

OKP 42 2000

**INSTRUMENT FOR MEASURING  
POWER QUALITY PARAMETERS  
AND ELECTRIC VALUES IN POWER NETWORKS  
PQP-A Energotester**

**User's Manual**

Edition 1

2014

# Contents

<b>INTRODUCTION</b> .....	<b>4</b>
<b>1 SAFETY REQUIREMENTS</b> .....	<b>6</b>
<b>2 GENERAL INFORMATION AND OPERATION PRINCIPLE</b> .....	<b>6</b>
2.1 PURPOSE AND FIELDS OF APPLICATION.....	6
2.2 ENVIRONMENTAL CONDITIONS.....	7
2.3 CONTENTS OF DELIVERY PACKAGE .....	7
2.4 SPECIFICATIONS.....	8
2.5. DESIGN AND OPERATION.....	18
<b>3 PREPARING FOR OPERATION</b> .....	<b>20</b>
3.1. OPERATING RESTRICTIONS.....	20
3.2 UNPACKING.....	20
3.3 PREPARING FOR OPERATION.....	20
3.3.1 <i>Controls and Connectors</i> .....	20
3.3.2 <i>Turning on / off</i> .....	22
<b>4. OPERATION</b> .....	<b>24</b>
4.1 OPERATOR INTERFACE.....	24
4.1.1 <i>Passwords</i> .....	24
4.1.2 <i>Status symbols</i> .....	24
4.1.3 <i>Main menu</i> .....	26
4.2 MEASUREMENTS.....	26
4.2.1 <i>Measuring currents and voltages</i> .....	27
4.2.2 <i>Measuring phase angles</i> .....	29
4.2.3 <i>Measuring Power Quality Parameters</i> .....	30
4.2.4 <i>Measuring power</i> .....	32
4.2.5 <i>Measuring frequency and frequency deviation</i> .....	34
4.2.6 <i>Measuring harmonics and interharmonics</i> .....	34
4.2.7 <i>Waveforms</i> .....	38
4.2.8 <i>Events</i> .....	38
4.2.9 <i>Measuring energy</i> .....	39
4.2.10 <i>Synchronized measurements</i> .....	40
4.3 LOGGING OF PQP .....	42
4.3.1 <i>Introduction. Applying Energotester's design versions for power quality monitoring and analysis</i> .....	42
4.3.2 <i>Logging options</i> .....	43
4.3.3 <i>Selecting site name</i> .....	44
4.3.4 <i>Selecting declared voltage</i> .....	45
4.3.5 <i>Supply system</i> .....	45
4.3.6 <i>PQ threshold sets</i> .....	45
4.3.7 <i>PQ report period</i> .....	49
4.3.8 <i>PQ report list</i> .....	49
4.3.9 <i>LOGGER START mode</i> .....	50
4.3.10 <i>Clearing memory</i> .....	50

4.4 SETTINGS .....	51
4.4.1 “Settings” menu and access levels.....	51
4.4.2 Connection type.....	51
4.4.3 Voltage and current ranges.....	53
4.4.4 Selecting type of external instrument transformers.....	53
4.4.5 Setting date and time.....	55
4.4.6 Firmware version.....	56
4.4.7 Menu settings .....	57
4.4.8 Language.....	58
4.4.9 Password.....	58
4.4.10 Distribution of measurement log memory .....	59
4.4.11 Mains synchronization .....	60
4.4.12 Reset to default settings.....	60
4.5 DIAGNOSTICS .....	61
4.5.1 Diagnostics of GPS receiver .....	61
4.5.2 Diagnostics of power supply unit (accumulators).....	62
<b>5 USER MAINTENANCE.....</b>	<b>63</b>
<b>6 STORAGE.....</b>	<b>64</b>
<b>7 TRANSPORTATION.....</b>	<b>64</b>
<b>8. MARKING AND SEALING.....</b>	<b>64</b>
<b>9 WARRANTY.....</b>	<b>65</b>
<b>10 PACKING FORM.....</b>	<b>67</b>
<b>11 ACCEPTANCE FORM.....</b>	<b>67</b>
<b>12 WARRANTY CLAIM.....</b>	<b>68</b>
<b>13 CALIBRATION PROCEDURE.....</b>	<b>69</b>
<b>APPENDIX A. CONNECTING CURRENT CLAMPS.....</b>	<b>70</b>
<b>APPENDIX B. CONNECTION SCHEMATICS.....</b>	<b>75</b>

# Introduction

This User Manual (the UM) describes Energotester PQP-A of Energotester PQP-A-AX, Energotester PQP-A-SX and Energotester PQP-A-IX modifications, hereinafter referred to as the instruments or Energotester (the latter name refers to any of the instruments), designed to measure electrical values and power quality parameters (hereinafter referred to as PQP) in power networks .

The UM describes their operation, maintenance, transportation, storage, and manufacturer's warranty conditions. The UM also includes information about the calibration procedure, packing form and acceptance form.

Energotester comes in several modifications marked as follows:

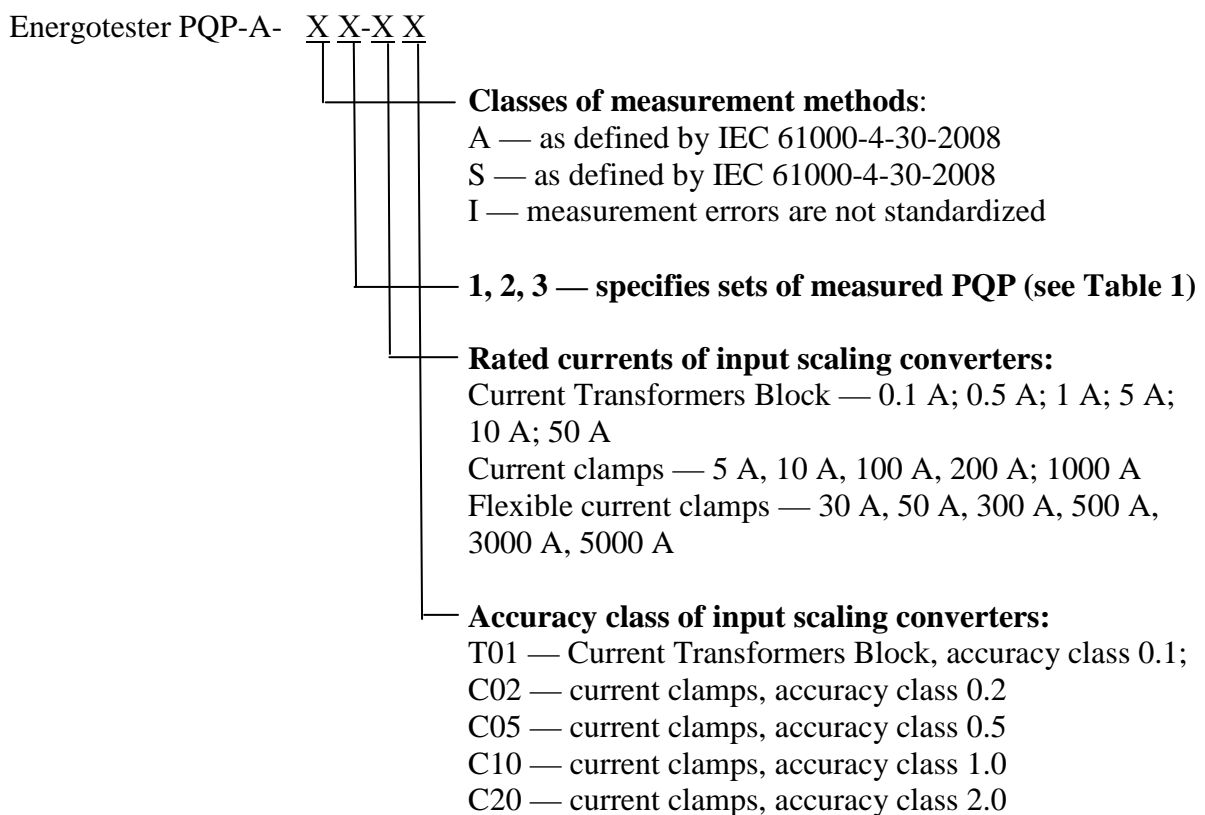


Table 1

## Sets of measured PQP according to design options

Power quality parameter	Design option (X)		
	1	2	3
Steady-state voltage deviation	+	+	+
Frequency deviation	+	+	+
Negative sequence voltage ratio	+	+	+
Zero sequence voltage ratio	+	+	+
Total Harmonic Distortion of voltage	+	+	+
Voltage harmonics	+	+	+
Voltage dip duration	+		+
Voltage dip depth	+		+
Residual voltage (during voltage dip)	+		+
Voltage swell duration	+		+
Maximum swell voltage magnitude	+		+
Voltage swell height (as per Russian standard GOST 13109-97)			
Duration of voltage interruption	+		+
Residual voltage (during voltage interruption)	+		+
Flicker short-term severity	+	+	+
Flicker long-term severity	+	+	+
Underdeviation of voltage	+	+	+
Overdeviation of voltage	+	+	+
RMS voltage of centred interharmonic subgroup	+	+	+
Mains signalling voltage			+
Note: PQP measurements available are marked with "+" sign.			

Examples of legends that may be specified in purchase orders:

**Energotester PQP-A-A3-100/1000C05** — Energotester with class A PQP measurement (IEC 61000-4-30-2008) and logging functions, design option 3 (set of measured PQP as per Table 1), with 100 A and 1000 A current clamps (accuracy class 0.5).

**Energotester PQP-A-S2** — Energotester with class S PQP measurement (IEC 61000-4-30-2008) and logging functions, design option 2 (set of measured PQP as per Table 1), without input scaling converters.

**Energotester PQP-A-I2-10C02-300/3000C20** — Energotester with PQP indication (no logging function, measurement error not standardized), design option 2 (set of measured PQP as per Table 1), with 10A (0.2 accuracy class) and 300/3000A current clamps (2.0 accuracy class).

# 1 Safety requirements

1.1 When putting Energotester into operation and during operation, "Interbranch Rules for Labor Safety (Safety Rules) When Operating Electrical Systems" (M, "Energoatomizdat", RD-153-34.0-03.150-00) must be observed.

The symbol



on the front panel is intended to alert the user to the presence of the important operating instructions. See section 3, "Turning on".

1.2 The Instruments are operated according to the safety requirements specified in IEC 61010-1; measurement performance classes II и III; degree of protection against pollution 1; and double reinforced insulation.

Protection provided by the enclosure: IP51.

1.3 The maximum value of phase-to-neutral voltages at the measuring inputs shall not exceed 400 V.

The maximum value of line voltages between the measuring inputs shall not exceed 600 V.

## 2 General information and operation principle

### 2.1 Purpose and fields of application

The Instruments are meant for:

- Measuring and logging of basic power quality parameters (PQP), as defined by IEC 61000-4-30 and IEC 61000-4-7;
- Measuring and logging of electrical network parameters in single- and three phase networks: RMS currents and voltages, no matter what their waveforms may be (sinusoidal or not); active, reactive and apparent electric power and energy;
  - For voltage and current meters as well as active, reactive and apparent power meters: in-situ control of their performance and connection check;
  - For single- and three-phase electric energy meters: control of their performance and connection check without breaking into current circuits;
- Measurement of electrical parameters in secondary circuits (load power), as applied to metering and billing systems.

The instruments can be used for:

- Inspecting the enterprises involved in electric power generation or consumption (electric power audit);
- AC power certification (applicable for "I" design option);
- Long term monitoring of PQP and power quality analysis;
- Adjustment and testing of power supply systems.

## 2.2 Environmental conditions

2.2.1 Environmental conditions are specified in Table 2.1.

Table 2.1

**Operating and calibration conditions for Energotester PQP-A instruments**

Contributing parameter	Value (range of values)	
	Calibration	Operating
Ambient temperature, °C	23 ± 5	-20 to 55
Relative humidity, %	30 to 80	90 at 30 °C
Atmospheric pressure, mm Hg (kPa)	630–795 (84–106)	537–800 (70–106.7)

Energotester shall be powered from the batteries or from mains (80V to 220V, 42 to 70Hz).  
On powering up Energotester, the batteries are charged automatically.

## 2.3 Contents of delivery package

Particular delivery package may be agreed to contain items specified in Table 2.2.

Table 2.2

Item description	Order No	Qty
Energotester PQP-A		1
"Energomonitoring" software		1
AA type battery (at least 2100 mA·h)		4
Test leads (4 colors)		4
PC connection cable, USB interface		1
User's Manual		1
Package		1
<b>Optional accessories</b> (included when specified in the Supply Agreement)		
Current clamp kit 10 A		3
Shunt $I_N = 10$ A, for 10 A current clamps		1
Current clamp kit 100 A		3
Shunt $I_N = 10$ A, for 100 A current clamps		1
Shunt $I_N = 100$ A, for 100 A current clamps		1
Current clamp kit 1000 A		3
Shunt $I_N = 100$ A, for 1000 A current clamps		1
Shunt $I_N = 1000$ A, for 1000 A current clamps		1

Item description	Order No	Qty
Current clamp kit 30/300/3000 A		3
Satellite antenna (for Energotester PQP-A-AX only)		1
Power adapter with mains cable ( $U_{out} = 12.6 \text{ V}$ , $I_{out} = 0.8 \text{ A}$ )		1
Note: Repair documentation can be supplied on request.		

## 2.4 Specifications

### 2.4.1 Available options

2.4.1.1 In terms of measurement characteristics and sets of measured parameters, Energotester comes in the following modifications:

**AX** — class A measurements of PQP (according to IEC 61000-4-30-2008), sets of measured PQP as specified for the design options listed in Table 1;

**SX** — class S measurements of PQP (according to IEC 61000-4-30-2008), sets of measured PQP as specified for the design options listed in Table 1;

**IX** — indication of PQP (measurement errors not standardized), sets of measured PQP as specified for the design options listed in Table 1.

#### 2.4.1.2 The instruments can be supplied:

- without input scaling converters;
- with input scaling converters.

If Energotester is supplied with input scaling converters, its legend contains the complete list of these converters including their rated currents and accuracy class (as specified in the purchase order).

Energotester may be supplied complete with the following input current converters:

- Current Transformer Block (CTB), accuracy class 0.1 (XT01 in the legend); "X" means the position where CTB rated currents are listed (divided by "/" symbol);
- Current clamps, accuracy class 0.2 (XC02 in the legend); "X" means the position where rated currents are listed (divided by "/" symbol);
- Current clamps, accuracy class 0.5 (XC05 in the legend); "X" means the position where rated currents are listed (divided by "/" symbol);
- Current clamps, accuracy class 1.0 (XC10 in the legend); "X" means the position where rated currents are listed (divided by "/" symbol);
- Flexible current clamps, accuracy class 2.0 (XC20 in the legend); "X" means the position where rated currents are listed (divided by "/" symbol).

In the legend, input scaling converters of different types are divided from each other by "-" symbol.

Rated currents of input scaling converters:

- Current Transformers Block — 0.1 A; 0.5 A; 1.0 A; 5 A; 10 A; 50 A;
- Current clamps — 5 A, 10 A, 100 A, 200 A; 1000 A;
- Flexible current clamps — 30 A, 300 A, 500 A, 3000 A, 5000 A.

2.4.2 Energotester PQP-A-AX measures power quality parameters and other parameters of electric power. See Tables 2.4 and 2.5 for measurement ranges and permissible limits of fundamental measurement errors.

#### 2.4.3 Specifications of Energotester PQP- A-SX:

- Limits of permissible fundamental error for measurements of basic PQP (listed in Table 1) are two times greater than the values stated in items 1–25 (Table 2.4);
- Limits of permissible fundamental error of real time clock is  $\pm 2 \text{ s}$  per 24 hours;



- Limits of permissible fundamental error for current measurements (made with use of input scaling converters) are two times greater than the values stated in items 1-16 (Table 2.5).

#### 2.4.4 Specifications of Energotester PQP-A-IX:

- Limits of permissible fundamental measurement error are two times greater than the values stated in items 1–5 (Table 2.4);
- Limits of permissible fundamental error of real time clock is  $\pm 2$  s per 24 hours;
- Limits of permissible fundamental error for current measurements (made with use of input scaling converters) are two times greater than the values stated in items 1-8 and item 15 (Table 2.5).

Table 2.4

**Measurement ranges and permissible values of measurement error stated for Energotester PQP-A-AX**

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
1 RMS of AC voltage [U], V	from $0.01U_N$ to $2U_N$	relative, % $\pm[0.1+0.01(U_{din}/U-1)]$	Class A, IEC 61000-4-30
2 RMS of 1st (fundamental) voltage harmonic [ $U_1$ ], V	from $0.01U_N$ to $2U_N$	relative, % $\pm[0.1+0.01(U_{din}/U_1-1)]$	
3 DC voltage [ $U_D$ ], V	from $0.01U_N$ to $2U_N$	relative, % $\pm[0.2+0.02(U_N/U_D-1)]$	
4 Phase angle between fundamental harmonics of input voltages, degrees	from 0 to 360	absolute, degrees $\pm 0,1$	$0.1U_N \leq U \leq 1.5U_N$
5 AC frequency [ $f_1$ ], Hz	from 42.5 to 75	absolute, Hz $\pm 0,01$	$0.1U_N \leq U \leq 2U_N$ Class A, IEC 61000-4-30
6 Frequency deviation, Hz	from -7.5 to 25	absolute, Hz $\pm 0,01$	$0.1U_N \leq U \leq 2U_N$ Class A, IEC 61000-4-30
7 Underdeviation of voltage, % of $U_{din}$	from 0 to 100	absolute, % of $U_{din}$ $\pm 0.1$	
8 Overdeviation of voltage, % of $U_{din}$	from 0 to 100	absolute, % of $U_{din}$ $\pm 0.1$	
9 Steady-state voltage deviation, % of $U_{din}$	from -100 to 40	absolute, % of $U_{din}$ $\pm 0.1$	
10 Negative sequence voltage ratio ( $u_2$ ) and zero sequence voltage ratio ( $u_0$ ), %	from 0 to 20	absolute, % $\pm 0,15$	
11 Total Harmonic Distortion of voltage [ $THD_U$ ]**, %	from 0 to 100		$0.1U_N \leq U \leq 1.5U_N$ $U_{MAX}^* < 2.8U_N$ Class A, IEC 61000-4-30
		absolute, % $\pm 0,05$	$THD_U < 1.0$
		relative, % $\pm 5,0$	$THD_U \geq 1.0$
12 Voltage harmonic of order n [ $K_U(n)$ ]**, %	from 0 to 50		$0.1U_N \leq U \leq 1.5U_N$ $U_{MAX} < 2.8U_N$ ; n from 2 to 50 Class A, IEC 61000-4-30
		absolute, % $\pm 0,05$	$K_U(n) < 1.0$

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
		relative, % $\pm 5,0$	$K_U(n) \geq 1.0$
13 RMS value of a voltage harmonic subgroup of order n [ $U_{sg,h}$ ], V	from 0 to $0.5U_N$		$0.1U_N \leq U \leq 1.5U_N$ $U_{max} < 2.8U_N$ n from 2 to 50 Class A, IEC 61000-4-30
		absolute, V $\pm 0.0005 U_{din}$	$U_{sg,h} \leq 0.01U_N$
		relative, % $\pm 5,0$	$U_{sg,h} \geq 0.01U_N$
14 RMS value of a voltage interharmonic centred subgroup of order n [ $U_{isg,h}$ ], V	From 0 to $0.15U_N$		$0.1U_N \leq U \leq 1.5U_N$ $U_{max} < 2.8U_N$ ; n from 0 to 50; Class A, IEC 61000-4-30
		absolute, V $\pm 0.0005 U_{din}$	$U_{isg,h} \leq 0.01U_N$
		relative, % $\pm 5$	$U_{isg,h} \geq 0.01U_N$
15 RMS value of mains signalling voltage at a carrier frequency 0.1 to 3 kHz, [ $U_S$ ], V	from 0 to $0.3U_N$		$0.1U_N \leq U \leq 1.5U_N$ $U_{max} < 2.8U_N$ Class A, IEC 61000-4-30
		absolute, V $\pm 0.0015 U_{din}$	$U_S \leq 0.03U_N$
		relative, % $\pm 5,0$	$U_S \geq 0.03U_N$
16 Positive sequence voltage [ $U_s$ ], zero sequence voltage [ $U_{0(1)}$ ] and negative sequence voltage $U_{2(1)}$ for 1st harmonic, V	from 0 to $2U_N$	absolute, V $\pm 0.0015 U_{din}$	
17 Residual voltage (during voltage dip), V	from $0.01U_N$ to $1.1 U_N$	relative, % $\pm [0.1 + 0.01(U_{din}/U - 1)]$	Class A, IEC 61000-4-30
18 Residual voltage (during voltage interruption), V	from $0.01U_N$ to $0.2 U_N$	relative, % $\pm [0.1 + 0.01(U_{din}/U - 1)]$	
19 Voltage dip depth, %	from 10 to 100	absolute, % $\pm 0,2$	
20 Duration of voltage interruption, s	from 0.01 s to 60 min	absolute, s $\pm 0,2$	

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
21 Duration of voltage dip, s	from 0.02 s to 600 s	absolute, s $\pm 0,02$	
22 Maximum magnitude of voltage swell, V	from $1.1U_N$ to $2U_N$	reduced, % of $U_{din}$ $\pm 0,2$	
23 Duration of voltage swell, s	from 0.02 s to 600 s	absolute, s $\pm 0,02$	
24 Flicker short-term severity, relative units	from 0.2 to 10	relative, % $\pm 5,0$	
25 Flicker long-term severity, relative units	from 0.2 to 10	relative, % $\pm 5,0$	
26 Reading of real-time clock	—	absolute, s $\pm 0,005$	Synchronized with Coordinated Universal Time (UTC)
		absolute, s per 24 hours $\pm 0,5$	without UTC synchronization At a temperature of $-20$ to $55$ °C

Notes:

- $U_N$  — rated (nominal) voltage determined by the measurement range selected from the sequence: 240V, 60V, 10V (phase voltages) and 415V, 104V, 17.3V (line voltages).
- $U_{din}$  — declared input voltage (the value obtained from the declared supply voltage as per EN 50160: 2010 divided by a transducer ratio).

2. \*  $U_{MAX}$  — maximal instantaneous voltage value at which Energotester PQP-A-X displays and logs an overvoltage condition;  
\*\* Total harmonic distortion and individual harmonic components are measured according to IEC 61000-4-30 and IEC 61000-4-7 standards (based on r.m.s. values of voltage harmonic subgroups).

Table 2.5

**Measurement ranges and permissible values of measurement error stated for Energotester PQP-AA-XCX (equipped with input current converters)**

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
1 RMS of AC current (I), A		relative, %	
	from $0.01I_N$ to $2I_N$	$\pm[0.1+0.01(I_N/I-1)]^I$ $\pm[0.2+0.02(I_N/I-1)]^{II}$ $\pm[0.5+0.05(I_N/I-1)]^{III}$	
	from $0.05I_N$ to $2I_N$	$\pm[1.0+0.05(I_N/I-1)]^{IV}$ $\pm[2.0+0.1(I_N/I-1)]^V$	

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
2 RMS of 1st current harmonic ( $I_1$ ), A		relative, %	
	from $0.01I_N$ to $2I_N$	$\pm[0.1+0.01(I_N/I_1-1)]^I$ $\pm[0.2+0.02(I_N/I_1-1)]^{II}$ $\pm[0.5+0.05(I_N/I_1-1)]^{III}$	
	from $0.05I_N$ to $2I_N$	$\pm[1.0+0.05(I_N/I_1-1)]^{IV}$ $\pm[2.0+0.1(I_N/I_1-1)]^V$	
3 Phase angle between fundamental harmonics of voltage and current in the same phase, degrees	from 0 to 360	absolute, degrees $\pm 0.2^{I, II}$ $\pm 0.5^{III, IV, V}$	$0.2 I_N \leq I \leq 2I_N$ $0.2U_N \leq U \leq 2U_N$
4 Active power [P], W	from $0.01P_N$ to $2.25P_N$	relative, %	$P_N = Q_N = S_N = U_N \cdot I_N$ ; $0.1 U_N \leq U \leq 1.5U_N$
		$\pm 0.1^I$ ; $\pm 0.2^{II}$ $\pm 0.5^{III}$ ; $\pm 1.0^{IV}$ ; $\pm 2.0^V$	PF = 1 $0.05 I_N \leq I \leq 1.5 I_N$
		$\pm 0.2^I$ ; $\pm 0.4^{II}$ ; $\pm 1.0^{III}$	$0.01 I_N \leq I \leq 0.05 I_N$
		$\pm 0.15^I$ ; $\pm 0.3^{II}$ ; $\pm 1.0^{III}$ ; $\pm 2.0^{IV}$ ; $\pm 4.0^V$	PF 0.5L...1... 0.5C $0.1 I_N \leq I \leq 1.5 I_N$
5 Reactive power (Q), Var, calculated with geometrical method	from $0.01Q_N$ to $2.25Q_N$	$\pm 0.25\% ^I$ ; $\pm 0.5\% ^{II}$	$0.02 I_N \leq I \leq 0.1 I_N$
		relative, %	$0.1 U_N \leq U \leq 1.5U_N$
		$\pm 0.2^I \pm 0.5^{II}$ $\pm 1.0^{III} \pm 2.0^{IV, V}$	PF <sub>R</sub> = 1 $0.05 I_N \leq I \leq 1.5 I_N$
		$\pm 0.3^I$ ; $\pm 0.75^{II}$ ; $\pm 1.5^{III}$	$0.02 I_N \leq I \leq 0.05 I_N$
		$\pm 0.2^I$ ; $\pm 0.5^{II}$ $\pm 1.0^{III}$ ; $\pm 2.0^{IV}$ ; $\pm 4.0^V$	PF <sub>R</sub> 0.5L...1... 0.5C $0.1 I_N \leq I \leq 1.5 I_N$
$\pm 0.3^I$ ; $\pm 0.75^{II}$ ; $\pm 1.5^{III}$	$0.05 I_N \leq I \leq 0.1 I_N$		
$\pm 0.3^I$ ; $\pm 0.75^{II}$ $\pm 1.5^{III}$ ; $\pm 2.5^{IV}$ ; $\pm 4.0^V$	PF <sub>R</sub> 0.25L...1... 0.25C $0.1 I_N \leq I \leq 1.5 I_N$		

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
6 Reactive power of the fundamental harmonic [Q <sub>1</sub> ], Var	from 0.01Q <sub>N</sub> to 2.25Q <sub>N</sub>	relative, %	0.1 U <sub>N</sub> ≤ U ≤ 1.5U <sub>N</sub>
		±0.1 <sup>I</sup> ; ±0.2 <sup>II</sup> ; ±0.5 <sup>III</sup> ; ±1.0 <sup>IV</sup> ; ±2.0 <sup>V</sup>	PF <sub>R</sub> = 1 0.05 I <sub>N</sub> ≤ I ≤ 1.5 I <sub>N</sub>
		±0.2 <sup>I</sup> ; ±0.4 <sup>II</sup> ; ±1.0 <sup>III</sup>	0.01 I <sub>N</sub> ≤ I ≤ 0.05 I <sub>N</sub>
		±0.15 <sup>I</sup> ; ±0.30 <sup>II</sup> ; ±1.0 <sup>III</sup> ; ±2.0 <sup>IV</sup> ; ±4.0 <sup>V</sup>	PF <sub>R</sub> 0.5L...1... 0.5C 0.1 I <sub>N</sub> ≤ I ≤ 1.5 I <sub>N</sub>
		±0.25 <sup>I</sup> ; ±0.50 <sup>II</sup>	0.02 I <sub>N</sub> ≤ I ≤ 0.1 I <sub>N</sub>
		±[0.25+0.02(Q <sub>N</sub> /Q - 1)] <sup>I</sup> ±[0.5+0.05(Q <sub>N</sub> /Q - 1)] <sup>II</sup> ±[1.0+0.1(Q <sub>N</sub> /Q - 1)] <sup>III</sup> ±[2.0+0.1(Q <sub>N</sub> /Q - 1)] <sup>IV</sup>	PF <sub>R</sub> 0.2L...1... 0.2C 0.1 I <sub>N</sub> ≤ I ≤ 1.5 I <sub>N</sub>
7 Apparent power [S], VA	from 0.01 S <sub>N</sub> to 2.25S <sub>N</sub>	relative, %	0.01 I <sub>N</sub> < I < 1.5I <sub>N</sub> 0.1U <sub>N</sub> < U < 1.5U <sub>N</sub>
		±0.2 <sup>I,II</sup> ; ±1.0 <sup>III</sup> ; ±2.0 <sup>IV</sup> ±2.0 <sup>I,II</sup> ; ±2.0 <sup>III</sup> ; ±4.0 <sup>IV</sup>	from 0.1S <sub>N</sub> to 2.25S <sub>N</sub> from 0.01S <sub>N</sub> to 0.1S <sub>N</sub>
8 Power factor [PF]	from -1.0 to +1.0	absolute	from 0.05P <sub>N</sub> to 2.25P <sub>N</sub> 0.01 I <sub>N</sub> < I < 1.5I <sub>N</sub> 0.1U <sub>N</sub> < U < 1.5U <sub>N</sub>
9 Active energy (import and export), kW·h		Limits of permissible error for active energy measurements are equal to the limits of permissible error for measurements of active power stated for the corresponding Energotester PQP-A design option.	
10 Reactive energy (import and export), kVar·h		Limits of permissible error for reactive energy measurements are equal to the limits of permissible error for measurements of reactive power stated for the corresponding Energotester PQP-A design option.	
11 Total Harmonic Distortion of current <sup>VI</sup> [THD <sub>I</sub> ], %	from 0 to 200		with Current Transformers Block 0.01 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub> ; with Current clamp kit 0.1 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
		absolute, % ±0.05	THD <sub>I</sub> < 1.0

Parameter	Current range	Type and limit of permissible fundamental measurement error	Note
		relative, % ±5.0	THD <sub>I</sub> ≥ 1.0
12 Current harmonic of order n, <sup>VI</sup> (K <sub>I</sub> (n)), %	from 0 to 100		n from 2 to 50; with Current Transformers Block 0.01 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub> ; with Current clamp kit 0.1 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
		absolute, % ±0.05	K <sub>I</sub> (n) < 1.0
		relative, % ±5.0	K <sub>I</sub> (n) ≥ 1.0
13 Positive sequence current [I (1)], zero sequence current [I 0(1)] and negative sequence current [I 2(1)] (for 1st harmonic), A	from 0 to 2I <sub>N</sub>	absolute, A	
		±0.01 I <sub>N</sub> <sup>I, II</sup>	0.01 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
		±0.02 I <sub>N</sub> <sup>III, IV, V</sup>	0.05 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
14 RMS value of current in neutral conductor, A	from 0 to 2I <sub>N</sub>	absolute, A	
		±0.01 I <sub>N</sub> <sup>I, II</sup>	0.01 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
		±0.02 I <sub>N</sub> <sup>III, IV, V</sup>	0.05 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>
15 Positive sequence active power [P (1)], zero sequence active power [P 0(1)] and negative sequence active power [P 2(1)] for 1st harmonic, W	from 0.01I <sub>N</sub> U <sub>N</sub> to 1.5I <sub>N</sub> U <sub>N</sub>	absolute, W ±0.01P <sub>N</sub> <sup>I, II</sup> ±0.02P <sub>N</sub> <sup>III, IV, V</sup>	0.1 I <sub>N</sub> ≤ I ≤ 2 I <sub>N</sub>

Notes:

1 I<sub>N</sub> — Nominal (rated) current is determined by the rated current of input current converters that may be selected from the sequence: 0.1 A, 0.5 A, 1 A, 5 A, 10 A, 30 A, 50 A, 100 A, 300 A, 500 A, 1000 A, 3000 A, 5000 A.

2 PF<sub>R</sub> = Q/S — reactive power factor.

3 <sup>I</sup> for Energotester PQP-A with Current Transformers Block;

<sup>II</sup> for Energotester PQP-A with Current clamp kit (0.2 accuracy class);

<sup>III</sup> for Energotester PQP-A with Current clamp kit (0.5 accuracy class);

<sup>IV</sup> for Energotester PQP-A with Current clamp kit (1.0 accuracy class);

<sup>V</sup> for Energotester PQP-A with Flexible current clamp kit (2.0 accuracy class).

4 <sup>VI</sup> Total harmonic distortion and individual harmonic components are measured according to IEC 61000-4-30 and IEC 61000-4-7 standards (based on r.m.s. values of current harmonic subgroups).

2.4.5 The Instruments of Energotester PQP-A-AX and Energotester PQP-A-SX modifications support logging of the following data and events (with further transfer to a PC):

- Statistic PQ data [number of measurements lying inside their Normal Permissible Limits (NPL) and Utmost Permissible Limits (UPL) as well as number of measurements falling outside their NPL and UPL throughout a day (24 hours) provided that averaging periods are 10 s for frequency deviation and 3 s, 10 min and 2 hours for the other PQP; logging capacity is 512 days];
  - Residual voltage and duration of voltage dips and interruptions;
  - Maximum swell magnitude voltage and duration of voltage swells;
  - Flicker short-term severity values for 10 min measurement periods;
  - Power quality parameters (as per IEC 61000-4-30) and electric network parameters with 3 sec, 10 min, and 2 hour averaging periods with logging capacity of no less than:
    - 36 hours at 3 sec averaging time;
    - 12 months at 30 min averaging time;
    - 24 months at 2 hour averaging time.

2.4.6 Limits of additional temperature error caused by ambient temperature fluctuations within operating temperature range do not exceed 20% of the limits of fundamental measurement error per each 10° C deviation from the calibration temperature.

2.4.7 When input signal does not constitute a sine waveform, the Instruments still support measurement of network parameters and PQP, provided that amplitude values of current and voltage never exceed 150% of the nominal values of measurement ranges ( $U_N$  and  $I_N$ ).

2.4.8 The Instruments of Energotester PQP-A-AX and Energotester PQP-A-SX modifications provide for calculation and logging of the following statistic PQ data: maximum and minimum (to be checked against Utmost Permissible Limits), upper and lower (to be checked against Normal Permissible Limits) PQ values and number of measurements lying inside and falling outside the NPL and UPL per each day (24 hours). Logging capacity without rewriting is 512 days.

The instruments provide for simultaneous calculation and logging of electrical network parameters (see section 4.3.3) averaged over 3 s, 10 min and 2 hours. Logging capacity (considering memory distribution function) is no more than:

- 24 hours at 3 s averaging time;
- 200 days at 10 min averaging time;
- 6 years at 2 h averaging time.

The Instruments of Energotester PQP-A-AX and Energotester PQP- A-SX modifications provide for:

- Calculation and logging of magnitude and duration of voltage dips/swells with storage capacity 16000 events;
- Flicker short-term severity values captured over 10 min measurement periods with logging capacity of 512 days.

Energotester records measurement results into its internal non-volatile memory. Data storage time is unlimited when the Instrument is powered off. Memory storage areas used to record PQ data and averaged values of electric quantities are filled in rotation. By default, a logging session starts as it is enabled and stops that very moment a month later. However, the user can set the end of the logging session to any date and time.

Energotester supports data transfer to a PC via serial interfaces.

It provides for displaying the following measurement results on the graphic display:

- Basic power quality parameters;
- Electrical network parameters averaged over 1/3 s in 3 s periods;

Data length of measured voltage values on the display is five significant digits and a polarity sign (represented as:  $\pm x.xxxx$ ,  $\pm xx.xxx$ ,  $\pm xxx.xx$  (V, kV). Data length of measured values of current on the display is five significant digits and a polarity sign (represented as:  $\pm x.xxxx$ ,  $\pm xx.xxx$ ,  $\pm xxx.xx$ ,  $\pm xxx.x$ ,  $\pm x.xxxx$  (A, kA). Measured values of power are represented by at least four significant digits



and a polarity sign (represented as:  $\pm x.xxxxx$ ,  $\pm xx.xxx$ ,  $\pm xxx.xx$ ,  $\pm xxxx.x$ ,  $\pm x.xxxx$  (W, kW, Var, kVar, VA, kVA)).

2.4.9 The built-in real time clock makes it possible to record the time of data logging over all parameters measured, as they are stored in the internal memory (in the Energotester's logs). Date and time setting to a new value is available. The clock is powered by a built-in battery with at least 2 years life-time.

2.4.10 Energotester uses two-level protection system based on ten-digit passwords. The user gains access to a certain operation level depending on the password entered at power-up.

2.4.11 Energotester remains operational when 0.5 sec. overload occurs on its measurement channels, provided that:

- RMS value of measured phase voltage never exceeds 600 V;
- RMS value of measured current never exceeds  $2I_N$  A.

Energotester will regain its metrological characteristics within 15 min after the overload removal.

2.4.12 Apparent power consumed by each voltage measurement channel is 1.0 VA or less. Input impedance per each voltage measurement channel is 0.4 M $\Omega$  as a maximum, input capacitance is 30 pF as a maximum.

2.4.13 Energotester is considered set for stable operation in 30 minutes after applying power. From that point its technical characteristics are as stated in Tables 2.2 and 2.3.

2.4.14 At the instant of either power supply failure or full battery discharge, Energotester goes to "power-off" state. The log being recorded is closed like in normal operation mode. Each time a shutdown occurs in logging mode, the Instrument automatically restarts as soon as it regains power. Then the Instrument resumes logging according to the parameters set before shutdown.

2.4.15 Time of continuous operation of Energotester powered from the battery (without mains supply) is no less than 2 hours (after one full charge cycle).

2.4.16 Power consumption from mains is 10 VA or less.

2.4.17 Overall dimensions (length, width, depth), mm (or less):  $250 \times 160 \times 91$ .

Energotester's weight (accessories excluded) does not exceed 1.0 kg.

2.4.18 Mean Time to First Failure (MTFF) is at least 44000 hours.

Average lifetime -10 years or longer.

## 2.5. Design and operation

2.5.1 Energotester's block diagram is shown in Fig. 2.1.

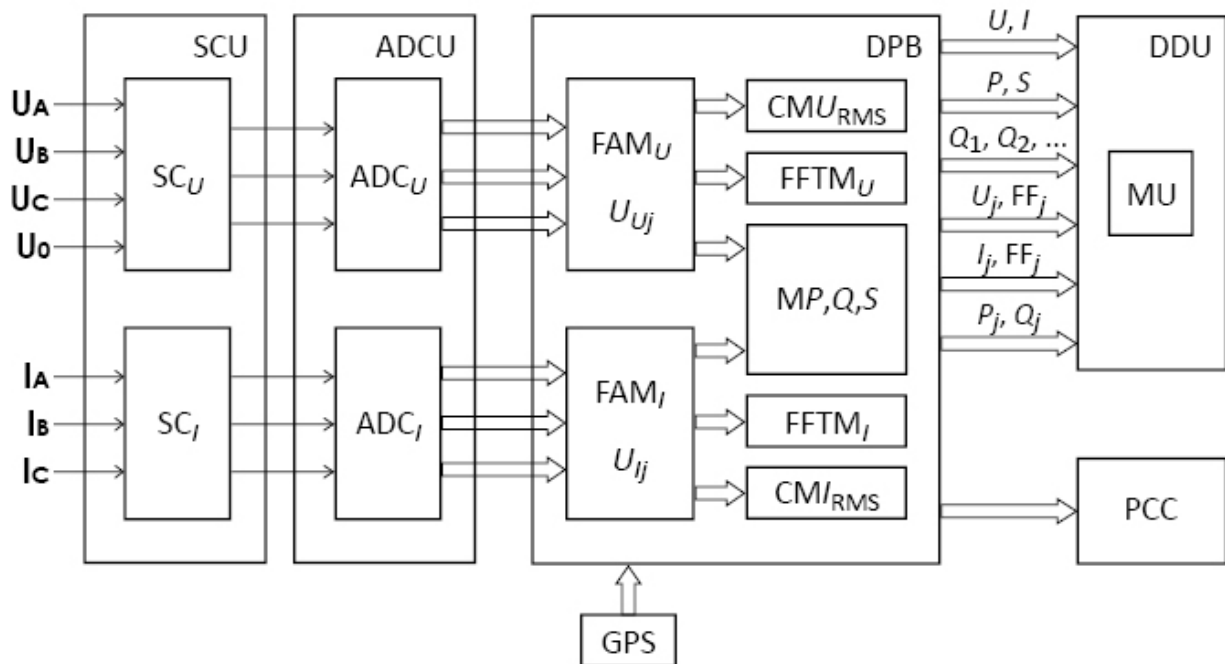


Fig 2.1 Block Diagram

SCU— Unit of Scaling Converters of voltage ( $SC_U$ ) and current ( $SC_I$ ); ADCU— Unit of Analog-to-Digital Converters of voltage ( $ADC_U$ ) and current ( $ADC_I$ ); D — Data Display Unit (graphical display and keyboard); MU — Memory Unit; PCC — PC Connection Unit; GPS — GPS receiver; DPB— Data Processing Block;  $FAM_U$ ,  $FAM_I$  — "Former of Array" Modules;  $CM_{U_{RMS}}$ ,  $CM_{I_{RMS}}$  — Calculating Modules for RMS values,  $M P, Q, S$  — Module calculating active, reactive and apparent power;  $FFT_{M_U}$ ,  $FFT_{M_I}$  — Fast Fourier Transform Modules

2.5.2 Energotester shares basic principles of Analog-to-Digital Conversion (ADC) and the Sampling Method. In the SCU, three-phase input voltages and currents are converted into 5V level voltage signals compliant with  $ADC_U$  and  $ADC_I$  measuring ranges. Instantaneous signal values are converted into digital codes by six ADCs and routed to the DPB. In the DPB, the arrays of sampled instantaneous values of voltage ( $U_{uj}$ ) and current ( $U_{ij}$ ) are created ( $j$  is the number of a sample). Programmatically calculated values of measured parameters are shown on the Data Display, stored in the Memory Unit and may be transferred to a PC, if necessary.

Energotester can determine all of the AC network parameters simultaneously: current, voltage, frequency, phase angles, individual harmonic current and voltage components ( $n$  from 1 to 50), active, reactive and apparent power.

2.5.3. The Unit of Scaling Converters includes clamp-on CTs (or instrument current transformers – 3 pcs) each one individually calibrated (electronically compensated) to match a certain measuring channel, and three voltage dividers. SCU relays are processor-controlled. The processor issues the commands (in the form of a potential) to switch over voltage inputs. The controller outputs the value of an active measuring range on the graphical display. The relays serve to switch among voltage measuring ranges for the input transformers.

2.5.4 The ADC Unit has 6 identical channels. They operate independently converting  $\pm 5V$  analogue input signals into 24-bit binary data. Each channel includes two chips: an input amplifier and ADC itself. Type AD8656 chip, the input amplifier, matches the scaling converters due to its low output voltage drift, negligible temperature drift, and ultra-low input currents. Channel's input

impedance is over 50 MOhm. Signal taken from the amplifier is fed into the ADC chip. The latter performs complete 24-bit conversion without signal quality degradation, and transmits the result in serial code to the controller upon request. As to the entire Measuring board, it takes voltages applied to the measuring inputs, digitizes them, and passes the results onto the Processor board.

2.5.5 Data Processing Block, otherwise called the Processor board or the Controller board, exercises full control over Energotester. It is responsible for making calculations over the arrays of digitized samplings, storing the results in non-volatile memory and displaying them on LCD screen, counting time, marking the intervals as per real-time clock, exchanging data with external devices (PCs), and receiving commands and data from operator's keyboard. The Controller board bears the ultimate responsibility for smooth operation of the entire instrument. At the heart of the Controller is a Texas Instruments dual-core signal processor. Such a solution makes possible prompt upgrading of the firmware, keeping the hardware intact.

Data from ADC are processed programmatically and shown on Data Display. Calculations over sampled data are based on ADC readings taken over 0.2 sec (800 samples per period are taken at 50 Hz frequency). Actual values are recalculated and displayed every 3 s.

2.5.6 Memory Unit provides storage space for measurement results, settings, etc.

2.5.7 Power Supply Unit generates voltages for the Processor and Measuring boards

2.5.8 Graphical LCD Display and operator's membrane keyboard are both mounted on the Device's front panel and connected to the Processor Board. The keyboard is used to select operation and display modes, configure the Device etc.

2.5.9 GPS receiver provides for high-accuracy synchronization with international time scale UTC which makes it possible to apply IEC 61000-4-30 (class A) measurement procedures and flagging concept.

## 3 Preparing for operation

### 3.1. Operating restrictions

If Energotester has been moved from a cold environment (with ambient temperature below  $-5^{\circ}\text{C}$ ) 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. In case of a drop in ambient temperature for  $10^{\circ}\text{C}$  or more, Energotester shall be kept for at least 30 minutes under operating conditions not connected to power.

**Note!** Energotester must not be used under the ingress of moisture inside its body.

The contrast of LCD screen image can be impaired under the temperature below  $-10^{\circ}\text{C}$ . However, this does not affect the performance.

### 3.2 Unpacking

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

The delivery package is specified in Table 2.1.

Unpack the instrument, unscrew the cover of the battery compartment and insert 4 batteries provided in the delivery package considering their polarity.

## 3.3 Preparing for operation

### 3.3.1 Controls and Connectors

Controls and connectors are listed in Table 3.1.

Table 3.1

Key	Name and Function
0...9	Numeric keypad: Press to type in numeric values
↓ ↑	Up and down arrow keys: press to scroll through various menu items or data fields; Press to increase or decrease a value by 1 in the "value entry" mode
← →	Left and right arrow keys: Press to scroll through various menu items or data fields
`ENT`	Enter: Press to activate a menu item, enter data, enable a selected mode, or insert a symbol while entering a name
'ESC'	Escape: Press to exit a mode or leave some current menu item for an upper level menu
`F`	Function: press as a hot key to exit from any menu item and enable "Connections and ranges" mode
'ON'	Press (3 quick strokes) to turn on the Instrument, Press and hold to turn the instrument off.

Energotester's upper panel is shown in Fig. 3.1.

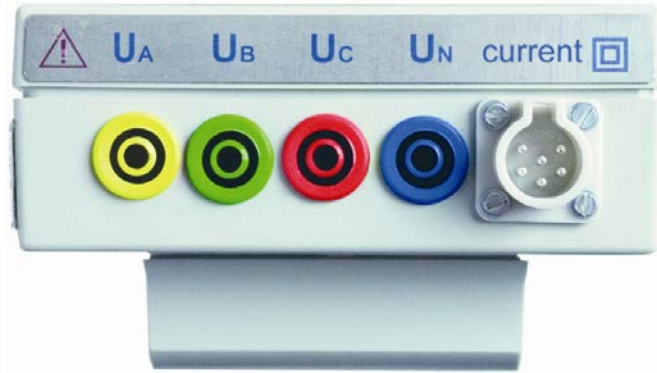


Fig. 3.1 Upper panel

$U_A$  ( $U_{L1}$ ),  $U_B$  ( $U_{L2}$ ),  $U_C$  ( $U_{L3}$ ),  $U_N$  — plugholes for connection to phase voltages and neutral; "Current" — connector for connection to input current converters (current clamps).

Front and rear panels are shown in Fig. 3.2.

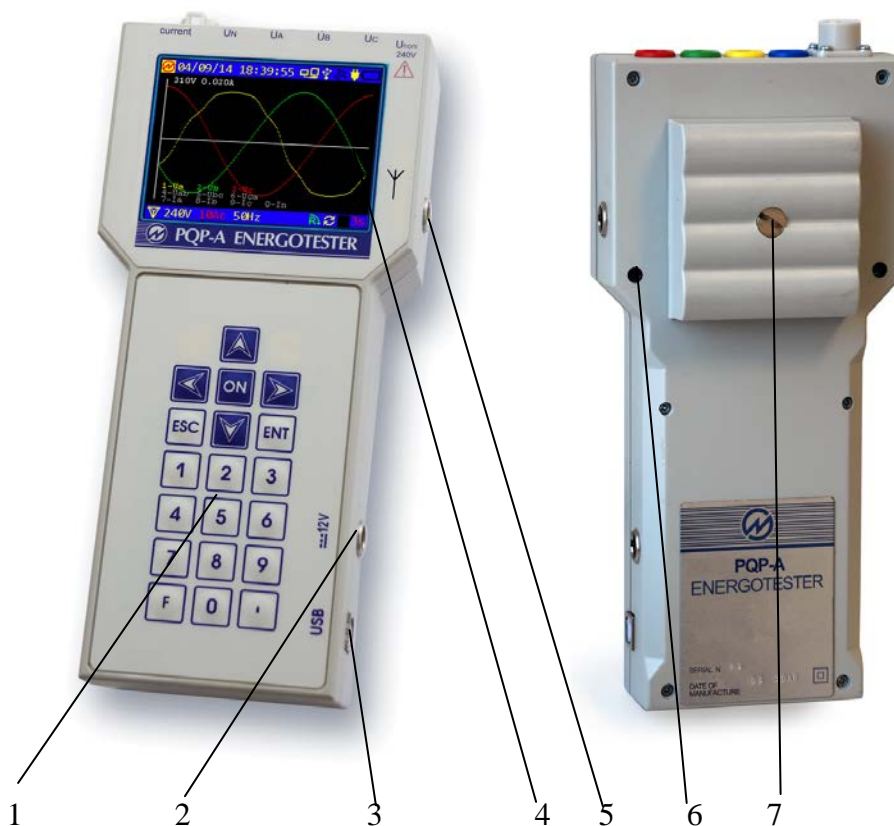



Fig. 3.2. Front and rear panels

1 — Keyboard; 2 — Power Supply connector; 3 — USB port for connection to a PC; 4 — Graphic display; 5 — GPS antenna connector; 6 — Seal; 7 — Battery compartment

### 3.3.2 Turning on / off

The symbol  placed on the front panel is intended to alert the user to the presence of the important operating instructions listed below. Warning notices are used in the text as follows: NOTE: [important information on the topic discussed in a given section or paragraph]; Caution! [Affects equipment – if not followed may cause damage to the Device]; Warning! [Affects personnel safety – if not followed may cause bodily injury or death.]

**Warning!** To avoid electric shock, it is strongly recommended to connect (disconnect) the Instrument to the measured circuits when they are de-energized. Otherwise, connection (disconnection) to the measured circuits shall be carried out by qualified service personnel in compliance with local safety regulations in force.

**Caution!** Current clamps must not be connected to DC circuits.

Clips of measuring cables and current clamps shall be connected to Energotester first, BEFORE being attached to the powered contacts or live conductors of the circuit to be measured.

**Caution!** It is strongly recommended that jaw faces of current clamps be kept clean and free from any dirt or oxidizing, to ensure the jaws are fully closed. If there is a tight clearance between the clamped jaws, the measurement accuracy may be considerably impaired.

**Caution! You must not** connect Energotester to mains via Power Adapter if expendable (**non-rechargeable**) AA batteries are inside its battery compartment instead of rechargeable batteries (accumulators).

**Note!** The number of charge cycles of the accumulators is limited and substantially determined by their quality and operating conditions.

Power Energotester from mains in the following order:

- Connect "12.6 V" output of the Power Adapter to "DC 12.6 V" input of the Instrument (see Fig. 3.2);
- Plug the mains cable of the Power Adapter to mains socket.
- ***Press ON button three times to turn on the Instrument.***

Voltage circuits have three plugholes  $U_A (U_{L1})$ ,  $U_B (U_{L2})$ ,  $U_C (U_{L3})$  for phase voltages, one more plughole  $U_N$  for connection to neutral, and one connector for phase currents  $I_A (I_{L1})$ ,  $I_B (I_{L2})$ ,  $I_C (I_{L3})$ . Galvanic isolation among the current circuits is provided by current clamps. The voltage circuits are symmetrical and have one common point (neutral conductor). Use manufacturer-supplied cables only. Inspect the cables. Ensure all joints are made properly to avoid overheating and excessively high resistance. A multitude of Energotester's connections are pictured in Appendices A and B.

**Note:** When Energotester is powered by the accumulators (without mains supply), time of its continuous operation depends on the number of charge cycles. With 2700mA·h Ni-Mh batteries, Energotester is operational for at least 2 hours after one 4.5 hour charge cycle

**Note!** When Energotester is turned on for the first time, it is recommended to make it run into shutdown without mains supply (to full discharge of the batteries). Then connect Energotester to mains supply via Power Adapter and fully charge the batteries (battery condition indicator will be displayed in green), see section 4.1.2.

After applying power and performing self-test and initialization during a few seconds, Energotester goes to the initial configuration mode. During the initialization, performance of every unit is checked and signal processing and calculation programs are loaded (Fig. 3.3).

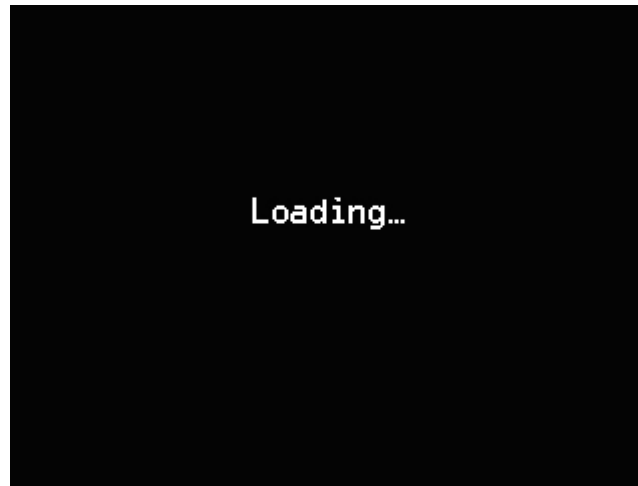


Fig 3.3 "Loading..." screen

At the conclusion of the load procedure, Energotester goes to the password entry mode (Fig.4.1.1) and becomes operational immediately after entering a correct password. To ensure that its metrological characteristics are as specified in Table 2.2, Energotester shall be kept powered for at least 5 minutes.

The display shows: Manufacturer's logo, current date and time, circuit connection type and various status symbols (battery charge level etc.) in the upper line, as well as measuring range and some other status symbols in the lower line. The status symbols are described in section 4.1 (Operator interface).

**To turn off Energotester,** press and hold ON key for 2 s, or select the "Shut down" option from the Main menu. The latter option also allows the user to restart the Instrument via "Password entry" screen.



Fig. 3.4 "Shut down / Restart" screen

# 4. Operation

## 4.1 Operator Interface

### 4.1.1 Passwords

After applying power and performing self-test, initialization and program loading procedures, Energotester goes to the password entry mode (Fig. 4.1.1). User access within the Instrument may be granted at two levels. The access level determines the set of options available within the “Settings” menu (see section 4.4.1). Both 1st and 2nd level passwords must contain 10 digits.



Fig. 4.1.1 Password entry screen

The following passwords are factory preset:

- 2nd level password – 2222222222;
- 1st level password – 0000000000.

Password entry is finished by pressing ENT.

### 4.1.2 Status symbols

Operator interface was designed on the model of nested menus. Keys `ENT`, `ESC`, ↓, ↑, ←, and ⇒ are used to navigate to a desired menu item. Location and functions of the controls and indicators are given in Fig. 3.2 and Table 3.1.

Regardless of the mode, the top status line displays (Fig. 4.1.2):

- Actual date and time
- Power supply mode and charge level of the accumulators ("AC power plug" and "Battery" symbols)

Three symbols  indicate PC connection and GPS receiver states:

 — PC connection on/off,  — USB connection on/off,  — wireless (WLAN) connection on / off.

The third ("Satellite") symbol is described in detail in sections devoted to time settings and GPS diagnostics.



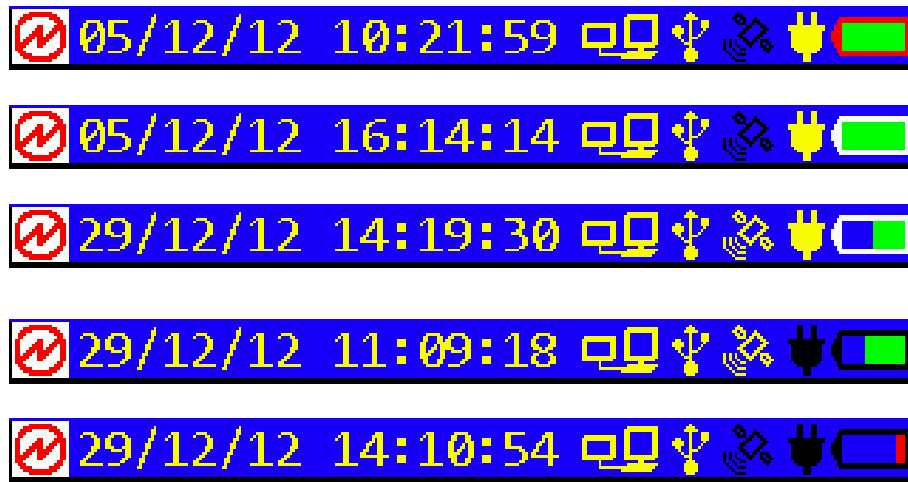


Fig. 4.1.2 Top status line



Fig. 4.1.3 Bottom status line

The bottom status line (Fig. 4.1.3) displays:

- Circuit connection scheme (the leftmost symbol);
- Voltage and current measurement ranges (the range value displayed in red means that the input signal is applied via instrument transformers) and type of input current converters:
  - c — current clamps
  - t — Current Transformer Block
  - f — flexible current clamps;
- Nominal frequency;
- Phase rotation indicator (R) L (red)— reversed; R (grey)— not determined; R (green)— correct;
- Synchronization with measured voltage:
  - Grey — no synchronization
  - Yellow — synchronization with phase L1 (A) or line L1L2 (AB)
  - Green — synchronization with phase L2 (B) or line L2L3 (BC)
  - Red — synchronization with phase L3 (C) or line L3L1 (CA);
- Actual status of logging mode (black square - no logging; circle - logging is active; red circle - an actual logging session was not interrupted; yellow circle - an actual logging session was interrupted).

An hourglass (the rightmost symbol) appears for a short time while Energotester is being reconfigured e.g. after changing its circuit connection scheme. In the presence of this symbol, the user is allowed to navigate through screens / menu items. The indication of the delay only relates to measurement processes. Operation mode is indicated by "3s" indicator (blinking from red to white means updating of 3s averages).

Voltage measurement ranges are available as 10V, 60V and 240V.

Measuring range and circuit connection options are available via the "Settings" menu. In addition, the Measuring range selection function may be called up promptly from no matter what menu or item, just by pressing `F` hotkey.

### 4.1.3 Main menu

On entering the correct password, Energotester takes you to the “Main menu” window. Main menu items correspond to basic operation modes and settings (Fig.4.1.4).



Fig. 4.1.4 Main menu

Use ↓, ↑ keys to select an item, and `ENT` key to enter the selected mode.

**Note:** The operator interface may be modified with respect to the order of displaying information. However, the changes do not affect metrological and technical characteristics of the Instrument.

## 4.2 Measurements

The “Measurements” screen is shown in Fig. 4.2.1.

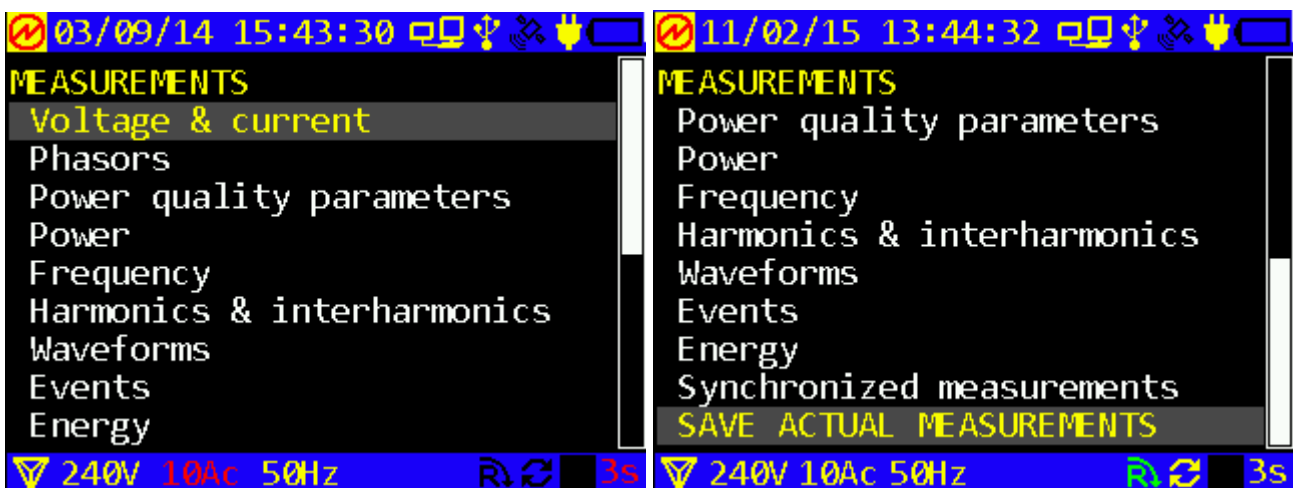


Fig. 4.2.1 "Measurements" menu

**CAUTION !** Before making any measurements, set the Instrument up for nominal phase voltage, phase current and circuit connection scheme you want to measure and select voltage connection type and CT type (if applicable). Press 'F' key to open the corresponding screen.

The "Measurements" menu contains nine options, the use and selection of which is dependent on user need: power; current and voltage; harmonics; phase angles; etc. Press ↓ or ↑ to cycle through menu options. Press 'ENT' to enable an option, press 'ESC' to return to the Main Menu

Except for “Waveforms”, measurement modes specified in the menu show “real time” parameters on their respective screens. On-screen data are updated each 3 seconds.

**Note!**

For all measurement screens:

Indication of phase parameters: Ua, Ub, Uc, Ia, etc.

Indication of phase-to-phase parameters: Uab, Ubc, Uca, Iab etc.

### 4.2.1 Measuring currents and voltages

In the "Voltage and Current" measuring mode, 4 screens are available. The screens are cycled with  $\leftarrow$ ,  $\rightarrow$  keys. The screens are shown in Fig. 4.2.2 (three phase 4-wire connection).

Energotester displays measured values of voltage, current and power considering scaling factors (turns ratios) selected in the corresponding items of the "Connections and Ranges" menu (called up by pressing 'F' hotkey): "Voltage connection", "VT type" and "CT type". In particular, if Energotester is connected to the object under review via voltage and/or current instrument transformers (namely to the VT and/or CT secondary windings), it displays measurement results considering transformer ratios. To display primary currents, voltages and power values, it is necessary to select proper types and parameters of CTs and VTs.

Use `ESC` key to return to the main menu.

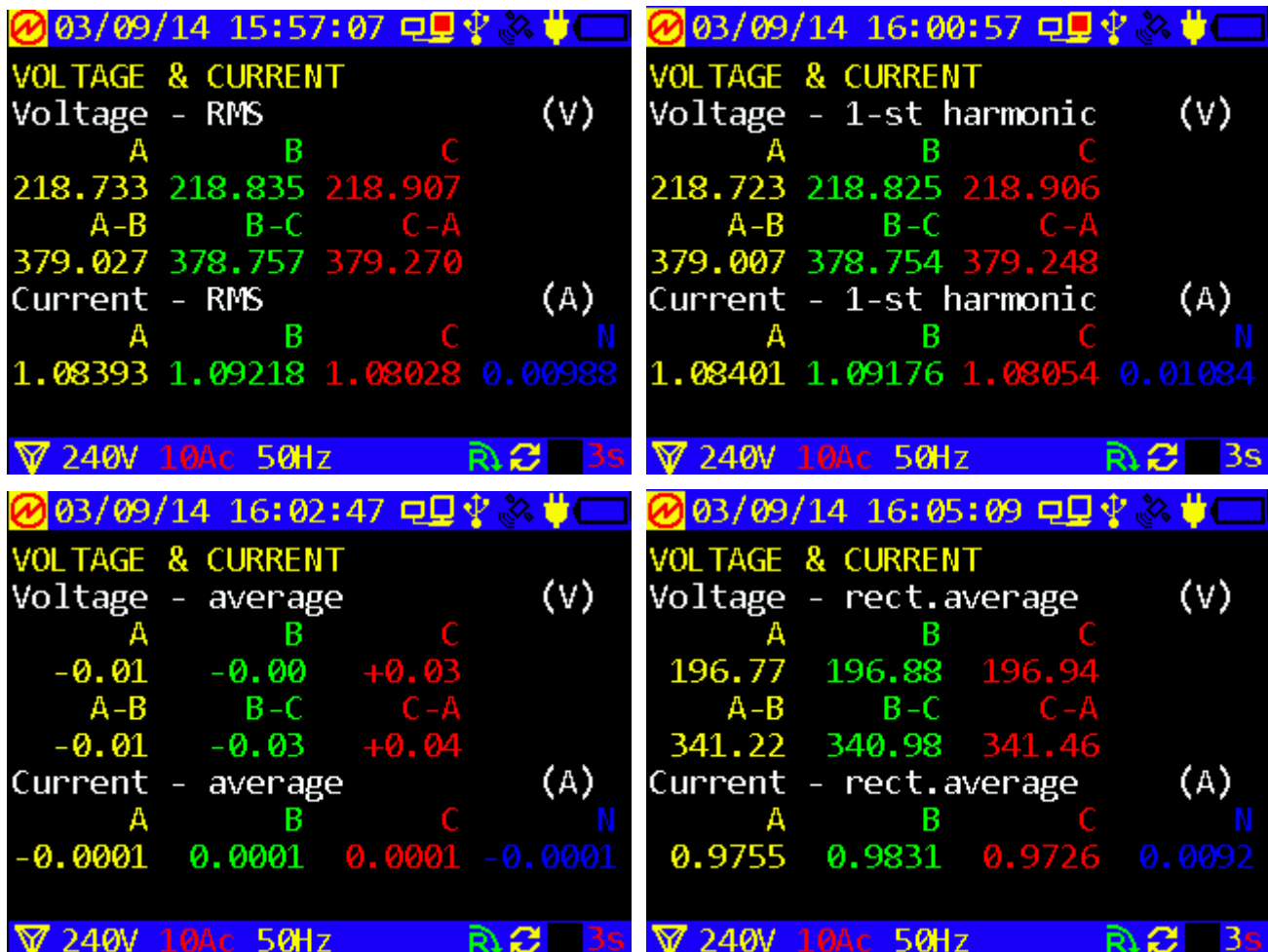


Fig. 4.2.2. "Voltage and Current" screen for three-phase 4-wire connection

#### Three-phase 4-wire connection

Values displayed:

RMS of phase and phase-to-phase voltages and currents;

Average-rectified values of phase voltages and currents;

Average values (DC component) of phase voltages.

**Three-phase 3-wire connection**

Values displayed:

RMS of phase currents and RMS of phase-to-phase voltages;

Average-rectified values of phase currents.

**Single-phase 2-wire connection**

Values displayed:

RMS of current and voltage;

Average-rectified values of current and voltage;

Average value of voltage  $U_{DC}$  (DC component).

If a signal has no AC voltage component, its average voltage value  $U_{DC}$  (DC component) equals DC voltage supplied.

**Note:** Physically speaking, the effective (root mean square or RMS) values of voltage and current relate to power (heat energy) dissipated through an active load (e.g., a bulb or a water heater),

$$P = U_{RMS} I_{RMS} = U_{RMS}^2 / R = I_{RMS}^2 R$$

Where:

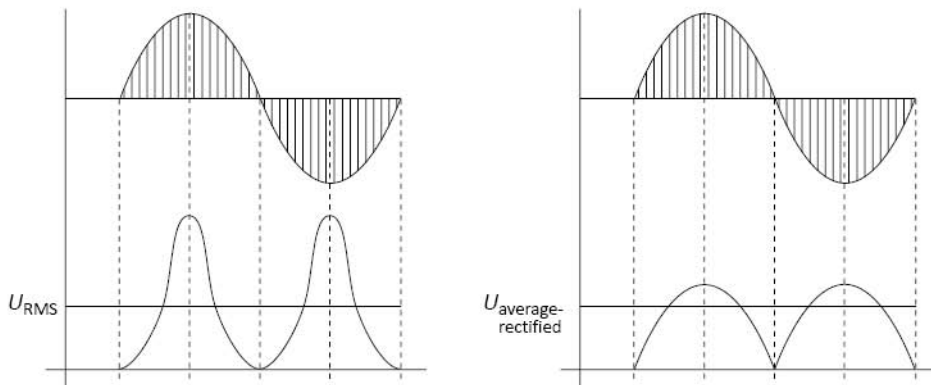
$I_{RMS}$ ,  $U_{RMS}$  are the effective (root mean square) values of voltage and current;

P is the active power dissipated through an active load;

R is the active load resistance.

The algorithm of **RMS** voltage (current) calculation may be simplistically phrased as follows: instantaneous voltage (current) values measured by the ADC are squared and averaged, and then the square root is extracted.

**Average** voltage (current) value is calculated from the weighted sum of voltage (current) instantaneous samples. The sign is determined by the DC component.



Certain physical quantities (e.g. the magnetic force of attraction between a solenoid and a core) are proportional to the average-rectified values of voltage (current). The algorithm of **Average-rectified** voltage (current) value calculation may be simplistically described as averaging over the weighted sum of instantaneous samples coming from the ADC. All voltage (current) samples are considered positive.

In case of DC voltage (current), its RMS, Average and Average-rectified values are equal in magnitude.

For a pure sinusoidal signal, the average value equals zero; the RMS and average-rectified values are related by a constant factor.

If a signal is not sinusoidal, its RMS, Average, and Average-Rectified values may differ.

Let's consider rectangular pulses with 10 V amplitude and pulse period-to-pulse duration ratio of 10.



RMS voltage value for such a pulse train would be:

$$U_{RMS} = \sqrt{\frac{10^2 V}{10}} \approx 3.16V$$

Average and Average-Rectified voltage values are:

$$U_{\text{average}} = U_{\text{average-rectified}} = \frac{10\text{V}}{10} = 1\text{V}$$

When this voltage is applied to an 1 Ohm resistor, the power dissipated in the resistor would be:  
 $P = U_{\text{RMS}} I_{\text{RMS}} = 3.16 \cdot 3.16 \approx 10\text{W}$

There are a number of RMS-scaled instruments that actually measure average-rectified values of voltage (current), e.g. the instruments based on an electrodynamic measuring principle. It is important to consider that such instruments display correct values of voltage (current) only in case of a pure sinusoidal signal.

**Caution!** The screen line showing average values of current is informative for technical service personnel only, considering that DC current component cannot pass through input transformers and current clamps.

## 4.2.2 Measuring phase angles

In the "Phasors" mode, the display shows: phase angles between 1st voltage harmonics and phase angles between 1st voltage and current harmonics. Phase angles in degrees are put in column on the left part of the screen; the right display area shows a vector diagram. The vector diagram reflects the same phase relations, with long vectors being voltages, and shorter vectors standing for currents (Fig. 4.2.6).

To check phase rotation for a three-phase system, make sure that angles  $U_{A(1)} \wedge U_{B(1)}$ ,  $U_{B(1)} \wedge U_{C(1)}$ ,  $U_{C(1)} \wedge U_{A(1)}$  are positive (clockwise rotation).

Press `ESC` key to return to the previous mode.

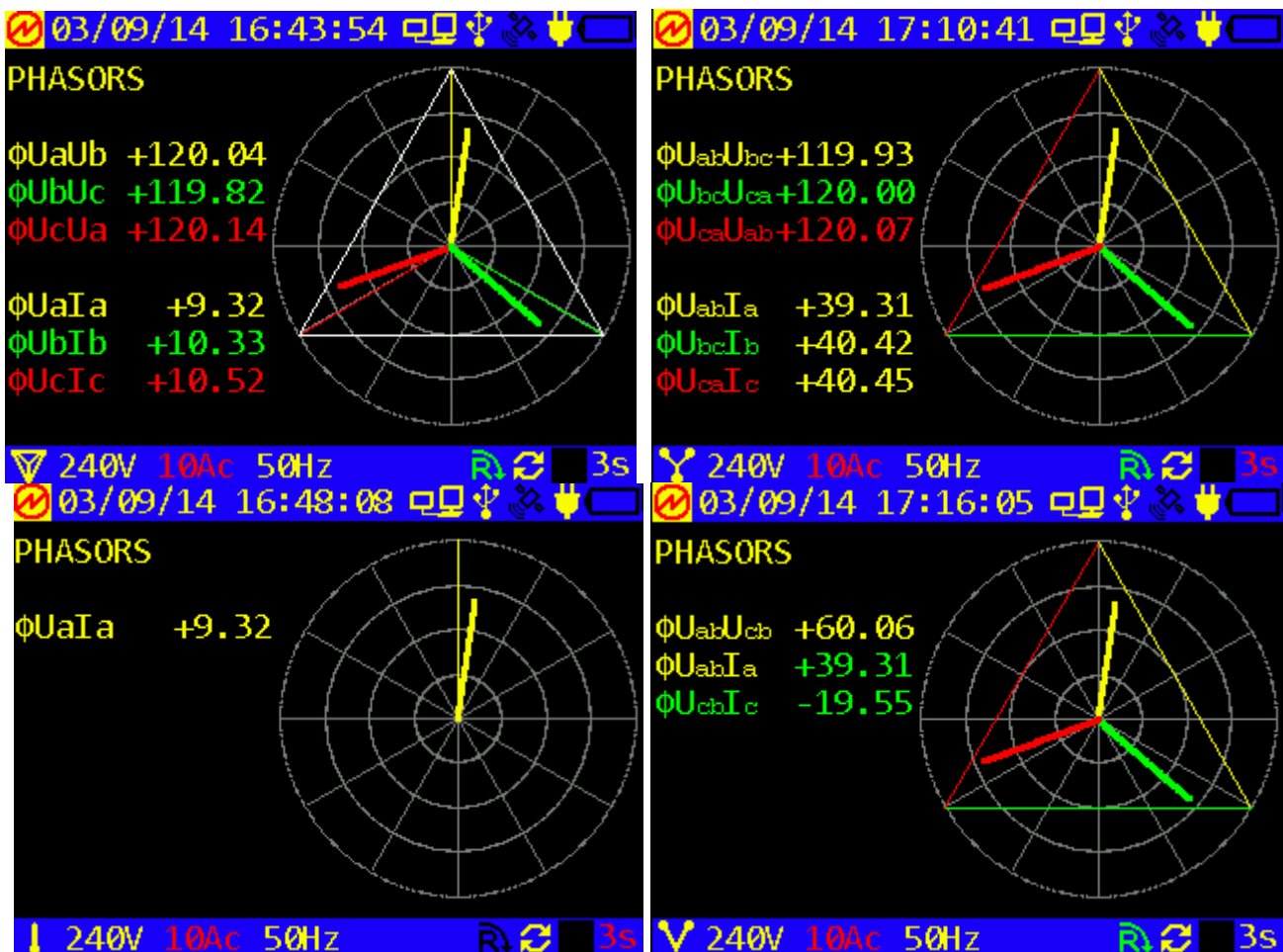


Fig. 4.2.3 "Phasors" screen for different circuit connections

### **Three-phase 4-wire connection**

Values displayed:

Phase angles between 1st harmonics of phase voltages

Phase angles between 1st voltage and current harmonics per each phase.

### **Three-phase 3-wire connections**

Values displayed:

Phase angles between 1st harmonics of phase-to-phase voltages

Phase angles between 1st harmonics of phase-to-phase voltages and 1st harmonics of phase currents.

### **Single phase 2-wire circuit connection**

The screen displays phase angle between the 1st harmonics of current and voltage.

**Caution!** Each time the RMS value of voltage or current is found less than 1 % of its nominal range, no parameters in “Phase Angles” mode are calculated. Instead, angles between voltages are displayed as  $\sim 90^\circ$ , and angles between voltages and currents are displayed as  $\sim -90^\circ$ .

## ***4.2.3 Measuring Power Quality Parameters***

Selecting "Power Quality Parameters" option from the Main menu will take you into a set of 6 screens (Fig. 4.2.4) linked in a chain (use  $\leftarrow$ ,  $\rightarrow$  to browse through the screens). These screens make it possible to view all power quality parameters measured by Energotester.

Press 'ESC' to return from the "Power Quality Parameters" mode to the Measurements menu.

PQP being measured are displayed with or without logging.

Data are updated in intervals equal to averaging times stated in EN 50160 standard for corresponding power quality parameters.

Other parameters are updated each 3 seconds.

Flicker measurement procedure starts on opening the Voltage Flicker window. The first measured Pst value appears on the “real-time” screen with 10-minute delay which corresponds to the Flicker observation period. Then Pst values are updated each 2 hours.



Fig. 4.2.4 View of PQP screens

### 4.2.4 Measuring power

The Power screen displays the following power-related parameters:

- Active power;
- Reactive Power;
- Apparent power;
- Power factor.

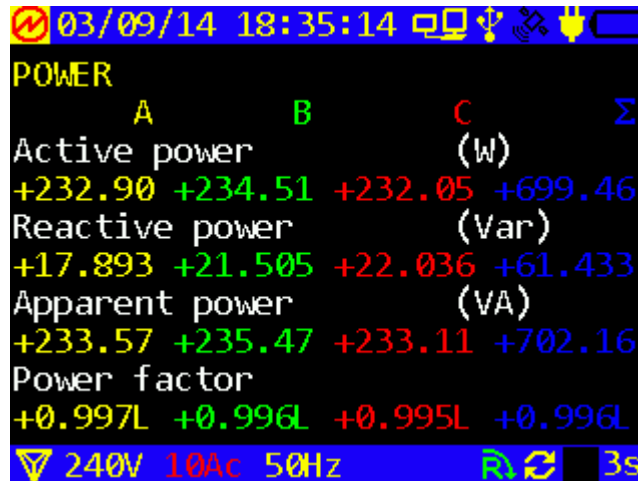


Fig. 4.2.5 "Power" screen for three-phase 4-wire connection

#### Three-phase 4-wire connection

Values displayed:

Per phase and total active, reactive and apparent power:

- Active power P,
- Apparent power S,
- $Q_1$  — Reactive power of fundamental harmonic.

In addition, the screen displays:

Power factor per each phase.

#### Three-phase 3-wire connection

Values displayed:

Total values of active, reactive and apparent power:

- Active power P,
- Apparent power S,
- $Q_1$  — Reactive power of fundamental harmonic.

In addition, the screen displays:

Total power factor.

#### Single-phase 2-wire connection

Values displayed:

Values of active, reactive and apparent power:

- Active power P,
- Apparent power S,
- $Q_1$  — Reactive power of fundamental harmonic.

In addition, the screen displays:

Power factor.

#### Notes on reactive power:

Reactive power can be calculated by geometrical, phase-shift, or cross-connection methods.



When calculation of reactive power values follows the phase shift method, instantaneous voltage value is multiplied by instantaneous current value displaced in phase by  $90^\circ$ . The method of cross-connection takes the product of instantaneous value of phase current, and the instantaneous value of line voltage.

In theory, if a three-phase system is symmetrical and free of non-linear distortions, the reactive power would be of the same value, regardless of the calculation method. When the symmetry is broken within the system of voltage vectors ( $U_{AB} \neq U_{BC} \neq U_{CA}$ ), the reactive power calculated with cross-connection method turns out different from what the other two methods give. Non-linear distortion makes the power calculated with geometrical method differ from the other two. Thus, under real conditions the three values of reactive power are never precisely the same.

Regular power system is typically equipped with reactive power meters of a certain type (e.g., in Russia meters operating on the principle of cross-connection are used in three-phase systems; meters based on phase shift method are typical for single-phase systems). Thus, when testing a meter, its principle of operation should be taken into account.

**Caution!** Each time the RMS value of voltage or current is found less than 1 % of its nominal range, the reactive power is not calculated with phase shift method: zeroes (0) are displayed instead of a measured value.

### Notes on power factor:

For pure sinusoidal signal, active, reactive and apparent powers are computed from the formulae:

$$P = U_{\text{RMS}} I_{\text{RMS}} \cos \varphi,$$

$$Q = U_{\text{RMS}} I_{\text{RMS}} \sin \varphi,$$

$$S = U_{\text{RMS}} I_{\text{RMS}},$$

where

$I_{\text{RMS}}, U_{\text{RMS}}$  are effective (root mean square) values of voltage and current;

$\varphi$  is phase angle between current and voltage.

Power factor can be expressed as:

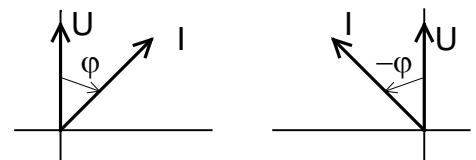
$$\text{PF} = P/S$$

For a perfect sinusoidal signal:

$$\text{PF} = \frac{P}{S} = \frac{U_{\text{RMS}} I_{\text{RMS}} \cos \varphi}{U_{\text{RMS}} I_{\text{RMS}}} = \cos \varphi$$

By definition, the PF is a number between 1 and -1 (letters L or C stand for load type: L – inductive; C – capacitive, e.g. 0.52L, 0.83C, -0.92C). Although PF is directly concerned with phase angle between current and voltage, there may be a case (e.g. in the presence of severe signal distortion in a current circuit), that  $PF < 1$  at zero phase shift between current and voltage ( $\varphi = 0$ ,  $\cos \varphi = 1$ ). The more current and voltage curves differ from pure sine, the more  $K_p$  differs from  $\cos \varphi$ .

Power Factor is basically determined by the type of loads connected to the system (inductive or capacitive). If current lags voltage (phase angle between current and voltage is positive), the load is inductive. If current leads voltage (phase angle between current and voltage is negative), the load is capacitive.



The current vector may be in one of 4 quadrants relative to the voltage vector.



Quadrant	Interval			Load type
	Angle between current and voltage	Active power	Reactive Power	
I	0° to 90°	$U_{RMS}I_{RMS}$ to 0	0 to $U_{RMS}I_{RMS}$	Inductive
II	90° to 180°	0 to $-U_{RMS}I_{RMS}$	$U_{RMS}I_{RMS}$ to 0	Capacitive (negative)
III	180° to 270° (-180° to -90°)	$-U_{RMS}I_{RMS}$ to 0	0 to $-U_{RMS}I_{RMS}$	Inductive (negative)
IV	270° to 360° (-90° to 0°)	0 to $U_{RMS}I_{RMS}$	$-U_{RMS}I_{RMS}$ to 0	Capacitive

Positive active power (energy) relates to energy import, negative active power (energy) corresponds to energy export. Positive reactive power (energy) indicates an inductive load with energy import, or a capacitive load with energy export.

**Note:** To measure apparent power consumed by a current instrument transformer load, use  $U_n=10V$ .

#### 4.2.5 Measuring frequency and frequency deviation



Fig. 4.2.6 "Frequency and frequency deviation" screen

The screen displays measured values of frequency and frequency deviation. Press `ESC` key to return to the previous mode.

#### 4.2.6 Measuring harmonics and interharmonics

In the "Harmonics" mode, the following screens are available:



Fig. 4.2.7 "Harmonics and Interharmonics" options

"RMS values" option on both screens will take the user into a set of screens (use  $\leftarrow$ ,  $\rightarrow$  keys to browse through the screens). Number and contents of the screens depend on circuit connection scheme. Keys  $\downarrow$ ,  $\uparrow$  are used to scroll up and down to see all of 50 harmonics.

For "Harmonic subgroups" the displayed parameters are as follows:

- RMS values of U and I harmonics up to 50 (including THD and maximum values);
- Coefficients - U and I harmonics from 2 to 50 with respect to the 1<sup>st</sup> harmonic in % (including THD and maximum values)
- Diagrams;
- K-factor.

Maximum values of harmonic or interharmonic components can be set to zero by pressing numeric key "0".

"RMS values" screens related to "Interharmonic groups" look in the same way.



Fig. 4.2.8. Typical "RMS Values" screens ("Harmonic subgroups" and "Interharmonic groups" options)

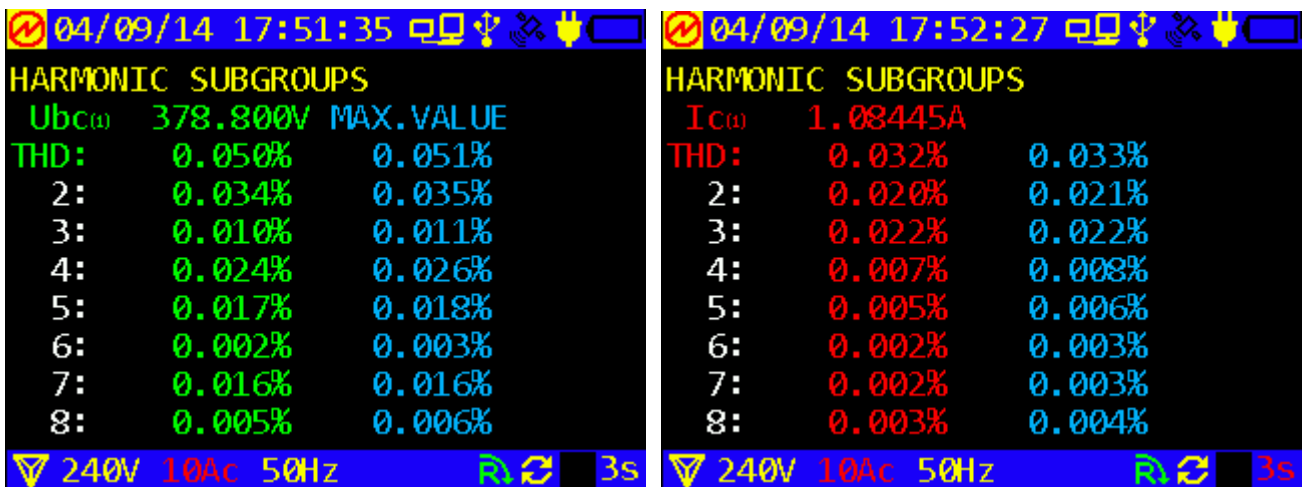


Fig. 4.2.9 Typical "Coefficients" screens ("Harmonic subgroups" menu)

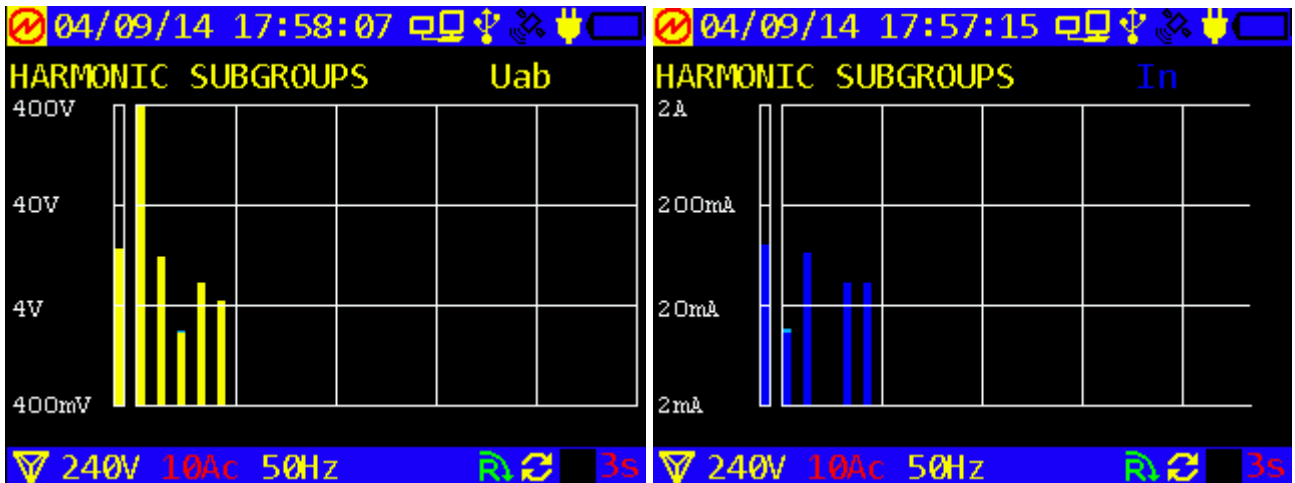


Fig. 4.2.10 "Diagrams" screen ("Harmonic subgroups" menu)

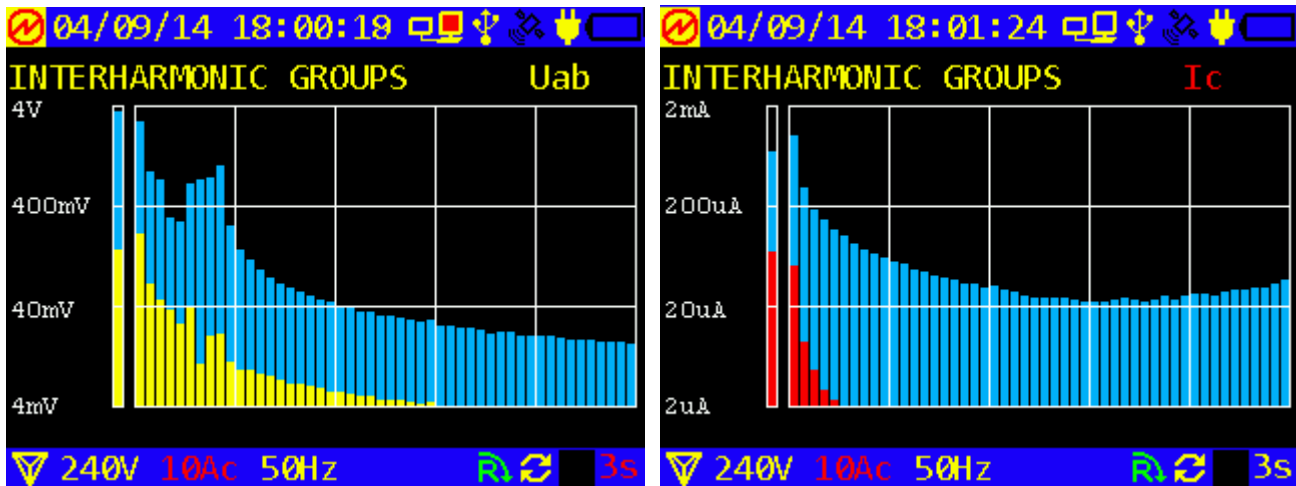


Fig. 4.2.11 "Diagrams" screens ("Interharmonic groups" menu)

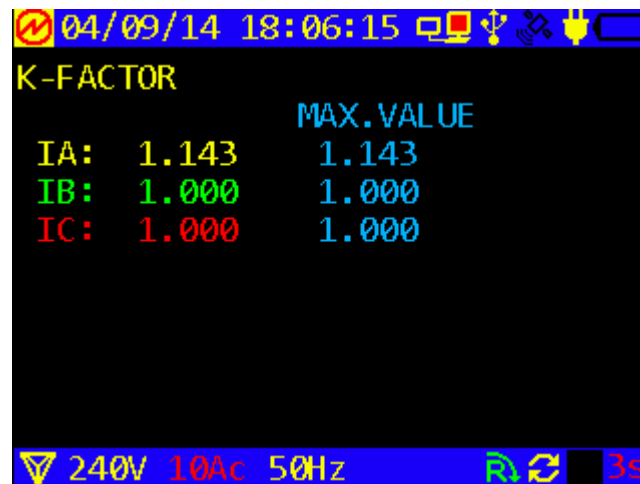


Fig. 4.2.12 "K-factor" screen ("Harmonic subgroups" menu)

**Note:** Each time the RMS value of voltage or current is found less than 1 % of its nominal range, the Harmonics mode related parameters are not calculated: zeroes (0) are displayed instead of measured values.

### Notes on K-factor:

Presence of high-order harmonics of current and voltage in electric circuits create a major problem either for the circuits or for the connected equipment. For example, higher harmonic currents passing through the transformers considerably impair their characteristics being responsible (among other things) for transformer heating and magnetic flux losses. Moreover, conventional transformers can even become dangerous under severe non-linear load conditions.

K-factor is one of the parameters used to estimate non-linear load characteristics in electric circuits. K-factor =1 indicates a linear load in the circuit (no harmonics).

Regarding the transformers, the K-factor rating is used by transformer designers to reflect the ability of the transformer to withstand harmonic content while operating within the temperature range specified for its insulation system (typically, K-factor is given in the transformer's technical specifications). The higher the transformer K-factor, the greater is its resistance to non-linear distortion conditions.

The algorithm used to calculate K-factor is:

$$K = \frac{\sum_{h=1}^{34} (i_h \cdot h)^2}{\sum_{h=1}^{34} i_h^2}, \text{ where:}$$

$i_h$  – rms value of  $h$ -order harmonic current passing through a load;

$h$  - harmonic order.

### K-factors for some typical loads:

Welders: K=4

UPS without input filtering: K=13

Motor drives: K=20

### 4.2.7 Waveforms

In the "Waveforms" mode, Energotester plots voltage and current waveforms on its display (Fig. 4.2.13). On entering the mode, the display shows "phase A" voltage waveform. By pressing number keys `1`, `2`, `3`, `4`, `5`, `6` the user can make visible or hide other waveforms (Ua, Ub, Uc, Ia, Ib, and Ic respectively). In addition, maximal amplitude values for all current and voltage curves being displayed are shown in the upper part of the screen. Waveforms are updated each 3 s.

Press `ESC` key to return to the previous mode.

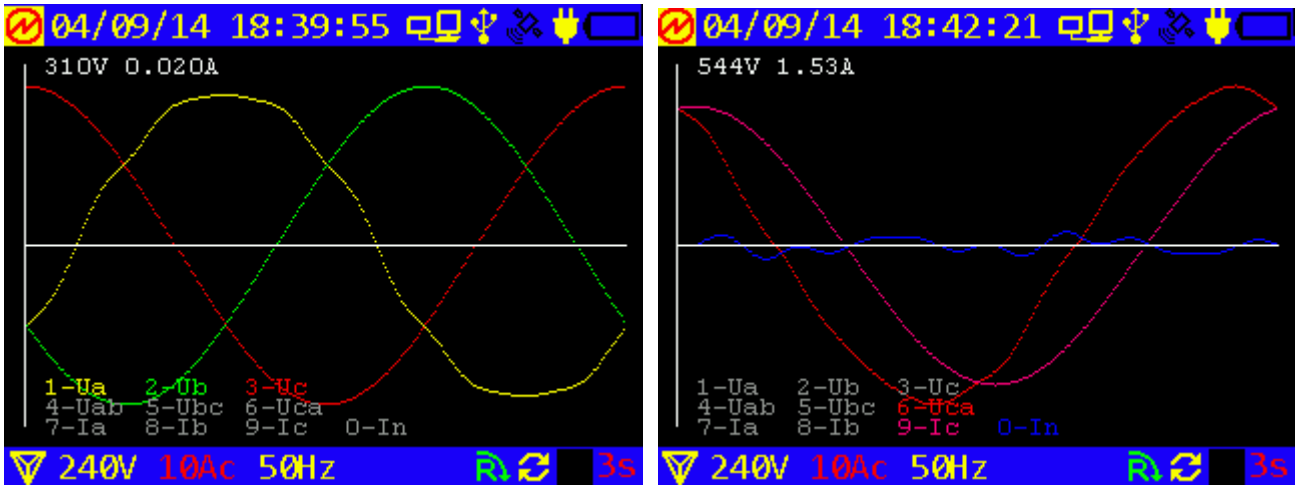


Fig. 4.2.13 "Waveforms" screen

### 4.2.8 Events

In the "Events" menu the user can specify thresholds for three types of events to be recorded in the memory, namely:

- Voltage dips;
- Voltage swells;
- Voltage interruptions.

"Events" options are shown in Fig. 4.2.14.

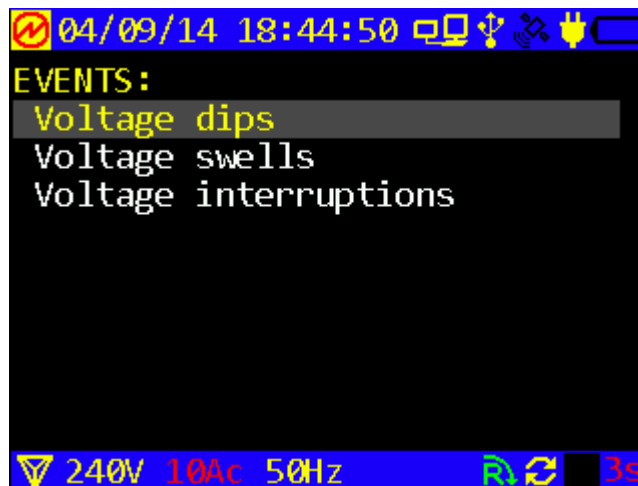


Fig. 4.2.14 "Event type" selection screen

On selecting the event type, Energotester opens one of the screens pictured below.



Fig. 4.2.15 "Events" screens

### 4.2.9 Measuring energy

In the "Energy" measurement mode, 2 options are available:



Fig. 4.2.16 "Energy measurement type" selection screen

On selecting the "Progressive total" option, time count and energy measurement start automatically. The screen displays:

- Time count in minutes and seconds;
- Cumulative total values of active (kW·h) and reactive (kvar·h) energy.

Energy is measured continuously. Energy measurements start on turning on the Instrument and stop on turning it off, or on changing the basic settings, e.g., circuit connection scheme, ranges and the like. The energy is measured for all phases in total and displayed separately for export and import directions. In this mode, Energotester calculates energy usage like an electric energy meter.

The mode is controlled with "1" and "2" numeric keys (reset and stop functions respectively).

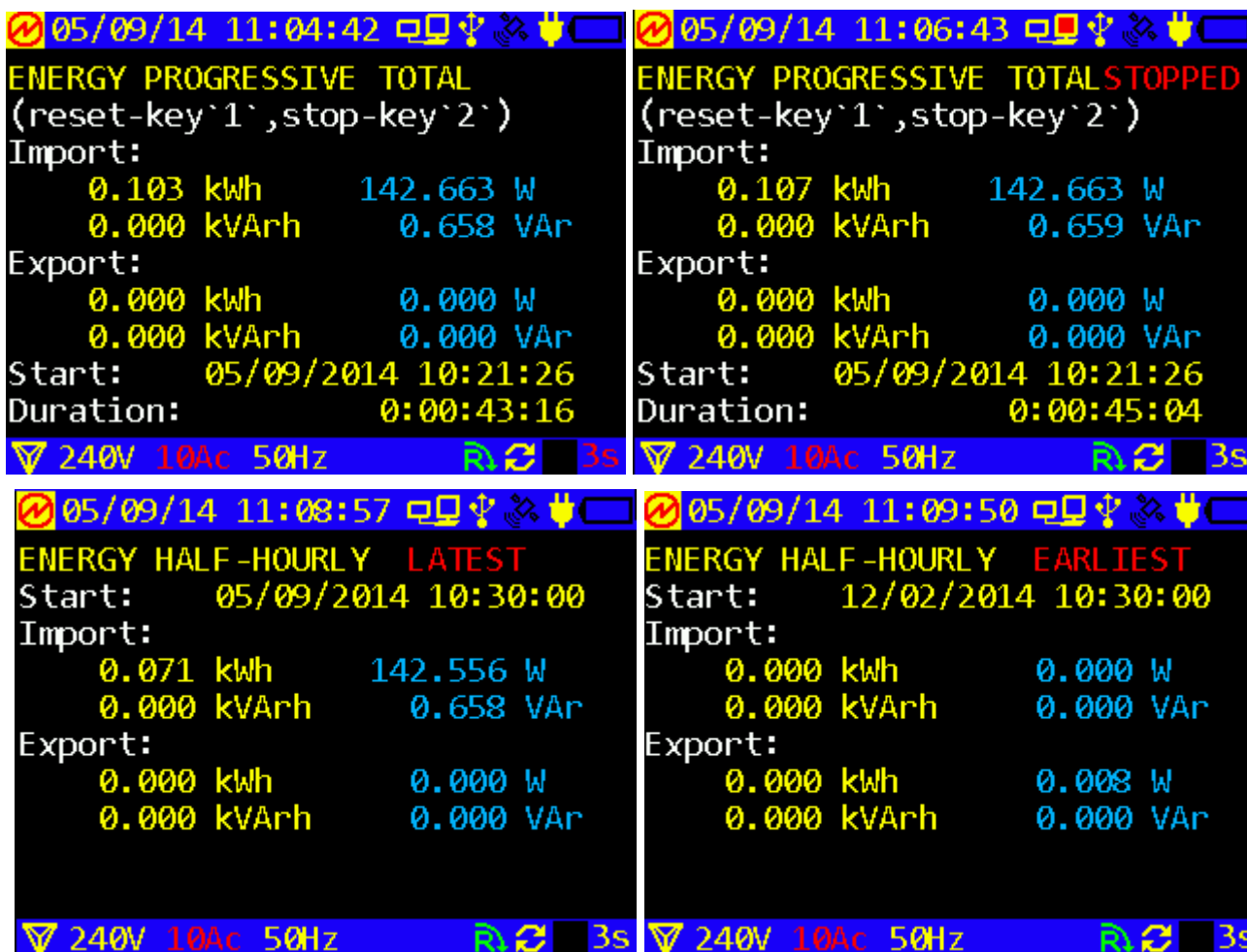


Fig. 4.2.17 "Energy" screens

**Note:** It is recommended to carry out energy measurements as for on-peak load so also for off-peak load periods.

"Half-hourly" measurements start on XX:00 min or XX:30 min after entering the "Half-hourly" option (e.g., if you enter the mode on 17:45, the measurements will start on 18:00, entering the mode on 18:07 means that the measurements will start on 18:30). Measurement results are recorded (updated) each 30 min. Each reading is an energy value calculated for the half-hour period from the latest update. Multiplied by 2, the energy reading equals the average value of power (kW, kVar) obtained for the corresponding 30 min.

### 4.2.10 Synchronized measurements

In the "Synchronized measurements" mode, the display shows: Start time of a measurement, measurement duration (in periods) and measurement results.

Start time of measurements should be set at least 30 s later than the present time.

Other restrictions applied to measurement start time and duration settings are as follows: the start time should be a multiple of 10 min (e.g. 16:10, 17:20 etc) and the measurement duration should be a multiple of 10 (e.g. 150 periods, 160 periods etc).



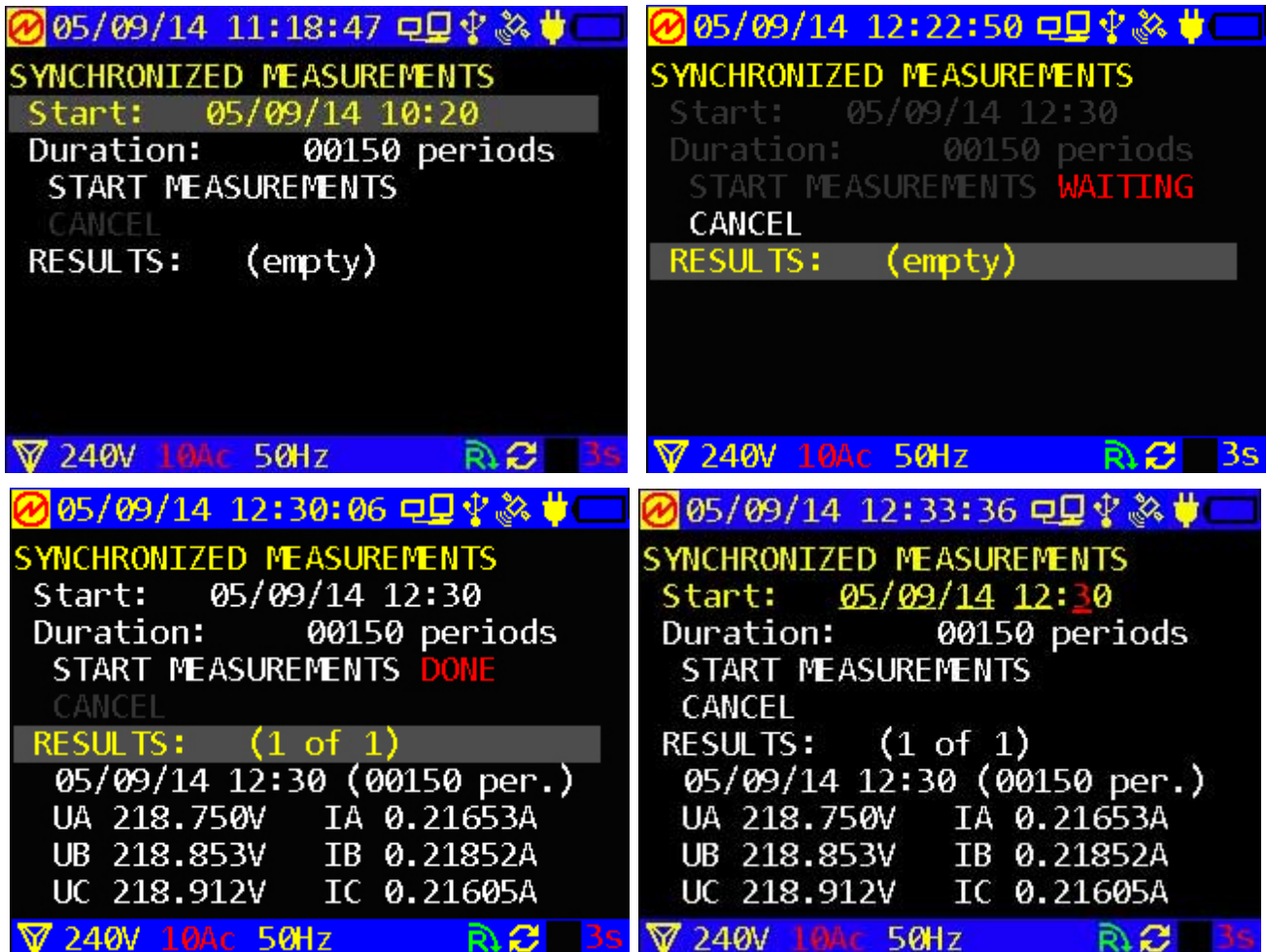


Fig. 4.2.18 Screens used to set up, enable and view synchronized measurements

The 4<sup>th</sup> screen displays changing of Start measurement time (the cursor is highlighted in red).

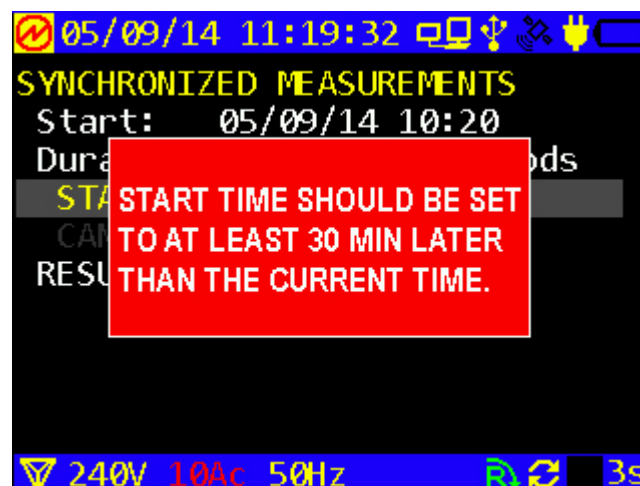
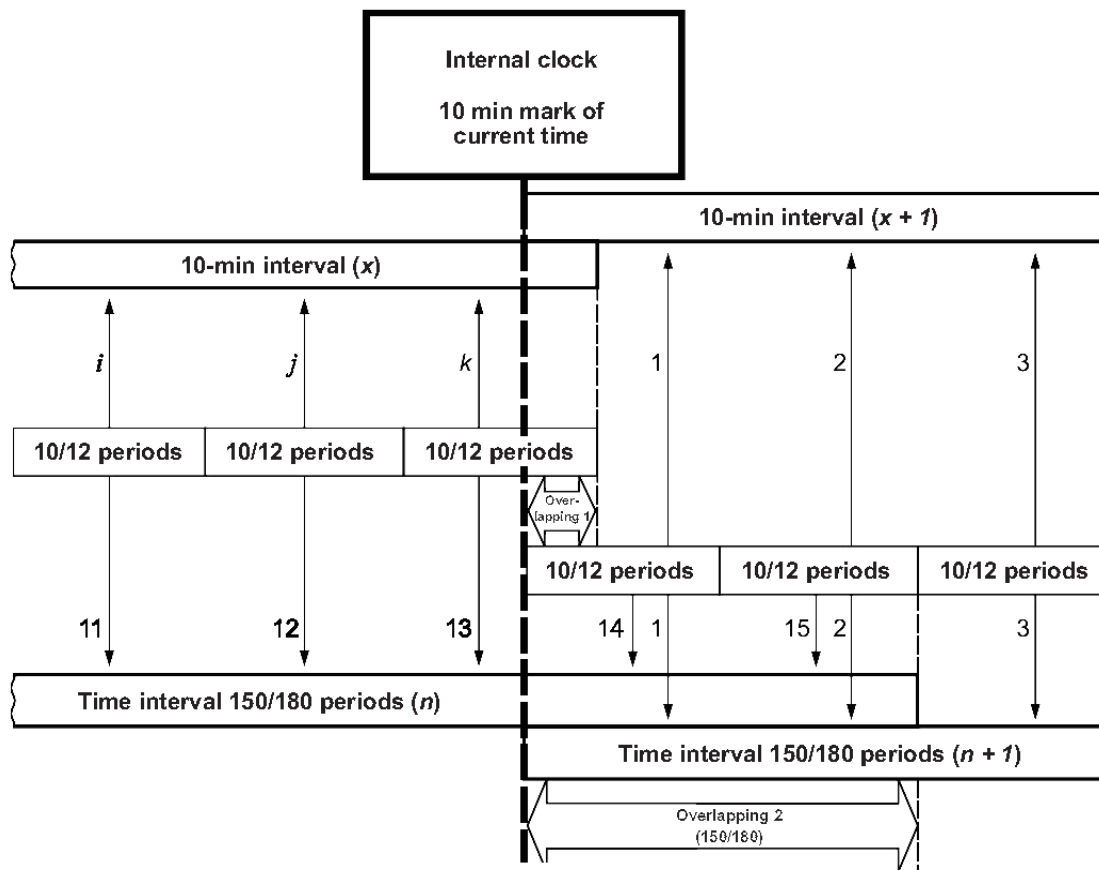


Fig 4.2.19 "Error setting" message



Synchronization chart

#### 4.2.11 “Save actual measurements”

On selecting the item, the values of all measured parameters (averaged over 3 s) are recorded into the internal memory for one time.

### 4.3 Logging of PQP

#### 4.3.1 Introduction. Applying

#### **Energotester's design versions for power quality monitoring and analysis**

Energotester PQP-A-AX(-SX) comes in 3 design versions with regard to sets of measured PQP (see Table 1).

Each set can be used for particular purposes:

1 — AC power certification (testing of compliance with EN 50160: 2010 requirements), PQP monitoring. The following parameters are monitored and registered:

$\delta U_{(-)}$  and  $\delta U_{(+)}$  — under- and overdeviation of power supply voltage, %  $U_N$ ;

$\delta f$  — frequency deviation, Hz.

In addition, all of the parameters defined by EN 50160: 2010 (excluding Flicker values) along with events and their data (not standardized) are monitored and documented. Option used for AC power certification purposes (IEC 61000-4-30 class A measurements): Energotester PQP-A-A1.

2 — Regular power quality inspection and AC power certification (testing of compliance with EN 50160: 2010 requirements). All EN 50160: 2010 parameters are documented excluding events (not registered). Option used for AC power certification purposes (IEC 61000-4-30 class A measurements):

Energotester PQP-A-A2. Option intended for regular power quality inspection (IEC 61000-4-30 class S measurements): Energotester PQP-A-S2.

3 — Used to record all power supply voltage changes defined and described in EN 50160: 2010. Option used for AC power certification purposes (IEC 61000-4-30 class A measurements): Energotester PQP-A-A3.

Complete with clamp-on current sensors (clamps), Energotester can be used to:

- Carry out power quality analysis (determine distortion factors),
- Build consumer load graphs,
- Test automatic meter reading systems,
- Detect sources of energy losses.

### 4.3.2 Logging options

Functions of measuring and viewing of power quality parameters as well as recording of averaged values of electric quantities into the non-volatile memory (logging mode) are enabled from the "Power Quality Logger" main menu option (Fig. 4.3.1).



Fig. 4.3.1 "Power Quality Logger" options

"Power Quality Logger" menu has 10 options selectable with  $\downarrow$ ,  $\uparrow$  keys. Press `ENT` to select a mode or `ESC` to return to the menu. On entering the selected menu option, a selection and/or editing window for the parameter will appear.

Following the list of logging settings, the screen displays START LOGGER or STOP LOGGER commands. The command active at the moment is visible (see the 3<sup>rd</sup> screen in Fig. 4.3.1). In other

words, when logging is in progress the screen shows STOP LOGGING command, and a "red circle" indicator is displayed in the bottom line.

### 4.3.3 Selecting site name

The site name ("Installation name") option is used to specify identification fields that will be represented in the test report. Energotester saves the current name of installation under review in the memory and stores 10 names used earlier. The "Installation name" option of POWER QUALITY LOGGER menu gives access to this data.

Fig. 4.3.2 shows the selection and editing windows used to create a new site (installation) name. This is done by replacing characters in the current name field.



Fig. 4.3.2 Site name selection and entry windows

On entering the "Installation name" editing mode, the currently active installation name is displayed in NEW NAME field. The editing procedure implies replacing characters (selected by the cursor in the form of character's red highlight) in this NEW NAME line.

At every step, a character in the current name line highlighted in red with upper cursor is replaced. You can move this cursor along the NEW NAME line with commands **< >** (located in the bottom line of the Character Table). To do this, place the lower "Character Table" cursor on one of these commands and press ENT.

On selecting the character to be replaced, position the cursor on the Character Table, select the desired character using arrow keys and press ENT. On doing this, the old character in the NEW NAME line is replaced with a new one, and the cursor will appear on the next character position. It is possible to go to the lower case mode (only once while editing one name). To do this, select **abc/абв** field and press ENT.

Position the upper cursor (located in the NEW NAME line) on the next character to be replaced and repeat the procedure. Then press ENT.

At the end of the procedure, place the cursor on **ENTER** command and press the ENT key to record the new name into the memory. Energotester will open the screen shown in Fig. 4.3.2 on the left with the new name in the current name line. Press ESC to return to the "Power Quality Logger" screen.

Ten last used installation names are stored in the memory and can be selected from the "10 Last-used" menu.

### 4.3.4 Selecting declared voltage



Fig. 4.3.4 Declared voltage selection screen

The screen is called up by selecting its name in the "Power Quality Logger" menu.

The default declared voltage can be edited with the right/left arrow keys and numeric keys. Press ENT to open the editing window. The new value is confirmed by pressing ENT. Conditions of the logging session will be changed at this moment.

Please note that the new declared voltage value can only be selected within the frames outlined with min. and max. thresholds.

### 4.3.5 Supply system

The menu is used to select the type of power supply system under review. Power supply system type determines how the results will be calculated.



Fig. 4.3.5 Supply system selection screen

### 4.3.6 PQ threshold sets

"PQ threshold sets" option contains sets of PQ thresholds (standard sets are listed in Table 4.3.1). Power Quality Parameters are measured and calculated on this basis. The PQ threshold selection window contains six options. Four of them correspond to four GOST 32144-2013 (EN 50160: 2010) points related to standard nominal voltages of the network under review, as measured at the probe connection point. Two more sets of PQ thresholds are customer-defined.

Settings of all types are stored in the internal memory, each one in two variant records: for single phase / three-phase 4-wire and three-phase 3-wire networks. Selection of a variant is made automatically according to the circuit connection type specified on the "Circuit connection" screen. By default, the

custom settings are set to 0.38 kV values. Use ↓ or ↑ keys to select the type of settings. Press ‘ENT’ to activate the new set or ‘ESC’ to reject. Either of these actions will bring up the "Power Quality Logger" window. The user can create and maintain the custom settings either on a PC (“Network Energomonitoring” program) or via “PQ threshold sets” → ”Custom Threshold Sets 1” and “Custom Threshold Sets 2” menu. Frequency deviation can take positive and negative values, other parameters are always positive. The GOST 32144-2013 (EN 50160) standard settings cannot be changed. When using instrument transformers to connect to a 6-25 kV, 35 kV, or 110-220 kV network, Energotester nominal voltage is set so as to fit secondary voltage of the instrument transformers to let the logged results be recalculated considering transformer ratio. While using PC “Network Energomonitoring” program to process logged results, be sure to declare the transformer(s) by entering the actual transformer ratio in an appropriate dialog box (see Network Energomonitoring program, User Manual).

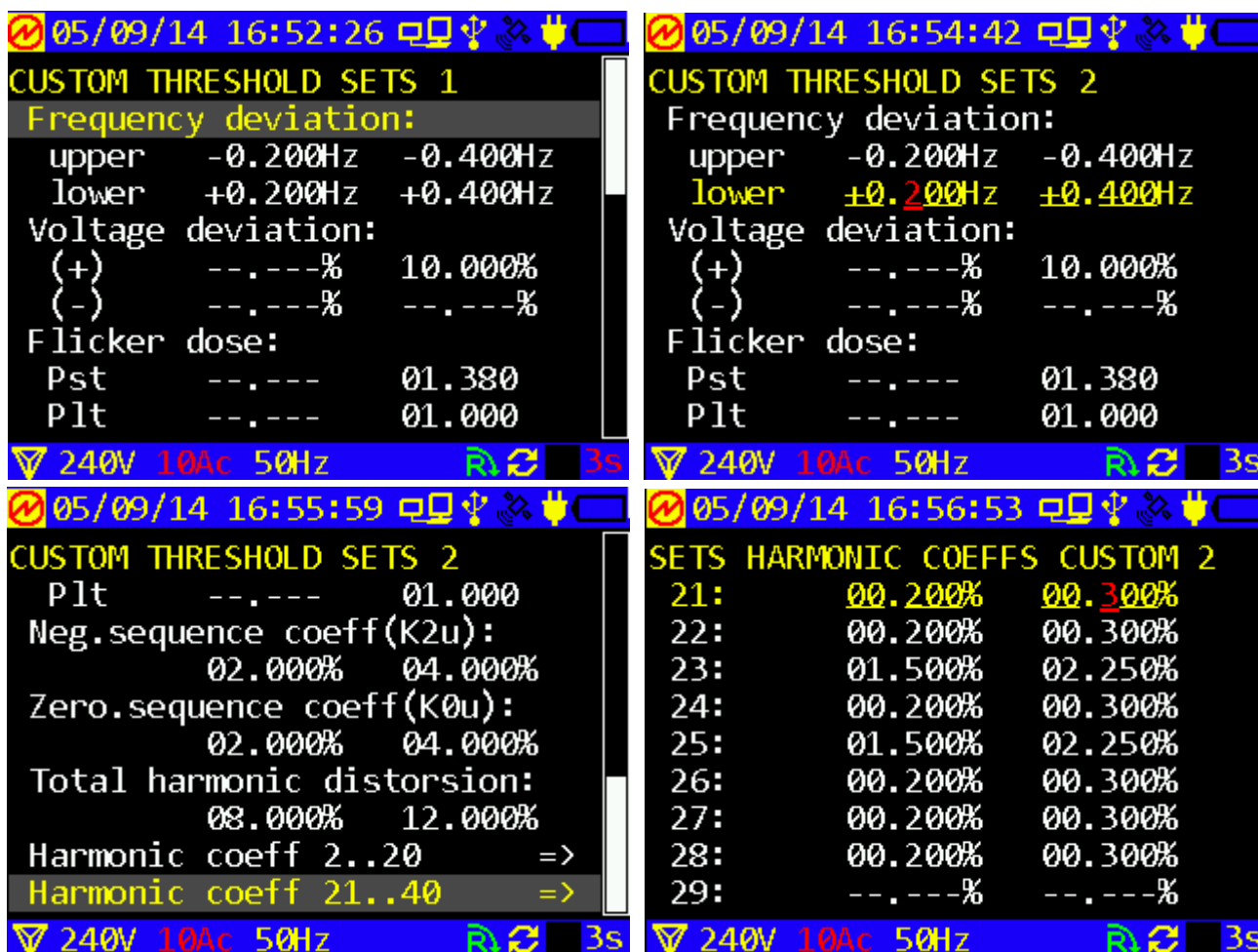


Fig. 4.3.6 Sets of custom PQ thresholds

Table 4.3.1

## Standard settings according to GOST R 54149-2010

Order	95% of time				100% of time			
	0.38 kV	6—25 kV	35 kV	110—220 kV	0.38 kV	6—25 kV	35 kV	110—220 kV
Total	8.00	5.00	4.00	2.00	12.00	8.00	6.00	3.00
2	2.00	1.50	1.00	0.50	3.00	2.25	1.50	0.75
3	5.00	3.00	3.00	1.50	7.50	4.50	4.50	2.25
4	1.00	0.70	0.50	0.30	1.50	1.05	0.75	0.45
5	6.00	4.00	3.00	1.50	9.00	6.00	4.50	2.25
6	0.50	0.30	0.30	0.20	0.75	0.45	0.45	0.30
7	5.00	3.00	2.50	1.00	7.50	4.50	3.75	1.50
8	0.50	0.30	0.30	0.20	0.75	0.45	0.45	0.30
9	1.50	1.00	1.00	0.40	2.25	1.50	1.50	0.60
10	0.50	0.30	0.30	0.20	0.75	0.45	0.45	0.30
11	3.50	2.00	2.00	1.00	5.25	3.00	3.00	1.50
12	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
13	3.00	2.00	1.50	0.70	4.50	3.00	2.25	1.05
14	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
15	0.30	0.30	0.30	0.20	0.45	0.45	0.45	0.30
16	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
17	2.00	1.50	1.00	0.50	3.00	2.25	1.50	0.75
18	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
19	1.50	1.00	1.00	0.40	2.25	1.50	1.50	0.60
20	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
21	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
22	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
23	1.50	1.00	1.00	0.40	2.25	1.50	1.50	0.60
24	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
25	1.50	1.00	1.00	0.40	2.25	1.50	1.50	0.60
26	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
27	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
28	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
29	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
30	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
31	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
32	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined

33	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
34	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
35	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
36	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
37	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
38	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
39	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
40	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
41	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
42	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
43	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
44	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
45	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30
46	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
47	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
48	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined
49	not defined	not defined	not defined	not defined	not defined	not defined	not defined	not defined
50	0.20	0.20	0.20	not defined	0.30	0.30	0.30	not defined



### 4.3.7 PQ report period

The PQ report period option is used to select one of two report periods. Power Quality logs will be statistically processed on this basis.

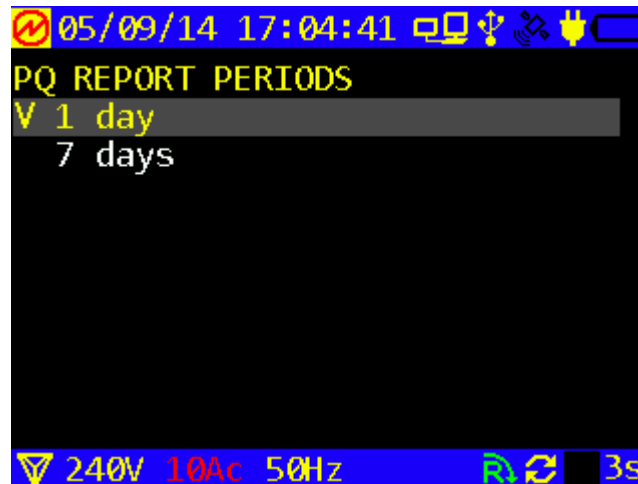


Fig. 4.3.7 PQ report period screen

### 4.3.8 PQ report list

"PQ report list" screen shows data on PQ logs.

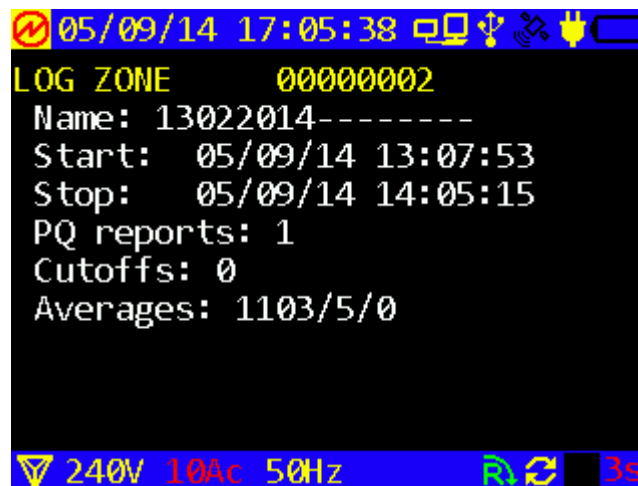


Fig. 4.3.8 "PQ report list" screen

More details about the PQ log are shown on pressing ENT.

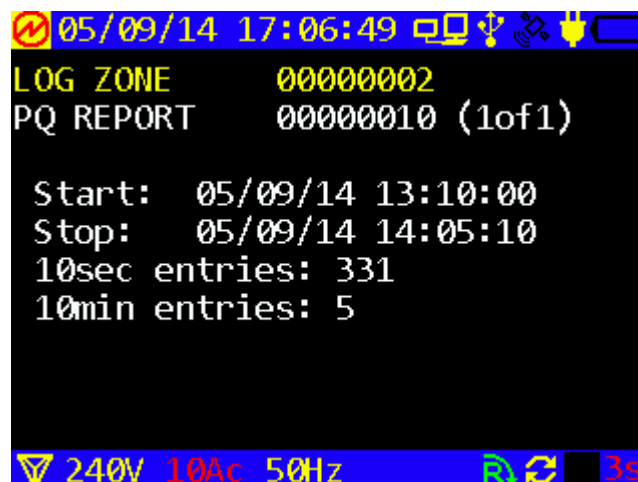


Fig. 4.3.9 "PQ report list" details

### 4.3.9 LOGGER START mode

The "Logger Start" option is used to select start type - immediate (manual) or timed.

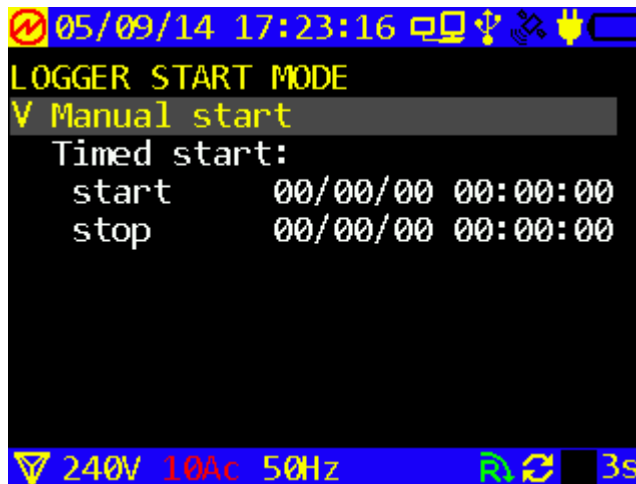


Fig. 4.3.10 Start type selection window

**Note!** To enable a timed start, specify start and stop time of a logging session, highlight the "Timed Start" option and press ENT.

### 4.3.10 Clearing memory

Clearing memory command makes it possible to delete logs of all types from the internal memory.

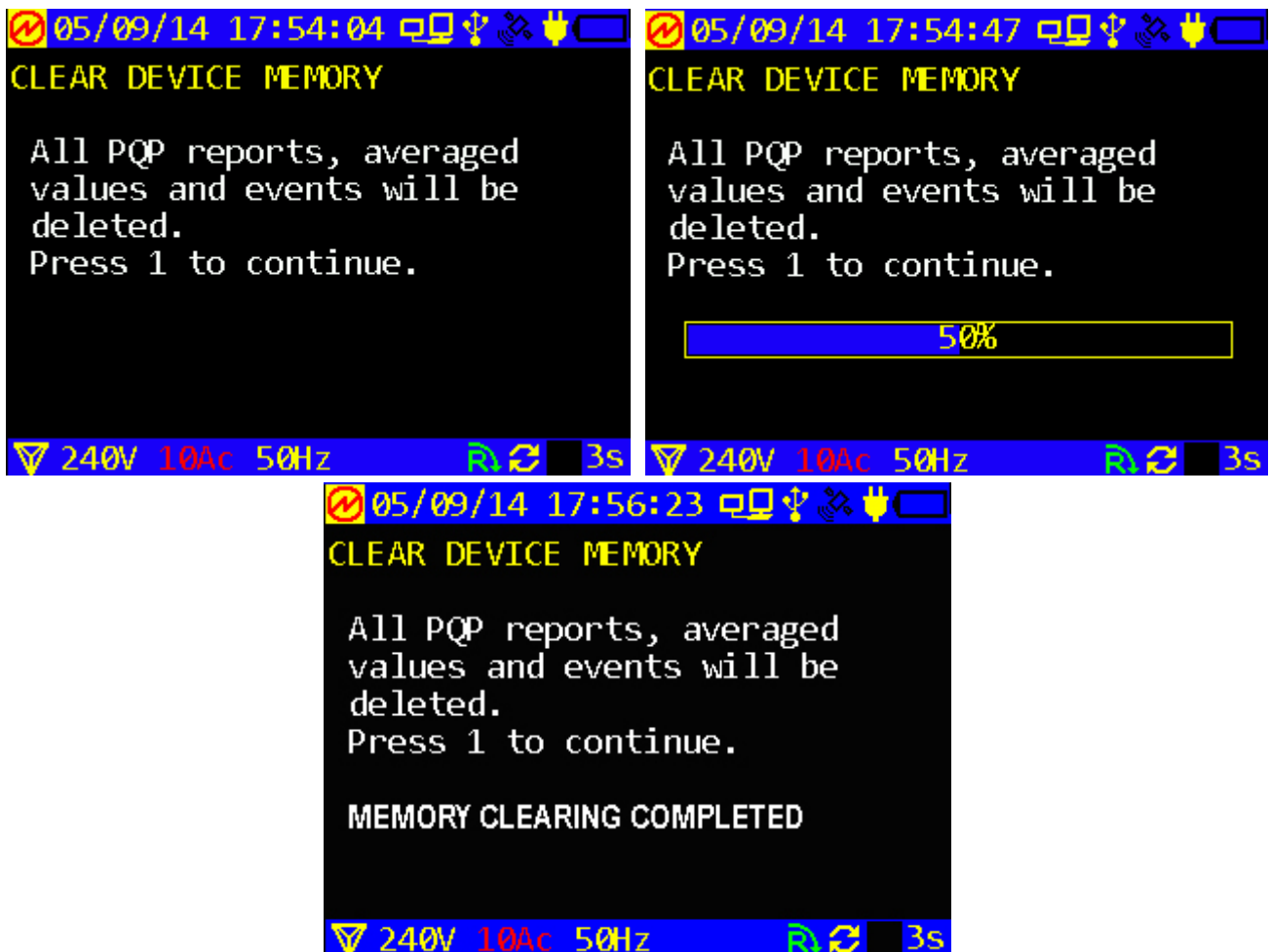


Fig. 4.3.11 Memory clearing

## 4.4 Settings

### 4.4.1 "Settings" menu and access levels

The user gains access to a certain set of options available within the "Settings" menu (Fig. 4.4.1) depending on the password entered at power-up. The 1st level password gives access to the following 5 menu items:

- Connections and ranges;
- Firmware version;
- Date and time;
- Menu settings;
- Distribution of measurement log memory;
- Mains synchronization.

The 2nd level password makes it possible to enable one more option in addition to the 5 listed above:

- Reset to default settings.

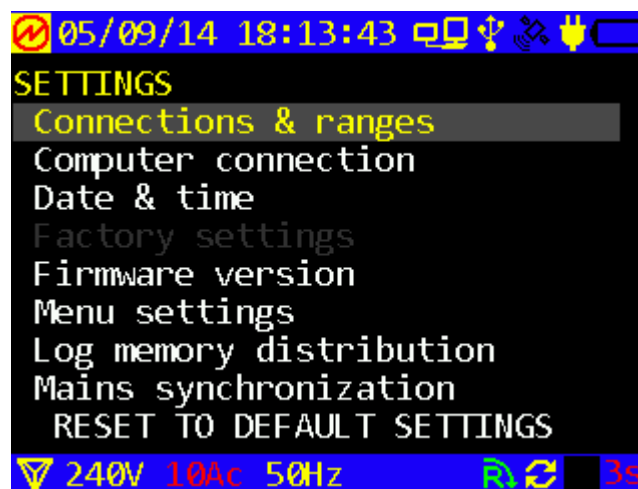


Fig. 4.4.1 "Settings" menu

Each item of the "Settings" menu gives access to relevant options to be modified. Use ↓ and ↑ keys to navigate through the items. Press `ENT` to select a mode or `ESC` to return to the main menu.

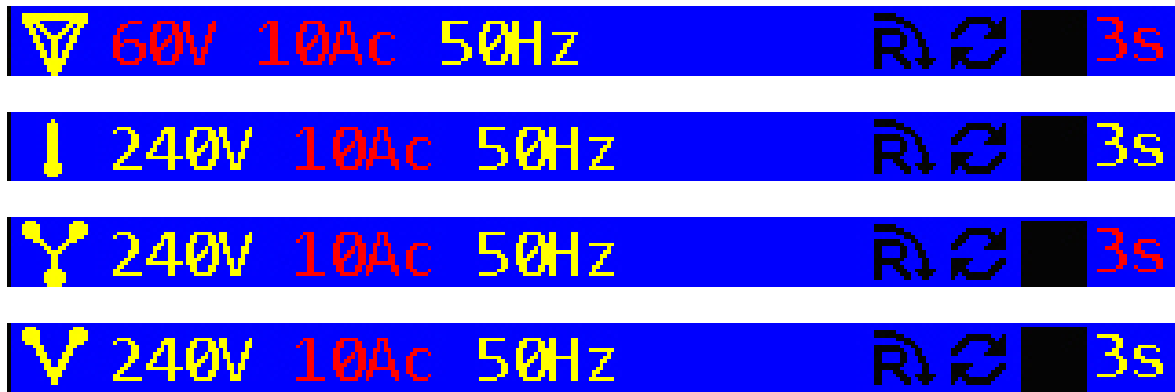
"Connections and ranges" function may be called up either via the menu or just by pressing 'F' hotkey (from any menu item).

### 4.4.2 Connection type

"Connection type" is a compulsory screen displayed after power-up. However, the user may want to enter "Connection type" window and declare another connection type gently, not forcing the Energotester to be powered down and up. The "Connection type" window is shown in Fig. 4.4.2 on the left.

Three phase 4-wire, three phase 3-wire, and single phase 2-wire connection types are available. Typical connections to the circuits under test are pictured in the appendix.

Connection type selected from among the options of the corresponding window determines the basis for further measurements and calculations. The actual type of circuit connection is constantly displayed in the bottom status line.



**Note:** In the three-phase 3-wire mode, there are two options to connect the Device to the current circuits:

- Energotester is directly connected to phase A, B and C current circuits;
- Energotester is connected to phases A and C (3-phase Aron connection). The value of phase B current is derived programmatically.

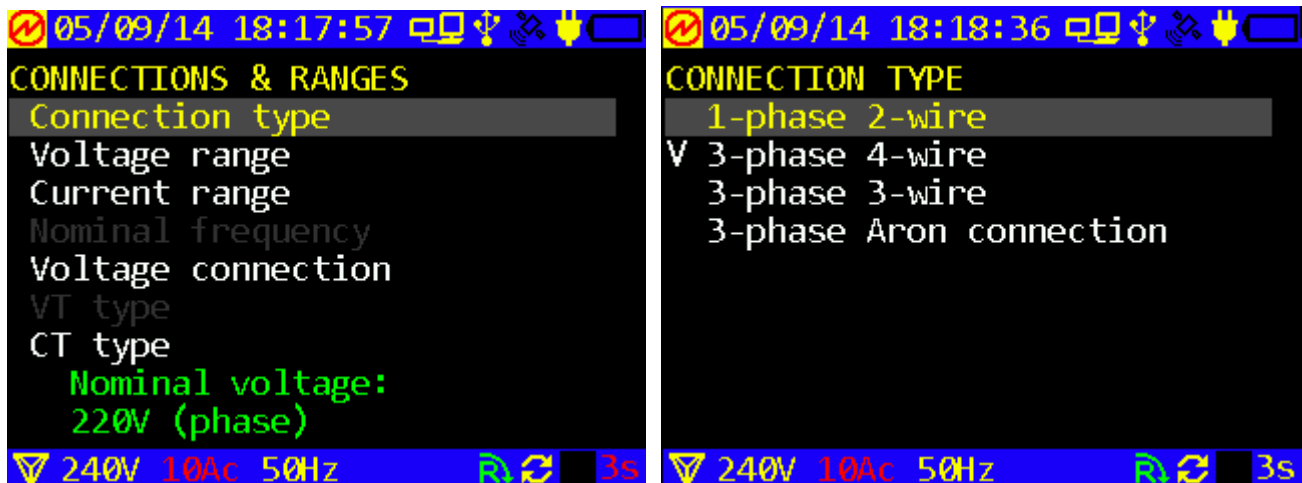


Fig. 4.4.2 Circuit type selection window

In the "Connection type" screen (Fig. 4.4.2), the required connection scheme is selected with ↓ and ↑ keys and confirmed by pressing ENT. Measurement conditions will be changed at this moment. The new status symbol appears on the left part of the status line, and the "hourglass" icon indicating reconfiguration in progress appears on its right part. When the "hourglass" disappears (in a few seconds), Energotester is ready for operation.

### 4.4.3 Voltage and current ranges

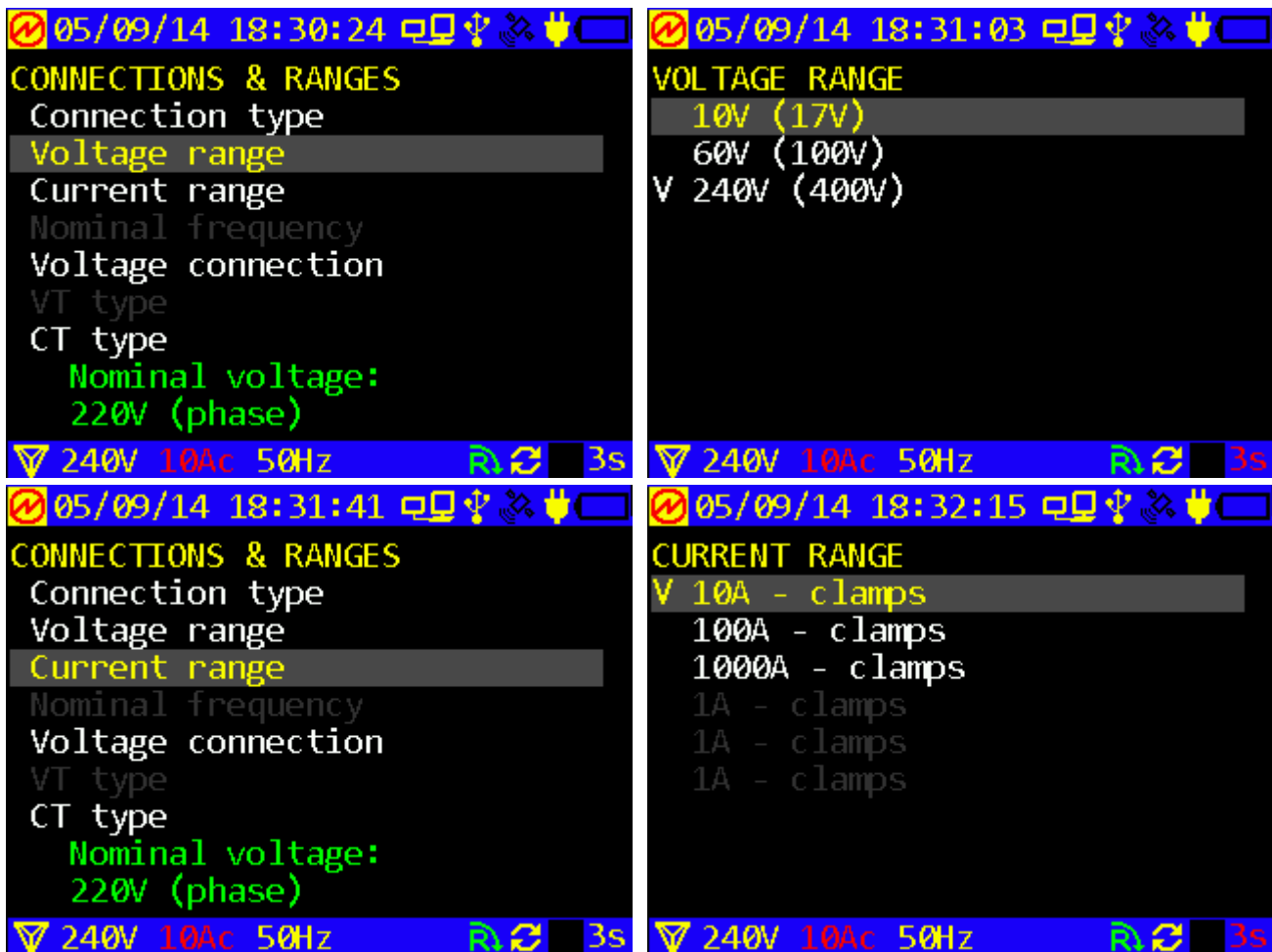


Fig. 4.4.3 Voltage and current range selection screens

The required ranges are selected with ↓ and ↑ keys and activated by pressing ENT. Measurement conditions will be changed at this moment. The new status symbol appears on the left part of the status line, and the "hourglass" icon indicating reconfiguration in progress appears on its right part. When the "hourglass" disappears (in a few seconds), Energotester is ready for operation.

Selection of nominal frequency (50 or 60 Hz) is made in the same way.

### 4.4.4 Selecting type of external instrument transformers

"CT type" and "VT type" items of "Connections and ranges" menu are used only if the input signal is applied to Energotester via external instrument transformers ("Transformer operated" option shall be preset in the menu). The required transformer type is selected with ↓ and ↑ keys and confirmed by pressing ENT. At this moment, the measurement range of voltage (current) related to the selected transformer is highlighted in red at the left side of the bottom status line. The hourglass icon at the right side indicates that Energotester is being reconfigured.

At the same time, the first digit in the turns ratio entry field becomes red. This means that the user has a possibility to confirm the selected turns ratio or to change it (if necessary).

In both cases, the value in the field is recorded into the memory on pressing ENT. The selected value is marked with a tick.



Fig. 4.4.4 Transformer selection windows

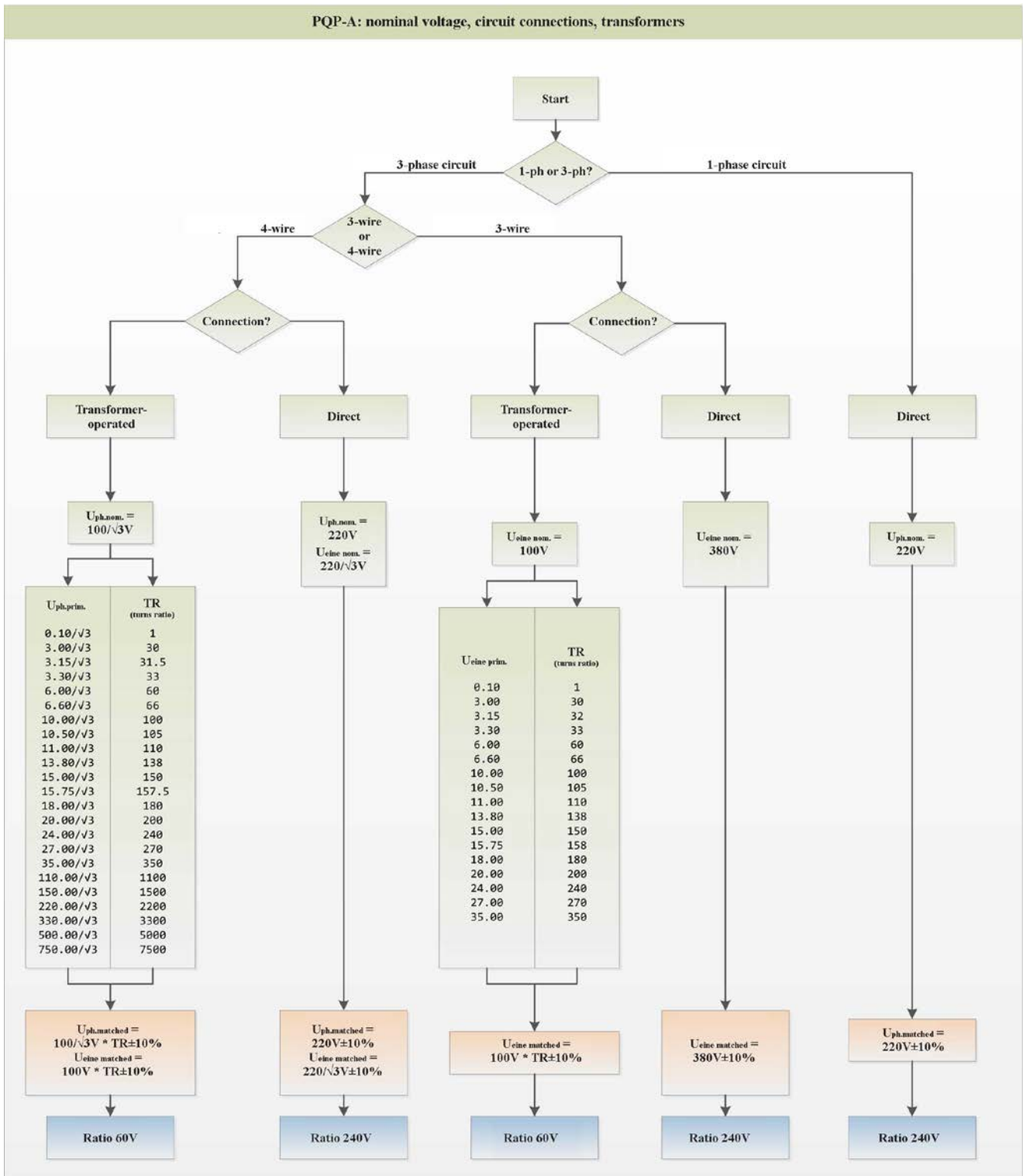


Fig. 4.4.5 Algorithm indicating selection of voltage nominal values and types of transformers for various circuit connections

### 4.4.5 Setting date and time

Date and time can be adjusted in the window shown on the left of Fig. 4.4.6. The screenshot corresponds to the active state of GPS-receiver:

- "Satellite" symbol (the 3rd symbol from the right side of the top status line) is displayed in yellow (in "No GPS signal" state the satellite is displayed in black outline);
- Field displaying time deviation from GPS is being updated.

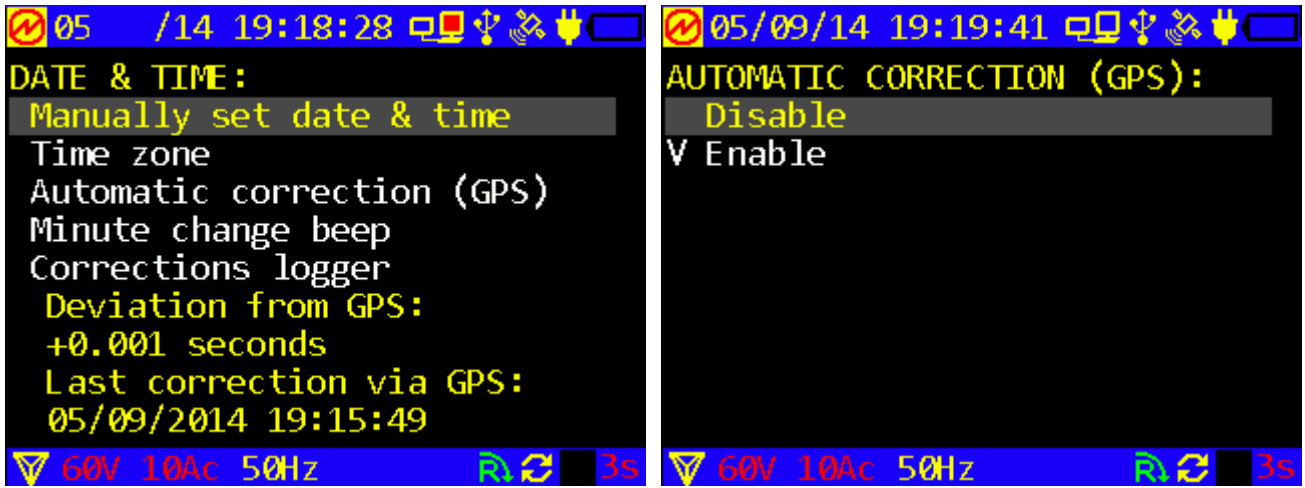


Fig. 4.4.6 Time correction screens

"Automatic correction" option is used to turn the automatic correction on and off (the right screenshot of Fig. 4.4.6) with ↓, ↑ and ENT keys. The selected item is marked with a tick. This has no effect on GPS receiver mode, since the receiver operates regardless of whether Energotester uses its data for time correction or not.

Fig. 4.4.7 shows the window where the date and time can be set manually. The "Satellite" symbol in the status line indicates that GPS-receiver is in "No signal" state.

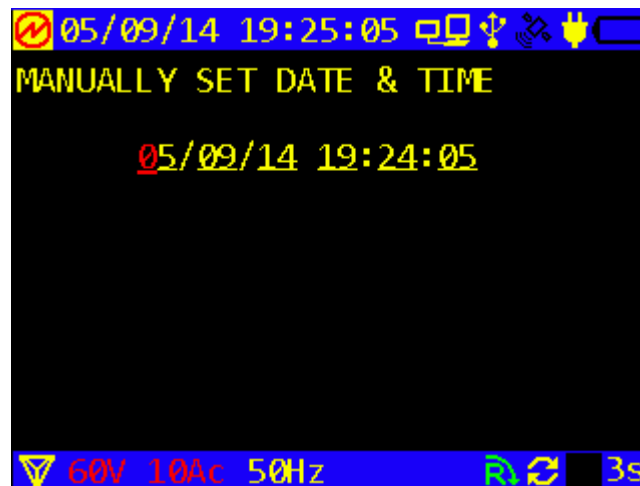


Fig. 4.4.7 Screens for setting date and time

After selection of the screen (Fig. 4.4.7), it shows the date and time currently set for the system clock (the same is displayed in the top status line). The first digit is highlighted, which means that the field is editable.

Editing is done with the arrow keys: up/down arrow keys for selection of digits and left/right keys for position. The selection is confirmed by pressing ENT.

On pressing ENT, Date and Time of the system clock is changed, and the "Corrections Logger" is updated (see Fig. 4.4.7).

#### 4.4.6 Firmware version

"Firmware version" is a read-only option showing manufacturer data (firmware version etc.).



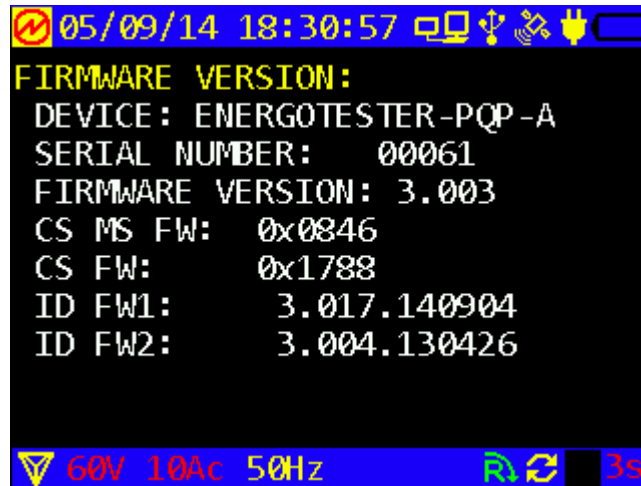


Fig. 4.4.8 "Firmware version" window

#### 4.4.7 Menu settings

Fig. 4.4.9 shows 2 screens of the "Menu settings" option: "Backlight power saving" and "Brightness". The windows are self-explanatory.

To set the required mode, select the corresponding field and press ENT. The tick appears next to the selected mode. Then you can return to the previous menu by pressing ESC.



Fig. 4.4.9 Backlight intensity and power saving modes

"Measurements colour scheme" option (Fig. 4.4.10) is used to set monochrome or colour (yellow - phase A(L1), green - phase B(L2), red - phase C(L3), blue - Neutral) modes of displaying measurement results.

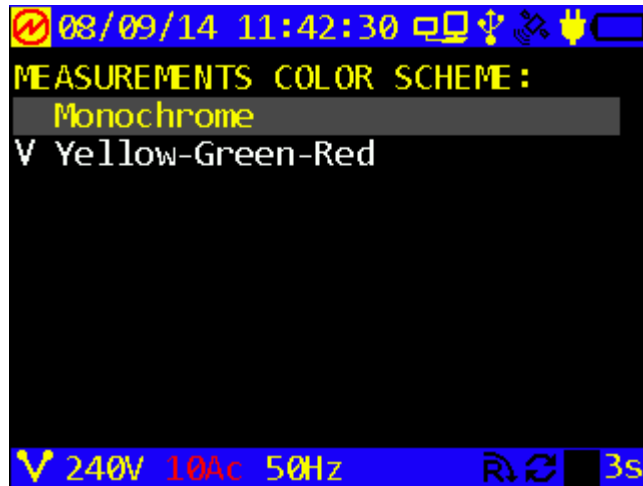


Fig. 4.4.10 "Measurements colour scheme" window

#### 4.4.8 Language

“Language” option gives the possibility to choose the language for messages and alphanumeric fields on the screens.



Fig. 4.4.11 “Language” menu

#### 4.4.9 Password

Fig. 4.4.12 shows a set of windows where you can change the current password of the instrument, provided that its access level is equal or less to that typed in when turning the instrument on. There is no need to enter the current password. Enter a new password, press ENT, repeat the password and press ENT once again. If you fail to enter two identical numbers, you will be prompted to make another attempt.

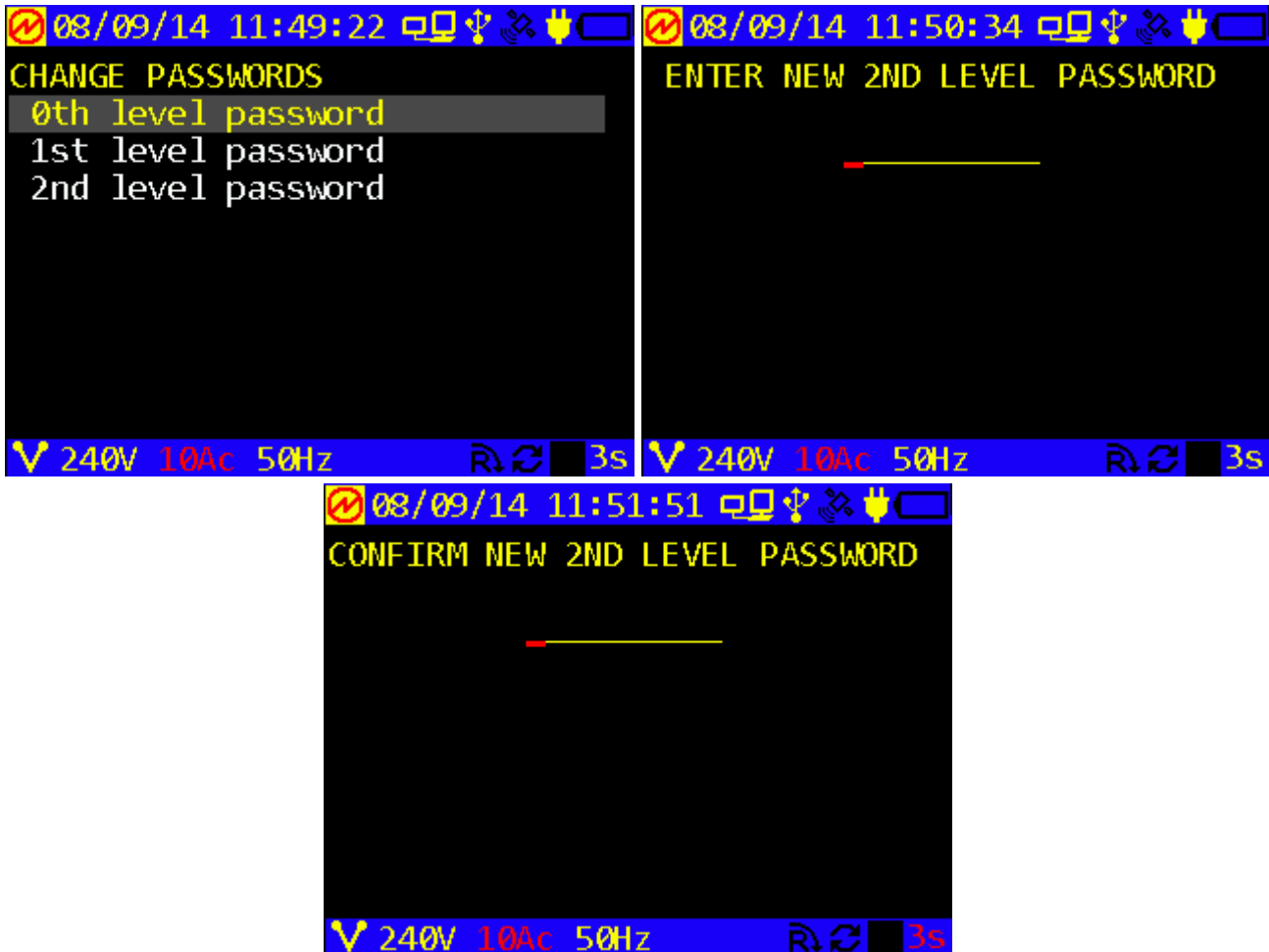


Fig. 4.4.12 "Password changing" windows

In case of entering a correct password 2 times, the following message will be displayed:

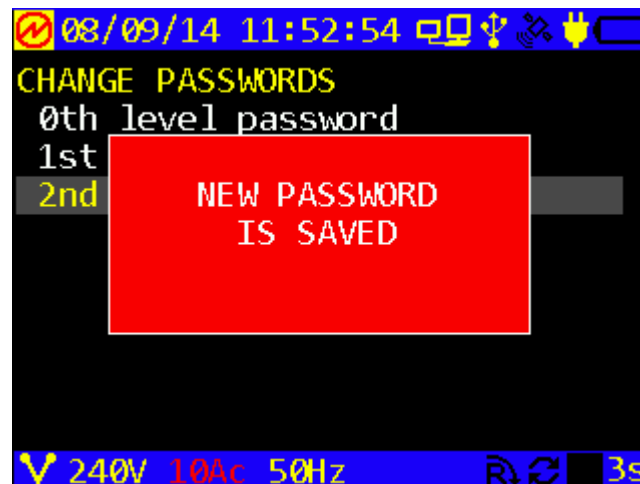


Fig. 4.4.13 "Correct password" message

On pressing ENT, Energotester returns to the "Change passwords" menu. The new password is accepted from this moment. Press ESC to return to the previous window without saving changes.

#### 4.4.10 Distribution of measurement log memory

Fig. 4.4.14 shows 2 windows used to specify the percentage of memory capacity associated with measurement logs of a certain type. The logs are sorted by averaging time. On selecting the log type and pressing ENT, the memory capacity (%) entry field becomes editable.

Editing is done with the arrow keys: up/down arrow keys for selection of digits and left/right keys for position. The selection is confirmed by pressing ENT.

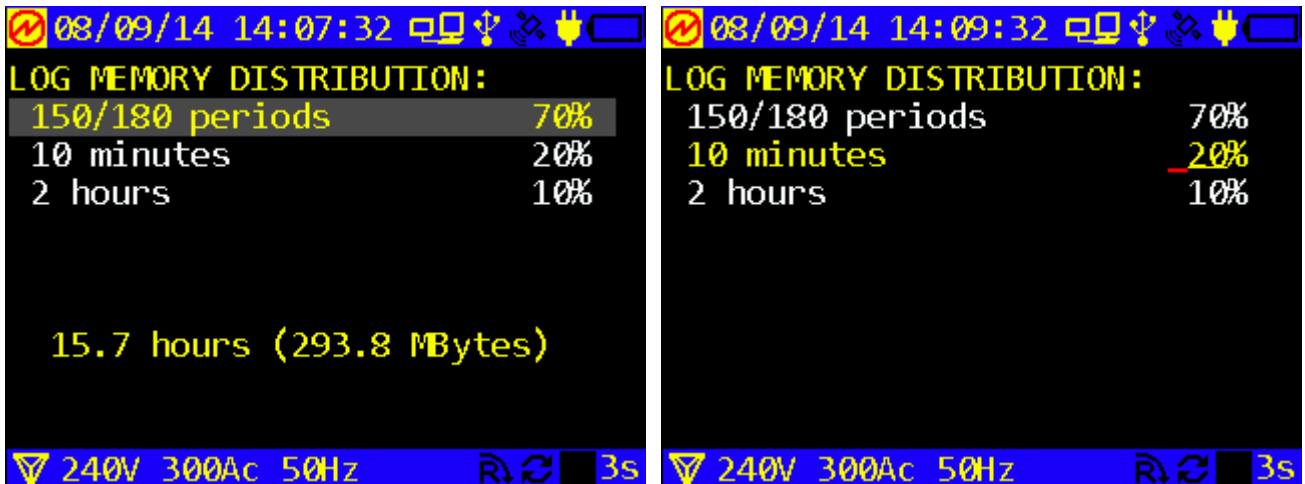


Fig. 4.4.14 "Log memory distribution" windows

On pressing ENT, the changes are accepted and Energotester returns to the previous window.

**NOTE!** Memory capacity (expressed as a percentage) assigned to the log of a certain type can be only changed by decreasing the percent value (the values assigned to other logs will be increased automatically).

#### 4.4.11 Mains synchronization

"Mains synchronization" function (Fig. 4.4.15) can be used to synchronize the sampling rate of the instrument with mains frequency or frequency of the internal generator. It has 2 options: "Enable" (synchronization with mains frequency) and "Disable" (synchronization with the internal generator).



Fig. 4.4.15 "Mains Synchronization" options

#### 4.4.12 Reset to default settings

The function (Fig. 4.4.16) is used to clear the user configuration and to restore the factory default settings.

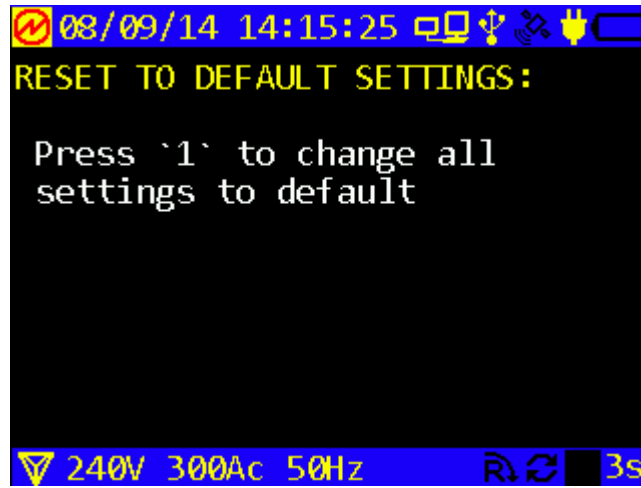


Fig 4.4.16 "Reset to default settings" window

## 4.5 Diagnostics

The “Diagnostics” screen is shown in Fig. 4.5.1. Units to be checked are selected with ↓, ↑ keys. ‘ENT’ and ‘ESC’ keys are used to access an option and return to the main menu respectively.

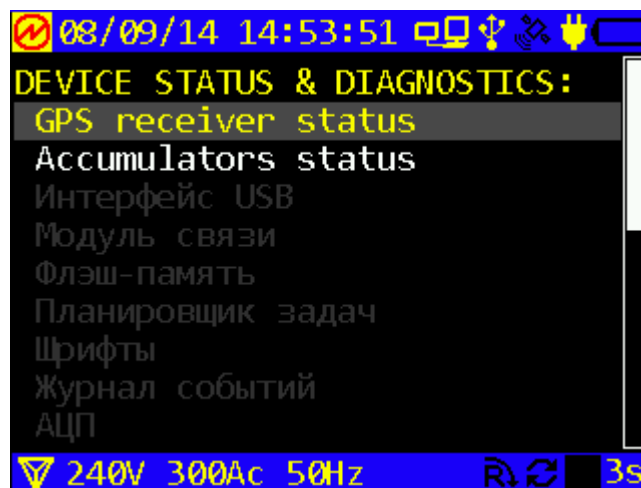


Fig. 4.5.1 "Diagnostics" screen

### 4.5.1 Diagnostics of GPS receiver

Fig. 4.5.2 shows 4 screens related to 4 states of GPS receiver:

- Antenna not connected;
- Antenna recently connected;
- Normal GPS receiver operation;
- Antenna recently disconnected.

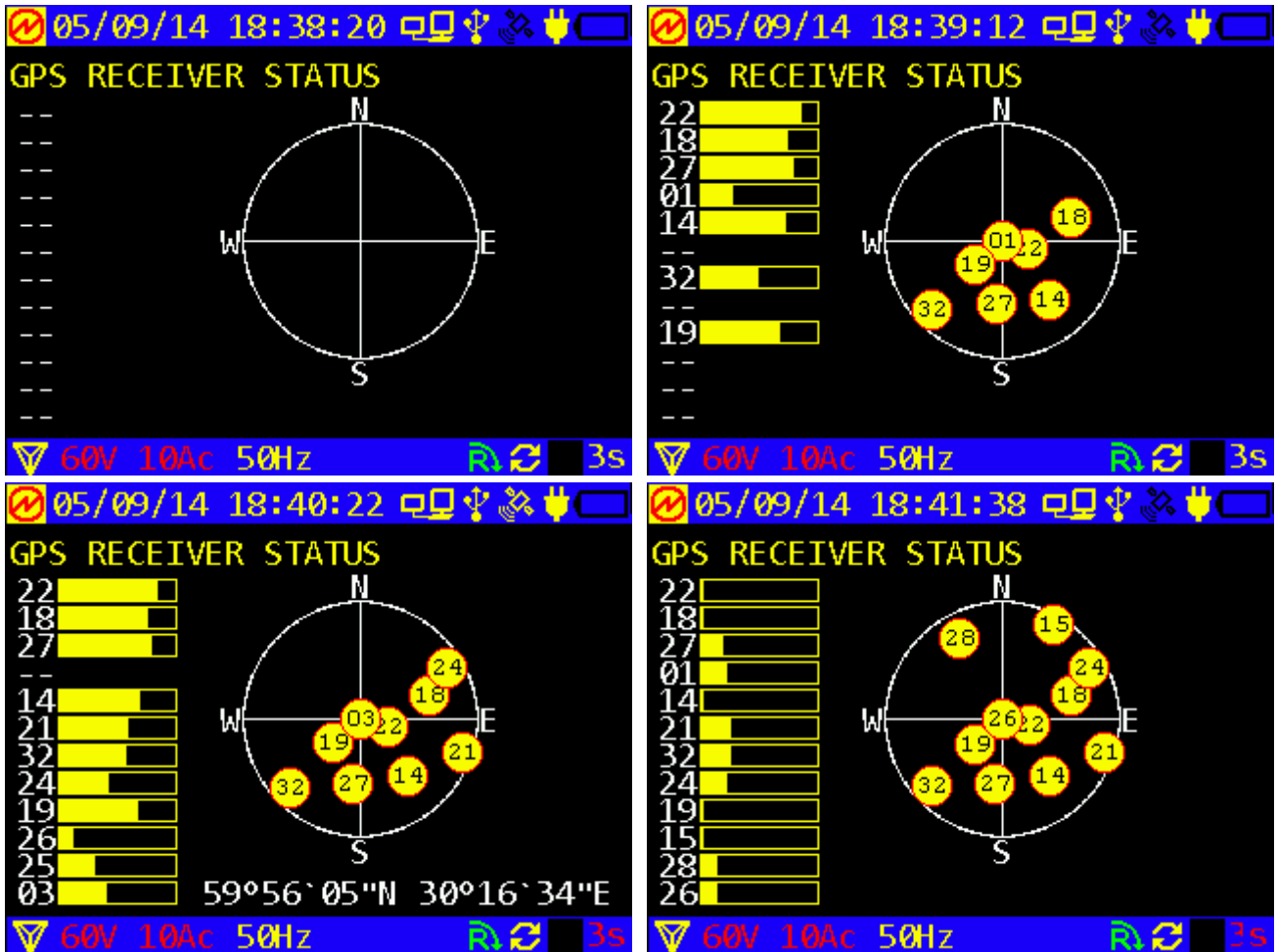


Fig. 4.5.2 Four states of GPS receiver

The screens pictured above show that "Satellite" symbol is displayed in yellow only at reception of correct GPS data.

#### 4.5.2 Diagnostics of power supply unit (accumulators)

The screenshots shown in Fig. 4.5.4 ("Accumulators" submenu) represent two states of the power supply unit:

- Battery is half charged, Power Adaptor disconnected;
- Battery charge is about 70%, Power Adaptor connected.

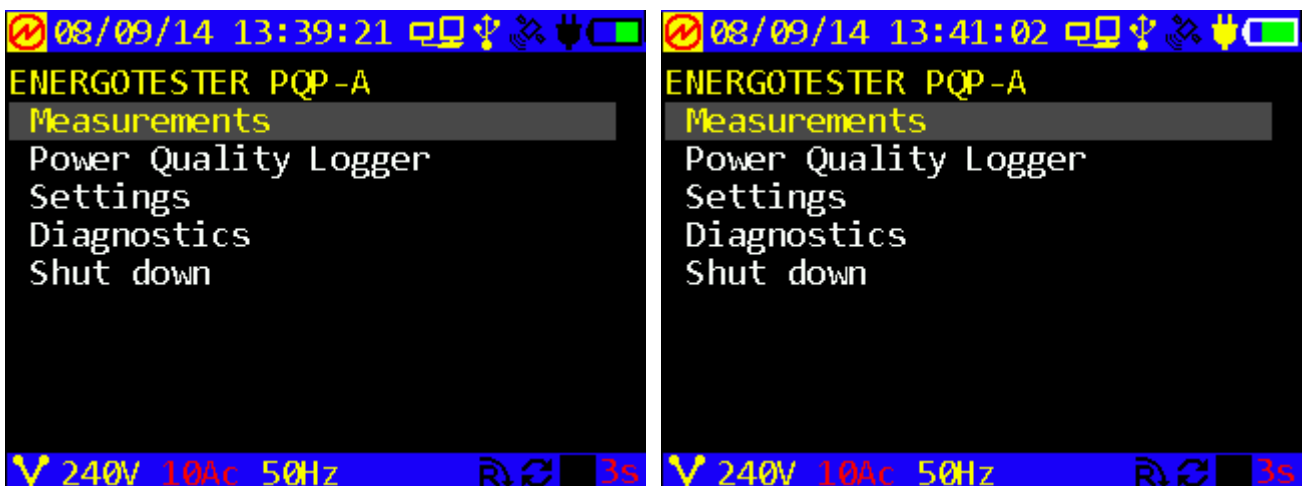


Fig. 4.5.4 Battery status screens

## 5 User Maintenance

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

5.2 Every maintenance operation shall meet safety requirements described in Sections 1 and 3.3.2.

5.3 Routine maintenance includes the following operations:

- Cleaning the display and keyboard with a damp cloth;
- Cleaning the oxidized contacts and checking the reliability of their fixing;
- Cleaning the jaw faces of current clamps with a soft damp cloth; any dirt may cause malfunction of the clamps; do not use abrasives, solvents, alcohol.

5.4 Troubleshooting

No	Fault	How to solve the problem
1	Energotester does not start up.	Check that the batteries are inserted in the battery compartment. Power the Device from mains via Power Adapter. It is highly recommended to fully charge the batteries. See section 3.3.2. Check that the Power Adapter cable is reliably connected.
2	Energotester spontaneously shuts down.	Charge the batteries or connect Energotester to mains via Power Adapter
3	The batteries are discharged too soon.	Change the faulty batteries and fully charge the new ones following the procedure described in section 3.3.2.
4	No USB connection between the Device and PC.	Check data transfer settings in the Device Manager tab or in the MarsEnergocommunicator (MarsEnergocommunicator.exe) program. Check USB cable.
5	No GPS signal	Check GPS antenna connection. See section 4.5.1. "Diagnostics of GPS receiver".

## 6 Storage

6.1 Energotester shall be stored indoor, in a heated storeroom.

Storage conditions in the manufacturer's package:

Ambient temperature: from 0 to 40° C;

Relative humidity: 80% at 35° C.

Storage conditions without the package:

Ambient temperature: from 10 to 35° C;

Relative humidity: < 80% at 25° C.

6.2 The storeroom should be free from current-conductive dust, acid or alkali fumes and other aggressive substances.

## 7 Transportation

The Device should be transported packed in the manufacturer's box. The Device can be transported in any enclosed vehicle including air-tight heated plane cargo compartment.

Ambient conditions allowed during transportation:

Ambient temperature: - 40 °C to +50 °C;

Relative humidity < 90% at 25 °C.

## 8. Marking and sealing

### 8.1 Marking

The Device's front panel bears the following stenciled marks:

- Name of the Instrument (PQP-A Energotester);
- Sign of National Registry of Measuring Instruments;
- Manufacturer's trademark;
- Power supply type, nominal power supply voltage.

The nameplate on the Device's case bears:

- Designation of the model and number of technical specifications;
- Manufacturer's name;
- Manufacturer's serial number (the number indicated on the Device's nameplate and the ones specified in the User's manual and on the nameplate of the accessories shall be identical);

8.2 Side and face walls of the transportation box bear handling symbols: "Fragile", "Keep dry" and "Top".

8.3 The Manufacturer's and Calibrator's seal is installed in the hole of a fastening screw. After opening Energotester for repair, the seal should be reinstalled by the authorized Service Companies only.



## 9 Warranty

9.1 The warranty terms and conditions listed below comply with applicable consumer protection laws of the Russian Federation.

9.2 All products of Mars-Energo are warranted against defects in manufacture or material **for a period of 18 (eighteen) months** from the date of purchase from Mars-Energo. Warranty period for the batteries is 6 (six) months from the date of purchase from Mars-Energo. Equipment believed to be defective may be sent within the warranty period to Mars-Energo for inspection (Warranty Claim enclosed, transportation prepaid). If the inspection by Mars-Energo confirms that the product is defective, it will be repaired or replaced (at Mars-Energo's option) at no charge, within the underlisted limitations (paragraph 9.4), and returned prepaid to the location specified in the buyer's Warranty Claim. All replaced parts become the property of Mars-Energo.

### 9.3. Warranty terms and conditions

9.3 In the event of any Device's failure or defect in manufacture or material during the warranty period (provided that the transportation, storage and operating conditions outlined in this Manual are fulfilled), send the Device to Mars-Energo along with the sales invoice or other proof of Device's ownership and date of purchase. If the documents outlined in the previous section are absent, the warranty period is calculated from the date of Device manufacture.

Mars-Energo retains the right to reject a warranty claim, if the documents listed in the previous section are filled out incompletely, incorrectly or illegibly. This warranty will not be applicable for the Devices whose serial number has been altered, removed or made illegible.

This warranty will not be applicable for damages to your Device caused during shipment to and from Mars-Energo location.

This warranty will not be applicable:

- 1) For parts requiring regular maintenance or replacement due to natural wear;
- 2) For consumable parts (parts, the nature of which is to become worn or depleted with use, such as batteries);
- 3) For damages to the Device caused by:
  - a) any use other than correct use described in the User manual including:
    - Handling the Device resulting in mechanical damages, cosmetic defects, modification of the Device, or damages to the LCD;
    - Damages caused by incorrect installation;
    - Damages caused by any maintenance other than correct maintenance described in the User manual;
    - Damages caused by installation and use inconsistent with the technical and safety standards in force in the country where the Device has been installed and used;
  - b) Damages caused by computer virus infection or by use of software not supplied by Mars-Energo, or damages caused by incorrect software installation;
  - c) Damages caused by condition or defects of a system or its elements with which or as part of which the Device was used, excluding the other Mars-Energo products intended for use with the Device;
  - d) Damages caused by accessories or ancillary equipment not made or authorized by Mars-Energo with respect to their type, condition or characteristics;
  - e) Damages caused by repairs or attempts to repair the Device executed by an unauthorized person or company;
  - f) Damages caused by adjustments or modifications made to the Device without prior written consent of Mars-Energo;
  - g) Damages caused by negligent handling;
  - h) Damages caused by accidents, fire, ingress of liquids, chemicals or other materials, flood, vibration, heat, improper ventilation, variations of supply voltage, improper power supply or input

voltage, electrostatic discharge including lightning, or any other impacts or external actions beyond the reasonable control of OOO Mars-Energy and not covered by the technical documentation for the Device.

The present warranty only covers hardware failures. This warranty does not cover failures of software (produced either by OOO Mars-Energy or by other manufacturers ), which are the subject of express or implied end user license agreements, separate warranties, or exclusions.

9.4 Mars-Energy establishes the lifetime for the products outlined above (excluding the batteries) of 4 (four) years from the date of purchase from Mars-Energy. Warranty period for the batteries is 2 (two) years from the date of purchase from Mars-Energy. *Please note that warranty period and lifetime differ from each other.*

9.5 It is highly recommended to make a backup copy of the data from the Device's internal memory and store it on another (external) media. Mars-Energy shall in no circumstances be liable for any direct or indirect damages or losses, whether incidental, consequential or otherwise, including but not limited to loss of profits, loss of use or any deletion, corruption, destruction or removal of data, disclosure of confidential information or infringement of privacy, data recovery expenses, losses arising out of interruption of commercial, production or other activities based on use or loss of use of the Device.

Manufacturer's address (for warranty claims):

**Mars-Energy**

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

Manufacturer's address (Production and Service departments):

V.O. Kozhevennaja Line, 29-5, Saint-Petersburg, Russia, 199106

Tel/Fax: (812) 309-02-06

E-mail: service@mars-energo.ru

## 10 Packing Form

PQP-A Energotester \_\_\_\_\_ No \_\_\_\_\_. The aforesaid equipment has been packed by Mars-Energo in compliance with the Technical Requirements in force.

Packer signature \_\_\_\_\_ (*Initials and name*)

Date: \_\_\_\_\_

## 11 Acceptance Form

PQP-A Energotester \_\_\_\_\_ No \_\_\_\_\_ Firmware version \_\_\_\_\_ The aforesaid equipment has been manufactured in compliance with Technical Specifications TS 4220-034-49976497-2013 and conforms to the Technical Requirements in force.

Head of Quality  
Control Department \_\_\_\_\_ (*Initials and Name*)

Corporate Seal:

Date: \_\_\_\_\_

Date of sale \_\_\_\_\_

Corporate Seal: \_\_\_\_\_ (*Initials and Name*)

## 12 Warranty Claim

In the event of any Device's failure or defect in manufacture or material during the warranty period (provided that the transportation, storage and operating conditions outlined in this Manual are fulfilled), send the Device to Mars-Energo along with the Warranty Claim containing the following information:

- Device's Model and Serial number; Date of manufacture; Date of putting the Device into operation;
- Condition of the manufacturer's seals (in place, destroyed, absent);
- Description of the failure or defect;
- Buyer details (Company name, address, etc., including name and phone number of whom the reply may concern).

# 13 Calibration Procedure

PQP-A Energotester \_\_\_\_\_ serial number \_\_\_\_\_

The Device's 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 Device undergoes primary post-manufacture calibration, and then it is calibrated after each repair. Regular calibration is performed during operation. A period of four calendar years is considered maximum time between calibrations.

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

## Appendix A. Connecting current clamps

The 10A Current clamps are connected to PQP-A Energotester via 10A Shunt (Fig. A1). In this case, the Device's current measuring range shall be set to "C 10A". When connecting the Device to the circuit under test via the 10A current clamps, take into account that current clamps are directional. Be sure to plug each colour (red, yellow, green) wire from the Device into the "source" socket of the associated clamp. Each blue or black ("return") wire from the Device is correspondingly plugged into the "load" socket of the associated clamp. An arrow embossed next to the clamp sockets stands for the direction "source → load". The direction is also meaningful when jaws are clamped around the current carrying conductor. There is another "source → load" arrow embossed on the jaws and pointing along the conductor (see Fig. A-2). If the jaws are clamped correctly, → the pointer shows which way the power is transmitted.

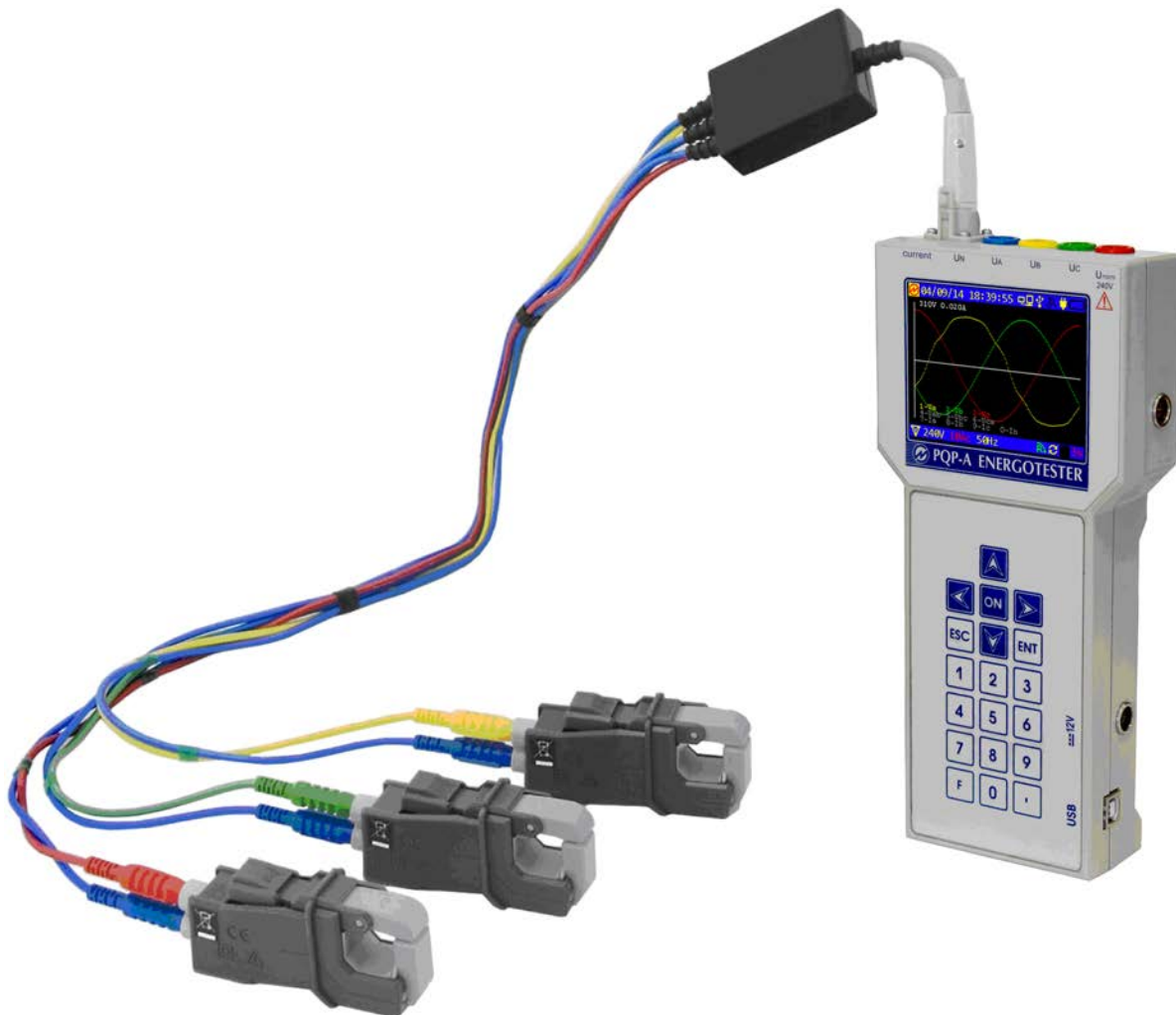


Fig. A1 Connecting the 10A- or 100A-Current Clamps to Energotester via the corresponding shunt



Fig. A2 Flow direction mark 'source → load' on the 10A and 100A clamps

The 100A Current clamps are connected to PQP-A Energotester via Shunt 100A (Fig. A1). In this case, the Device's current measuring range shall be set to "C 100A". When connecting the Device to the circuit under test via the 100A current clamps, take into account that current clamps are directional. Be sure to plug each colour (red, yellow, green) wire from the Device into the "source" socket of the associated clamp. Each blue or black ("return") wire from the Device is correspondingly plugged into the "load" socket of the associated clamp. An arrow embossed next to the clamp sockets stands for the direction "load → source". The direction is also meaningful when jaws are clamped around the current carrying conductor. There is another "source → load" arrow embossed on the jaws and pointing along the conductor (see Fig. A2). If the jaws are clamped correctly, → the pointer shows which way the power is transmitted.

The 1000A Current clamps are connected to PQP-A Energotester via a Shunt (Fig. A3). The 1000A Current Clamps can support both 1000A mode (if connected via 1000A Shunt) and 100A mode (if connected via 100A Shunt). Depending on the mode, the Device's current measuring range shall be set to "C 1000A" or "C 100A". When connecting the Device to the circuit under test, take into account that current clamps are directional. Be sure to plug the "lead-in" ("source") and "return" ("load") wires from the Device into the `S1` and `S2` sockets of the clamp, respectively (see below Fig. A6). The direction is also meaningful when jaws are clamped around the current carrying conductor. There is "A~" pointer (lateral arrow) stenciled on the jaws and pointing along the conductor . `P1` and `P1` marks on its sides stand for "source" and "load", respectively. If the jaws are clamped correctly, the pointer shows which way the power is transmitted (see Fig. A4).



Fig. A3 Connecting PQP-A Energotester to 1000A Current Clamps





Fig. A4 Stenciled marks "source → load" on a 1000A Current Clamp

**30 / 300 / 3000 A**  
**flexible Current Clamps with amplifier (integrator)**

The 30 / 300 / 3000A current clamps are of frameless design with flexible loops and a three-range (30; 300; 3000A) amplifier (range selection module included, see Fig. A.5).



**Fig. A.5.** Flexible Current Clamps 30 / 300 / 3000A with 3-range amplifier

To enable the required range in the amplifier, short press the red button on its front panel. Each pressing of the button enables the next range 30 A → 300 A → 3000 A → 30A. Do not forget to set the corresponding measurement range in the Instrument.

To switch the amplifier off, press the red button for approximately 2 seconds.

When connecting Energotester to the circuit under test via flexible current clamps 30/300/3000A, take into account that the clamps are directional. When clamping each flexible loop around the respective network's conductor, take into account the pointer embossed on the loop's connector. This pointer looks like a lateral arrow and prompts the direction "Source → Load". If the loop is clamped correctly, the pointer shows which way the power is transmitted through the conductor. NOTE: To achieve the highest accuracy, be sure to keep the measuring loop's connector in the point most distant from the current carrying conductor.

The 30A /300A/3000A amplifier (integrator) is powered either from two Ni-Cd or Ni-MH 1.25V rechargeable batteries of AA type or from two expendable AA batteries (1.5V).

Time of battery-powered operation depends on the type, capacity (mA · h) and lifecycle stage of the batteries. The guaranteed time of continuous operation is 8 days.

The 30/300/3000A amplifier shows low charge level of the batteries (see the table below).

#### Low charge indication in 30/300/3000A amplifier

Mode	Indication	State
No power applied	All LEDs are off	Instrument is off
Normal operation	One of the measurement range indicators is on, "Charge" indicator is off	Instrument works correctly
Caution	"Charge" indicator flashes once in 3 s periods	Instrument works correctly however charging / replacement of the batteries is required
Alarm	"Charge" indicator flashes 3 times in 3 s periods	Instrument stops measurements, Charging / replacement of the batteries must be done urgently

#### CAUTION!

It is strongly recommended to disconnect the clamps from measured circuits and switch the amplifier off before opening the battery compartment.

#### CAUTION!

**Do not connect the Power Adapter (used to charge rechargeable batteries) to the 30A /300A/3000A amplifier with expendable batteries (1.25V rechargeable batteries of AA type) inside it!**

## Appendix B. Connection schematics

A multitude of connections are pictured below in this Appendix. They cover both supplying the instrument with power and connecting it to the circuits to be measured. Energotester can support connection schemes of 3 types: three-phase 4-wire, three -phase 3-wire, and single-phase 2-wire. Voltage signals (up to 400 V as measured phase-to-neutral) are applied to Energotester's voltage inputs via voltage test leads connected to phases of the network under review. Measured currents are applied to Energotester's current inputs via current clamps (maximum permissible currents are determined by the type of current clamps in use).

Each current clamp kit is connected to the instrument via a suitable shunt (Appendix A). The Energotester's measuring range should be set accordingly (C10A, C100A, C300A, C1000A, C3000A).

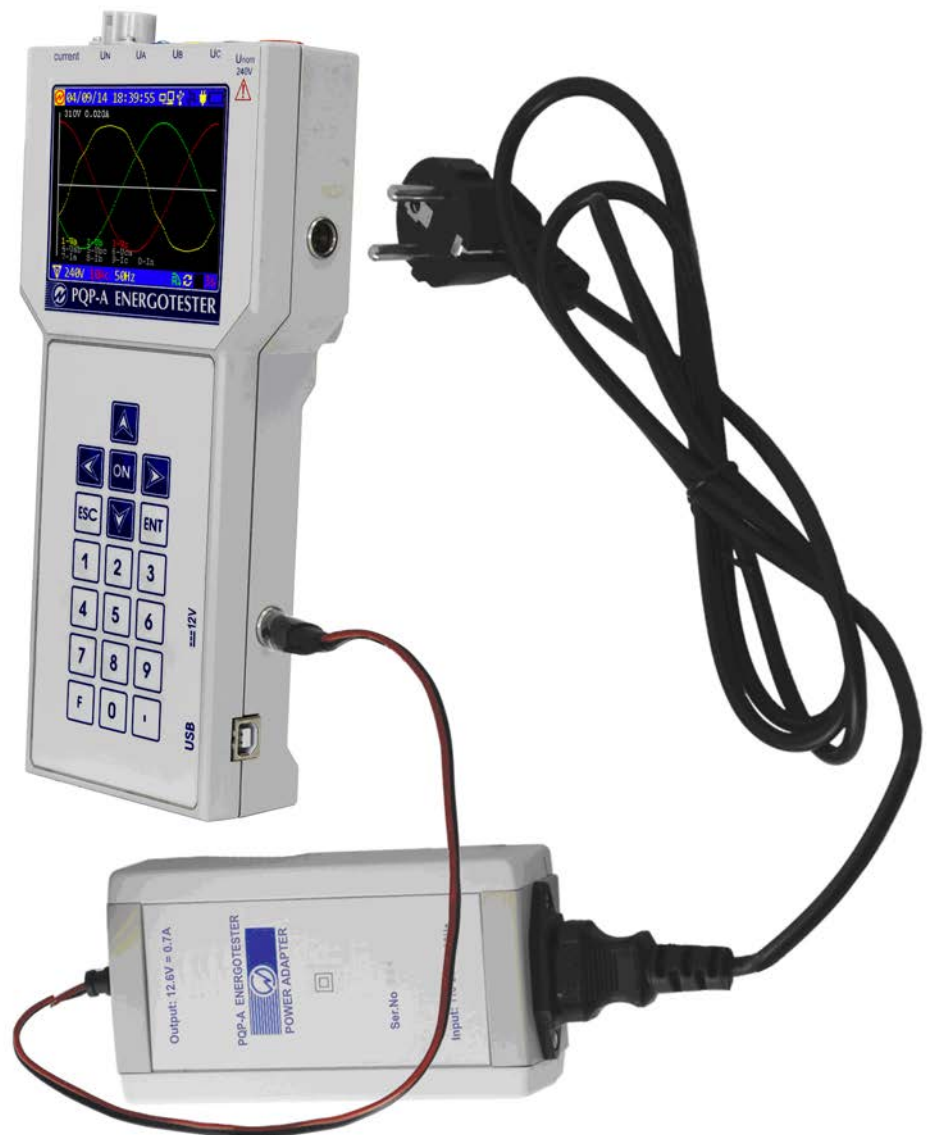


Fig. B1 Connecting Energotester to mains via power adapter

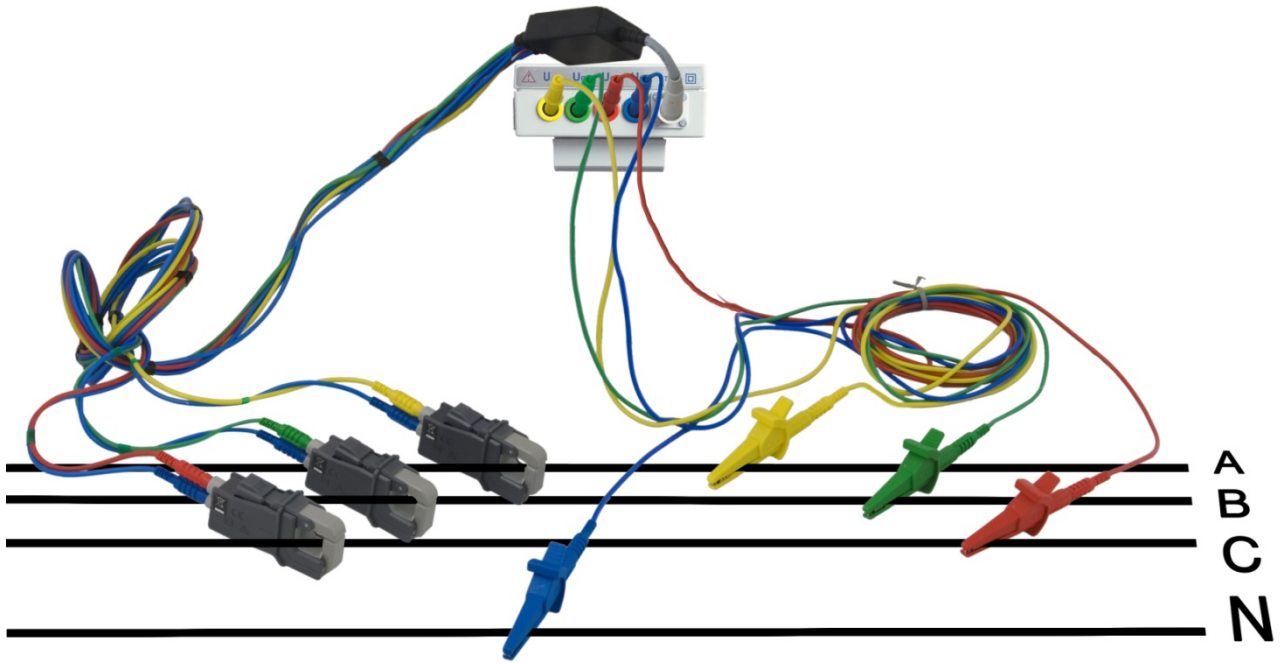


Fig. B2 Connecting Energotester to three-phase 4-wire network

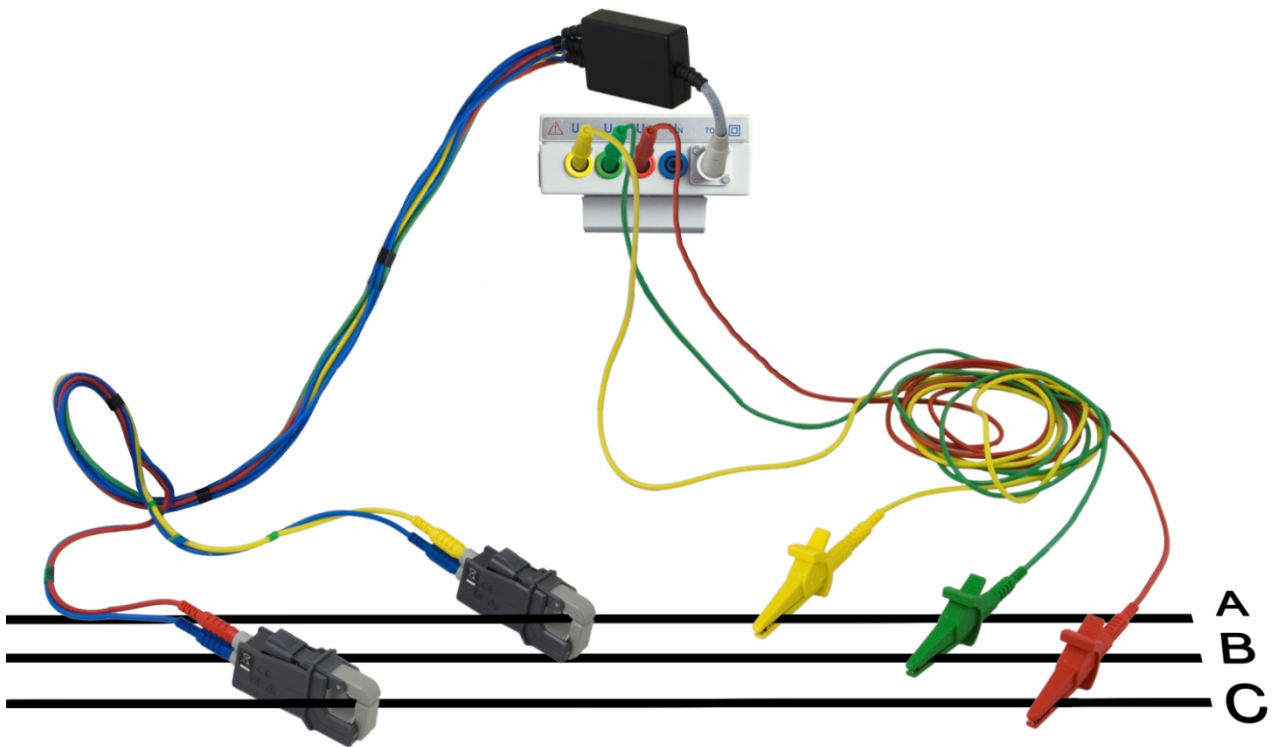


Fig. B3 Connecting Energotester to three-phase 3-wire network

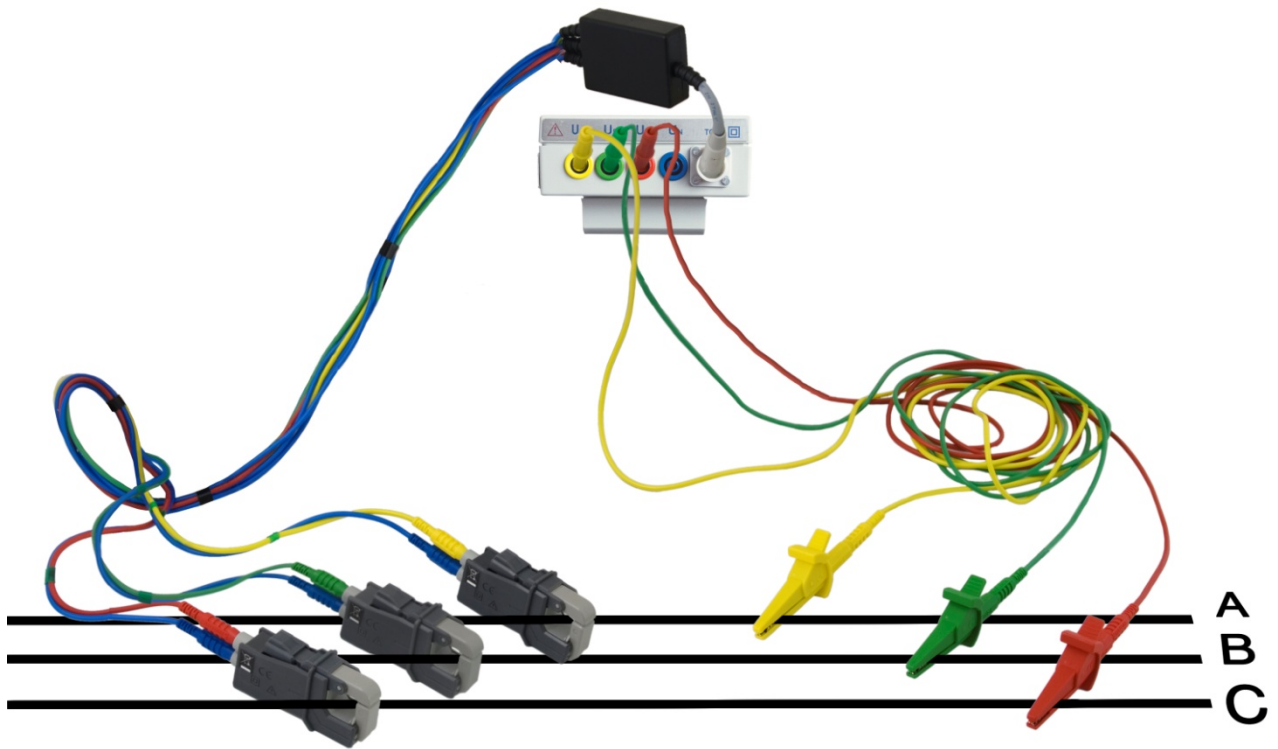


Fig. B4. Connecting Energotester to three-phase 3-wire network

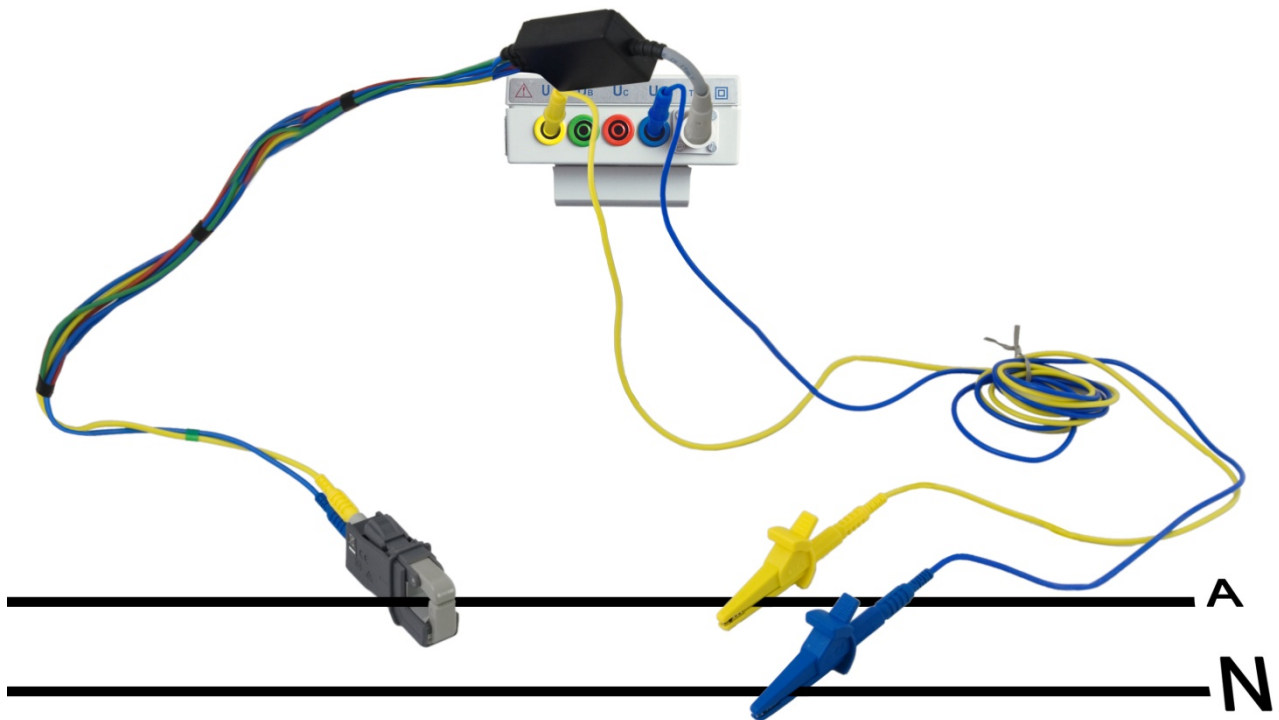


Fig. B5 Connecting Energotester to single-phase 2-wire network