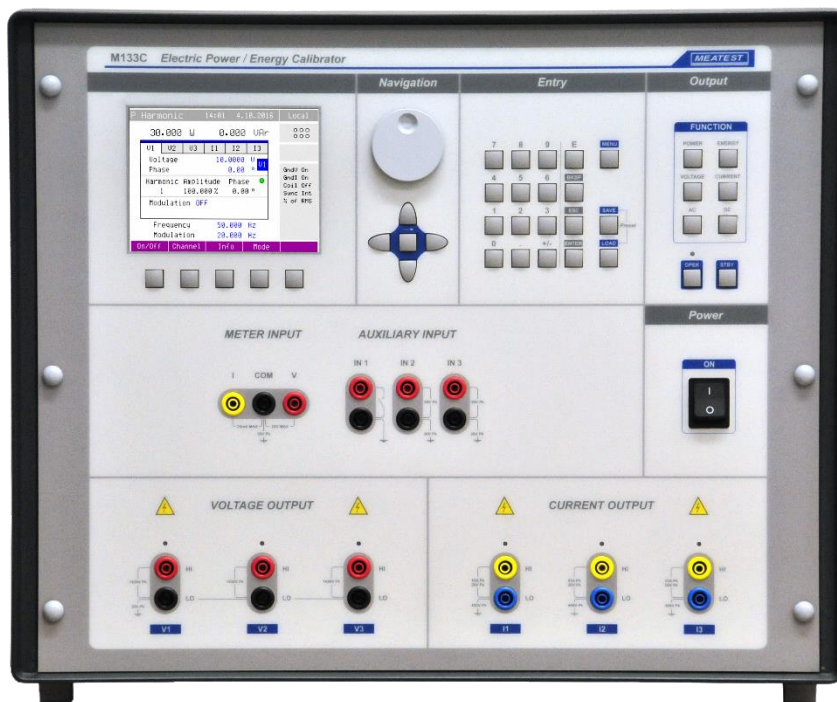


M133C/M133Ci Power & Energy Calibrator

user manual



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1. Introduction

M133C Three (single) phase power calibrator is a multifunction calibrator used primarily as a standard for calibration laboratories. It can be used for calibration of any measuring instrument which measures voltage, current, power, energy, phase and frequency. The calibrator is equipped with a built-in multimeter, which can be used simultaneously with output functions. Transducers of various types, regulators and sensing units can be therefore checked without the need for additional measuring instruments.

M133C model is equipped with special functions for testing power line voltage analyzers. It can generate calibrated harmonic and interharmonic distortion, fluctuation harmonics, flickers, ramp signals and others.

M133Ci model is delivered without the option of harmonic/interharmonic functions.

Basic features of the calibrator include generation of calibrated AC voltage in the range of 1 V to 600 V and DC voltage in the range of 1 V to 280 V, DC and AC current in the range of 5 mA to 30 A. Phase shift for all outputs (3x voltage and 3x current) can be set independent for each output. The best accuracy of the calibrator is 0.025 % for voltage and 0.035 % for current. Internal ranges (voltage 10, 30, 70, 140, 280 V and 600 Vac, current 0.3, 1, 2, 5, 10 and 30 A) are suitable for accurate testing of power transducers. Maximum frequency range is 15 Hz to 1000 Hz.

Internal multimeter with 20 mA, 10 V and 10 kHz (0.02 % accuracy) can be used to measure normalized signals coming from transducers.

The calibrator can easily fit within calibration systems featuring Power software support.

1.1. Front panel overview

The front panel of the calibrator includes a TFT color display, control buttons and output terminals. The following picture shows the control part of the front panel.

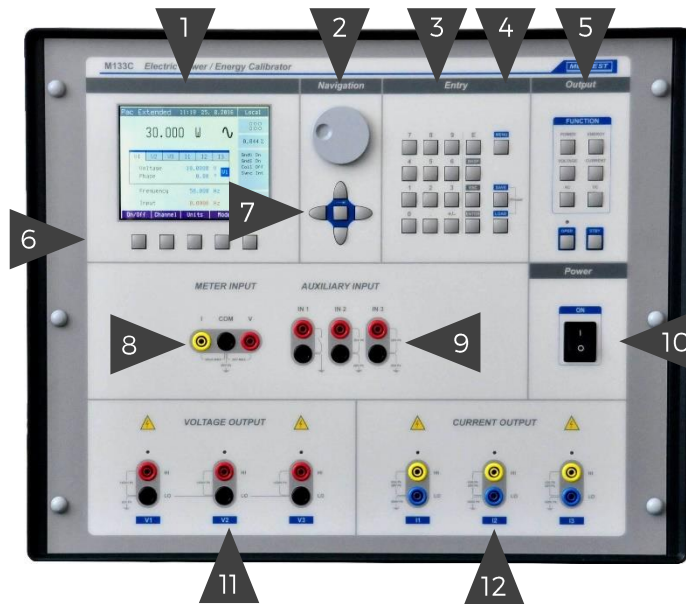


Figure 1 Front panel

1. Display - The display is divided to three horizontal sections:

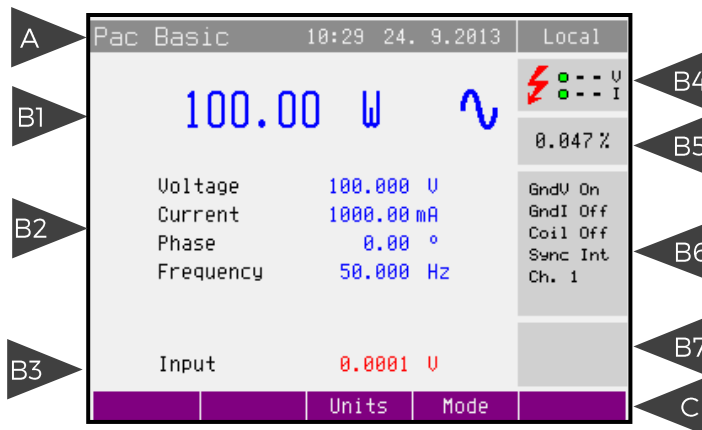


Figure 2 Display

A) Information line:

- Selected function (Pac Basic – Power AC basic mode)
- Date and time
- Remote control state (Local – keyboard, Remote – computer)

B) Main area - This section displays the set-up values of generated signals and the data related to the calibrator status. The section includes the following types of data:

1. Main value - There is displayed main output value with the unit and indication of AC or DC (picture). There is displayed also actual position of cursor ▲▼ if the parameter is in edit mode. Position of cursor can be changed using keys ◀, ▶ and parameter can be changed using keys ▲, ▼ or using the rotary knob. If output voltage exceeds 50V sign of danger voltage is displayed before main value.
2. Auxiliary parameters - This section displays auxiliary parameters of actually selected function:
 - Voltage (functions power and energy)
 - Current (functions power and energy)
 - Phase / Power factor (functions power and energy)
 - Frequency (AC functions)
 - Power (energy)
 - Dose of energy (energy)
3. Measured value - Value measured using internal multimeter with unit. Value „over“ is displayed if measured signal is out of range.
4. Outputs state - Window displays which phase units are connected (one phase to three phase), which terminals are used for signal generation and also informs about output voltage higher than 50V.

Symbols displayed in window:

⚡ - warning, displayed if output voltage is higher or equal 50V.

□ - phase unit (channel) is connected, output is off

■ - phase unit (channel) is connected, output is on

- - phase unit (channel) is not connected

5. Specification
6. In the field specification of set-up output signal is shown. Uncertainty is related to the main parameter. Label BUSY instead of uncertainty is displayed, if calibrator is not within specified parameters or if internal reconnection is in process. This can occur during changing the functions, changing set parameters, switching output terminals ON and OFF. Specification is not available in power functions „P Harmonic“ and „P Interharmonic“.
7. Information section

The information section located in the right part of the display and displays additional information related to the selected function:

- information about the grounding method of output terminals: GndU, GndI as set up using the menu „Calibrator“.
- information about voltage terminal configuration (2-wire / 4-wire) as set up using the menu „Calibrator“.
- information about the use of 25-turn coil or 50-turn coil (COIL x50) as set up using the menu „Calibrator“.
- information about number of controlled output channels (only functions „Power Pac“ and „Energy Eac“).

8. Meter's information section

C) Display softkeys - The functions of these keys change during operation (depends on actual display mode).

2. Rotary knob - The rotary knob integrates several functions. By turning the knob to the left or right, the user can:
 - step through the options
 - enter numeric values

The function of the rotary knob can usually be performed by the cursor buttons. The central button is used to confirm the selection (Select) or change the function of the rotary knob (value change or position change).

3. Numeric keyboard - The keyboard allows the entry of numeric values on the display. ENTER button is used to confirm the selection. CANCEL button can be used to cancel the entry.
4. Direct keyboard - MENU button is used to open the Main menu of the instrument (parameters setting). SAVE (RECALL) buttons can be used to save (recall) the actual setting of the instrument

(all values including parameters). Capacity of the memory is up to 100 different settings. Each setting contains simple text description.

5. **Function buttons** - Function buttons can be used to call-up the functions of the calibrator directly. The following buttons are provided:

Function	Key
Power	P
Energy	E
Voltage	U
Current	I
AC	AC
DC	DC
Output ON (Operate)	ON
Output OFF (Standby)	OFF

After the function mode is changed, the parameters of the respective function are restored. If the respective function was never used, the calibrator resets to its reference values.

6. **Display buttons** - There are five buttons below the display, whose meaning changes depending on the contents of the display. These buttons usually call-up the “local Menu” (units, modes, etc.).
7. **Cursor buttons** - The keyboard includes two buttons (◀, ▶) which allow the cursor to be set to the required position at the display. These buttons are usually used to step through the options and to move from one option to another or between the menu levels. Numeric values can be set in some control modes as well. In these cases, the buttons marked (▲, ▼) allow the user to increase or decrease the number at the cursor button.
The central button is used to select value you want to change (TAB).
8. **Meter input** - Input terminals for internal multimeter. The COM terminal is common for all measuring. The V terminal is for DC voltage (10V) and frequency (10kHz) measuring. The mA terminal is for DC current (20mA) measuring.
9. **Auxiliary input** - Auxiliary input terminals for energy counting and for AC output signal synchronization.
10. **Power switch** - Turns instrument AC power ON and OFF.
11. **Voltage output** - Voltage outputs HI and LO terminals (three phases L1, L2 and L3).
12. **Current output** - Current outputs HI and LO terminals (three phases L1, L2 and L3).

Colors on display

Common rules are used for applied color of labels and values.

1. Red color is applied, when displayed value is measured by the calibrator.
2. Blue color is applied for parameters or values, which can be set-up or modified directly from front panel keyboard or via Main menu.
3. Black color is used for fix values, labels, notes, parameters which cannot be modified and for other fix text with general information purpose.
4. Meaning of display buttons is always shown the lowest line. If there is no description above display button, the button is not active in selected function.

1.2. Rear panel overview

Rear panel includes ventilation holes, power cord socket, power line fuse, power line voltage selector 115/230V, fuse for internal multimeter, interface connectors GPIB, RS232 and RJ45, BNC outputs connectors and metal central ground terminal.

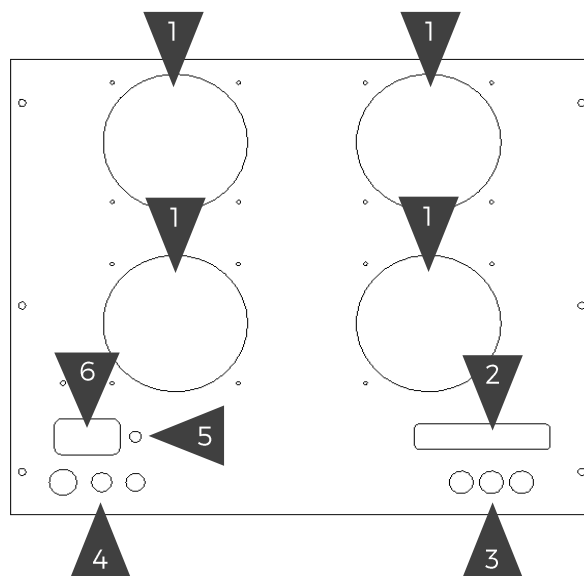


Figure 3 Rear panel

1. Forced ventilation holes
2. GPIB, RS-232 and RJ45 connectors
3. From right to left:
 - 1) Energy pulse output - reference output (see Energy pulse output in Chapter 4.2)
 - 2) Sample reference output - manufacturing and service only
 - 3) Phase reference output - internal reference signal for 0 ° phase (all output channels are synchronized with this signal)
4. From right to left:
 - 1) power line switch
 - 2) fuse for internal multimeter (T100mA / 250V)
 - 3) power line fuse
5. Central ground terminal
6. Power line entry

1.3. Options and accessories

Basic accessories (included in delivery)

- Power line cord 1 pc
- User's manual 1 pc
- Test report 1 pc
- Spare fuse 1 pc
- Test cable banana-banana 1000V - 32 A, black 3 (1) pcs
- Test cable banana-banana 1000V - 32 A, red 3 (1) pcs
- Test cable banana-banana 1000V - 32 A, blue 3 (1) pcs
- Test cable banana-banana 1000V - 32 A, yellow 3 (1) pcs
- 133-01 High Current Adapter 1 (0) pc
- RS232 cable 1 pc

(Test cable 1000V/32A – 12 pcs with Three phase version and 4 pcs Single phase version)

Values in brackets are for single phase version. Delivered with EU plug, other plug types available upon request.

Following accessory is not part of standard delivery and can be extra ordered:

- 140-50 Current coil 25 and 50 turns up to 1000A
- 151-25 Current coil 25 turns up to 2250A
- Option 10 Test lead 32A/1000V (black)
- Option 11 Test lead 32A/1000V (red)
- Option 12 Test lead 32A/1000V (blue)
- Option 13 Test lead 32A/1000V (yellow)
- IEEE488/IEEE488 GPIB cable, 2m
- Caliber Universal application SW for automated calibration.

Version	Description
M133C 3phase	Three phase, extended version with power quality
M133Ci 3phase	Three phase, sine wave base version
M133C 1phase	Single phase, extended version with power quality
M133Ci 1phase	Single phase, sine wave base version

Table 1 M133C versions



Figure 4 133-01 High Current Adapter

Standard part of delivery the three-phase power calibrator is the option 133-01. Using this adapter all current outputs are connected in parallel and the configuration can deliver up to 90 A in single phase mode.

Calibrator is available in Three or Single phase version. Both versions look the same. The only difference is that the Single phase version doesn't contain channels 2 and 3. Single phase version can be upgraded to Three phase version by the manufacturer.

1.4. Remote control

The calibrator can be integrated into automated calibration systems (ATS) and generally controlled from remote computer via following remote control interfaces:

- RS232
- GPIB (IEEE488)
- LAN

When controlled remotely, maximum ratings of calibrator's output signals as well as all other specifications are the same as in manual mode.

Meatest software package WinQbase + Caliber is recommended for best automation results. This system is designed for automated and semi-automated calibrations of digital and analogue meters including uncertainty calculation, result evaluation and certificate printing according to ISO 17025 standard.

1.4.1. Connection setup

Only one interface can be used for communication at any given time. Default active interface is RS232, other interfaces can be selected in MENU->Interface->Active interface. To establish connection between the calibrator and computer, set interface settings in your computer accordingly:

RS232 and USB connection settings

- COM port see available COM ports in Windows Device Manager
- Baudrate RS232 according to MENU->Interface->RS232 Baudrate (9600 by default)
- Data bits 8
- Stop bits 1
- Parity None
- Handshake (XON/XOFF) Off

GPIB connection settings

- GPIB Address according to MENU->Interface->GPIB Address (2 by default)

LAN connection settings

It is necessary to download special driver that creates virtual COM port. Application software uses this virtual COM port for communication via Ethernet.

Description: https://www.hw-group.com/products/hw_vsp/index_en.html

Driver download: https://www.hw-group.com/files/download/sw/version/hw-vsp3s_3-1-2.exe

1.4.2. SCPI commands and protocol

See M133C SCPI manual for complete SCPI reference, more details on communication setup and troubleshooting.

2. Getting started

Inspect package contents when unboxing the calibrator for the first time. See chapter 1.3 for complete list of accessories.

2.1. Safety precautions

The instrument has been designed in Safety Class I according to EN 61010-1. The design reflects the requirements of A2 amendment standard. Safety is ensured by the design and by the use of specific components. The manufacturer is not liable for the damage caused by modification of the construction or replacement of parts with non-original ones.

Safety symbols used on the equipment:



Warning, risk of danger.



Warning - risk of electric shock. Hazardous voltage above 50 V DC or AC might be present.



Protective earth.

To prevent possible electrical shock or personal injury:

- Read carefully safety information before you use the Product.
- Do not alter the Product and use only as specified, or the protection supplied by the Product can be compromised.
- Do not use the Product if it is altered or damaged.
- Use this Product indoors only.
- Use power cord approved for local mains voltage and plug configuration and rated for the Product.
- Keep hands away from all Product terminals and exposed metal cable parts during operation. High voltage on those may be cause death or serious injury.
- Do not connect the calibrator to other voltage than set by the voltage selector.
- Do not block the vent openings located at the rear panel, bottom panel and prevent dust and moisture contamination.
- Whenever possible ground Lo output terminals (GndU On, GndI On).
- Do not overload the power stages by leaving the calibrator switched on with the load connected for a long time, especially on 30 A current range and 140 V and 280 V voltage ranges.

2.2. Power on and warm-up

The calibrator should be powered by 230/115 V – 50/60 Hz mains. It is a laboratory instrument whose parameters are guaranteed at 23 ± 2 °C. Before powering on the instruments, place it on a level surface. Do not cover the vents at the bottom side and the fan opening at the rear panel.

Before connecting the calibrator to the mains, check the position of the mains voltage selector located at the rear panel.

Plug one end of the power cord into the connector located at the rear panel and connect the other end of the power cord into a wall outlet. Turn the calibrator on with mains switch. You should see following splash screen:

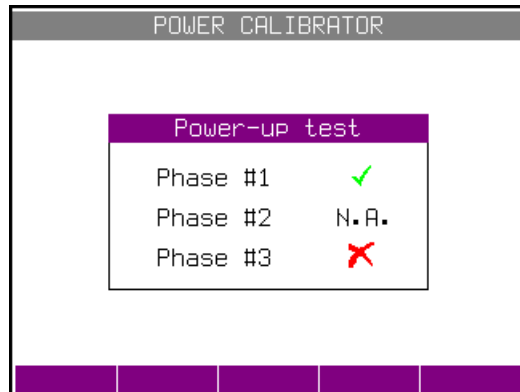


Figure 5 Starting screen

The calibrator performs internal hardware checks for 5 seconds. Configuration of the instrument is displayed in the end of this test (connected phase channels).

- ✓ - phase unit is connected and ready
- N.A. - phase unit is not connected
- ✗ - phase is connected, but failed

After the tests conclude, the calibrator resets to its reference state, i.e. the following parameters are set: GPIB address of the calibrator is factory-preset to 2. This value is valid until the user changes it.

Warm-up

The calibrator works after it is switched on and the initial checks complete. Specified parameters are only guaranteed after the instrument warms up. During this period, the instrument cannot be calibrated. The display shows “cannot access the calibration” message if calibration is attempted during this period.

2.3. Function setup

Calibrator output (source) function can be set using FUNCTION buttons. Push any FUNCTION button to change function. Push AC or DC button for required function mode.

Once a function is selected, you can change the main value as well as auxiliary output parameters like frequency in AC modes or phase shift in AC power function. Pressing Mode button will open submenu where various modes of the selected function can be chosen.

Function parameters can be edited in three ways:

- Numeric keypad. Write a value directly and confirm either by softkey with appropriate unit or ENTER button to set value in base unit (for example V).

Cursor keys and rotary button. Push ▲▼ buttons or turn rotary knob to increment/decrement selected digit by one. Move through parameter digits using ◀▶ buttons or push the rotary knob to switch to digit selection mode, rotate to a new digit and confirm with another push.

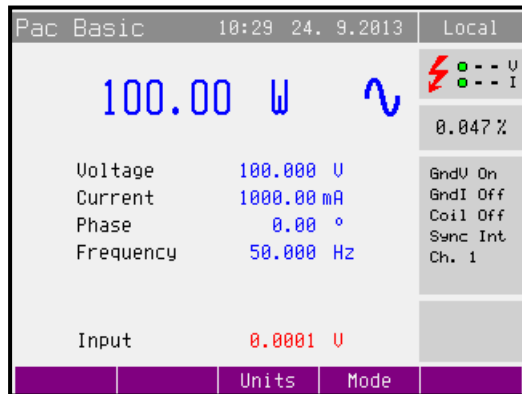


Figure 6 Main and auxiliary parameters

Described methods change the main parameter by default. If there are any other parameters on display, you can switch between them using → button. Picture above shows Power Basic function with main value 100 W and four auxiliary parameters: voltage, current, phase and frequency.

2.4. Signal output

Calibrator output can be turned on by pushing OPER button. STBY button turns output off. Output turns off automatically on calibrator startup and function switch. Output state is indicated by LED light above the OPER button as well as green circle on the right side of the display. Diagram below Source label shows which terminals are currently being used.

2.5. Connection / disconnection of output terminals

After switching the AC power supply on the output terminals are disconnected in all modes.

Press the “OPER” button to connect the output signal to the terminals. Green LED above the “OPER” button is lit.

Press the “STBY” button to disconnect the output terminals. Green LED goes off.

Output terminals are disconnected automatically under following conditions:

- Function mode change
- Output voltage exceeds 100V. It occurs if you change the output value that is below 100V to the new value above 100V.
- Calibrator is overloaded.
- Changing parameters of power distortion functions.
- Changing frequency for voltage above 280V
- Energy counting is finished.
- Output voltage exceeds 280V while current outputs are floating. It occurs if you change the output value that is below 280V to the new value above 280V and current outputs are not grounded (GndI Off). Calibrator disconnects output terminals, grounds the current terminals and displays following message:

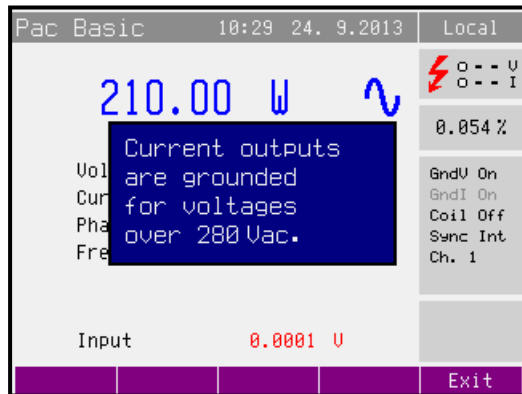


Figure 7 Floating current output protection

- Grounding state of current outputs will be recovered according to the Setup Menu automatically as soon as the voltage will drop below 280V.

Control sequence when output voltage over 100 V is selected

When output voltage over 100 V is selected, the information section of the display shows the symbol which informs that a life-threatening voltage will be present at the output terminals. If the output terminals are currently connected, they will be disconnected when output voltage over 100 V is selected. OPER button must be pressed to reconnect the output signal to the output terminals. After the OPER button is pressed green LED is lit and the information section of the display shows the symbol notifying the user about the connection of the dangerous output signal to the output terminals.

Voltage, and frequency can be set without the outputs being disconnected. The output terminals are automatically disconnected when changing between AC and DC ranges or when changing the function mode.

2.6. What to do in case of failure

If an obvious failure occurs during the operation (e.g. the display is not lit, the fan is not turning), the calibrator must be switched off immediately. First, check the fuse located in the power cord receptacle. Procedure is following:

- Remove the end of power cord from the mains connector at the rear panel.
- Insert the blade of a flat screwdriver into the opening cut in the mains voltage selector and pry out the fuse holder.
- Remove the fuse. Replace it with new fuse of the same rating if the fuse was broken.
- Replace the fuse holder, reconnect the power cord and switch on the calibrator. If the problem persists, contact the manufacturer.

If an obvious fault is evidenced, e.g. a measurement range or an operating mode is not functional, the user cannot correct the fault. Contact the manufacturer.

Hidden faults can cause different symptoms and be caused by different causes. Usually, they cause instability of some parameter. Hidden defects can be caused by unacceptable distortion, degraded insulation etc. In this case contact the manufacturer.

Sometimes it seems that the calibrator has hidden defect, when the rules for correct operation are not adhered to. In this case, the fault is caused by the operator. Most frequent cases of false “hidden defects”:

- mains voltage out of tolerance limits or unstable
- wrong grounding of the measurement circuit (bad connection of the ground terminal of the mains outlet, or several ground connections when grounding loops are formed)
- proximity to sources of intensive influence, whose products are spread through the mains or propagated by the electromagnetic field
- strong electrostatic or electromagnetic field which can cause major instability during calibration using higher impedance.

3. Menu reference

The calibrator allows many other, less frequently used parameters to be set. Setup menu is used to set these parameters. Setup menu is opened by pressing MENU button. If output terminals are connected, they will be disconnected and the following display appears:

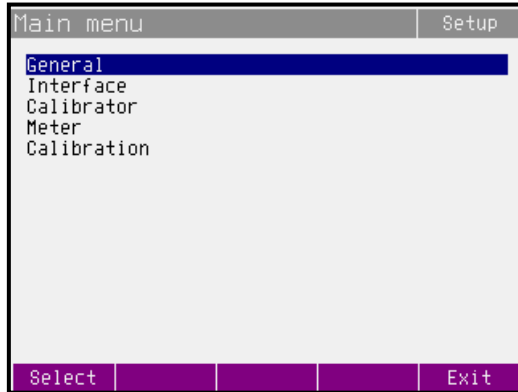


Figure 8 Main menu

Use \wedge or \vee cursor button or the rotary knob to browse the menu options. Press „Select“ softkey or press in on the rotary knob to select highlighted item. Press „Exit“ softkey to leave the selected menu level.

New settings are retained when the calibrator is switched off.

The Main menu contains items:

1. General – general instruments settings (display, keyboard, time, date)
2. Interface – parameters of instruments remote control
3. Calibrator – parameters of signal generation
4. Meter – parameters of multimeter
5. Calibration – instruments calibration data

3.1. General menu

Submenu contains basic parameters of display and keyboard.

- | | |
|------------------------|---|
| - Language | Language version of user interface |
| - Volume | [0 – 100 %] |
| - Brightness | [0 – 100 %] |
| - Beeper | [On/Off] |
| - Calibration password | Sets new calibration password |
| - Time | System time in HH:MM:SS format |
| - Date | System date in selected format [DD.MM.YYYY] |
| - Device Information | Shows serial number, HW & SW versions, etc. |

3.2. Interface menu

Submenu contains remote control parameters.

Menu item	Range / format	Default value
Active bus	RS232/IEEE488/Ethernet	RS232
RS232 Baudrate	1200 - 115200	9600
IEEE488Address	0 - 30	2
Ethernet Settings		
> IP Address	IPv4	192.168.001.100
> Local network mask	IPv4	255.255.255.000
> Local network gateway	IPv4	255.255.255.255

3.3. Calibrator menu

Submenu contains parameters that affect generated signal.

Voltage Sources GND	This parameter allows to connect Lo terminals of all voltage channels to GND. In practice this means that Lo voltage terminals are grounded. By selecting an item from the list GndU Off and GndU On type can be selected.	
Current Sources GND	<p>This parameter allows to connect Lo terminals of all current channels to GND. In practice this means that Lo current terminals are grounded. By selecting an item from the list GndI Off and GndI On type can be selected.</p> <p>It is recommended to ground all output channels (GndU On, GndI On). If the meter to be calibrated has Lo terminal grounded, it is recommended to unground the corresponding calibrator's output to exclude ground loops.</p> <p>Note: If neither the calibrator's output, nor the meter's inputs are grounded, signal/noise ratio can arise at the calibrator's output.</p>	
Phase unit	Sets the unit used for presentation the phase shift between the voltage and current output in the power and energy generation modes. By selecting an item from the list Deg (°) and Cos (Lead, Lag) unit can be selected.	
Phase rotation	Phase rotation setting. By selecting an item from the list POS (standard phase) and NEG (reversed phase) rotation can be selected.	
280V range lock (Feature is active fo single harmonic modes only)	OFF position (default state)	140V range is used for values between 70.001V and 140.000V 280V range is used for values between 140.001V and 280.000V
	ON position	280V range is used for values between 70.001V and 280.000V
Current Coil	Sets the calibrator for connection the 25/50-turn current coil (clamp ammeters calibration). The coil multiplies the output current either 25 times or 50 times depending on set parameter. By selecting an item from the list Coil Off, Coil x25 and Coil x50 type of connected current coil can be selected.	
Synchronization (Sets the external synchronization of the output signal)	External synchronized signal has larger distortion than internal synchronized signal because of fine frequency tuning.	
	Internal	Internal synchronization
	Power line	Synchronization to the power supply
	External IN1	Synchronization to the passive signal on input 1 - output collector or relay contact
	External IN2	Synchronization to the active signal on input 2
External IN3	Synchronization to the active signal on input 3	

Active channels (Pac, Eac)	Sets the number of controlled channels in the three phase configuration. This parameter is valid only for Pac Basic and Eac Basic function modes. By selecting an item from the list 1 (output is from the main channel only), 1-2 (output from Channel 1 and Channel 2) and 1-2-3 (output from all three channels) number of used channels can be selected.		
Harmonic components	% of RMS value	RMS value is constant (isn't changed by changing harmonic components value). New RMS value changes amplitude of all harmonic components.	
	% of fundamental	Fundamental value is constant (isn't changed by changing harmonic components value). RMS value is changed by entering new harmonic components value.	
Energy	Energy units	Sets the unit used for energy. By selecting an item from the list Ws and Wh unit can be selected.	
	Energy - output	Internal pull-up - This parameter allows to connect the internal pull-up resistor (150 Ω) to the Energy pulse output.	
		Output constant	Value - sets number of pulses per selected unit (pulses generated on Energy pulse output on the rear panel BNC).
			Unit - sets unit of Output constant value (pulses generated on Energy pulse output on the rear panel BNC).
	Energy - input IN1	Internal pull-up - allows to connect the internal pull-up resistor (150 Ω or 1 k Ω) to the Energy pulse input.	
Input filter - allows to add input filter for contact debouncing. Input frequency with the input filter is limited to 400 Hz			
Maintain Voltage Signal	This parameter allows to maintain the voltage signal on test completion in energy counting modes (Packet / Counter / Timer).		
Dip Swell	Dip-Swell repetition	Sets the repetition of Dip/Swell shape in P Dip/Swell mode. By selecting an item from the list One Shot (without repetition) and Repeat can be repetition selected. If Repeat is selected, Dip/Swell shape is generated after trigger repeatedly until disconnecting output terminals.	
	Dip-Swell synchronization	Sets the synchronization of Dip/Swell shape with internal phase 0°. By selecting an item from the list Sync Off and Sync On can be synchronization selected. If Sync Off is selected, Dip/Swell generation starts immediately after trigger. If Sync On is selected, Dip/Swell is synchronized with the internal phase 0° (channels with phase shift 0°).	
	Dip-Swell ext. trigger	Enables external triggering in P Dip/Swell mode. By selecting an item from the list Input Off and Input IN3 can be external trigger selected. If Input Off is selected, Dip/Swell generation can be started only internal (keyboard or remote control). If Input IN3 is selected, Dip/Swell generation can be started internal or by falling edge applied to the input IN3. The input must remain low for 10 μ s after the falling edge to be recognized properly.	

3.4. Meter menu

Submenu contains parameters that affect measured signal.

Sets the internal multimeter measuring function and range. By selecting an item from the list Voltage (DC voltage 0-12V), Current (DC current 0-24mA) and Frequency (Frequency 1Hz-15kHz) function can be selected.

3.5. Calibration menu

Calibration password is required to access the Calibration Menu. Default calibration password is „0”. For more detail about calibration see the chapter 6.

3.6. Preset menu

Preset menu is not part of the main menu. It has own buttons.

Preset feature allows you to save and recall one of up to 100 calibrator configurations so that you can get to work quickly instead of setting up the calibrator every single time. Push Preset Save button and choose one location 0-99 to save current setting.

To recall a predefined configuration, push Load Preset key and pick one of saved preset and configuration will be loaded.

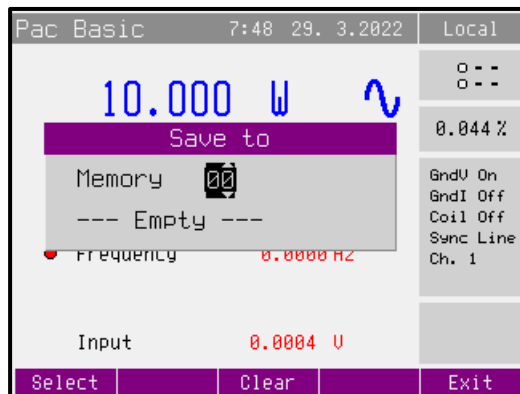


Figure 9 Preset menu

4. Control of the calibrator

4.1. AC/DC power

The calibrator can generate exact value of electric power and energy. Power function modes provides output voltage at VOLTAGE OUTPUT HI – LO terminals and output current at CURRENT OUTPUT HI – LO terminals. Depending on the setting of the calibrator, voltage up to 600 Vef can be present at the terminals.

Power setting range:	0.005 VA to 18 kVA (each channel)
Voltage setting range:	1 to 600 Vac, 1 to 280 Vdc
Current setting range:	5 mA to 30 A
Power factor setting range:	-1 to +1 (phase 0 to +359.99 °)
Frequency setting range:	DC, 15 Hz to 1 kHz

Control in the power mode

Press “P” button on the calibrator and then select AC or DC mode by pressing „AC“ or „DC” button. The display shows the following data:

- main value of set power in selected unit of measurement VA, W, VAR
- voltage at VOLTAGE OUTPUT HI-LO terminals
- current through CURRENT OUTPUT HI-LO terminals
- power factor or the phase shift between the voltage and current in °.
- frequency, if AC power is selected
- uncertainty of set power

Set desired value of power using numeric keyboard, potentiometer or cursor buttons. Output power is not yet connected to the output terminals.

Connect the instrument to be calibrated to VOLTAGE OUTPUT HI-LO and CURRENT OUTPUT HI-LO terminals or short the CURRENT OUTPUT HI-LO terminals.

Press OPER button.

Green LED is lit above the “OPER” button to indicate the connection of simulated electrical power to the output terminals. Connected terminals are also displayed in the „Outputs state“ window as green circles.

Desired power is connected to output terminals.

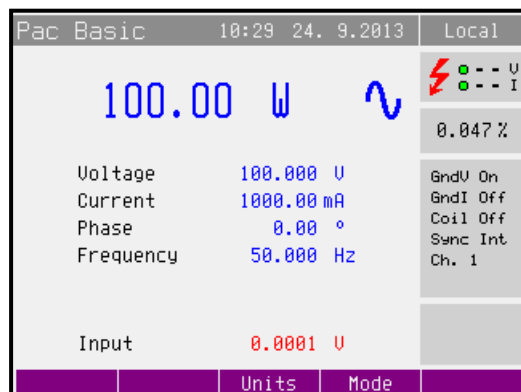


Figure 10 Basic mode

Power factor polarity (Lead/Lag softkey)

In case that phase shift between voltage and current is expressed as power factor you can change its polarity using „Lead/Lag“ softkey. The Lead polarity presents capacity load (current before voltage). The Lag polarity presents inductance load (voltage before current).

Power units (Units softkey)

The calibrator can display AC power in one of three ways:

1. apparent power in VA
2. active power in W
3. reactive power in VAR

Use “Units” softkey to open the units selection menu. Select the required expression using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey. The value of displayed power is recalculated together with new units selection. DC power can be expressed only in W.

The calibrator can display the phase relation of output voltage and current as power factor (–1 to +1) or as phase shift in degrees (0 to 359.99 °). Main menu is used to change the method of displaying the phase relation.

Power modes (Mode softkey)

Output power can be generated in different power modes:

AC power

Mode	Name	Description
Basic	Pac Basic	AC power basic mode. Phase shift between channels output voltages are fixed (120° and 240°). All parameters are the same for all channels. Number of active channels can be defined in Main menu (1, 2 or 3).
High I	Pac High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.
Extended	Pac Extended	Parameters for all calibrators outputs (3x voltage, 3x current) can be set quite independently in this mode. For each output you can define amplitude (V or A) and phase shift (°). Phase shift is relative to the internal reference.
Harmonic (version M133C only)	P Harmonic	Mode is used for generation harmonic signal composed of up to 50 harmonic components. All components can be defined independently for all outputs (3x voltage, 3x current). Beside this mode allows modulation by sine or square signal.
Interharmonic (version M133C only)	P Iharmonic	Mode is used for generation interharmonic signal. One interharmonic component can be add independently for all outputs (3x voltage, 3x current).
Dip/Swell (version M133C only)	P Dip/Swell	Mode is used for generation dips or swells on the output signal. All parameters can be defined independently for all outputs (3x voltage, 3x current).

DC power

Mode	Name	Description
Basic	Pdc Basic	DC power basic mode. Only first channel 1 is controlled in this mode.
High I	Pdc High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.
Extended	Pdc Extended	Parameters for all calibrators outputs (3x voltage, 3x current) can be set quite independently in this mode. For each output you can define amplitude (V or A).

Use „Mode“ softkey to open the mode selection menu. Select the required mode using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey. Output terminals are disconnected if the new mode is selected.

4.1.1. Setting the power in modes Pdc Basic and Pac Basic

The calibrator allows several ways of setting the value of generated power.

Setting the main power value

The main value can be changed using numeric keyboard, changing the digit at the cursor position after selecting the cursor position with ◀, ▶ buttons or using the rotary knob.

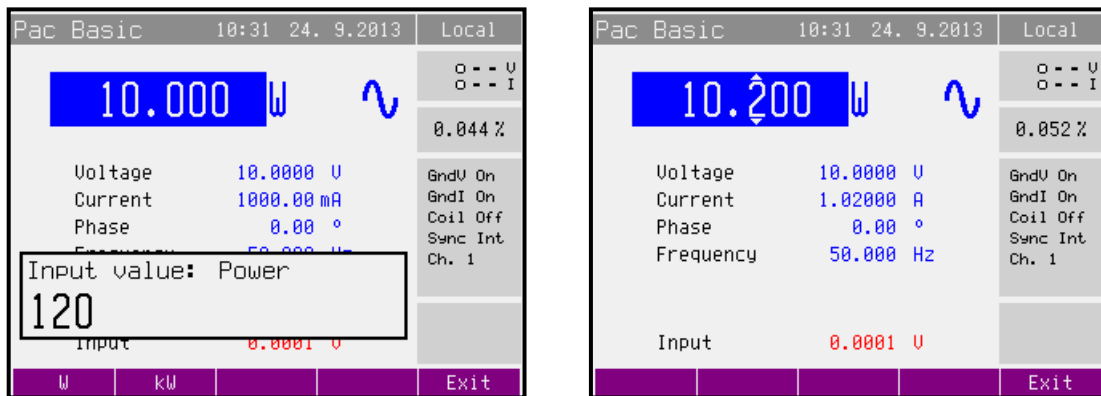


Figure 11 Basic mode – main parameter setup

Output power is changed by changing the value of output current.

Setting the voltage

The main power value can be changed by changing the voltage.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V softkey. The value can be set using cursor buttons or rotary knob as well.

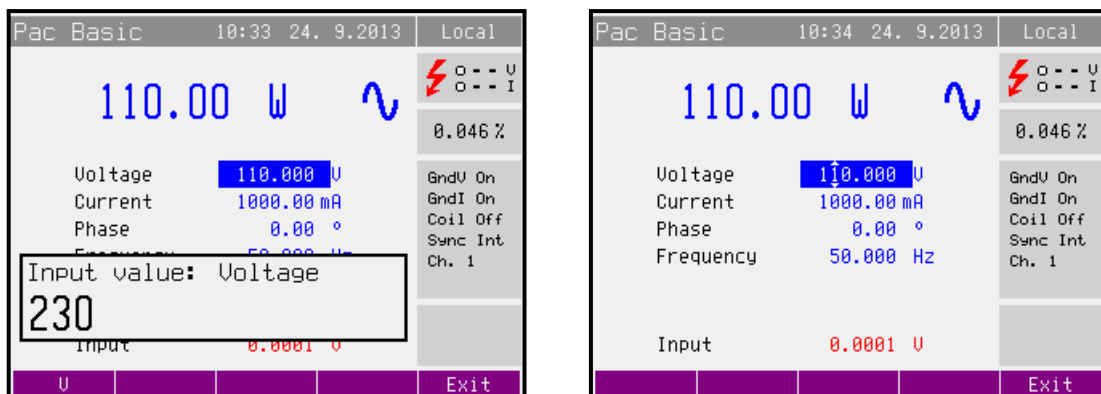


Figure 12 Basic mode – voltage setup

Main power value is recalculated using new set voltage and existing setting of current and power factor.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

Setting the current

The main power value can be changed by changing the current.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the current value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing mA or A softkey. The value can be set using cursor buttons or rotary knob as well.

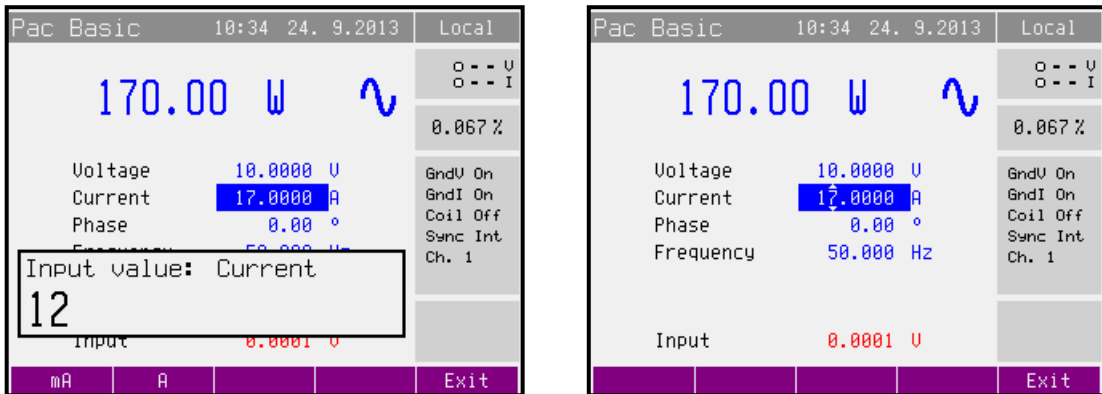


Figure 13 Basic mode – current setup

Main power value is recalculated using new set current and existing setting of voltage and power factor.

Setting the power factor (AC power only)

If W or Var is indicated, the main power value can be changed by changing the power factor. Change of power factor does not change the output apparent power.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the power factor (phase) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Lead or Lag softkey. The value can be set using cursor buttons or rotary knob as well.

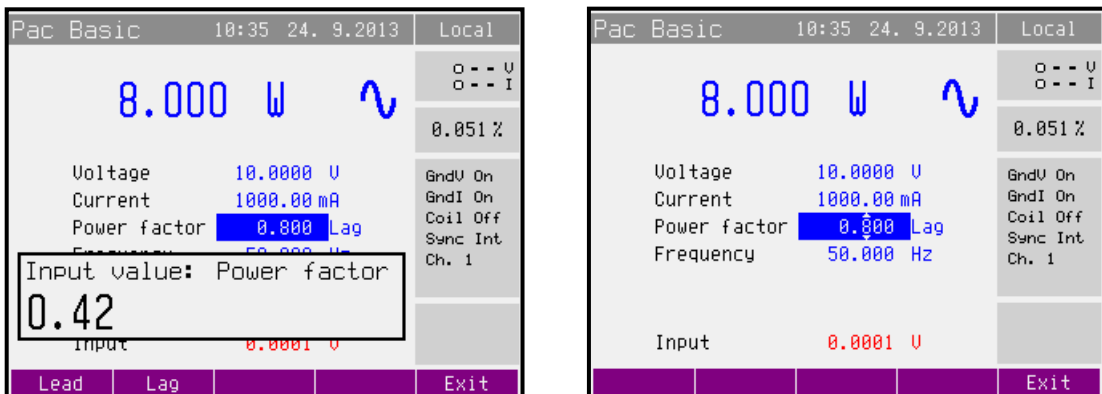


Figure 14 Basic mode – power factor setup

Main power value is recalculated using new set power factor and existing setting of current and voltage. The calculation is only made if active or reactive power is displayed.

4.1.2. Setting the power in modes Pdc High I and Pac High I (Three phase version only)

In this mode current outputs of all channels are connected in parallel using optional adapter. Current range is increased three times.

Voltage terminal Channel 1 are used in high current modes.

Power setting is the same as in modes Pdc Basic a Pac Basic.

4.1.3. Setting the power in modes Pdc Extended and Pac Extended

Modes allow independent parameter setting for all calibrators outputs (3x voltage, 3x current) For each output you can define amplitude (V or A) and phase shift (°). Phase shift is relative to the internal reference.

The main power value displays summed power calculated as sum of power of all connected channels. It is not possible to change this value directly. Color of this value is black.

Each calibrators output (U1, U2, U3, I1, I2, I3) is displayed as a folder. The folder U1 is active after selecting the Extended mode. Next folders are activated by repeatedly pressing „Channel“ softkey.

Pressing „On/Off“ softkey disables (enables) the active output. Only enabled outputs will be connected after pressing the „OPER“ button. Enabled outputs are highlighted by blue rectangle above the output name. After the AC power on all outputs of connected phase units (channels) are enabled.

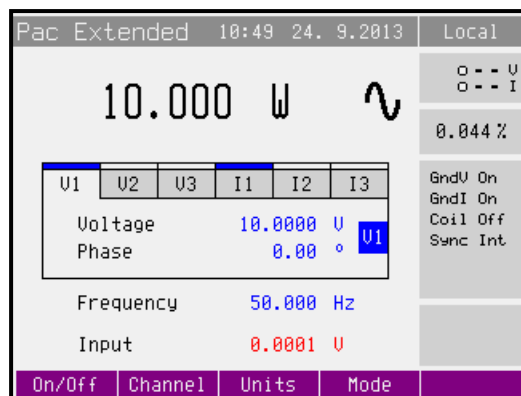


Figure 15 Extended mode

Picture displays state after AC power on. Both outputs of main phase unit are enabled, active is output U1.

Setting the amplitude of voltage (current)

The main power value can be changed by changing the amplitude of voltage (current).

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage (current) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

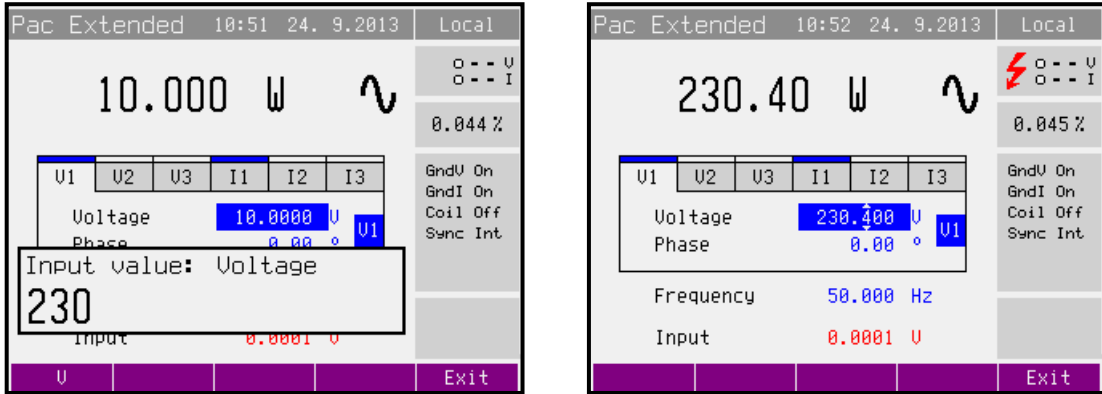


Figure 16 Extended mode - voltage setup

Main power value is recalculated using new amplitude.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

Setting the phase (AC power only)

If W or Var is indicated, the main power value can be changed by changing the power factor. Change of power factor does not change the output apparent power.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the phase value appears in edit mode (blue background).

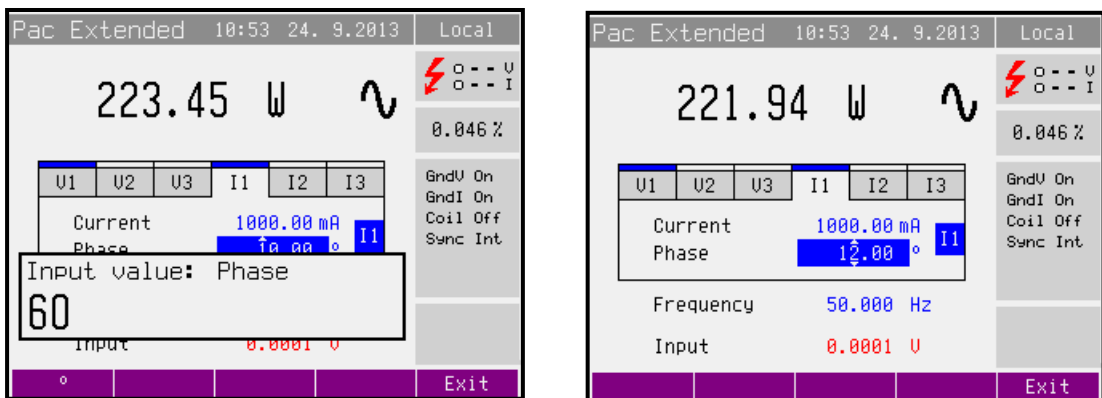


Figure 17 Extended mode - phase setup

The value can be set using numeric keyboard and confirmed by pressing ° softkey. The value can be set using cursor buttons or rotary knob as well.

Main power value is recalculated using new set phase and existing setting of current and voltage. The calculation is only made if active or reactive power is displayed.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting the frequency (AC power only)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the frequency value appears in edit mode (blue background).

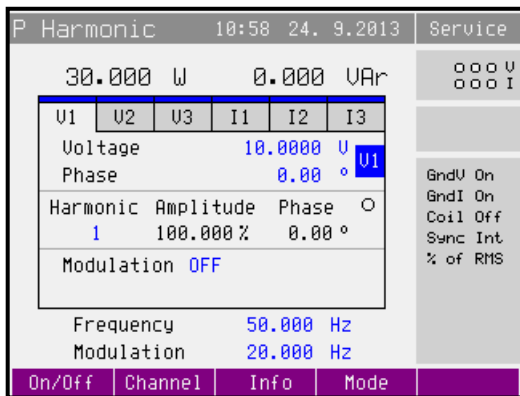
The value can be set using numeric keyboard and confirmed by pressing Hz softkey. The value can be set using cursor buttons or rotary knob as well.

4.1.4. Setting the power in P Harmonic mode (model M133C only)

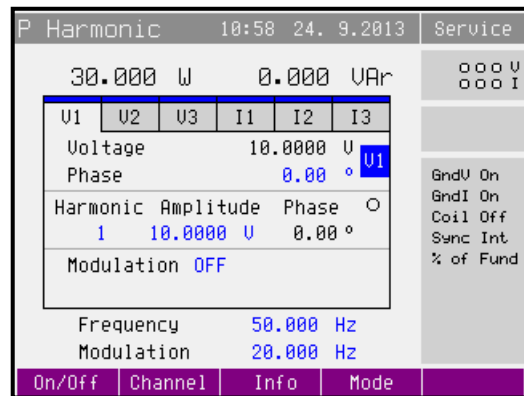
Mode is used for generation harmonic signal composed of up to 50 harmonic components. All components can be defined independently for all outputs (3x voltage, 3x current). Beside this mode allows modulation by sine or square signal.

Each calibrators output (U1, U2, U3, I1, I2, I3) is displayed as a folder. The folder U1 is active after selecting the Harmonic mode. Next folders are activated by repeatedly pressing „Channel“ softkey.

Pressing „On/Off“ softkey disables (enables) the active output. Only enabled outputs will be connected after pressing the „OPER“ button. Enabled outputs are highlighted by blue rectangle above the output name. After the AC power on all outputs of connected phase units (channels) are enabled.



Harmonics defined as “% of RMS”



Harmonics defined as “% of Fundamental”

Figure 18 Harmonic mode

Pressing „Info“ button displays informative window. There is displayed used range for every output. Range is important for uncertainty calculation, because the uncertainty is not displayed in mode P Harmonic.

Internal multimeter is not available in P Harmonic mode.

Setting the amplitude of voltage (current)

Amplitude can be defined as RMS value (harmonics components are defined as % of RMS) or Fundamental harmonic value (harmonics components are defined as % of Fundamental harmonic).

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage (current) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new amplitude is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

Setting the phase

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the phase value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing ° softkey. The value can be set using cursor buttons or rotary knob as well.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting amplitude and phase of harmonic components

First should be selected required harmonic component (1-50). Repeatedly press the “Sel” button (in the middle of cursor buttons) until the parameter Harmonic appears in edit mode (blue background).

Number of harmonic component can be set using numeric keyboard and confirmed by pressing „Enter“ button. The value can be set using cursor buttons or rotary knob as well. Next to the harmonic component number is displayed amplitude and phase of this harmonic component.

Pressing the „Sel“ button appears the amplitude of selected harmonic component in edit mode (blue background). This is not valid for the fundamental harmonic (1. harmonic component) if harmonics components are defined as % of RMS. Amplitude of fundamental harmonic is calculated using the RMS value of output signal and amplitudes of harmonic components 2-50 in this case.

Amplitude of harmonic components 2-50 can be set using numeric keyboard and confirmed by pressing „%“ softkey. The value can be set using cursor buttons or rotary knob as well. Amplitude can be set in range 0 to 30.000%. Amplitude is expressed as % of RMS value or % of Fundamental harmonic.

Phase of harmonic components 2-50 can be set using numeric keyboard and confirmed by pressing „°“ softkey. The value can be set using cursor buttons or rotary knob as well. Phase can be set in range 0.00 to 359.99 °.

„Harm+“ („Harm-“) softkeys facilitate listing among harmonics components. Softkeys displays amplitude of next (previous) harmonic component.

„Ampl. “ („Phase “) softkeys switch between Amplitude and Phase edit mode for selected harmonic component.

All harmonic components 2-50 can be cleared by pressing „Clear“ softkey. „Clear“ softkey is available if the fundamental harmonic is displayed.

Output terminals are disconnected if new amplitude is set

Setting of modulation

After AC power on modulation is switched off (OFF). First should be selected shape of modulation signal. Repeatedly press the “Sel” button (in the middle of cursor buttons) until the parameter

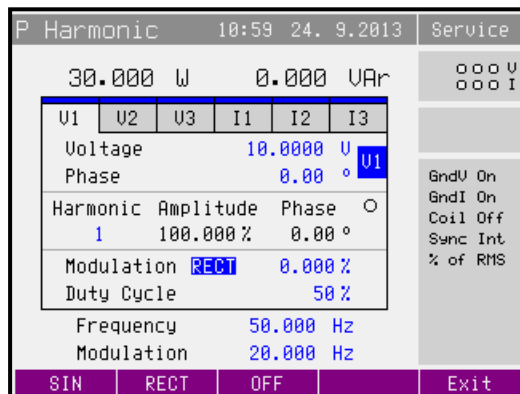


Figure 19 Harmonic mode - modulation setup

Modulation appears in edit mode (blue background). Shape can be selected using „SIN“, „RECT“ or „OFF“ softkey. Duty cycle (1 to 99%) is available for rectangular modulation signal.

All harmonic components are modulated by modulation signal.

Frequency of modulation signal is determined by parameter „Modulation“.

4.1.5. Setting the power in P Interharmonic mode (model M133C only)

Mode is used for generation signal composed of fundamental harmonic and one interharmonic component. All parameters can be defined independently for all outputs (3x voltage, 3x current).

Each calibrators output (U1, U2, U3, I1, I2, I3) is displayed as a folder. The folder U1 is active after selecting the Interharmonic mode. Next folders are activated by repeatedly pressing „Channel“ softkey.

Pressing „On/Off“ softkey disables (enables) the active output. Only enabled outputs will be connected after pressing the „OPER“ button. Enabled outputs are highlighted by blue rectangle above the output name. After the AC power on all outputs of connected phase units (channels) are enabled.

Pressing „Info“ button displays informative window. There is displayed used range for every

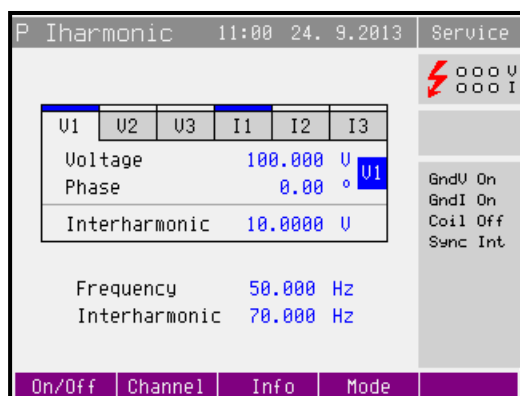


Figure 20 Interharmonic mode

output. Value of used range is important for uncertainty calculation, because the uncertainty is not displayed in P Interharmonic mode.

Internal multimeter is not available in P Interharmonic mode.

Setting the amplitude (RMS value) of voltage (current)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage (current) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new amplitude is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting the phase

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the phase value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing ° softkey. The value can be set using cursor buttons or rotary knob as well.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting the amplitude (RMS value) of interharmonic component

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the interharmonic value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new amplitude is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

4.1.6. Setting the power in P Dip/Swell mode (model M133C only)

Mode is used for generation dips or swells on the output signal. All parameters can be defined independently for all outputs (3x voltage, 3x current).

Each calibrators output (U1, U2, U3, I1, I2, I3) is displayed as a folder. The folder U1 is active after selecting the Dip/Swell mode. Next folders are activated by repeatedly pressing „Channel“ softkey.

Pressing „On/Off“ softkey disables (enables) the active output. Only enabled outputs will be connected after pressing the „On“ button. Enabled outputs are highlighted by blue rectangle above the output name. After the AC power on all outputs of connected phase units (channels) are enabled.

Pressing „Trigger“ button starts generation of Dip/Swell shape. Generation can be started (triggered) also from input IN3. Dip/Swell shape is divided into five time periods. Length of these periods can be changed. Active period is during the generation shown in the box.

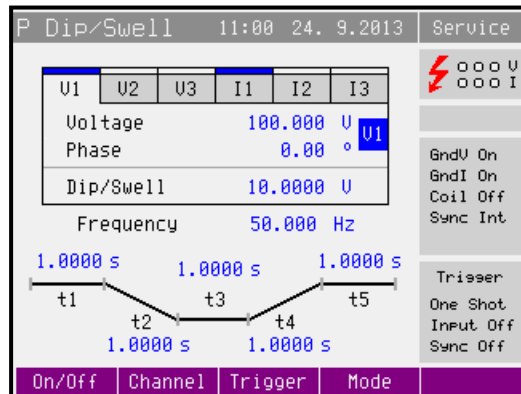


Figure 21 Dip/Swell mode

- t1 Voltage (Current) amplitude is generated during period t1 after trigger
- t2 amplitude is fluently changed to Dip/Swell amplitude
- t3 Dip/Swell amplitude is generated
- t4 amplitude is fluently changed to Voltage (Current) amplitude
- t5 Voltage (Current) amplitude is generated

There are following trigger parameters in Setup menu:

Dip/Swell repetition:

One Shot - trigger starts generation of one Dip/Swell shape

Repeat - trigger starts repeated generation of Dip/Swell shapes

Dip/Swell synchronization:

Sync Off - Dip/Swell shape starts immediately after trigger

Sync On - start of Dip/Swell shape is synchronized with the phase 0°

Dip/Swell ext. trigger

Input Off - Dip/Swell can be triggered only internal (keyboard or remote control)

Input IN3 - Dip/Swell can be triggered internal or by external TTL falling edge signal applied to input IN3

Internal multimeter is not available in P Dip/Swell mode.

Setting the amplitude (RMS value) of voltage (current)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage (current) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new amplitude is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting the phase

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the phase value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing ° softkey. The value can be set using cursor buttons or rotary knob as well.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting the amplitude (RMS value) of Dip/Swell

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the Dip/Swell value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V (mA, A) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new amplitude is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

Setting Dip/Swell time periods

Repeatedly press the “Sel” button (in the middle of cursor buttons) until required time period (t1, t2, t3, t4 or t5) appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing ms (s) softkey. The value can be set using cursor buttons or rotary knob as well.

Output terminals are disconnected if new time is set.

Next folders (outputs) are activated by repeatedly pressing „Channel“ softkey.

4.2. AC/DC energy

The calibrator can generate exact value of electric power and energy. Energy function modes provides output voltage at VOLTAGE OUTPUT HI – LO terminals and output current at CURRENT OUTPUT HI – LO terminals. Depending on the setting of the calibrator, voltage up to 600 V_{eff} can be present at the terminals.

Power setting range:	0.005 VA to 18 kVA (each channel)
Voltage setting range:	1 to 600 Vac, 1 to 280 Vdc
Current setting range:	5 mA to 30 A
Power factor setting range:	-1 to +1 (phase 0 to +359.99 °)
Time setting range:	1 to 10000 s
Frequency setting range:	DC, 15 Hz to 1 kHz

Energy pulse output

(only for calibrators with this output)

Energy pulse output is located on the rear panel (BNC connector in the right bottom corner). Frequency of pulses is proportional to the energy generated by calibrator and is defined by the energy meter constant (can be changed in setup menu).

There are two types of output selectable in setup menu:

- open collector (up to 30V / 100mA)
- open collector with the pull-up resistor 150Ω connected to +5V

Frequency range of energy pulse output: 0.02 Hz to 1 MHz

Control in the energy mode

Press “E” button on the calibrator and then select AC or DC mode by pressing „AC“ or „DC” button. The display shows the following data:

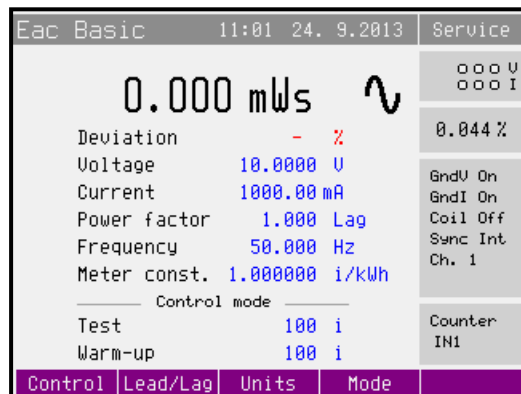


Figure 22 Basic mode - Energy

- main value – running energy counter in selected unit of measurement VAs, Ws, Vars
- deviation between energy meter and calibrator – calculation is based on pulses generated by meter
- voltage at VOLTAGE OUTPUT HI-LO terminals
- current through CURRENT OUTPUT HI-LO terminals
- power factor or the phase shift between the voltage and current in °.
- frequency, if AC power is selected
- meter constant (number of pulses per kWh/kVAh/kVARh generated by energy meter)
- energy counting method (control mode)
- uncertainty of energy and deviation

Set desired energy parameters using numeric keyboard, rotary knob or cursor buttons. Output power is not yet connected to the output terminals.

Connect the instrument to be calibrated to VOLTAGE OUTPUT HI-LO and CURRENT OUTPUT HI-LO terminals or short the CURRENT OUTPUT HI-LO terminals.

Select the Control mode.

Press OPER button.

Green LED is lit above the “OPER” button to indicate the connection of simulated electrical power to the output terminals. The calibrator starts energy dose generation. Main value displays running energy, control mode parameters displays running time, counted pulses or measured frequency. Current terminals are disconnected as soon as energy batch is finished. Voltage terminals are disconnected only if parameter “Maintain Voltage Signal” is set to “Off”. Otherwise the voltage terminals are disconnected after pressing “STBY” button.

Ways of energy counting (Control)

Calibration of Energy meter:

There are different ways how to control the energy dose counting.



Figure 23 Energy meter calibration example

Packet

(Time counting)

The simplest (but less accurate) way is to count the time.

Counter / Timer

(Pulse counting)

The other way is to count pulses from energy meter. This method is called „rolling start“ method. Meter must be connected to input IN1 or IN2. Press the OPER key on the calibrator. The calibrator starts to count energy after counting “Warm-up” pulses from the meter (rolling start). Counting is finished after the set number of “Test” pulses is reached. The calibrator disconnects the output terminals and shows energy delivered between set number of “Test” pulses. Calibrator also displays deviation of the meter in % (meter constant must be defined).

In Counter mode is measuring interval defined by number of pulses. In Timer mode is measuring interval defined by time.

Free run

(Frequency measuring)

Calibrator measures frequency of pulses from measured meter. Meter must be connected to input IN1, IN2 or Meter. Deviation between meter and calibrator is continuously calculated and displayed (meter constant must be defined). Calibrator displays deviation between measured and internal "reference frequency" in %.

Use “Control” softkey to open the energy counting method selection menu. Select the required method using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey.

Power factor polarity (Lead/Lag softkey)

In case that phase shift between voltage and current is expressed as power factor you can change its polarity using „Lead/Lag“ softkey. The Lead polarity presents capacity load (current before voltage). The Lag polarity presents inductance load (voltage before current).

Power units (Units softkey)

The calibrator can display AC power (energy) in one of three ways:

1. apparent power in VA (VAs)
2. active power in W (Ws)
3. reactive power in Var (VArS)

Use “Units” softkey to open the units selection menu. Select the required expression using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey. The value of displayed power is recalculated together with new units selection. DC power (energy) can be expressed only in W (Ws).

The calibrator can display the phase relation of output voltage and current as power factor (–1 to +1) or as phase shift in degrees (0 to 359.99 °). Main menu is used to change the method of displaying the phase relation.

Energy modes

(Mode softkey)

Output energy can be generated in different energy modes:

AC energy

Mode	Name	Description
Basic	Eac Basic	AC energy basic mode. Phase shift between channels output voltages are fixed (120° and 240°). All parameters are the same for all channels. Number of active channels can be defined in Main menu (1, 2 or 3).
High I	Eac High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

DC energy

Mode	Name	Description
Basic	Edc Basic	DC energy basic mode. Only first channel 1 is controlled in this mode.
High I	Edc High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

Use „Mode“ softkey to open the mode selection menu. Select the required mode using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey. Output terminals are disconnected if the new mode is selected.

4.2.1. Setting the energy in modes Edc Basic and Eac Basic

The calibrator allows several ways of setting the value of generated energy.

Setting the voltage

The energy (power) value can be changed by changing the voltage.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V softkey. The value can be set using cursor buttons or rotary knob as well.

Energy (power) value is recalculated using new set voltage and existing setting of current and power factor.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

Setting the current

The energy (power) value can be changed by changing the current.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the current value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing mA or A softkey. The value can be set using cursor buttons or rotary knob as well.

Energy (power) value is recalculated using new set current and existing setting of voltage and power factor.

Setting the power factor (AC power only)

If Ws or VAr is indicated, the energy (power) value can be changed by changing the power factor. Change of power factor does not change the output apparent energy.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the power factor (phase) value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Lead or Lag softkey. The value can be set using cursor buttons or rotary knob as well.

Energy (power) value is recalculated using new set power factor and existing setting of current and voltage. The calculation is only made if active or reactive power is displayed.

Setting the frequency (AC energy only)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the frequency value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Hz softkey. The value can be set using cursor buttons or rotary knob as well.

Setting the Meter constant

Meter constant defines number of pulses sent by the meter for selected energy unit.

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the Meter constant value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Enter softkey. The value can be set using cursor buttons or rotary knob as well.

Setting the time (test, warm-up counters)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the time value (or “Test” / “Warm-up” values) appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Enter softkey. The value can be set using cursor buttons or rotary knob as well.

4.2.2. Setting the power in modes Edc High I and Eac High I (Three phase version only)

In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

Output voltage terminals are on the main unit (Channel 1).

Power setting is the same as in modes Edc Basic a Eac Basic.

4.3. AC/DC voltage

The calibrator can generate calibrated voltage. Output terminals for voltage ranges are VOLTAGE OUTPUT HI – LO terminals. Depending on the setting of the calibrator, voltage up to 600 Vef can be present at the terminals.

Voltage setting range: 1 to 600 Vac, 1 to 280 Vdc

Control in the voltage mode

Press “U” button on the calibrator and then select AC or DC mode by pressing „AC“ or „DC” button. The display shows the following data:

- main voltage value at VOLTAGE OUTPUT HI-LO terminals
- frequency, if AC voltage is selected
- uncertainty of voltage

Set desired value of voltage using numeric keyboard, potentiometer or cursor buttons. Output voltage is not yet connected to the output terminals.

Connect the instrument to be calibrated to VOLTAGE OUTPUT HI-LO.

Press OPER button.

Green LED is lit above the “OPER” button to indicate the connection of output terminals.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

Overloading of output terminals

If the output terminals are overloaded or short-circuited in the voltage mode, the calibrator disconnects the signal from the output terminals and reports „Output Overload“.

4.3.1. Setting the voltage in modes Udc Basic and Uac Basic

The calibrator allows several ways of setting the value of generated voltage.

Setting the voltage

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the voltage value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing V softkey. The value can be set using cursor buttons or rotary knob as well.

Setting the frequency (AC voltage only)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the frequency value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Hz softkey. The value can be set using cursor buttons or rotary knob as well.

Note: Read also chapter 2.5 Connection / disconnection of output terminals.

4.4. Generation of calibrated current

The calibrator can generate calibrated current. Output terminals for current ranges are CURRENT OUTPUT HI – LO terminals.

Current setting range: 5 mA to 30 A

When 25/50-turn coil (option 140-50) is used, AC current range is to 1000 A.

Control in the current mode

Press “I” button on the calibrator and then select AC or DC mode by pressing „AC“ or „DC” button. The display shows the following data:

- main current through the CURRENT OUTPUT HI-LO terminals
- frequency, if AC current is selected
- uncertainty of current

Set desired value of current using numeric keyboard, rotary knob or cursor buttons. Output current is not yet connected to the output terminals.

Connect the instrument to be calibrated to CURRENT OUTPUT HI-LO.

Press OPER button.

Green LED is lit above the “OPER” button to indicate the connection of output terminals.

If Coil x50 or Coil x25 function is activated (see below – Main menu), the optional current coil must be connected to the output terminals. The calibrator can be used to calibrate clamp Ammeters up to 1500 A. The calibrator generates AC and DC current within the range up to 20 A with current coil.

Overloading of output terminals

When external circuit connected to current output terminals is disconnected or there is higher voltage at the load than permitted, the calibrator disconnects the output terminals and displays „Output Overload“ message. The same message can be displayed when 50-turn coil is used for AC current output at frequencies above 80 Hz. It depends on the set current and the type of ammeter connected.

Current modes (Mode softkey)

Output current can be generated in different current modes:

AC current

Mode	Name	Description
Basic	Iac Basic	AC current basic mode. Only first channel 1 is controlled in this mode.
High I	Iac High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

DC current

Mode	Name	Description
Basic	Idc Basic	DC current basic mode. Only first channel 1 is controlled in this mode.
High I	Idc High I	In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

Use „Mode“ softkey to open the mode selection menu. Select the required mode using cursor buttons or the rotary knob. Confirm the selection by pressing the rotary knob or the “Select” softkey. Output terminals are disconnected if the new mode is selected.

4.4.1. Setting the current in modes Idc Basic and Iac Basic

The calibrator allows several ways of setting the value of generated current.

Setting the current

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the current value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing mA or A softkey. The value can be set using cursor buttons or rotary knob as well.

Setting the frequency (AC current only)

Repeatedly press the “Sel” button (in the middle of cursor buttons) until the frequency value appears in edit mode (blue background).

The value can be set using numeric keyboard and confirmed by pressing Hz softkey. The value can be set using cursor buttons or rotary knob as well.

4.4.2. Setting the current in modes Idc High I and Iac High I (Three phase version only)

In this mode current outputs of all channels are connected in parallel (using the 133-01 High Current Adapter). Current range is increased three times.

Current setting is the same as in modes Idc Basic a Iac Basic.

4.5. Multimeter

The calibrator includes a built-in multimeter which can measure DC voltage, DC current and frequency. Measured signal must be connected to the “METER INPUT” terminals. Terminals mA, COM are for current measurements. Terminals V, COM are for voltage and frequency measurements.

The manufacturer does not recommend connection of multimeter inputs to calibrator outputs.

Such connection can result in presence of high voltage at multimeter inputs, which can damage the multimeter.

4.5.1. Function selection

Measurement function should be selected in Main menu (item Meter).

Press UP, DOWN display buttons or use the rotary knob to select one of the following functions:

- Voltage – DC voltage range 10V
- Current – DC current range 20mA
- Frequency – frequency range 10 kHz

Notes:

- The multimeter can be used as a DC multimeter with ranges 10V and 20mA.
- Frequency measurement is possible up to 15 kHz. Input signal must be within 0.2 to 5 V range. Square wave or pulse shape of the input signal is expected.

5. Verification test

Procedure recommended for verifying parameters of the calibrator is described in this chapter. During tests it is not necessary access to the interior of the instrument.

5.1. Required equipment

Following instruments are required for performance verification test:

- 8 1/2 digit multimeter type HP3458A or Fluke 8508A, or other type with accuracy 0.01 % on AC voltage
- Multifunction calibrator MEATEST M142 or M140 with DC ranges 10V, 20mA and AC range 10V / 15kHz.
- resistance shunt 10 m Ω , 100 m Ω Burster 1280, or other type with accuracy 0.01% with known AC/DC difference to 1 kHz
- counter HP 53181A, HO 53130, BM 642 or other with accuracy 0,001 %
- power meter 0.01 % like Radian research RX-23

HP8903A Distortion analyzer and scope with bandwidth min. 20 MHz. 100 kHz bandwidth is recommended for THD measuring of AC signals.

5.2. Configuration of the calibrator

Calibrator should be tested directly from the front panel terminals To suppress influence of noise or interference with power line frequency in measuring circuit it is recommended following setting of the calibrator (in Main menu):

- | | |
|------------------------|----------|
| 1. Current coil | Coil Off |
| 2. Voltage sources GND | GndU On |
| 3. Current sources GND | GndI On |

Note: If it is grounded neither calibrator nor standard meter, higher level can occur on the output terminals.

In general, when calibrator is connected to the standard meter, ground loops can be arise through power line connection. Ground loops can result apparently worse noise, short term stability or non-harmonic distortion of output signal. If necessary use toroidal chokes to suppress this products.

Use sin waveform of the output signal on all AC tests.

Performance verification may be performed after warm-up period i.e. 1 hour after switching on. Calibrator have to be in temperature stabilize condition at minimum 8 hours before performance verification test is started.

5.3. Verification procedure

Following part describes procedure of performance verification test. Recommended measuring points are the same as the points in table of limits (see tables below).

1. Connect the calibrator to the mains and let them switched on for at least one hour in a laboratory at 23 ± 1 °C.
2. Connect voltage input of the standard multimeter to the voltage output terminals of the calibrator. Set appropriate parameters on the standard multimeter to achieve its best accuracy.
3. Perform 30 VDC linearity, DC voltage, 30 VAC linearity, AC voltage tests according to the tables I, II, III, IV. Deviations should not exceed specified limits.
4. Connect current input of standard multimeter to the current output terminals of the calibrator. Set appropriate parameters on the standard multimeter to meet its best accuracy.
5. Perform 1 ADC linearity, DC current, AC current tests according to the tables V, VI, VII. Deviations should not exceed specified limits.
6. Connect standard powermeter to the appropriate output and current terminals of the calibrator.
7. Perform AC/DC power test according to the table VIII. Deviations should not exceed specified limits.
8. Connect output voltage terminals of the calibrator to the counter. Set output voltage 5 VAC, frequency 1 kHz.
9. Perform frequency test according to the table IX. Deviation should not exceed specified limit.
10. Connect input voltage terminals of calibrator's internal multimeter to the output terminals of the standard calibrator. Set appropriate value of frequency and DC voltage according to the table X.
11. Perform multimeter test in points FREQUENCY 10000Hz and 10 VDC. Deviations should not exceed limits in the tables below.
Note: Because accuracy of calibrator output is not accurate enough in all points, use external standard counter (frequency) or multimeter (DC voltage) connected in parallel to the output terminals to obtain exact value on the output.
12. Connect input current terminals of calibrator's internal multimeter to the output terminals of the standard calibrator. Set appropriate value of DC current according to the table X.
13. Perform multimeter test on range 20 mA DC according to the table X. Deviation should not exceed specified limit.
14. Connect distortion meter to the voltage output terminals of the calibrator. Set output voltage 10 VAC, frequency 1000 Hz and sin waveform.
15. Check harmonic distortion of output signal. It should not exceed 0.05%.

If calibrator is out of limits is in some points of this test, appropriate function and range should be recalibrated. It is not necessary to recalibrate all functions, but only this one, which does not meet specification. See chapter Calibration mode, where recalibration procedure is described.

5.4. Test points

Function	Range	Nominal	Min value	Max value	Unit	Frequency
DC Voltage	10	10	9.9975	10.0025	V	
		-10	-10.0025	-9.9975	V	
	30	12	11.9952	12.0048	V	
		14	13.9949	13.0051	V	
		16	15.9946	16.0054	V	
		18	17.9943	18.0057	V	
		20	19.9940	20.006	V	
		22	21.9937	22.0063	V	
		24	23.9934	24.0066	V	
		26	25.9931	26.0069	V	
		28	27.9928	28.0072	V	
		30	29.9925	30.0075	V	
		-12	-12.0048	-11.9952	V	
		-14	-14.0051	-13.9949	V	
		-16	-16.0054	-15.9946	V	
		-18	-18.0057	-17.9943	V	
		-20	-20.0060	-19.9940	V	
		-22	-22.0063	-21.9937	V	
		-24	-24.0066	-23.9934	V	
		-26	-26.0069	-25.9931	V	
	-28	-28.0072	-27.9928	V		
	-30	-30.0075	-29.9925	V		
	70	70	69.9825	70.0175	V	
		-70	-70.0175	-69.9825	V	
	140	140	139.965	140.035	V	
		-140	140.035	-139.965	V	
	280	280	299.93	280.07	V	
		-280	-280.07	-299.93	V	
AC Voltage	10	10	9.9978	10.0022	V	55 Hz
	30	12	11.9956	12.0044	V	55 Hz
		14	13.9969	14.0031	V	55 Hz
		16	15.9965	16.0035	V	55 Hz
		18	17.9960	18.0040	V	55 Hz
		20	19.9956	20.0044	V	55 Hz
		22	21.9952	22.0048	V	55 Hz
		24	23.9947	24.0053	V	55 Hz
		26	25.9943	26.0057	V	55 Hz
		28	27.9938	28.0062	V	55 Hz
		30	29.9934	30.0066	V	20 Hz
		30	29.9922	30.0078	V	55 Hz
		30	29.9934	30.0066	V	120 Hz
	30	29.9934	30.0066	V	1 kHz	
	70	70	69.9846	70.0154	V	55 Hz
	140	140	139.9692	140.0308	V	55 Hz
	280	280	279.9384	280.0616	V	55 Hz

Function	Range	Nominal	Min value	Max value	Unit	Frequency
	600	600	599.844	600.156	V	55 Hz
DC Current	300	300	299.895	300.105	mA	
		-300	-300.105	-299.895	mA	
	1	0.4	0.3998	0.4002	A	
		0.5	0.499775	0.500225	A	
		0.6	0.59975	0.60025	A	
		0.7	0.699725	0.700275	A	
		0.8	0.7997	0.8003	A	
		0.9	0.899675	0.900325	A	
		1.0	0.99965	1.00035	A	
		-0.4	-0.4002	-0.3998	A	
		-0.5	-0.500225	-0.499775	A	
		-0.6	-0.60025	-0.59975	A	
		-0.7	-0.700275	-0.699725	A	
		-0.8	-0.8003	-0.7997	A	
		-0.9	-0.900325	-0.899675	A	
		-1.0	-1.00035	-0.99965	A	
	2	2	1.9993	2.0007	A	
		-2	-2.0007	-1.9993	A	
	5	5	4.99825	5.00175	A	
		-5	-5.00175	-4.99825	A	
	10	10	9.9955	10.0045	A	
		-10	-10.0045	-9.9955	A	
	30	30	29.985	30.015	A	
-30		-30.015	-29.985	A		
AC Current	300	300	299.895	300.105	mA	55 Hz
	1	1	0.99965	1.00035	A	55 Hz
		1	0.9995	1.0005	A	800 Hz
	2	2	1.9992	2.0008	A	55 Hz
	5	5	4.99825	5.00175	A	55 Hz
	10	10	9.9955	10.0045	A	55 Hz
30	30	29.985	30.0150	A	55 Hz	
DC Voltage from Current	20	20	19.994	20.006	mV	
		-20	-20.006	19.994	mV	
	330	330	329.637	330.363	mV	
		-330	-330.363	-329.637	mV	
5	5	4.9965	5.0035	V		
	-5	-5.0035	-4.9965	V		
AC Voltage from Current	20	20	19.994	20.006	mV	55 Hz
	330	330	329.637	330.363	mV	55 Hz
	5	5	4.9965	5.0035	V	55 Hz
Power (Voltage = 240V)	480	480	479.784	480.216	W	55 Hz, PF = 1
	480	240	239.82	240.180	W	55 Hz, PF = 0.5, lagging
	480	240	239.82	240.180	W	55 Hz, PF = 0.5, leading
	2400	2400	2398.73	2401.27	W	55 Hz, PF = 1
	2400	1200	1199.028	1200.972	W	55 Hz, PF = 0.5, lagging
	2400	1200	1199.028	1200.972	W	55 Hz, PF = 0.5, leading

Function	Range	Nominal	Min value	Max value	Unit	Frequency
FREQ	1000	1000	999.95	1000.05	Hz	

Multimeter						
FREQ	10	10	9.9995	10.0005	kHz	
V-DC	10 V	10	9.9987	10.0013	V	
V-DC	10 V	-10	-10.0013	9.9987	V	
A-DC	20	20	19.9967	20.0033	mA	
A-DC	20	-20	-20.0033	-19.9967	mA	

Table 2 List of main test points

6. Adjustment

Adjustment is done through MENU > Calibration. This menu item is password protected, default factory set calibration code is "0".

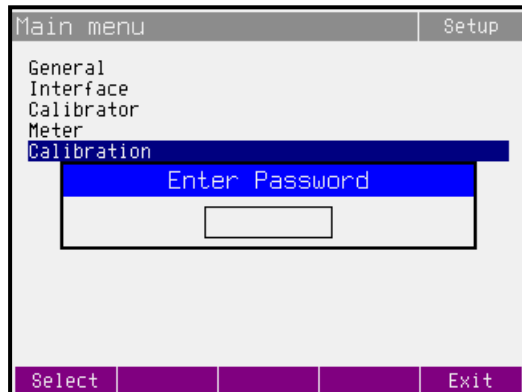


Figure 24 Password entry

6.1. Calibration menu structure

Calibration data are sorted in a tree structure with following hierarchy:

1. Channels and Meter
2. Functions (f.e. Voltage DC)
3. Ranges (f.e. 10 V)
4. Calibration points (f.e. zero offset)

Note: Meter have ranges and functions together.

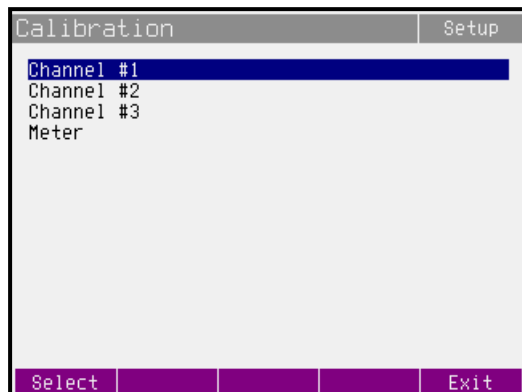


Figure 25 Calibration menu

Once range level of the tree structure is reached, calibration points are displayed in following format:



Figure 26 Calibration point adjustment

Softkeys have the following meaning:

Write - new calibration value is entered into the memory, old value is lost. The calibrator returns to the previous menu.

Skip - current calibration step is skipped, old value is retained in the memory. The calibrator returns to the previous menu.

Moreover, the display shows the range which is being calibrated (Range 10Vac), and the value to be set at the external standard multimeter (value in brackets 1V).

Calibration value adjustment

Values denoted without any unit show relative position within selected range. Such points can be adjusted by changing the value so that the output signal measured by external standard multimeter reaches the required calibration point as close to nominal value as possible. When this value is reached, press Write softkey to write new calibration value to the calibration memory. If you press Exit softkey, the calibrator ignores the new value and old value is retained.

The procedure is repeated for all calibration points of the selected function.

6.2. Calibration points

Each function of the calibrator has assigned fixed calibration points which have to be set during the calibration.

The calibrator needs no calibration of the following parameters:

- frequency
- phase relationship (power factor) of output voltage and current in AC power and AC energy generation modes
- DC and AC power and energy

6.2.1. Voltage and current AC functions

Function	Range	Nominal value	
		Low	High
AC Voltage	10 V	1 V	10 V
	10 V	10 V	10 V
	30 V	10 V	30 V
	30 V	30 V	30 V
	70 V	30 V	70 V
	70 V	70 V	70 V
	140 V	70 V	140 V

Function	Range	Nominal value	
		Low	High
	140 V	140 V	140 V
	280 V	140 V	280 V
	280 V	280 V	280 V
	600 V	280 V	600 V
	600 V	600 V	600 V
AC Current	300 mA	30 mA	300 mA
	300 mA	300 mA	300 mA
	1 A	300 mA	1 A
	1 A	1 A	1 A
	2 A	1 A	2 A
	2 A	2 A	2 A
	5 A	2 A	5 A
	5 A	5 A	5 A
	10 A	5 A	10 A
	10 A	10 A	10 A
	30 A	10 A	30 A
	30 A	30 A	30 A

Table 3 Calibration points - AC voltage and current

6.2.2. Voltage and current DC functions

Function	Range	Nominal value	
		Low	High
DC Voltage	10 V	1 V	10 V
	10 V	10 V	10 V
	-10 V	-10 V	-1 V
	-10 V	-10 V	-10 V
	30 V	10 V	30 V
	30 V	30 V	30 V
	-30 V	-30 V	-10 V
	-30 V	-30 V	-30 V
	70 V	30 V	70 V
	70 V	70 V	70 V
	-70 V	-70 V	-30 V
	-70 V	-70 V	-70 V
	140 V	70 V	140 V
	140 V	140 V	140 V
	-140 V	-140 V	-70 V
	-140 V	-140 V	-140 V
	280 V	140 V	280 V
	280 V	280 V	280 V
	-280 V	-280 V	-140 V
	-280 V	-280 V	-280 V

Function	Range	Nominal value	
		Low	High
DC Current	300 mA	30 mA	300 m
	300 mA	300 mA	300 mA
	-300 mA	-300 mA	-30 mA
	-300 mA	-300 mA	-300 mA
	1 A	300 mA	1 A
	1 A	1 A	1 A
	-1 A	-1 A	-300 mA
	-1 A	-1 A	-1 A
	2 A	1 A	2 A
	2 A	2 A	2 A
	-2 A	-2 A	-1 A
	-2 A	-2 A	-2 A
	5 A	2 A	5 A
	5 A	5 A	5 A
	-5 A	-5 A	-2 A
	-5 A	-5 A	-5 A
	10 A	5 A	10 A
	10 A	10 A	10 A
	-10 A	-10 A	-5 A
	-10 A	-10 A	-10 A
30 A	10 A	30 A	
30 A	30 A	30 A	
-30 A	-30 A	-10 A	
-30 A	-30 A	-30 A	

Table 4 Calibration points - DC voltage and current

6.2.3. Voltage and Current AC functions (P Harmonic and P Interharmonic)

Function	Range	Nominal value	
		Low	High
AC Voltage	10 V	1 V	10 V
	10 V	10 V	10 V
	30 V	10 V	30 V
	30 V	30 V	30 V
	70 V	30 V	70 V
	70 V	70 V	70 V
	140 V	70 V	140 V
	140 V	140 V	140 V
	280 V	140 V	280 V
	280 V	280 V	280 V
AC Current	300 mA	30 mA	300 mA
	300 mA	300 mA	300 mA
	1 A	300 mA	1 A
	1 A	1 A	1 A
	2 A	1 A	2 A

Function	Range	Nominal value	
		Low	High
	2 A	2 A	2 A
	5 A	2 A	5 A
	5 A	5 A	5 A
	10 A	5 A	10 A
	10 A	10 A	10 A
	30 A	10 A	30 A
	30 A	30 A	30 A

Table 5 Calibration points - AC voltage and current (P har. and P Interhar.)

6.2.4. Multimeter

Function	Range	Nominal value	
		Low	High
Multimeter	10 V	0 V	10 V
	10 V	10 V	10 V
	20 mA	0 mA	20 mA
	20 mA	20 mA	20 mA
	10 kHz	10 kHz	10 kHz

Table 6 Calibration points multimeter

6.3. Full calibration procedure

Required instruments

Following pages describe procedure of the full calibration. Following instruments are required for calibration:

- 8 1/2 digit multimeter type HP3458A or Fluke 8508A, or other type with accuracy 0.001 % on DC voltage
- Calibrator Meatest M142 or M140 with DC ranges 10V, 20mA a AC range 10V / 10kHz.
- Resistance shunt 10 mΩ, 100 mΩ Burster 1280, or other type with accuracy 0.01%
- Counter HP 53181A, HO 53130, BM 642 or other with accuracy 0,001 %
- Powermeter 0.02- 0.05 %, Zimmer LG95 or better

HP8903A Distortion analyzer and scope with bandwidth min. 20 MHz are recommended for THD measuring of AC signals.

Calibration procedure

Connect the calibrator and the multimeter to the mains and let them switched on for at least three hours in a laboratory at 23 ± 1 °C.

Press Menu button to call up the Main menu, select Calibration end press Select softkey to enter the calibration menu.

Enter the calibration code and press Enter button (default calibration code is "0").

- A) AC voltage ranges calibration:
1. Connect the voltage input terminals of the multimeter to the VOLTAGE OUTPUT HI - LO terminals of the calibrator.
 2. Select Voltage AC#1 from the calibration menu and confirm by pressing Select softkey. Switch calibrator's output terminals ON (OPER button).
 3. Follow the instructions provided on the calibrator's display and the ACU table to adjust the calibrator's output in the calibration points.
 4. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.
 5. Switch output terminals OFF (STBY button). Disconnect multimeter and calibrator.
 - Repeat steps 1 to 5 also for Voltage AC#2 and Voltage AC#3.
- B) AC current ranges calibration
1. Select Current AC#1 from the calibration menu and confirm by pressing Select softkey. Set the same function on external multimeter.
 2. Follow the instructions provided on the calibrator's display and the ACI table to adjust the calibrator's output in the calibration points.
 3. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.
 4. Resistance shunt should be used on 2, 5, 10 and 30 A ranges, if standard multimeter does not cover this range.
 - Repeat steps 1 to 4 also for Current AC#2 and Current AC#3.
- C) DC voltage ranges calibration
1. Select Voltage DC#1 from the calibration menu and confirm by pressing Select softkey. Switch calibrator's output terminals ON (OPER button).
 2. Follow the instructions provided on the calibrator's display and the DCU table to adjust the calibrator's output in the calibration points.
 3. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.
 4. Switch output terminals OFF (STBY button). Disconnect multimeter and calibrator.
 - Repeat steps 1 to 4 also for Voltage DC#2 and Voltage DC#3.
- D) DC current ranges calibration
1. Select Current DC#1 from the calibration menu and confirm by pressing Select softkey. Set the same function on external multimeter.
 2. Follow the instructions provided on the calibrator's display and the DCI table to adjust the calibrator's output in the calibration points.
 3. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.
 4. Resistance shunt should be used on 2, 5, 10 and 30 A ranges, if standard multimeter does not cover this range.
 - Repeat steps 1 to 4 also for Current DC#2 and Current DC#3.
- E) AC voltage modulation ranges calibration (P Harmonic, P Interharmonic modes, model M133C only)
1. Select Voltage MOD#1 from the calibration menu and confirm by pressing Select softkey. Switch calibrator's output terminals ON (OPER button).
 2. Follow the instructions provided on the calibrator's display and the MOD ACU table to adjust the calibrator's output in the calibration points.
 3. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the

output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.

4. Switch output terminals OFF (STBY button). Disconnect multimeter and calibrator.
 - Repeat steps 1 to 4 also for Voltage MOD#2 and Voltage MOD#3.

F) AC current modulation ranges calibration (P Harmonic, P Interharmonic modes, model M133C only)

1. Select Current MOD#1 from the calibration menu and confirm by pressing Select softkey. Set the same function on external multimeter.
2. Follow the instructions provided on the calibrator's display and the MOD ACI table to adjust the calibrator's output in the calibration points.
3. To adjust the calibrator's output in the calibration points, press Select softkey and use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the output voltage. Confirm correctly set value by pressing Write softkey. If you want to skip the calibration point whose calibration you have already entered, press Exit softkey.
4. Resistance shunt should be used on 2, 5, 10 and 30 A ranges, if standard multimeter does not cover this range.
 - Repeat steps 1 to 4 also for Current MOD#2 and Current MOD#3.

G) Multimeter calibration

Built-in multimeter calibration consists of the calibration of 10 V voltage range, 20 mA current range and 10 kHz frequency range.

External calibrator of higher precision class should be used to calibrate the built-in multimeter (Meatest M142). If accurate external calibrator is not available an 8 1/2 digit multimeter is recommended for calibration.

1. 10 V DC voltage range calibration
 - Select Meter from the calibration menu. Press Select softkey to select the first calibration point, 0 V.
 - Make short on calibrators input terminals METER INPUT V-COM.
 - Main value presents the calibration point. Leave value 0.000 and press Write softkey.
 - Select calibration point 10 V.
 - Connect external voltage 10 V to the calibrator input terminals METER INPUT V-COM. Exact value can be measured by parallel standard voltmeter.
 - Adjust main value on the display. It should be equal to the value measured by standard multimeter. Use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the main value. Confirm new value by pressing Write softkey.
2. 20 mA DC current range calibration
 - Select Meter from the calibration menu. Press Select softkey to select the first calibration point, 0 mA.
 - Make short on calibrators input terminals METER INPUT mA-COM.
 - Main value presents the calibration point. Leave value 0.000 and press Write softkey.
 - Select calibration point 20 mA.
 - Connect external current source 20 mA to the calibrator input terminals METER INPUT mA-COM. Exact value can be measured by serial standard ammeter.
 - Adjust main value on the display. It should be equal to the value measured by standard multimeter. Use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the main value. Confirm new value by pressing Write softkey.
3. 10 kHz frequency range calibration
 - Select calibration point 10 kHz.
 - Connect external AC voltage 10 kHz (voltage between 5 to 10 V) to the calibrator input terminals METER INPUT V-COM. Exact frequency value can be measured by parallel standard counter.
 - Adjust main value on the display. It should be equal to the value measured by standard counter. Use ◀, ▶, ▲, ▼ cursor buttons, rotary knob or numeric keyboard to adjust the main value. Confirm new value by pressing Write softkey.

7. Maintenance

This chapter explains how to perform the routine maintenance to keep your device in optimal operating conditions.

7.1. Replacement of fuse

The calibrator includes a fuse located in the mains connector at the rear panel. Replace the fuse as follows:

1. Switch off the calibrator
2. Remove the end of power cord from the mains connector at the rear panel.
3. Insert the blade of a flat screwdriver into the opening cut in the mains voltage selector and pull out the fuse holder.
4. Remove the fuse and replace it with new fuse of the same rating.

7.2. Rules for correct operation

Especially the following rules should be adhered to guarantee correct operation of the calibrator:

- The calibrator can only be switched on and off by pressing the mains switch located at the rear panel.
- Do not connect the calibrator to other voltage than set by the voltage selector.
- Do not block the vent openings located at the rear panel and bottom panel.
- The calibrator must not be operated in dusty environment. It was designed to be used in a laboratory.
- No liquid or small objects can be permitted to enter the calibrator through the vent openings.
- Do not switch the calibrator outside its operating temperature range.
- Connect the instruments to be calibrated to proper output terminals. There is no way of protecting the calibrator from the damage caused by some improper connections.
- Do not damage the output terminals by plugging in “bananas” thicker than the terminals were designed for.
- Whenever possible, use the setup menu to ground Lo output terminals (GndU On, GndI On).
- Do not overload the power stages by leaving the calibrator switched on with the load connected for a long time, especially on 30 A current range and 140 V and 280 V voltage ranges.
- If the instruments to be calibrated are not connected to calibrator’s output terminals using original cables, ensure that cables suitable for the calibration voltage and current are used. Maximum output voltage can reach 600 V AC and the maximum output current can reach 30 A AC.

7.3. Regular maintenance

To keep the device in mint condition, clean the case and front panel keys using a soft cloth slightly dampened with either water or a non-abrasive mild cleaning solution that is not harmful to plastics.

7.4. Error messages

If an error occurs during the calibrator's operation or control, error message is displayed on the display. Errors can be caused by:

- Incorrect control using the front panel, i.e. attempts to force a prohibited mode, e.g. setting an out-of-range value, overloading of output terminals etc.,
- Incorrect control using GPIB or RS-232 interface.
- Calibrator's fault.

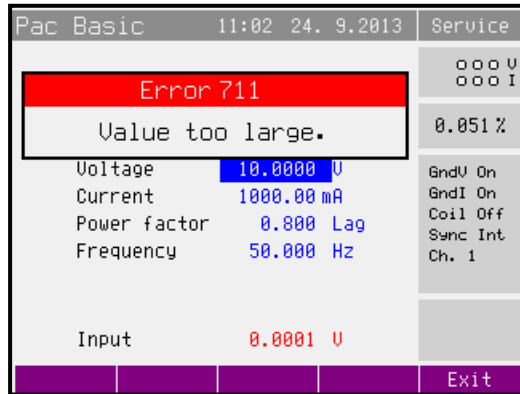


Figure 27 Error message

Sample error message which appears when too large value is attempted to set up is shown below. All error messages are displayed in the frame overlapped main screen.

The following table lists contains an overview of error codes that you might come across when operating the calibrator. Complete list of errors is available in SCPI manual.

Error code groups	Description and most notable error codes
-430 to -110	Remote interface errors. See SCPI manual.
501 - 503	Eeprom fails. Restart the instrument and if the error persists, please report this error to the Service Center.
701 - 707	Protective element has been triggered and output/input has been shut off in order to prevent calibrator damage. Check for excessive load. If the error persists, please report this error to the Service Center. 703 - Calibrator power stage overheated. Leave terminals off to cool down.
722 - 748	Error in internal communication. Restart the instrument and if the error persists, please report this error to the Service Center.
750 - 755	Amplitude of harmonic signals on voltage or current channels are too high. Reduce amplitudes of indicted harmonic components.
770	Source function is unavailable. Ask Meatest for possible upgrades.

Table 7 Error code overview

8. Specification

Accuracies include long-term stability, temperature coefficient, linearity, load and line regulation and the traceability of factory and National calibration standards. Specified accuracy is valid after one hour warm up in temperature range 23 ± 2 °C. Specifications below describe 1-year absolute accuracy.

DC/AC voltage (sine amplitude)

Summary range:	1 – 600 Vac, 1 – 280 Vdc
Voltage resolution:	5½ dig.
Frequency range:	DC, 15 Hz – 1000 Hz
Frequency accuracy:	0.005%
Frequency resolution:	0.001 Hz below 500 Hz, 0.01 Hz below 1000 Hz
Distortion:	< 0.05 %

Range	% value + % range	Max. burden (mA)*	% value + % range	Max. burden (mA)*	% value + % range	Max. burden (mA)†
Voltage	DC		15 – 40 Hz 70 – 1000 Hz		40 – 70 Hz	
1.0000 – 10.0000 V	0.015 + 0.01	100	0.016 + 0.01	100	0.012 + 0.01	100
10.0001 – 30.0000 V	0.015 + 0.01	200	0.016 + 0.01	200	0.012 + 0.01	200
30.001 – 70.000 V	0.015 + 0.01	200	0.016 + 0.01	200	0.012 + 0.01	300
70.001 – 140.000 V	0.015 + 0.01	200	0.016 + 0.01	200	0.012 + 0.01	300
140.001 – 280.000 V	0.015 + 0.01	150	0.016 + 0.01	150	0.012 + 0.01	200
280.001 – 600.000 V ²	--	--	0.024 + 0.01	50	0.016 + 0.01	60

1. Sum of all currents (three phases) is limited to 400mA
2. Only fundamental harmonic in range over 280Vac, frequency range 20 – 1000 Hz

DC/AC current (sine amplitude)

Summary range:	5 mA – 30 A (90 A using M133-01 High Current Adapter)
Current resolution:	5½ dig.
Frequency range:	DC, 15 Hz – 1000 Hz
Frequency accuracy:	0.005%
Frequency resolution:	0.001 Hz below 500 Hz, 0.01 Hz below 1000 Hz
Distortion:	< 0.1 %

Range	% value + % range	Max. compliance voltage (V)	% value + % range		Max. compliance voltage (V _{pk})	
Current	DC		15 – 40 Hz 70 – 1000 Hz	40 – 70 Hz	15 – 400 Hz	400 – 1000 Hz
5.000 – 300.000 mA	0.0175 + 0.01	8	0.021 + 0.02	0.0175 + 0.01	8	5
0.30001 – 1.00000 A	0.0175 + 0.01	8	0.021 + 0.02	0.0175 + 0.01	8	5
1.00001 – 2.00000 A	0.0175 + 0.01	8	0.021 + 0.02	0.0175 + 0.01	8	5
2.00001 – 5.00000 A	0.0175 + 0.01	5	0.021 + 0.02	0.0175 + 0.01	5	5
5.0001 – 10.0000 A	0.021 + 0.015	5	0.028 + 0.02	0.021 + 0.015	5	5
10.0001 – 30.0000 A	0.0245 + 0.015	5	0.035 + 0.02	0.0245 + 0.015	5	5

When option 140-50 Current Coil is used, add 0.3% to the accuracy specified in the table above. Output current is multiplied by factor 25 or 50 depending on applied coil range.

Relative accuracy in "High Current Modes" (output current up to 90A) is numerically the same as relative accuracy in standard current modes for three times lower current. Example: Relative accuracy for current 90Adc in High Current mode is the same as relative accuracy for current 30Adc in Standard mode (0.03955%).

Voltage from Current Terminals

Frequency range: DC, 15 Hz – 400 Hz with no distortion functions

Distortion: < 0.1 %

Range	% value + % range	Source impedance	Min. load to maintain specifications
1.000 – 20.000 mV	0.05 + 0.1	1 Ω	25 Ω
20.001 – 330.000 mV	0.05 + 0.06	1 Ω	25 Ω
0.33001 – 5.00000 V	0.05 + 0.02	18 Ω	450 Ω

Phase and power factor (sine amplitude)

Phase range: 0.0° – 359.99°

Frequency range: 15 Hz – 1000 Hz

Phase resolution: 0.01°

Power factor range: -1 – +1 (Lead, Lag)

Power factor resolution: 0.001

Power factor accuracy: $dPF = 1 - \cos(\varphi+d\varphi)/\cos \varphi$

Phase accuracy $d\varphi$ (°)³

Range	15 – 70 Hz	70 – 400 Hz	400 – 1000 Hz
5 – 8 mA	0.4	0.4	1.0
8 – 100 mA	0.05	0.1	0.4
0.1 – 10 A	0.01	0.1	0.4
10 – 30 A	0.05	0.1	0.4

3. Table valid for internal frequency synchronization. Add stability of external signal for external synchronization.

DC power

Summary range: 0.005W – 8400 W (25.2 kW with current coil option 140-50)

Power unit: W

DC electric power accuracy (%) ⁴					
Current	Voltage				
	10.0000 V	30.0000 V	70.000 V	140.000 V	280.000 V
300.000 mA	0.038	0.038	0.038	0.038	0.038
1.00000 A	0.038	0.038	0.038	0.038	0.038
5.00000 A	0.038	0.038	0.038	0.038	0.038
10.0000 A	0.045	0.045	0.045	0.045	0.045
30.0000 A	0.048	0.048	0.048	0.048	0.048
90.0000 A ⁵	0.048	0.048	0.048	0.048	0.048

4. The best option is listed.

5. Available in High I mode using 133-01 High Current Adapter.

AC power (sine amplitude)⁶

Summary range: 3x (0.005VA – 18 kVA (600 kVA with current coil option 140-50))

Frequency range: 15Hz – 1000 Hz

AC real power accuracy (%) for PF = 1.0 f = 40 – 70 Hz						
Current	Voltage					
	10.0000 V	30.0000 V	70.000 V	140.000 V	280.000 V	600.000 V
300.000 mA	0.037	0.037	0.037	0.037	0.037	0.039
1.00000 A	0.037	0.037	0.037	0.037	0.037	0.039
5.00000 A	0.037	0.037	0.037	0.037	0.037	0.039
10.0000 A	0.043	0.043	0.043	0.043	0.043	0.046
30.0000 A	0.046	0.046	0.046	0.046	0.046	0.048
AC electric power accuracy (%) for PF = 0.8 f = 40 – 70 Hz						
Current	Voltage					
	10.0000 V	30.0000 V	70.000 V	140.000 V	280.000 V	600.000 V
300.000 mA	0.039	0.039	0.039	0.039	0.039	0.041
1.00000 A	0.039	0.039	0.039	0.039	0.039	0.041
5.00000 A	0.039	0.039	0.039	0.039	0.039	0.041
10.0000 A	0.045	0.045	0.045	0.045	0.045	0.047
30.0000 A	0.080	0.080	0.080	0.080	0.080	0.081
AC electric power accuracy (%) for PF = 0.5 f = 40 – 70 Hz						
Current	Voltage					
	10.0000 V	30.0000 V	70.000 V	140.000 V	280.000 V	600.000 V
300.000 mA	0.047	0.047	0.047	0.047	0.047	0.049
1.00000 A	0.047	0.047	0.047	0.047	0.047	0.049
5.00000 A	0.047	0.047	0.047	0.047	0.047	0.049
10.0000 A	0.053	0.053	0.053	0.053	0.053	0.055
30.0000 A	0.158	0.158	0.158	0.158	0.158	0.159

6. The best option is listed.

(Real) Power accuracy calculation:

Reactive Power accuracy calculation:

Apparent Power accuracy calculation:

DC Power accuracy calculation:

$$dP_W = \sqrt{(dU^2 + dI^2 + dPF^2 + 0.01^2)} (\%)$$

$$dP_{VAR} = \sqrt{(dU^2 + dI^2 + dPF_{VAR}^2 + 0.01^2)} (\%)$$

$$dP_{VA} = \sqrt{(dU^2 + dI^2 + 0.01^2)} (\%)$$

$$dP_{Wdc} = \sqrt{(dU^2 + dI^2 + 0.01^2)} (\%)$$

Where:

$$dPF = \text{abs}(100 * (1 - \cos(\varphi + d\varphi) / \cos(\varphi))) [\%]$$

$$dPF_{VAR} = \text{abs}(100 * (1 - \sin(\varphi + d\varphi) / \sin(\varphi))) [\%]$$

φ is set phase [°]

dU is accuracy of set voltage [%]

dI is accuracy of set current [%]

d φ is accuracy of set phase [°]

Example1 (Real power accuracy calculation, U=230V, I=5A, $\varphi=60^\circ$, f=50Hz):

$$dU = 0.012\% + 0.01\% * 280/230 = 0.0242\%$$

$$dI = 0.0175\% + 0.01\% * 5/5 = 0.0275\%$$

$$dPF = \text{abs}(100 * (1 - \cos(60^\circ + 0.01^\circ) / \cos(60^\circ))) = 0.0302\%$$

$$dP_W = \sqrt{(0.0242^2 + 0.0275^2 + 0.0302^2 + 0.01^2)}\% = 0.049\%$$

Example2 (Reactive power accuracy calculation, U=230V, I=5A, $\varphi=60^\circ$, f=50Hz):

$$dU = 0.012\% + 0.01\% * 280/230 = 0.0242\%$$

$$dI = 0.0175\% + 0.01\% * 5/5 = 0.0275\%$$

$$dPF_{VAR} = \text{abs}(100 * (1 - \sin(60^\circ + 0.01^\circ) / \sin(60^\circ))) = 0.0101\%$$

$$dP_{VAR} = \sqrt{(0.0242^2 + 0.0275^2 + 0.0101^2 + 0.01^2)}\% = 0.039\%$$

DC/AC energy (sine amplitude)

Voltage range: 1 – 280 Vdc (600 Vac)

Current range: 5 mA – 30 A

Power factor range: - 1 – + 1

Time range: 1 – 1e8 s

Time resolution: 0.1 s

Time interval accuracy: 0.01 % + 0.1 s

Max counts: 4e9

Energy accuracy calculation

In Packet control mode:

$$dE = \sqrt{(dP^2 + dt^2)} (\%)$$

In Counter, Timer and Free run control modes:

$$dE = dP (\%)$$

Where:

dP is accuracy of set power [%]

dt is accuracy of selected time interval [%]

Non harmonic signals (model M133C only)

Harmonic and interharmonic distortion (H/I products)

Fundamental harmonic frequency range: 15 Hz – 1 kHz

Fundamental harmonic amplitude accuracy: 0.2 % of range

Harmonics (2 – 50) frequency range: 30 Hz – 5 kHz

Interharmonic frequency range: 15 Hz – 1 kHz

Max. of harmonic products: 63

Number of interharmonic products: 1

Frequency accuracy: 0.005 %

Fundamental harmonic phase accuracy: 0.2° for 15.000 Hz – 70.000 Hz
0.5° for 70.001 Hz – 400.000 Hz

1° for 400.001 Hz – 1000.00 Hz

Harmonics (2 – 50) phase accuracy: 5 us (typical value, not guaranteed)

Amplitude range of H/I products: max. 30% of RMS output value

Amplitude resolution of H/I products: 0.001 %

Noise & Distortion: - 60 dB

Amplitude accuracy of H/I products

Range	% of range	% of range
	30 – 3000 Hz	3000 – 5000 Hz
All voltage ranges	0.1	0.2
0.005000 – 0.300000 A 0.300001 – 1.000000 A 1.000001 – 2.000000 A	0.1	0.2
2.000001 – 5.000000 A 5.000001 – 10.000000 A	0.2	0.4
10.000001 – 30.000000 A	0.2	0.8

Modulation (Flicker)

Fundamental harmonic frequency range:	15 Hz – 1 kHz
Single harmonic (2 – 50) frequency range:	30 Hz – 5 kHz
Modulation frequency range:	0.001 Hz – 50 Hz
Modulation depth:	0 – 30%
Modulation depth resolution:	0.001%
RMS amplitude accuracy:	0.2 % of range
Waveform of modulation signal:	sine, rectangular
Modulation depth accuracy:	0.2 %

Dip/Swell

AC voltage range:	0.1 V – 280 V
AC current range:	1 mA – 30 A
Amplitude accuracy:	0.2 % of range ^{*1}
Frequency range:	15 Hz – 1 kHz
Timing ^{*2}	
t1 range:	0 s – 60 s
t2 range:	0.1 ms – 60 s
t3 range:	2 ms – 60 s
t4 range:	0.1 ms – 60 s
t5 range:	0 s – 60 s

^{*1} range is selected according to the highest value of output signal

^{*2} t1 + t5 > 2 ms

Multimeter

Function	Total range	Accuracy	Resolution / Range
DC voltage	0 – ±12 V	0.01 % + 0.01 %	100 μ V / 10V
DC current	0 – ±25 mA	0.01 % + 0.01 %	100 nA/20mA
Frequency	1 Hz – 15 kHz	0.005 %	10 μ Hz – 0.1 Hz

Optical scanning head (option 133-02)

Frequency range & accuracy:	same as multimeter
Sensor size:	32 mm diameter x 24 mm height
DUT attachment:	magnetic

Auxiliary inputs

Input IN1 (energy pulses, synchronization)

Max frequency	1 MHz (400 Hz for debounced input)
Min pulse width	500 ns
Input low level max	0.8 V
Input high level min	3.2 V
Internal pull-up values	150 Ω / 1 k Ω at 5V nominal

Input IN2 (energy pulses, synchronization)

Max frequency	10 kHz
Input low level max	0.8 V
Input high level min	3.5 V

Input IN3 (trigger, synchronization)

Min pulse width	10 us
Input low level max	0.8 V
Input high level min	3.5 V

General data

Warm up time:	60 min
Operating temperature:	+13 °C – +33 °C, humidity < 80 %
Storage temperature:	-10 °C – +55 °C, humidity < 90 %
Reference temperature:	+21 °C – +25 °C
Temperature coefficient:	0.1x spec /°C outside reference temperatures
Dimensions:	500(D) x 520(W) x 430(H) mm
Netto weight:	59 kg (M133C Three phase version) 37 kg (M133C Single phase version)
Power supply:	115/230V +/- 10%, 47...63 Hz
Power consumption:	max. 1875 VA
Safety class:	I, according EN 1010
Languages:	English, Chinese (simplified)

9. Revisions

9.1. Change 1:

Added test points for:

DC Voltage from current (Chapter 5.4.)

AC Voltage from current (Chapter 5.4.)

CE Certificate of conformity

According to EN ISO/IEC 17050-1:2010 standard as well as 2014/30/EU and 2014/35/EU directives of European Parliament and European Council, MEATEST, spol. s r. o., manufacturer of M133C Electric Power/Energy Calibrator based in Železná 3, 619 00 Brno, Czech Republic, declares that its product conforms to following specifications:

Safety requirements

- EN 61010-1 ed. 2:2010 + A1:2016 + COR1:2019-03

Electromagnetic compatibility

- EN 61000 part 3-2 ed. 5:2019
- EN 61000 part 3-3 ed. 3:2014
- EN 61000 part 4-2 ed. 2:2009
- EN 61000 part 4-3 ed. 3:2006 +A1:2008+A2:2011+Z1:2010
- EN 61000 part 4-4 ed. 3:2013
- EN 61000 part 4-5 ed. 3:2015 + A1:2018
- EN 61000 part 4-6 ed. 4:2014
- EN 61000 part 4-11 ed. 2:2005
- EN 61326-1 ed. 2:2013

Brno

September 25th, 2020

Place

Date



Signature