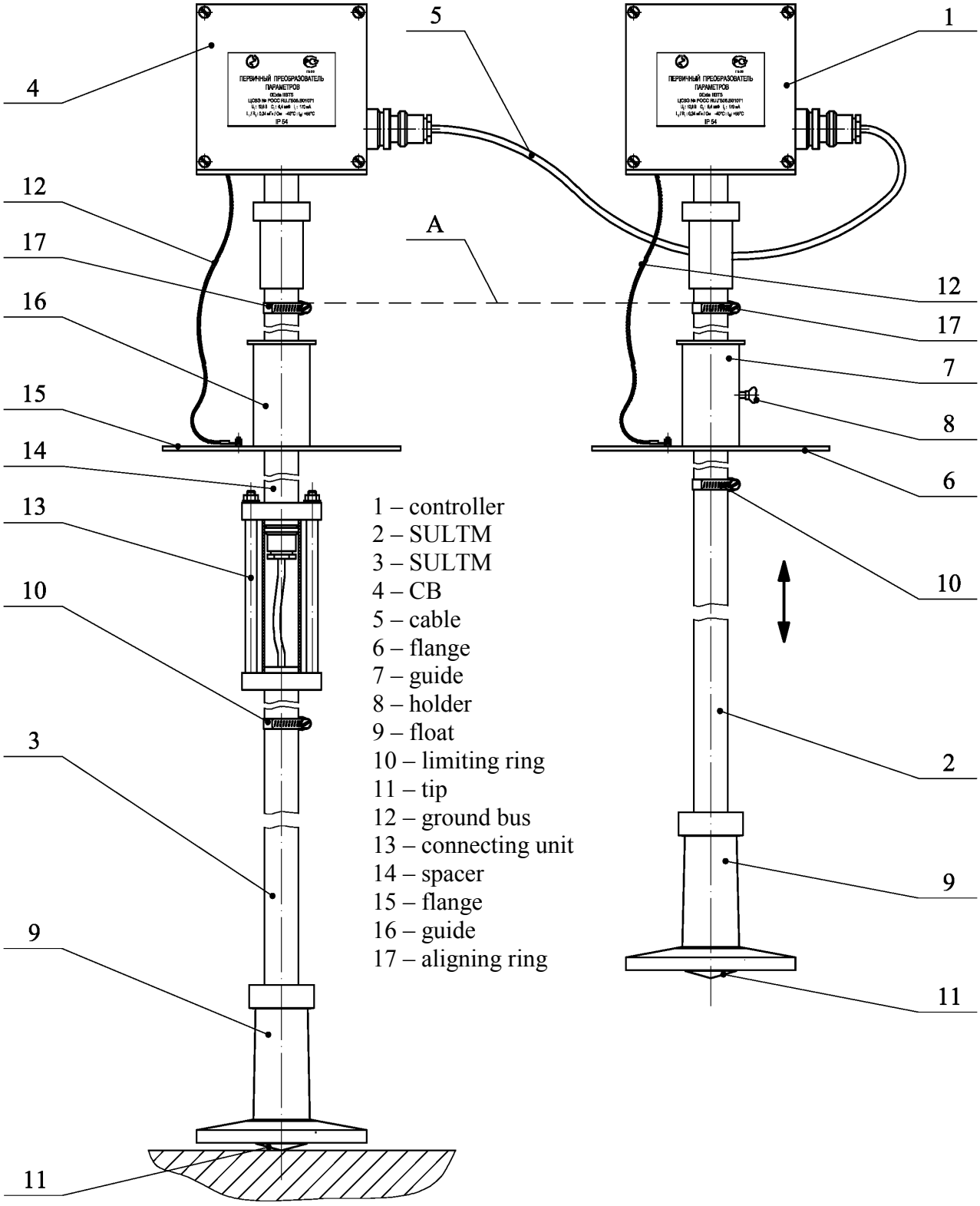
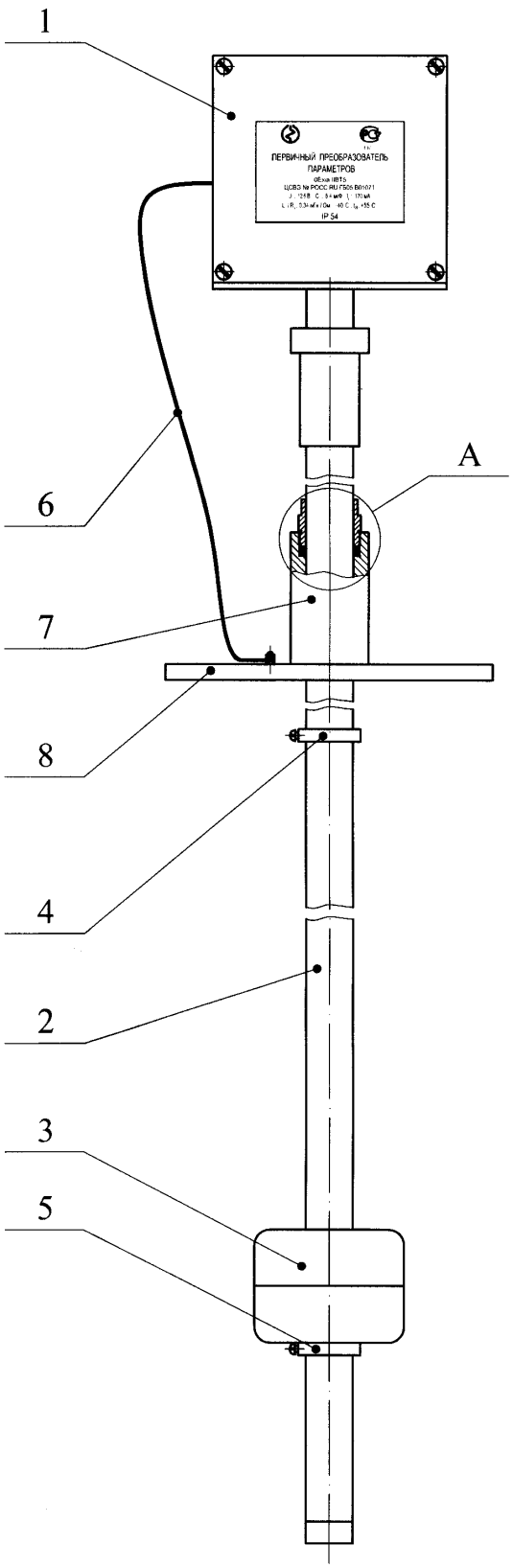
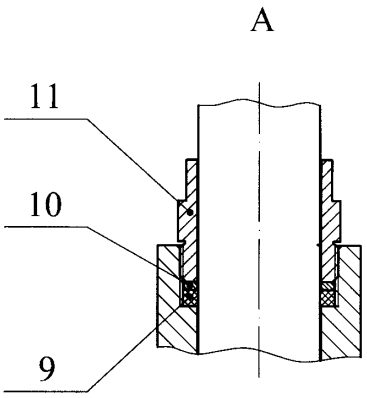


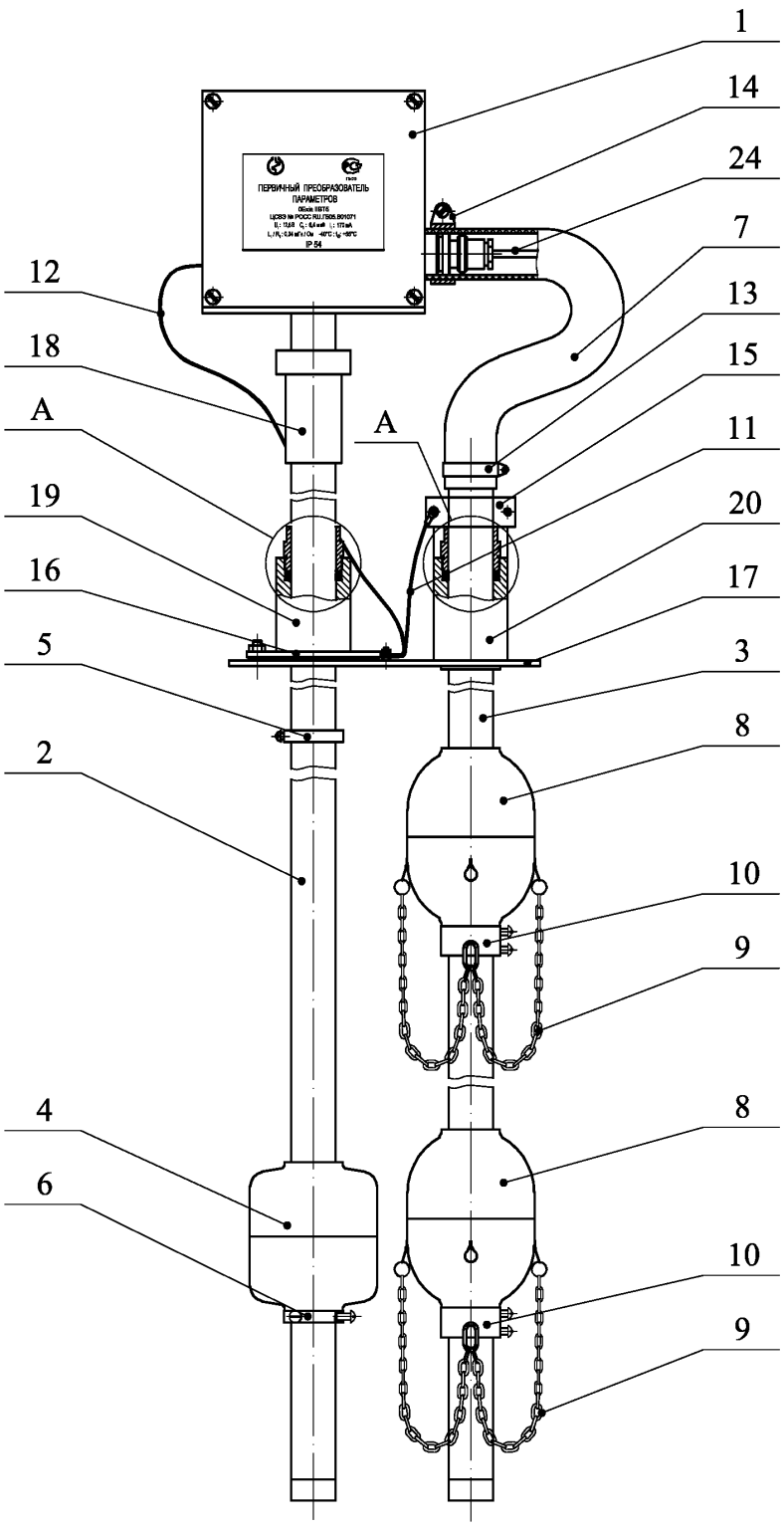
Figure 1.5.1.4.2 – PPR КШЮЕ.407533.004-01



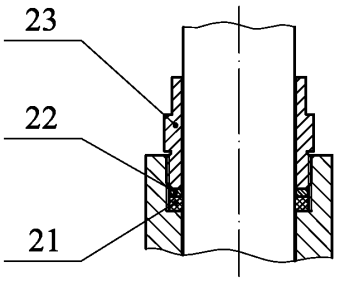


1 – controller
2 – SULTM
3 – float
4 – upper limiting ring
5 – lower limiting ring
6 – ground bus
7 – guide
8 – flange
9 – gasket
10 – ring
11 – bushing

Figure 1.5.1.5.1 – PPR КШИОЕ.407533.005

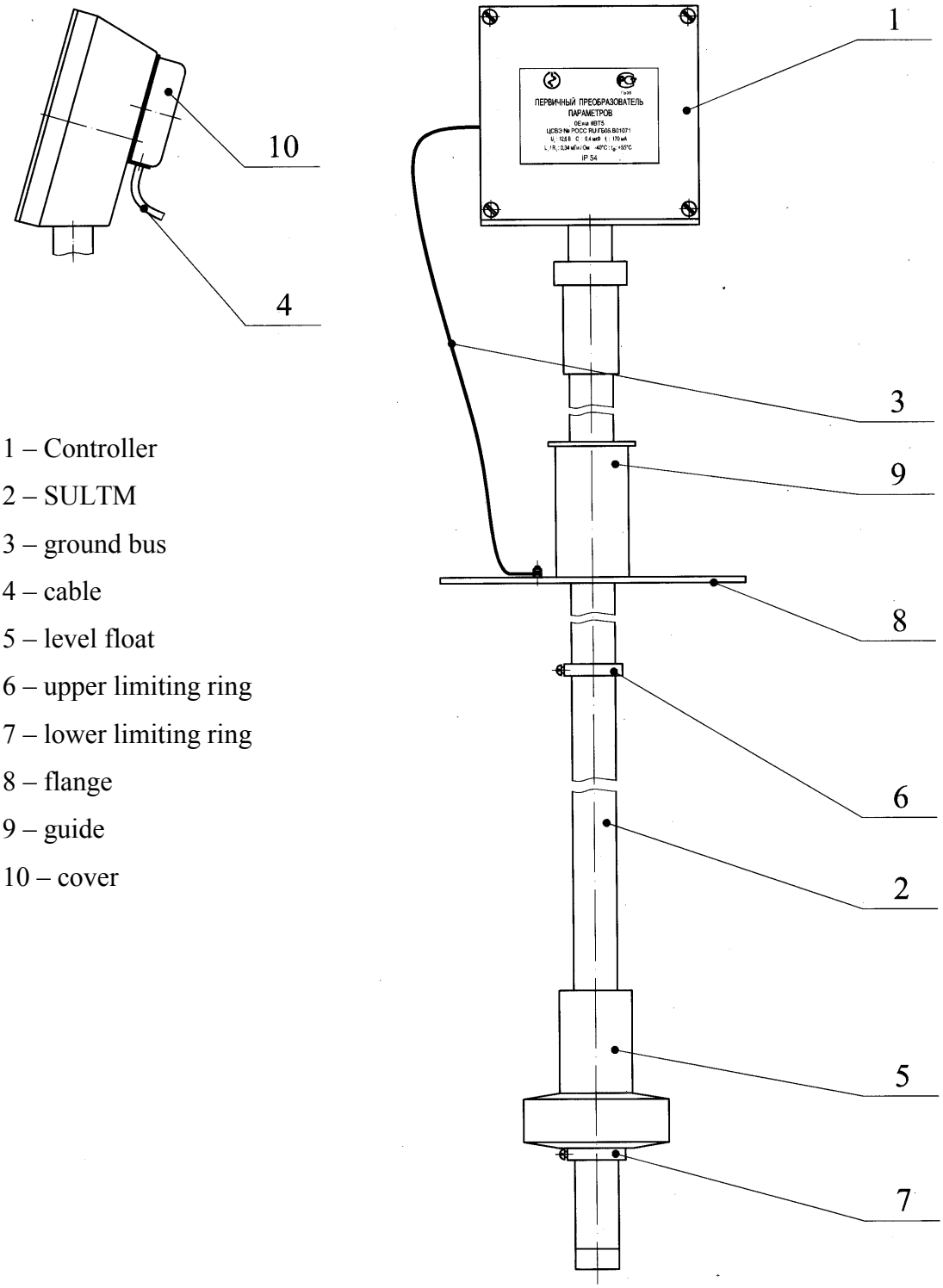


A (2 places)



1 – controller
2 – SULTM
3 – SUDM
4 – level float
5 – upper limiting ring
6 – lower limiting ring
7 – hose
8 – density float
9 – balancing chain
10 – chain fixing ring
11, 12 – ground bus
13, 14 – clamp
15 – grounding clamp
16 – SULTM flange
17 – SUDM flange
18 – connecting unit of controller with SULTM
19 – guide
20 – guide
21 – gasket
22 – ring
23 – bushing
24 – cable

Figure 1.5.1.5.2 – PPR КШЮЕ.407533.005-01



1 – Controller
2 – SULTM
3 – ground bus
4 – cable
5 – level float
6 – upper limiting ring
7 – lower limiting ring
8 – flange
9 – guide
10 – cover

Figure 1.5.1.6.1 – PPR КШИОЕ.407533.006

1.5.1.6 PPR control converter

PPR КШЮЕ.407533.006 (Control) is given in figure 1.5.1.6.1, and is used inside a double-shell expansion tank for liquid level measurement. Level and temperature measurement principles are desribed in par. 1.5.1.1.

1.5.1.7 Pressure sensors PrS

Pressure sensor PrS structure in КШЮЕ.406233.001-02 for connection to PPR (one PrS is connected to PPR controller in parallel) is shown in figure 1.5.1.7.1. Measured pressure is transmitted through nozzle 1 into the working space of pressure reorganizing sensor 2, influences titanium diaphragm 3. Cylinder 4 is hermetically joined to nozzle 1 through bushing 10 and covered by cover 5. The cylinder contains pressure transducer module 6, and commutation module 7 with connector 8 for communication line connection with PPR or JB. PTM 6 and CM 7 are tightly connected at 90 degree angle. Cover 5 has gland seal for connection cable.

The PrS operation is based on the tensoeffect in "silicon on supphire" structures. Measured pressure influences the titanium diaphragm which has a soldered sapphire backing with epitaxial silicon tensoresistors. The diaphragm bends under the measured pressure thus the tensoresistors resistence forming the measuring bridge is changed proportionally. Bridge disbalance transfers PTM into a digital signal (RS-485 interface).

Supply voltage of PT equals to 12 V, current consumption is approximately 5 mA.

PrS КШЮЕ.406233.001-01 is used in group without cable 9. Group of PrS contains up to nine devices and connects to CD channel through JB.

1.5.1.8 Joint box JB

JB КШЮЕ.408845.002 (fig. 1.5.1.8.1) contains a case with glands inserts, circuit board with 10 connecting clamps, resistor divider and overvoltage protection units. Connecting clamps are linked to circuit board in parallel. The resistor divider provides normal operation of RS-485 interface, used for connecting PrS and CD.

1 – nozzle
2 – primary pressure reorganising sensor
3 – diaphragm
4 – cylinder
5 – cover
6 – PTM
7 – ComM
8 – clip
9 – cable
10 – bushing
11 – marker
12 – display

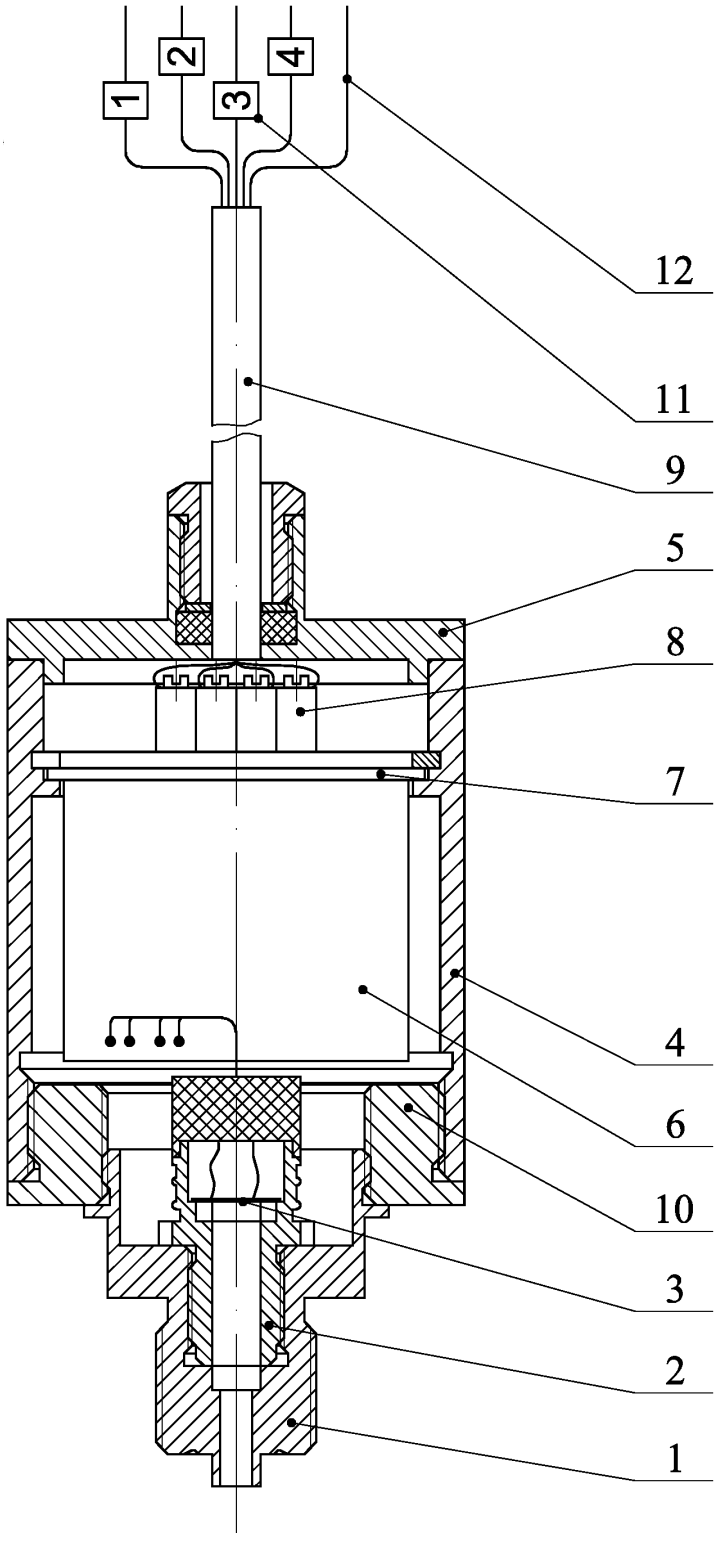


Figure 1.5.1.7.1 – PrS КШИОЕ.406233.001-02

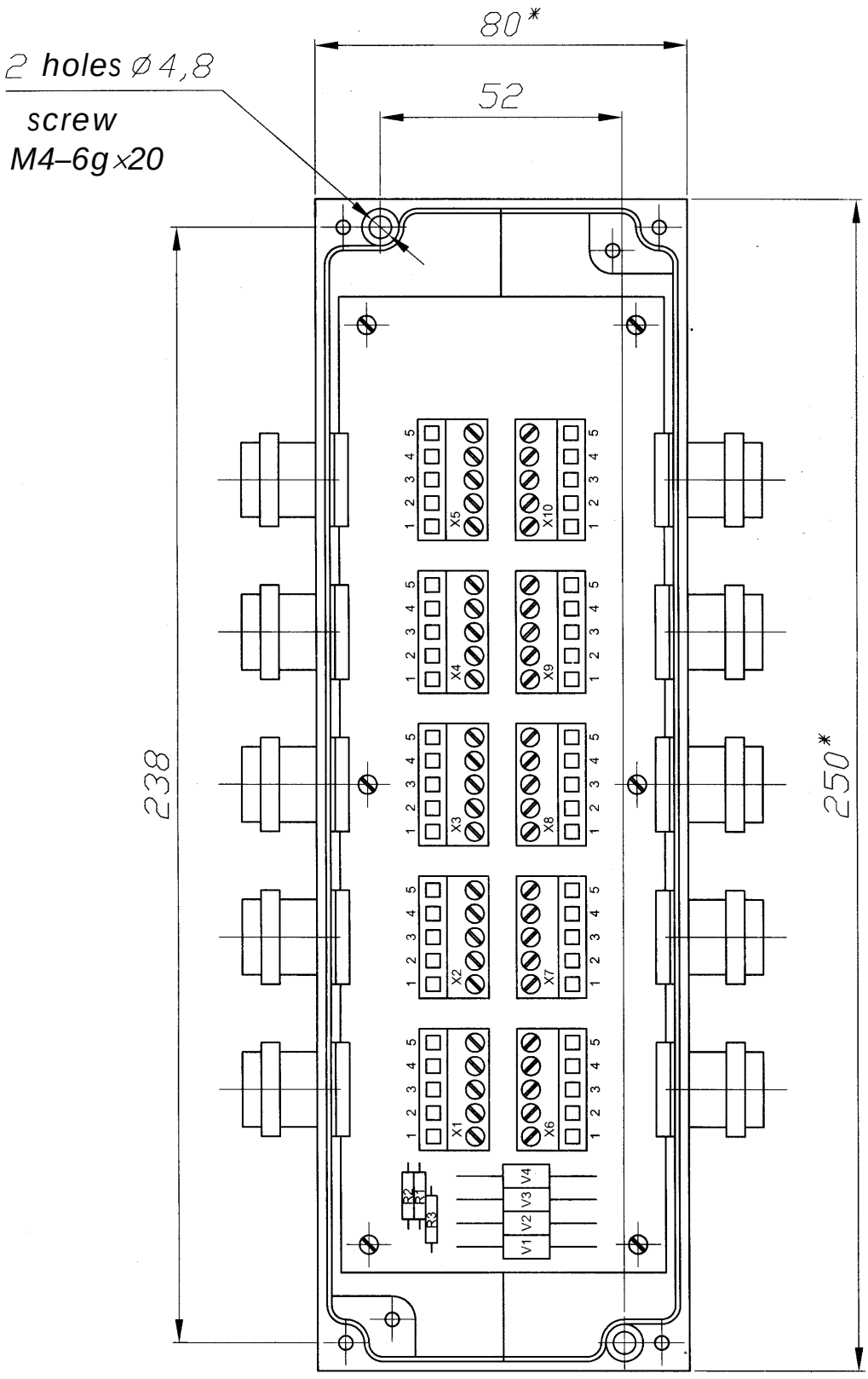


Figure 1.5.1.8.1 – ЈВ КШЮЕ.408845.002

1.5.2 Structure and operation of the central unit

1.5.2.1 Computing device CD

The computing device is a block of computing unit CU, power supply unit PSU, junction box JB, interface block IB1.

CU provides collection of measurement data from PPR and from PrS and data processing with output on displaying devices (such as IU, PC). CU initializes exterior devices control (pump, light and sound alarm) basing on input data received from CM. CU tests its own hardware operation and collects results of other units internal testing. Test results can be shown on displaying devices.

A structural diagram of computing unit is shown in figure 1.5.2.1.1

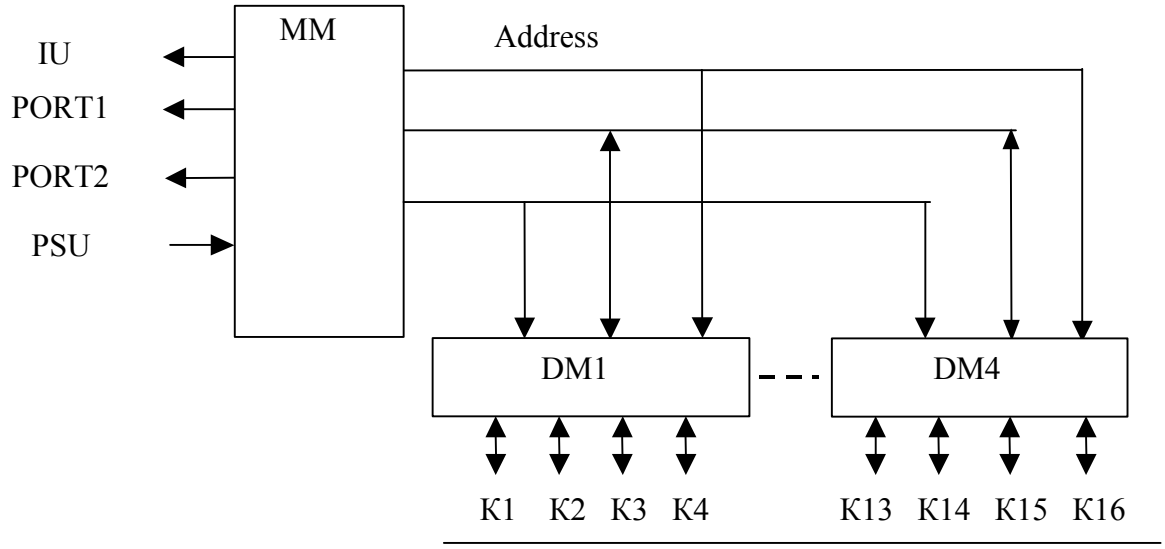


Figure 1.5.2.1.1

CU contains: MM and from one to four distributing modules DM. All parts are linked by bus 6, which consists of address bus, data bus and supply circuit. MM forms an address bus, which consists of DM selecting circuits and channel selecting circuits inside DM. The DM is positioned on the address bus by internal crossing.

Data bus is a multiplex bidirectional asynchronous sequential channel. The channel is linked to a microchip port at one side. At the other side the channel is connected to K1 - K16 channels through multiplexers, an optocoupler and RS-485 generators.

The MM contains an interface port of “current-loop” type for connection with IU, RS-232 (PORT 1) socket with galvanic insulation for PC connection and RS-485 (PORT 2) for CM connection. Ports are protected from overvoltage in the lines.

The Computing unit port is connected with a PSU through a socket in the MM. The Computing unit consumes +5 V, +27 V of stabilized voltage and + 10 V of non-stabilized voltage.

+5 V voltage is used for power supply of MM computing devices and linking circuits with the DM. Power supply of "Port 1" and "Port 2" interfaces is done through a DC/DC converter.

+10 v voltage is transmitted to IU by the IU socket.

+27 V voltage provides intrinsically safe power supply of + 12 V K1...K16 channels.

1.5.2.2 Power Supply Unit (PSU)

The power supply of the PSU is provided from the AC circuit with voltage 220^{+22}_{-33} V and frequency (50 ±1) Hz. The consumption current must be below 0.6 A. The power supply circuits are protected with fuses.

The PSU outputs:

- stabilized voltage +(5±0.25) V with pulse amplitude at the output no more than 15 mV;
- stabilized voltages +(27 ± 1) V with pulse amplitude at the output no more than 15 mV;
- non-stabilized voltages +(10.5 ± 3) V with pulse amplitude at the output no more than 15 mV.

1.5.2.3 Interface block (IB 1)

The IB1 synchronizes RS-232 of CU (PORT1) and RS-485 line. The unit is supplied from the connection circuits with the CU.

Output of the IB1 is adjusted by DIP-switches. DIP-switches define a connection mode type (2 or 4) and connect circuits. Adjustment options:

– RS-485, four cables link, intermediate device in the power circuit;
– RS-485, four cables link, terminal device in the power circuit;
– RS-422, four cables link;
– RS-485, two cables link, intermediate device in the power circuit;
– RS-485, two cables link, terminal device in the power circuit.

Please refer to КШЮЕ.421451.001ИМ for details of the IU 1 adjustment.

1.5.2.4 Indicating unit (IU)

The IU is intended for providing connection between an operator and information display on a two-string sixteen-digital indicator and for sound alarm signals transmission.

The IU structural diagram is given in figure 1.5.2.4.1. The IU is operated in the mode of constant information display and periodically requires data from the CU.

The IU push-buttons serve for changing the displayed data type. Button-pushing is accompanied with a sound signal. Please refer to the Operator's manuals КШЮЕ.421451.001 РО1 and КШЮЕ.421451.001РО3 for the complete description of compliance of the button pushed and the data displayed and on the IU.

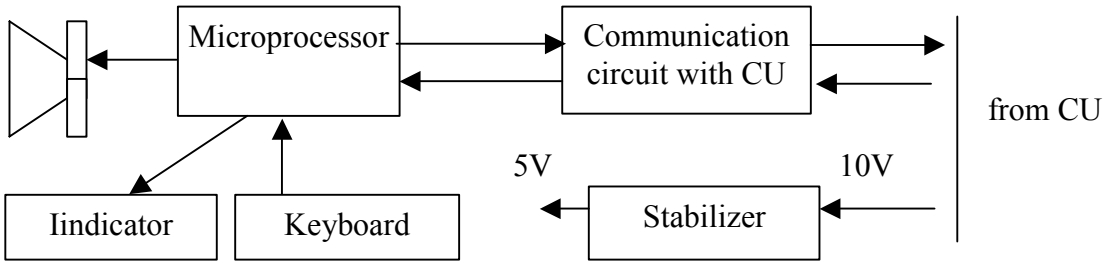


Figure 1.5.2.4.1

1.5.2.5 Control module (CM)

Structure of the CM is given in figure 1.5.2.5.1

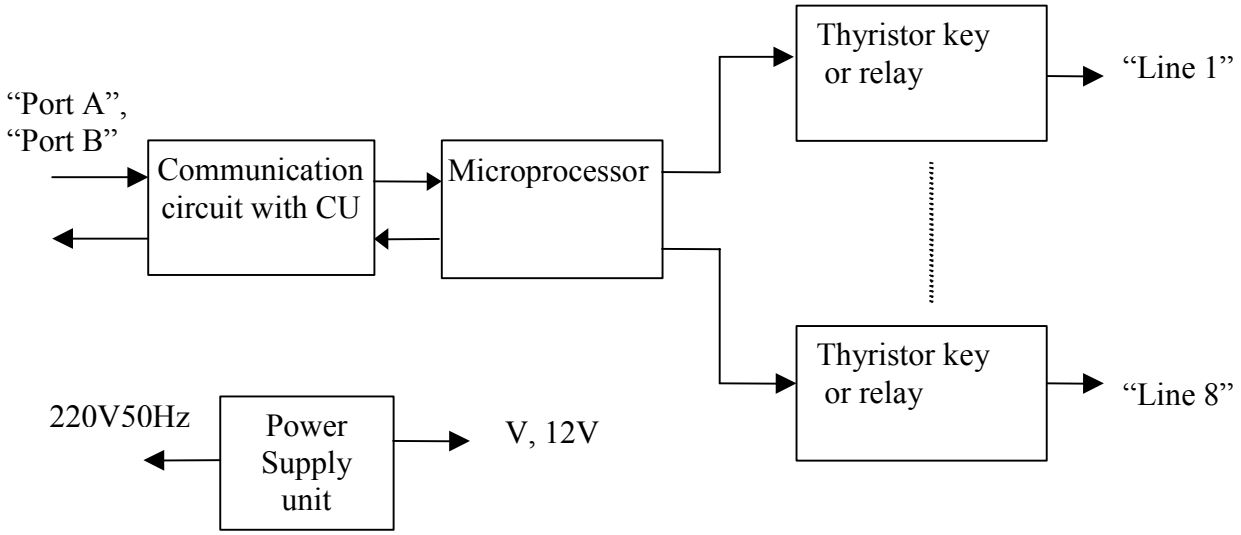


Figure 1.5.2.5.1

The CU is fed from AC 220 V, 50 Hz power circuit. The PSU gives stabilized voltages 5V and 12V at the output.

The CU with the CD connection is provided by "Port A", "Port B" connection clamps that are connected in parallel. Connection interface – RS-485, semiduplex. Each CU in the system shall have a unique net address determined by an internal cross-connection. Units are labelled as "Section XX" where XX is a unit number in system.

The CU has from one up to eight outputs of peripheral control channels.

Control Outputs options are the following:

AC 0,5	Swithing Thyristor key on AC 220V 50 Hz. with load current from 0.1 till 0.5A;
AC 0,1	AC voltage Switching relay for AC 220V 50 Hz with load current from 0.01 till 0.1A ;
DC 0,5	DC 0.5 DC Swithing relay for 27 V voltage with 0.5 A load current. DC 0.5 output differs from AC0.1 by spark-capacitors.

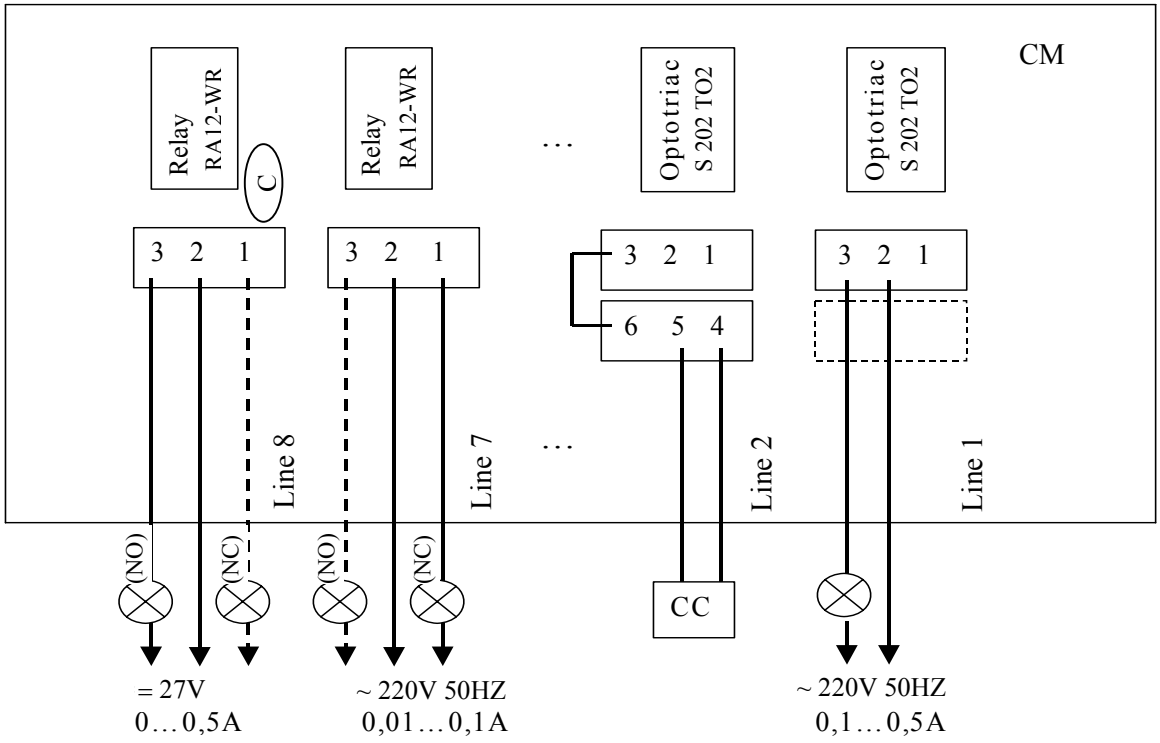
Connection of controls to the PSU is done through clamp connectors "Line 1"... "Line 8"(figure 1.5.2.5.2). Examples of few connecting options:

a.) Line 1- connection of controls to 220 V 50 Hz external power source and 0.1...0.5A current consumption to the CU output of AC 0.5 type;

b.) Line 2- connection of alarm to the AC 0.5 CM (contacts 3-6 are connected by an intersection);

c.) Line 7 - connection of controls to the 220 V 50 Hz external power source and the 0.01…0.1A current consumption to the normally open (NO) contacts of the AC 0.1 CM output;

d.) Line 8 – connection of controls with the external power source of DC up to 27 V and up to 0.5 A consumption current to normally closed (NC) contacts of the DC 0.5 CM output. The output is bridged with a spark capacitor (C).



NO – normally open contact
NC – normally closed contact
CC – alarm connection

Figure 1.5.6.2 – Controls connection options

1.5.2.6 Miscellaneous

1.5.2.6.1 RS-232/USB converter

The RS-232/USB converter provides the connection of the PC and RS-232 device through a USB-port. The RS-232/USB converter with the IB1 connects a CU to a PC through an USB-port with connecting line at a distance up to 100 m (fig. 1.4.1.4.2).

The converter operates together with a PC-loaded software driver that displays a USB-connection to a virtual sequential (COM) port. The Software driver allows an access to the device for the User's program similar to RS-232 port. Converter's power supply is provided from the USB interface.

1.5.2.6.2 RS-485/USB converter.

RS-485/USB converter provides the connection to the PC through USB-port using RS-485 interface. The converter together with the IB1 provides connection of the CU and PC through USB-port at the distance up to 1200 m (fig.1.4.1.4.5).

The Converter is operated together with a software driver. The Software driver allows an access to the device for the User's program similar to RS-232 port. Converter's power supply is provided from the USB interface.

1.5.2.6.3 RS-485/232 converter

RS-485/USB converter synchronizes PC with RS-232 and RS-485 line. Converter as a system together with the IB1 provides connection of the CU and PC through RS-232 port at the distance up to 1200 m (fig. 1.4.1.4.4).

Converter's power supply is provided from AC 220 V, 50 Hz.

1.5.2.6.4 «Бия-С» public voice device contains an electric lamp of no more than 25 Watt, a sound electrodynamic unit of no more than 60 Watt. The public voice device operating temperature range is from minus 40ºC till +50ºC with 98% relative humidity at 25ºC. If installed outdoors the public voice device is to be sheldered. The public voice device can be connected to the AC 0.5 CU output («CC» – in figure 1.5.2.5.2).

1.6 Explosion-proof protection.

1.6.1 "Explosion-proof design of the intrinsically safe electric circuit is provided in line with "ia" explosion-proof category". The protection complies with requirements of GOST R 51330.0-99 and GOST R 51330.10-99.

Functional arrangement of the explosion protection is given in fig.1.6.1.1. CD, IU, CM and PC are located outside of the explosion-hazardous zone. PPR, PrS and JB are installed in explosion-hazardous zone.

1.6.2 The PSU provides supply of spark-hazardous circuit (SHC) that is galvanically joined with intrinsically safe circuits (ISC). Output voltage of the PSU-U shall not exceed 32 V. A dividing transformer is of the short-circuit resistant design. Power winding is current protected (every wire includes a safety fuse). Power winding and output winding are installed on two different reels. Output winding provides the power supply to the SHC galvanically joined to the ISC. Insulation between windings can hold the voltage of 2500 V, and 1500 V - between winding and casing.

1.6.3 The CU provides a galvanic disconnection of the ISC and CM and PC by optrons and DC/DC transformer ($U_{insulation}$ = 1500V). Intrinsic safety of CU output circuits (for PPR, PrS and JB) is provided by optron interconnections ($U_{insulation}$ = 500 V) and the ISC executed on the basis of the current limiting resistor R=200 Ohm, 10 Watt and 1N5349B voltage regulation diode.

Intrinsically-safe unit maximum output performance:

Voltage Uo, V	12.6
Current Io, mA	170
Outer capacity Co, μF	7.0
Relation of outer inductance to resistance Lo / Ro, mH / Ohm	0.34

1.6.4 Intrinsic safety of PPR is provided by limitation of capacity, inductance and current, and also by the galvanic disconnection between ISC and grounded parts. Insulation between PPR casing and ISC can withstand the voltage of 500V.

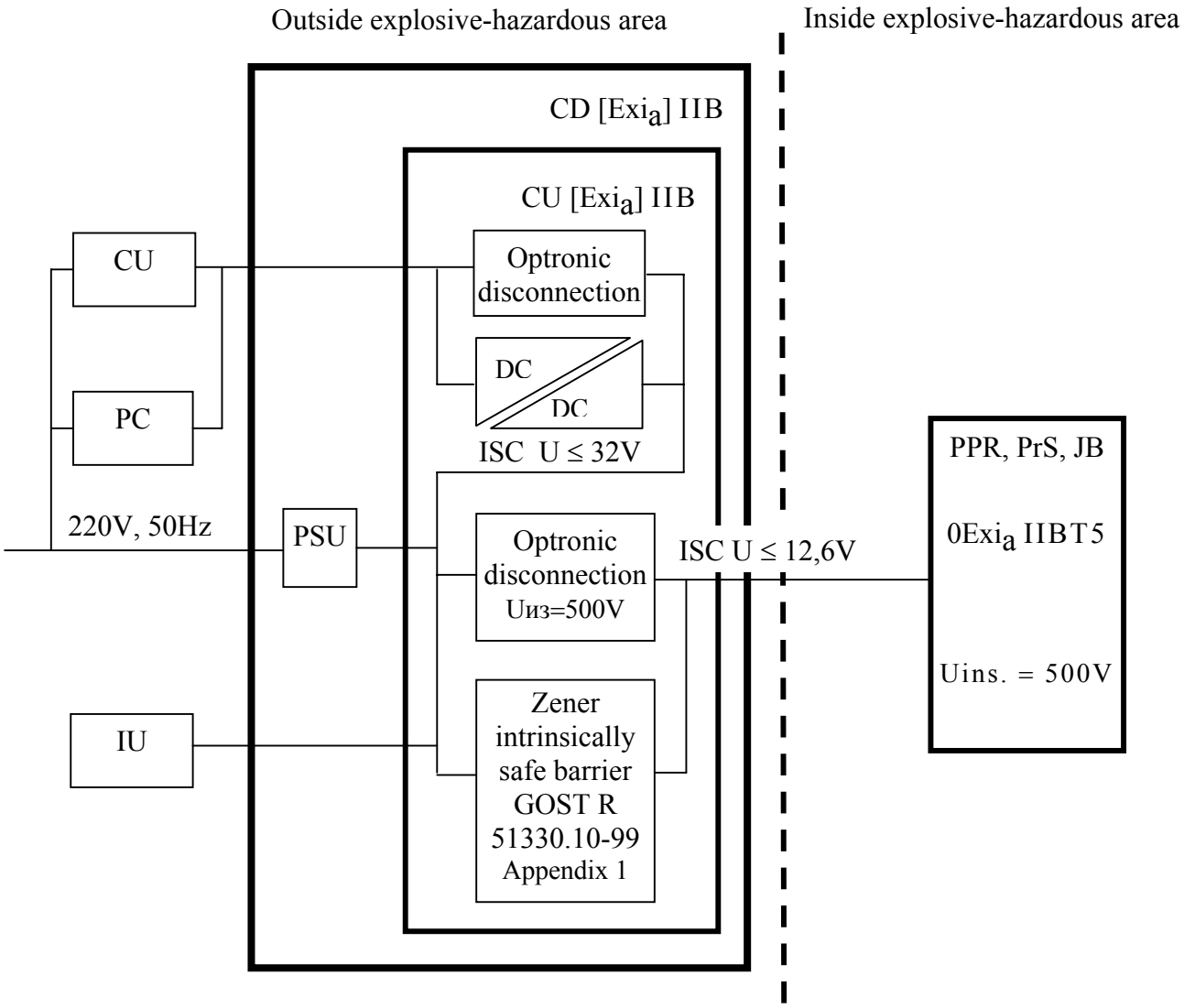
PPR maximum electrical intrinsically safe performance:

Input voltage Ui, V	12.6
Input current Ii, mA	170
Inner Capacity Ci, μF	6.4
Relation of total inner inductance to resistance Lo / Ro, mH / Ohm	0.34

1.6.5 Intrinsic safety of PrS is provided by limitation of capacity, galvanic disconnection between intrinsically safe circuit and grounded parts. Insulation between PrS casing and ISC can withstand 500V.

Maximum PrS intrinsically safe performance:

Input voltage Ui, V	12.6
Input current Ii, mA	170
Inner Capacity Ci, μF	0.6
Inner inductance, μH	100



Optronic disconnection – H11L1optrons
TEN-3 0511 DC/DC converter manufactured by «TRACO», Uins. = 1500V
Zener intrinsically safe barrier elements: - resistor 220 Ohm ± 5%, 10 Watt;
- zener diode 1N5349B (Ustab. = 12 V ± 5%)

Figure 1.6.1.1 – Explosion protection functional diagram

1.6.6 JB Intrinsic safety is provided by the interconnection of ISC and the equipment grounding. Insulation between the intrinsically safe circuit and the JB casing equals 500 V.

JB maximal intrinsic safe performance:

Input voltage Ui, V	12.6
Input current Ii, mA	170
Inner capacity, pf	100
Inner inductance, μH	100

1.6.7 All intrinsically safe elements (current limiting resistors and Zenor diodes) are loaded of no more than 2/3 of threshold values of currents, voltages and power in normal and emergency operating modes.

1.6.8 The CU is produced as a solid body to avoid accidental damage of the intrinsically safe unit. CD, PSU, CU, PPR, PrS and JB structure in the leakage ways part and electric gaps comply with GOST R 51330.10-99.

1.6.9 All components have an explosion protection labeling as given in par. 1.8.2.

1.6.10 Maximum intrinsic safe links performance for PPR, PrS, JB and CU:

Link capacity, C_L μF	0.6
Link inductance L_L, mH	1.5

1.7 Measuring means, tools and materials:

1.7.1 Please refer to instruction КШИОЕ.421451.001ИМ for the description of measuring means, tools, equipment and materials used for the system installation.

1.7.2 Please refer to Operator's Manual КШИОЕ.421451.001РО3 for the description of measuring means and equipment used in adjustment of the density measurement channel.

1.8 Labeling and sealing

1.8.1 Each component in the system is labelled by:

а) inscription on the device where the following is stated:
- manufacturer's trademark;
- device description;
- confirmation mark;
- protection class rating;
- certification center and certificate number;

б) nameplate where the following is stated:
- measuring tool type confirmation mark;
- device (system) designation;
- system technical regulations (TU) number;
- serial number and production date;
- manufacturer's trademark;
- manufacturer's name;
- manufacture's country;
- plant and manufacturer's legal addresses.

1.8.2 Compound parts of a system are labelled as explosive-safe

a) On PPR controller cover – “0ExiaIIBT5 ЦСВЭ № РОСС RU.ГБ05.В02136 Ui : 12.6V Ci : 6,4μF Ii : 170 mA Li /Ri : 0,34mH /Ohm -40°C≤ t_a ≤ +55°C”;

b) on the PrS casing – “0ExiaIIBT5 ЦСВЭ № РОСС RU.ГБ05.В02136 Ui : 12.6V Ci: 0,6μF Ii : 170mA Li : 100μH -40°C≤ t_a ≤ +55°C ”;

c) On the JB cover – “0ExiaIIBT5 ЦСВЭ № РОСС RU.ГБ05.В02136 Ui : 12,6V Ii : 170 mA Ci : 100pF Li : 100μH -40°C≤ t_a ≤ +55°C ”;

d) on the CU casing - “[Exia]IIB ЦСВЭ № РОСС RU.ГБ05.В02136 Uo : 12,6 V Co : 7,0 μF Io : 170 mA Lo /Ro : 0,34 μH/Ohm +10°C≤ t_a ≤ +35°C ”;

e) on the CD cover “[Exia]IIB ЦСВЭ № РОСС RU.ГБ05.В02136 Um : 242 V Uo : 12,6 V Io : 170 mA Co : 7,0 μF Lo /Ro : 0,34 mH/ Ohm +10°C≤ t_a ≤ +35°C ”.

1.8.3 Devices have a water-proof and dust-proof labelling according with par.1.1.4c).

1.8.4 Labelling is put on the visible part of the device's surface.

1.8.5 All system parts are labelled at the Manufacturer's plant (except for the CD and CM) with an “ ОТК2 ” adhesive sign.

Comments - CD, CM, PrS and JB are sealed by the commissioning service.

1.8.6 Package is marked by a label containing:

a) device description;
b) device mass;
c) production date;
d) manufacture's country;
e) plant and Manufacturer's legal addresses;
f) conformation mark.

1.8.7 The package with the accompanying documentation is marked as "Accompanying documentation".

1.9 Packaging

1.9.1 IU, CD, CM, JB, PrS, level and density floats are packaged in cardboards. Maintanance documents are put in a folder. Cables, rubber gaskets and other materials are packed in polyethylene bags (if necessary).

1.9.2 PPR kit is tightened by bracings. PPR controllers have protection covers on.

1.9.3 The package is not sealed.

2 Intended use

2.1 Operational limits

2.1.1 Environmental conditions must not exceed values of par. 1.1.4 and 1.2.14…1.2.16.

2.1.2 Flooding of PPR, PrS, JB by underground water and other liquids is not acceptable.

2.1.3 The system metrological features shall be maintained on condition that the Consumer (organisation) follows requirements to quality control of the measured liquid and storage conditions (requirements for petroleum products in line with GOST 1510 - 84).

WARNING! Operation of PPR, PrS and JB without safety covers is prohibited.

2.2 Safety measures at installation and operation.

2.2.1 Benzine, diesel fuel and other petroleum products are combustible liquids and thus vapours create explosive mixtures in reaction with air.

2.2.2 Maximum permissible concentration of petroleum products is 300 mg/m3 and hazard category of petroleum products on the influence on human health is 4th.

2.2.3 Preliminary and periodical examinations of employees involved in work with petroleum products are to be done according to the plant regulations.

2.2.4 **WARNING! Electrical voltage inside system components is hazardous for human life.**

Only employees that passed safety rules introductory training is mandatory for all employees involved in work with high voltage electric devices.

2.2.5 Safety rules knowledge must be tested at least once a year.

2.2.6 Explosion protection provision during installation and maintenance

2.2.6.1 The following reference documents are to be followed at installation and operation:

- GOST R 51330.13-99;
- chapter 3.4 “Consumer's Electric Device Operation Rules Manual”;
- chapter 7.3 PUE "Electric Device Design Rules";
- the given manual and other regulations.

2.2.6.2 Only employees are allowed to the system operation only after studying the present Maintenance Manual and passing a safety rules training.

2.2.6.3 A system must be inspected before use. Special attention is to be paid on the explosion-safe labelling, preventive signs, working order, sealing, couplings.

2.2.6.4 It is important to maintain devices that provide the system explosion safety in good order.

2.3 Preparation of the system to operation

2.3.1 Unpackaging

2.3.1.1 Check preservation of package when the sysem is delivered.

2.3.1.2 Take off packaging after opening.

ATTENTION! PPR КШИОЕ.407533.002, -01…-05 are unpacked after lifting to the top of the tank.

2.3.1.3 Check system completeness in accordance with component's list and certificates.

2.3.2 System installation

2.3.2.1 System installation is to be done according with "Manual for installation, commissioning and adjustment" КШИОЕ.421451.001ИМ.

2.4 System operation

2.4.1 Please refer to Operators manuals КШИОЕ.421451.001РО1 or КШИОЕ.421451.001РО3 for sequence of entering in measuring, configuring and utility modes and also a list of possible malfunctions and how to eliminate them.

3 System Maintenance

3.1 General guidance

3.1.1 Maintenance service is to be done after repair, storage, and periodically at operation. Maintenance service consists of preventive works and check-up.

3.1.2 Maintenance service must be executed by personnel that studied the current Mantainence Manual and passed a safety rules training.

3.2 Safety measures

3.2.1 Maintenance service safety measures are described in par. 2.2.

3.3 Maintenance service regulations

3.3.1 Service operations and frequency are described in chart 3.1.

Chart 3.1

Operation description	Facility subject to technical maintenance	Frequency	Item of maintenance manual
1.Visual inspection of the device, labelling and sealing.	CD, CM, PPR, PrS, JB	every 6 months	3.3.2
2.Inspection and cleaning of floats and AWL	PPR	every 6 months	3.3.3
3. Instruments accuracy testing	System	every 6 months, And also before maintenance testings	3.3.4
4. Inspection and cleaning of ventilation nozzles	CD	every 6 months	3.3.5
5. Inspection and testing of cable lines and ground circuits	System	every 6 months	3.3.6

Note - The frequency of actions on par. 2 and 3 is determined by conditions of product storage and can be changed.

3.3.2 CD, CM, PPR, PrS, JB are to be visually inspected for checking damages, cleanness of system components, presence of labels and seals and protective covers of PPR, PrS and JB. If the surface is contanimated it is to be cleaned with a clean piece of cloth soaked in alcohol or detergent solution.

3.3.3 Inspection of liquid and density floats is to be executed after dismantling of AWL, and PPR. If the floats and AWL are contaminated they are to be cleaned similar to par. 3.3.2.

3.3.4 ΔП measurements accuracy is determined on the instruments adjustment principle (КШЮЕ.421451.001РО3) for each system densimeter. If ΔП value exceeds the limits of the permissible absolute accuracy of the densimeter measurements the system is to include a correction factor. It is recommended to carry out an additional testing of the corresponding instruments channels before entering correction factors.

3.3.5 Cleaning of CD air grating is executed by a brush meanwhile a CD cover is to be opened. It is also necessary to clean CU and PSU ventilation nozzles in case of blockage.

3.3.6 Inspection and check-up of PPR, SD, JB, CD cable connection and ground circuits are done using measuring device permitted to use on site. Resistance of the cable insulation shall not exceed 1 MOhm. Resistance of the ground circuit shall not exceed 4 Ohm.

3.3.7 System operability testing

3.3.7.1 The system power supply is to be turned on and the IU measures liquid parameters, such as level, temperature, density, pressure, volume, mass, and level of bottom water. All measures shall be within the measuring range indicated in the system passport. Error notices are not acceptable.

3.3.8 Technical inspection

3.3.8.1 The system testing is to be done with frequency as stated in the Check-up Manual КШЮЕ.421451.001МП and also after PPR and PrS repair.

3.3.9 Packaging and unpackaging

3.3.9.1 The system must be packaged when it is delivered from the Manufacture by any transport means.

3.3.9.2 Necessary preparations before packaging must be the following: visual inspection, check-up of operability as described in par. 3.3.7.1, all the malfunctions to be eliminated.

3.3.9.3 Dismantle the system, cover steel exterior parts with ЦИАТИМ-201 lubricant in line with GOST 6267-74 (screws, toggle switches and etc.).

3.3.9.4 Next step: the system is to be put in Manufacturer's packaging.

3.3.9.5 The system is to be unpackaged part before putting into operation.

3.3.9.6 Sequence of the system unpackaging:

- take off the package from the system;
- clean steel surface from lubricant;
- install a system in line with КШЮЕ.421451.001ИМ instruction.

4 Current Repair Works

4.1 General notice

4.1.1 The system is to be repaired by the organization that has a permit for explosion-proof equipment repair works.

4.1.2 Repairs that require disassembly of PPR, PrS, JB, CU, PSU, CM are to be executed at the manufacturer's plant.

4.1.3 CD, CM must be sealed on site after repair.

4.2 Safety measures

4.2.1 Switch off power supply before connecting and disconnecting of components.

4.2.2 Test continuity of ground circuits and system components before switching on the power supply.

4.2.3 Other safety measures are described in par. 2.2.

4.3 Fault-finding and how to eliminate them

Please refer to КШЮЕ.421451.001РО1 or КШЮЕ.421451.001РО3 for fault-finding and ways how to eliminate them.

5 Storage

5.1 If stored for a long time the system should be located in the manufacturer's package in a warm room.

5.2 The room requirements are as follows: air temperature between +5 and +25°C, relative humidity no more 80 %, absence of vapours of acids, alkalis and other aggressive substances.

6 Transportation

6.1 The System may be transported:

- by trucks on highways at distance no more than 3000 km, with speed lower 60 km/h;
- for ground road at distance no more than 500 км, with speed lower than 30 km/h;
- no limits for speed, distance or height for the transportation by railway, water or air.

6.2 Preparation to transportation

6.2.1 The system is to be preserved in accordance with par. 3.3.9.

6.2.2 The system is to be put in the plant boxes in line with packaging lists.

It is allowed to use proper packaging produced outside of the plant if it provides protection against environmental and mechanical effects.

6.3 The package is to provide multiple times transportation of the system for tank calibration by truck. Package of PPR must be fast attached to the truck.

7 Utilization

7.1 A system with the expired service period and other nonrepairable defects must be utilized.

7.2 A system unit with nonrepairable defects and malfunctions can also be utilized.

7.3 There are no special requirements for the system utilization.

Appendix A
(mandatory)

Typical subranges of density measurements and densimeter setting levels.

A.1 Typical subranges of density measurements are described in chart A.1

Chart A.1

Type of product	Subranges of density measurements, kg/m^3	
	surface densimeter	immersion densimeter
benzene with octane number 80	690…760	679…779
benzene with octane number 9x	725…795	703…803
diesel fuel	810…880	794…894
kerosene	765…840	752…852
oil	860…943	852…952
liquefied gas	–	499…599

A.2 Surface densimeter measures density of the top liquid layer in a tank (100 – 200mm down from surface).

A.3 Typical setting levels of immersion densimeters are shown in chart A.2, exact values aregiven in PS for system.

Chart A.2

PPR designation	Densimeter setting level ($У_{set.\ i}$), mm							Note
	П1	П2	П3	П4	П5	П6	П7	
КШИОЕ.407533.002, -01…-05	800	2600	5200	6600	9200	10600	13200	Option 1 Liquid take-in up to 16 m
	800	2900	5800	7400	10300	11900	14800	Option 2 Liquid take-in up to 18 m
КШИОЕ.407533.001 -02, -03 КШИОЕ.407533.005 -01	400	minimum plant spacing, mm $\Delta У_{set}$= ΔHi +250			–			ΔHi – operating float travel distance ΔH_i = 400mm
КШИОЕ.407533.003 -02…-04	250 + ΔHi	minimum plant spacing, mm $\Delta У_{set}$= ΔHi +250			–			

A.4 Minimum level of product that can be indicated on the surface densimeter is 340 mm, and for an immersion densimeter corresponds to the level of its installation in line with the system specification plus 300 mm.

If level drops below densimeter П1 setting level the last valid density value is stored in memory and is further corrected in line with the product temperature.

Appendix B
(for information)

Chart B.1 – List of reference documents

Designation	Description	Items
1	2	3
GOST 12.2.007.0-75	SSBT. Electrical devices. General safety requirements.	1.2.21
GOST 12997-84	GSP items. General technical conditions.	1.1.4a)
GOST 14254-96	Protection categories provided by shells (IP code)	1.1.4b)
GOST 1510-84	Petroleum and petroleum products. Marking, packaging, transportation, storage.	2.1.3
GOST 21130-75	Electrical devices. Grounding clips and signs. Structure and dimensions.	1.2.21
GOST 6267 – 74	Lubricant ЦИАТИМ-201. Technical conditions.	3.3.9.3
GOST R 51330.0-99 IEC 60079-0-98	Explosion-proof electrical apparatus. Part 0. General requirements.	1.1.3 1.6.1
GOST R 51330.10-99 IEC 60079-11-99	Electrical apparatus for explosive atmospheres. Part 11. Intrinsic Safety *i*.	1.1.3 1.6.1 1.6.3 1.6.8
GOST R 51330.13-99 IEC 60079-14-96	Explosion-protected electrical apparatus. Part 14. Electrical Installations in explosive gas atmospheres (other than mines).	1.1.2 2.2.6.1
GOST R 8.595-2004	GSI. Petroleum and petroleum product mass. General requirements to measuring methods.	1.2.8
PUE	Electrical installation design regulations. Sixth edition.Revised.2000.	1.1.2 2.2.6.1
PEEP	Consuming electrical apparatus operating rules.	2.2.6.1
GOST 8.477-82	State check-up diagram for liquid level measuring means	1.1.2
NPB 111 – 98	Petroleum stations. Fire-safety requirements.	1.2.12
GOST 10348 - 80	Installation multicore cables with plastic insulation.	1.2.9
GOST R 8.563-96	State System of measurement assurance. Measurement procedures.	1.2.8

Continuation of chart B.1

1	2	3
КШЮЕ.421451.001РО1	STRUNA measuring system. Operator's manual.	1.2.11a), 1.5.2.4, 2.4.1, 4.3
КШЮЕ.421451.001РО3	STRUNA measuring system. Operator's manual.	1.2.11a), 1.5.2.4, 1.7.2, 2.4.1, 3.3.4, 4.3
КШЮЕ.421451.001МП	GSI STRUNA measuring system. Check-up procedures	3.3.8.1
КШЮЕ.421451.001ИМ	STRUNA measuring system. Installation, startup and adjustment manual.	1.2.18, 1.5.2.3, 1.7.1, 2.3.2.1, 3.3.9.6
КШЮЕ.421451.001И1	STRUNA measuring system. Calibration data input chart in the calibration chart manual.	1.2.8
КШЮЕ.421451.001ПО	STRUNA measuring system. "Кедр 2.1" interface protocol	1.2.11b)
КШЮЕ.421451.001РОП	STRUNA measuring system. Manual for PC operator.	1.2.11c)
КШЮЕ.421451.001ВЭ	STRUNA measuring system. List of operational documents.	1.3.1n)