ME48

Capacitive High-Voltage Transducers

Instrument-class, Voltage-scaling

CHVT-series from Mars-Energo LLC

Models: CHVT-10, CHVT-35, CHVT-110, CHVT-220, CHVT-330

USER'S MANUAL

Edition 3

MC2.727.002 UM

2007

CONTENTS

Introduction

The manual covers CHVT series of **Capacitive High-Voltage Transducers**, a set of metrological equipment (hereinafter referred to as "the CHVT") included in Mars-Energo product line for the power industry. This booklet, "the Manual", considers in length the CHVT design and operation, maintenance procedures, etc. It also describes the CHVT technical characteristics, transportation and storage, as well as manufacturer's delivery and warranty conditions.

The CHVT may be tailored to the needs of an end-user by (i) equipping it with various input converters, (ii) applying specific design solutions, and (iii) providing options in terms of metrological characteristics.

1 Safety Requirements

1.1 The CHVT shall be operated and serviced in compliance with local safety regulations in force applicable to electrical installations.

1.2 The CHVT is included in the product range of equipment compliant with the requirements of IEC 61010-1 1993 ("Safety requirements for Electrical Equipment for Measurement Control and Laboratory Use").

Warning notices are used in the text as follows:

NOTE: [important information on the topic discussed is placed herein];

Caution! [important information on the CHVT – failure to follow may cause damage to the Equipment];

Warning! [important information on personnel safety – failure to follow may cause bodily injury or death].

1.3 The CHVT provides the electrical shock protection according to IEC 61010-1 (Category I). Electric strength of secondary circuit insulation satisfies 1-minute withstand-voltage test of 3kV/50Hz load applied from an external source.

1.4 Protection provided by the enclosures is according to Russian State Standard (GOST) 14254 (IP20 code) that corresponds to IEC 60259. In terms of these documents, the protection is categorized to be Assembly class I, Contamination factor 1.

1.5 Electric insulation of input electrode (conducting primary high voltage) is strong enough to satisfy the requirements of Russian State Standard (GOST) 1516.2-97.

1.6 CHVT tests by elevated voltage shall be conducted and assisted by the personnel familiar with (i) the provisions this Manual, (ii) general arrangement and operating techniques of every device, accessory, equipment or instrument involved in the test, and (iii) local norms and safety re-

quirements applicable to electrical installations rated over 1000V.

1.7 CHVT-aided measurements shall be conducted by an operator qualified as at least Category IV personnel, according to local Code applicable to operations on electrical installations rated over 1000V. When several persons are involved, the person in charge of the test shall be at least Category IV; the others may be Category III, but not less.

2 General Description

2.1 Function of the CHVT

The CHVT is meant for conversion of high-range AC voltages (applied to CHVT input) into low-range voltages on its output, with conversion factor held constant.

CHVT fields of application are:

- Calibration of service-class instrument voltage transformers. In this case the CHVT is used as a reference standard to Class 0.2 (or less accurate) converters of voltage.
- Measurements within high range of voltage.

2.2 Operating Conditions

Normal ambient temperature is considered to be (20±5) ^{o}C.

Environmental conditions for CHVT operation may range as follows:

- Ambient temperature, °C + 5 to + 35
- Relative humidity, % up to 90 at 30°C
- Atmospheric pressure, kPa 70 to 106.7

The CHVT is supplied from mains (220±20 V, 50±0.5 Hz), provided that total harmonic distortion (THD_U) of voltage never exceeds 5%.

2.3 CHVT Delivery Package

Table 2.1 sums up the contents of CHVT delivery package. Models CHVT-10 and CHVT-35 are supplied with two voltage amplifiers (IAV, each complete with its accessories) rated at (6, 10) and (15, 35) kV, respectively. Hence, parenthesized "Qty" numbers in Table 2.1.

Table 2.1

Item Description	Order N^{o}	Qty
Primary conversion unit (PCU)	TU 4227-027-49976497-2005	1 (2)
Instrument amplifier of voltage (IAV)	MC2.032.161	1 (2)
C2 Cable (PCU-IAV instrument linkage)	MC4.853.161	1 (2)
C1 Cable (PCU internal jumper)	MC6.705.002	1 (2)
CHVT User's Manual	MC2.727.002 UM	1 copy
Calibration procedure description	MC2.727.002 CP	1 copy
Manufacturer's package	MC4.171.100	1
C4 Cable (corona-free or silicon-insulated high-voltage connection)	MC4.850.002	1

2.4 Technical Characteristics

2.4.1 Five models of the CHVT determine electrical parameters in accordance with nominal voltages and permissible error limits specified in Table 2.2, provided that primary (measured) voltage is variable from 40 to 120 % of the indicated nominal value (input sub-range).

Table 2.2

CHVT model	**Nominal value of primary voltage, kV**	**Nominal value of secondary voltage, V**	**Permissible fundamental error (see paragraph 2.4.2)**			
			Accuracy class 0.1		Accuracy class 0.05*	
			Voltage error, %	Angle error, min	Voltage error, %	Angle error, min
CHVT-10	6	100	±0.1	±5	±0.05	±3
	10	100	±0.1	±5	±0.05	±3
CHVT-35	15	100	±0.1	±5	±0.05	±3
	35	100	±0.1	±5	±0.05	±3
CHVT-110	110/√3	100/√3	±0.1	±5	±0.05	±3
CHVT-220	220/√3	100/√3	±0.1	±5	±0.05	±3
CHVT-330	330/√3	100/√3	±0.1	±5	±0.05	±3

* subject to special order

2.4.2 While operated on-site within temperature range specified in section 2.2, the CHVT may introduce some additional error not exceeding 100 % of the fundamental one.

2.4.3 See Tables 2.3 and 2.4 for technical characteristics of the two basic units of the CHVT.

Table 2.3. Technical characteristics of Instrument amplifier of voltage (IAV)

IAV Characteristic	**Value**
Overall dimensions (Height x Width x Depth), mm	(80x185x225) ±5
Maximum weight, kg	1.5
Permissible load impedance, kOhm	not less than 100
Permissible load capacity, nF	not greater than 5.0
Maximum power consumed from mains, VA	10

Table 2.4. Technical characteristics of Primary conversion unit (PCU)

CHVT model	**Nominal value of primary voltage, kV**	**Voltage applied during 1-min test, kV**	**Gauge pressure of SF6 gas filling, MPa**		**Dimensions of the capacitor unit** (height x diameter), **mm**	**Maximum weight, kg**
			Nominal	Minimum		
CHVT-10	6	22	0.1	0.0	350x150	4
	10					
CHVT-35	15	60	0.3	0.2	450x200	8
	35					
CHVT-110	110/√3	100	0.3	0.2	650x280	25
CHVT-220	220/√3	183	0.3	0.2	950x300	35
CHVT-330	330/√3	267	0.35	0.25	1100x350	45

2.4.4 The CHVT is considered ready for stable operation after a lapse of 30 minutes since its power-up. From that point on CHVT technical characteristics are as described in this chapter. More specifically, its metrological properties are as specified in Table 2.2.

2.4.5 CHVT continuous run-time shall not exceed 4 hours, after which 1-hour standing time is required.

2.4.6 Mean Time to First Failure (MTFF) of the CHVT is at least 8000 hours.

Typical lifetime – at least 10 years.

2.5 General arrangement and Principles of operation

2.5.1 CHVT block diagram is pictured below:

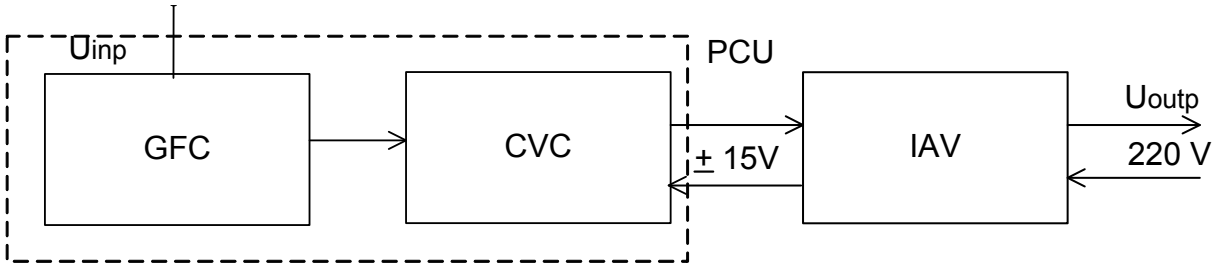


Fig 2.1 Flow chart and Block diagram of the CHVT

2.5.2 Two units comprise the major part of the CHVT:

- Primary conversion unit (PCU) that includes gas-filled capacitor (GFC) and electronic current-to-voltage converter (CVC);
- Instrument amplifier of voltage (IAV).

When the CHVT is connected to determine phase-to-phase voltage (6, 10, 35 kV), two PCUs are used, each linked to a separate input of differential IAV unit.

Primary voltage from the circuit under review is applied to capacitor's high-voltage electrode. Current-to-voltage converter (CVC) accepts AC flow from the capacitor. AC voltage generated by the CVC is applied to IAV amplifier which makes it in range with nominal value of secondary voltage declared for the model.

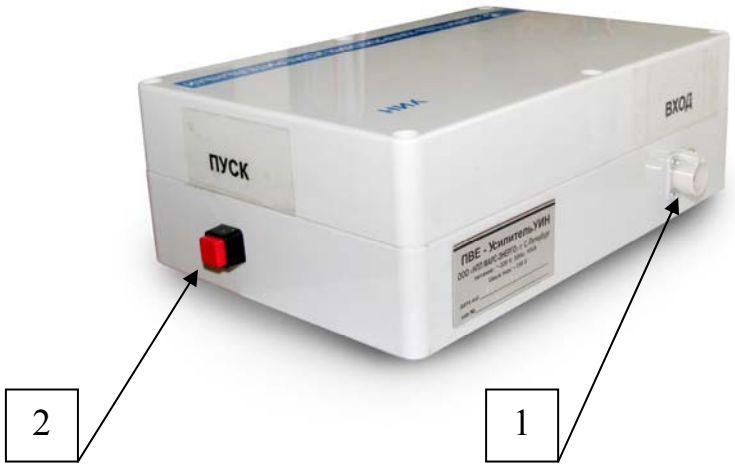
The CVC is supplied from IAV unit.

The entire CHVT requires no setting procedures.

2.5.3 The two major units of the CHVT are pictured on Fig. 2.2 to 2.5.

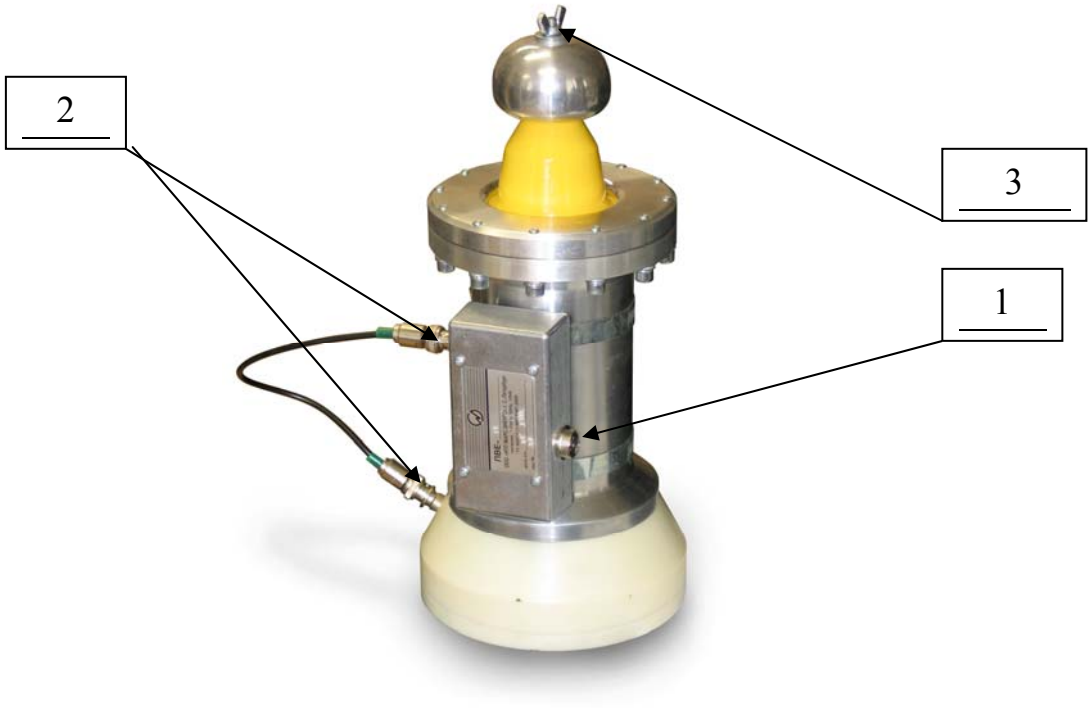
1) "Output" terminals for voltage test leads (black is neutral). Supply signal to a measuring instrument.
2) "Output" coaxial connector. It supplies the same signal that "Output" terminals do (item 1 above).
3) "Ready" indicator (shows the readiness of the CHVT);
4) "Mains" socket for 220V mains cord (complete with indicating power switch).

Fig 2.2 IAV unit front panel



1) "Input" socket (just one for single-input IAV unit).
   Accepts plug from Instrument cable C2 (order N^{o} MC4.853.161).
2) "Start" button (initiates measurement).

Fig 2.3 IAV unit rear panel

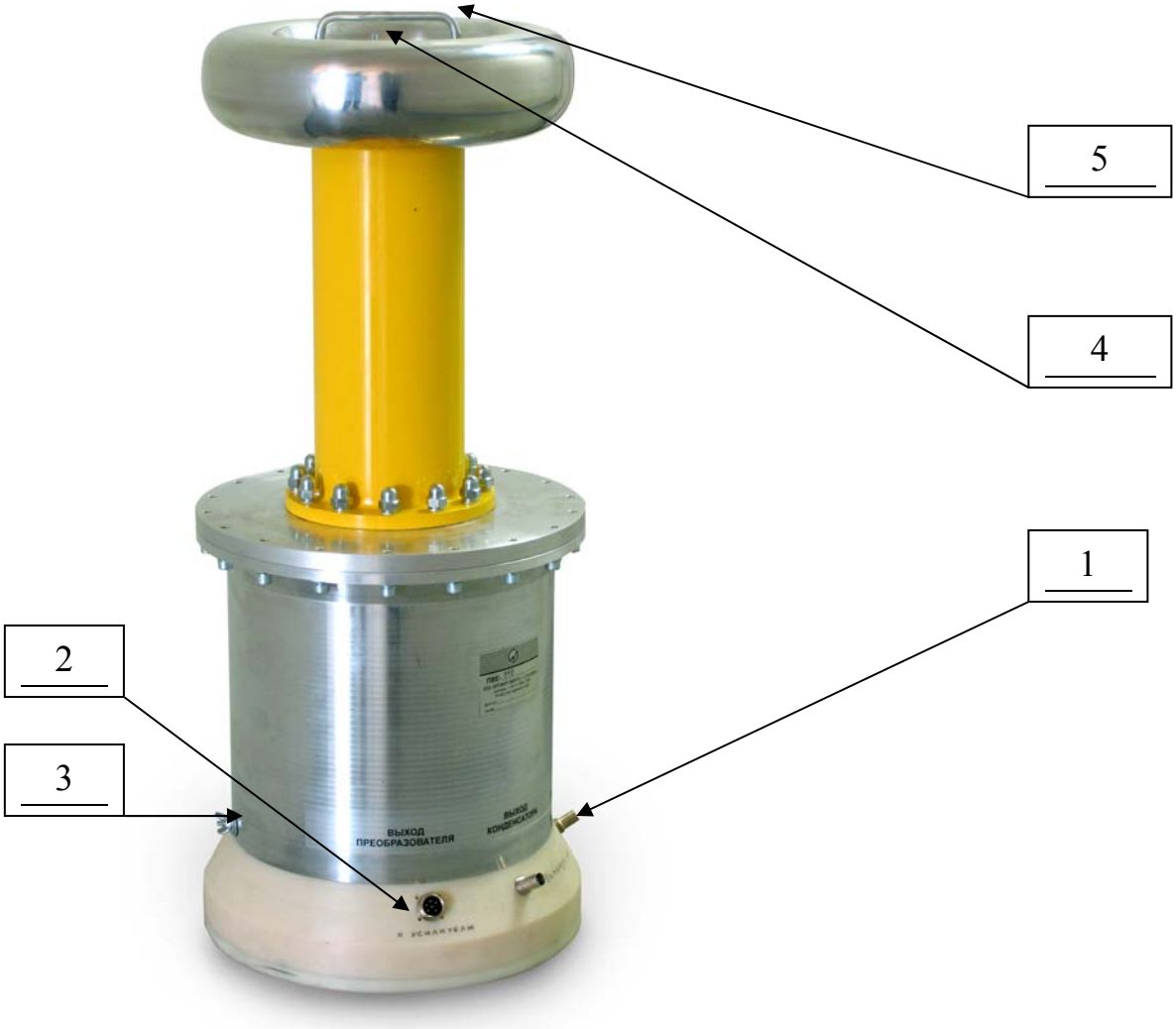


1) Connector for linkage between PCU and IAV;
2) Connectors for linkage between CVC input and GFC output via C1 jumper cable;
3) High-voltage electrode.

Fig 2.4a PCU for the CHVT-10

1) Connectors for linkage between CVC input and GFC output via C1 jumper cable;
2) Connector for linkage between PCU and IAV;
3) Ground terminal; 4) High-voltage electrode.

Fig 2.4b PCU for the CHVT-35



1) Connectors for linkage between CVC input and GFC output via C1 jumper cable;
2) Connector for linkage between PCU and IAV;
3) Ground terminal; 4) High-voltage electrode. 5) Lifting bracket

Fig 2.4c PCU for the CHVT-110

Figure 2.5. Bottom view of PCU and its manometer.

3 Placing in Service the CHVT

3.1 Notes on Operating Conditions

Caution! If the CHVT has been moved from a cold environment (with ambient temperature below 0 ^{o}C) into a warm one, it shall be left to stand for at least 4 hours at room temperature before applying power, to make sure that no condensation remains inside.

Warning! The CHVT shall not be used under the ingress of moisture on insulator or inside IAV body.

3.1.1 Gas pressure inside gas-filled capacitor (GFC) shall be at least equal to minimum value specified in Table 2.4 for the model.

3.1.2 Check to see if the surface of GFC insulator is clean. Use lint-free cloth moistened with ethyl alcohol to remove dirt or deposits, if there are any.

3.2 Unpacking

Check that the delivery package contains all items specified in Supply Agreement. Check to see if the manufacturer's seal is intact. Should anything in the package is found damaged, contact the supplier immediately.

3.3 Putting into Operation

3.3.1 Ensure that all measuring instruments to be grounded be provided with reliable linkage to protective ground loop. Ground linkage shall be secured before, but removed after all other connections.

Use manufacturer-supplied cables only. Inspect the cables. Ensure all joints are made properly to avoid overheating and excessively high resistance.

4 Operating Techniques

Warning! *The circuits to be measured shall be completely de-energized before connecting or disconnecting the CHVT to them. This rule must be complied with as well as all regulations in force applicable to electrical installations.*

4.1 General guidelines for linkage

4.1.1 Immediate linkage between ground terminal on the transformer under test and CHVT ground terminal shall be made with copper conductor of at least 4 mm^2 cross-section connected in turn to protective ground loop.

4.1.2 The CHVT shall accept low-voltage cables *before* being connected to high-voltage conductor of the circuit to be measured.

4.1.3 Before connecting the CHVT to its load (measuring instrument) make sure that load parameters comply with the requirements specified in Table 2.3 for IAV unit.

4.1.4 Suppose a CHVT consists of two PCUs and a differential IAV unit. When such a set is connected phase-to-neutral way, “Input-1” socket of the IAV accepts plug from Instrument cable C2, while “Input-2” is left disconnected.

4.1.5 Sample diagram of phase-to-neutral connection of the CHVT is pictured in Appendix A (Fig. A-1); another diagram on Fig. A-2 gives an example of phase-to-phase connection.

4.2 Precautions when applying high voltage (all models except CHVT-330)

4.2.1 Before applying 50 Hz high voltage to the CHVT, take safety measures and make sure that (i) gas pressure in PCU capacitor is at least equal to minimum permissible value that Table 2.4 declares for the model, and (ii) test voltage does not exceed 120% of model’s nominal value specified in Table 2.2. Each CHVT has its model indicated on the nameplate stenciled on its body.

4.2.2 **Warning! The entire nominal input voltage shall in no way be applied like a “kick” given from network side.**

4.2.3 It is recommended that immediate linkage between high-voltage conductor of the transformer under test and CHVT high-voltage electrode be made with corona-free high-voltage “C4 Cable” included in CHVT delivery package. The sole exception is CHVT-10 connection made with silicon insulated “C4 Cable”.

4.3 Special measures before applying high voltage to CHVT-330

Warning! *Be sure to make provisions below when connecting the CHVT-330 to high voltage.*

4.3.1 Mount the CHVT-330 on a support of at least 400 mm height (e.g. manufacturer's box).

4.3.2 Use corona-free bus to link high-voltage electrode of the CHVT-330 to output conductor of high-voltage electric installation. The bus shall vertically drop on CHVT-330 high-voltage electrode (its vertical portion immediately above the CHVT-330 shall be at least 1 meter long).

4.3.3 CHVT-330 unobstructed clearance to high-voltage electric installation shall be at least twice the required insulation distance attributable to either the installation or the CHVT-330, whichever is greater.

4.3.4 Linkage between terminals of high-voltage electrodes shall be of uniform topology, as compared to the linkage between ground terminals.

4.4 Turning the CHVT on

CHVT turning-on procedure includes the following steps:

- Set on the "Mains" switch on front panel of IAV unit;
- Depress IAV "Start" button and hold it for the duration of 1 to 3 seconds;
- Check to see that "Ready" indicator is lit on IAV front panel;
- If it is, proceed to measurements after a lapse of 10 to 15 minutes.

NOTE: Incorrect wiring of measurement circuits may prevent "Ready" indicator from going on, or cause the light to rise and fall. Check if (i) the connections are made as instructed in sections 4.1 to 4.3, and (ii) IAV unit load is within permissible limits specified in Table 2.3.

5 User Maintenance

5.1 Maintenance is the care and servicing that the user provides for keeping his equipment operational over its life cycle.

5.2 Every maintenance operation shall meet safety requirements described in sections 1 and 4, as well as local technical norms and safety regulations in force. Damage to the equipment should be repaired by the manufacturer.

5.3 If the equipment is used appropriately, it requires no occasional maintenance but checking gas pressure before each test. Routine maintenance includes minor operations, such as:

Table 5.1

Operation	Intervals
Strength test of electric insulation	Once a year
Cleaning the insulator surface with alcohol	At least once in a month
Cleaning capacitor's output connector with alcohol	At least once in a month
Gas pressure check	At least once in a month, not counting checks before tests
Inspection of the connectors: checking the reliability of their fixing plus cleaning the oxidized contacts, if any.	Once a year

5.4 Malfunctions and remedies.

Table 5.1

№	Failure	Typical cause and remedy
1	Though "Mains" switch is on, power is not supplied.	Make sure the power cord is plugged into operational mains socket.
2	Though "Start" button is depressed, "Ready" indicator either remains off, or the light rises and falls.	Overload condition on IAV output. Check IAV unit load against Table 2.3.
2	Gas pressure in PCU dropped below minimum value specified for the model.	Pressure-tightness defect. To be corrected by the manufacturer.

6 Storage Conditions

6.1 The CHVT shall be stored indoor, in a heated storeroom.

Storage conditions in the manufacturer's package:
Ambient temperature: 0°C…+40°C
Relative Humidity: ≤ 80% at 35 °C

6.2

Storage conditions without the package:
Ambient temperature: +5°C …+35°C
Relative Humidity: ≤ 80% at 25 °C

6.3 The content of dust, evaporated alkalis or acids, aggressive gases, and other corrosive agents in storeroom air shall not exceed the limits specified for type 1 atmosphere in Russian State Standard (GOST) 15150-69.

7 Transportation

7.1 The CHVT should be transported packed in the manufacturer's box.

7.2 The CHVT can be transported in any enclosed vehicle including air-tight plane cargo compartment.

Ambient conditions allowed during transportation:
Ambient temperature: -20°C…+55°C
Relative Humidity: ≤ 90% at 25 °C

8 Marking and Sealing

8.1 Rear panel of IAV unit has manufacturer's stamp (nameplate) that bears:
- IAU model and serial number;
- Manufacturer's name and trade mark;
- Power supply type and nominal voltage;
- Maximum output voltage;
- Date of manufacture.

8.2 The manufacturer's stamp (nameplate) stenciled on PCU body displays:
- Sign of National Registry of Measuring Instruments;
- Manufacturer's name and trade mark;
- PCU model and serial number;
- Date of manufacture;
- Power supply type and nominal voltage.

8.3 Side and end faces of CHVT shipping container bear the following handle-with-care symbols: "This side up", "Fragile", "Shelter from humidity".

8.4 The seal is installed in the hole of an IAV init fastening screw.

After opening the unit for repair, the seal should be reinstalled by the authorized Service Companies only.

9 Warranty

9.1 Mars-Energo LLC warrants that the Equipment will be free from defects in material and workmanship for a period ending on earlier of 18 (eighteen) months from its purchase date. During this warranty period, Mars-Energo will repair or replace the Equipment sent to Mars-Energo by customer which Mars-Energo reasonably determines as defective in accordance with the warranty.

9.2 Equipment believed to be defective may be sent (transportation prepaid) within the warranty period to Mars-Energo for inspection. The following documents shall be enclosed:

- Warranty claim (see section 12);
- Reasonable evidence (original invoice, cash receipt or similar document specifying the dealer's name, purchase date, model and serial number of the Equipment) proving that the Equipment was purchased within the 18 months period to the date of claim. Without the said evidence, the beginning of warranty period is dated back to Equipment manufacture.

Mars-Energo will not bear the cost of Equipment diagnosis, repair or replacement if the enclosed documents are illegible or improperly filled in.

The warranty is considered null and void if the serial number on Equipment nameplate has been erased, emended or made illegible.

If the inspection by Mars-Energo confirms that the Equipment is defective, it will be repaired or replaced (at Mars-Energo's option) at no charge, within the underlisted limitations (paragraph 9.3), and returned prepaid to the location specified in the customer's Warranty claim. Expendables and consumables are not included in this warranty.

9.3 The above warranty does not cover repair of damage attributable to:

1) normal wear of an Equipment part;

2) depletion or wear-out of an expendable or consumable (material or component to be replenished or replaced repeatedly during Equipment lifetime), e.g. non-rechargeable galvanic cell;

3) damage to hardware or software (or their alteration) attributable to:

a) failure of customer to operate the Equipment properly, including:

- Equipment misuse resulted in physical damage to internal parts, surface, controls, or LCD screen;
- Equipment installation or maintenance in defiance of the instructions outlined in the User's manual;
- Equipment operation in defiance of local technical norms and safety regulations in force;

b) Equipment infection with computer viruses, improper installation of software, or running the Equipment under control of customer-supplied software;

c) defects within (or negative influence of) any customer's upper-level system or its components (other than Mars-Energo products compatible with the Equipment);

d) running the Equipment with accessories, peripherals, and ancillary equipment of the type, standard, and condition other than those recommended by Mars-Energo;

e) Equipment repair attempted or made by customer or third parties;

f) Equipment adjustment or alteration without previous Mars-Energo consent given in writing;

g) gross negligence of all kinds, accident, fire, flood, penetration of moisture, chemicals or other substances, failure or fluctuations of electrical power or air conditioning, improper supply voltage, Equipment exposure to heat shock, radiation, electrostatic discharges (including lightning), or other external factors.

9.4 This warranty extends to hardware components only, and does not include any software from Mars-Energo or other supplier licensed to customer (explicitly, implicitly, or exclusively) without benefit of Mars-Energo warranties.

9.5 We strongly recommend that some removable media be used to maintain an actual backup copy of all data you store in Equipment internal memory. Mars-Energo will in no way accept responsibility for any specific, accidental, direct or indirect damage or losses attributable to Equipment usage or failure to use the Equipment, including but not limited to, (i) missed profit or benefit, (ii) disruption in business or stoppage of work, (iii) data loss or failure to use the data, (iv) expenses of data recovery, (v) disclosure of confidential information or violation of privacy.

Manufacturer's address for warranty claims follows.

Mars-Energo LLC.
113A, Fontanka embankment,
Saint-Petersburg, Russia 190031

Tel/Fax (when dialed outside Russia):
007 812 315 13 68; 007 812 327 21 11.

10 Packing Form

CAPACITIVE HIGH-VOLTAGE TRANSDUCER
"CHVT-xxx" _____№_____

The aforesaid equipment has been packed by Mars-Energo LLC.
in compliance with the Technical Requirements in force.

Packer signature: _____ (*Initials and Name*)
Date: _____

11 Acceptance Form

CAPACITIVE HIGH-VOLTAGE TRANSDUCER
"CHVT-xxx" _____№_____

The aforesaid equipment has been manufactured in compliance with Technical Specifications TS 4220-026-49976497-2005 and conforms to the Technical Requirements in force.

Head of Quality Control Department: _____ (*Initials and Name*)

Corporate Seal:
Date: _____

Date of sale: _____

(Signature) _____ (*Initials and Name*)

(Corporate Seal)

12 Warranty Claim

In the event of any Equipment malfunction or defect in workmanship or material during the warranty period (provided that the transportation, storage and operating conditions outlined in this Manual are fulfilled), send the Equipment to Mars-Energo LLC along with Warranty claim containing the following information:

1) Equipment Model and Serial number;

2) Date of manufacture;

3) Date of putting the Equipment into operation;

4) Condition of the manufacturer's seals (in place, destroyed, absent). See section 8 for the location of the seals.

5) Description of the malfunction or defect;

6) Customer details (Company name, address, etc., including name and phone number of whom the reply may concern).

Find equipment identification data on the nameplate located on the body or rear panel of the Equipment.

13 Calibration Procedure

The Equipment calibration procedure shall be carried out in compliance with the calibration methods established by D.I. Mendeleev Institute for Metrology (VNIIM, Saint-Petersburg, Russia).

The calibration procedure is described in the document (MC2.727.002CP) included in the delivery package (see Table 2.1).

A period of one calendar year is considered maximum time between calibrations.

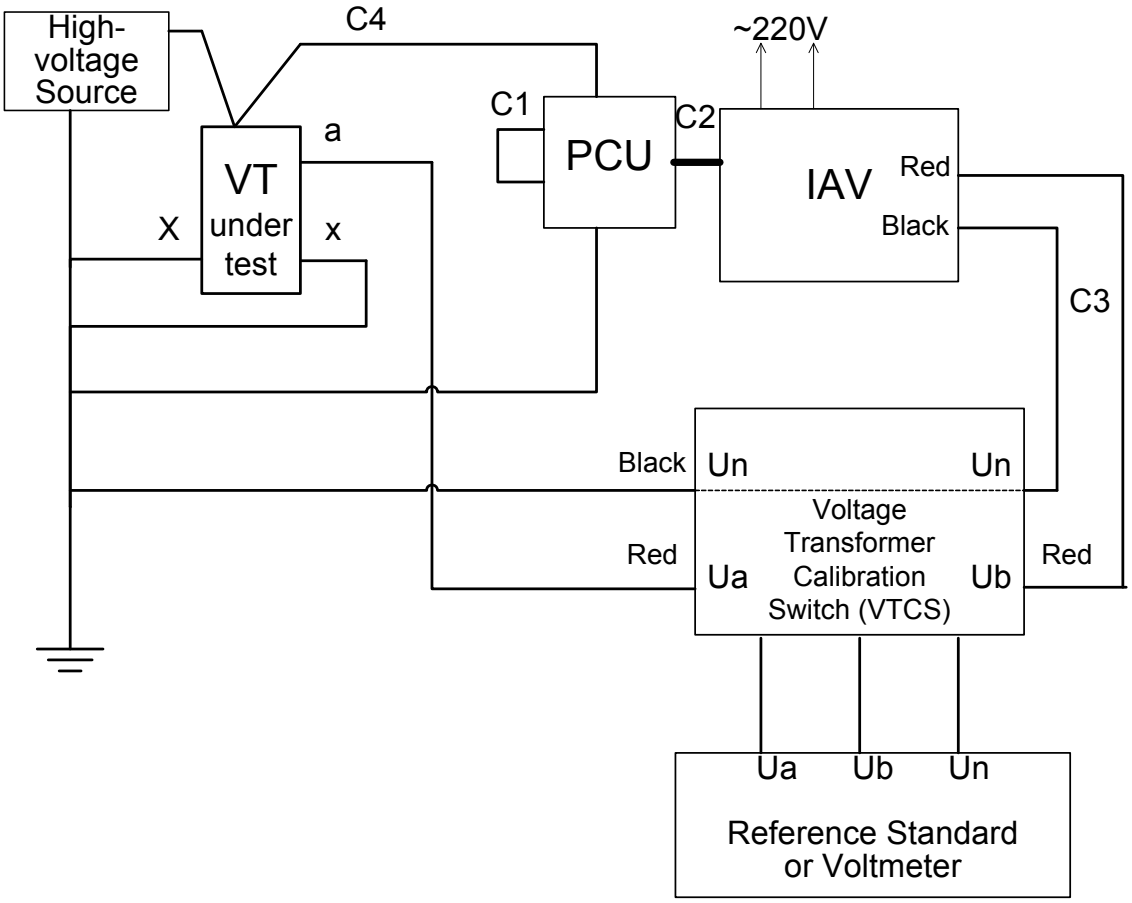
Mars-Energo LLC bears the responsibility to calibrate the Equipment before delivery and after each repair.

Use the calibration check form below to keep a record of calibrations over Equipment life cycle:

"CHVT-xxx", serial number_____

Date of Calibration	Type of Calibration	Calibration Results	Calibrator's Signature, Initials and Name

Appendix A. Recommended diagrams of Connections



PCU Primary Conversion Unit, included in CHVT delivery package;

IAV Instrument Amplifier of Voltage, included in CHVT delivery package;

C1 Coaxial cable (PCU internal jumper);

C2 PCU-IAV instrument linkage;

C3 IAV-Comparator instrument linkage;

C4 High-voltage connection (corona-free or silicon-insulated).

Fig. A-1 Circuit diagram of CHVT connection to comparator

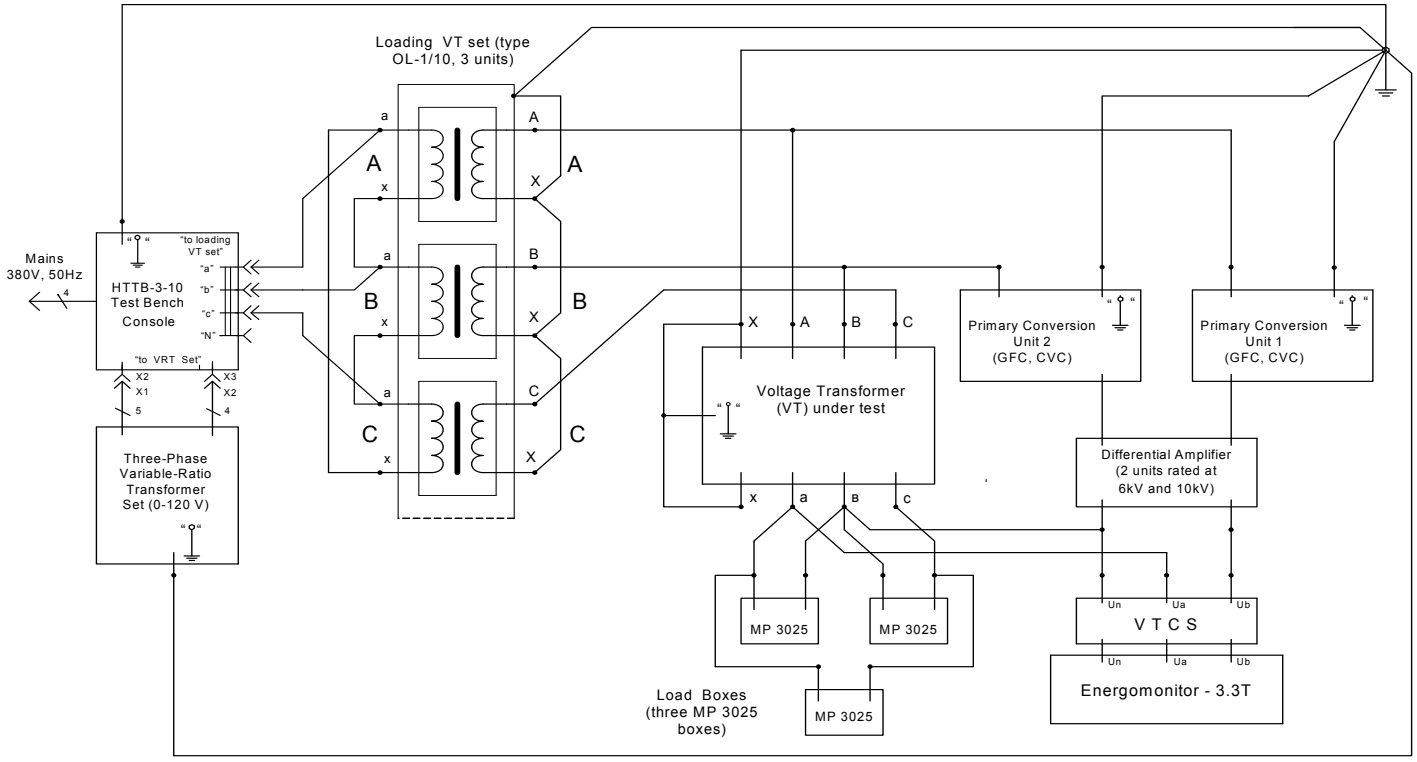


Fig. A-2 Circuit diagram of CHVT phase-to-phase connection