Applied Precision
Measurement and Test Solution

Reference Standard

Standard Meter of Electrical Power and Energy

Model
RS 2130
RS 2330
RS 1130
RS 1330

User's Guide

Version: 9.3b

Content

1. Safety Considerations and Instructions

This unit has been designed and tested according to EN 61010 standard and has left the manufacturer's premises in a state fully complying the safety standards.
In order to maintain the unit in a safe state and to ensure safe operation, the following instructions must be reviewed and fully understood before operation:

- When the unit is to be permanently cabled, first connect an uninterruptible protective earth ground conductor before making any other connection.
- If the unit is to be connected to other equipment or accessories, prior to energizing any unit verify that common ground exists between them.
- Verify that the available mains voltage corresponds to specification of the unit.
- The Safety Class I unit provided with disconnectible AC supply cable and plug may only be operated from a power socket with protective earth ground connection.
- Any interruption or loosening of the protective earth ground conductor either inside or outside the unit or in an extension cable will cause a potential shock hazard that could result in personal injury.
- The protective earth ground conductor shall not be interrupted intentionally.
- To avoid electrical shock do not remove protection or covers of the unit; refer to qualified AP Service Center for maintenance of the unit.
- For continued protection against hazard, replace the line fuse(s) only with the same type and current rating.
- Observe safety regulations and rules and also additional safety instructions whether specified in manual for prevention of accidents.

2. Device Description

2.1 Introduction

The Reference Standard is the single-phase (RS 2110) and three-phase (RS 2310) version of precision meter for electrical power and energy measurement.

The Reference Standard is designed to meet all requirements put on a reference standard in a single- and three-phase electricity meter testing and calibration systems. The Reference Standard can be set to any real or artificial mode of operation in three phase system and is capable to evaluate the individual quantities per phase and the three-phase cumulative quantities as well.

The Reference Standard is based on precision 24-bit A/D conversion and digital signal processing technology enabling accurate evaluation of all main and informative quantities. Beyond measurement of all kinds of power, voltage, current and phase, the meter measures the harmonic content and distortion of the input signals.

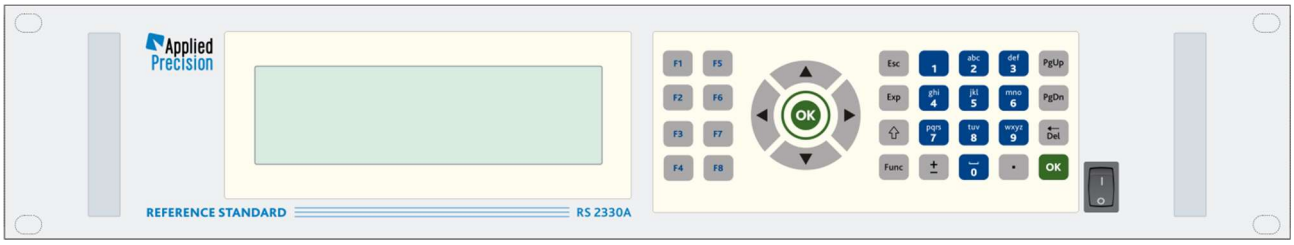
The Reference Standard has independent input circuits for the individual phases. This feature in combination with the possibility to assign the impulse output to any combination of the input channels (phases) enables for example to use the device in one phase system while the free channels can gather additional information like power consumption of the current and voltage circuits for contact error monitoring.

The Reference Standard makes harmonic analyze of the voltage and current spectrum and measures and computes these quantities shown in display of the device:

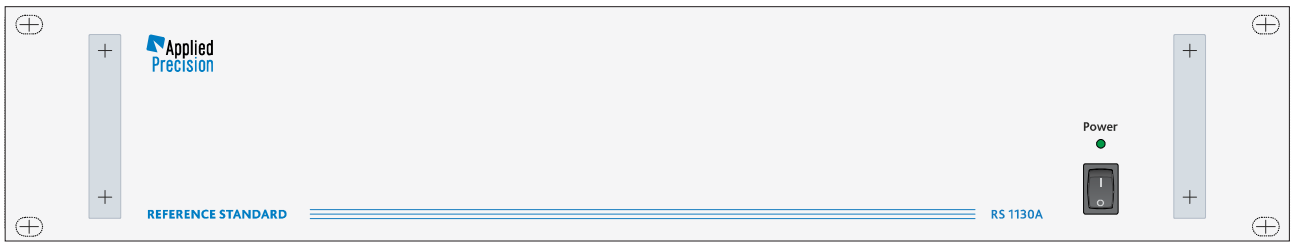
Quantity	Description	Code	Unit
Voltage	Effective value of the alternating voltage	U	V
Current	Effective value of the alternating current	I	A
Phase U	Phase offset between U_x and U_1	φ_U	°
Phase I	Phase offset between U and I	φ_I	°
Frequency	Frequency	f	Hz
Power Factor	Power factor	Λ	-
Distortion of Voltage	Distortion of voltage	DF_U	%
Distortion of Current	Distortion of current	DF_I	%
Active Power	Active power	P	W
Reactive Power	Reactive power	Q	VAr
Apparent Power	Apparent power	S	VA
Phase-to-phase Voltage	Phase-to-phase voltage	U_{pp}	V
Sum of Active Power	Sum of active powers in all channels	ΣP	W
Sum of Reactive Power	Sum of reactive powers in all channels	ΣQ	VAr
Sum of Apparent Power	Sum of apparent powers in all channels	ΣS	VA
Sum of square Voltage / 1Ω	Sum of square voltage / 1 Ω	ΣsqrU/1Ω	W
Sum of square Current / 1Ω	Sum of square current / 1 Ω	ΣsqrI/1Ω	W
Active Energy	Active Energy	E_p	kWh
Reactive Energy	Reactive Energy	E_q	kVArh
Apparent Energy	Apparent Energy	E_s	kVAh
Impedance Module	Module of impedance	Z	Ω
Impedance Phase	Phase of impedance	φ	°
Impedance Real Part	Real part of impedance	R	Ω
Impedance Imaginar Part	Imaginar part of impedance	X	Ω
Net Factor	Net power factor	nΛ	-

Default configuration shows in main screen these quantities: **P,U,I,f,φ,DF_U,DF_I**

2.2 Front Panel and Rear Panel



Front Panel of models RS 2x30



Front Panel of models RS 1x30

Rear Panel

2.3 Rear Panel Connectors and Clamps

Mains	- Power supply connection
GND	- Ground for digital and analogue circuits
Case/Earth	- Metal parts of the device case and the guard wire of the network socket
RS232	- Communication bus RS 232
COM	- Communication bus RS 422 used when device works as slave
OPS	- Communication bus RS 422 used when device works as master
Ext.	- Analogue input and output signals
Control	- Digital input and output signals
F_{OUT0}	- Impulse output FOUT0
F_{OUT1}	- Impulse output FOUT1
F_{OUT2}	- Impulse output FOUT2
F_{OUT3}	- Impulse output FOUT3
F_{IN}	- Impulse input
L1, L2, L3	- Three independent measurement channels
I	- Current clamps
U	- Voltage clamps
Lo	- Reference voltage clamp
Hi	- Active current clamp
In	- Current input clamp
Out 120 A Max	- Current output clamp for 120 A range
Out 5 A Max	- Current output clamp for 5 A range *

* *special version*

Warning:

Connecting the clamp *GND* of the device to the power supply causes the risk of life and can lead to the destruction of the device.

The clamp *Lo* and *GND* can be only connected in the case there's no mean of gaining of the dangerous voltage on the *Lo* clamp.

2.4 Connecting of the Device

The three phase version of the device is equipped with three independent channels *L1, L2, L3*. Each of them has two inputs: Current input (*CURRENT*) and voltage input (*VOLTAGE*). The inputs are insulated from each other; therefor its connection is arbitrary. The basic connection of the voltage and current clamps (only for one channel) for indicating of positive power (energy) is shown on the Figure 1.

The benefit of this connection is that its own input current of the voltage input of the device does not load the current input of the device. The measurement error caused by the volt drop on the current clamps is negligible due to use of electronically compensated current transformer in the current input.

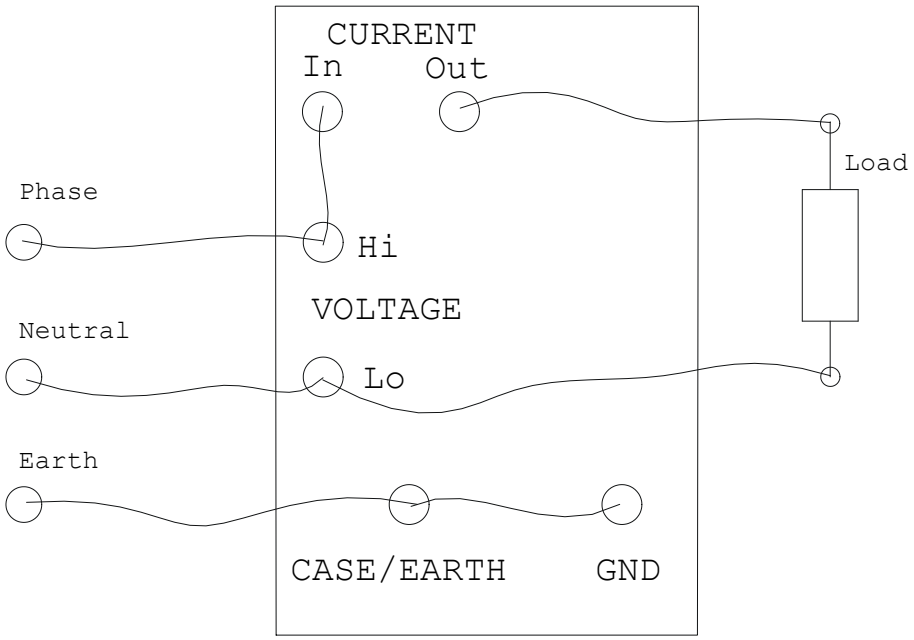


Figure 1

The inner ground of the electronic circuits connected to the *GND* clamp is common for both analogue and digital circuits. The input voltage clamps *Lo* and *Hi* are in a differential connection against the *GND*, i.e. the device measures the voltage difference between the clamps *Lo* and *Hi*. Each of the *Lo* and *Hi* clamps can be loaded by operating voltage up to 500V against the *GND* clamp.

The positive orientation of the voltage difference is defined as U_{hi} - U_{Lo}.
The positive orientation of the current is from the clamp *In* to the clamp *Out*.

The lowest error caused by the finite symmetry of the potential input circuits can be reached by connecting the neutral wire (or the wire with the lowest voltage against the guard wire) to the *Lo* input clamps and the phase wires to the *Hi* clamps. The inner ground of the device, that is *GND* clamp, is connected to the safety ground i.e. to zero voltage.

When connecting the device as an independent measuring device without connecting of the communication channels, there is no grounding connected from the outside power supply. In this case it is appropriate to connect the inner ground with the lowest potential by connecting the *GND* clamp with the *Case/Earth* clamp and thus to the guard wire in the socket outlet.

3. Local Control

The device RS 2x30 can be controlled locally using its display and keyboard. The content of the display and the way the device is controlled depends on the current mode of the device.

Device modes:

- **basic mode**
- **menu mode**
- **graphical mode for displaying of harmonic parts**
- **OPS Measurement Mode**
- **special modes**

The display in the **basic mode** shows values of measured and activated parameters. The way how the information is displayed can be modified by the menu parameters. Each measured parameter can be switched on or off for display. The maximum number of concurrently displayed measured parameters on display is 7. When there are allowed to be displayed more than 7 measured parameters, there are displayed on the top 7 measured parameters according to their priorities. To display the menu in the basic mode press any key. For return to the basic mode quit the menu or the special mode you have selected.

The **menu mode** is used to control the device from a cascade menu displayed on the screen of the display. The measurement continues in the background while using menu mode. The only difference is that the actual values of the measured parameters are not displayed to the user. The menu is used to set parameters of the device and perform calibrations, tests etc. To display the menu in the basic mode press any key.

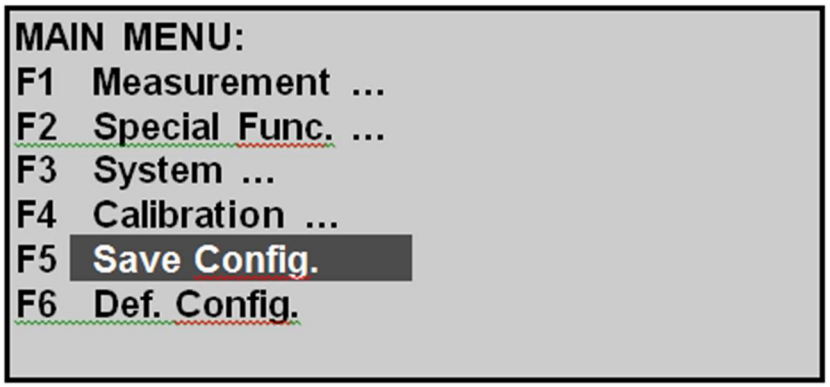
The **graphical mode for displaying harmonic parts** can be activated only when the FFT signal analyse module is attached. To enter this mode, press the DEL key in the basic mode. For return to the basic mode press DEL, "ESC" or the OK key. This mode is designed for informative displaying of amplitudes of the harmonic parts of measured voltages and currents. The bar on the left side of y-axis is the amplitude of the 1st harmonic part. Next harmonic parts are displayed in the right direction. No. of maximum frequency can be set in configuration menu. The background noise, if activated, is displayed between the columns of the harmonic parts. Amplitudes of all of the harmonic parts are displayed in a ratio scale related to first harmonic part. The amplitude of the first harmonic part is set to 1. All six amplitudes of the input channels are displayed as three voltage/current pairs. Switching between the displayed channels can be done pressing keys "LEFT" and "RIGHT". Change of the ratio scale on the screen of the display can be done pressing the keys "UP" and "DOWN".

The **OPS Measurement Mode** is used to control Local Evaluation Unit OPS and measure error of connected electricity meter. This mode can be selected from menu <Measurement / Energy / Impulse / OPS Meas> or with "EXP" key from the basic mode. To close this mode, press "ESC" or "EXP" button. The basic activities of the device are not suspended – device is measuring in background. Detailed description of this mode is in chapter 5.9.1 Operation Modes.

Special modes include calibration modes, test mode etc. The basic activities of the device are suspended in these modes and the whole device is dedicated to the specific mode. To enter a specific special mode, use the menu device modes. The way the device is controlled while working in the special mode fully depends on the mode. The instructions shown on the screen and the description of the specific mode in the manual explain the activities in special mode.

3.1 Manual Control

The menu is composed of a number of cascade levels. One of the levels is shown on the following figure:



The name of the menu level is shown in the first row of the display (The top level is called MAIN MENU and all the other levels have their names set according to their contents).

Items of the specific menu are shown in the rows below the menu label. The maximal number of items shown in a single menu screen is determined by the number of function keys (F1, F2 ... F6) on the keyboard of the device. Each menu item is labelled by the assigned function key, followed by the name of the menu item and in the right part of the menu there is a possible value of the menu item.

Types of the menu items:

- **submenu** - the label ends with characters ... - by choosing this menu item you enter a lower level of the menu. Some submenus are protected by a password, what is typical for the calibration submenu.
- **command** - the label ends with special characters and the right part of the menu label is empty - by choosing this menu item a specific command is executed.
- **parameter** - the label doesn't end with special characters and the right part of the menu label contains a value - choosing this item menu the current value of the specified parameter can be changed.

3.1.1 Menu Entering Keys

If the device appears in a basic state, the menu can be entered using:

OK	- enter the main level and first item highlighting
F1, F2...	- enter the basic menu level with immediate item selection which is attached to key used (i.e. in accordance with a type of the given item, immediate switch to the lower level, or immediate execution of the instruction, or immediate editing of the parameter value will happen, respectively),
1, 2...	- enter into the main menu level and item highlight with a given sequence number,
another key	- enter into the main level and first item highlight.

3.1.2 Menu Control Keys

DOWN	- pointer shift of the actual highlight item down, if the pointer is set at the last item, it will move to the first one,
UP	- pointer shift of the actual highlight item up, if the pointer is set at the first item, it will move to the last one,
ESC	-skip from the menu mode to the basic device state without considering the actual menu level,
LEFT and DEL	-shift in a cascade menu structure one level up, in direction to the main menu; if the main menu was the actual level than the skip out and return to the basic device state will happen,
RIGHT and OK	- actual (highlight) item selection
F1, F2...	-item selection with used attached soft key

3.1.3 Parameter Value Editing Keys

By parameter type item selection, editing mode will start and a change of this parameter value can be performed.
If the parameter value is optional (i.e. ON/OFF, ENABLED/DISABLED...), the options are offered with the highlighted actual value, UP and DOWN keys can be used for other value selection and approved using OK key or skip out without accepting change.
If the parameter value is of numeric type, the actual value is offered as start value of the editing mode. The value is highlight what indicates the possibility of value editing (the first used key is UP, DOWN, LEFT, RIGHT or BS respectively), delete (the first used key is DEL) or begin overwrite. Key functions in editing mode are as follows:

- DOWN skip to the text end,
- UP skip to the text beginning,
- LEFT pointer shift one character left,
- RIGHT pointer shift one character right,
- OK new value acknowledgement and editing mode termination,
- ESC editing mode termination without changes acceptation,
- DEL delete the character before the pointer and move to left by one char position
- EXP entry of the exponent character
- FUNC no special meaning so far (for new FW versions)
- +/- entry of '-' character or overwrite of the character '-' by '+' character
- '.' entry of '.' character
- 0,1,2 ... 9 entry of the given number

3.1.4 Functional Key and Keys Combinations

Functional key is:

- "Func" key in bottom line of front panel (in newer devices with 29 keys membrane keypad)

or

- red SHIFT key in bottom line of front panel (in older devices with 33 keys panel keypad)

Functional key can be used in key combinations.
In some key combinations as functional key works also key +/-.

Immediate Display Contrast Change

In a basic mode (when actual values of measured quantities are displayed) it is possible to change the display contrast (without necessity to enter the device menu) using the following keys combinations:

1. +/- (Func key) and UP ...contrast enhancement in large steps
2. +/- (Func key) and DOWN ...contrast decrease in large steps
3. +/- (Func key) and LEFT ...contrast enhancement in small steps
4. +/- (Func key) and RIGHT ...contrast decrease in small steps

Remark: Display contrast change using keys is not possible on old version devices where this can be done only by using a small potentiometer placed on the front panel.

3.2 Menu Description

Structure of the device menu is shown in the Appendix

3.2.1 Main Menu

Measurement.... - measurement menu,
Special func. … - special functions menu,
System ... - settings menu,
Calibration... - calibration menu,
Save Config. - saving of configuration parameters from the memory on the FLASH disk. Values of parameters saved on the disk remain unchanged after device is switched off. Actual values set during operation of the device reside in RAM which is destroyed, after the device switch off. After power on of the device values of configuration parameters from the FLASH disk are loaded.
Def. Config. - loading of configuration parameter values preset by manufacturer. This can be used after extensive altering of configuration and unexpected behavior of the device

3.2.2 Measurement Menu

Input / Range... - Range menu,
Energy ... - Energy menu,
Frequency Mode ... - menu of output frequency settings,
Operation Mode - operation mode selection menu with regard of wires number and power type. Available modes are described in chapter 5.9.1 Operation Modes.
Time Base - setting of Time Base value
Harm. Meas Mode - setting the number of harmonics, which will be measured – FUNDAMENTAL ONLY, FIRST n HARMONICS, or ALL 63 HARMONICS,
Harm. Meas Limit - setting the limit number - N of harmonics, which will be measured and evaluated. This parameter also influences the number N from menu item „**Harm. Meas Mode**". for the second option.
Note: If ALL 63 HARMONICS option was chosen in previous menu, then the parameter in this menu is placed in parentheses which means that this option will not be considered during measurements.
Appar. Meas Mode - setting the way of apparent power acquisition. There are two options – MEASURED or FROM P&Q (by calculation from active and reactive power)

3.2.3 Special Functions Menu

Vector Diagram -> - displays the Vector Diagram i.e. phases of all 6 channels (3 x U, 3 x I)

Harmonic Graph -> - graphic representation of harmonic content. There is a chart on the left and by up and down arrows zooming is changed in range 1x - 20x. On the right side there is a list of harmonic items where the 1st column from left (Harm) means the number of harmonic item, 2nd column (U[%]) states for harmonic item's amplitude in % related to the fundamental harmonic and the 3rd column (ph[°]) states for phase shift of harmonic item. Paging of this list is possible via left and right arrows on the keypad.

History - Measured history values menu. This feature is described in chapter 0 Measured Values History System.

Talk Only … - settings of menu 'TALK ONLY'. Parameter value STATE is OFF or ON for disabling resp. enabling of this mode. Item „COM..." sets this mode specifically for this port in terms of its state, format and transferred quantities.

Fout Response … - setting the responses of impulse output. QUICK MODE – turning on the mode of quick responses, parameter THRESHOLD holds the threshold value stated in %.

Keyboard Test - launching of keypad test

3.2.4 System Menu

About - summary of basic device information: device type, device model, device serial number, (device class), hardware version and firmware version.

RS-232... - RS 232 menu, service port setting

Display.... - display menu

Keyboard … - keyboard menu contains items for the setting of short voice signal generation by each operation of keys (BEEP) and settings of keypad locking feature. Keypad locking has these options: LOCK@SWITCH ON for locking the keypad right after each device switch on, LOCK PASSWORD for password change and LOCK NOW ->.

Watchdog - parameter activating/deactivating the device watchdog. If it is allowed, then in case of device freezing, the device is reset.

Date & Time - actual device date and time, this is possible to change by editing,

Control Port - user output-input port menu control,

Remark: If the keypad is locked, a small icon with a figure of key appears in the top of display. To unlock the keypad enter the password and press OK.

3.2.5 Calibration Menu

More Calib... - maintenance calibration and calibration constants menu
This calibration menu is protected by a password – it is intended for change of the device calibration constants or for the device calibration by the manufacturer or other qualified person.

Per. Autocalib - parameter (ON) or (OFF) enabling or disabling automatic call of short device selfcalibration

Autocalib - short device selfcalibration activation (lasts for approx. 10 sec.). The short calibration calibrates input circuits of device against internal DC voltage reference. This helps to suppress the influence of ambient temperature changes.

3.2.6 Calibration Menu „More Calib...“

Access to this menu is password protected.

Calib Funcs … - setting of calibration functions
Calib Const. … - setting of calibration constants
Ext. Ratio … - setting the recalculation ratio of input values if the device (e.g. transformer) connected to Reference Standard requires it
DSP method - setting of Digital Signal Processing method of calculation of signal amlitudes. Parameter value is 'Direct&FFT' or 'Only FFT'. Default setting is 'Only FFT'.
Noise Filter - setting of Noise Filter. Parameter value is ON of OFF.
Password Change - calibration menu password change
Save Calib. - save of calibration constant values from the memory into the disk. Values saved on the disk are independent on the device bias and thus remain unchanged after device switch off. This is in contrary to actual values in the memory influencing device functions, which are lost, after the device switch off. The device switch on always loads values from the disk,
Load Def. Calib - loading of calibration parameters preset by the manufacturer.

3.2.7 Range Menu

Voltage Auto - parameter setting the state of automatic setting of the measured voltage range. The parameter value is ON or OFF,
Voltage - parameter setting the voltage range which is used for the voltage measurement if the automatic setting is switched-off,
Current Auto - parameter setting the state of automatic setting of the measured current range. The parameter value is ON or OFF,
Current - parameter setting the current range which is used for the current measurement if the automatic setting is switched-off,
Voltage Factor - parameter for input voltage ratio factor value. The device indicates and uses the voltage value equal to product of the measured voltage value and the voltage factor value. The voltage factor is used in case of input voltage transformer.
Current Factor - parameter for input current ratio factor value. Device indicates and uses the current value equal to product of the measured current value and the current factor value.

3.2.8 Energy Menu

Impulse... - impulse output menu,
Dosage … - dosage function menu,
Start / Stop -> - Start or Stop of energy accumulation into dedicated registry,
Reset -> - deletion of registry, which store the accumulated energy values,
RESET Key - enabling or disabling the use of resetting (Func) key in basic mode. This key resets the registry storing the accumulated energy values.
Energy Unit - setting the unit of energy measurement with two options – basic quantity per second or "kilo-quantity" per hour. Energy quantities with power/energy type then in basic mode will appear respectively in Ws, VArs and VAs or using the other option in kWh, kVArh and kVAh.

3.2.9 Frequency Mode Menu

Freq Mode - setting of Frequency Mode either to option AUTOMATIC or to FIXED FREQ. Option AUTOMATIC let the device automatically choose the channel, from which input frequency is calculated.

Fixed Freq. - setting the fixed frequency value if the previous parameter is set to FIXED FREQ. otherwise (AUTOMATIC) this value is not taken into account

Channel Mode - setting of channel from which input frequency is calculated in case that parameter „**Freq Mode**" is set to AUTOMATIC. There are four options – AUTOMATIC, VOLTAGE, CURRENT and FIXED.

Fixed Channel - channel selection for fixed mode – one of 6 options (combinations L1 – L3 and voltage, current). However, the previous parameter „**Channel Mode**" has to be set to FIXED.

Remark: If the value is placed in parentheses, it is not considered, because the superior parameter is most likely set into AUTO option.

3.2.10 History Mode Menu

Show History -> - display of historical statistics

State - enabling or disabling the History function

Quantities - without the possibility of any change (all quantities)

Integr. Time - integration time is always equal to the value of TIME BASE, which is set in Measurement Menu. INTEGR. TIME item does not allow to change its value.

Reset - resetting the History records

3.2.11 Menu TALK ONLY

State - enabling or disabling TALK ONLY Mode, which serves to continuous sending of measured data to communication port

COM1 ... - to enter the settings of COM1 port in order to get more options of TALK ONLY Mode

3.2.12 Menu TALK ONLY COM1

State - enabling or disabling TALK ONLY Mode on COM1 port

Format - sent data format setting either to SHORT or LONG

Quantities ... - to enter the list of quantities where every single available quantity can be selected in order to continuously send their values via COM1 port

3.2.13 Output Frequency Response Menu

Quick Mode - enabling or disabling the Quick Response Mode

Threshold - setting the threshold value in %

3.2.14 RS-232 Menu

Baud Rate - parameter setting the RS-232 serial line communication rate set value in bauds. The value of the parameter is 4800, 9600, 19200, 38400, 57600 or 115200 bauds, respectively,

Data bits - parameter setting the number of data bits set value on the RS-232 serial line. The parameter value is 7 or 8, respectively,

Parity - parameter setting the RS-232 serial line set value. The parameter value is "ODD" for the odd parity, EVEN for the even parity and NO for the no parity, respectively,

Stop bits - parameter setting the number of stop bits set value on the RS-232 serial line. The parameter value is 1 or 2, respectively,

3.2.15 Display Menu

Quantities... - quantities menu

Display - parameter setting the state of measured results values appeared on the display. The value of the parameter is ON or OFF for the switched-on or switched-off results depicting on the display, respectively. Parameter is not related to the device menu depicting, which is displayed always if it is activated,

Resolution - resolution setting: STANDARD = results with standard number of decimal digits according to the shown variable type; HIGH – number of decimal digits is raised by 1 comparing to option STANDARD; MAXIMAL - number of decimal digits is raised by 2 comparing to option STANDARD.

Service Info - enabling or disabling (ON / OFF) of service information

Large Font - parameter setting the state when measured quantity is displayed in large font. The option is activated if only one quantity is chosen to be displayed,

Harm. Graph... - harmonic items graph menu

Contrast... - display contrast change menu

VGA Output - parameter Disables or Enables VGA output on the rear side of newer devices

3.2.16 Keyboard Menu

Beep - enabling or disabling the beep functionality of the keyboard,

Lock@SwitchOn - enabling or disabling the automatic keypad lock right after each device switch on

Lock Password - keypad unlocking password change

Lock Now -> - instant keypad lock with a basic mode activation.

3.2.17 Impulse Menu

FoutX Config. ... - four similar items (where X = 0,1,2,3) for four impulse outputs of the device. Each one represents an access into submenu containing settings of particular impulse output.

Fin Meas/Test ... - Frequency Input menu

OPS Meas/Test ... - OPS Measurement Mode menu

3.2.18 Impulse Outputs Fout1 … Fout3 Menu

Output State - parameter setting the state of the device impulse output, which enables frequency generation proportional to the measured power. The parameter value is ACTIVE ENERGY for the frequency generation proportional to the measured active power, REACTIVE ENERGY for the frequency generation proportional to the measured reactive power, APPARENT ENERGY for the frequency generation proportional to the measured apparent power, FIXED for constant frequency generation and OFF for impulse output switched-off, respectively.

Channel Lx - parameter setting the selection of individual channels (L1, L2 or L3) for impulse output functions. The value of the parameter is ON or OFF for the switched-on or switched-off selection of the appropriate channel, respectively.

Fixed freq. - frequency value on the device impulse output in case that "State" parameter is in the state "FIXED".

Energy Factor -parameter setting the device impulse output multiplicity constant if the parameter "State" is in the state ACTIVE ENERGY, REACTIVE ENERGY or APPARENT ENERGY, respectively. Generated frequency is proportional to the product of this constant and sum of measured values of the given type of power in the selected channels. These channels are given in "Channel Lx" parameters placed in the Energy menu. Unit of showed value is in 1/Ws (1/Vas, 1/Vars) or 1/kWh (1/kVAh, 1/kVArh) and depends on values of Energy Factor and Factor Unit parameters.

Energy F. Unit - parameter setting the unit in which the value of parameter Energy Factor is showed. Parameter is 1/Ws (1/Vas, 1/Vars) or 1/kWh (1/kVAh, 1/kVArh).

3.2.19 Impulse Input Fin Menu

Fin Meas/Test -> - start of Frequency Input screen (measurement is started immediately)

Fin Config … - Frequency Input Configuration menu

MUT Constant - parameter setting the constant of Meter Under Test

MUT Const. Unit - parameter setting the unit in which the value of parameter MUT Constant is showed. Parameter is 1/Ws (1/Vas, 1/Vars) or 1/kWh (1/kVAh, 1/kVArh).

Int. Time - parameter setting the integration time for Fin measurement

3.2.20 Frequency Input Configuration Menu

Input State - parameter setting the state of the device frequency input which is proportional to some type of measured power. The parameter value is ACTIVE ENERGY for the frequency input proportional to the measured active power, REACTIVE ENERGY for the frequency input proportional to the measured reactive power or APPARENT ENERGY for the frequency input proportional to the measured apparent power, respectively.

Channel Lx - parameter setting the selection of individual channels (L1, L2 or L3) for impulse input functionality. The value of the parameter is ON or OFF for the switched-on or switched-off selection of the appropriate channel, respectively.

3.2.21 OPS Measurement Mode Menu

OPS Meas/Test -> - start of OPS Measurement Mode screen
Fout0 Config … - Impulse Output Fout0 Menu (this functionality is dependent on Fout0 settings)
MUT Constant - parameter setting the constant of Meter Under Test
Sample Type - parameter setting the mode of operation of OPS Measurement Mode. Parameter value is 'Impulses' or 'Int. Time'.
Int. Time - parameter setting the Integration Time for OPS Measurement Mode
No. of Impulses - parameter setting the Number of Impulses for OPS Measurement Mode
No. of Samples - parameter setting the Number of Samples for OPS Measurement Mode

3.2.22 Dosage Menu

Start - dosage instant start
Stop - dosage instant stop
Mode - setting of dosage function in respect of a type – TIME, ACTIVE ENERGY, REACTIVE ENERGY or APPARENT ENERGY, SQUARE VOLTAGE, SQUARE CURRENT, OFF,
Time - setting the dosage lasting for time dosage, stated in seconds,
Energy - setting the dosage amount for energy type dosage,
Energy Unit - setting the unit of energy when energy dosage is set,
Contact SI Mode - setting the SI contact into the state CONTACT OPEN or CONTACT CLOSED or AUTO,
Contact SU Mode - setting the SU contact into the state CONTACT OPEN or CONTACT CLOSED or AUTO,
Contact SI Auto ... - entry to Contact SI Auto Mode Menu,
Contact SU Auto ... - entry to Contact SU Auto Mode Menu,
Contact SI State - setting the SI contact state – open or closed,
Contact SU State - setting the SU contact state – open or closed,

3.2.23 SI/SU Contacts Menu in Auto Mode

Start State - setting the SI/SU contact state for dosage start, there are three options –OPEN, CLOSED and UNCHANGED,
Start Delay - setting the delay of dosage starting, stated in seconds
Stop State - setting the SI/SU contact state for dosage stop, there are three options – OPEN, CLOSED and UNCHANGED,
Stop Delay - setting the delay of dosage stopping, stated in seconds

3.2.24 Control Port Menu

Signal OUTx - parameter of the direct control of the appropriate bite at the user control port (value LOW corresponds to the logical 0, and value HIGH to logical 1, respectively),
Signal Inx - parameter (which can be changed) setting the actual state of appropriate bites at the user control port (value LOW corresponds to the logical 0, and value HIGH to logical 1, respectively),
Init values... - control port initializing menu,

3.2.25 Quantities Menu

This menu contains list of quantities which device measures or calculates from the measured quantities. Displaying of selected quantities may be switched-on (ON) or switched-off (OFF). Up to seven quantities can be displayed simultaneously. In case that only one quantity is chosen, the **Large font** parameter, which determines if measured quantities are displayed in capitals or small fonts, is applied.

3.2.26 Harmonic Graph Menu

Harm. graph - parameter enabling (ENABLED) or banning (DISABLED) harmonic items of measured signals graph displaying, if the FFT module of signal analysis is present,

Background - parameter switching-on (ON) or switching-off (OFF) displaying of the noise background in the graph of harmonic items of measured signals,

Max. freq. - parameter setting the maximal frequency displayed in the graph of harmonic items of measured signals

3.2.27 Contrast Menu

Increase (+) - display contrast increase
Decrease (-) - display contrast decrease
Store - display contrast value storage into the device memory

3.2.28 Control Port Initialization Menu

Signal OUTx - parameter setting the initialization value (set after the device switch on) on the appropriate bite of the user control port (value LOW corresponds to the logical 0, and value HIGH to logical 1, respectively)

4. Remote Control

Device control and measured values collection may be performed via remote control using RS-232 interface. RS-232 parameters can be configured from the front panel in the menu. Communication is performed using device commands created in accordance with agreements of the SCPI standard (Standard Commands for Programmable Instruments). The most important agreements of this standard are:

- parentheses { } restrict parameter in the command strain
- parentheses [ ] restrict optional parameters or parts of commands
- parentheses < > restrict parameter, which is due to be replaced by the value
- perpendicular line (|) separate options, from which exactly one has to be chosen
- introductory parts of words in the command strain in capitals are obligatory and small fonts at the end of words are optional *(command SYSTem:VERSion? is identical with SYST:VERS? but command SYSTe:VERSi? is not allowed)*
- letters size in the command is optional *(command SYST:VERS? is identical with sYsT:VeRs?)*

4.1 Commands

Summary list of commands is available in the Appendix

4.1.1 General Commands

***IDN?**
Request for the device identification string (with the maximal length of 35 characters).
***RST**
Device reset.
SYSTem:ERRor?
Request for the error announcement from the error announcement register. This register is a FIFO type (=first in first out). Its capacity is 20 errors announcement with 80 characters to be the maximal length of error announcement.
SYSTem:VERSion?
Request for the device firmware version.
SYSTem:HWVersion?
Request for the device hardware version.
SYSTem:CLASs?
Request for the device class.
SYSTem:SERNumb?
Request for the device serial number.

4.1.2 Other Commands

All other commands are function specific and are described in Functions and Features chapter.

5. Features and Functions

5.1 System Time

Device has its own clock and calendar - date and time can be used (set and red).
They can be controlled by menu item System / Date & Time or by remote interface commands:

SYSTem:TIMe?
Request for the device system time. Reply is the text string in "YYYY-MM-DD hh:mm:ss.xx" format.

SYSTem:TIMe {<time>}
Setting of the device system time to value defined by <time> parameter, which is a text string in "YYYY-MM-DD hh:mm:ss.xx" format. Change in the device system time happens immediately.

SYSTem:TIMe:BEGin?
Request for the last switch-on (or reset) time of the device. Reply is the text string in "YYYY-MM-DD hh:mm:ss.xx" format.

Definition of format "YYYY-MM-DD hh:mm:ss.xx" (example: "1996-05-20 17:23:19.04730"):

YYYY ..... year (4 digits)	hh ..... hour (2 digits)
MM ..... month (2 digits)	mm .... minutes (2 digits)
DD ..... day (2 digits)	ss ..... seconds (2 digits)
	xx ..... fraction of second (max. 5 decimal digits)

5.2 Display

Display functions and parameters can be controlled using these remote commands:

DISPlay?
Request for the setting of measurement results depicting on the device display.
If it is switched-off the reply is "0", otherwise is "1".

DISPlay {OFF|ON}
Switch off | switch on of the measurement results depicting on the device display. Switching-off means empty display during the measurement. However, activated device menu is always displayed.

DISPlay:TEXT?
Request for the setting of the user text, which is depicted on the device display. The empty string means user text extraction switch off.

DISPlay:TEXT {<"text">}
User text extraction (bordered by quotation marks) on the device display. Sending this command with the empty string can do user text extraction switch off.

DISPlay:RESolution?
Request for state of Display Resolution mode. Answer is 0 (Standard), 1 (High) or 2 (Maximal). In High and Maximal modes are measured results shown more precisely (with more decimal places).

DISPlay:RESolution {<state = 0 | 1 | 2>}
Setting of state of Display Resolution mode. Parameter is 0 (Standard), 1 (High) or 2 (Maximal). In High and Maximal modes are measured results shown more precisely (with more decimal places).

DISPlay:LARGe?
Request for state of Large Font mode. Answer is 0 (disabled) or 1 (enabled).
If Large Font is enabled and only one unit is selected in Quantities submenu then measured results of this unit are shown with large font.

DISPlay:LARGe {<state = 0 | 1>}
Setting of state of Large Font mode. Parameter is 0 (disabled) or 1 (enabled).
If Large Font is enabled and only one unit is selected in Quantities submenu then measured results of this unit are shown with large font.

DISPlay:REFResh
Immediate refresh of display.

5.3 Keyboard

Keyboard functions and parameters can be controlled remotely.

5.3.1 Keyboard Beep

Beep after every press of any key of keyboard can be controlled by menu item System / Keyboard / Beep or by remote interface commands:

SYSTem:KEYBoard:BEEP?
Request for state of keyboard beep function. Answer is: 0 (disabled) or 1 (enabled).

SYSTem:KEYBoard:BEEP {<state>}
Setting of keyboard beep function. Parameter is: 0 (disabled) or 1 (enabled).

5.3.2 Keyboard Lock

Keyboard Lock function can be used for locking keyboard of device. Keyboard can be configured to automatically lock after switch on of device. Keyboard can be locked without using password manually by menu item or by command. Locked keyboard can be unlocked by remote command (no password is needed) or by keyboard when password followed by key OK is typed. Special password used only for unlocking keyboard can be defined in menu.
For unlocking keyboard can be used also calibration password (needed for entering calibration submenu). Function is controlled by submenu System / Keyboard or by remote interface commands:

SYSTem:KEYBoard:LOCK?
Request for state of Keyboard Lock. Answer is: 0 (not locked) or 1(locked).

SYSTem:KEYBoard:LOCK
Keyboard locking.

SYSTem:KEYBoard:UNLock
Keyboard unlocking.

SYSTem:KEYBoard:LCKatswitchon?
Request for setting of AutoLockAtSwitchOn parameter. Answer is: 0 (OFF) or 1 (ON).

SYSTem:KEYBoard:LCKatswitchon {<state>}
Setting of AutoLockAtSwitchOn parameter. If this parameter is ON then device starts operate after switch on with locked keyboard. Parameter <state> is 0 (OFF) or 1 (ON).

5.3.3 Keyboard Emulation

Emulation of press of any key can be done by remote interface command:

SYSTem:KEYBoard {<code = 0-255>}
Send of key code to device. Device will "press corresponding key".

Emulation codes:

Key	Code	Shift code
ESC	255	223
OK	254	222
FUNC/SHIFT	253	221
PL_MN	252	220
DEL	250	218
INS	249	217
EXP	248	216
F6	247	215
F5	246	214
F4	245	213
F3	244	212
F2	243	211
F1	242	210
DOWN	241	209

Key	Code	Shift code
UP	240	208
RIGHT	239	207
LEFT	238	206
NUMB_9	57	205
NUMB_8	56	204
NUMB_7	55	203
NUMB_6	54	202
NUMB_5	53	201
NUMB_4	52	200
NUMB_3	51	199
NUMB_2	50	198
NUMB_1	49	197
NUMB_0	48	196
POINT	46	195

Code is for direct press of key. Shift code is for press of key together with shift key.

5.4 Input / Output User Port (CONTROL PORT)

The device contains one input/output user port, which can be used for controlling external devices. This port contains 4 input, 4 output, 4 dosage, 2 impulse and 1 ground signals.
It is possible remotely (via RS-232 interface) or locally (from the front menu of the device) to:

- detect (read) values of input signals,
- modify (set) values on output signals,
- set initial states (values which will be set at the device start up) of output signals,
- control dosage contacts using dosage function.

Control connector signals can be controlled by menu item System / Control Port or by remote commands:

SYSTem:CONTrol:INPort?
Request for state of input signals. Answer is 0(=0000_B) - 15(=1111_B). LSB is IN0.

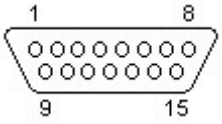
SYSTem:CONTrol:OUTPort?
Request for set state of output signals. Answer is 0(=0000_B) - 15(=1111_B). LSB is OUT0.

SYSTem:CONTrol:OUTPort {<param>}
Setting of state of output signals. Parameter is 0(=0000_B) - 15(=1111_B). LSB is OUT0.

SYSTem:CONTrol:OUTPort:INIT?
Request for initial state of output signals. Answer is 0(=0000_B) - 15(=1111_B). LSB is OUT0.

SYSTem:CONTrol:OUTPort:INIT {<param>}
Setting of initial state of output signals. Parameters is 0(=0000_B) - 15(=1111_B). LSB is OUT0.

Control port description



Pin #	Name	Description
1	OUT 0	**Output signals** (TTL levels)
2	OUT 1	
3	OUT 2	
4	OUT 3	
5	SU1	**Voltage dosage contacts** (max. 125V, 1A)
6	SU2	
7	SI1	**Current dosage contacts** (max. 125V, 1A)
8	SI2	
9	IMP+	**Output impulses** (RS-485 levels)
10	IMP-	
11	IN0	**Input signals** (TTL levels)
12	IN1	
13	IN2	
14	IN3	
15	GND	**Ground** (TTL level)

All pins are galvanically isolated (optical and relay isolation)

5.5 Serial Port (RS-232 PORT)

Setting of serial COM1 (RS-232) port can be viewed / changed by submenu System / RS-232 or by remote interface commands:

SYSTem:SETup:COM1?

Request for COM1 setup. Answer is : baudRate(1200-115200), data bits (7 or 8), parity (N=none, O=odd, E=even) and stop bits (1 or 2) separated by commas.

SYSTem:SETup:COM1 {<baudRate>} [,{7 | 8} [,{N | O | E} [,{1 | 2}]]]

Setting/requesting of COM1 setup. Parameter baudRate has available values 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Optional other parameters define: data bits (7 or 8), parity (N=none, O=odd, E=even) and stop bits (1 or 2).

5.6 Configuration & Calibration settings

Configuration settings (values of parameters in all menus except Calibration menu) can be saved or loaded by menu items Save Config and Def. Config in Main menu or by remote interface commands:

SYSTem:CONFig:SAVe

Save configuration.

SYSTem:CONFig:LOAD

Load user configuration.

SYSTem:CONFig:LOAD:DEFault

Load default configuration.

Calibration settings (values of parameters in Calibration menu) can be saved or loaded by menu items Save Calib and Load Def. Calib in password protected Calibration menu or by commands:

SYSTem:CALib:SAVe {<password>}

Save calibration. Parameter is the password used for entering Calibration menu of device.

SYSTem:CALib:SAVe:DEFault {<AP_password>}

Save default calibration. Parameter is AP password.

SYSTem:CALib:LOAD

Load calibration.

SYSTem:CALib:LOAD:DEFault

Load default calibration.

5.7 Password

Calibration settings menu is protected with password.
Default password is 1234.

Password can be changed after entering password protected section of calibration settings menu. SERVICE menu is separate section which appears after entering calibration settings using special service menu password or device serial number dependent one time password.

5.8 Autocalibration

Device is very precise equipment and requires being autocalibrated in some time intervals. Autocalibration automatically adjusts device's parameters in relation to temperature and other factors to be able to guarantee its specification.

During this autocalibration (takes approx. 10 seconds) device is not measuring input signals because of internal calibration process. Impulse output (adjusted after every period of measured signal) is during autocalibration holding its state (last measured value).

Device is as default configured so, that autocalibration is started automatically every 10 minutes (in first 30 minutes of device's operation is this period 5 minutes). User should disable this feature always before important measuring (typically before starting generation of some loadpoint) and enable it again after end of this measuring (after stopping loadpoint). This is recommended operation of device in Meter Test Equipments and ensures:

- autocalibration between loadpoints or in idle state of equipment,
- no influence of autocalibration on measured values during loadpoints.

Start and state of autocalibration can be controlled by menu Calibration or by remote interface commands:

SYSTem:CALib:AUTo?
Request for the state of the automatic call of the device autocalibration (SHORT SELFCALIBRATION). Answer is : ON (autocalibration is enabled) or OFF (disabled).

SYSTem:CALib:AUTo {<state = 0 | 1 >}
Setting of the state of device autocalibration (SHORT SELFCALIBRATION).
Parameter is 0 (disabled) or 1 (enabled).

SYSTem:CALib:SELF { SHORT | FULL }
Start of the autocalibration (SELFCALIBRATION). Parameter SHORT initiates short and parameter FULL complete autocalibration.

SYSTem:STATus?
Request for the status of the device.
Answer is: -1 (calibration or selfcalibration is in progress), 1 (classic measurement mode is activated), 2 (OPS Measurement Mode is activated) or 0.

5.9 Measurement

5.9.1 Operation Modes

The device can perform active, reactive and apparent power and energy measurement in 6, 4 or 3 wire mode with generation of energy impulses on an impulse output. The mean frequency at the impulse output is proportional to the sum-power.

There are 8 operating modes for power and energy measurement:

Number	Code	Operation Mode
0	P6	Active power and energy in 6-wire mode
1	P4	Active power and energy in 4-wire mode
2	P3	Active power and energy in 3-wire mode
3	N6	Reactive power and energy in 6-wire mode (natural)
4	N4	Reactive power and energy in 4-wire mode (natural)
5	N3	Reactive power and energy in 3-wire mode (natural)
6	K4	Reactive power and energy in cross-connected (artificial) mode
7	K3	Reactive power and energy in cross-connected (artificial) mode

Letters in Code column determine how the active and reactive power will be calculated:

P- mode – applicable for active power measurement – active power is accurate, evaluated by the integration of immediate values U*I, reactive power is calculated from active and apparent power of one period according to relation below.
Apparent power:

$$S = U.I$$

Reactive power:

$$Q = \sqrt{S^2 - P^2}$$

N- mode – applicable for reactive power measurement in cases, where P mode doesn't lead into requested results of reactive power. Reactive power is calculated according relation below, active power is then calculated from apparent and reactive power.
Reactive power calculated as summation of powers of all harmonics:

$$Q = \sum_{h=1}^{n} U_h I_h sin\varphi_h$$

where n is count of higher harmonics. This concept is mentioned in IEEE 1459-2010 appendix A in relation with apparent power measurement in the presence of distorted signal shapes.
Apparent power:

$$S = U.I$$

Active power is calculated:

$$P = \sqrt{S^2 - Q^2}$$

K- mode – this method defines the calculation of reactive power, which is valid only in system, where phase voltages are equal to phase offsets 2π/3 and 4π/3, which means in symmetrical system.
Reactive power calculation is realized according to relation:

$$Q_1 = U_{12} I_3 \sqrt{3}$$
$$Q_2 = U_{23} I_3 \sqrt{3}$$
$$Q_3 = U_{31} I_1 \sqrt{3}$$

In relation with the reactive powers there exists one more possibility to change another setting in Measurement menu, which directly has nothing to do with operating modes: Harm. meas mode – FUNDAMENTAL ONLY.

This setting allows to evaluate only 1. harmonic content of signal. There exists such standards, which defines the reactive power according the relation below, that means as reactive power of 1. harmonic content. But this setting influences all measured quantities.

$$Q = U_{fund} I_{fund} sin\varphi_{fund}$$

Reactive power is defined according to IEC 62053-24 as reactive power of fundamental harmonic content. This type of reactive power is also defined in IEEE 1459-2010 as fundamental reactive power.

Numbers in Code column determine how the neutral wire will be connected:

X**6** - 6 wires – each phase (L1, L2, L3) has its own neutral wire (N1, N2, N3). They can be on different potential, it means the independent 3 phase voltages measurement.
X**4** - 4 wires, 3 phase wires and common neutral. The device interconnects the N1-N2-N3 internally, N should be connected to N2, the N1 and N3 clamps should be disconnected externally.
X**3** - 3 phase wires without N, triangel connection, phase-to-phase voltages are measured.

Operation Mode can be controlled by menu item Measurement / Operation Mode or by remote commands:
MEASure:OPERatingmode {<param>}
Setting of Operation Mode. Parameter is Operation Mode's number (0-7) or code (P6-K3).
MEASure:OPERatingmode?
Request for setting of Operation Mode. Replay is Operation Mode's number (0-7).

5.9.2 Measuring Time Interval (Time Base)

All measured values are evaluated in the interval of the internal Time Base. The interval is defined in seconds and the default setting is 1s.
Time Base value is saved in configuration and recalled after switch-on of device. Time Base value can be controlled by menu item Measurement / Time Base or by remote interface commands:
MEASure:TIMEbase?
Request for setting of Time Base. Answer is time in seconds.
MEASure:TIMEbase {<time>}
Setting of Time Base. Parameter is time in seconds.

5.9.3 Division Factor

Division Factors (Current Division Factor and Voltage Division Factor) describe characteristic of input circuits. They give the input division ratio: (measured voltage) / (voltage lead to the device) i.e. the product of the device measured value and the division factor value gives the result.
They can be controlled by menu items Voltage Factor and Current Factor in Measurement / Input / Range menu or by remote interface commands:
SYSTem:DIVision:VOLTage {<factor>}
Setting of the Voltage Division Factor.
SYSTem:DIVision:VOLTage?
Request for the setting of the Voltage Division Factor.
SYSTem:DIVision:CURRent {<factor>}
Setting of the Current Division Factor.
SYSTem:DIVision:CURRent?
Request for the setting of the Current Division Factor.

5.9.4 Extern Ratio

Extern Ratio factors are multiplier or divider factors of externally connected transformer, controlled by password protected menu Calibration / More Calib / Ext. Ratio or by remote interface commands:

SYSTem:EXT:RATio? {<chnl = 1 - 6>}
Request for Extern Ratio value for defined channel,
SYSTem:EXT:RATio {<chnl = 1 - 6>},{<factor>}
Setting of Extern Ratio value for defined channel.

5.9.5 Ranges configuration

Internal voltage and current ranges can be controlled by menu Measurement / Input / Range or by remote interface commands:

VOLTage:AC:RANGe {<range>}
Voltage measuring range setting,
VOLTage:AC:RANGe?
Request for the set voltage measuring range,
VOLTage:AC:RANGe:AUTO {OFF|ON}
Switch off | switch on of the automatic setting of the voltage measuring range,
VOLTage:AC:RANGe:AUTO?
Request for the state of the automatic setting of the voltage measuring range. The respond is "0" if it is switched-off, or "1" if it is switched-on.

CURRent:AC:RANGe {<range>}
Current measuring range setting.
CURRent:AC:RANGe?
Request for the set current measuring range.
CURRent:AC:RANGe:AUTO {OFF|ON}
Switch off | switch on of the automatic setting of the current measuring range.
CURRent:AC:RANGe:AUTO?
Request for the state of the automatic setting of the current measuring range. The respond is "0" if it is switched-off, or "1" if it is switched-on.
CURRent:AC:RANGe:INP?
Request for the state of the current input switch (40A/120A). Answer is: 0 (40A), 1 (120A) or -1 (error).
This command can be used only in (special edition) devices with 40/120A input.
CURRent:AC:RANGe:INP {<state>}
Setting of state of the current input switch (40A/120A). Parameter is: 0 (40A) or 1 (120A).
This command can be used only in (special edition) devices with 40/120A input.

5.9.6 Measurement data acquisition

Most of measured values are returned by measurement commands in a form of a set of three real numbers (e.g. +3.456789E-03, +4.567891E-03, +5.678912E-03) without unit.

MEASure:VOLTage:AC?
Request for the measured voltage value,
MEASure:VOLTage:AC:PHASe?
Request for the phase of measured voltage,
MEASure:VOLTage:AC:DISTortion?
Request for the distortion of measured voltage,
MEASure:VOLTage:AC:SUM:SQuare?
Request for the sum of squares of measured voltages,
MEASure:VOLTage:FREQuency?
Request for the measured voltage frequency value,

MEASure:CURRent:AC?
Request for the measured current value,
MEASure: CURRent:AC:PHASe?
Request for the phase of measured current,

MEASure: CURRent:AC:DISTortion?
Request for the distortion of measured current,
MEASure: CURRent:AC:SUM:SQuare?
Request for the sum of squares of measured currents.

MEASure:POWer:AC[:ACTive]?
Request for the measured active power value,
MEASure:POWer:AC:REACtive?
Request for the measured reactive power value,
MEASure:POWer:AC:APParent?
Request for the measured apparent power value,
MEASure:POWer:AC:FACTor?
Request for the power factor value,
MEASure:POWer:AC:SUM:ACT?
Request for the sum of measured active powers,
MEASure:POWer:AC:SUM:REACtive?
Request for the sum of measured reactive powers,
MEASure:POWer:AC:SUM:APParent?
Request for the sum of measured apparent powers.

MEASure:IMPedance:AC:MODule?
Request for the impedance module value,
MEASure:IMPedance:AC:PHASe?
Request for the impedance phase value,
MEASure:IMPedance:AC:REAL?
Request for the impedance real part value,
MEASure:IMPedance:AC:IMAGinar?
Request for the impedance imaginary part value.

MEASure:FREQuency?
Request for measured frequency.
MEASure:FREQuency:CHANnel?
Request for channel on which frequency was measured. Answer is channel number (0-5).
MEASure:FREQuency:MODe?
Request for frequency measuring mode. Answer is 0 (automatic) or 1 (fixed freq).
MEASure:FREQuency:MODe {<mode>}
Setting of frequency measuring mode. Parameter is 0 (automatic) or 1 (fixed freq).
MEASure:FREQuency:MODe:VALue?
Request for frequency in fixed frequency measuring mode. Answer is frequency in Hz.
MEASure:FREQuency:MODe:VALue {<freq>}
Setting of frequency in fixed frequency measuring mode. Parameter is frequency in Hz.
MEASure:FREQuency:MODe:CHANnel?
Request frequency channel mode. Answer is 0 (auto), 1 (voltage), 2 (current) or 3 (fixed).
MEASure:FREQuency:MODe:CHANnel {<mode>}
Setting of frequency channel mode. Parameter is 0 (auto), 1 (voltage), 2 (current) or 3 (fixed).
MEASure:FREQuency:MODe:CHANnel:FIX?
Request for channel in fixed frequency channel mode. Answer is channel number (0-5).
MEASure:FREQuency:MODe:CHANnel:FIX {<chnl>}
Setting of channel in fixed frequency channel mode. Parameter is channel number (0-5).

MEASure:VALue:UI?
Request for aggregated result of voltages and currents.
MEASure:VALue:UIP?
Request for aggregated result of voltages, currents and phases.
MEASure:VALue:PUI?
Request for aggregated result of active powers, voltages and currents.
MEASure:VALue:PUIP?
Request for aggregated result of active powers, voltages, currents and phases.
MEASure:VALue:PQS?
Request for aggregated result of active, reactive and apparent powers.

5.9.7 Energy Accumulation

Device accumulates energy in three separate energy registers (one for active energy, one for reactive energy and one for apparent energy). Each energy register is accumulating energy only for those channels (L1, L2, L3) which are enabled for main (Fout0) impulse output in Measurement / Energy / Impulse menu.
Energy accumulation can be started, stopped and reset by remote commands.
Reset (clearing of all energy registers) can be done also during accumulation (when it is running).
Reset can be done also manually from device keypad using functional (FUNC/SHIFT) key but only when this functionality is enabled in Measurement / Energy / RESET -> menu item.

MEASure:ENERgy:STARt
Command for energy measurement start.
MEASure:ENERgy:STOP
Command for energy measurement stop.
MEASure:ENERgy:RESet
Command for energy measurement reset - energy registers are set to zero.
MEASure:ENERgy:STATus?
Request for status of energy measurement.
Answer is: 1 for running and 0 for stopped energy measurement.
MEASure:ENERgy:ACTive?
Request for actual value of active energy cumulated during energy measurement.
Answer is one number in VAs.
MEASure:ENERgy:ACTive:K?
Request for actual value of active energy cumulated during energy measurement.
Answer is one number in kVAh.
MEASure:ENERgy:REACtive?
Request for actual value of reactive energy cumulated during energy measurement.
Answer is one number in VArs.
MEASure:ENERgy:REACtive:K?
Request for actual value of reactive energy cumulated during energy measurement.
Answer is one number in kVArh.
MEASure:ENERgy:APParent?
Request for actual value of apparent energy cumulated during energy measurement.
Answer is one number in Ws.
MEASure:ENERgy:APParent:K?
Request for actual value of apparent energy cumulated during energy measurement.
Answer is one number in kWh.

MEASure:ENERgy:K?
Request for energy cumulated during energy measurement.
Energy returned by command depends on setting of main (Fout0 Config.) impulse output set in Measurement / Energy / Impulse menu and answer is one number in kWh, kVAh or kVArh.

Main (Fout0) output set to	Returned energy
APPARENT ENERGY	Apparent energy cumulated during energy measurement
REACTIVE ENERGY	Reactive energy cumulated during energy measurement
any other setting	Active energy cumulated during energy measurement

5.10 Impulse Output

The impulse output of the device is used for continuous energy measurement. The frequency of impulses is a product of the measured absolute power value and the constant of the frequency output. The impulse output can be configured to generate a constant frequency as well.
The impulse output can be controlled by submenu "Measurement / Energy / Impulse" or by remote interface commands:

SYSTem:ENERgy:CHANnel?
Request for the setting of the individual channel selection for functions related to the energy. Reply are three (in a sequence for channels L1, L2 and L3) values 0 or 1 (0 denounce for switched-off and 1 for switched-on given channel selection, respectively) separated by a commas (e.g. "1,0,1").

SYSTem:ENERgy:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
Setting of the individual channel selection for functions related to the energy. The parameters value (in a sequence for channels L1, L2 and L3) is ON or OFF for switched-on or switched-off given channel selection, respectively. This setting influences the summing up of the individual channels into the value of the generated frequency on the device impulse output if this is in the ENERGY mode.

SYSTem:ENERgy:IMPulse?
Request for the setting of the multiplication constant on the device impulse output. Reply is real number with the value of the set multiplication constant (e.g. "+2.500000E+02"). The unit of this constant is 1/Ws or 1/VAs .

SYSTem:ENERgy:IMPulse {<factor>}
Setting of the multiplication constant of the device impulse output which generates the impulse signal proportional to the measured energy. Parameter <factor> is the multiplication constant of the impulse output in the unit of 1/Ws or 1/VAs.

SYSTem:ENERgy:IMPulse:STATe?
Request for the state of the device impulse output. Reply is number:

0 … state is OFF
1 … state is ACTIVE POWER
2 … state is REACTIVE POWER
3 … state is FIXED
4 … state is APPARENT POWER

SYSTem:ENERgy:IMPulse:STATe {0|1|2|3|4} | {OFF|ACTIVE|REACTIVE|FIXED|APPARENT}
Setting of the device impulse output state. Parameter is state code (0 to 4 listed in previous command) or state name.

SYSTem:ENERgy:IMPulse:FIXed?
Request for the constant frequency value (which is generated if the impulse output is in the state FIXED). Reply is the text string containing a real number with the value of this frequency (e.g. "+1.000000E+03"). This value is in a Hz unit.

SYSTem:ENERgy:IMPulse:FIXed {<freq>}
Setting of the constant frequency value (which is generated if the impulse output is in the state FIXED). Parameter <freq> is the frequency value in Hz unit.

SYSTem:ENERgy:IMPulse:ECONstant?
Request for the setting of the constant of the meter under test connected to Reference Standard via external Local Evaluation Unit OPS. Answer is the constant value in unit 1/kWh or 1/kVAh.

SYSTem:ENERgy:IMPulse:ECONstant {<constant>}
Setting of the constant of the meter under test connected to Reference Standard via external Local Evaluation Unit OPS which is using 10000 nominal impulses for evaluation of error. Parameter <constant> is in unit of 1/kWh or 1/kVAh.
Setting this parameter changes also device impulse output constant parameter using this formula: IMPulse = ECONstant * 10000 / DIVider.

SYSTem:ENERgy:IMPulse:DIVider?
Request for the impulse division factor, which can be used for dividing device impulse output constant (and also constant of the meter under test) parameters.

SYSTem:ENERgy:IMPulse:DIVider {<divider>}
Setting of the impulse division factor, which can be used for dividing device impulse output constant (and also constant of the meter under test) parameters. Default value of impulse division factor is 1.

SYSTem:ENERgy:DOSage:...
Remote interface commands for DOSAGE function. See chapter 5.18 Dosage.

SYSTem:ENERgy:OUTx:STATe? x=0,1,2 or 3
Request for the state of the device impulse output OUTx. Reply is: 0 (for OFF), 1 (for ACTIVE POWER), 2 (for REACTIVE POWER), 3 (for FIXED) or 4 (for APPARENT POWER).

SYSTem:ENERgy:OUTx:STATe {0|1|2|3|4} | { OFF | ACTIVE | REACTIVE | FIXED | APPARENT } x=0,1,2 or 3
Setting of the state of device impulse output OUTx. Parameter is state code (0 to 4 listed in previous command) or state name.

SYSTem:ENERgy:OUTx:CHANnel? x=0,1,2 or 3
Request for the setting of the individual channel selection for impulse output OUTx functions related to the energy. Reply are three (in a sequence for channels L1, L2 and L3) values 0 or 1 (0 denounce for switched-off and 1 for switched-on given channel selection) separated by a commas (e.g. "1,0,1").

SYSTem:ENERgy:OUTx:CHANnel {0|1|OFF|ON},{0|1|OFF|ON},{0|1|OFF|ON} x=0,1,2 or 3
Setting of the individual channel selection for impulse output OUTx functions related to the energy. The parameters value (in a sequence for channels L1, L2 and L3) is ON or 1 for switched-on state and OFF or 0 for switched-off state of given channel selection. This setting influences the summing up of the individual channels into the value of the generated frequency on the device impulse output OUTx if this is in the (ACTIVE, REACTIVE or APPARENT) ENERGY mode.

SYSTem:ENERgy:OUTx:FIXed? x=0,1,2 or 3
Request for the constant frequency value (which is generated if the impulse output OUTx is in the state FIXED). Reply is the text string containing a real number with the value of this frequency (e.g. "+1.000000E+03"). This value is in a Hz unit.

SYSTem:ENERgy:OUTx:FIXed {<freq>} x=0,1,2 or 3
Setting of the constant frequency value (which is generated if the impulse output OUTx is in the state FIXED). Parameter <freq> is the frequency value in Hz unit.

SYSTem:ENERgy:OUTx:FACTor? x=0,1,2 or 3
Request for the setting of the multiplication constant on the device impulse output OUTx. Reply is real number with the value of the set multiplication constant (e.g. "+2.500000E+02"). The unit of this constant is 1/Ws or 1/VAs.

SYSTem:ENERgy:OUTx:FACTor {<factor>} x=0,1,2 or 3
Setting of the multiplication constant of the device impulse output OUTx which generates the impulse signal proportional to the measured energy. Parameter <factor> is the multiplication constant of the impulse output in the unit of 1/Ws or 1/VAs.

5.11 Impulse Input

The impulse input Fin of the device can be used for direct comparison of any reference / working standard to this device.
The condition is that both devices measure same signal under same configuration (type of energy, included channels, constant) therefore the setting of these parameters in this device is available.
Integration time allows configure the length of the measurement.
State of the measurement and result are indicated on Impulse Input screen and can be also obtained by remote interface commands.
The impulse input functionality can be controlled by submenu "Measurement / Energy / Impulse / Fin Meas/Test" (described in above chapters) or by these remote interface commands:

SYSTem:ENERgy:IN:STARt?
Request for the state of the device impulse input measurement.
Reply is: 0 (for OFF), 1 (for running measurement), 2 (for finished measurement) or negative number (-1, -2) for measurement error.

SYSTem:ENERgy:IN:STARt
Start of new impulse input measurement.

SYSTem:ENERgy:IN:ERRor?
Request for the result (last measured error value) of the impulse input measurement.

SYSTem:ENERgy:IN:TIMe?
Request for the setting of integration time parameter. Returned value is the time in seconds.

SYSTem:ENERgy:IN:TIMe {<intTime>}
Setting of integration time parameter in unit seconds.

SYSTem:ENERgy:IN:STATe?
Request for the state of the device impulse input Fin – proportional to one type of energy. Reply is: 0 (for ACTIVE POWER), 1 (for REACTIVE POWER) or 2 (for APPARENT POWER).

SYSTem:ENERgy:IN:STATe {0|1|2}
Setting of the state of the device impulse input Fin – proportional to one type of energy. Parameter is: 0 (for ACTIVE POWER), 1 (for REACTIVE POWER) or 2 (for APPARENT POWER).

SYSTem:ENERgy:IN:CHANnel?
Request for the setting of the individual channel selection for impulse input Fin functionality related to the energy. Reply are three (in a sequence for channels L1, L2 and L3) values 0 or 1 (0 denounce for switched-off and 1 for switched-on given channel selection) separated by a commas (e.g. "1,0,1").

SYSTem:ENERgy:IN:CHANnel {0|1|OFF|ON},{0|1|OFF|ON},{0|1|OFF|ON}
Setting of the individual channel selection for impulse input Fin functionality related to the energy. The parameters value (in a sequence for channels L1, L2 and L3) is ON or 1 for switched-on state and OFF or 0 for switched-off state of given channel selection. This setting influences the summing up of the individual channels into the value of frequency compared with the frequency of the device impulse intput Fin.

SYSTem:ENERgy:IN:CONStant?
Request for the setting of the constant of the device impulse input Fin. Reply is real number in unit 1/Ws (1/VAs, 1/VArs).

SYSTem:ENERgy:IN:CONStant {<constant>}
Setting of the constant of the device impulse input Fin. Parameter <constant> is in the unit of 1/Ws (1/VAs, 1/VArs).

5.12 Impulse Quick Response mode

Mode designed for special applications for sensing signals with dips is high sense measurement mode in which device sets frequency of impulse output quickly according to measured signal (switches off impulse output immediately after detecting last period of measured signal and switches on after first period of new signal).

Mode can be controlled locally (by menu items) or remotely (via commands).

Local control

Special Func. / Fout Response / Quick_Mode with possible values ON and OFF.
Special Func. / Fout Response / Treshold with default value 3%.

Remote interface commands

MEASure:IMPulse:QRESponse?
Request for state of Impulse Quick Response mode. Answer: 0=OFF (disabled) or 1=ON (enabled)
MEASure:IMPulse:QRESponse {<enable=0|1>}
Setting of state of Impulse Quick Response mode. Parameter: 0 (=OFF /disabled) or 1 (=ON /enabled)
MEASure:IMPulse:QRESponse:TREShold?
Request for threshold value of Impulse Quick Response mode. Answer: threshold (0-100%)
MEASure:IMPulse:QRESponse:TREShold {<treshold=0-100>}
Setting of threshold value of Impulse Quick Response mode.
Parameter: threshold (0-100%) ... default value is 3%

Remark:
Quick_Mode parameter value (ON/OFF) is not stored into configuration and therefore it's value is remembered only until device switch-off. After switch-on of the device has this parameter always value OFF.

5.13 Harmonics

5.13.1 Harmonic Content

Harmonic content of measured signals is available locally and also remotely.

Local show can be activated by menu item Special Func. / Harmonic_Graph -> and shows harmonic graph and values of amplitudes and phases of all measured harmonics. Change of view and listing can be done in graph using arrow keys.

Remote interface commands

MEASure:SIGNal? {<phase = 0 | 1 | 2> },{<unit = 0 | 1>},{<harmonic = 0-63>}
Request for signal's harmonic content for defined harmonic number.
Parameters: phase (0=L1, 1=L2, 2=L3), unit (0=U, 1=I) and harmonic number
Answer: amplitude and phase (two comma separated real numbers)
Examples:

MEASure:SIGNal? 0,0,2	… reading of content of 2nd harmonic of U_{L1}
MEASure:SIGNal? 2,1,5	… reading of content of 5th harmonic of I_{L3}
+1.234567E-01, +9.456789E+01	… answer for MEASure:SIGNal? Command

MEASure:SIGNal:AMPL? {<phase = 0 | 1 | 2> }, {<unit = 0 | 1>} [,{<harmonic = 0-63>}]
Request for amplitude of defined harmonic of defined input signal.
Parameters: phase (0=L1, 1=L2, 2=L3), unit (0=U, 1=I) and harmonic number
Answer: amplitude of harmonic (all harmonics if last parameter omitted)
MEASure:SIGNal:PHASe? {<phase = 0 | 1 | 2> }, {<unit = 0 | 1>} [,{<harmonic = 0-63>}]
Request for phase of defined harmonic of defined input signal.
Parameters: phase (0=L1, 1=L2, 2=L3), unit (0=U, 1=I) and harmonic number
Answer: phase of harmonic (all harmonics if last parameter omitted)
MEASure:SIGNal:SAMPle? {<phase = 0 | 1 | 2> }, {<unit = 0 | 1>}
Request for raw samples of defined input signal.
Signal data are always actual - not influenced by next subcommand HOLD.
Parameters: phase (0=L1, 1=L2, 2=L3) and unit (0=U, 1=I)
Answer: raw samples of defined signal separated by spaces. Each sample is an integer value.
Quantity of these integers is equal to points of FFT (max. / typically 128).
MEASure:SIGNal:HOLD
Command for storing actual values of signals in all 6 measured channels into memory = holding data actual in time of sending this command. This command influences only next command used for reading amplitudes of holded samples. Reading values is not clearing or refreshing registers … it means new HOLD command has to be used for new data.
MEASure:SIGNal:AMPLitude? {<phase = 0 | 1 | 2> }, {<unit = 0 | 1>}
Request for amplitude of samples of defined input signal - holded in memory by HOLD command.
Parameters: phase (0=L1, 1=L2, 2=L3) and unit (0=U, 1=I)
Answer: samples of defined signal separated by spaces [in values Amperes or Volts].
Each sample is in exponential format: **+#.#####E+##**
Quantity of these samples is equal to points of FFT (max. / typically 128).

5.13.2 Harmonic Limitation

Harmonics Measurement Limitation system enables to limit calculation of measured values only from defined number of harmonics.

Local configuration

Measurement / Harm. Meas Mode with possible values:
FUNDAMENTAL_ONLY, FIRST_X_HARMONICS, ALL_63_HARMONICS
Measurement / Harm. Meas Limit with possible values 2 - 63 (for 128 pt. FFT).

Remote interface commands

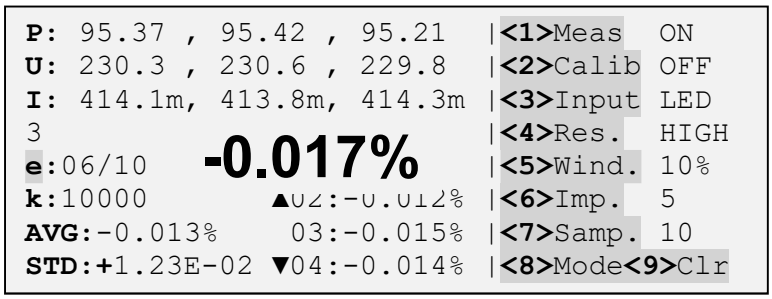
MEASure:HARM?
Request for harmonic measurement limitation system mode.
Answer: 0 = ALL_HARMONICS, 1 = FUNDAMENTAL_ONLY, 2 = FIRST_X_HARMONICS
MEASure:HARM {<mode=0-2>}
Setting of harmonic measurement limitation system mode.
Parameter: mode (0 = ALL_HARMONICS, 1 = FUNDAMENTAL_ONLY, 2 = FIRST_X_HARMONICS)
MEASure:HARM:LIMit?
Request for user defined max. harmonic used for calculations.
Answer: harmonic number (2 - 63)
MEASure:HARM:LIMit {<X=2-63>}
Setting of user defined max. harmonic used for calculations.
Parameter: harmonic number (2 - 63)

5.14 Vector Diagram

Vector diagram can be activated by key DEL. In this diagram are showed all voltages and currents (minimal amplitudes are 0.5V, 0.5mA).
Diagram represents graphic interpretation of harmonic content. There is a chart on the left and by up and down arrows zooming is changed in range 1x - 20x. On the right side there is a list of harmonic items where the 1st column from left (Harm) means the number of harmonic item, 2nd column (U[%]) states for harmonic item's amplitude in % related to the fundamental harmonic and the 3rd column (ph[°]) states for phase shift of harmonic item.
Paging of this list is possible via left and right arrows on the keypad. Repeated pressing of DEL button rotates the currently displayed channel. There are 6 available channels:
L1 VOLTAGE, L1 CURRENT ... L3 CURRENT.

5.15 Meter Error Test and Meter Constant Test

Meter error can be measured in **OPS Measurement Mode**. This mode is used to control Local Evaluation Unit OPS and to measure error of connected electricity meter. This mode can be selected using menu item Measurement / Energy / Impulse / OPS Meas/Test -> or by pressing "EXP" key from the basic mode if device has installed appropriate hardware (hardware versions 1.08 or higher). Mode can be closed by pressing "ESC" or "EXP" buttons.
The basic activities of the device are not suspended – device is measuring in background.



OPS Measurement Mode window – Meter Error Test

Description of OPS Measurement Mode window:

Left part of window

1st - 3rd Line:

- **measured values** ... measured values of (active, reactive or apparent) power, voltage and current in all channels.

4th - 5th Line:

- **mode indicator** ..... mode indicator shown in the beginning of 5th line: "e" indicates meter error test and "k" indicates meter constant test.
- **impulse counter** ..... counter of impulses captured from tested meter shown in the beginning of 4th line. This number has initial value equal to value of right part parameter "Imp." and is lowered by 1 after every received impulse. When it reaches zero then the new measured sample is calculated.
- **sample counter** ..... counter of samples shown in the beginning of 5th line after mode indicator. Counter shows progress: number of measured samples / required number of samples set in right part parameter "Samp.".
- **error / state** ..... measured meter error or actual state (mode) of local evaluation unit OPS is shown with large letters in both lines

6th Line:

- **k** ..... meter constant of the meter under test (set in Measurement / Energy / Impulse submenu)

7th Line:

- **AVG**..... average value from all measures samples shown after getting second sample and updated after each new sample. After finishing of test (measuring required number of samples) is this value result of test.

8th Line:

- **STD** ..... standard deviation value of all measures samples shown after getting second sample and updated after each new sample.

Middle part of window

6th - 8th Line:

- **samples** ..... list of measured samples with their sequence numbers. List can be browsed using UP and DOWN arrows.

Right part of window

Right part of window contains list of available keys – some of them are associated with parameters which values are shown next to key indicator.

- **1** or **F1 / Meas** ..... key for entering or leaving MEAS mode of the OPS unit. This key starts / ends meter testing when all other parameters are set to correct values. Actual state is indicated in end of line: ON or OFF.
- **2** or **F2** / **Calib** ..... key for entering or leaving BARGRAPH / CALIB mode of the OPS unit. Actual state is indicated in end of line: ON, SET or OFF.
- **3** or **F3** / **Input** ..... key for setting input mode: LED, DISK or S0.
- **4** or **F4** / **Res.** ..... key for setting resolution: LOW = results with two decimal places and 10000 nominal impulses (100 ppm resolution) or HIGH = results with three decimal places and 60000 nominal impulses (17 ppm resolution)
- **5** or **F5** / **Wind.** ..... key for setting measurement window used by OPS during capturing marks from rotation disks. Value can be 0-100%.
- **6** or **F6** / **Imp.** ..... key for setting of "OPS predivider" e.g. number of impulses captured by OPS unit needed for every sample. Value can be 1-60000.
- **7** / **Samp.** ..... key for setting the number of samples needed for evaluation of test. Values can be 1-50.
- **8** / **Mode** ..... key for setting testing mode: Meter Error Test, Meter Constant Test with value shown in [/kWh or /kVAh] or Meter Constant Test with value shown in [/Ws or /VAs]
- **9** / **Clr** ..... key for clearing of history (list) of measured samples. Usage of this key when testing is in progress makes reset of the test without interruption of the test.

Meter Constant Test

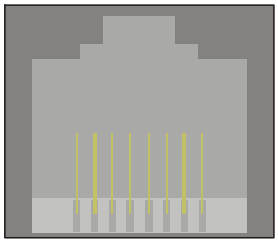
```
P: 95.37 , 95.42 , 95.21   |<1>Meas  ON
U: 230.3 , 230.6 , 229.8   |<2>Calib OFF
I: 414.1m, 413.8m, 414.3m  |<3>Input LED
                           |<4>Res.  LOW
k:      9987.546           |<5>Wind. ---
                           |<6>Imp.  5
        r/kWh              |<7>Samp. 10
                           |<8>Mode<9>Clr
```

OPS Measurement Mode window – Meter Constant Test

Description of OPS Measurement Mode window

Meter Constant Test can be measured in same **OPS Measurement Mode** as Meter Error Test after changing testing mode and pressing F1. Result of test is calculated meter constant.
There are two possible options of evaluation – r/kWh or r/Ws, changed by button "8" (Mode).

5.15.1 COM and OPS connectors



On OPS connector have signals IMP +, RX +, TX + +5V level and signals IMP -, RX -, TX - -5V level.

Pin #	COM connector		OPS connector	
	Name	Usage	Name	Usage
1	GND		GND	
2	+15V/200mA		+15V/200mA	
3	IMP -	freq. output -	IMP -	freq. output -
4	IMP +	freq. output +	IMP +	freq. output +
5	RX -	from PC -	TX -	to OPS -
6	RX +	from PC +	TX +	to OPS +
7	TX -	to PC -	RX -	from OPS -
8	TX +	to PC +	RX +	from OPS +

5.15.2 Remote interface commands

SYSTem:OPS:ACTive?
Request for the state of OPS Measurement Mode,
SYSTem:OPS:STARt
Command for starting OPS Measurement Mode,
SYSTem:OPS:STOP
Command for stoping OPS Measurement Mode,
SYSTem:OPS:ERRor?
Request for error of measured electricity meter in OPS Measurement Mode.
Error is returned in a form of a real number (e.g. -1.45). If no error is available the text string "Not available" is returned.
SYSTem:OPS:STATus?
Request for status of Local Evaluation Unit OPS. Return values (status codes):

0 … READY mode	5 … MEASURE mode - new error value available
1 … BARGRAPH mode	6 … MANUAL mode
2 … CALIB mode	7 … COPY mode
3 … MEASURE mode	8 … COUNTER mode
4 … MEASURE mode - not recognized mark	9 … IS mode

For information about modes see manual of Local Evaluation Unit OPS.

SYSTem:OPS:STATus {<status_code>}
Command for setting Local Evaluation Unit OPS into required state (mode). Parameter is number from 0 to 9 and corresponds to status codes listed in previous command.

SYSTem:OPS:INPut?
Request for active input of Local Evaluation Unit OPS. Return values:

0 … LED input is active	2 … DISK input is active
1 … S0 input is active	3 … COPY input is active

SYSTem:OPS:INPut {<input_code>}
Command for selecting required input of Local Evaluation Unit OPS. Parameter <input_code> is number from 0 to 3 and corresponds to input codes listed in previous command.

SYSTem:OPS:RESolution?
Request for actual resolution of errors measured on Local Evaluation Unit OPS. Return value is 0 if resolution is standard (two decimal places) or 1 if resolution is high (three decimal places).

SYSTem:OPS:RESolution {<resolution_code>}
Command for selecting required resolution of errors measured on Local Evaluation Unit OPS. Parameter is 0 if required resolution is standard (2 decimal places) or 1 if high (3 decimal places).

SYSTem:OPS:DIVider?
Request for actual input divider value in Local Evaluation Unit OPS. Return value is number from 1 to 65535.

SYSTem:OPS:DIVider {<divider>}
Command for setting required input divider value in Local Evaluation Unit OPS. Parameter <divider> is number from 1 to 65535.

SYSTem:OPS:WINDow?
Request for actual measurement window in Local Evaluation Unit OPS. Return value is real number (e.g. 7.5).

SYSTem:OPS:WINDow {<window>}
Command for setting required measurement window in Local Evaluation Unit OPS. Parameter window is real number from 0 to 100.

SYSTem:OPS:MEASure:MAXCount?
Request for max. number of measured samples (parameter under key '7' in manual mode).

SYSTem:OPS:MEASure:MAXCount {<samples>}
Command for setting max. number of measured samples. Parameter <samples> is from 1 to 50.

SYSTem:OPS:MEASure:COUNt?
Request for actual number of measured samples (= progress of measurement)

SYSTem:OPS:MEASure:RESult:AVG?
Request for average value of measured samples.

SYSTem:OPS:MEASure:RESult:STD?
Request for standard deviation value of measured samples.

SYSTem:OPS:MEASure:RESult:SAMPle? {<index>}
Request for value of measured sample with specified index. Parameter <sample_index> is from 1 to 50.

5.16 Measured Values History System

Device can log measured values (energy, power, voltage, current …) into his history memory. Capacity of this memory is approximately 100.000 measurements of all available measured quantities which means approx. 26 hours of logging at default integration time 1 second or more when integration time is longer.

Measured Values History system can be configured locally (via menu of the device) or remotely (via commands on RS-232 interface).

Historical values of measured data are available locally from display or remotely.

Configuration Parameters and Functions

STATE – general enable/disable parameter of this function (ENABLE / DISABLE)

QUANTITIES – selection of quantities which will be logged into history memory (ALL)

INTEGR. TIME – integration time for accumulation / calculation of samples for each selected quantity. Samples are stored into historical memory. Value 0 means integration time equal to parameter Time Base (configurable from Measurement submenu).

RESET – reset of Measured Values History system (clearing of all measured values from memory)

Local Configuration

Configuration parameters and functions are accessible locally from this submenu:
SPECIAL FUNC. / HISTORY

Remote Configuration

Configuration parameters and functions can be accessed remotely using these commands:
SYSTem:HISTory:STATe {0 | 1}
General disabling (0) or enabling (1) of Measured Values History functionality.
SYSTem:HISTory:STATe?
Request for state of Measured Values History functionality. Reply is 0 if disabled or 1 if enabled.
SYSTem:HISTory:INTegrtime {time}
Setting of integration time of Measured Values History functionality. Parameter defines time. Value 0 means integration time equal to measurement parameter Time Base.
SYSTem:HISTory:INTegrtime?
Request for setting of integration time of Measured Values History functionality.
SYSTem:HISTory:RESet
Reset of Measured Values History functionality (clearing of historical memory).

Access to Logged Data and Statistics

Logged data can be accessed remotely using this command:
SYSTem:HISTory:GET? {quantityCode}, {chnl}, {"timeString" }
Request for value from historical memory. Reply is historical value of defined quantity in defined channel in defined time. First parameter is quantity code, second parameter is channel code (1, 2 and 3 for L1, L2 and L3 channels) and third parameter is time string in "YYYY-MM-DD hh:mm:ss.xx" format.

Example: SYST:HIST:GET? 0,1,"2009-09-20 17:23:19.04730"

List of quantities codes

CODE	QUANTITY	CODE	QUANTITY	CODE	QUANTITY
0	**Active Power**	1	**Voltage**	2	**Current**
3	**Reactive Power**	4	**Apparent Power**	5	**Phase UU**
6	**Phase UI**	7	**Frequency**	8	**Distortion of Voltage**

9	**Distortion of Current**	10	**Active Energy**	11	**Reactive Energy**
12	**Apparent Energy**				

Description of "YYYY-MM-DD hh:mm:ss.xx" format

Example: "2009-09-20 17:23:19.04730".

Meanings of format parts:

YYYY .. year (4 digits)	hh ..... hour (2 digits)
MM ..... month (2 digits)	mm .... minutes (2 digits)
DD ..... day (2 digits)	ss ..... seconds (2 digits) xx … fraction of second (max. 5 digits)

Local Operation

Logged data, statistics and some functions are available in these windows:

- HISTORY STATISTIC accessible by menu item MEASUREMENT / HISTORY / SHOW
- HISTORY VALUES accessible from HISTORICAL STATISTIC via Val function (F5 or 5 key)

HISTORY STATISTIC Window

```
HISTORY STATISTIC of  Active Power [W]
STATE :running   BEG:2009-12-21 09:17:20
MEMORY:12.345%   END:2009-12-21 11:16:32
ACT[1]:+1.23456E+02
MIN[1]:+1.20647E+02 /2009-12-21 09:36:14
MAX[1]:+1.24894E+02 /2009-12-21 10:19:56
AVG[1]:+1.23986E+02 STDEV[1]: 1.234E-01
<1>Start <2>Calc <3>Quant <4>Chnl <5>Val
```

Description of window items:

1st Line:

- **window** ..... name of the window: "HISTORY STATISTIC"
- **quantity** ..... name of the quantity for which statistic is shown. Names of all quantities: **"Active Power [W]", "Voltage [V] ", "Current [A]", "Reactive Power[VAr]", "Apparent Power [VA]", "Phase U [°]", "Phase I [°]", "Distortion U [%]", "Distortion I [%]", "Frequency [Hz]"**

2nd & 3rd Line:

- **STATE** ..... state of the history functionality: "running" or "stopped".
- **MEMORY** ..... used memory percentage (0 - 100 %)
- **BEG** ..... date and time of first logged value (= beginning of logging)
- **END** ..... date and time of last logged value (= end of logging)

4th - 6th Line:

- **ACT[x]** ..... actual (last) measured value of channel x (=1, 2 or 3)
- **MIN[x]** ..... minimal measured value / it's date and time of channel x (=1, 2 or 3)
- **MAX[x]** ..... maximal measured value / it's date and time of channel x (=1, 2 or 3)

7th Line:

- **AVG[x]** ..... average of all measured values of channel x (=1, 2 or 3)

- **STDEV[x]** ..... standard deviation of all measured values of channel x (=1, 2 or 3). Value is in parentheses when not actual (new value was measured after last calculation of STDEV value)

8th Line – keys:

- **1** or **F1** ..... key for starting / stopping of logging. All measured values and statistics are available after stopping of logging until next start or until performing reset (which is available from MEASUREMENT / HISTORY submenu)
- **2** or **F2** ..... key for (re)calculation of statistical values (minimal, maximal, average and standard deviation values) for selected quantity. Recalculation is done automatically if quantity is changed during stopped logging. When quantity is changed during running logging then recalculation has to be called manually for achieving statistical values or actual standard deviation.
- **3** or **F3** ..... key for selecting quantity for which statistical values are shown. Quantity can be changed also during running logging but recalculation has to be called when statistical values are needed.
- **4** or **F4** ..... key for selecting channel (1=L1, 2=L2, 3=L3) for which statistical values are shown. Channel can be changed also during running logging and don't require recalculation for getting actual statistical values. Some quantities (frequency) are not measured as three-phase quantities therefore channel is not shown for them.
- **5** or **F5** ..... key for entering "HISTORY VALUES" window in which all measured values are available.

HISTORY VALUES Window

```
HISTORY VALUES  of   Active Power [W]
   1: +1.21234E+02 /2009-12-21 09:17:20
   2: +1.21216E+02 /2009-12-21 09:17:21
   3: +1.21209E+02 /2009-12-21 09:17:22
   4: +1.21195E+02 /2009-12-21 09:17:23
   5: +1.21176E+02 /2009-12-21 09:17:24
   6: +1.21157E+02 /2009-12-21 09:17:25
<▲,▼> <◄,►> <3>Quant <4>Chnl=x <5>Exit
```

Description of window items:

1st Line:

- **window** ..... name of the window: "HISTORY VALUES"
- **quantity** ..... name of the quantity for which values are shown. Names of all quantities: **"Active Power [W]", "Voltage [V] ", "Current [A]", "Reactive Power[VAr]", "Apparent Power [VA]", "Phase U [°]", "Phase I [°]", "Distortion U [%]", "Distortion I [%]", "Frequency [Hz]"**

2nd - 7th Line:

- **DATA** ..... measured data with its number (counted from 1), value and date and time. Empty 7th line indicates reaching end of list during browsing or paging data.

8th Line – keys:

- ▲ and ▼ ..... keys for browsing data by one line
- ◄ and ► ..... keys for paging data by 6 lines
- **3** or **F3** ..... key for selecting quantity for which measured values are shown.
- **4** or **F4** ..... key for selecting channel (1=L1, 2=L2, 3=L3) for which measured values are shown. Selected channel is shown in last line between <4> and <5> keys.
- **5** or **F5** ..... key for exiting "HISTORY VALUES" window and return into "HISTORY STATISTIC" window
- **Backspace** ..... key for jumping to the beginning of the list of data

- **DEL** or **INS** ..... key for jumping to the end of the list of data

Remarks / known issues:

- *Selection of quantities is not available (all measured quantities are always logged)*
- *Integration time cannot be changed and is always same as Time Base value*
- *Obtaining of historical values using command SYST:HIST:GET? maybe not fully functional in fw 7.00 for all quantities*

5.17 Mode 'TALK ONLY'

The 'TALK ONLY' mode enables to continuously send (at Time Base rate) measured values to communication port COM1 (RS-232).

All quantities measured by device can be enabled / disabled for automatic sending. For details see separate chapter Quantities.

Format of sent information can be LONG or SHORT. LONG format was used in older versions of firmware and is supported for compatibility reasons. New SHORT format is more effective because of fewer characters used in it.

All configuration parameters of this mode are saved in configuration and can be controlled in Measure / Talk Only menu or by commands.

5.17.1 LONG format description

"<codeLF>:<channel>=<value><SI><cr><lf>"

Explanation of expressions:

<codeLF>	measuring function long format code,
<channel>	label of the measuring channel: L1, L2 or L3,
<value>	real number of the measured value in the SI units in the exponential format,
<SI>	label of an SI unit of the measuring function,
<cr><lf>	End of line characters

Example : **"VOLT:AC:L1=+1.234567E+08 V"**

5.17.2 SHORT format description

"<codeSF>=<valueL1>,<valueL2>,<valueL3><cr><lf>"

or

"<codeSF>=<value><cr><lf>"

Explanation of expressions:

<codeSF>	measuring function short format code,
<valueLx>	real number of the measured value in channel Lx - if 3 phase information
<value>	real number of the measured value - if information common for all phases
<cr><lf>	End of line characters

Example: **"U=+2.300253E+01,+2.299568E+01,+2.300145E+01"** or **"sP=+1.234567E+04"**

5.17.3 Commands

SYSTem:TALKonly {0 | 1}
General disabling (0) or enabling (1) of 'TALK ONLY' mode.
SYSTem:TALKonly?
Request for state of 'TALK ONLY' mode. Reply is 0 if disabled or 1 if enabled.
SYSTem:TALKonly:COM1 {0 | 1}
Disabling (0) or enabling (1) of COM1 (RS-232) output in 'TALK ONLY' mode.
SYSTem:TALKonly:COM1?
Request for state of COM1 (RS-232) output in 'TALK ONLY' mode. Reply is 0 if disabled or 1 if enabled.
SYSTem:TALKonly:COM1:FORMat {0 | 1}
Setting LONG format (0) or SHORT format (1) of COM1 output in 'TALK ONLY' mode.
SYSTem:TALKonly:COM1:FORMat?
Request for format setting of COM1 output in 'TALK ONLY' mode. Reply is 0 for LONG format or 1 for SHORT format.
SYSTem:TALKonly:COM1:QUANtities {<qParam>}
Setting of quantities sent on COM1 output in 'TALK ONLY' mode. Quantities parameter (qParam) is decimal number containing binary information about enabled/disabled quantities. For format of parameter see detailed description in Mode 'TALK ONLY' chapter.
SYSTem:TALKonly:COM1:QUANtities?
Request for setting of quantities sent on COM1 output in 'TALK ONLY' mode. Reply is decimal number containing binary information about enabled/disabled quantities. For format of parameter see detailed description in Mode 'TALK ONLY' chapter.

5.17.4 Quantities parameter

Quantities parameter is 32-bit decimal word, used in commands for enabling/disabling of quantities. Every quantity Qx is represented by bit X. Value 0 of this bit X disables quantity Qx and value 1 of bit X enables quantity Qx.

Format of quantities parameter:

bit #	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Q #	Q21	Q20	Q19	Q18	Q17	Q16	Q15	Q14	Q13	Q12	Q11	Q10	Q09	Q08	Q07	Q06	Q05	Q04	Q03	Q02	Q01

Example: For enabling Q01(Active Power), Q02(Voltage), Q03(Current) and Q11(Frequency) has quantity parameter value 2055 (= $2^1 + 2^2 + 2^3 + 2^{11}$).

5.17.5 Quantities list

Q #	QUANTITY	codeLF	codeSF	SI unit
Q01	**Active Power**	POW:AC	P	W
Q02	**Voltage**	VOLT:AC	U	V
Q03	**Current**	CURR:AC	I	A
Q04	**Reactive Power**	POW:AC:REAC	Q	VA
Q05	**Apparent Power**	POW:AC:APP	S	VA
Q06	**Power Factor**	POW:AC:FACT	pf	-
Q07	**Impedance Module**	IMP:AC:MOD	Z	ohm
Q08	**Impedance Phase**	IMP:AC:PHAS	Ph	deg
Q09	**Impedance Real Part**	IMP:AC:REAL	R	ohm
Q10	**Impedance Imaginar Part**	IMP:AC:IMAG	X	ohm
Q11	**Frequency**	FREQ	F	Hz
Q12	**Distortion of Voltage**	VOLT:AC:DIST	dU	%
Q13	**Distortion of Current**	CURR:AC:DIST	dI	%
Q14	**Phase UU**	PHAS:UU	phU	deg
Q15	**Phase UI in Lx channel**	PHAS:UI	phI	deg
Q16	**Phase-to-phase Voltage**	VOLT:AC:PP	Upp	V
Q17	**Sum of Active Power**	POW:AC:SUM	sP	W
Q18	**Sum of Reactive Power**	POW:AC:SUM:REAC	sS	VA
Q19	**Sum of Apparent Power**	POW:AC:SUM:APP	sQ	VA
Q20	**Sum of square Voltage / 1Ω**	VOLT:AC:SUM:SQR	sUU	W
Q21	**Sum of square Current / 1Ω**	CURR:AC:SUM:SQR	sII	W

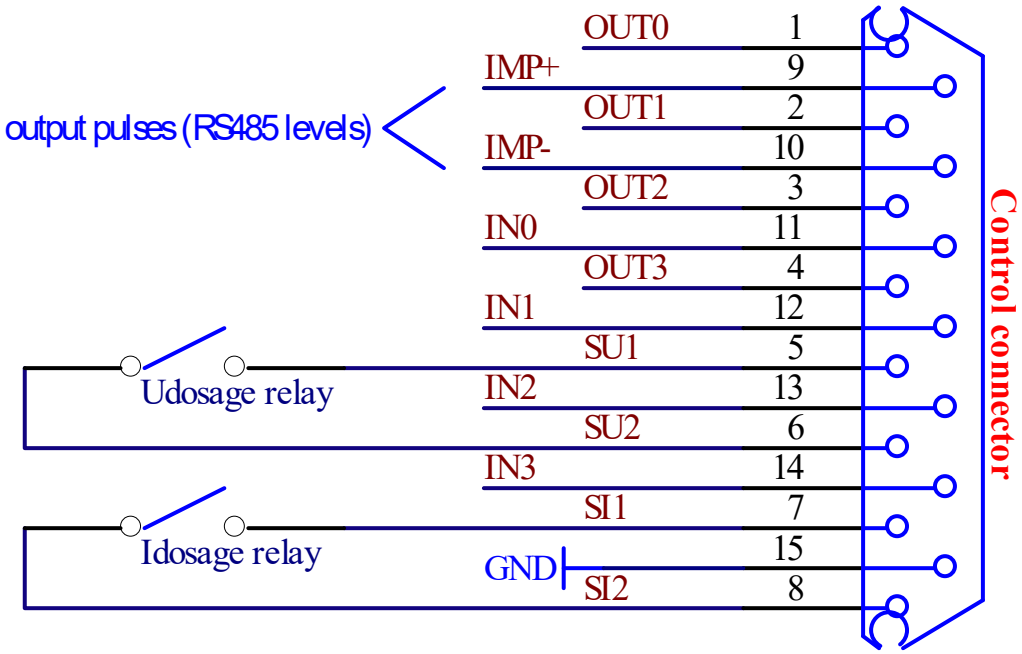
5.18 Dosage

The SU/SI output of the device can be used for performing time or energy dosage in combination with a power source, as used during so-called 'dial-tests' or 'register tests' of electricity meters.
SU and SI are passive relay contacts, which can be used to control the switch-on and switch-off of voltages and currents of the power source in a meter test bench. They can be steered directly by commands or by the reference meter during dosage functions. The contacts are normally closed in all functions except during dosage function, where they are opened at start and closed at the end, depending on the defined initial and end status of the contacts.

5.18.1 Dosage contacts SU/SI

SU and SI are potential free contacts located on device in Control connector. During energy and time dosage operations are these contacts used to control a power source or to control the switching of current and voltage.

Loading capacity of the contacts: max. 125V, 1A



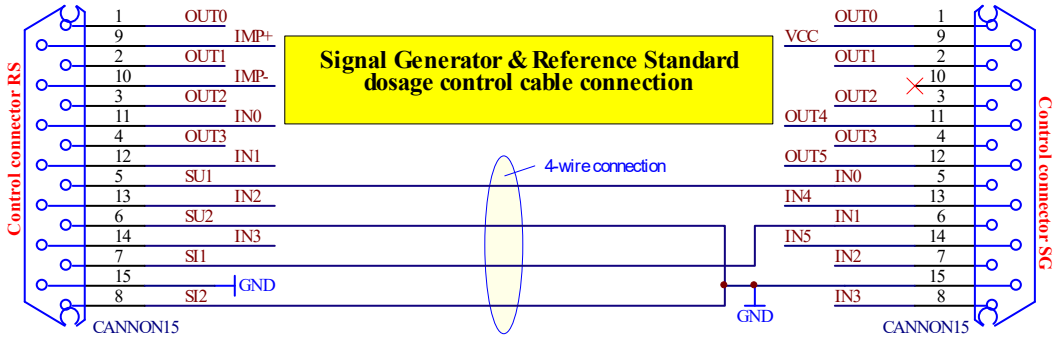
INx ... input TTL signals
OUTx ... output TTL signals
IMPx ... output impulses: RS485 levels
GND ... TTL signals ground

SUx ... voltage dosage contacts (max. 125V,1A)
SIx ... current dosage contacts (max. 125V,1A)

(Note: all pins galvanically isolated:
optical and relay isolation)

5.18.2 Dosage cable AP Reference Standard – AP Power Source

This dosage cable AP Reference Standard - AP Power Source is needed for dosing:



5.18.3 Preparation for dosage

- One of the 8 operating modes for active or reactive energy must be selected.
- Dosage energy or time must be defined.

- During a dosage function is recommended to not use auto range system.
- The load values for the test: current, voltage and phase angle must be defined and switched on at the source.
- Definition of initial and end status of relay contacts SU / SI must be defined.
- The status before start, after start and after stop of dosage of the contacts as well as switching delay times for each contact can be defined. It can be defined that only current is switched off and on or that both voltage and current are switched off.

5.18.4 Running of dosage

After initiating dosage (with menu item or command "Start" or "Init") the relay contact disconnect the load regarding the definition made to allow writing down the initial reading of the energy registers. After starting dosage (with menu item or command "Start") the dosage is immediately started and the relay contacts are closed regarding the definition. The Device now counts the predefined amount of energy or time.
If the amount of energy or time is reached or if the dosage is stopped earlier (with menu item or command "Stop") the contacts are opened again to switch off the power source regarding the definition. Now the final reading of the energy registers can be read and the error can be calculated. Dosage function is ended by menu item or command "Stop" or "Cancel".

5.18.5 Dosage Modes

There are 6 Dosage Modes:

Number	Code	Dosage Mode
0	TIME	Time dosage
1	ACTIVE	Energy dosage of active energy
2	REACTIVE	Energy dosage of reactive energy
3	APPARENT	Energy dosage of apparent energy
4	SQRU	Energy dosage of square voltage / 1ohm
5	SQRI	Energy dosage of square current / 1ohm

5.18.6 Controlling and configuring of dosage function

Dosage function can be controlled and configured by submenu "Measurement / Energy / Dosage" or by remote commands:

Commands for controlling of dosage function:

SYSTem:ENERgy:DOSage:INIT
Initialization of dosage function.
SYSTem:ENERgy:DOSage:STARt
Start (or initialization) of dosage function.
SYSTem:ENERgy:DOSage:STOP
Stop (or cancel) of dosage function.
SYSTem:ENERgy:DOSage:CANCel
Cancel of dosage function.

Commands for configuring dosage:

SYSTem:ENERgy:DOSage:MODe {<mode>}
Setting of Dosage Mode. Parameter is number (0-5) or code (TIME, ACTIVE …) of Dosage Mode.
SYSTem:ENERgy:DOSage:MODe?
Request for state of Dosage Mode.
SYSTem:ENERgy:DOSage:TIMe {<time>}
Setting of time (in seconds) for time dosage.
SYSTem:ENERgy:DOSage:TIMe?
Request for time for time dosage.
SYSTem:ENERgy:DOSage:ENERgy {<energy>}
Setting of energy (in Ws or VAs) for energy dosage.
SYSTem:ENERgy:DOSage:ENERgy?
Request for energy (in Ws or VAs) for energy dosage.
SYSTem:ENERgy:DOSage:ENERgy:KWH {<energy>}
Setting of energy (in kWh or kVAh) for energy dosage.
SYSTem:ENERgy:DOSage:ENERgy:KWH?
Request for energy (in kWh or kVAh) for energy dosage.

Commands for configuring SU/SI contacts mode:

SYSTem:ENERgy:DOSage:CONTact:VOLTage:MODe {<mode>}
Setting of SU contact mode. Parameter <mode> is 0(contact always OPEN), 1(contact always CLOSED) or 2(contact AUTOmatically controlled by device).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:MODe?
Request for setting of SU contact mode. Reply is 0(contact always OPEN), 1(contact always CLOSED) or 2(contact AUTOmatically controlled by device depending on configuration).
SYSTem:ENERgy:DOSage:CONTact:CURRent:MODe {<mode>}
Setting of SI contact mode. Parameter <mode> is 0(contact always OPEN), 1(contact always CLOSED) or 2(contact AUTOmatically controlled by device).
SYSTem:ENERgy:DOSage:CONTact:CURRent:MODe?
Request for setting of SI contact mode. Reply is 0(contact always OPEN), 1(contact always CLOSED) or 2(contact AUTOmatically controlled by device depending on configuration).

Commands for configuring SU/SI contacts behavior in AUTO mode:

SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STARt:STATe {<state>}
Setting of SU contact state in AUTO mode after start of dosage function. Parameter <state> is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STARt:STATe?
Request for setting of SU contact state in AUTO mode after start of dosage function. Reply is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STARt:STATe {<state>}
Setting of SI contact state in AUTO mode after start of dosage function. Parameter <state> is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STARt:STATe?
Request for setting of SI contact state in AUTO mode after start of dosage function. Reply is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STOP:STATe {<state>}
Setting of SU contact state in AUTO mode before start and after end of dosage function. Parameter <state> is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STOP:STATe?
Request for setting of SU contact state in AUTO mode before start and after end of dosage function. Reply is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STOP:STATe {<state>}
Setting of SI contact state in AUTO mode before start and after end of dosage function. Parameter <state> is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STOP:STATe?
Request for setting of SI contact state in AUTO mode before start and after end of dosage function. Reply is 0(contact OPEN), 1(contact CLOSED) or 2(contact state UNCHANGED).

SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STARt:DELay {<delay>}
Setting of SU contact switch delay in AUTO mode after start of dosage function. Parameter <delay> is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STARt:DELay?
Request for setting of SU contact switch delay in AUTO mode after start of dosage function. Reply is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STARt:DELay {<delay>}
Setting of SI contact switch delay in AUTO mode after start of dosage function. Parameter <delay> is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STARt:DELay?
Request for setting of SI contact switch delay in AUTO mode after start of dosage function. Reply is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STOP:DELay {<delay>}
Setting of SU contact switch delay in AUTO mode before start and after end of dosage function. Parameter <delay> is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:VOLTage:AUTo:STOP:DELay?
Request for setting of SU contact switch delay in AUTO mode before start and after end of dosage function. Reply is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STOP:DELay {<delay>}
Setting of SI contact switch delay in AUTO mode before start and after end of dosage function. Parameter <delay> is delay in seconds (e.g. 0.05).
SYSTem:ENERgy:DOSage:CONTact:CURRent:AUTo:STOP:DELay?
Request for setting of SI contact switch delay in AUTO mode before start and after end of dosage function. Reply is delay in seconds (e.g. 0.05).

Commands for direct control of SU/SI contacts:

SYSTem:ENERgy:DOSage:CONTact {<SI>},{<SU>}
Direct setting of state (0=open / 1=closed) of SI and SU contacts.
SYSTem:ENERgy:DOSage:CONTact?
Request for state (0=open / 1=closed) of SI and SU contacts.
SYSTem:ENERgy:DOSage:CONTact:VOLTage {<SU>}
Direct setting of state (0=open / 1=closed) of SU contact.
SYSTem:ENERgy:DOSage:CONTact:VOLTage?
Request for state (0=open / 1=closed) of SU contact.
SYSTem:ENERgy:DOSage:CONTact:CURRent {<SI>}
Direct setting of state (0=open / 1=closed) of SI contact.
SYSTem:ENERgy:DOSage:CONTact:CURRent?
Request for state (0=open / 1=closed) of SI contact.

Commands for reading status of dosage function:

SYSTem:ENERgy:DOSage?
Request for general status of dosage function. If dosage function is active reply is: percentage, done energy or time and full energy or time.
SYSTem:ENERgy:DOSage:STATus?
Request for status of dosage function. Reply is 0 (dosage not active), 1 (dosage initialized), 2 (dosage started and running) or 3 (dosage stopped).
SYSTem:ENERgy:DOSage:STATus:PERCentage?
Request for done percentage of dosage.
SYSTem:ENERgy:DOSage:STATus:VALue?
Request for done value (time or energy amount) of dosage.
SYSTem:ENERgy:DOSage:STATus:TIMe?
Request for left time of time dosage in seconds.
SYSTem:ENERgy:DOSage:STATus:ENERgy?
Request for left energy of energy dosage in Ws resp. VAs.
SYSTem:ENERgy:DOSage:STATus:ENERgy:KWH?
Request for done energy of energy dosage in kWh resp. kVAh.

5.18.7 Commands for reading measured values

Command for reading of measurement commands:

MEAS:VAL:CONF {<xHI>},{<xLO>}

This command allows to set the mask based on which MEAS:VAL? returns values. This command accepts decimal values and also hexadecimal using 0x prefix. Parameters are: xHI = higher 32bits of the word, xLO = lower 32bits of the word. Default values of configuration word when not set are (xHI, xLO): **0x00000000, 0x08FC3FFF**. Possible values of parameters xHI, xLO: **decimal (0 - 4294967295)** or **hexadecimal with prefix '0x' (0x0 - 0xFFFFFFFF)**.

Bit No.	Hexadecimal weight of bit	Quantity		
		Code	Channel	Name
1	0x0000000000000001	U1	L1	Voltage
2	0x0000000000000002	U2	L2	
3	0x0000000000000004	U3	L3	
4	0x0000000000000008	I1	L1	Current
5	0x0000000000000010	I2	L2	
6	0x0000000000000020	I3	L3	
7	0x0000000000000040	P1	L1	Active Power
8	0x0000000000000080	P2	L2	
9	0x0000000000000100	P3	L3	
10	0x0000000000000200	P123	L123	
11	0x0000000000000400	Q1	L1	Reactive Power
12	0x0000000000000800	Q2	L2	
13	0x0000000000001000	Q3	L3	
14	0x0000000000002000	Q123	L123	
15	0x0000000000004000	S1	L1	Apparent Power
16	0x0000000000008000	S2	L2	
17	0x0000000000010000	S3	L3	
18	0x0000000000020000	S123	L123	
19	0x0000000000040000	phU1	L1	Phase Shift of voltage
20	0x0000000000080000	phU2	L2	
21	0x0000000000100000	phU3	L3	
22	0x0000000000200000	phI1	L1	Phase Shift of current
23	0x0000000000400000	phI2	L2	
24	0x0000000000800000	phI3	L3	
25	0x0000000001000000	PF1	L1	Power Factor
26	0x0000000002000000	PF2	L2	
27	0x0000000004000000	PF3	L3	
28	0x0000000008000000	f	-	Frequency
29	0x0000000010000000	sync-f	-	Synchronization channel of frequency
30	0x0000000020000000	DFU1	L1	Voltage Distortion
31	0x0000000040000000	DFU2	L2	
32	0x0000000080000000	DFU3	L3	
33	0x0000000100000000	DFI1	L1	Current Distortion
34	0x0000000200000000	DFI2	L2	
35	0x0000000400000000	DFI3	L3	
36	0x0000000800000000	Ep1	L1	Active Energy

37	0x0000001000000000	Ep2	L2	
38	0x0000002000000000	Ep3	L3	
39	0x0000004000000000	Ep123	L123	
40	0x0000008000000000	Eq1	L1	**Reactive Energy**
41	0x0000010000000000	Eq2	L2	
42	0x0000020000000000	Eq3	L3	
43	0x0000040000000000	Eq123	L123	
44	0x0000080000000000	Es1	L1	**Active Energy**
45	0x0000100000000000	Es2	L2	
46	0x0000200000000000	Es3	L3	
47	0x0000400000000000	Es123	L123	
48	0x0000800000000000	Upp12	L1-L2	**Voltage between phases**
49	0x0001000000000000	Upp23	L2-L3	
50	0x0002000000000000	Upp31	L3-L1	
51	0x0004000000000000	phUpp1223	L12-L23	**Phase Shift of phase voltage**
52	0x0008000000000000	phUpp2331	L23-L31	
53	0x0010000000000000	phUpp3112	L31-L12	
54	0x0020000000000000	psU	-	**Phase Sequence of voltage**
55	0x0040000000000000	psI	-	**Phase Sequence of current**
56	0x0080000000000000	rU1	L1	**Voltage Range**
57	0x0100000000000000	rU2	L2	
58	0x0200000000000000	rU3	L3	
59	0x0400000000000000	rI1	L1	**Current Range**
60	0x0800000000000000	rI2	L2	
61	0x1000000000000000	rI3	L3	
62	0x2000000000000000	*Reserved / not used*		
63	0x4000000000000000	*Reserved / not used*		
64	0x8000000000000000	*Reserved / not used*		

Appendix

Command Summary

***IDN?**
***RST**

DISPlay?
DISPlay {OFF|ON}
DISPlay **:TEXT?**
:TEXT {<"text">}

:RESolution?
:RESolution {<param>}

:LARGe?
:LARGe {<param>}

:REFResh

MEASure **:VOLTage:FREQuency?**
:VOLTage:AC?
:VOLTage:AC:DISTortion?
:VOLTage:AC:PHASe?
:VOLTage:AC:SUM:SQuare?
:VOLTage:AC:FREQuency?

:CURRent:AC?
:CURRent:AC:DISTortion?
:CURRent:AC:PHASe?
:CURRent:AC:SUM:SQuare?

:POWer:AC[:ACTive]?
:POWer:AC:REACtive?
:POWer:AC:APParent?
:POWer:AC:FACTor?
:POWer:AC:SUM:ACT?
:POWer:AC:SUM:REACtive?
:POWer:AC:SUM:APParent?

:IMPedance:AC:MODule?
:IMPedance:AC:PHASe?
:IMPedance:AC:REAL?
:IMPedance:AC:IMAGinar?

:FREQuency?
:FREQuency:CHANnel?
:FREQuency:MODe?
:FREQuency:MODe {<mode>}
:FREQuency:MODe:VALue?
:FREQuency:MODe:VALue {<mode>}
:FREQuency:MODe:CHANnel?
:FREQuency:MODe:CHANnel {<chnl>}
:FREQuency:MODe:CHANnel:FIX?
:FREQuency:MODe:CHANnel:FIX {<freq>}

MEASure **:ENERgy:K?**
:ENERgy:STARt
:ENERgy:STOP
:ENERgy:RESet
:ENERgy:STATus?
:ENERgy:ACTive?
:ENERgy:ACTive:K?
:ENERgy:REACtive?
:ENERgy:REACtive:K?
:ENERgy:APParent?
:ENERgy:APParent:K?

:VALue?
:VALue:CONFiguration?
:VALue:CONFiguration {<xHI>},{<xLO>}
:VALue:UI?
:VALue:UIP?
:VALue:PUI?
:VALue:PUIP?
:VALue:PQS?

:SIGNal?
:SIGNal:AMPL?
:SIGNal:PHASe?
:SIGNal:SAMPle?

:OPERatingmode?
:OPERatingmode {<mode>}

:HARMonicmeasmode?
:HARMonicmeasmode {<mode=0-2>}
:HARMonicmeasmode:LIMit?
:HARMonicmeasmode:LIMit {<X=2-63>}

:TIMebase?
:TIMebase {<time>}

[SENSe:] **VOLTage:AC:RANGe?**
VOLTage:AC:RANGe {<range>}
VOLTage:AC:RANGe:AUTo?
VOLTage:AC:RANGe:AUTo {OFF|ON}

CURRent:AC:RANGe?
CURRent:AC:RANGe {<range>}
CURRent:AC:RANGe:AUTo?
CURRent:AC:RANGe:AUTo {OFF|ON}

SYSTem **:EXT:RATio?** {<chnl = 1 - 6>}
:EXT:RATio {<chnl = 1 - 6>},{<factor>}

:DIVision:VOLTage?
:DIVision:VOLTage {<factor>}
:DIVision:CURRent?
:DIVision:CURRent {<factor>}

SYSTem **:ENERgy:CHANnel?**
:ENERgy:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
:ENERgy:IMPulse?
:ENERgy:IMPulse {<factor>}
:ENERgy:IMPulse:STATe?
:ENERgy:IMPulse:STATe {0 | 1 | 2 | 3 | 4} | {OFF | ACTIVE | REACTIVE | FIXED | APPARENT}
:ENERgy:IMPulse:FIXed?
:ENERgy:IMPulse:FIXed {<freq>}
:ENERgy:IMPulse:ECONstant?
:ENERgy:IMPulse:ECONstant {<constant>}
:ENERgy:IMPulse:DIVider?
:ENERgy:IMPulse:DIVider {<divider>}
:ENERgy:IMPulse:QRESponse?
:ENERgy:IMPulse:QRESponse {<enable=0|1>}
:ENERgy:IMPulse:QRESponse:TREShold?
:ENERgy:IMPulse:QRESponse:TREShold {<treshold=0-100>}

:ENERgy:OUT0:STATe?
:ENERgy:OUT0:STATe {0 | 1 | 2 | 3 | 4} | {OFF | ACTIVE | REACTIVE | FIXED | APPARENT}
:ENERgy:OUT0:CHANnel?
:ENERgy:OUT0:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
:ENERgy:OUT0:FIXed?
:ENERgy:OUT0:FIXed {<freq>}
:ENERgy:OUT0:FACTor?
:ENERgy:OUT0:FACTor {<factor>}

:ENERgy:OUT1:STATe?
:ENERgy:OUT1:STATe {0 | 1 | 2 | 3 | 4} | {OFF | ACTIVE | REACTIVE | FIXED | APPARENT}
:ENERgy:OUT1:CHANnel?
:ENERgy:OUT1:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
:ENERgy:OUT1:FIXed?
:ENERgy:OUT1:FIXed {<freq>}
:ENERgy:OUT1:FACTor?
:ENERgy:OUT1:FACTor {<factor>}

:ENERgy:OUT2:STATe?
:ENERgy:OUT2:STATe {0 | 1 | 2 | 3 | 4} | {OFF | ACTIVE | REACTIVE | FIXED | APPARENT}
:ENERgy:OUT2:CHANnel?
:ENERgy:OUT2:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
:ENERgy:OUT2:FIXed?
:ENERgy:OUT2:FIXed {<freq>}
:ENERgy:OUT2:FACTor?
:ENERgy:OUT2:FACTor {<factor>}

:ENERgy:OUT3:STATe?
:ENERgy:OUT3:STATe {0 | 1 | 2 | 3 | 4} | {OFF | ACTIVE | REACTIVE | FIXED | APPARENT}
:ENERgy:OUT3:CHANnel?
:ENERgy:OUT3:CHANnel {OFF|ON},{OFF|ON},{OFF|ON}
:ENERgy:OUT3:FIXed?
:ENERgy:OUT3:FIXed {<freq>}
:ENERgy:OUT3:FACTor?
:ENERgy:OUT3:FACTor {<factor>}

SYSTem **:ENERgy:IN:STARt?**
:ENERgy:IN:STARt
:ENERgy:IN:ERRor?
:ENERgy:IN:TIMe?
:ENERgy:IN:TIMe {<intTime>}
:ENERgy:IN:STATe?
:ENERgy:IN:STATe {0|1|2}
:ENERgy:IN:CHANnel?
:ENERgy:IN:CHANnel {0|1|OFF|ON},{0|1|OFF|ON},{0|1|OFF|ON}
:ENERgy:IN:CONStant?
:ENERgy:IN:CONStant {<constant>}

:ENERgy:DOSage:... see chapter Dosage

:ENONly {OFF|ON}
:ENONly?

:HISTory:STATe {0 | 1}
:HISTory:STATe?
:HISTory:INTegrtime {time}
:HISTory:INTegrtime?
:HISTory:RESet
:HISTory:GET? {quantityCode}, {chnl}, {"timeString" }

:TALKonly?
:TALKonly {OFF|COM}
:TALKonly:COM1?
:TALKonly:COM1 {<param>}
:TALKonly:COM1:FORMat?
:TALKonly:COM1:FORMat {0 | 1}
:TALKonly:COM1:QUANtities
:TALKonly:COM1:QUANtities {<qParam>}

:CALib:SELF {SHORT|FULL}
:CALib:AUTo {OFF|ON}
:CALib:AUTo?
:CALib:SAVe {<password>}
:CALib:SAVe:DEFault {<password>}
:CALib:LOAD
:CALib:LOAD:DEFault

:CONFig:SAVe
:CONFig:LOAD
:CONFig:LOAD:DEFault

SYSTem **:OPS:ACTive?**
:OPS:STARt
:OPS:STOP
:OPS:ERRor?
:OPS:STATus?
:OPS:STATus {<status_code>}
:OPS:INPut?
:OPS:INPut {<input_code>}
:OPS:RESolution?
:OPS:RESolution {<resolution_code>}
:OPS:WINDow?
:OPS:WINDow {<window>}
:OPS:DIVider?
:OPS:DIVider {<divider>}
:OPS:MEASure:MAXCount?
:OPS:MEASure:MAXCount {<samples>}
:OPS:MEASure:COUNt?
:OPS:MEASure:RESult:AVG?
:OPS:MEASure:RESult:STD?
:OPS:MEASure:RESult:SAMPle? {<index>}

:KEYBoard
:KEYBoard:BEEP?
:KEYBoard:BEEP {<state>}
:KEYBoard:LOCK?
:KEYBoard:LOCK
:KEYBoard:UNLock
:KEYBoard:LCKatswitchon?
:KEYBoard:LCKatswitchon {<state>}

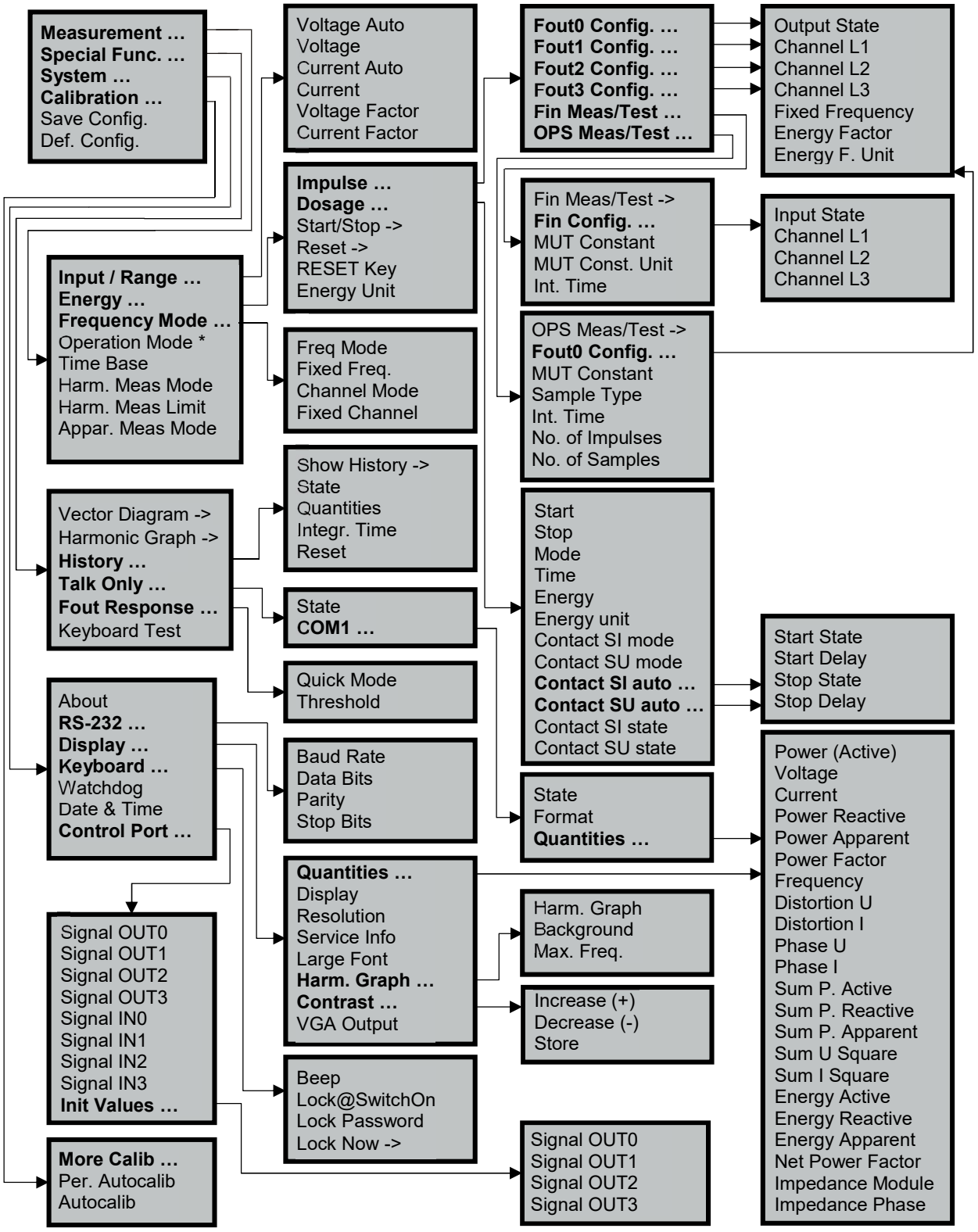
:CONTrol:INPort?
:CONTrol:OUTPort?
:CONTrol:OUTPort {<param>}
:CONTrol:OUTPort:INIT?
:CONTrol:OUTPort:INIT {<param>}

:SETup:COM1?
:SETup:COM1 {<baudRate>} [,{7 | 8} [,{N | O | E} [,{1 | 2}]]]

:TIMe {<time>}
:TIMe?
:TIMe:BEGin?

:STATus?
:ERRor?
:VERSion?
:HWVersion?
:CLASs?
:SERNumb?

Menu



** presence in menu depends on hardware configuration*

DECLARATION OF CONFORMITY

Manufacturer's Name: Applied Precision Ltd.

Manufacturer's Address: Stavitelska 1
831 04 Bratislava
SLOVAKIA

Declares, that the product

Product Name: Reference Standard

Model Number(s): RS 2130A, RS 2130E, RS 2130S
RS 2330A, RS 2330E, RS 2330S
RS 1130A, RS 1130E, RS 1130S
RS 1330A, RS 1330E, RS 1330S

Product Option(s): all options of the above product

Conforms with the following European Directives:

Low Voltage Directive: 2006/95/EC (dated 12.12.2006)

EMC Directive: 2004/108/EC (dated 15.12.2004)

Conforms with the following product standards:

Safety: EN 61010-1 (dated 2001/2002/2003)

EMC: EN 61326 (dated 1997)

Product is safe under conditions of standard application and carries the CE marking

CE

1 December 2009

Date

Ladislav GRNO

Director