ОКР 42 2190

РА1.007.004РЭ

VOLTAMPEREPHASEMETER

«PARMA VAF-A(C)»

Operation Manual

PA1.007.004 РЭ

.

PARMA Ltd., Saint-Petersburg
2021

Appearance of voltamperephasemeter
“PARMA VAF-A(C)” with accessories

CAUTION!
Do not run the instrument without studying the contents of this document.
In view of a continuous work for improving the instrument, revisions, not influencing its technical characteristics and not reflected in this document, can be made in its design.

CAUTION!
In case of a loss of operating documents: verification methods and operation manuals as well as the verification method for a voltamperephasemeter of “PARMA VAF-A(C)” can be copied at our site: www.parma.spb.ru.

CONTENTS

This operation manual is intended for studying a voltamperephasemeter “PARMA VAF-A(C)”.

The operation manual contains technical characteristics, operation principle description, setting-up and commissioning procedure as well as other information, required for the correct operation of a voltamperephasemeter “PARMA VAF-A(C)”.

Please send offers and comments for the operation of a voltamperephasemeter “PARMA VAF-A(C)”, as well as for the content and execution of operating documents by the address:

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1 REGULATORY REFERENCES

TR TS 004/2011 On safety of low-voltage equipment.

TR TS 020/2011 Electromagnetic compatibility of technical equipment.

GOST 12.2.091-2012 (IEC 61010-1:2001) Safety requirements for electrical equipment for measurement, control and laboratory use. Part 1. General requirements.

GOST 12.3.019-80 OSSS. Electrical tests and measurements. General safety requirements.

GOST 15150-69 Machines, instruments and other industrial products. Modifications for different climatic regions. Categories, operating, storage and transportation conditions as to environment climatic aspects.

GOST 22261-94 Means for measuring electrical and magnetic quantities. General specifications.

GOST 30804.4.2-2013 Electromagnetic compatibility of technical equipment. Immunity to electrostatic discharge. Requirements and test methods.

GOST 30804.4.3-2013 Electromagnetic compatibility of technical equipment. Radiated, radio-frequency, electromagnetic field immunity. Requirements and test methods.

GOST 30804.4.4-2013 Electromagnetic compatibility of technical equipment. Immunity to nanosecond impulsive disturbance. Requirements and test methods.

GOST 30804.4.11-2013 Electromagnetic compatibility of technical equipment. Voltage dips, short interruptions and voltage variations immunity. Requirements and test methods.

GOST IEC 61140-2012 Protection against electric shock. Common aspects for installation and equipment.

GOST IEC 61010-2-032-2014 Safety of electrical equipment for measurement, control and laboratory use. Part 2-032. Particular requirements for hand-held and hand-manipulated current sensors for electrical tests and measurement.

GOST IEC 61010-2-033-2013 Safety requirements for electrical equipment for measurement, control, and laboratory use. Part 2-033. Particular requirements for hand-held multimeters and other meters, for domestic and professional use, capable of measuring mains voltage.

GOST R 50648-94 (IEC 1000-4-8-93) Electromagnetic compatibility of technical equipment. Immunity to power frequency magnetic field. Technical requirements and test methods.

GOST R 51317.4.5-99 Electromagnetic compatibility of technical equipment. Microsecond high energy pulse disturbance immunity. Requirements and test methods.

GOST R 51317.4.6 -99 Electromagnetic compatibility of technical equipment. Immunity to conducted disturbance induced by radio-frequency fields. Requirements and test methods.

GOST R 51522.1-2011 (IEC 61326-1:2005) Electromagnetic compatibility of technical equipment. Electrical equipment for measurement, control and laboratory use. Part 1. General requirements and test methods.

GOST R 51522.2.2-2011 Electromagnetic compatibility of technical equipment. Electrical equipment for measurement, control and laboratory use. Part 2-2. Particular requirements for portable test, measuring and monitoring equipment used in low-voltage distribution systems. Test configurations, operational conditions and performance criteria.

GOST R IEC 60086-1-2010 Primary batteries. Part 1. General.

2 DESIGNATIONS AND ABBREVIATIONS

2.1 This operation manual applies the following designations and abbreviations:

ADC – Analog-digital converter
VAF – voltamperephasemeter “PARMA VAF-A(C)”
PC – Personal computer
VFT – Voltage-frequency transducer
SW – Software
USB – (Universal Serial Bus) — serial data transmission interface for medium-speed and low-speed peripherals and power supply of peripherals.

3 SAFETY REQUIREMENTS

3.1 The VAF in terms of protection against electric-shock hazard corresponds to the requirements of GOST 12.2.091, erection category (overvoltage category) II (CAT. II). The class of protection against electric-shock hazard is II as per GOST IEC 61140.

3.2 The protection degree of metering unit casing against the penetration of solid matter and moisture is IP41 as per GOST 14254.

3.3 “ Rules of technical operation of electric installations of consumers” for plants to 1000 V shall be observed during the VAF operation.

3.4 Persons, having the electric safety group of no lower than 3, duly certified for a work permit to consumer electrical plants to 1000 V and learned this manual, can be eligible for the VAF operation.

3.5 During measurements, it is required to observe the safety requirements as per GOST 12.3.019.

3.6 VAF input circuits, if a voltage is available in the analyzed circuits, should be connected with a strict observation of “Rules of technical operation of electric installations of consumers”.

3.7 When determining the VAF phase sequence in the three-phase mode, inputs A, B and C are automatically wye interconnected, while the resistance between any two “wye beams” is no less than 2 MOhm.

4 DESCRIPTION OF VAF AND ITS OPERATION PRINCIPLES

4.1 Function

4.1.1 Full trade name, type and designation: Voltamperephasemeter “PARMA VAF-A(C)”, TU 4221-028-31920409-2014.

4.1.2 Certification information:

— Conformance declaration of TS No. RU D-RU.ML02.B00084 dated 25.11.2015 is accepted on the basis of test sheets No. 2978, № 2978/EMC, NSTCTC Reglamentsert Ltd valid to 24.11.2020.

— Voltamperephasemeter “PARMA VAF-A(C)” is registered in the State register of instruments under No. 68887-16, order No. 562 dated 12.05.2016.

The VAF is intended for measuring:

— direct current voltage;
— alternate current voltage and rate;
— alternate current voltage and rate of first harmonic;
— alternate current frequency;
— phase displacement angles between input signals;
— active, reactive and output power;
— power factor (cos φ);

— continuity test of electrical conductors ("Testing continuity" mode),
— as well as determination of phase sequence.

4.1.3 The VAF can be applied during complex tests of protections of generators, transformers, lines, in current and voltage transformers circuits, setting-up of phase-sensitive relaying schemes, etc.

4.1.4 Normal application conditions as per 4.2.1 of this manual.

4.1.5 Operating application conditions in terms of climatic effects as per 4.2.3 of this manual.

4.2 Ambient conditions

4.2.1 Normal VAF application conditions as per GOST 22261:

— nominal ambient air temperature of plus 20 °C. Allowable deviation of ambient air temperature of ±5 °C.
— relative air humidity of 30 to 80 %;
— atmospheric pressure of 84 to 106 kPa.

4.2.2 Operating VAF application conditions in terms of climatic effects shall correspond to the requirements of group 4 as per GOST 22261:

— ambient air temperature of minus 20 to plus 55 °C with the usage of storage batteries;
— ambient air temperature of minus 30 to plus 55 °C with the usage of alkaline batteries;
— relative air humidity of 90 % at 30 °C;
— atmospheric pressure of 70 to 106.7 kPa.

4.2.3 VAF placement category as per GOST 15150 – 5, atmosphere type II, altitude of 2000 m.

4.2.4 By its transportation conditions, the VAF shall be related to the group 4 as per GOST 22261. Limit VAF transportation conditions shall be as follows:

— ambient air temperature of minus 30 to plus 55 °C;
— relative air humidity of 90 % at 30 °C;
— atmospheric pressure of 70 to 106.7 kPa.

4.2.5 In terms of mechanical effects, the VAF corresponds to the requirements of group 4as per GOST 22261.

4.2.6 In terms of electromagnetic compatibility, the VAF corresponds to the requirements of noise resistance of equipment, used in the controlled electromagnetic environment, as per TR TS 020/2011, GOST R 51522.1.

4.2.7 The VAF stands the effect of the following interference:

— electrostatic discharges as per GOST 30804.4.2, stiffness degree 2 – contact discharge, stiffness degree 3 – air discharge; functioning quality criterion A;
— radio-frequency electromagnetic field as per GOST 30804.4.3, stiffness degree 1; functioning quality criterion A;
— nanosecond impulse interference as per GOST 30804.4.4, stiffness degree 3; functioning quality criterion A;
— conducted interference, induced by radio-frequency electromagnetic fields as per GOST R 51317.4.6, stiffness degree 2; functioning quality criterion A;
— power frequency magnetic field as per GOST R 50648, stiffness degree 4; functioning quality criterion A;
— microsecond impulse interference as per GOST R 51317.4.5, stiffness degree 2; functioning quality criterion A;
— dynamic power voltage changes as per GOST 30804.4.11, stiffness degree 3 – voltage dips, stiffness degree 2 – voltage interruption, stiffness degree 3 – voltage surges; functioning quality criterion A.

VAF radio interference shall correspond to the requirements of 7.2 GOST R 51522.1 for equipment class A.

4.3 VAF structure

4.3.1 The supply set of voltamperephasemeter “PARMA VAF-A(C)” contains:

— Metering unit – 1 pce;
— CS (measuring channel) – 1 pce;
— CS (reference channel) – 1 pce;
— voltage probe – 2 pairs;
— voltage probe set (universal)* – 1 set;
— network power module with applied microUSB cable – 1 pce;
— voltamperephasemeter “PARMA VAF-A(C)”. Operation manual of PA1.007.004РЭ – 1 pce;
— voltamperephasemeter “PARMA VAF-A(C)”. Verification method of PA1.007.004МП – 1 pce;
— voltamperephasemeter “PARMA VAF-A(C)”. Form of PA1.007.004ФО – 1 pce;
— storage batteries of AA size type – 4 pcs;
— bag – 1 pce;

Note “*” – supplied on Customer’s request.

4.4 Technical characteristics

4.4.1 Guaranteed technical characteristics

4.4.1.1 The VAF ensures the measurement of electrical power parameters within the ranges and with errors, corresponding to the ones specified in table 1.

4.4.1.2 The VAF provides the determination of phase sequence in a three-phase system with a voltage within the range of 1 to 600 V.

4.4.1.3 Reference technical characteristics:

4.4.1.4 The impedance of voltage channels is no less than 1 MOhm.

4.4.1.5 The VAF withstands an overload during 1 minute for the voltage of 2•Uк, where Uк is the final value of measured voltage range (600 V).

4.4.1.6 The VAF withstands an overload during 1 minute for the current of 2•Iк, where Iк is the final value of measured current rate range (40 A).

4.4.1.7 Opening of a magnet core of a current sensor is 8 mm.

4.4.1.8 The setting time of operating mode is no more than 10 s.

4.4.1.9 Input electric power of VAF from the integrated power supply is no more than 2.5 V·A.

4.4.1.10 The mean time to recover the operating condition is no less than 1 hour.

4.4.1.11 The mean time between failures is no less than 8000 hours.

4.4.1.12 The mean service life is no less than 10 years.

4.4.1.13 Weight: metering unit – no more than 1 kg, (weight of metering unit of reference and measuring current sensors, packed into a bag) is no more than 2.2 kg.

4.4.1.14 Outline dimensions: metering unit – no more than 156x98x36 mm, (weight of metering unit of reference and measuring current sensors, packed into a bag) is no more than 255x150x160 mm.

Table 1

Measured parameter	Measurement range	Limits of allowable error during measurement of corrected[1)], (γ) %, relative, (δ) % and absolute (Δ) values	Note
Direct current voltage, U, V	0.5 to 600	$\Delta = \pm (0.5+0.005*X)$	
Alternate current voltage of first harmonic, $U_{(1)}$, V	0.3 to 600	$\gamma = \pm 0.05$	at $U \leq 0.1\ U_K$
		$\delta = \pm 0.5$	at $U \geq 0.1\ U_K$
Alternate current voltage, U_{RMS}, V	0.3 to 600	$\gamma = \pm 0.05$	at $U \leq 0.1\ U_K$
		$\delta = \pm 0.5$	at $U \geq 0.1\ U_K$
Alternate current rate of first harmonic, $I_{(1)}$, A	0.004 to 40	$\gamma = \pm 0.01$	at $I \leq 0.1\ I_K$
		$\delta = \pm 1$	at $I \geq 0.1\ I_K$
Alternate current rate, I_{RMS}, A	0.004 to 40	$\gamma = \pm 0.01$	at $I \leq 0.1\ I_K$
		$\delta = \pm 1$	at $I \geq 0.1\ I_K$
Circuit resistance, R, Ohm	1 to 500	$\Delta = \pm (0.3+0.035*X)$	
Power factor, cos φ	minus 1 to plus 1		
Alternate current voltage and rate frequency, *f* Hz	45 to 55	$\Delta = \pm 0.01$	at $U \geq 2$ V & $I \geq 100$ mA
		$\Delta = \pm 0.05$	at $0.4\ V \leq U \leq 2$ V & $5\ mA \leq I \leq 100$ mA
Phase displacement angles, degrees	0 to 360	$\Delta = \pm 1$	at $U \geq 10$ V & $I \geq 10$ mA
		$\Delta = \pm 3$	at $U \leq 10$ V & $I \leq 10$ mA
Active power, P, W	0 to 24000	$\gamma = \pm 0.003$	at $P \leq 24$ W
		$\delta = \pm 3$	at $P \geq 24$ W
Reactive power, Q, var	0 to 24000	$\gamma = \pm 0.003$	at $Q \leq 24$ var
		$\delta = \pm 3$	at $Q \geq 24$ var
Gross power, S, VA	0 to 24000	$\gamma = \pm 0.003$	at $S \leq 24$ VA
		$\delta = \pm 3$	at $S \geq 24$ VA

[1)]For calculating the corrected measurement errors, the final range value is accepted as the normalized value.
Where – U_K, I_K – final value of measurement range.
U_{RMS}, I_{RMS} – valid value of AC voltage, rate.
$U_{(1)}$, $I_{(1)}$ – value of first harmonic AC voltage, rate.
X – measured value of voltage, resistance.

4.5 VAF power supply

4.5.1 The VAF power supply in the off-line mode is done from integrated power supplies (4 galvanic elements of AA size type of 1.5 V each or 1.2 V NiMH storage batteries of AA size type).

4.5.2 For charging VAF storage batteries, an on-line power unit with microUSB port is provided.

CAUTION! WHEN BATTERIES ARE USED (UNCHARGED GALVANIC ELEMENTS), IT IS PROHIBITED TO CONNECT THE POWER SUPPLY TO THE VAF MICROUSB PORT!

4.5.3 When the power supply is connected to the microUSB port of the VAF metering unit, the instrument is automatically switched to the external power supply with a simultaneous recharge of storage batteries. When the instrument is off, the storage batteries are not charged.

4.5.4 A wrong installation of power elements causes no VAF damages.

4.6 VAF structure and operation

4.6.1 Configuration

4.6.1.1 The VAF is a portable automated electronic instrument, consisting of a metering unit, reference and measuring current sensors. The metering unit is done in an insulated high-impact plastic casing. For the reliability and convenience during VAF operation, it is placed into a work bag, also serving for storage of current sensors and accessories.

4.6.1.2 The appearance of metering unit is specified at figure 1.

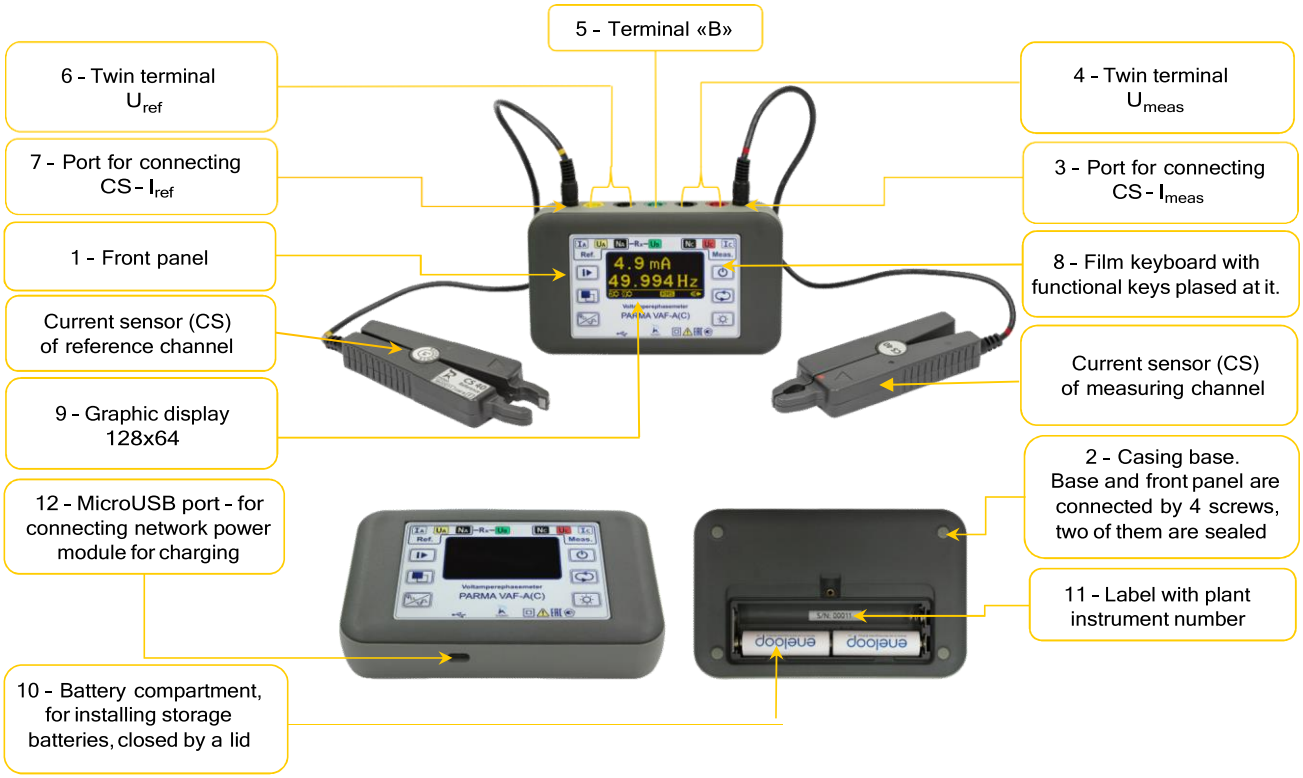

Figure 1 Appearance of VAF metering unit and current sensor

4.6.1.3 The metering unit casing consists of a front panel (1) and base (2), connected by four screws, two of them are sealed.

4.6.1.4 The casing base contains:

— battery compartment (10), for the placement of four DC power elements of AA size type, is closed with a lid, which is fixed to the casing by a screw, in the same place (in battery compartment) there is a label (11) with a plant VAF number;

— magnetic plate for fixing a bag or steel surface at a steel surface during measurements at customer's site;

CAUTION! THE INSTRUMENT HAS A STRONG MAGNET; MAGNIFICATION OF TOOLS AND FASTENERS IS POSSIBLE. TAKE CARE ABOUT HANDLING OF MEASURING EQUIPMENT!

— port (12) of microUSB-adapter, intended for charging accumulators and for feeding VAF from a utility power source is located at the side surface of casing base;

— two terminals (6) of reference voltage channel Uref – black terminal – "neutral" for connecting a neutral wire, and a yellow terminal for connecting the "phase" or a positive potential of reference voltage signal, and during the determination of phase sequence for connecting the voltage signal of phase 'A';

— (5) – single terminal 'B' for connecting the voltage signal of phase 'B' during the determination of phase sequence;

— (4) – two terminals of measuring voltage channel Umeas – black terminal – "neutral" for connecting a neutral wire, and a red terminal for connecting the "phase" or a positive potential of

measuring voltage signal, and during the determination of phase sequence for connecting the voltage signal of phase ‘C’;

— (3) & (7) – Imeas & Iref port for connecting the connector of reference and measuring current sensors;

— (8) – film keyboard with functional keys and (9) – graphic display of 128x64 points are located at the front panel of VAF casing (1).

4.6.2 VAF operation description

4.6.2.1 The VAF has three voltage channels (Ua, Ub & Uc) and two current channels Ia & Ic.

4.6.2.2 All three voltage channels are identical and consist of a resistance divider, isolating amplifier with galvanic isolation and scaling amplifier with an anti-aliasing filter. The channel Ua is used as a reference one during the measurement of phase angles, channel Ub is applied during measurements in the three-phase mode as well as combined with the input of “Testing continuity” mode. Channels Ua and Ub have a common neutral terminal Na and galvanically isolated from the rest part of VAF. Channel Uc is used as a measuring one, has its neutral terminal Nc and is also galvanically isolated from the rest part of VAF. When switched in the three-phase measurement mode, terminals Na and Nc are combined by an internal switching relay.

4.6.2.3 Current channels Ia and Ic contain a resistance shunt and scaling amplifier with an anti-aliasing filter.

4.6.2.4 For measuring the resistance, a VFT, generating a frequency signal, proportional to the voltage drop in the measured circuit, is used. The reference voltage source and VFT input are provided with an overvoltage protection (450 V) and in the “Testing continuity” mode, they are connected to the input Ub via switching relay contacts.

4.6.2.5 All the measured signals are supplied to a 8-channel ADC, equipped with a digital input filter and access and storage station. The discretion frequency is 6400 Hz with adaptive setting for the input signal period. The mathematical processing and calculation of displayed values are done at a microcontroller. The microcontroller also has data output functions to the graphic LED display, query of 6-key keyboard, network control of input signals and calculation of VFT impulses as well as the control of circuit power supply and storage batteries charge.

4.6.2.6 The power supply of digital VAF portion is done from a 3.3 V voltage converter, and +/-5 V voltage converters are used for the power supply of analog portion. A microUSB input, also acted together with a programmable current source for charging storage batteries, is used as an external power supply for the instrument operation.

4.7 Operational limitations

4.7.1 It is forbidden to operate the VAF in ambient conditions, different from the ones described in 4.2 of this manual.

4.7.2 It is forbidden to transport and store the VAF in ambient conditions, different from the ones described in sections 10 and 11 of this manual.

4.7.3 It is forbidden to store the VAF with discharged power elements.

4.7.4 It is unreasonable to connect measuring current sensors to the reference channel port or to use current sensors from another VAF because it causes the increase of a measurement error and does not guarantee that the metrological characteristics correspond to the requirements in table 1 of this operation manual.

4.7.5 Before carrying out measurements requiring connections in galvanically isolated circuits of AB and C channels the device should be turned on and then apply measured signals.

4.8 Unpacking and repacking

4.8.1 VAF unpacking and repacking should be done as per 4.8.2 and 4.8.3 of this operation manual.

4.8.2 During unpacking, the following work order should be observed:

— Open the box.

— Pull out from the box:

— insert;

— operational documents packed into a polyethylene package (form, operation manual in a soft copy);

— power elements in packing;

— work bag, provided with pockets for storing VAF, current sensors, measuring probes and accessories.

— Pull out from the bag:

— metering unit;

— reference and measuring current sensors.

4.8.3 Repacking should be done in the reverse sequence.

— After repacking, an external VAF inspection should be done:

— inspect the availability and integrity of seals on the metering unit;

— VAF and accessories shall not have visible external damages of casing and control bodies;

— there shall not be any unfixed things inside the VAF;

— insulation shall not have cracks, carbonization and other damages;

— VAF marking, accessories and cables shall be easy readable and do not have damages.

4.9 Installation procedure

4.9.1 Operating VAF position can be either. The place is selected on the basis of the location of measured network, and the length of current sensors.

5 SETTING-UP PROCEDURE

5.1 Setting-up procedure

5.1.1 During setting-up it is required to observe the safety requirements as per GOST 12.3.019.

5.1.2 Pull out the metering unit from the bag, unscrew a bolt at the back wall, closing the compartment of power elements, and install 4 storage batteries as per the marking at the lid. Use power elements of AA size type, corresponding to the requirements of GOST R IEC 60086-1.

5.1.3 Turn the VAF power on, wait for its loading and be sure that the indicator displays the sufficient level of power element charge. If required, charge storage batteries or replace them.The charge is done as per it. 4.5 of this operation manual. Close the battery compartment lid, screw the bolt.

5.1.4 Check the cleanness of contact surfaces of magnetic circuit of current sensor if required to clean them.

5.1.5 The VAF shall be fixed at the bag lid or at a metal surface.

CAUTION! IT IS NOT RECOMMENDED TO CONNECT THE MEASURING CURRENT SENSORS TO THE REFERENCE CHANNEL PORT, THE REFERENCE CURRENT SENSORS TO THE MEASURING CHANNEL PORT OR USE CURRENT SENSORS FROM ANOTHER VAF BECAUSE IT CAUSES THE INCREASE OF MEASUREMENT ERRORS.

5.2 Instruments, tools and accessories

5.2.1 VAF verifying instruments are specified in 7.3.2 of this manual.

5.2.2 For installing and replacing storage batteries, a cross-head screwdriver is required.

6 WORK PROCEDURE

6.1 Safety measures

6.1.1 During the VAF operation, the “Rules of technical operation of electric installations of consumers” for plants to 1000 V shall be observed.

6.1.2 Persons, having the electric safety group of no lower than 3, duly certified for a work

permit to consumer electrical plants to 1000 V and learned this manual, can be eligible for the VAF operation.

6.1.3 During measurements, it is required to observe the safety requirements as per GOST 12.3.019.

6.1.4 VAF input circuits, if a voltage is available in the analyzed circuits, should be connected with a strict observation of “Rules of technical operation of electric installations of consumers”.

6.2 Appearance and position of setting and start bodies

6.2.1 The appearance of VAF front panel is specified at figure 2.

6.2.2 The VAF provides the switching possibility of modes of operation and display of measured values. For this purpose, a film keyboard with functional keys is provided at the front panel.

6.2.3 The VAF has no range switches. All the switching processes are done automatically on the basis of the evaluation of incoming signals.

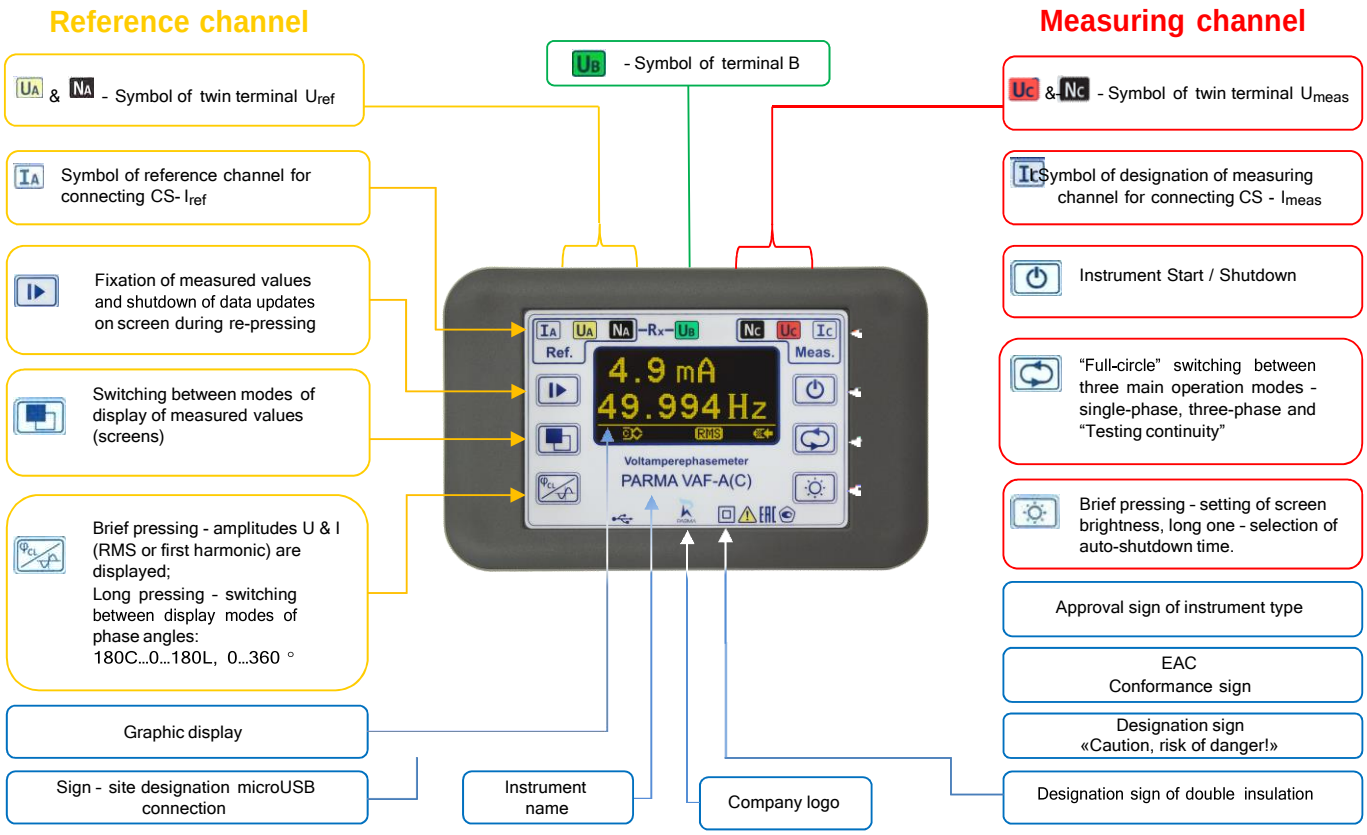

Figure 2 – VAF front panel

6.2.4 For beginning the operation, turn the VAF power on by brief pressing of the button  . After the VAF power is on, it produces self-testing and identification.

6.2.5 After power is on, during 2-3 s, the screen displays the Company logo, in case of a successful self-testing, plant numbers are then displayed as specified at figures 3 and 4.

Figure 3

6.2.6 The upper line indicates the instrument plant number, issue year, then plant numbers of measuring and reference current sensors, the lower one displays the VAF software version.

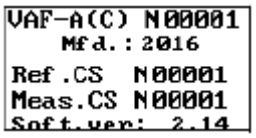

Figure 4

6.2.7 After being on, the VAF begins its operation in the single-phase mode. The switching between modes is done by brief pressing of the button . In total, 3 VAF operation modes: single-phase, three-phase and "Testing continuity" modes are realized (figure 5, 6).

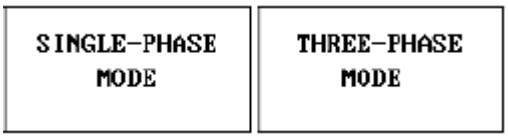

Figure 5

Figure 6

6.2.8 Two voltage and current rate display modes are realized in the single-phase and three-phase modes. The switching is done by brief pressing at the button and is accompanied by displaying an information message at the indicator, as shown at figure 7.

Figure 7

6.2.9 Long pressing (over 3 s) of the button ensures the switching between two angle display modes and is accompanied with displaying of the information message, shown at figure 8.

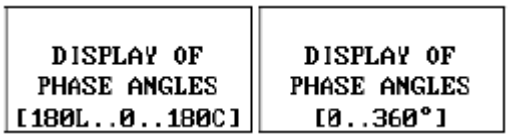

Figure 8

6.2.10 During the operation under the conditions of faint illumination, the indicator brightness control is provided. For this purpose, press the front panel button with the sign . Re-pressing allows selecting one of five brightness levels (full-circle) as shown at figure 9. Upon the expiration of three seconds after the last pressing, the instrument returns to the previous operation mode, keeping the selected indicator brightness.

Figure 9

6.2.11 Long pressing (over 3 s) of the button is intended to select the auto-shutdown time. Re-pressing allows cyclically selecting one of five time values (3, 5, 10, 15, 30 minutes) as shown at figure 10. Upon the expiration of three seconds after the last pressing, the instrument returns to the previous operation mode, keeping the selected auto-shutdown time value.

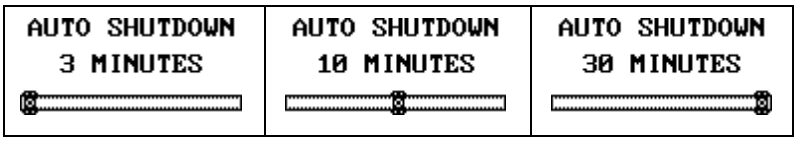

Figure 10

6.2.12 Pressing of the button ensures the fixation of measured values and deactivation of parameter update at the VAF screen until being re-pressed.

6.2.13 The lower screen part displays the following information:

Table 2

Graphical sign	Purpose	Note
A, B	Current sensors are connected to the reference I_a or measuring I_c channel.	Blinking of one of designations means that the screen displays the measurement results in the corresponding channel.
Uc, Ua	Signal is supplied to the measuring, reference channel.	Sign availability means that the screen displays the measurement results in the corresponding channel.
	For this measurement mode, the calculated parameter values are displayed at two (three) screens.	Switching between screens is ensured by pressing the button .
P	Pause – Fixation of measured values and deactivation of parameter update at screen.	It is ensured by pressing the button .
VDC	Sign of DC voltage availability at VAF inputs	Measurement of DC voltage
RMS, A(1)	Display of measured values: Root-mean-square values (RMS); First harmonic values (A(1)),	Switching between display modes during AC voltage measurement – by pressing the button .
R, R	Display of the measured resistance minus the stored reference value.	Blinking icon indicates that the screen displays the result of measuring relative resistance.
	VAF power indicator from external source (microUSB port) and simultaneous SB charging.	Animated SB charge indicator.
	VAF power supply is done from integrated power elements.	Storage battery charge indicator.

6.3 Measurement procedure

6.3.1 Alternate current rate and frequency measurement

6.3.1.1 For measuring alternate current rate and its frequency, both the measuring and reference current sensors connected to the homonymic VAF channel can be used.

6.3.1.2 The reference current sensor shall be connected to the reference channel port, marked as Iref, and the measuring current sensor – to the measuring channel port Imeas, as shown at figure 11.

Figure 11

6.3.1.3 Brace the current lead with current sensors so that the sign "●", located at the casing of current sensors, indicate the direction towards the current source, clip ends is reliably closed, and, if possible, the current lead is in the clip middle.

6.3.1.4 For switching of display modes of root-mean-square values of alternate current rate and first harmonic values, the button shall be pressed at the front panel, then the dis- play will show the sign or . RMS A(1)

6.3.1.5 The screen displays measured values of alternate current rate and frequency, measured in A and Hz correspondingly, as shown at figure 11a.

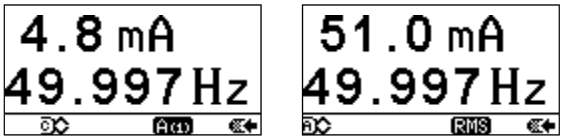

Figure 11a

6.3.1.6 When the reference and the measuring current sensors are connected to the instrument simultaneously, the measurement results are displayed at two screens, which can be switched by pressing the button . While blinking of the symbol or indicates the amplitude of which channel – reference or measuring – is displayed at the indicator. Except the measured current rate values, it also displays the frequency and phase displacement angle between channels as shown at figure 11b. For more details about the measurement of phase displacement angle see 6.3.5.

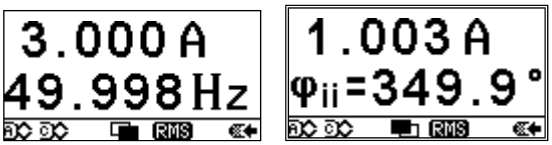

Figure 11b

6.3.2 AC voltage and frequency measurement

6.3.2.1 For measuring AC voltage and its frequency, both the measuring and reference VAF channel shall be used.

6.3.2.2 Connect terminals of the measuring VAF channel, marked as Umeas, to the AC source as shown at figure 12.

Figure 12

6.3.2.3 For viewing root-mean-square values of AC voltage, go to the view mode of valid values by pressing the button  at the front panel, then the display will show the sign RMS.

6.3.2.4 In the single-phase operation mode, the measurement results are indicated as per the figure 12a. The screen shows measured AC voltage and frequency values, measured in V and Hz correspondingly.

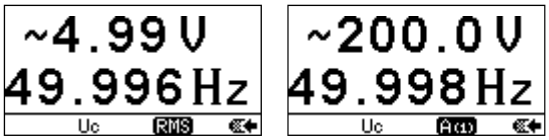

Figure 12a

6.3.2.5 For measuring three-phase voltage, connect the VAF to the three-phase system as shown at figure 12b.

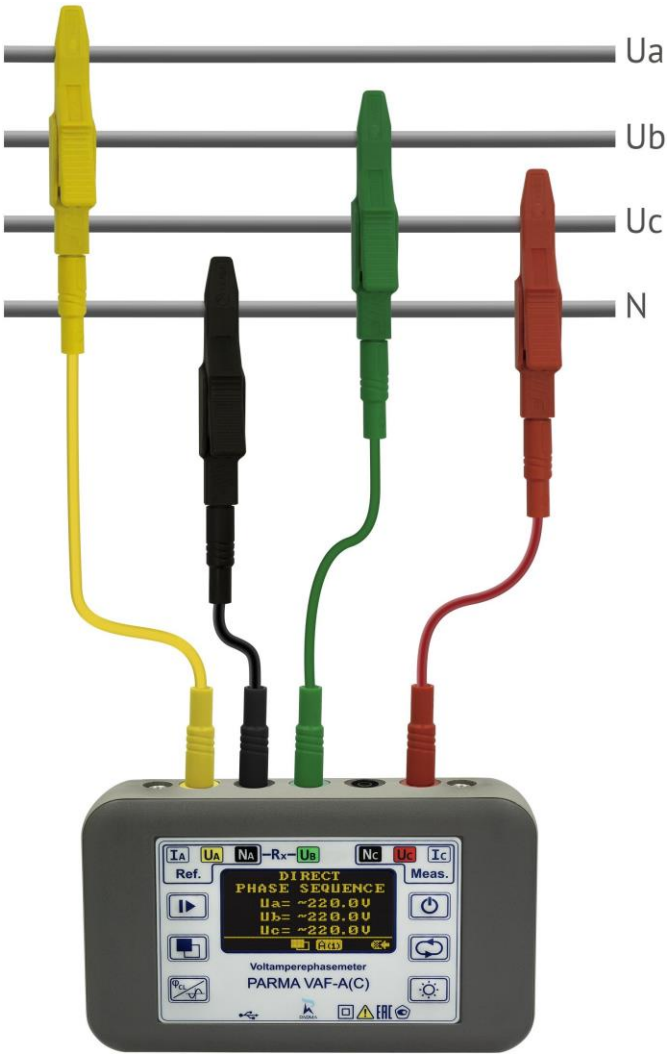

Figure 12b

6.3.2.6 For going to the three-phase VAF operation mode, it is required to press briefly the button . In the three-phase mode, the measurement results are indicated as per the figure 12c, the display modes of measured values (screens) are switched by pressing the button .

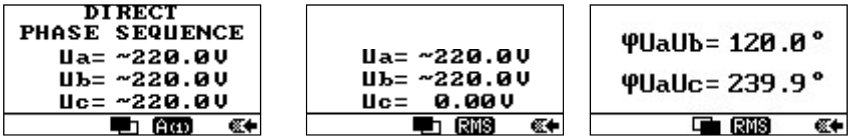

Figure 12c

6.3.2.7 For viewing root-mean-square values of AC voltage, go to the view mode of valid values by pressing the button at the front panel, then the display will show the sign RMS.

6.3.2.8 The first screen shows measured values of AC voltage measured in each channel in V as well as the phase sequence (if the signal is available at all the VAF voltage channels).

6.3.2.9 The second screen shows phase displacement angles of φUaUb, φUaUc.

6.3.3 DC voltage measurement

6.3.3.1 For measuring DC voltage, both the measuring and reference VAF channels can also be used. VAF determines automatically a type of current in measured circuit.

6.3.3.2 For measuring DC voltage, connect DC source to VAF terminals, while the positive potential of DC source should be connected to the red (yellow) terminal. If the voltage is

supplied with the reverse polarity, display readings will be indicated with the negative sign (figure 13).

Figure 13

6.3.3.3 The display, as shown at figure 13a, indicates the measured DC voltage value with the indication of the polarity in V.

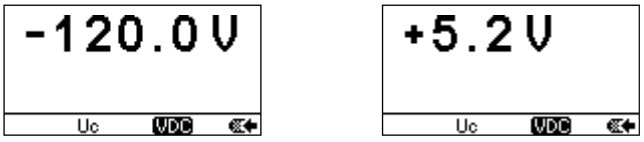

Figure 13a

6.3.3.4 A symbol located in the lower part of screen (VDC) indicates a current type.

6.3.4 Active, reactive and gross power measurement

6.3.4.1 For measuring active, reactive and gross power, it is required to use only VAF measuring current and voltage channels.

6.3.4.2 The measuring current sensor shall be connected to the measuring channel port marked as Imeas (see fig. 14).

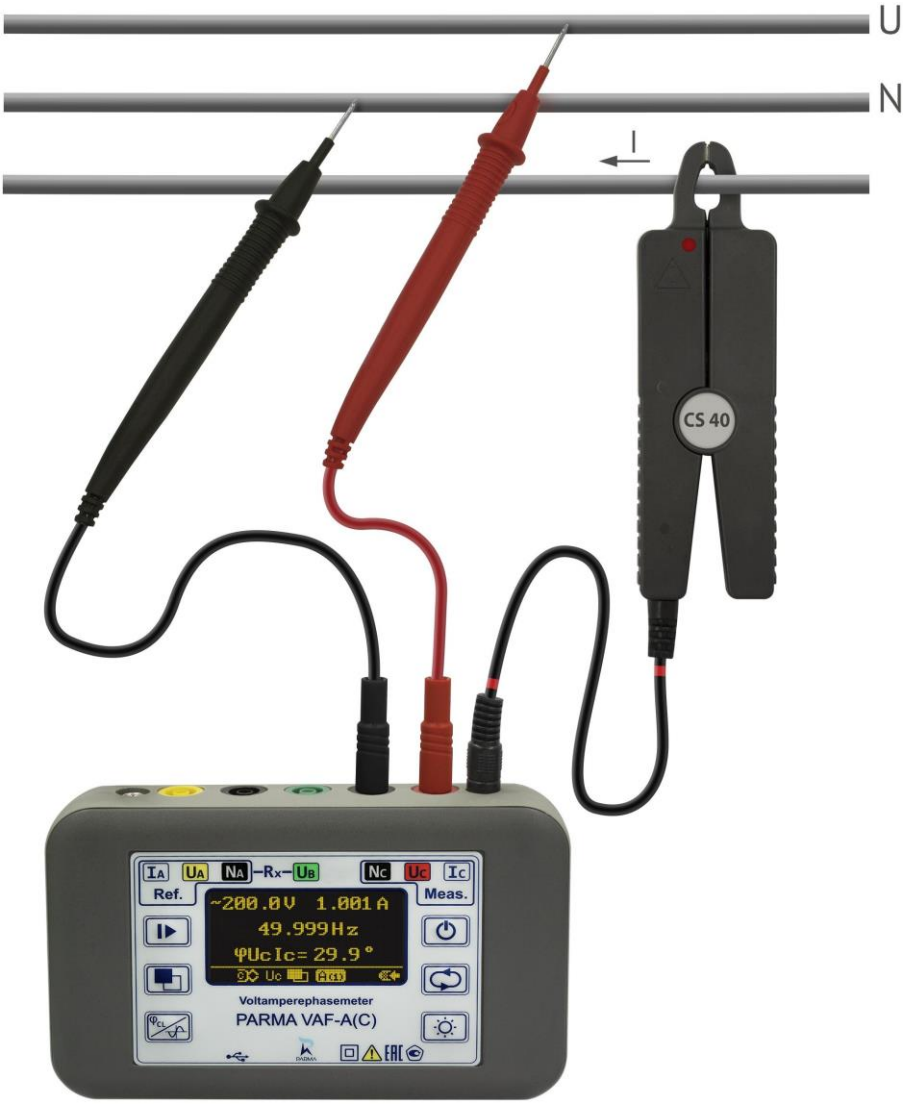

Figure 14 Connection diagram for measuring power

6.3.4.3 Brace the current lead with current sensors so that the sign "●", located at the casing of current sensors, indicate the direction towards the current source, clip ends is reliably closed, and, if possible, the current lead is in the clip middle.

6.3.4.4 Supply AC voltage to the measuring channel terminals, marked as Umeas, con- nect a phase conductor to the red terminal, and connect a "neutral" to the black terminal.

6.3.4.5 A measured AC voltage value in V is indicated at the first screen, as shown at figure 14a, in the upper line at the left, at the right – AC rate value in A, in the middle of the second line – AC frequency in Hz, in the lower line – phase displacement angle between the voltage and current of reference channel.

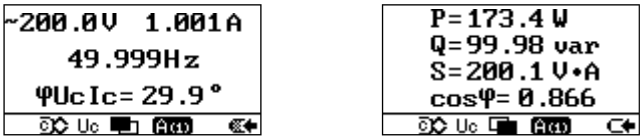

Figure 14a

6.3.4.6 The second screen with a sign indicates values of active, reactive and gross power in W, VAR, V*A accordingly, in the lower line – power factor.

6.3.4.7 When measuring power, the phase voltage Uc, supplied to the input "Uc meas", relative to which the phase displacement angle is measured for the current sensor of measuring channel, connected to the input "Ic meas", is accepted as the basis.

6.3.5 Phase displacement angle measurement

6.3.5.1 The coordinate system, accepted in the relay protection, is used during the measurement of angles. In this case, the phase voltage Ua, supplied to the input “Ua ref” is accepted as the basis, while the positive angle count goes clockwise. In separate measurement modes with unsupplied voltage Ua, the current sensor Ia, connected to the input “Ia ref” can be used as the basis, in this case, the principle of angle measurement and display remains the same.

6.3.5.2 Displaying of phase displacement angles in the instrument is possible both within the range of [0..360] degrees and within the range of [-180..0..+180] using symbols “L”, “C” in the end. In this case, the positive angle, counted clockwise, characterizes the inductive lagging (current) and is designated by the symbol “L”. During the negative angle, i.e. during capacitive leading (current), the symbol “C” is displayed.

6.3.5.3 For measuring the phase displacement angles, it is required to supply reference and measuring signals to the corresponding instrument inputs. The reference VAF input can be connected to the AC voltage source as the reference signal source, as well as the reference current sensor can be applied. The measuring VAF input and/or measuring current sensor can alsobe used for connecting measuring signals. Depending on the combination of active inputs, the instrument displays measured phase angles between the corresponding reference and measuring channels.

6.3.5.4 A quantity of active inputs can be from two (reference current/voltage channel – measuring current/voltage channel) to five (reference current and voltage channel, measuring current and voltage channel, phase voltage Ub).

6.3.5.5 For measuring phase angles in the single-phase mode switch the VAF into this mode by brief pressing of the button  , then connect the instrument as per the figure 15. In this case, the reference sensor is connected to the reference channel port, marked as “Ia ref”, the measuring current sensor – to the measuring channel port, marked as “Ic meas”. Brace the current lead with current sensors so that the sign “●”, located at the casing of current sensors, indicate the direction towards the current source, clip ends is reliably closed, and, if possible, the current lead is in the clip middle.

CAUTION! When connecting the current sensors, it is required to observe the marking because they are not interchangeable. An additional phase displacement angle will be measured during an erroneous connection or wrong orientation of current sensors.

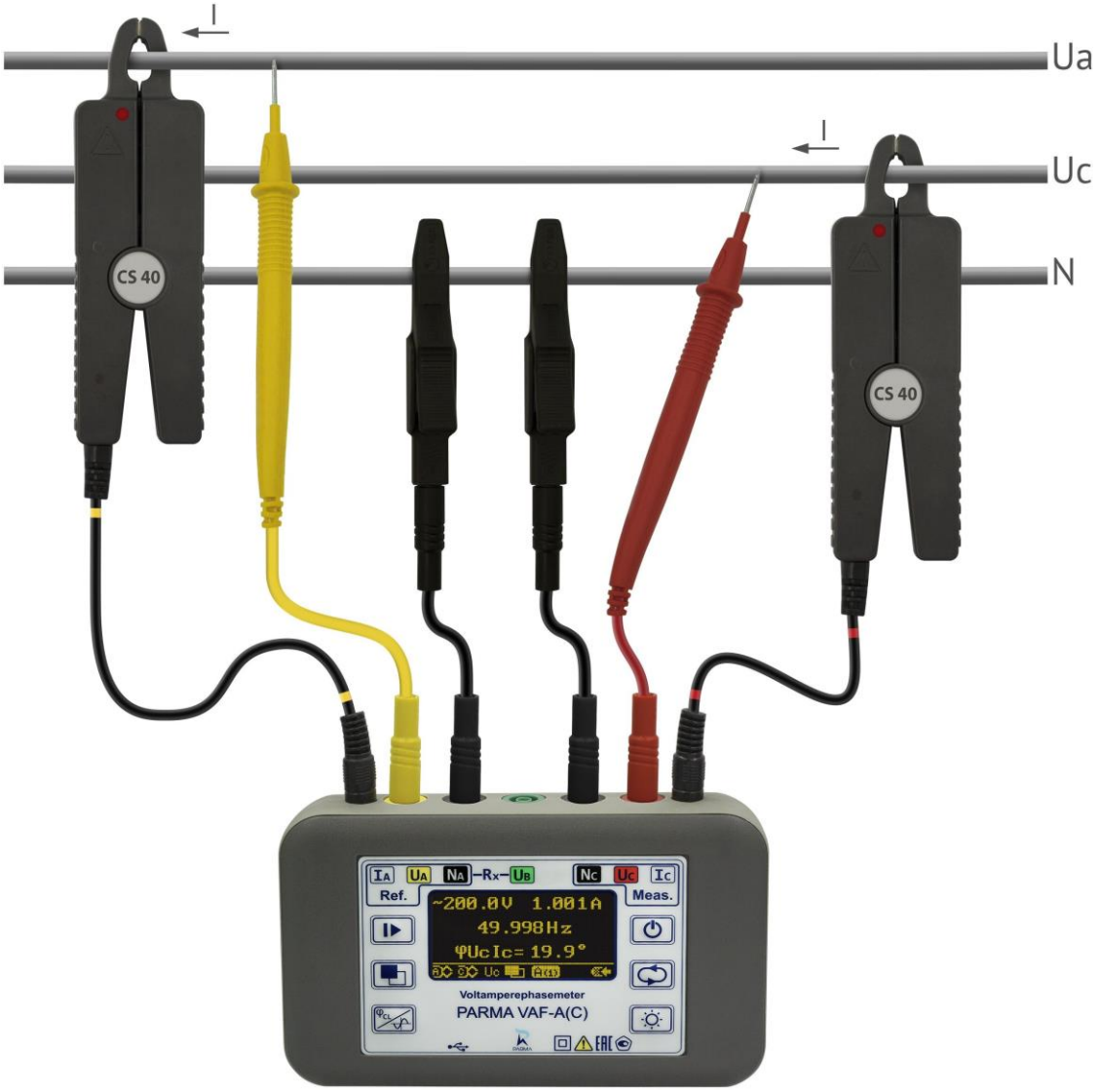

Figure 15

6.3.5.6 The diagram, specified at figure 15, reflects the maximally possible in the single-phase mode quantity of measured and displayed parameters. When the quantity of inputted signals is lower, the number of displayed parameters is also reduced (see it.6.3.5.4). It should be considered that, in the single-phase mode, the phase angle between the voltage "Ua ref" and the reference channel current "Ia ref" is not displayed.

6.3.5.7 Parameters, specified in the full connection diagram, are shown at figure 15a. A measured AC voltage value in V is indicated in the upper line at the left, at the right – AC rate value in A, in the middle of the second line – AC frequency in Hz, in the lower line – phase displacement angle between the voltage and current of measuring channel.

6.3.5.8 At the second screen – phase displacement angles between currents and voltages of the reference and measuring channels. Switching between the display modes of measured values (screens) is done by pressing the button  .

6.3.5.9 Long pressing (over 3 s) of the button  ensures the switching between two display modes of the phase displacement angles (figure 8).

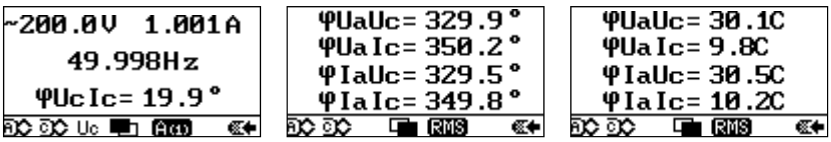

Figure 15a

6.3.5.10 For measuring the phase displacement angles in the three-phase system, it is required to press briefly the button  for transferring into the three-phase operation mode and to connect the instrument to the measuring circuit.

6.3.5.11 If only voltage circuits are connected to the VAF inputs as shown at figure 12b, then the measurement results of voltage values and phase displacement angles are indicated as per the figure 12c. The first screen indicates AC voltage values in V, measured by the VAF, as well as the phase sequence (if the signal at all the VAF voltage channels is available); and the second screen indicates the phase displacement angles φUaUb and φUaUc. Switching between the display modes of measured values (screens) is done by pressing the button  .

6.3.5.12 Connection to the reference channel port, marked as “Ia ref” of the current sensor, as specified at figure 15b, allows measuring the phase angle for each of voltages Ua, Ub and Uc relative to the reference channel current Ia. The measurement results are indicated as per the figure 15c.

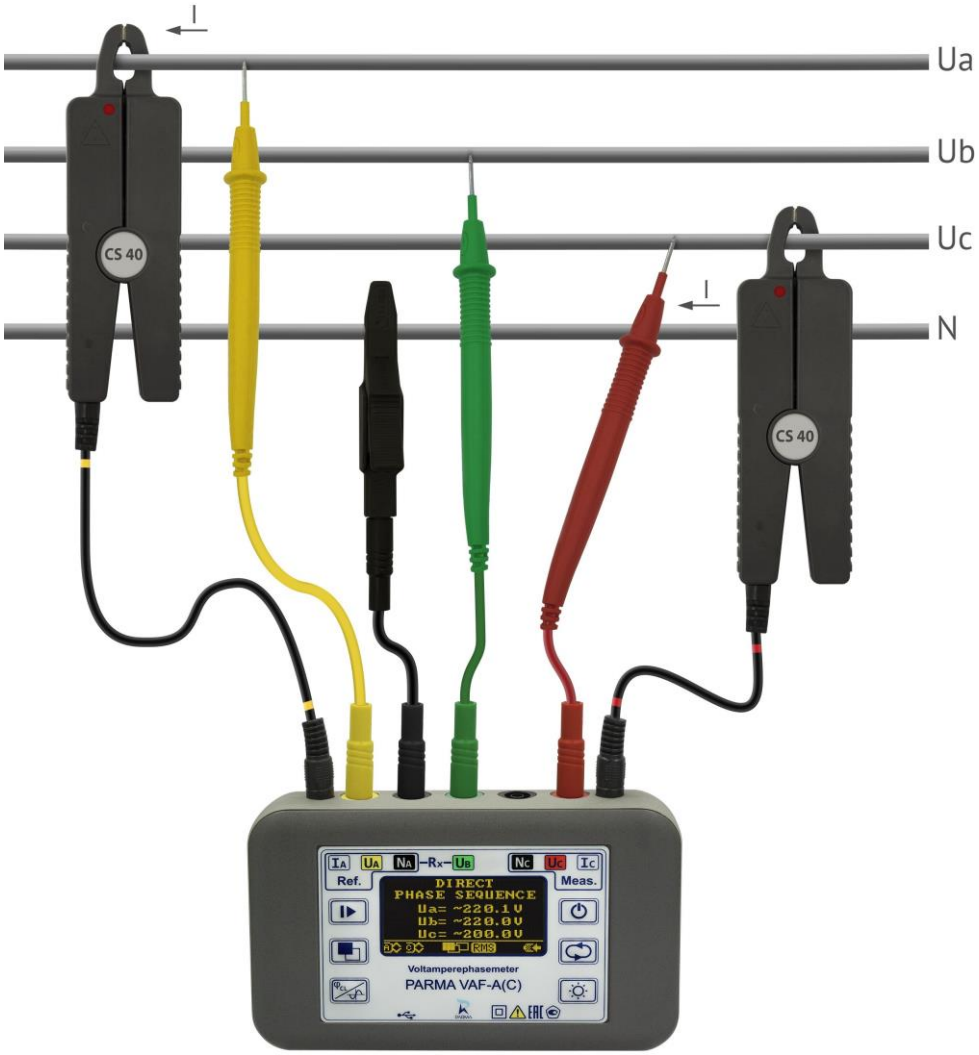

Figure 15b

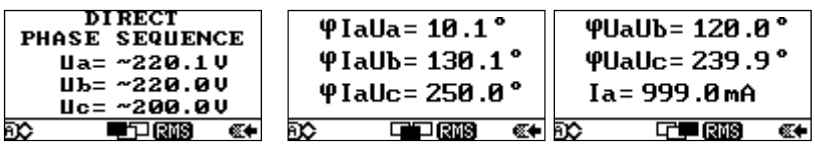

Figure 15c

6.3.5.13 The first screen indicates AC voltage values in V, measured by the VAF, as well as the phase sequence (if the signal at all the VAF voltage channels is available); and the second screen indicates the phase displacement angles φIaUa, φIaUb, φIaUc. The third screen indicates the phase displacement angles φUaUb and φUaUc, as well as the value of the AC current reference channel. Switching between the display modes of measured values (screens) is done by pressing the button  . The display format [0..360] or [180C..0..180L] is set by a long pressing of the button  .

6.3.5.14 If the corresponding voltages are unavailable, zero values of phase angles are displayed.

6.3.5.15 Connection to the measuring channel port, marked as “Ic meas” of the current sensor does not change the displayed parameters.

6.3.6 Continuity check of electrical conductors

6.3.6.1 For measuring the circuit resistance, it is required to connect the VAF to the measured circuit and go to the “Testing continuity” mode by pressing the button  , as shown at figure 16.

6.3.6.2 The measurement is done in the “Testing continuity” mode with 1mA current at a voltage between terminals of no more than 4.5 V.

Figure 16

6.3.6.3 In this operation mode, the measurement results are indicated as per the figure 16a.

Figure 16a

6.3.6.4 When the resistance is lower than 10 Ohm supplied to the VAF, the supply of a continuous audible signal is provided. If the circuit resistance is more than 500 Ohm, the corresponding displaying is provided at the VAF screen.

6.3.6.5 To compensate resistance of test cables or check the schematic, you should circuit cables it using this circuit and briefly press the button, while the actual resistance value will be displayed as the value of reference resistance Rref. In addition, in the lower line of the display the flashing icon shows R , as per the figure 16b. In this case, if the value Rref not exceed 100 Ohm, VAF will switch to the display mode of the resistance-compensated, i.e. the stored correction will be subtracted automatically from the measured value at a further measuring resistance.

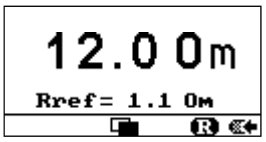

Figure 16b

6.3.6.6 If the voltage in the measured circuit exceeds 5 V, then it is displayed at the indicator together with the resistance. In this case, the measured resistance value cannot be considered as reliable.

6.3.6.7 If the voltage level exceeds the critical level of 36 V, a warning is outputted. The maximally allowable DC voltage, for which the protection of inputs is designed in the “Testing continuity” mode, is 450 VDC or 300 VAC.

6.3.7 Determination of phase sequence

6.3.7.1 The determination of phase sequence is possible only during the instrument operation in the three-phase mode.

6.3.7.2 For transferring into the three-phase mode, it is required to press briefly the button  .

6.3.7.3 Connect the VAF terminals A, B and C to the three-phase system, as shown at figure 17, defined by the phase sequence (0 °, minus 120 °, 120 °). The correct determination of phase sequence is possible only if all three phases are connected as per the VAF marking.

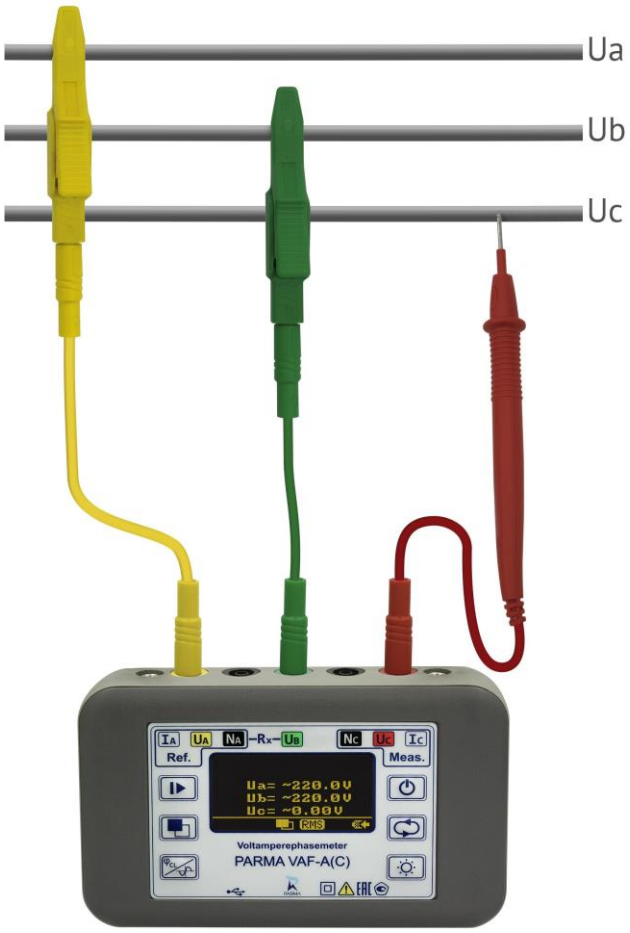

Figure 17

6.3.7.4 In case of the voltage absence at any VAF terminal, the phase sequence is not determined (figure 17a).

6.3.7.5 The phase sequence determination result is displayed in the text format as shown at figure 17a. The measured AC voltage values in V are displayed at the first screen, and the phase sequence – at the second one.

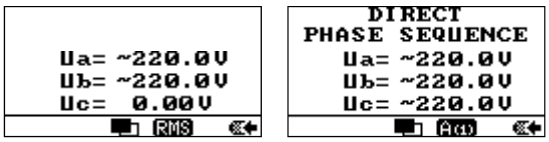

Figure 17a

7 MAINTENANCE

7.1 The commissioned VAF does not require special maintenance, except periodical inspection, replacement of power elements and cleaning of contact surfaces of the magnet core of current sensor.

8 RUNNING REPAIR

8.1 The repair can be done only by the manufacturer or organizations authorized by him/her.

9 STORAGE

9.1 The packing order during the VAF posing to storage is as per 5.2 of this manual.

9.2 Storage conditions in terms of the effect of climatic factors correspond to GOST 15150, group 5.

9.3 It is forbidden to store the VAF with DC power elements. It can cause the electrolyte

outflow and VAF damage.

9.4 Product stack is no more than 10 boxes in height.

10 TRANSPORTATION

10.1 By transportation conditions in terms of the effect of mechanical factors of the environment, the VAF is related to the group 4 as per GOST 22261 and is suitable for the transportation in well-amortized transport types (by aircraft, ships, railroad transport, railless land transport). The requirements of GOST 22261, in this case, do not cover the product in tare.

10.2 Transportation conditions in terms of the effect of climatic factors correspond to the group 4, GOST 22261.

11 TARE AND PACKING

11.1 Packing in terms of the effect of climatic factors of the environment corresponds to GOST 22261, group 4.

11.2 Packing in terms of the effect of mechanical factors of the environment corresponds to GOST 22261, group 4.

11.3 Outline tare dimensions are no more than (270x165x170) mm.

11.4 Gross weight is no more than 2.5 kg.

12 MARKING AND SEALING

12.1 The instrument indicates: name, type, trademark of manufacturer, national conformance mark (after type registration), plant number, production year, designation of input and output circuits, rated voltage, current type and power frequency.

12.2 The packing indicates: product name and type, plant number, trademark and name of manufacturer, number of technical product specifications.

12.3 The instrument sealing is done by mastic identifying the opening. Do not break seals!