

Multifunctional Portable Test System MTS-ME-3.3T1-P

User Manual

Edition 2

MC2.702.500-01 UM

2016

TABLE OF CONTENTS

INTRODUCTION	3
1 SAFETY REQUIREMENTS	3
2 DESCRIPTION AND OPERATING PRINCIPLES	3
2.1 Sphere of application	3
2.2 Description of the test system and its components	4
2.2.1 <i>Multi-functional reference meter Energomonitor -3.3TI</i>	<i>6</i>
2.2.2 <i>Generator Energoforma 3.3</i>	<i>8</i>
2.2.3 <i>Generator Energoforma 3.3-100</i>	<i>10</i>
2.2.4 <i>Scanning heads</i>	<i>10</i>
2.3 Design and Operation	11
3 preparing for operation	12
3.1 Notes on operating conditions	12
3.2 Turning on	12
4 operation	13
4.1 PC-controlled operation	13
4.2 Operation in stand-alone mode	13
5 technical support	14
<i>Appendix A. Connection diagrams</i>	15
<i>Appendix B. Software</i>	17
<i>Appendix C. Practical notes for testing electrical energy meters ...</i>	19

INTRODUCTION

This User Manual describes the multi-functional test system MTS ME 3.3T1-P (the test system below) manufactured in compliance with Technical Specifications TS 4381-053-49976497-2013.

1 SAFETY REQUIREMENTS

1.1 While the test system is being used as intended, the “Interbranch rules for Labour Safety (Safety Rules) When Operating Electrical Systems” (M., Energoatomizdat, 2001) and the corresponding local electrical safety requirements must be observed.

The symbol



placed on the components of the test system is intended to alert the user to the presence of important operating instructions. See section 3.2 “Turning on”.

1.2 The test system is operated according to the safety requirements specified in IEC 61010-1; Measurement category: II; degree of protection against pollution: 1.

1.3 IEC 60529 protection code: IP20.

1.4 The components of the test system must be connected to the grounding bus before applying power to the test system.

2 DESCRIPTION AND OPERATING PRINCIPLES

2.1 Sphere of application

The multi-functional test system MTS ME 3.3T1-P is designed to perform calibration and verification of measuring instruments listed in the next section. The system generates waveforms with the electrical parameters specified below and measures electrical parameters such as active, reactive and apparent power, AC frequency, current and voltage, phase angles, power factor, and power quality parameters, including (but not limited to):

- RMS of the fundamental harmonic of voltage (U_{C1})
- RMS of the voltage harmonic of order h (frequency $h \cdot f_1$), $h = 2 \dots 50$ (U_{Ch})
- RMS of the voltage interharmonic of order m (frequency $m \cdot f_1$), $m = 0.5 \dots 50.5$ in 1.0 increments (U_{Cm})
- RMS of the fundamental harmonic of current (I_{C1})
- RMS of the current harmonic of order h , $h = 2 \dots 50$ (I_{Ch})
- RMS of the current interharmonic of order m (frequency $m \cdot f_1$), $m = 0.5 \dots 50.5$ in 1.0 increments (I_{Cm})
- Phase angle between the voltage harmonic of order h and the current harmonic of order h in the same phase
- Voltage harmonic of order h in reference to fundamental harmonic, $h = 2 \dots 50$ [$K_U(h)$]
- Current harmonic of order h in reference to fundamental harmonic, $h = 2 \dots 50$ [$K_I(h)$]

- Active power of the fundamental harmonic (P_1)
- Reactive power of the fundamental harmonic (Q_1)
- Active power of the harmonic of order h , $h=2\dots 50$ ($P_{(h)}$)
- Total Harmonic Distortion of voltage (THD_U)
- Total Harmonic Distortion of current (THD_I)
- Positive sequence voltage of the fundamental (U_1)
- Zero sequence voltage of the fundamental (U_0)
- Negative sequence voltage of the fundamental (U_2)
- Negative sequence voltage ratio (K_{2U}) and zero sequence voltage ratio (K_{0U})
- Positive sequence current of the fundamental (I_1)
- Zero sequence current of the fundamental (I_0)
- Negative sequence current of the fundamental (I_2)
- Phase angle between the voltage and current of positive, or negative, or zero sequence
- Flicker short-term severity
- Duration of voltage dip (Δt_d)
- Depth of voltage dip (δU_d)
- Height of voltage swell ($K_{sw U}$)
- Duration of voltage swell (Δt_{sw})

Typical applications include metrological (test) laboratories at industrial enterprises.

2.2 Description of the test system and its components

The reference instrument included in the test system utilizes analogue-to-digital conversion principle, so that the instantaneous values of input currents and voltages are converted into digital codes from which the arrays of sampled instantaneous values are created. The arrays are used by firmware (stored in the EEPROM memory of the central processor unit) to make all programmed calculations.

The test system can be used (separately or in combination with a PC that gives extra capabilities) for calibration and accuracy testing of the following single- and three-phase instruments:

- Active, reactive, and apparent energy meters
- Wattmeters, varmeters and measuring converters of active/reactive power
- Phase meters, frequency meters and power factor meters
- Voltmeters, ammeters, voltage and current measuring converters operating within the mains frequency range
- Power quality meters.

The test system operates in 2 modes:

- PC-controlled mode (with use of standard communications interfaces and Windows-based software)
- Stand-alone mode which means manual control of the test system via the keypads and graphical displays of the Energomonitor and Energoforma instruments.

The parameters and waveforms being measured and/or generated can be viewed either on the displays of the Energomonitor and Energoforma instruments (respectively) or on a PC.

The test system is powered from a mains supply ($220 \pm 10\%$ V, $50 \pm 5\%$ Hz, $THD \leq 5\%$).

The test system is offered in various options with respect to the output current ranges, power outputs of voltage and current channels etc.

The test system includes the components listed below.

- Reference measuring instrument: the multifunctional reference standard Energomonitor 3.3T1 (EM3.3T1) registered with National Registry of measuring instruments under #39952-08

- Source of test signals: the programmable waveform generator Energoforma 3.3 (EF3.3) or the programmable waveform generator Energoforma 3.3-100 (EF3.3-100).

The legend of the test system contains information about the options as specified in the purchase order:

MTS-ME XX-P-X-XXX-XX/XXX-X/XXX TS 4381-053-49976497-2013
 1 2 3 4 5 6

Meaning of the positions:

1 – relates to the reference meter in use:

- 3.3T1 – Energomonitor- 3.3T1

2 – relates to the design version option:

- P - portable

3 – relates to accuracy:

- 10 – includes Energomonitor 3.3T1

4 – relates to the maximum value of generated current I_{\max} , A:

- 12
- 110

5 – relates to the power output of the current/voltage channels (VA):

- 15/5
- 45/100

6 – relates to the output voltage range U_{\min}/U_{\max} , V:

- 6/264 (6...264 V) (nominal values of phase / phase-to-phase voltages: 60/60* $\sqrt{3}$ V and 220/220* $\sqrt{3}$ V).

For example, MTS ME 3.3T1-P-10-12-15/5-6/264 is a meter test system intended for verification and calibration of instruments that measure AC voltage, current and power, it is equipped with the reference meter Energomonitor 3.3T1 and the source of test signals Energoforma 3.3-12.



Fig. 1.1 MTS ME 3.3T1-P – general view

Connection diagrams of the test system are represented in Appendix A. A measuring instrument included in the test system is calibrated in accordance with its own calibration procedure.

2.2.1 Multi-functional reference meter Energomonitor -3.3T1

The front panel is shown in Fig. 2.1. The full description of the instrument is given in its own user manual. See the user manual for the Energomonitor 3.3T1 (MC3.055.028 UM document).

The voltage circuits of the instrument have three plugholes (**UA, UB, UC**) for phase test leads, and one more plughole (**UN** input) for a neutral one. As to the current circuits, they share one connector (input-output) for phase currents (**IA, IB, IC**). The Current Transformers Block (CTB) or current clamps provide galvanic isolation between the current circuits. The voltage circuits are symmetrical and have one common point (neutral conductor). All of the connectors and terminals are located on the upper panel of the EM3.3T1 (Fig. 2.2).

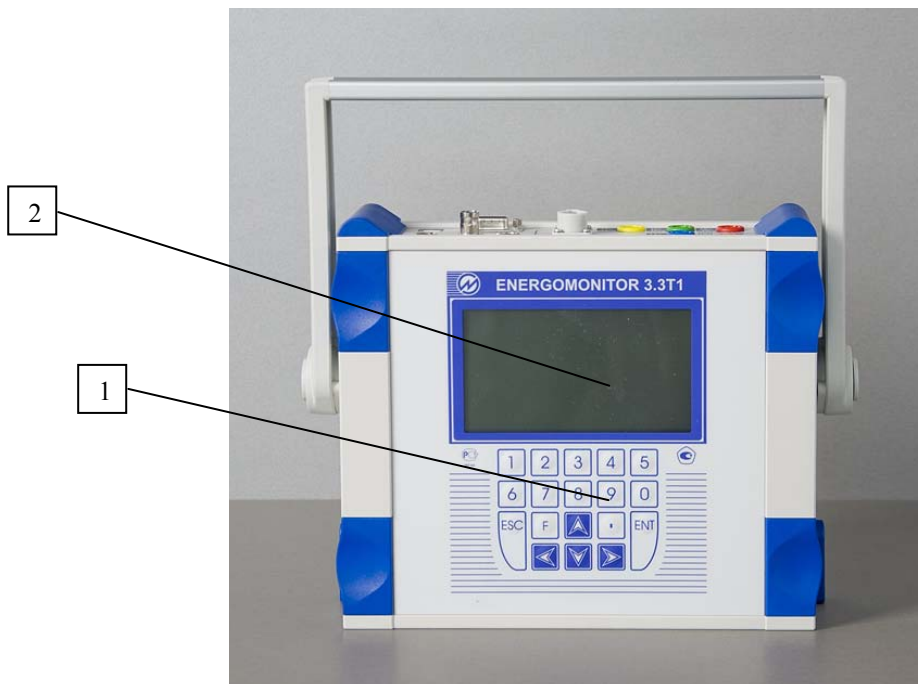


Fig. 2.1 Front panel
1 – keypad, 2 – display

The upper panel of the EM 3.3T1 is represented in Fig. 2.2.

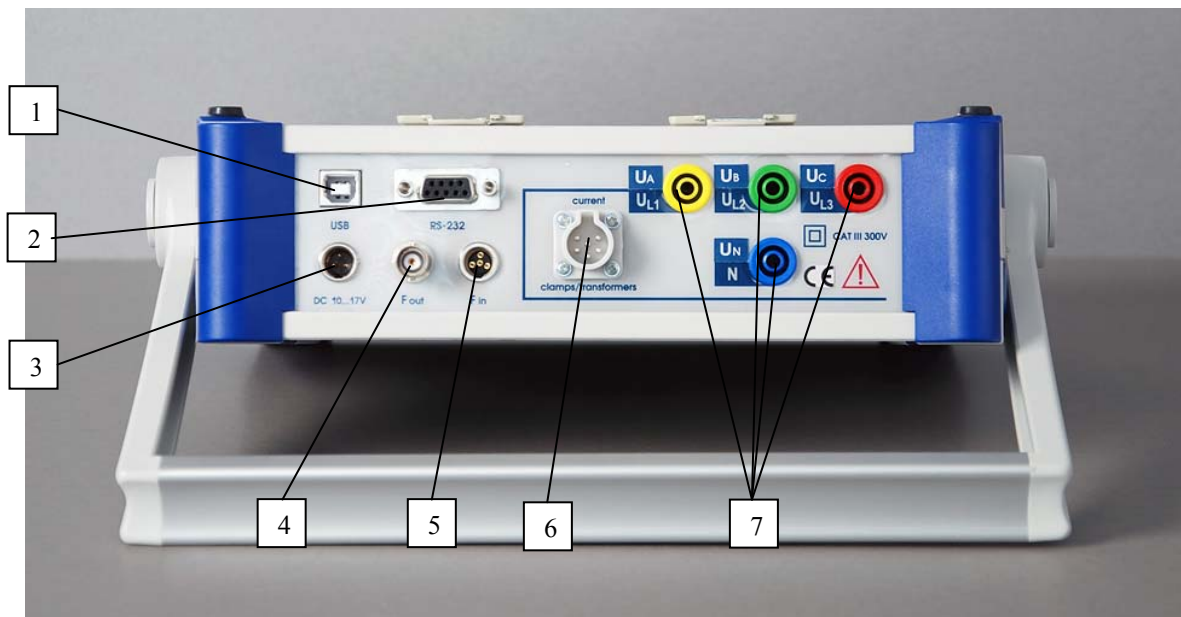


Fig. 2.2 Upper panel

1 – USB port, 2 – RS-232 port, 3 – socket for connecting Power Adapter, 4 – Frequency output, 5 – Pulse input, 6 – socket for connecting Current Transformers Block, 7 – Voltage inputs

The reference meter Energomonitor 3.3T1 performs the following functions:

- Measurement and logging of basic power quality parameters as per Russian state standard GOST 13109–97
- Measurement and logging of basic electrical power/energy parameters in single-phase and three-phase circuits (RMS values of current and voltage for sine and distorted waveforms, active, reactive and apparent power etc.)
- On-site testing, verification and calibration of single/three-phase active and reactive energy meters, testing of their performance and correctness of their connection (without breaking into the current circuits)
- On-site testing/calibration of voltage and current instrument transformers
- Measurement of electrical parameters in secondary circuits (load power), as applied to metering and billing systems
- On-site testing/calibration of measuring instruments and/or instrument-class (measuring) converters of voltage, current, active and reactive power
- Measurement of amplitude (peak) AC voltage values up to 500 Hz frequency in one/three channels or in a differential channel
- Testing/calibration of amplitude/peak voltmeters

The EM3.3T1 can be used for:

- Inspecting enterprises involved in electric power generation or consumption (electric energy audit)
- Power quality analysis for compliance with Russian power quality standard GOST 13109.

The EM3.3T1 is powered from mains $85\div 264$ V, (50 ± 5) Hz via the Power adapter or Rechargeable power supply (which is equipped with batteries 12V) from the delivery package. The EM3.3T1 accepts being powered from the said accessories only.

The technical characteristics of the EM3.3T1 correspond to the type of its input current converters (i.e. scaling converters of the current to be measured).

The current measurement channels of the EM3.3T1 are connected via scaling converters included in the delivery package. These may be current transformers or current clamp kits, complete with suitable shunts and/or cables. The EM-3.3T1 is provided with three current measurement channels that support measurement sub-ranges with nominal values as follows:

- 0.1 A with the Current Transformers Block
- 1 A with the Current Transformers Block
- 0.5 A with the Current Transformers Block
- 5 A with the Current Transformers Block
- 50 A with the Current Transformers Block
- 10 A with a current clamp kit 10 A
- 30 A with a flexible current clamp kit 30/300/3000 A
- 100 A with a current clamp kit 100 A
- 300 A with a flexible current clamp kit 30/300/3000 A
- 1000 A with a current clamp kit 1000 A
- 3000 A with a flexible current clamp kit 30/300/3000 A.

Voltage measurement channels are connected to the network under control directly or via scaling converters (i.e. voltage transformers, dividers etc.). The EM-3.3T1 is provided with three channels for direct measurement of phase-to-neutral (phase-to-phase) voltages with nominal values of 60 V (100 V), 120 V (200 V), 240 V (415 V).

The EM3.3T1 provides for measurements of the parameters of electrical power and power quality (according to GOST 13109–97).

The following monitored values are indicated on the graphical display:

- Basic power quality parameters
- Electrical/electrical power parameters averaged over 1.25; 2.5; 5; 10 s; 1; 15 or 30 min
- Errors of meters under test
- Errors of current and voltage transformers under test (tested with the especially designed accessories that provide proper connections among the test system and tested transformers).

The data length of measured values of current on the display is five significant digits and a polarity sign (represented as: $\pm x.xxxx$, $\pm xx.xxx$, $\pm xxx.xx$, $\pm xxxx.x$). The data length of measured voltage values on the display is five significant digits and a polarity sign (represented as: $\pm x.xxxx$, $\pm xx.xxx$, $\pm xxx.xx$). The measured values of power are represented by at least four significant digits and a polarity sign (represented as: $\pm x.xxx$, $\pm xx.xxx$, $\pm xxx.xxx$, $\pm xxxx.xx$, $\pm xxxxx.x$, $\pm xxxxxx$, $\pm xxxxxxx$).

While testing meters or other instruments through their frequency outputs, these instruments are connected to the frequency input F_{in} of the EM3.3T (located on its upper panel) via the Pulse Former or via the corresponding scanning head.

2.2.2 Generator Energoforma 3.3

The source of current, voltage and phantom power Energoforma 3.3 (the Generator below) is supplied as a self-contained hand-held module (see Fig. 2.1). It has three channels for generating voltages (phase voltages) and three independent channels for generating currents. There are three ways to specify a signal to be generated in digital form:

- By selecting one of standard signals from the Generator's internal memory or by specifying signal parameters (for a specific signal) from the built-in keypad
- By selecting a signal from the Library on a personal computer (PC below) via RS-232 interface running the EnForm software
- By specifying signal parameters manually from the built-in keypad.

Waveforms and signal parameters are viewed either on the built-in graphic LCD or on a PC via the EnForm software.

The Generator provides for generating currents and voltages for single- and three-phase AC circuits within the ranges specified in Tables 2.2 and 2.3.

Table 2.2

Output voltage ranges

Output voltage ranges, V	Nominal values of phase / phase-to-phase voltages for Generator's voltage and current amplifiers, V
60.001–268	220 / $220\sqrt{3}$
0–71.99	60 / $60\sqrt{3}$

Table 2.3

Output current ranges

Output current ranges, A	Nominal values of currents for Generator's current and voltage amplifiers, A
0.5000–12	5
0–0.54999	0.5

To provide short circuit protection, a 0.25A fuse is mounted on the output of each voltage channel.

Output ranges of the current and voltage amplifiers are processor-controlled. The processor transmits its commands to select a current or voltage output range to the relays.

The full description of the Generator is given in its own user manual. See the user manual for the Energoforma 3.3 (MC2.211.001 UM document) or Energoforma 3.3-100 (MC2.211.500 UM document).

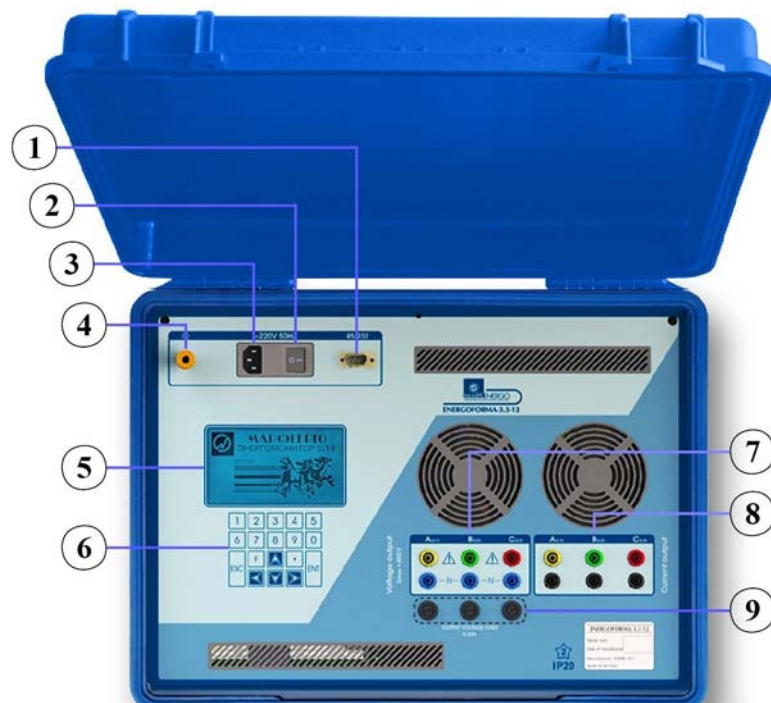


Fig. 2.3 Energoforma 3.3

1 – RS-232 connector, 2 – Mains switch, 3 – Mains input connector,
4 – Ground terminal, 5 – Display, 6 – Keypad, 7 – Voltage/neutral output terminals, 8 –
Current output terminals, 9 – Fuses for phase voltage outputs

2.2.3 Generator Energoforma 3.3-100

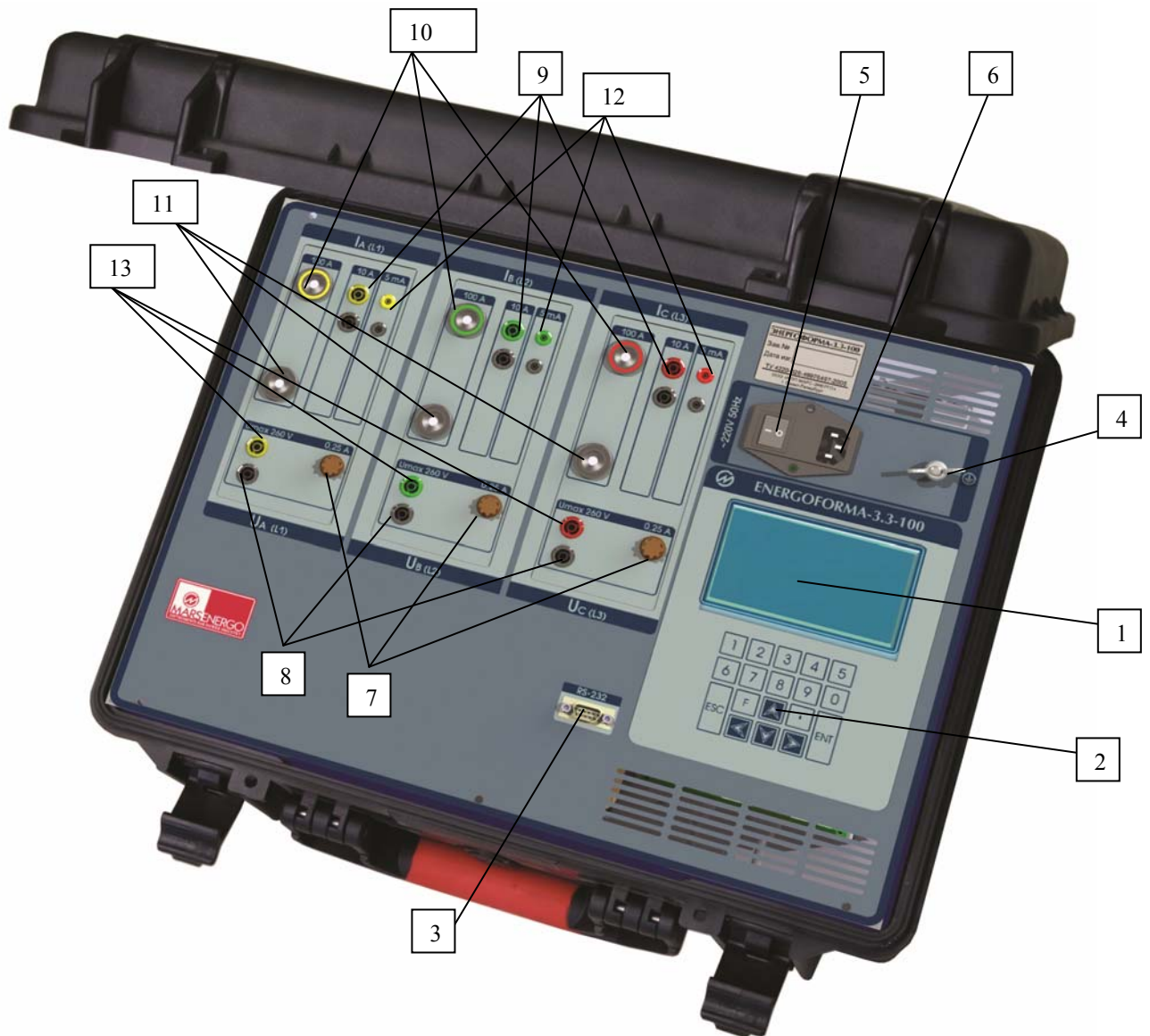


Fig 2.4 Energoforma 3.3-100

- 1 – Graphical display, 2 – Keypad, 3 –RS-232 port, 4 – ground terminal, 5 – Mains switch, 6 – Mains connector, 7 – Mains fuses, 8 – Neutral voltage output terminals, 9 – Terminals for connecting Generator to the inputs accepting current up to 12A, 10 – Terminals for connecting Generator to the inputs accepting current over 12 A, 12 – Terminals for connecting Generator to the inputs accepting current up to 1 A, 13 - Terminals for connecting Generator to the voltage inputs of the device under review

2.2.4 Scanning heads

With the Photoelectric scanning heads SH-E and SH-I, the test system may be used for on-site testing of electronic or induction single- and three-phase meters of active and reactive energy in the automatic mode.

The SH-E is an accessory for testing electronic type meters with optical pulse output. The SH-E is mounted onto the meter and connected to the pulse input **Fin** of the reference meter EM 3.3T1.

The SH-I is used for testing induction (disc) type meters. The SH-I is mounted onto the meter and connected to the pulse input **Fin** of the reference meter EM 3.3T1.

Tuning SH-E

Align SH-E's optical lens even with meter's LED. Then adjust "**Sensitivity**" knob to make SH-E's own LED ("**Pulse**" indicator) go on and out in time with the LED flashing on meter's optical pulse output.

Tuning SH-I

Turn the "**Sensitivity**" knob on the SH-I counter-clockwise as far as it will go (for minimum response). Then align the SH-I so as to bring the edge of the meter's disc into focus of the SH-I light emitting lens (the scanning beam must hit the black mark).

Turn the "**Sensitivity**" knob of the SH-I gently clockwise until the "**Pulse**" indicator on the SH-I starts responding to disk mark passages across the beam. Then adjust the sensitivity so as to ensure reliable SH-I response with neither false triggering no misfiring.

Note!

The SH-I is provided with auto-tuning function that corrects its behavior for light intensity. Auto-tuning causes some 20...40-second follow-up delay in sensitivity control.

If the "**Pulse**" indicator is still on, turn the "**Sensitivity**" knob slightly clockwise. Please adjust SH-I considering the delay in sensitivity control.

2.3 Design and Operation

The test system utilizes a comparison principle: the readings taken from the reference meter and from the device under test are compared. There are two sources of test signals that can be used with the test system: Energoforma 3.3 or Energoforma 3.3-100. The test signals configured in the Generator are simultaneously applied to the reference meter and to the device under test.

3 PREPARING FOR OPERATION

3.1 Notes on operating conditions

Caution! If the test system has been moved from a cold environment (with ambient temperature below minus 20° 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 test system shall not be used under the ingress of moisture inside its body.

3.2 Turning on

Warning! To avoid electric shock, it is strongly recommended to connect (disconnect) the test system to (from) measured circuits according to the local safety regulations in force.

Caution! The current amplifiers of the test system must be energized only if they are connected to an output circuit load (their output circuits must be closed via a device under test or calibrated coil or jumper).

The test system has four terminals for connecting phase voltage circuits (U_a, U_b, U_c, U_n) and six terminals for connecting phase current circuits (I_a, I_b, I_c, I_a*, I_b*, I_c*, each galvanically isolated from others). The voltage circuits are made symmetrical with the “neutral” as a common point. It is strongly recommended to make sure that all contacts are properly and reliably fixed to avoid overheating due to the high contact resistance.

When the test system components are powered up, the generator Energoforma 3.3 and reference meter Energomonitor 3.3T1 start their self-test and initialization procedures. On completing these procedures, the EM 3.3T1 shows its welcome screen with the manufacturer’s logo, type of the instrument and firmware version. The EF3.3 shows its main menu.

4 OPERATION

The test system is operated in two modes:

- PC-controlled mode (via RS-232 with the Energoform (EnForm) software)
- Standalone mode (manually controlled from the keypads of the EM3.3T1 and EF3.3).

4.1 PC-controlled operation

The PC-controlled mode is accessible with the Energoform (EnForm) program installed on your PC. The program works under OS MS Windows 98, 2000, XP, Vista, Windows 7 (32-bit and 64-bit architecture).

Recommended PC configuration:

- Processor Pentium III 500 MHz or more powerful
- At least 64 MB RAM
- At least 3 MB of disc space for installation
- Video adapter supporting 1024x768 resolution
- Mouse
- Two free COM-ports (RS-232) or Ethernet-adapter.

To simultaneously operate the Generator and multiple Reference Meters, several free COM-ports (RS-232) are required. If there are no free COM-ports on your computer, it is recommended to use the USB – 4-RS-232 adapter from the delivery package (if requested by the customer). For a more convenient work with large volumes of data, a more powerful computer may be requisite.

Caution! To run the Program correctly under Windows Vista or Windows 7 it is necessary to turn off the **User Account Control** option (UAC). See UAC disabling procedure in the user manual for the Energoform program (EnForm SW ver. 283+ UM document).

To control the test system with the Energoform software, the following steps should be made before:

- Connect the Reference Meter Energomonitor 3.3T1 and the Generator Energoforma 3.3 to serial ports on your computer.
- In the menu of the Energomonitor 3.3T1, select proper data exchange rate with a PC (see the EM3.3T1 user manual).

The Generator goes to the PC-controlled mode automatically if connected to a PC when the Energoform program is launched.

Refer to the user manual for the Energoforma 3.3 waveform generator.

4.2 Operation in stand-alone mode

In the stand-alone mode, the test system is operated via the keypads of the Reference Meter EM3.3T1 and Generator EF-3.3.

Operation of the Reference Meter Energomonitor 3.3T1 in the stand-alone mode is described in its user manual (MC3.055.028 UM document). Operation of the Generator Energoforma 3.3 in the stand-alone mode is described in its user manual (MC2.211.001 UM document).

Operation of the Generator Energoforma 3.3-100 in the stand-alone mode is described in its user manual (MC2.211.500 UM document).

5 TECHNICAL SUPPORT

If while operating the test system or any of its units or software, you have faced some problems, try first of all to find the answers in the documentation available (help files or user manuals).

Should you still need help after reviewing all of the available materials, please contact our Technical Support group.

Manufacturer's address (for technical support and warranty claims):

Mars-Energo

V.O. 13 Line, 6 - 8, office 41H, St. Petersburg, Russia

Tel/Fax: (812) 327-21-11, (812) 331-87-35 (812) 334-72-41

E-mail: mail@mars-energo.ru

www.mars-energo.com

Please provide our Technical Support with the following information:

1. Contact information (your Company's name, e-mail address and the name and phone number of whom the reply may concern)
2. Software version number (see Help\About... from the menu)
3. Device info (model name, serial number and firmware version)
4. Hardware configuration of your PC (CPU, motherboard, RAM, Hard Disc Drive)
5. Software configuration and version of your operating system
6. Description of the problem, including the complete text of error message (if any)
7. Other information that you consider to be important.

APPENDIX A. CONNECTION DIAGRAMS

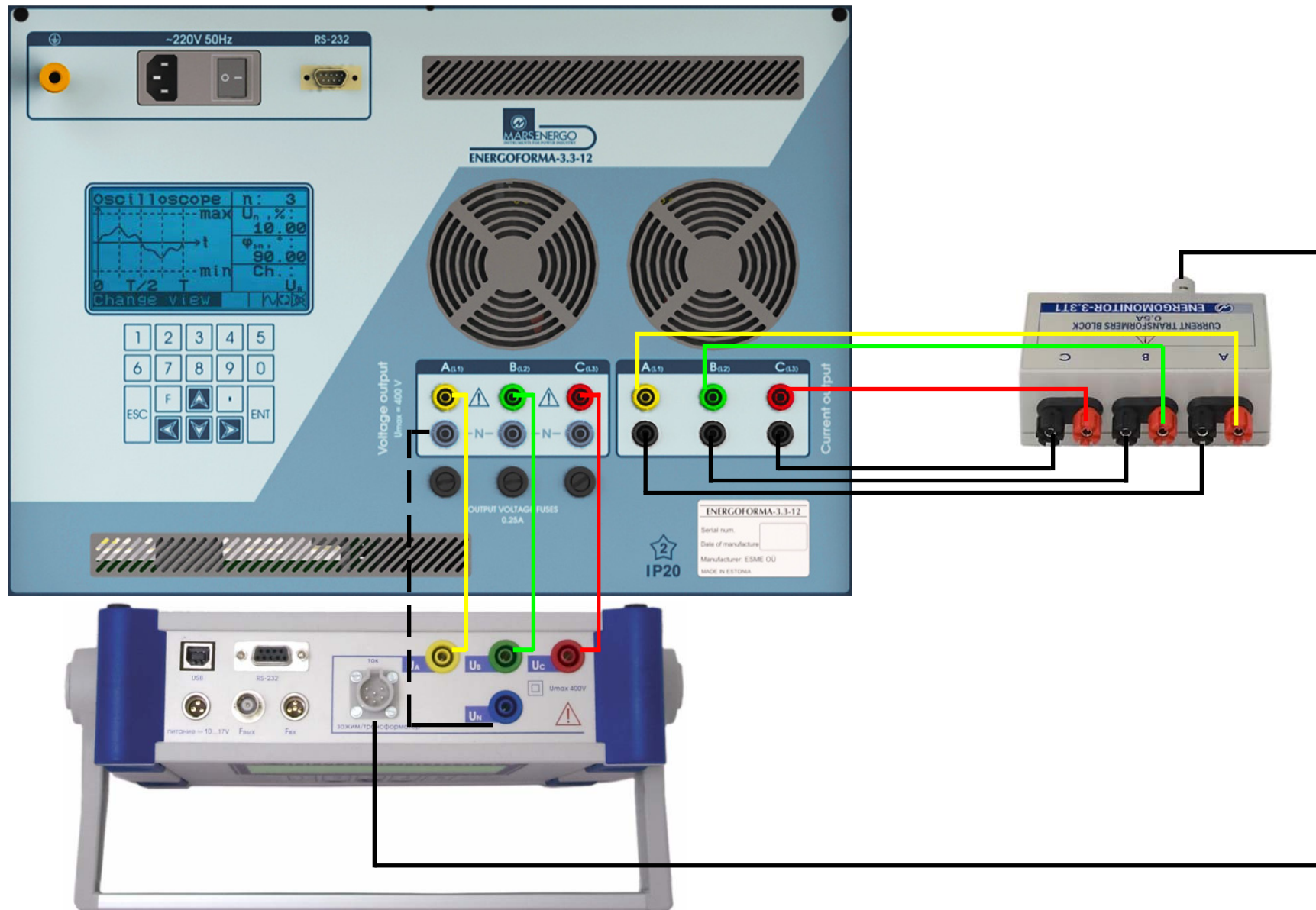


Fig. A.1 Connecting Generator Energoforma 3.3 and Reference meter Energomonitor 3.3T1

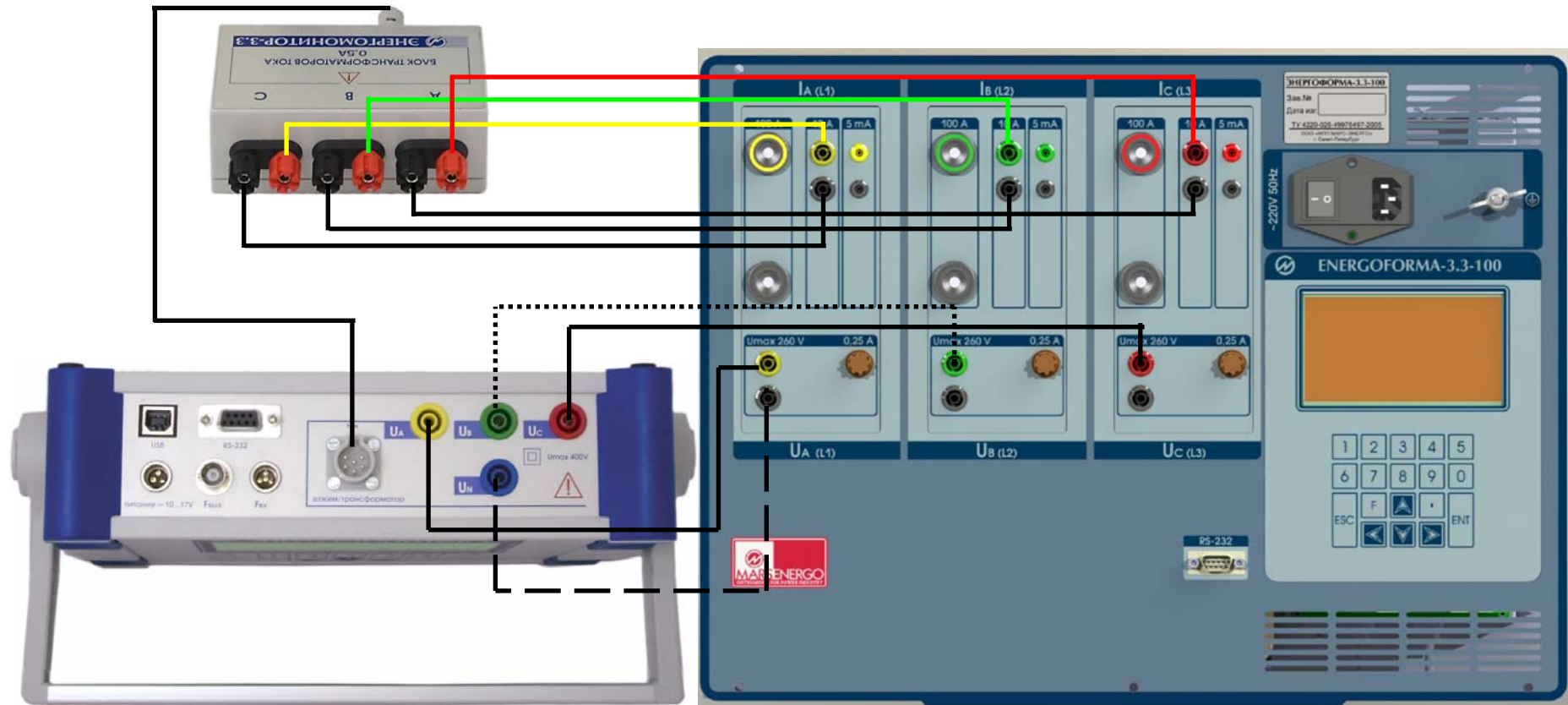


Fig. A.2 Connecting Generator Energoforma 3.3-100 and Reference meter Energomonitor 3.3T1

APPENDIX B. SOFTWARE

Depending on the purchase order, the delivery package of the test system may include the following programs from the Energoforma software package:

- Enegoform (Enform),
- EnfCalibrationRig
- EmCounter

Energoform (Enform)

The Energoform (Enform) program is a Windows-based software component designed to work as part of the test system together with the multifunctional reference meter Energomonitor 3.3T1 and generator Energoforma 3.3 or Energoforma 3.3-100.

The Energoform program makes it possible to:

- Read, via a serial port, logs of test results accumulated in the reference instrument and display them on a PC screen
- Enable required measurement ranges in the reference instrument upon user command
- Specify test signals in the Generator as required
- Test measuring instruments of pointer-and-scale and digital type in the manual mode
- Create test reports
- Save test procedures and test signals to files on the hard disc
- Read test signals from the library or record them into the library located in the internal memory of the Generator.

Operation of the Energoform (Enform) program is described in detail in the respective user manual.

EnfCalibrationRig

The EnfCalibrationRig program is a Windows-based software component designed to provide automatic work of the test system consisting of the multifunctional reference meter Energomonitor 3.3T1, generator Energoforma 3.3 or Energoforma 3.3-100, and meter error calculation unit Calmar-S.

The EnfCalibrationRig program makes it possible to:

- Carry out accuracy testing and verification of single- and three-phase electrical energy meters (from 1 to 3 meters simultaneously) in the fully automatic mode (with use of the meter error calculation unit Calmar-S)
- Carry out adjustment (calibration) of single- and three-phase electrical energy meters (from 1 to 3 meters simultaneously) in semi-automatic mode
- Perform accuracy testing and verification of single- and three-phase measuring converters with DC voltage or current outputs (up to 15 devices at a time) in fully automatic mode
- Perform adjustment (calibration) of single- and three-phase measuring converters with DC voltage or current outputs (up to 15 devices at a time) in semi-automatic mode
- Read, via a serial port, and display test results on a PC screen in both accuracy testing (verification) and adjustment (calibration) modes
- Create test procedures for electric energy meters and measuring converters, save the procedures to files or load them from files stored on the hard disc
- Generate signals included in previously created test procedures in both accuracy testing (verification) and adjustment (calibration) modes
- Read test results from the error calculators Calmar-S via the Ethernet interface (10 Mbit/s) in both accuracy testing (verification) and adjustment (calibration) modes
- Display test results on a PC screen in both accuracy testing (verification) and adjustment (calibration) modes
- Save the results of accuracy testing (verification) or adjustment (calibration) to files on the hard disc and load them from files for viewing

- Export test results into MS excel files.

All test procedures are carried out with use of the Calmar-S error calculators (each device under test is connected to its own error calculator). It is possible to simultaneously test up to 15 devices of the same type. The devices under test are connected to the test system according to the appropriate connection scheme and in the same way.

Meters are tested using the method of comparison of two frequencies. The pulse output of each meter is connected to the pulse input F_{in} of its own error calculator. The pulse output of the reference meter is connected to the reference pulse input $F_{(p)in}$ of each error calculator. The program supports testing of meters that measure electrical power of the following types: active, apparent, reactive (geometrical method), reactive (cross-connection method), and reactive (phase-shift method).

When testing measuring converters, the DC voltage or DC current output of each converter under test is connected to the respective DC voltage or DC current measuring input of its own error calculator Calmar-S. Single-phase converters can be connected to different phases (A/L1, B/L2, C/L3) of the test system.

EnfCalibrationRig supports testing of converters that measure the following quantities:

- AC voltage
- AC current
- Active power
- Apparent power
- Reactive power (by geometrical, cross-connection, and phase-shift methods)
- Frequency

Tested converters may be rated at AC voltage up to 1000V.

The Calmar-S accepts DC signals on its inputs ranged as follows:

[0 ... +5] V
[0 ... +10] V
[-5 ... +5] V
[-10 ... +10] V
[0 ... +20] mA
[+4 ... +20] mA
[0 ... +5] mA
[-5 ... +5] mA

The diagrams showing connections among the test system, Calmar-S and devices under test are given in the user manual for the Calmar-S error calculator.

Operation of the EnfCalibrationRig program is described in detail in the respective user manual.

EmCounter

The EmCounter program is a Windows-based software component designed to work as part of the test system together with the multifunctional reference meter Energomonitor 3.3T1.

EmCounter makes it possible to:

- Read, via serial RS-232 and USB ports, logs of test results, accumulated in the reference meter
- Save logs of test results on the hard disc
- Merge logs of test results made for one and the same device under test
- View previously recorded data in a convenient way
- Create test reports that can be printed or saved to files on the hard disc
- Create and maintain databases of tested devices and store the databases in files on the hard disc
- Export test results to MS Excel

Operation of the EmCounter program is described in detail in the respective user manual.

APPENDIX C. PRACTICAL NOTES FOR TESTING ELECTRICAL ENERGY METERS

Preparing for tests

When preparing to test electrical energy meters with the reference meter Energomonitor 3.3T1, it is necessary to consider the following:

- To test the meter with an electrical pulse output, it is necessary to connect the pulse output of the meter under test with the pulse input of the EM3.3T1 using the Pulse Former (included in the EM3.3T1 delivery package).
- To test the meter with an optical (LED) pulse output, it is necessary to use the scanning head SH-E (included in the EM3.3T1 delivery package). The SH-E is mounted onto the meter and connected to the pulse input **Fin** of the EM3.3T1. The connection scheme is shown in Fig. C1, where the current circuit of phase A is outlined with a bold line.
- To test the induction (disc) meter, it is necessary to use the scanning head SH-I or the Pulse Former. The SH-I is mounted onto the meter under test and connected to the pulse input **Fin** of the reference meter Energomonitor 3.3T1. The Pulse Former is used when it is impossible to detect the disc mark of the meter under test with the SH-I. In this case, the Pulse Former is connected to the pulse input **Fin** of the EM 3.3T1. Then someone should press the red button on its side when the mark on the disc edge aligns with that on the meter's enclosure (at this time a pulse comes to the **Fin** of the EM 3.3T1).

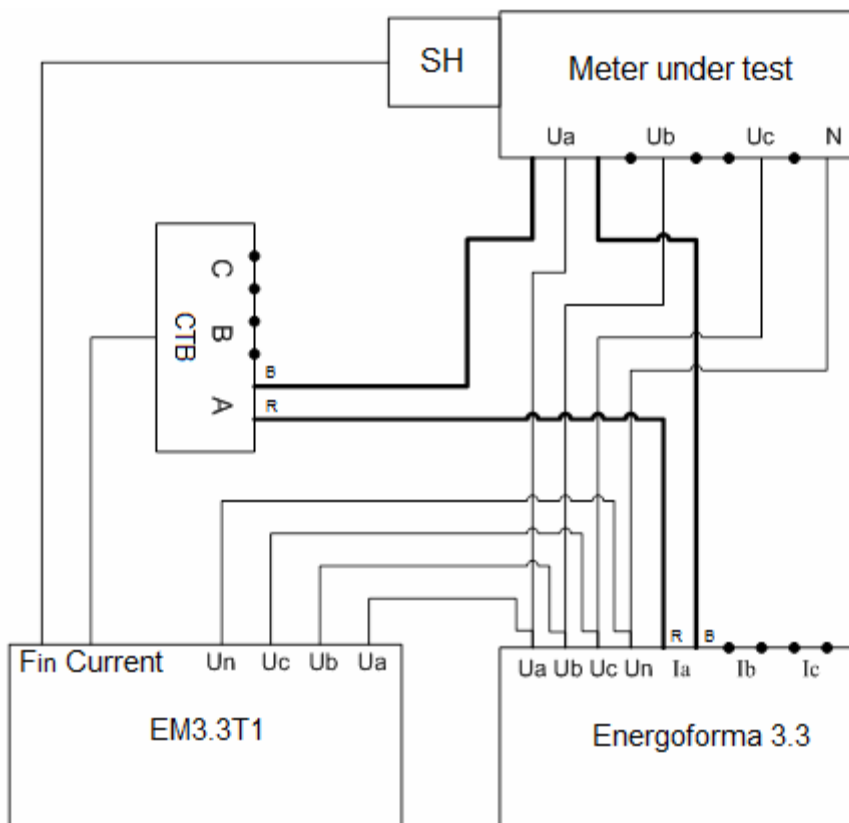


Fig. C1. Test scheme for the EM3.3T1

(current circuits of phases B and C are not shown for clarity)

CTB stands for a Current Transformers Block (from the EM3.3T1 delivery package)

SH stands for a Scanning Head (from the EM3.3T1 delivery package)

R stands for a red current terminal, **B** stands for a black current terminal

Testing electrical energy meters

Performance testing, accuracy testing, verification, adjustment and calibration are performed in accordance with the local procedures designed for testing electrical energy meters of particular type. Test signals are set from the keypad of the Energoforma 3.3 or from a PC via the EnForm software.

The test signals are as follows:

- Values of phase currents
- Values of phase voltages
- Values of current and voltage harmonics with reference to the first harmonic
- Frequency of the first harmonic
- Power factor per each phase etc.

Measurement results are read from the EM3.3T1 running a program from the Energoforma software package or manually. The results are recorded and represented in user-configurable test reports.