ZES ZIMMER
Electronic Systems

1-Phase LMG95
Precision Power Meter

User manual

Status: 2007/06/15

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Regard DIN 34!

We reserve the right to implement technical changes at any time, particularly where these changes will improve the performance of the instrument.

EG-Konformitätserklärung

für das

1Phasen Präzisions Leistungsmeßgerät

CE Conformity Declaration

for the

1Phase Precision Powermeter

LMG95

Hiermit wird bestätigt, daß das oben aufgeführte Gerät den Anforderungen der Richtlinien (2004/108/EG) und (2006/95/EG) der Europäischen Gemeinschaft entspricht.

We certify that the above device accomplishes with all requirements which are defined in the directives (2004/108/EC) and (2006/95/EC) of the European Community.

Diese Erklärung gilt für alle Geräte, die nach anhängenden Fertigungsunterlagen - die Bestandteil dieser Erklärung sind- hergestellt werden.

This certificate is valid for all devices that are produced according to the appending production instructions (which are a part of this certificate).

Zur Beurteilung der Sicherheit und elektromagnetischen Verträglichkeit wurden folgende Normen herangezogen:

For the judgement of safety and electromagnetic compatibility of the product the following standards were used:

EN61010-1:2001

EN61326-1:2006

EN61000-3-2:2006

EN61000-3-3:1995+A1:2001+A5:2005

Diese Erklärung wird vom Hersteller

This certificate of the manufacturer

Z E S ZIMMER Electronic Systems GmbH
Tabaksmühlenweg 30
D-61440 Oberursel

abgegeben durch

is given by

Georg Zimmer, Geschäftsführer

Oberursel, 1. Juni 2007

Georg Zimmer, Geschäftsführer

Test Certification

Instrument Type:

Serial Number:

ZES ZIMMER Electronic Systems GmbH certifies the above instrument to comply with all specifications contained in the delivered user manual. It has left the factory in mechanically and electrically safe condition.

The measuring instruments, tools and standards used in production, adjustment and calibration are calibrated according to ISO9000 (traceable to national standards) and correspond to the standard of precision required to maintain the specified accuracies.

ZES ZIMMER Electronic Systems

Date

Tabaksmühlenweg 30
D-61440 Oberursel

Quality Control

Request/order for a calibration

Instrument: O LMG90 O LMG95 O LMG310
O LMG450 O LMG500 O other:

Serial number:

For the above instrument the following should be done:

O Calibration (order-no KR-xxx)	O Adjustment with following calibration (order-no JKR-xxx)	O Input calibration, adjustment and output calibration (order-no KJKR-xxx)
O I **don't** want to get the latest software in the instrument (free of charge). I want to keep the actual implemented software version.		

Note:
Calibration is **only** to proof the differences between the instrument and the 'true' values
Adjustment is to set-up an instrument to meet its specifications.

Company :
Street :
ZIP/City :
Country :
Email :

Name (responsible for calibration) :
Phone :
Fax :
Department :

Customer number (if available):

Date: Sign:

Please send this paper via post or fax to:

Z E S ZIMMER Electronic Systems GmbH
Tabaksmühlenweg 30
D-61440 Oberursel
Germany

Tel. +49 (0)6171/628750
Fax +49 (0)6171/52086
Email sales@zes.com

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1 Instructions and Warnings

1.1 Safety Instructions

This instrument conforms to the IEC61010-1 guide lines concerning the protection of electrical instrumentation and has left the factory in a mechanically and electrically safe condition. To maintain safe operation, the user must follow the instructions and warnings contained in this manual. The instrument satisfies the requirements of **protection class I**. Accessible metal parts of the instrument are tested with respect to the mains connection using a potential of 1500V/50Hz. Before connecting the apparatus to the mains supply, ensure that the voltage displayed on the type plate equals the available mains supply voltage. A possible installed power supply selector has to be set up. The mains plug must only be connected to an earthed mains outlet. The earth connection must not be discontinued or broken by using an extension lead without earth connection. The instrument must be connected to the mains supply before any measurement or control circuits are connected to it. Any disconnection of the earth lead inside or outside of the instrument will endanger the operating personnel. Deliberate disconnection of the earth is not permitted. When the instrument is used in combination with other instruments, then proceed as follows:

The external earth connector on the back of the instrument must not be used to earth other electrical equipment. It is only intended to provide additional earthing of the instrument in case an error occurs in the circuit under test which may cause an earth current to flow in excess of 10A which cannot be carried by the mains supply cable. If this further earthing cannot be implemented, then the measuring circuit must be suitably fused prior to its connection to the instrument. In this case, it is necessary to connect the measuring instrument to an earth connection point via the earth connector using a conductor with sufficient cross section. If this is not possible, the instrument has to be connected to the circuit to be tested via adequate fuses. The measuring inputs are isolated against voltages up to 600V according to protection class I.

Opening the instrument exposes components which may be raised to a hazardous potential. All voltage sources must be disconnected from the instrument before any instrument covers are removed for the purpose of calibration, service, repair or changing components. When access is required for calibration, service or repair, only suitably qualified personnel are permitted access to an exposed and energised instrument.

Fuses may only be replaced with the correctly rated and recommended types. The use of repaired or short circuited fuses is not permitted. The instrument should be disconnected and disabled from accidental use when it is suspected that its safe operation cannot be warranted.

The required repair work must then be carried out by a suitably qualified person who is familiar with any dangers involved.

It must be considered unsafe to operate the instrument

- if there is visual evidence of physical damage
- if the instrument fails to operate correctly
- after long-term storage under unfavourable circumstances
- if there are condensation forms due to excessive temperature changes
- following rough transport conditions

If the instrument was opened, a high voltage test according to the technical data and a test of the protective conductor are necessary following the closing of the instrument.

Storage temperature range:	-20°C to +55°C
Climatic class:	KYG according to DIN 40040 0°C...40°C, humidity max. 85%, annual average 65%, no dewing

2 General

The 1-Phase Precision Power Meter LMG95 extends the ZES multimeter product range for power measurement. It benefits from experience and know-how gained from the successful ZES LMG90 and LMG310 series.

Due to the very high sampling rate which is used in this instrument, it is now possible to make extremely accurate power and efficiency measurements in 1-phase system configurations with a choice of load and signal components containing frequencies in the precision range from DC to 50kHz.

Transient observation and storage, harmonic analysis as well as time domain views of signals on the visual display (oscilloscope mode) are all available with this instrument.

A special feature of the instrument is the simple, direct and intuitive topology of the control buttons. The display of different quantities and menus for setting up the instrument is normally achieved with only a single touch of a button.

2.1 Features and application areas

Voltages and currents can be measured over a wide dynamic range. This makes the LMG95 instrument suitable for almost all professional measurement applications such as converter-fed alternating current machines and power- and energy electronic applications. Various wire- and phase configurations can be pre-selected to suit any required user application.

Another feature of the instrument is to suppress high frequency harmonics by means of selectable filters (option). This makes it possible to take only the fundamental harmonics into account, which are responsible for torque production.

Due to the exceptionally good common mode rejection of the individual channels it is possible to measure currents and voltages which float up to 600V and at high frequencies with respect to earth. This is particularly important for measurements in inverter- and rectifier circuitry and in switched mode power supply applications.

The harmonics option permits the measurement of high frequency harmonic reflections in networks conforming to IEC61000-3-2 standards and is therefore indispensable for tests according to these standards. The user can also obtain the energy distribution over different frequency ranges and can thus investigate their relative contribution to the total consumption of energy.

The LMG95 is suitable for measurements in electro magnetically noisy environments to IEC61000-4. This feature is of particular importance for measurements in power electronics.

Other applications include the measurement of reactive and non-linear component losses (such as in transformers, chokes, motors, capacitors, power supplies), the computation of the efficiencies of photovoltaic modules and other alternative energy components. Further on you can calculate energy and charge, e.g. of accumulators.

2.2 Usage of the manual

The LMG95 is controlled either by depressing buttons with hard-wired functions (in the following characterised by *italic* style), or by using soft keys (**bold** style) which will perform tasks that depend on a particular menu choice. This approach makes it possible to call all functions using a limited number of buttons without a need to call double or triple functions with one button. There are no menu trees so that the user does not need to fight her or his way through a menu jungle in order to call a particular display. Each menu can be called by simply pressing a single button.

The upper 6 buttons of the numerical keypad (*Default, Voltage, Current, Power, Int. Val and Graph*) enable the standard display of the measuring values by simply pressing a single button. In this menu a specified selection of the respective measuring values can be displayed using the soft keys.

The menus for the parameter set-up is called via the lower 6 buttons of the numerical keypad (*Measuring, Range, Int.Time, IF/IO, Misc., Custom*). Thereby, all the instrument parameters can be adjusted using the soft keys.

Despite the simple and intuitive operation of the controls, it is recommended that even experienced users should carefully read and work through this manual to eliminate operational mistakes and to explore the full capability of the instrument.

There are following measuring modes:

- normal mode: In this mode the LMG95 works as a power-meter with integrated scope function. The TRMS values of voltage and current, the power and derived values are measured via the power measuring channel.

- CE harmonics mode: In this mode the LMG95 works as an harmonic analyser. All measurements are judged according to the standards. There is only a minimum of settings to prevent set-up errors.

- CE flicker mode: In this mode the LMG95 works as a flicker meter. All measurements are judged according to the standards. There is only a minimum of settings to prevent set-up errors.

- Harm100 mode: In this mode the LMG95 works as an harmonic analyser for 100 harmonic components. You get many values like phase angles and the power at each frequency.

- Transient mode: In this mode the LMG95 works as a transient recorder. You can define special events when the storage of values should be stopped.

The active mode depends on the setting in the *Measuring* menu. Some other menus also depend on this setting (see the respective description).

For each measuring mode you find a chapter in the manual. Inside this chapter the different menus for this operating mode are described.

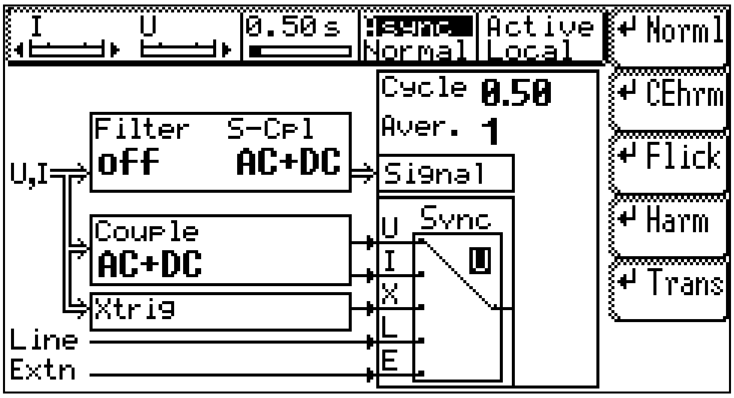


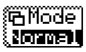
Figure 1: Measuring menu

2.3 General handling of the instrument

The main menus are reached by pressing the corresponding key of the keypad. In many menus you find softkeys which change their function depending on the menu.

All softkeys are of following types. They are identified by the small symbol in the upper left corner. The text in the softkeys depends on the context of the menu.

Execution softkey. The action described by the text is executed immediately without the possibility to cancel it.



Branch softkey. After pressing this softkey a new list of softkeys will appear. Now you can select one of this new softkeys or you can cancel the action be pressing *ESC*.

List softkey. After pressing this softkey you get a selection list. You can choose one element of the list (with the rotary knob) and then you can confirm your choice by pressing the rotary knob or *ENTER* or you can cancel the selection by pressing *ESC*.

Text edit softkey. After pressing this softkey you can enter identifiers (for example in the formula editor or to output values via the analogue outputs). This kind of text input is described in 4.5, ‘Entering identifiers, characters and text’

Count softkey. After pressing this softkey you can adjust the depending values with the opening up and down buttons in fixed steps.

Time softkey. After pressing this softkey you can adjust a time setting. The values for hours, minutes and seconds must be separated by a colon, pressing the button *Misc.* Then you can confirm your adjustments by pressing the rotary knob or *ENTER* or you can cancel the selection by pressing *ESC*.

Date softkey. After pressing this softkey you adjust a date. The values for day, month and year must be separated by a colon, pressing the button *Misc.* Then you can confirm your adjustments by pressing the rotary knob or *ENTER* or you can cancel the selection by pressing *ESC*.

Time duration softkey. After pressing this softkey you can adjust a time duration, in which e.g. an integration of values should be made. You can set up the duration in several data formats e.g. in seconds without a hyphen or by values for hours, minutes and seconds separated by a colon (pressing the button *Misc.*). Confirm your choice by pressing the rotary knob or *ENTER* or you can cancel the selection by pressing *ESC*.

Digit softkey. After pressing this softkey you must enter numbers. Then you can confirm your choice by pressing the rotary knob or *ENTER* or you can cancel the selection by pressing *ESC*.

3 Installation

3.1 Unpacking and putting into operation

Having unpacked the equipment, it should be checked for signs of damage. Damage due to transportation should be reported to the equipment supplier at the earliest opportunity. If it is not possible to use the damaged equipment safely, then the equipment should not be used.

The package should be stored for further transports (e.g. for the annual calibration according to ISO9000).

After delivery the following items should be present:
- 1 LMG95 1-phase precision measuring instrument
- 1 User manual
- 4 Safety type grey and violet laboratory cables, 2.5mm², 1m
- 1 Mains supply cable
- Further accessories as listed in the delivery note.

The instrument should only be used in a clean and dry environment and must never be operated in excessively dusty or moist spaces. To ascertain sufficient air circulation the instrument should only be operated in a horizontal position or tilted by means of the adjustable handle. The instrument should not operate in direct sunlight.

3.2 General set-up

In general the instrument stores the actual settings as well as the last used menu. Pressing the both lower softkeys when switching on the instrument will reset all settings to the default parameters.

3.3 Connection of the LMG95

The instrument conforms to protection class I. A suitable mains cable is supplied with the instrument for connection to an earthed mains supply point. When in use the unit must be securely earthed; continuity of the mains earth connection should be checked. Make sure that attention is paid to the following points:

⚠ **Warning!** The black terminals on the back of the instrument must be used for additional earthing in case an earth current in excess of 10A might result accidentally in the system under test. Since the earthing conductor of the mains supply is unable to carry such currents, the instrument have to be connected to a suitable earth point via an adequately rated cable. If reliable earthing cannot be realised, the connections between the system under test and the instrument must be fused appropriately. The earth terminal on the instrument must not be used as the only earth connection for the instrument nor must the test circuit be earthed from this terminal.

⚠ **Attention!** Before connecting the mains cable to an electricity supply, confirm that the mains supply voltage corresponds to the voltage printed on the model's identification plate.

⚠ **Warning!** Remove all power supplies to a test circuit before connecting a probe for measurement purposes.

⚠ **Attention!** **The following maximum values must not be exceeded:**

I*, I: maximum 21A (short-time 160A)

Shunt Input: maximum 10V signal voltage

When the instrument has a BNC connector for the shunt input you have maximum 600V@CAT III or 1000V@CAT II operating voltage against earth or instrument casing. When the shunt input uses a safety jack you have maximum 1000V@CAT III or 1500V@CAT II operating voltage against earth, instrument casing or voltage channel. See also 0, ‘Figure 36: Dimensions of 1 HU instrument instrument

Operating voltages’

U*, U: maximum 600V (short-time 1500V) between U and U*, maximum 1000V@CAT III or 1500V@CAT II operating voltage against earth, instrument casing or current channel.

⚠ **Attention!** The jacks for I, I* and Shunt Input are internally connected. If you measure a current, the Shunt Input jack has the same voltage against earth like the I jacks! The shield of the shunt / transformer input (protection BNC connector) is internally directly connected to the I jack. For this purpose do not connect the I/I* jack and the shunt input at the same time!

Attention! Use only cables with **safety** connectors and sufficient cross section (obtainable from the equipment manufacturer). This is also recommended for the protection BNC connectors!
Please take care that this cables have a sufficient testing voltage and are useable for the wanted over voltage category.

Attention! Do not use unisolated BNC cables

Attention! Cables of external sensors like clamps are often designed to operate with low voltages (<10V). For the operation itself this is ok, but if this cables touch a bare conductor this can be dangerous!

To ensure correct power measurement polarity, connect the cabling to the test circuit so that the grey terminals (U and I) are used as a reference. In other words, the signal source should point towards the terminals U* and I*.

When working with DC voltages/currents, note that the terminals marked with the '*' are the positive connections.

The following diagrams are some examples for typical connections of the LMG95. But all other measuring circuits are also possible (e.g. circuits which measure the correct current instead of the correct voltage).

3.3.1 Measuring circuit using the internal current path

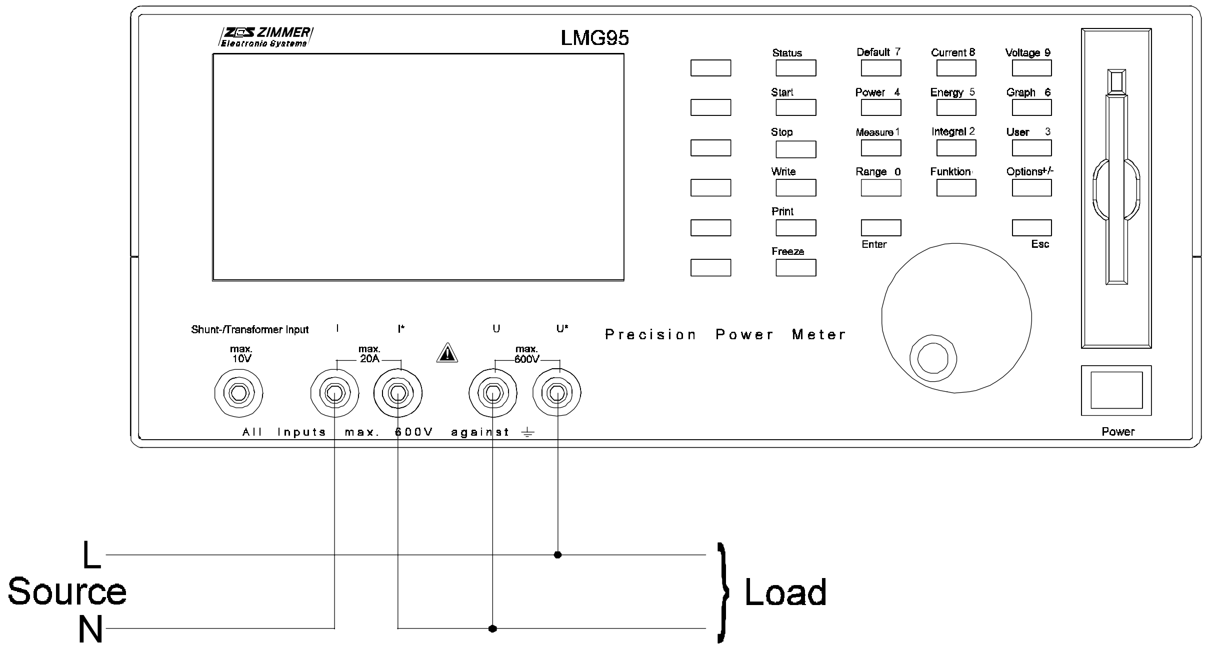


Figure 2: Standard measuring circuit

3.3.2 Measuring circuit using an external current transformer

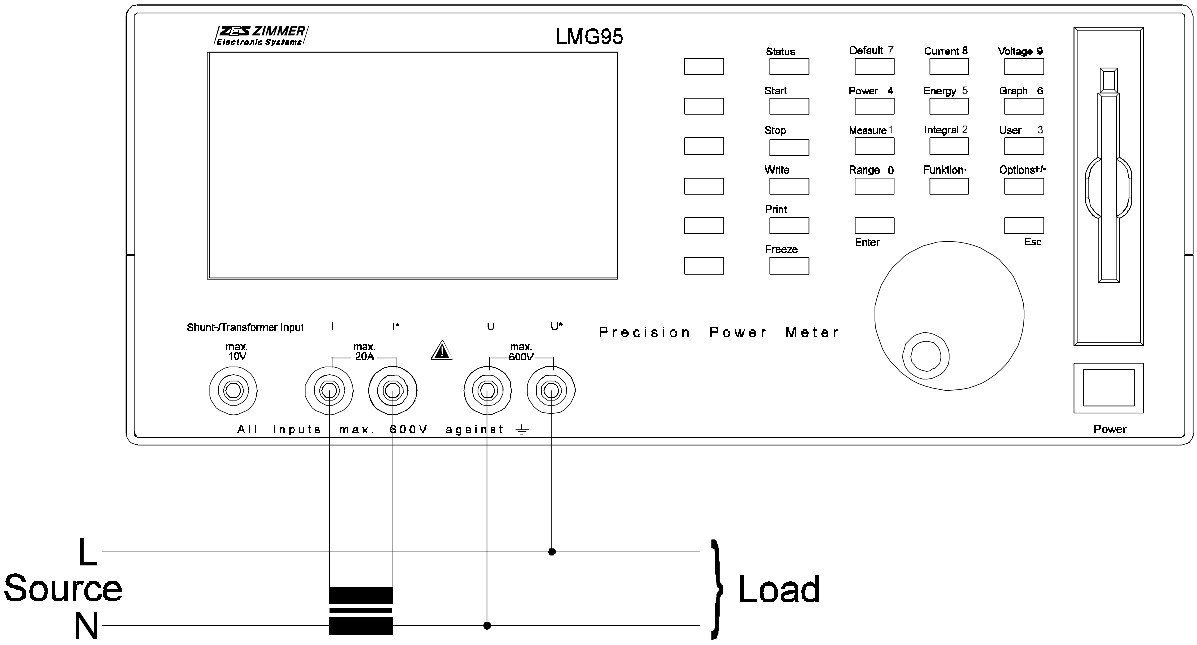


Figure 3: Measuring circuit with external current transformer

3.3.3 Measuring circuit using an external shunt

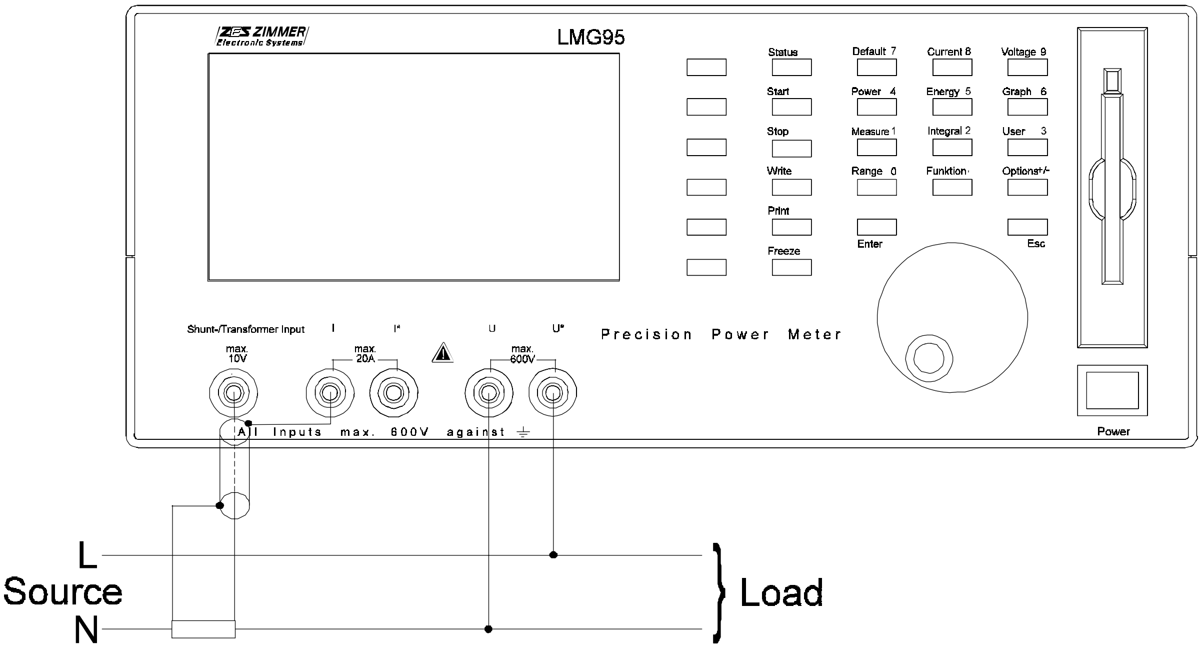


Figure 4: Measuring circuit with external shunt

3.3.4 Measuring circuit using an external current transducer

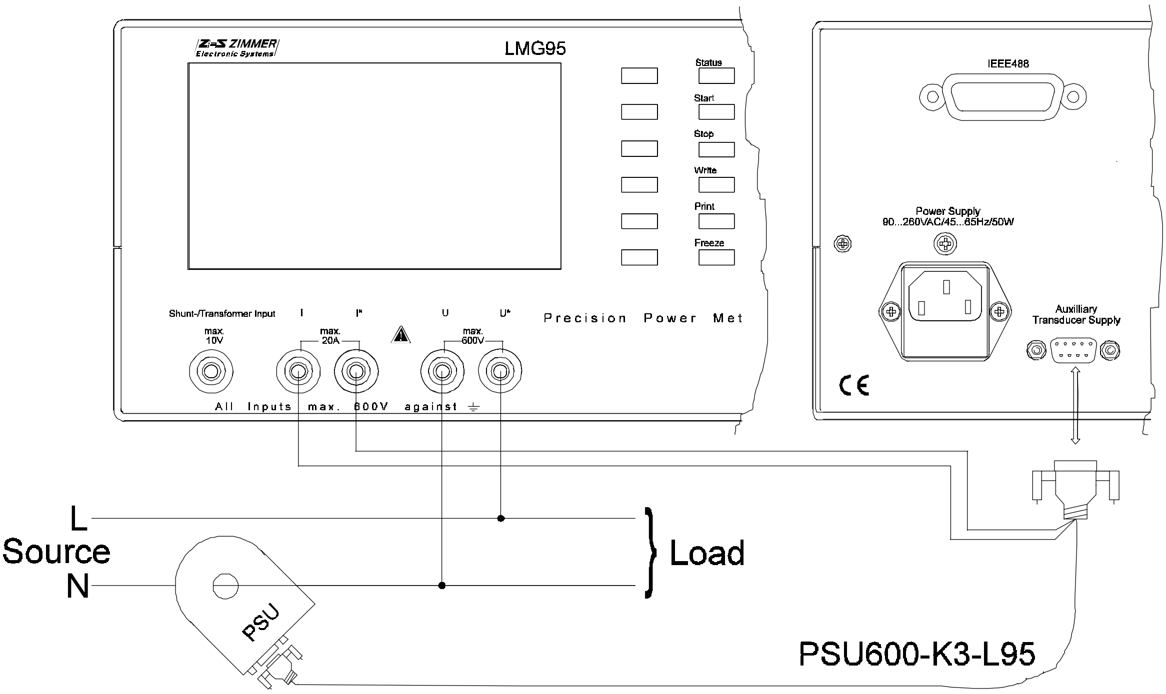


Figure 5: Measuring circuit with external transducer

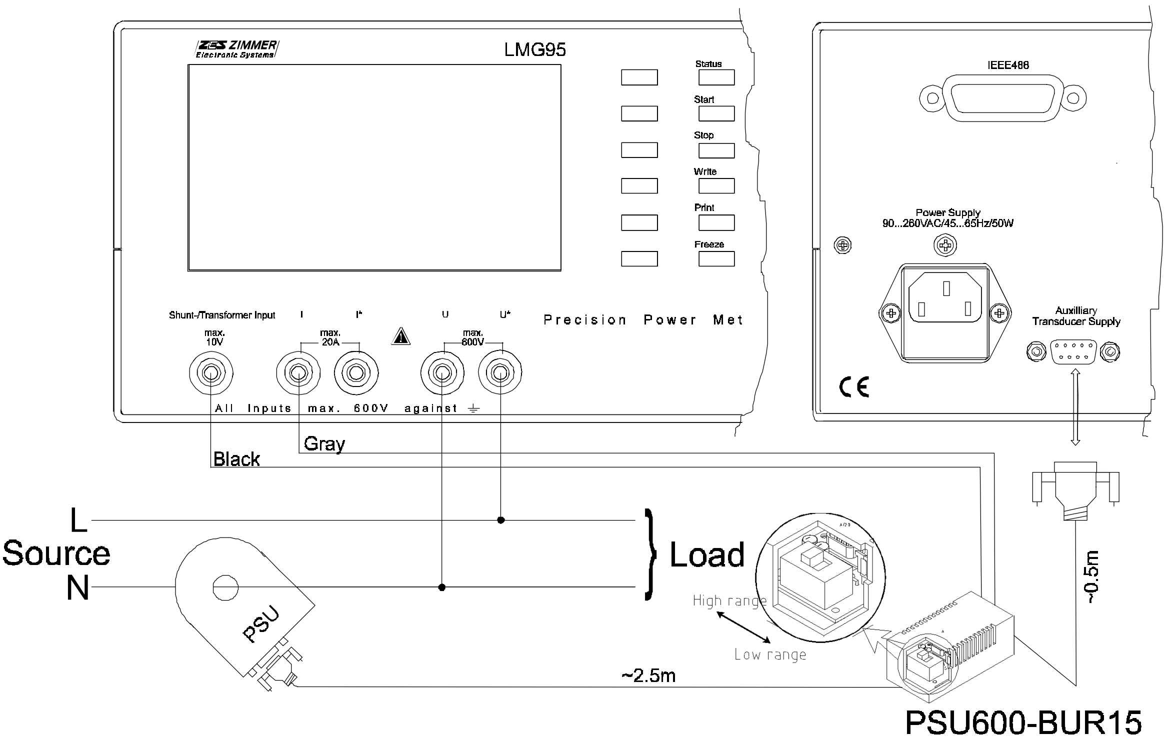


Figure 6: Measuring circuit with external transducer and PSU600-BUR15

This special current transducers of the PSU series can measure currents up to 600Apk in the frequency range from DC to >100kHz. The auxiliary supply for the transducer is taken from a 9 pin SUB-D jack from the rear of the instrument.

PSU600-K3-L95

The set-up of the range menu should look like this (for PSU600): Current scaling 1500, Shunt intern, current range 0.4Apk or smaller.

PSU600-BUR15

In the case of the burden is a switch. It can be positioned in direction to the both cable-connectors (Scaling 100) or in direction to the both capacitors (Scaling 1000). To change the switch you can use a small screw driver or similar. You don’t need to open the case.

The set-up of the range menu should look like this: Shunt extern, set current scaling to the value 100 or 1000 (see above). Depending on the scaling you can choose the 3A to 400A range (scaling 100) or the 30A to 4000A range (scaling 1000).

The green/red LED indicates, if the PSU works correctly or is in overload condition.

Scaling 100

Please note, that in this scaling you can only measure up to 350Apk!

Scaling 1000

Please note that the ranges from 1000A to 4000A should not be used, because the PSU can only transform up to 600Apk! You can measure in this ranges, but you will get a bigger error.

4 Instrument controls

4.1 Front panel

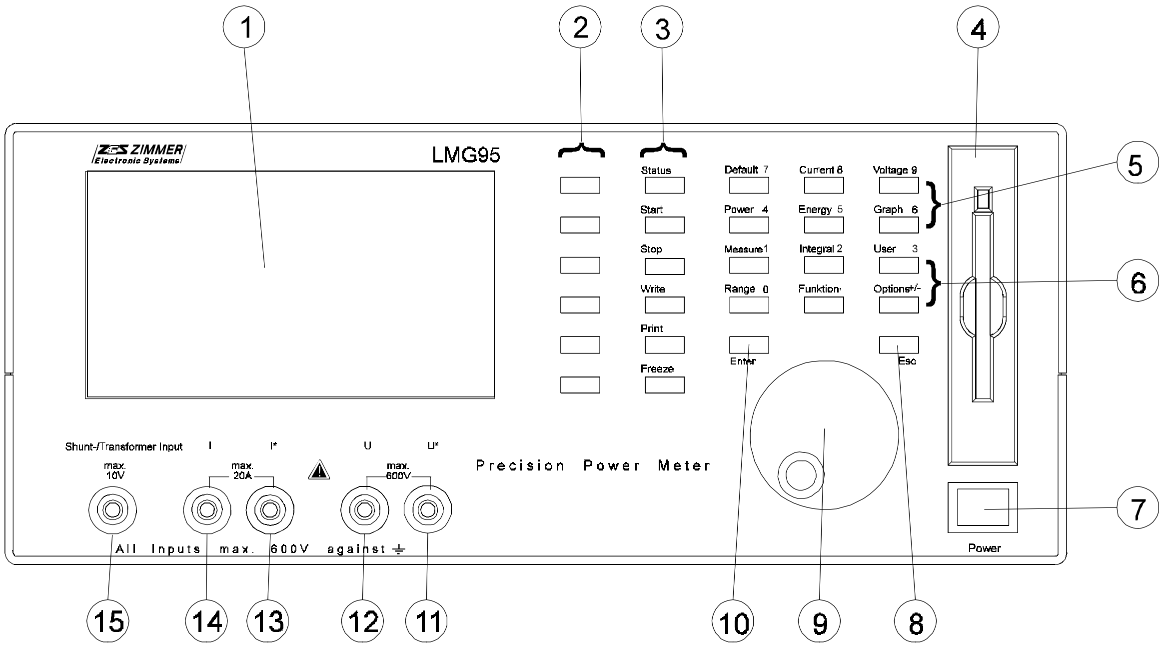


Figure 7: Front panel of the instrument

1 Graphical Display

2 6 Softkeys.
Their function depends on the indicated function in the display.

3 Special function keys:
Status: Here you get status information about the LMG95
Start: This key is used to start time dependent measurements
Stop: This key is used to stop time dependent measurements
Save/Recall: („Write“ on older instruments) The actual menu is stored to the memory card
Print/Log: The actual menu is send to the printer output
Freeze: Holds or enables the visual display

4 Memory Card Slot
Here the PCMCIA memory cards are inserted.

5 White menu selection keys
With this keys you can call different menus with the pure measuring values:
Default, Current, Voltage, Power, Int. Value (Energy on older instruments) and Graph.
A second function of this keys is to enter the digits from ‘4’ to ‘9’ when in a number entering mode.

6 Violet menu selection keys
With this keys you can call several menus for setting up the instrument:
Measure: The main measuring parameters
Int.Time: ('Integral' on older instruments) The parameters for time dependent measuring
Custom: ('User' on older instruments) The set-up of the custom defined menus
Ranges: The range selection of the measuring channels
Misc.: ('Function' on older instruments) Set-up of date, time and display brightness.
IF/IO: ('Options' on older instruments) Set-up of options
A second function of this keys is to enter the digits from '0' to '3' and '.' and '-' when in a number entering mode.

7 Mains switch

8 ESC key
This key is used cancel an entering mode and to quit an error message.

9 Rotary knob
This knob is used for several number settings, for selections in lists and for cursor moving. A turn to the right increases the number.

10 ENTER key
This key is used to finish an entering and to quit an error message

11 U*
Voltage input (high), 4mm violet safety socket

12 U
Voltage input (low), 4mm grey safety socket

13 I*
Current input (high), 4mm violet safety socket

14 I
Current input (low), 4mm grey safety socket

15 Shunt / transformer input
Input for voltages from external shunts and transformers, 4mm black safety socket

4.2 Rear panel

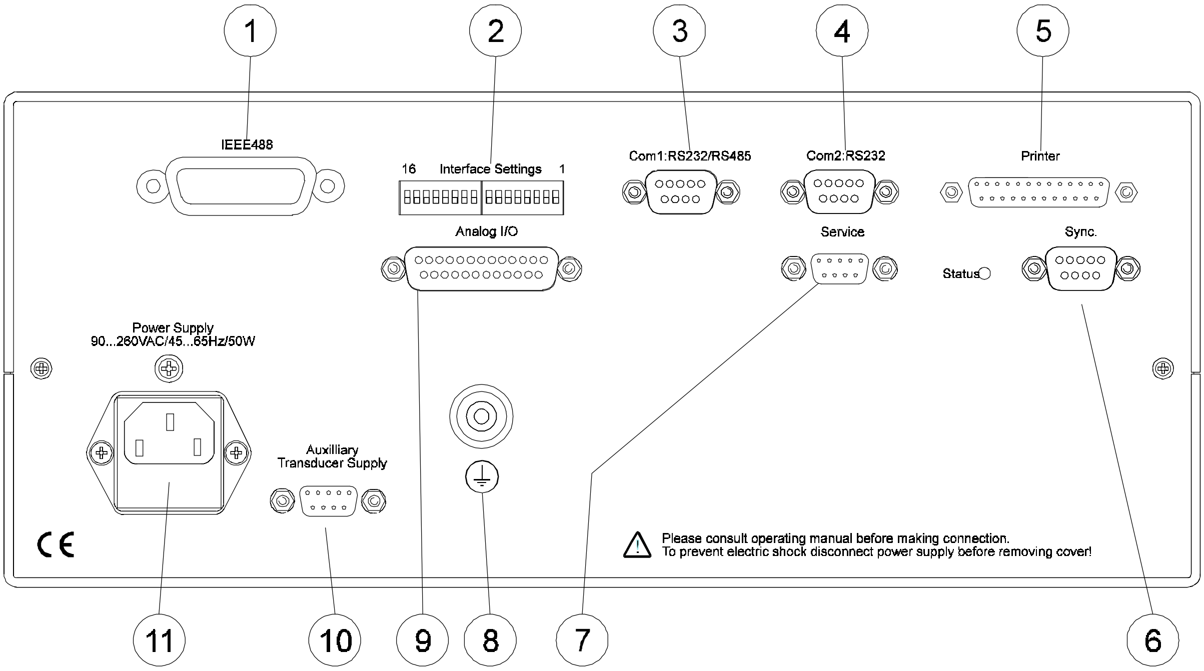


Figure 8: Rear panel of the standard instrument

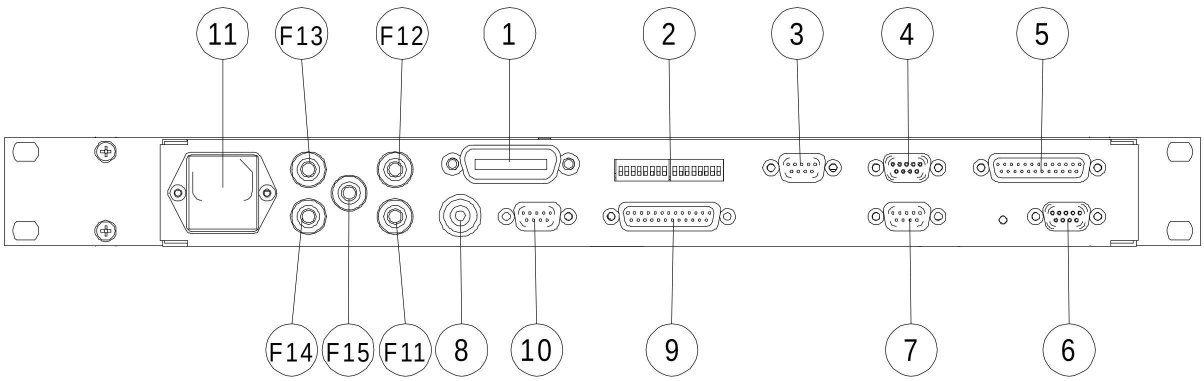


Figure 9: Rear panel of the 1HE instrument

1 IEEE488
Parallel interface, 24-pin micro-ribbon socket

2 DIP-Switches
This switches are used for external configuration of the interface parameters

3 COM1: Serial RS232 interface
This is the standard serial interface for remote control of the LMG95.
9-pin SUB-D socket

4 COM2: Serial RS232 interface
This is a serial interface which is reserved for further usage
9-pin SUB-D socket

5 Printer
Centronics compatible interface or printer connection
25-pin SUB-D socket

6 Sync.
Socket for external synchronisation and measuring time control of the LMG95.
9-pin SUB-D socket

7 Service
Socket for service purposes such like software update.

8 PE
Connector for additional earthing, pole terminal

9 Analogue I/O
Additional analogue and digital inputs and outputs for auxiliary signals.

10 Auxiliary transducer supply
Here a voltage of ±15V is available. It is used for external sensors.

11 Mains
Fused chassis plug with holder for micro fuses. Mains voltage 90...250V, 45...65Hz, about 30W
Micro fuse T1A/250V, 5x20mm, IEC127-2/3

For F11...F15 please refer to 11...15 of front panel section.

4.3 Display

The display is divided into 3 regions:

- The softkeys at the right border change their meaning depending on the actual menu. A softkey with a black background is an active softkey. A dotted softkey can not be used.
- The elements of the status line at the top of the display are described in ‘4.3.1 Status line’. In this line you can see the most important status information of the instrument. This line is always visible.
- In the main display the different menus are displayed. This can be measuring values or set up menus.
  At the bottom of this region a possible error message is displayed. This error messages have to be quit by pressing *Enter* or *Esc*.

4.3.1 Status line

Figure 10: Status line

The status line has the following 5 sub regions (from left to right):

- The current signal level indicator. Here you can see how much of the actual current range has been used. This display is important for the selection of the measuring range. An inverse displayed ‘LF’ indicates that signal of the channel is filtered. If the arrow to the left is blinking you should use next lower range. If the arrow to the right is blinking you should use the next bigger range.

- The voltage signal level indicator. Here you can see how much of the actual voltage range has been used. This display is important for the selection of the measuring range. An inverse displayed ‘LF’ indicates that signal of the channel is filtered. If the arrow to the left is blinking you should use next lower range. If the arrow to the right is blinking you should use the next bigger range.

- The time base indicator shows the actual chosen cycle time. The bar below this number shows how much of the cycle time is over.

- The synchronisation and mode indicator. In the first line you see the chosen synchronisation source. Possible values are ‘Line’, ‘Extern’, ‘Sync U’ and ‘Sync I’. If this display is written on a white background, a valid synchronisation signal is found. Else the instrument could not found a valid signal.
  In the second line you see the chosen measuring mode. Possible values are ‘Normal’, ‘CE-Harm’, ‘CE-Flk’, ‘HRM100’ and ‘Trans’.

- The freeze and remote indicator. In the first line ‘Active’ indicates, that the display is updated with measuring values. ‘Freeze’ indicates a frozen display. The actual displayed values don’t change until ‘Active’ is chosen again.
  In the second line ‘Remote’ indicates that the instrument is remote controlled by a PC. Some setting can now only be done by the PC but not at the front panel. ‘Local’ indicates, that the instrument works as a stand alone instrument.

4.4 General menus

If you are in a sub menu of a menu, you can reach the main menu by pressing the correct softkey, until you are in the main menu or you can press the menu button (e.g. *IF/IO*) again.

Here you find the description of menus which are equal for all measuring modes.

4.4.1 Misc.

On older instruments this key was called ‘Function’.
Here you can do 4 settings:

Date Here you can enter the actual date. This date is used inside the instrument.

Time Here you can enter the actual time. This time is used inside the instrument. Instead of the ‘:’ you have to enter a ‘.’.

Contrast Here you can change the contrast of the display.

Bright Here you can change the brightness of the display.

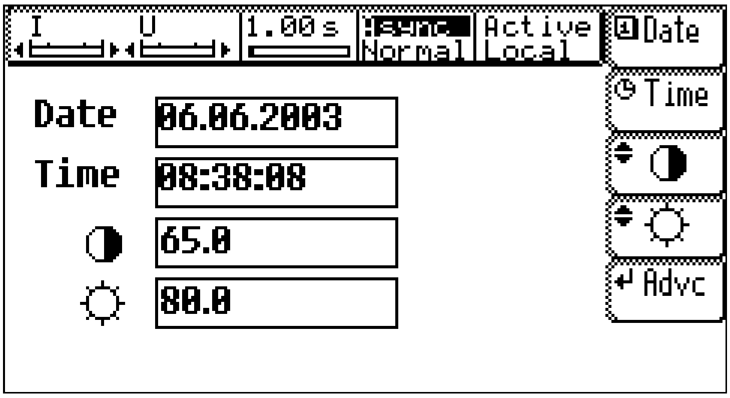


Figure 11: Misc. menu

Advc Here you can set-up some advanced, special things which should not be used under usual conditions. Just users which are sure to know what they do should change values in this menu. With wrong settings measuring results might be wrong! Following things ca be set-up:

Zero The zero point rejection (see 13.3, ‘Display of values’) can be switched off. It will be activated again each time you restart the instrument.

4.4.2 IF/IO

On older instruments this key was called ‘Options’.

In this menu you can set-up all features which are available as instrument options. Further on you see the actual software version and the installed options. With **List** you can choose a short list or detail list. In the last one you can scroll with the rotary knob.

4.4.2.1 Interfaces for remote control

With exception of the IEEE interface all interfaces could also be used for data logging (see 11, ‘Logging of values to drives, printer and interfaces’. To remote control the LMG you first have to set-up the wished interface for this job.

Press several times *IF/IO* to reach the IF/IO menu. By pressing **IF** you can set-up the remote device. You have several available ‘profiles’ from which you can select one (with **Dev.**). These profiles are predefined but they can be modified when necessary (with **Set**).

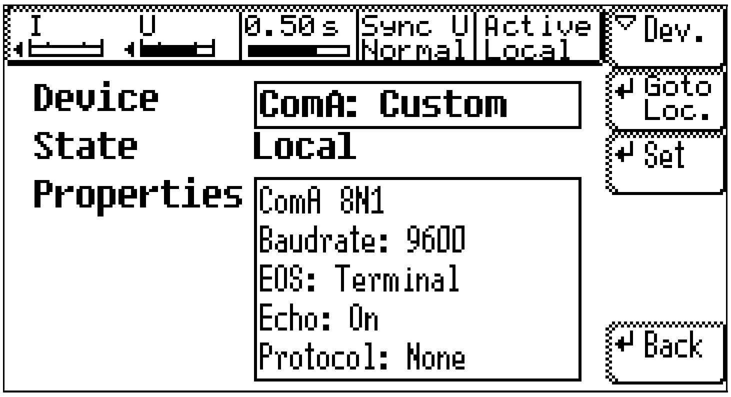


Figure 12: Interface Set-up

If you modify the remote control profile for ComA the data logging profile for ComA is not changed!

If you want to reserve an interface for logging, it can happen that this interface is already used for logging. In this case you are asked, if you want to reassign it for logging. Press *Enter* to do this or *Esc* to cancel.

4.4.2.1.1 Remote control profiles

The actual setting of a profile are displayed under properties. You can change them by pressing **Set**.

Following profiles are available. You get just these displayed which are physically present:

ComA: Terminal

Choose this profile if you are not familiar with the remote possibilities of the LMG and you want to try to enter some commands manually via a terminal program. You can just change the baud rate. The other parameters are set up to values (EOS=Terminal, Echo=off, Protocol=None) so that you can work with most terminal programs directly. The default value for the baud rate is 9600 baud.

ComA: Formula

Instead of entering a formula via the rotary knob you can also transfer it via the serial interface. If you want to do this, you can get a freeware program from ZES. This profile is predefined to communicate with this program. You just have to set-up the profile, connect LMG and PC with a 1:1 cable and start the software.

With this software you can create, read out, modify, write and save a formula.

ComA: OEM Appl

This should be chosen for external software like SYS61K, TERM-L5 or other software from ZES (if no other specification in the software exists). Most parameters are fixed (EOS=<lf>, Echo=off, Protocol=RTS/CTS) and you can just modify the baudrate. Default value is 38400 baud.

ComA: Custom

If you want to implement the LMG into your own system, you can set-up in this profile all parameters:

Baudrate	The serial interface supports baud rates from 1200 (maximum about 100 characters per second) up to 115200 baud (10000 characters per second). Usually you use the biggest value. Some old PC support just up to 38400 baud.
EOS	End-Of-String character(s). This are the characters which mark the end of a command or answer. Possible values are ‘<lf>‘, ‘<cr>, <cr><lf>‘ and ‘Terminal’. In ‘Terminal’ mode each ‘<cr>‘ of the computer is answered by a ‘<cr><lf>‘ of the LMG450. By this you get a nice display if you use an terminal program (if you have also activated the echo).
Echo	If this is set on, each character you send to the LMG is returned to the sender. By this you can check, if the cable is working and in a terminal program you see, what you have typed.
Protocol	The LMG supports ‘None’ protocol and ‘RTS/CTS’. The last one is a hardware handshake. It should be used, if the computer can’t read all data in real time and it gets very many data.

ComB: Custom

Same like ComA. Please note that you have to use a null modem cable.

GPIB

If you want to use this interface you need a GPIB controller in your PC. You have just to set-up the address of the LMG (in the range from 1 to 30).

SWITCHES

This is not a real profile but indicates that the interface settings are controlled by the DIP switches at the rear of the instrument (see 10.3.5, ‘Set-up using DIP switches’)

4.4.2.1.2 remote <-> local

If you send any characters to the LMG it changes to the remote state (you see a ‘REM’ in the status line). Then it is impossible to change any parameters like cycle time, because this might conflict with an actual remote command.

To leave this remote state you can send an ‘go-to-local’ command via interface or you can press the **Goto Local** softkey.

If you send further characters to the instrument it changes back to the remote state.

4.4.2.2 Processing signal interface

With **IO** you reach the set-up menus for the processing signal interface. With **Modul** you can choose the different types of input and output functions. **Set** is used to modify the settings. **back** returns to the *IF/IO* menu.

4.4.2.2.1 Analogue Input (Modul A_In)

If you are in the setting mode of this menu, you can do the following:

⇧⇩: This is used to select the input channel. You can do this also with the rotary knob.

ZERO: Here you set-up, which value will be displayed with 0V input.

FS: Here you set-up, which value will be displayed with 10V input.

Example: You select **ZERO** ‘30’ and **FS** ‘120’. Now you get with 0V input a display of 30, with 10V input a display of 120 and with 5V input a display of 75. The output is updated every measuring cycle.

back returns you to main menu.

4.4.2.2.2 Analogue Output (Modul A_Out)

If you are in the setting mode of this menu, you can do the following:

⇧⇩: This is used to select the output channel. You can do this also with the rotary knob.

VAL.: This allows you to set-up the value which should be output. See chapter 4.5, ‘Entering identifiers’ for details.
Please note that the values ‘Wave_u’, ‘Wave_i’ and ‘Wave_p’ can only appear once!

ZERO: Here you set-up, which value of **VAL.** will result an output of 0V.

FS: Here you set-up, which value of **VAL.** will result an output of 10V.

Example1: You select **VAL.** 'Utrms', **ZERO** '200' and **FS** '250'. Now you get with Utrms=200V an output of 0V, with Utrms=250V an output of 10V and with Utrms=230V an output of 6V. The output is updated every measuring cycle, because the values are calculated every measuring cycle.

Example2: You select **VAL.** 'wave u'. **ZERO** and **FS** have no influence on sample values. The full scale of 10V is reached with the maximum peak value of the range. Now you get the sampling values of the voltage on the output. The output is updated after every sample of the measuring channels (about 100kHz).

back returns you to main menu.

4.4.2.2.3 Digital Inputs (Modul D_In)

In this menu you get the actual state of the six digital inputs. The inputs 1 to 4 are only used for state indicating. The inputs 5 and 6 can be used as state indicators or for frequency and direction input (defined by the phase shift between input 5 and 6). In the last case the input 5 is used to measure the frequency. This is multiplied with the 'Scale' value and displayed under 'Frequency'. A negative frequency value indicates a reverse rotation direction. To change the scaling press **Set** and **SCALE**.

4.4.2.2.4 Digital Outputs (Modul D_Out)

If you are in the setting mode of this menu, you can do the following:

⇧⇩: This is used to select the digital output. You can do this also with the rotary knob.

VALUE: This allows you to set-up the value which should be output. See chapter 4.5, 'Entering identifiers' for details.

COND: Here you set-up, under which condition the output is in the 'alarm state' <u>(= high impedance of output, symbolised lamp is on!)</u>:
on: The output has always alarm state.
off: The output has never alarm state.
>=: The output has alarm state if the **VALUE** is bigger or equal to the **LIMIT**.
<: The output has alarm state if the **VALUE** is smaller than the **LIMIT**.

LIMIT: Here you set-up, which limit is compared to the **VALUE.**

Example: You select 'Itrms >= 164.00mA'. Now you get an alarm for every current bigger or equal to 164mA. The output becomes a high impedance state because a 'fail save' function is assumed.

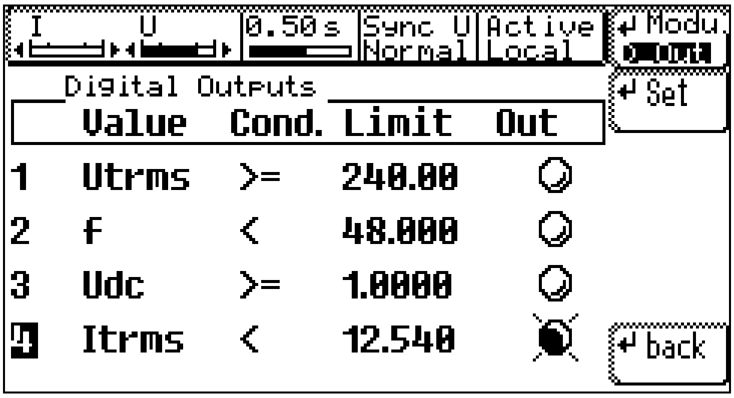


Figure 13: Limit menu

back returns you to main menu.

Fail Save Principle

The fail save principle should offer you highest safety in critical applications. The principle is, that a high impedance state is the alarm (active) state. By this also broken or not connected wires as well as not switched on instruments are recognized as fail. Only the low impedance state is recognized as no alarm (deactive).

4.4.2.3 Options key

If you press on the softkey with the key symbol you get an actual software key which represents all installed options in your instrument. Some options of the instrument are software options which can be released by another key. If you for example want to install the 100 Harmonics you send us or your local sales company an order about this option together with your Current Option Key and with your serial number (SN).

Then you get back a second key which you can enter after pressing the key symbol. If the second key is correct, the option is installed.

4.4.3 Formula editor

You reach the formula editor by pressing **Forml** in *Custom* menu.

With **Set** you start entering the formula. This is done like written in 4.5, ‘Entering identifiers, characters and text’.

4.4.3.1 General

The formula editor is similar like a simple programming language. The code is entered line by line. It is allowed to have several instructions in one line. Each instruction has to end with a ';'. Therefore an instruction can be written in more than one line. It is also allowed to have white spaces in the instruction as long as the keywords and identifiers are not divided by them. At the end of a line an automatic carriage return and linefeed are performed. A ‘#’ indicates the begin of a comment. The comment lasts, until a return is detected (can be entered with **new line**). An automatic inserted newline will NOT end the comment!

The instruction

```
var0=Utrms*Itrms;
```

is identical to

```
var0 = Utrms* Itrms;
```

or

```
var0 =
Utrms * Itrms;
```

‘<-’ deletes the character left of the cursor. If the cursor is at the first position of a line, it jumps to the last position of the previous line.

You leave the formula editor by pressing **End**. The program is now checked for correct syntax. Above the editor window you see then how many percent of the available memory space have been used.

The program (which includes the formulas) is executed when all values of a cycle have been calculated.

With **Reset** the 8 variables are preset to 0.0 but the formulas are still valid. This is important if you use recursive formulas or conditions. The **Reset** key can be found in the *Custom* menu itself as well as in the **Forml** sub menu.

4.4.3.2 Grammar

4.4.3.2.1 Instructions

Instructions control the program flow while execution. If there are no conditioned instructions, the flow is in the same order like the listing. The results of an instruction can be used afterwards.

An instruction consists of one or more expressions. Each instruction (except `if`) has to be finished with '`;`'. An instruction can be longer than one line. The result must not be assigned to a variable.

4.4.3.2.2 Condition instruction

Condition instructions choose between two alternative program flows. This is done by the expression following immediately to the word **`if`**.

```
if(expression) Instructions; fi
```
or
```
if(expression) Instructions; else Instructions; fi
```

The brackets for the expression are necessary. Then there could be one or more semicolon separated instructions which are executed if the expression was true. The end of the conditional execution is marked with **`fi`**, which is also necessary. The **`else`** part is optional.

Condition instructions can be nested, for example to realise a logical AND:

```
if(expression1)
   if(expression2)
      Instruction 1;
          :
      Instruction n;
   fi
fi
```

Example

```
if (Utrms>227.5)
   dout_off(1)
   dout_off(2)
else
   dout_on(4)
fi
```

If the voltage is bigger than 227.5V the digital outputs 1 and 2 are set to off. In the other case the output 4 is set to on.

4.4.3.2.3 Expressions

An expression is a sequence of operators, operands and functions. Expressions are in general recursive, which means they can be nested. But there is a practical limit in CPU power and memory which can cause the message "out of memory".

The order of evaluation of an expression depends on the priority of operands and on the brackets (see below).

4.4.3.2.4 Constants

Constants are always floating point. The valid range is ±3.4E-34 to ±3.4E+34. The number can be entered in usual or scientific notation. The decimal dot is only necessary for floating point numbers.

4.4.3.2.5 Variables

There is a decision between read only variables and read write variables. The first ones are all measuring values of LMG95 but also values like cycle time and measuring ranges. This variables can be used for calculation like constants. The second one are the 8 user defined variables.

So following is o.k.

```
var0=Utrms;
```

but

```
Utrms=0;
```

is not allowed.

A unit can be assigned to the variable. To assign the unit ‘cm’ to the varaible ‘a’ write:
a.cm=...

The result of expressions can only be stored in the 8 user defined variables with the default identifiers ‘var0’ to ‘var7’. This identifiers are valid until they are redefined in a formula. The redefinition is simply be done by using a not existing identifier. This identifier replaces the first variable which was not changed until now. The maximum length of the new identifier is 10 characters. In ‘Example 2’ the identifier **Uhigh** replaces the identifier **var0** and **Ulow** replaces **var1**. As you can see the identifiers are replaced in the order of the occurrence. If you press **End**, all occurrences of **var0** are replaced with **Uhigh** and so on. So you get in the user defined menu or the plot menu the new identifiers.

The read-only variables are identical to the identifiers in the menus (see 4.5, ‘Entering identifiers’.

4.4.3.2.5.1 Local variables

A third kind of variables are local variables. They are also user defined, but are not displayed in the custom menu. A local variable starts always with a ‘**$**’ character:

```
$test=Utrms*19.234;
b=Iac*$test;
```

In this example **$test** is not displayed, but only **b**.

4.4.3.2.5.2 Environment variables

These variables are accessible via the ‘**Env**’ ID as an array: **Env[0...7]**.

They are (in opposite to standard variables) not displayed, but they can (in opposite to local variables) be used externally (e.g. in the processing signal interface). Further on they can be set directly by the interface (see 10.2.2.1.1, ‘ENVironment ENV Env’).

4.4.3.2.6 Keywords

This are strings which are no variables or constants but which are used for controlling the formula editor:

`else` The end of the program sequence which is used if the condition of the **`if`** was true (no semicolon at the end!). All command after the **`else`** until the next **`fi`** are used, if the condition of the **`if`** was **`not`** true. The else is optional.

`fi` The end of the program sequence which is used if the condition of the **`if`** was true (no semicolon at the end!).

`if` The start of a conditioned program sequence. The condition have to follow in the round brackets.

4.4.3.2.7 Functions

The following functions are implemented at the moment (x is the result of a valid expression, constant or function):

`abs(x)` absolute value of x

`acos(x)` arcus cosine of x (result in radiant!)

`asin(x)` arcus sine of x (result in radiant!)

`bell()` generates a short sound with the internal speaker

`btst(x, bit_no)` Returns true, if in variable x bit number bit_no is set. The bits are counted from 1 to 32. You should only apply this function onto integer values like digital inputs or result of flicker measuring. Usually you should not use it with float numbers.

`cos(x)` cosine of x (argument in radiant!)

`digin(mask)`	Returns the value of the digital inputs. The values are coded in one byte: input 1-4 correspond to bit 0-3. So if the inputs 1 and 3 are active, the returned value would be 5. With mask you can define, which values are checked: With a mask of 4 only the input 3 is checked. In this case the return value can only be 4 or 0. The mask is useful when checking the status of one input, independent from the others. If you want to check all inputs, you should use a mask of 255!
`dout_off(nr)`	Switches digital output number nr off (into no-alarm state). $1 \le nr \le 4$
`dout_on(nr)`	Switches digital output number nr on (into alarm state). $1 \le nr \le 4$
`freeze()`	freezes the display (like key *freeze*)
`isrun()`	Returns 1, if the integration is running
`isstop()`	Returns 1, if the integration is stopped
`ln(x)`	$\log_e$ of x
`log(x)`	$\log_{10}$ of x
`print()`	Prints the menu in which you started the logging in 'by script' mode (see 11.3.1, 'Output intervals').
`reset()`	Same like **Reset** Softkey in *Time Int.* menu
`scale_i(x)`	Scales the current input, x is the scaling factor.
`scale_u(x)`	Scales the voltage input, x is the scaling factor.
`sin(x)`	sine of x (argument in radiant!)
`sqrt(x)`	The square root of x
`start()`	Same like pressing *Start*
`stop()`	Same like pressing *Stop*
`unfreeze()`	reactivates the frozen display

4.4.3.2.8 Operators

Operators are symbols which cause actions, when they meet variables, constants or formulas. The formula editor offers following operators, sorted by priority:

high priority

`:` Channel separator, used only for multi channel devices (like analogue inputs). E.g. Ain:3 is the third analogue input channel.

`[]` Index operator, used for indexed values (arrays), e.g. U[5] is the 5th harmonic of the voltage

`()` Function call, the value inside the brackets is parameter to the function

`-` Negation

`^` Exponent

`/ *` Division and multiplication

`+ -` Addition and subtraction

`<, ==, >` smaller, equal, bigger (comparator operators)

`=` setting of a value

`<>` not equal

low priority

If there are no brackets, the operators are used in the order listed above.

The result of:

`-3^2*4` is 36

`-(3^2)*-4` is also 36

4.4.3.2.9 Remarks

Each line starting with a '`#`' is a remark. See 4.4.3.2.15, 'Example 6:Switching digital outputs, depending on harmonics'. Only the first '`#`' is important, the other don't care.

4.4.3.2.10 Example 1: Freeze at limit violation

If the 23rd harmonic of voltage is bigger than 10V the display should be frozen and the instrument should inform you with a sound.

```
if(Uh[23] > 10)
   freeze();
   bell();
fi
```

Attention!

The function `freeze()` can cause the display to freeze at the start-up of the instrument. So be careful when using this function.

4.4.3.2.11 Example 2: Getting min/max values

You want to measure the biggest and smallest TRMS values of the voltage.

```
if (Uhigh==0)
   Ulow=RngU;
fi
if (Uhigh<Utrms)
   Uhigh=Utrms;
fi
if (Ulow>Utrms)
   Ulow=Utrms;
fi
```

The first `if` condition is used for resetting the minimum value: With **Reset** it would be set to 0 which is not sufficient, because this is already the smallest TRMS value. So if the maximum TRMS value is reset to 0.0, the minimum value is set to the range value which will not be reached under proper conditions. The second and third condition compute the maximum and minimum value and store them in the variables `Uhigh` and `Ulow` which can be read out in the *Custom* menu.

4.4.3.2.12 Example 3: Calculating THD+N

You want to measure the total distortion factor including noise (THD+N) of the voltage:

```
THDN=sqrt((Utrms^2-Uh[1]^2)/Uh[1]^2);
```

Please note that this will only work in the harmonic mode, because `Uh[1]` is only calculated there!

4.4.3.2.13 Example 4: Counting pulses

You want to count the number of current pulses of a battery above 3A (the pulse width has to be bigger than twice the cycle time!)

```
ibat=abs(Idc);
if (ibat>3.0)
   if (r == 0)
      n=n+1;
      r=1;
   fi
fi
if (ibat < 3.0)
   r=0;
fi
```

4.4.3.2.14 Example 5: Measuring of core material

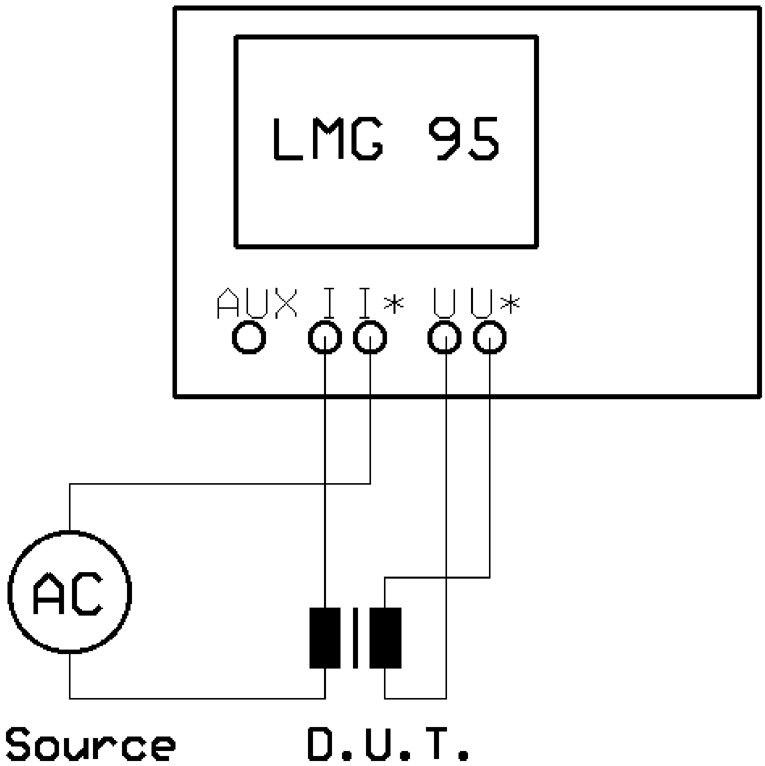


Figure 14: Core parameter measuring circuit

If you measure a core according to the above picture, you can calculate a lot of very important values with following formula:

```
Pfe=P;
Bpk=Urect/(4*f*3*0.0000916);
Hpk=Ipp/2*3/0.085608;
ua=Bpk/1.2566e-6/Hpk;
F=f;CFu=Ucf;CFi=Icf;pf=PF;
if(P>4.3) freeze();fi
if(P>1) bell();fi
```

The results are displayed in the *Custom* menu:

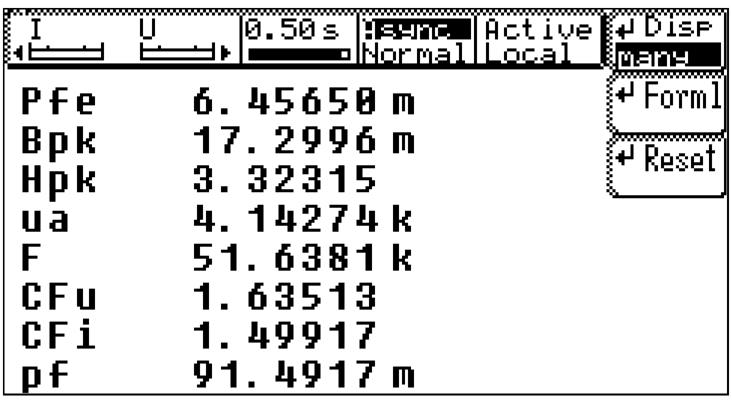


Figure 15: Core parameter display

A very detailed application note can be requested from ZES (please request NOTE17E.PDF).

4.4.3.2.15 Example 6:Switching digital outputs, depending on harmonics

```
### Wave1 ###
if(Ih[1]>0.08) dout_on(1);
else dout_off(1);
fi
### Wave3 ###
if(Ih[3]>0.068) dout_on(2);
else dout_off(2);
fi
### Wave5 ###
if(Ih[5]>0.05) dout_on(3);
else dout_off(3);
fi
```

The digital outputs 1 to 3 are switched on if the corresponding harmonic 1 to 5 is bigger than a defined value. In the other case the output is switched off.

4.4.3.2.16 Example 7: Calculation of the efficiency of a motor with torque and frequency input

For the measurement of the efficiency of a motor you can use the analogue and the frequency inputs. To input the torque of the motor use the analogue input (e.g. 1) and for the frequency use the digital frequency input (e.g. 1 Pin 12). For calculation of the efficiency you can use the following formula:

```
M=Ain:1;
n=DigFrq;
Pmech=M*n;
eta=Pmech/(P*100);
```

Important Note: The motor frequency connected to the frequency input (No.1) has to be counted and scaled in Hertz. Then you get a result in percent. The result is shown in the „Custom menu“.

4.4.3.3 Printing formulas

You can printout the formulas you have set-up. For this purpose choose ‘ASCII’ as type of the logging (see 11, ‘Logging of values to drives, printer and interfaces’). Please note, that the complete formula editor is printed out, not only the visible part.

4.4.4 Saving and restoring configurations

You can save up to 8 different set-ups for the instrument. With **Reset** you get the factory settings. Everything is reset, but not the 8 stored configurations.

4.4.4.1 Loading a configuration

After pressing *Save/Recall* you can load previously saved configurations. For this purpose choose the wanted one with the rotary knob and press **Recll.** All set-up values like range settings, formulas and measuring settings are restored. The actual settings are lost.

In the field ‘Active configuration mod()’ you see now the name of the selected configuration. If mod(*) is displayed, any of the settings are changed.

4.4.4.2 Saving the configuration

After pressing *Save/Recall* you can save the actual configuration. For this purpose choose the wanted position with the rotary knob and press **Save.** Now you have to specify a name for this entry (see chapter 4.5, ‘Entering identifiers, characters and text’). If the entry exists, it will be overwritten. All set-up values like range settings, formulas and measuring settings are saved.

4.5 Entering identifiers, characters and text

In some menus (e.g. in the plot menu or in the menu for the digital outputs) you have to enter an identifier or text to specify which value should be worked with (e.g. plotted).

If the cursor is at the first position and you press ←, the complete input field will be deleted.

If you have pressed the softkey to modify the identifier or text, you can either enter the desired value by moving the rotary knob (**Mode** has to be set to copy!) to the wished letter and pressing **Copy**. In this case you have to enter the letters in the same way you see them in the menus (e.g. ‘Utrms’). All available identifiers are listed in chapter 10.2, ‘Commands’. To find an identifier see also chapter 17, ‘Interface command and identifier index’. Or you can press the key of any valid menu (e.g. *Voltage*, *Current*, ...) and you get a list of the available values (in this mode).

Following values are available in the different menus:

Normal measuring mode

Default	Current	Voltage	Power	Int. Value	Measure	Custom	Misc.	IF/IO
f	f	f	f	q	Aver	Env	abs()	Ain
Iac	Iac	OvrU	P	EP	DisCyc	var0-11	acos()	DigFrq
Icf	Icf	Uac	PF	EQ	Cycle		asin()	Zero
Idc	Idc	Ucf	PHI	Et	Mtime		bell()	
Idcn	Idcn	Udc	Q	ES	Rcyc		cos()	
Idcp	Idcp	Udcn	Rser	tsec			digin()	
Itrms	Itrms	Udcp	S	Pm			dout_on()	
Iff	Iff	Utrms	Xser	Qm			dout_off()	
Iinr	Iinr	Uff	Z	Sm			freeze()	

Default	Current	Voltage	Power	Int. Value	Measure	Custom	Misc.	IF/IO
Iphi	Iphi	Uphi					isrun()	
Ipkn	Ipkn	Upkn					isstop()	
Ipkp	Ipkp	Upkp					log()	
Ipp	Ipp	Upp					ln()	
Irect	Irect	Urect					reset()	
RngI	RngI	RngU					scale_i()	
Iscal	Iscal	Uscal					scale_u()	
Env	OvrI						sin()	
OvrI							sqrt()	
OvrU							start()	
P							stop()	
PF							unfreeze()	
PHI							if();fi	
Q							2.7182818 (*e*)	
Rser							3.1415927 (π)	
S							1.2566e-6 (μ_0)	
Uac							8.854e-12 (ε_0)	
Ucf								
Udc								
Udcn								
Udcp								
Utrms								
Uff								
Uphi								
Upkn								
Upkp								
Upp								
Urect								
RngU								
Uscal								
var0-11								
Xser								
Z								

prCE Harmonic measuring mode

Default	Current	Voltage	Power	Measure	Custom	Misc.	IF/IO
f	f	f	f	Per	Env	abs()	Ain
Ih	Ih	Uh	Ph	Mtime	var0-11	acos()	DigFrq
Imav	Imav	Uthd	Pav			asin()	Zero
Iav	Iav	UL	PFm			bell()	
Ifm	Ifm	UMax	Qh			cos()	
Ithd	Ithd	UP	Sh			digin()	
IL	IL	OvrU	P			dout_on()	
Im	Im	Utrms	PF			dout_off()	
IP	IP	RngU	Q			freeze()	

Default	Current	Voltage	Power	Measure	Custom	Misc.	IF/IO
Ipohl	Ipohl		Rser			isrun()	
Ph	Ipohc		S			isstop()	
Pav	Ithc		Xser			log()	
PFm	Itrms		Z			ln()	
Ipohc	RngI					reset()	
Qh	Iscal					scale_i()	
Sh	OvrI					scale_u()	
Ithc						sin()	
Uh						sqrt()	
Uthd						start()	
UL						stop()	
UMax						unfreeze()	
UP						if();fi	
Itrms						2.7182818 (*e*)	
RngI						3.1415927 (π)	
Iscal						1.2566e-6 (μ_0)	
Env						8.854e-12 (ε_0)	
OvrI							
OvrU							
P							
PF							
Q							
Rser							
S							
Utrms							
RngU							
Uscal							
var0-11							
Xser							
Z							

CE Flicker measuring mode

Default	Current	Voltage	Power	Int. Value	Measure	Custom	Misc.	IF/IO
Uhwcf	f	Uhwcf	Phw	Uhwcf	Per	Env	abs()	Ain
dcl	dcs	dcl	f	dcl	Mtime	var0-11	acos()	DigFrq
dtl	dts	dtl	P	dmaxl	FlkPer		asin()	Zero
dmaxl	dmaxs	dmaxl	PF	Pltl			bell()	
Pltl	Plts	Pltl	Q	Pmoml			cos()	
Pmoml	Pms	Pmoml	Rser	Pstl			digin()	
Pml	Pmoms	Pml	S	Upkph			dout_on()	
Phw	Uhws	Phw	Xser				dout_off()	
Uhwl	Psts	Uhwl	Z				freeze()	
Pstl	Ithd	Pstl					isrun()	
Upkph	Itrms	Upkph					isstop()	
f	RngI	f					log()	

Default	Current	Voltage	Power	Int. Value	Measure	Custom	Misc.	IF/IO
dcs	Iscal	Uthd					ln()	
dts	OvrI	OvrU					reset()	
dmaxs		Utrms					scale_i()	
Plts		RngU					scale_u()	
Pms		Uscal					sin()	
Pmoms							sqrt()	
Uhws							start()	
Psts							stop()	
Ithd							unfreeze()	
Uthd							if();fi	
Itrms							2.7182818 (*e*)	
RngI							3.1415927 (π)	
Iscal							1.2566e-6 (μ_0)	
Env							8.854e-12 (ε_0)	
OvrI								
OvrU								
P								
PF								
Q								
Rser								
S								
Utrms								
RngU								
Uscal								
var0-11								
Xser								
Z								

HARM100 measuring mode

Default	Current	Voltage	Power	Measure	Custom	Misc.	IF/IO
D	f	f	D	Per	Env	abs()	Ain
f	Ih	Uh	f	Mtime	var0-11	acos()	DigFrq
Ih	Ithd	Uthd	Ph			asin()	Zero
Ithd	IP	UP	Qh			bell()	
IP	Itrms	Utrms	Sh			cos()	
Ph	RngI	RngU	P			digin()	
Qh	Iscal	Uscal	PF			dout_on()	
Sh	OvrI	OvrU	Q			dout_off()	
Uh			Rser			freeze()	
Uthd			S			isrun()	
UP			Xser			isstop()	
Itrms			Z			log()	
RngI						ln()	
Iscal						reset()	
Env						scale_i()	

Default	Current	Voltage	Power	Measure	Custom	Misc.	IF/IO
OvrI						scale_u()	
OvrU						sin()	
P						sqrt()	
PF						start()	
Q						stop()	
Rser						unfreeze()	
S						if();fi	
Utrms						2.7182818 (*e*)	
RngU						3.1415927 (π)	
Uscal						1.2566e-6 (μ_0)	
var0-11						8.854e-12 (ε_0)	
Xser							
Z							

Select one value with the rotary knob and press *Enter* to copy the list item into the edit line. If you have a multi channel value (e.g. analogue inputs) you have to enter a ':' behind this value and then the number of the channel (e.g. the identifier for the analogue input 3 would be 'Ain:3'). If you don't specify this number, '1' is the default value. Confirm your choise with *Enter*.

If the value is an array value, the desired index is entered in brackets '[' and ']' (example the 5th harmonic of the voltage would be Uh[5]). If you don't specify this number, '0' is the default value. Confirm your choise with *Enter*.

To select another position in the text, you have to set **Mode** to 'move' or 'line'. With 'move' you move character by character, with 'line' you move line by line, which is much faster in bigger text.

With **new line** you can insert a linefeed (if you have a multi line input box). Especially in conjunction with the formula editor you can reach a list of useful functions and operators by pressing *Misc.* (*Functions* on older instruments).

Finally close you inputs with **End**.

4.6 Entering numerical values

If you have entered a value by the numerical keypad and move the cursor to the right end and move the rotary knob to the right then the modifiers 'µ', 'm', 'k' and 'M' appear. So it is more simple to enter big or small values.

5 Normal measuring mode

In the normal measuring mode the LMG95 works as an high precision power meter. The voltage, current and power are measured directly, many other values are derived from these values.

5.1 Measuring configuration (Measuring)

When you came to this menu by pressing *Measure* you first have to choose **Norm(a)l** to enter this mode. With **Set** you can do several settings. All possible setting are displayed similar to a schematic. So you can see, which influences a change will have.

Sync Selects the signal which is used for synchronisation. There are following possible settings:

U The voltage signal is used

I The current signal is used

X Extended Trigger. See **Xtrig**.

Line The line signal is used

Extn The signal at the external synchronisation jack is used.

Depending on the value of **Sync** there is one softkey which changes from **Xtrig** (setting ‘X’) to **Coupl** (all other settings).

Coupl Selects how the voltage or current signal is coupled to the following trigger stage. This setting has **no** influence to the measured signals!

AC+DC The signal is directly coupled, including all signal parts.

BP The low frequency parts (<10Hz) and the high frequency parts (>300Hz) of the signal are cut off.

AM The signal will be demodulated when measuring AM signals. Only the envelope is used.

Xtrig Here you reach a menu where you can define very precise, what should be your trigger condition. This menu should only be used from very experienced users, because if you select wrong conditions, you might get wrong measuring results.

Signl Here you define the signal you want to trigger on. Available are: us, is, ps, us², is², u, i, p. For the meaning of this values please watch the functional diagram in 14.5, ‘Functional block diagram computing unit’

Filt Here you can define a digital filter which influences the signal to be triggered on. Please note 2 points:
1. For Example: You have a 50Hz signal and select p, you have a 100Hz p-wave! So a 87.5Hz filter will influence this signal!!!
2. You should always try to switch the HF-Rejection filter on (see point **Filter/S-Cpl**, **Filt** below) to prevent aliasing in the trigger signal.

Level Here you select the trigger level. If you for example select 'u' and a level of 100.0 the instrument will be triggered each time the voltage crosses the 100V line. Please note: If you select u² the level is 100V²!!

Hyst Usually you have a small noise on the signal. Without a hysteresis you might get several level crossings at a single 'real' crossing. With the hysteresis you can prevent this. For example you have a **Level** of 100V and a **Hyst** of 5V. If your signal comes from a value smaller than 95 V it has to climb up to 105V to get a positive crossing. If it comes from a value greater than 105V it has to fall below 95V to get a negative crossing.

back returns to the last menu.

What can you do with this very special trigger mode?
If you have signals with a big DC part and a quiet small AC part (e.g. pulsed loads with DC supply) you have the problem to trigger on the frequency of the AC part. The solution is, to set the **Level** to a value of about the DC part, so you get a good trigger level.
Another example is to measure pulse controlled currents. In fact this signals are AM signals with a 50Hz carrier and for example a 1.5Hz modulator. To get correct measuring results you would have to trigger on the 1.5Hz signal. To do this you just select 'i*i' as source and a 30Hz filter. So you have build up a quadrature demodulator. Now you select a trigger level (depending on the current) and your instrument will synchronise to the 1.5Hz signal of your pulse control.

Cycle Here the cycle time in seconds is defined. Valid values are from 0.05s to 60s. Any value in steps of 10ms is allowed.
While every cycle time the values of voltage, current and power are stored. At the end of each interval the measured values are computed to the displayed values.
The cycle time has always to be bigger or same like the period time of the signal.

Filter/S-Cpl

You reach a pop up menu where you can set the signal filter (**Filt**) and the signal coupling (**S-Cpl**):

Filt Here you can select if the filters in the signal path of voltage and current are active or not. This filters are only in the signal way and don't influence the synchronisation settings ‘U’ and ‘I’. But they influence the synchronisation **Xtrig**! Possible settings are:

off	All filters are switched off
HF-Rej	The analogue HF rejection filter is switched on.
30Hz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 30Hz is used
60Hz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 60Hz is used
87.5Hz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 87.5Hz is used
175Hz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 175Hz is used
1.4kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 1.4kHz is used
2kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 2kHz is used
2.8kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 2.8kHz is used
6kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 6kHz is used
9.2kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 9.2kHz is used
18kHz	Additionally to the HF rejection filter a digital Low-Pass Filter with a cut off frequency of about 18kHz is used

S-Cpl Here you define the signal coupling. This setting has **no** influence to the trigger signal! Possible settings are:

AC+DC: All parts of the signal are taken into calculation.

AC Only the AC parts of the signal are taken into calculation. The DC part is separated. Please note, that this separation is done by software after the measuring and not by hardware! So you don’t have any advantages concerning the measuring range and no influence to the scope values. The advantage of this coupling mode is the better accuracy, because all DC errors are eliminated.

Aver Here you can set-up, how many measuring cycles are averaged for the display. For example: If you choose 5 cycles, the display will be averaged over the last 5 cycles (sliding average!).

back returns you to main menu.

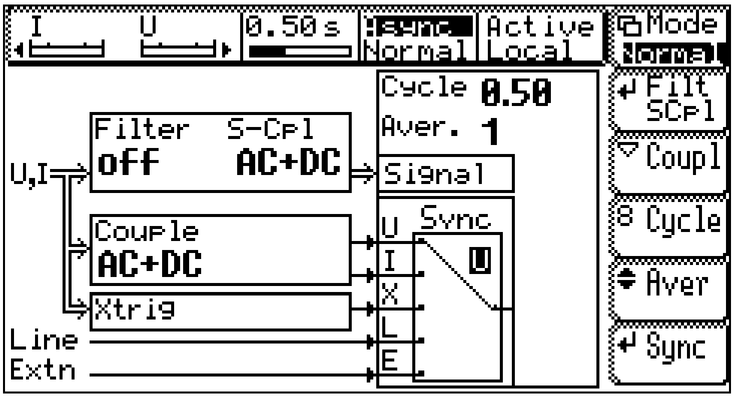


Figure 16: Measuring menu in normal mode

5.2 Measuring ranges (Range)

When you came to this menu by pressing *Range* you can choose with **I<->U** if you want to set-up voltage or current.

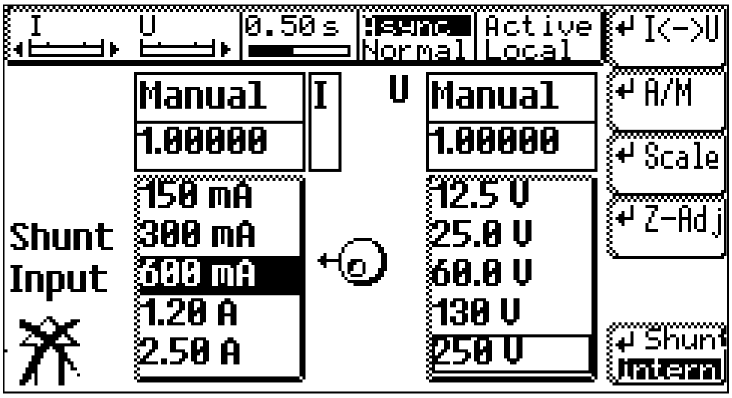


Figure 17: Range menu

With **A/M** the automatic or manual range setting is selected. This is only possible in the normal measuring mode. In all other modes the manual range selection is selected. The **Scale** button allows you to enter a scaling factor. With this scaling factor all values of this channel (and the power) are multiplied. This setting is usually used to enter the transformer ratio of current clamps, voltage transformers or the size of an external shunt.

With the shuttle knob you can select the required range (not in auto range mode!).

With the **Shunt** button you can select if the internal shunt or the external shunt is used. If you choose ‘Shunt extern’ you have to specify the shunt value. This is done by entering the reverse shunt value under **Scale**.
Example: You have a shunt with 2.5mΩ and have to enter the reverse value (1/0.0025=400) under **Scale**. The 30mV range (displayed as 30mA range) becomes now the 12A range (=30mV*400).

Example 1:
You have a current clamp with 1000A/1A ratio. In this case enter 1000 as scaling factor.

Example 2:
You have a current clamp with 1A/10mV ratio. This is equal to 100A/V, so you have to enter 100 as scaling.

Z-Adj allows you to adjust the zero point of the instrument. You can either adjust the internal current ranges together with the voltage ranges or you can adjust the external current ranges together with the voltage ranges. You have to choose this before pressing **Z-Adj** with **Shunt**.

Be careful with this function because you can also deadjust the instrument!!!

For the exact adjustment steps please refer to 12.3.2 'Zero adjustment of the instrument'.

Some notes for auto ranging

There are some special points you have to know, when using the auto range function:

- The peak current ranges (marked with 'Ap' in the range list) are never used for auto ranging. They can only be chosen manually.
- If you want to measure a single peak value never use the auto range function. The reason for this is, that the auto range function does not detect a too low range until it is overloaded! When it is overloaded and the range is changed, the last measurement might be invalid.
- Do not use the auto range function for very precise measurements. While a measurement you don't directly see which range is actually selected. Afterwards it is not possible to say what was the selected range and therefore you can't made an error calculation.
- Do not use the auto range function for measurings without gaps (e.g. energy, harmonics or flicker). The reason for this is the set-up time of the measuring channels after a range change.

5.3 Definition of measuring values

Following you find the definitions for all measuring values in the normal operation mode. The values are divided in two sections:

- The values from single measuring are measured while one measuring cycle and are independent from all other measuring cycles.

- The integrated vales are calculated from same values of several cycles.

The following basic definitions are used:

$u(t)$ The instantaneous value if the voltage

$i(t)$ The instantaneous value if the current

T The time of an integer number of the periods of the synchronisation signal. The integer factor depends on the chosen measuring cycle time. This time can vary from cycle to cycle! T is the real measuring time.

5.3.1 Values from single measuring

Voltage and current

true root mean square: $Utrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} u(t)^2\,dt}$ $Itrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} i(t)^2\,dt}$

DCn negative root mean square:

$$Udcn = \frac{1}{T}\int_{t=0}^{T} \begin{Bmatrix} u(t)\ for\ u(t) < 0 \\ 0\ for\ u(t) \geq 0 \end{Bmatrix} dt \qquad Idcn = \frac{1}{T}\int_{t=0}^{T} \begin{Bmatrix} i(t)\ for\ i(t) < 0 \\ 0\ for\ i(t) \geq 0 \end{Bmatrix} dt$$

DCp positive root mean square:

$$Udcn = \frac{1}{T}\int_{t=0}^{T} \begin{Bmatrix} u(t)\ for\ u(t) \geq 0 \\ 0\ for\ u(t) < 0 \end{Bmatrix} dt \qquad Idcn = \frac{1}{T}\int_{t=0}^{T} \begin{Bmatrix} i(t)\ for\ i(t) \geq 0 \\ 0\ for\ i(t) < 0 \end{Bmatrix} dt$$

DC root mean square: $Udc = \frac{1}{T}\int_{t=0}^{T} u(t)dt$ $Idc = \frac{1}{T}\int_{t=0}^{T} i(t)dt$

AC root mean square: $Uac = \sqrt{Utrms^2 - Udc^2}$ $Iac = \sqrt{Itrms^2 - Idc^2}$

peak-peak value: $Upp = \max(u(t)) - \min(u(t))$ $Ipp = \max(i(t)) - \min(i(t))$

rectified value: $Urect = \frac{1}{T}\int_{t=0}^{T} |u(t)|dt$ $Irect = \frac{1}{T}\int_{t=0}^{T} |i(t)|dt$

crest factor: $Ucf = \frac{Upk}{Utrms}$ $Icf = \frac{Ipk}{Itrms}$

form factor: $Uff = \frac{Utrms}{Urect}$ $Iff = \frac{Itrms}{Irect}$

Inrush current: $Iinr = \max(|i(t)|)$

Power

active power: $P = \frac{1}{T}\int_{t=0}^{T} u(t)i(t)dt$

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

apparent power: $S = Utrms * Itrms$

power factor: $PF = \lambda = \frac{|P|}{S}$

Behind the power factor might be a ‘i’ or ‘c’ showing, that the load is inductive or capacitive. This decision is only done under following conditions:

$$\lambda < 0.999 \;\; and \;\; 1.05 < Uff < 1.2 \;\; and \;\; 1.05 < Iff < 1.2 \;\; and \;\; f < 2kHz$$

That means current and voltage are nearly sinusoidal.
In all other cases there is neither ‘i’ nor ‘c’.

Please note: The i/c indication was developed for usual line applications. When the usage of the channels is very low or you work with very high frequencies you should take care, if the i/c indication is correct or not.

Phase angle

phase angle $\varphi = \arccos \lambda \;\; with \;\; \varphi = \varphi_{ui} = \varphi_u - \varphi_i$

The sign of the angle is derived from the i/c indication, ‘+’ for an inductive load, ‘-’ for a capacitive one. Here the current is the reference. This value is only valid at sinusoidal wave forms! The value can be in the range ±180°, values outside ±90° usually indicate negative active power.

Impedances

apparent impedance: $Z = \frac{Utrms}{Itrms}$

active impedance: $Rser = \frac{P}{Itrms^2}$

reactive impedance: $Xser = \frac{Q}{Itrms^2}$

5.3.2 Integrated values

The following basic definitions are used:

$_n$ The value from the measuring cycle number n.

N Is the number of measuring cycles for the integration. This number depends on the real measuring times and on the desired integration time.

Energy

active energy: $EP = \sum_{n=0}^{N} P_n * T_n$

reactive energy: $EQ = \sum_{n=0}^{N} Q_n * T_n$

apparent energy: $ES = \sum_{n=0}^{N} S_n * T_n$

Average values

average active power: $Pm = \frac{EP}{\sum_{n=0}^{N} T_n}$

average reactive power: $Qm = \frac{EQ}{\sum_{n=0}^{N} T_n}$

average apparent power: $Sm = \frac{ES}{\sum_{n=0}^{N} T_n}$

Miscellaneous

charge: $q = \sum_{n=0}^{N} Idc_n * T_n$

integration time: $t = \sum_{n=0}^{N} T_n$

5.4 Display of values

For the display of the values you can choose several menus.

5.4.1 Default

With *Default* you see the most important values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

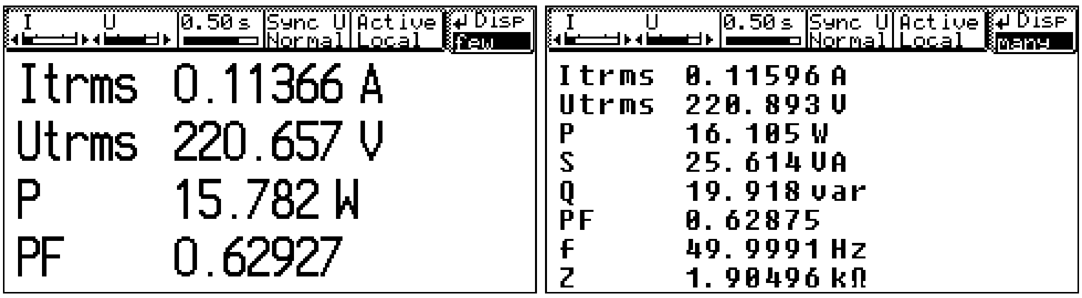


Figure 18: Default display with 4 and 8 values

5.4.2 Voltage

With *Voltage* you see the most important voltage values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

5.4.3 Current

With *Current* you see the most important current values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters. With the **Inrsh** key you can reset the last measured inrush current to 0. This softkey is only active when the manual measuring ranges are selected for current and Voltage! The average should be 1! If the inrush current is too big for the measuring range, a dashed line is displayed.

5.4.4 Power

With *Power* you see the most important power values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters. Further on you get the following resistor values: Z, X and R. **Please note that the values of X and R are only correct, if the voltage and current have a sinusoidal waveform!**

5.4.5 Energy

With *Int. Val* you see the most important energy values as well as derived values which also depend on time. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

5.4.5.1 Integral menu

In this menu (you reach it by *Int.Time)* you defines the measuring conditions for time dependent signals. **Reset** sets the display values to their default state (i.e. 0 for all energy values). This is only possible if the state (left beside the mode) is 'Hold'.

Mode Defines the integration mode. You can only change the mode, if the state is 'RESET'.

continuous After the integration is started it measures continuously until *Stop* is pressed. With the start of this measurement the values are automatically reset to 0.

interval — After the integration is started it measures continuously until the interval **t1** is over. With the start of this measurement the values are automatically reset to 0.

periodic — Same like ‘interval’, but with two differences:

- At the end of one interval a new one is started.
- The display is only updated at the end of an interval and not after every cycle.

summing — After the integration is started it measures continuously until *Stop* is pressed. With the start of the integration the values are NOT reset to 0!

t1 t1 is the time of the time interval in interval and periodic integration mode.

t0 t0 is the start time of an integration. In an additional menu you can enter time and date of the start. If you leave this menu with *Enter* you have to press *Start* to change the state of the integration changes to ‘wait’. If the entered time is reached, the integration starts.

Δt The running integration time. Please note, that this time can be smaller than the real time, for example because of invalid measuring cycles while a change in the measuring ranges.

Start of integration

In general there are three ways to start an integration. You can either enter a start time with **t0**, or you can simply press the *Start* button or you can start via the external sync jack of the LMG95 (see 14.1.1 External Synchronisation (Sync.)). The first cycle which is taken into account is the cycle which follows the actual cycle.

The integration time should be an integer number of times the cycle time.

Stop of integration

The last cycle which is taken into account is the cycle when the *Stop* button or any other stop signal appear.

State of integration

The integration can be in 6 different states:

Reset The energy measurement is stopped, the values are reset to 0
Wait If the start time is later than the actual time and you have started the integration this state appears until the start time is reached.
Start This state is displayed from the logical start of integration (e.g. pressing the *Start*

button) until the physical start of integration which is always the begin of the next cycle.

Run This is displayed while the physical integration is running

Stop This state is displayed from the logical end of integration (e.g. pressing the *Stop* button) until the physical end of integration which is always the end of the actual cycle.

Hold This is displayed if the integration has finished. The integrated values are hold, until the integration continuous (only summing mode) or the values are reset by **RESET** or *Start*.

The logical integration is running, if the state is displayed inverse.

5.4.6 Graphical display

With *Graph* you see the graphical display of the normal measuring mode. The first softkey (**Mode**) changes to the different functions:

Plot Changes to the plot function.

Scope Changes to the scope function.

5.4.6.1 Scope function

Above this graph you see the Y scaling (y/div) and the Y scaling factor. Under the graph you see the start position of the graph in seconds, the X scaling factor and the X scaling. You can do the following settings:

Sig Here you can choose the signal to be displayed. Possible values are:

- i The measured current after all activated filters.
- u The measured voltage after all activated filters.
- p The measured power after all activated filters.

Which of this values are available depends on the set-up with **more**.

xzoom This selects how many values in horizontal direction are displayed at one horizontal position. So it is possible to zoom in or out.

yzoom Here you can choose the vertical size of the wave.

move If you press several times to this button you see the second line changing:

x-pos The signal is moved if you use the rotary knob. So it is possible to see other parts of the waveform.

c1 The first cursor is moved when using the rotary knob. In the second line below the graph you see the X position in seconds and the value of the waveform at this position. The selected cursor position is constant. That means if you scroll the waveform the cursor can move out of the displayed window. If the cursor is outside the visible screen and you move the cursor, it will be set to the border of the visible screen.

c2 Same as c1

c1&c2 Both cursors are moved at the same time. In the second line under the graph you see the time difference and the Y value distance between the two cursors.

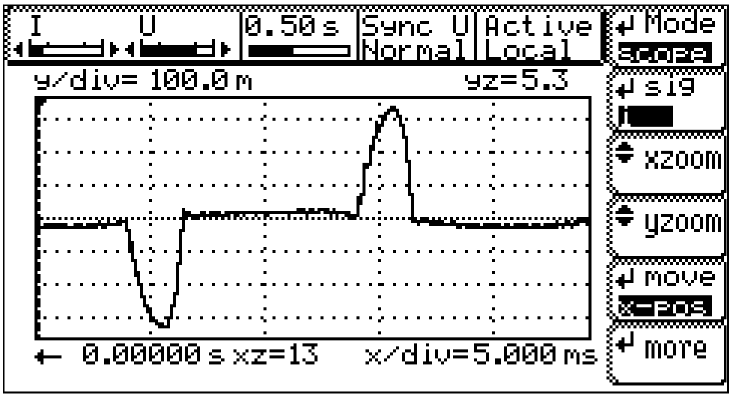


Figure 19: Scope display

more Here you can set-up which sample values are stored for what time. The duration for recording the sample values depends on several points:

- The available memory. This is displayed in the first line.
- The number of signals to be stored. With the rotary knob you can move to a signal and select it with ✓.
- **Cycls** allows you to define the minimum duration in times of the cycle time.

Because of this many influence factors the storing rate and the real duration (both displayed in bottom line) will vary if you change any of this parameters. In general you can say:

- The bigger the memory (65536 words or 4194304 words) the bigger the record rate. If the full record rate is reached, the duration will increase.
- The fewer signals to be stored, the bigger the record rate. If the full record rate is reached, the duration will increase.
- The shorter the cycle time, the bigger the record rate. If the full record rate is reached, the duration will increase.

If you transfer the sample values to a PC and you want to make evaluations in the frequency domain (e.g. digital filtering or FFT), please make sure that the sampling (record) rate is bigger than twice the Bandwidth!

dot The dot joiner connects two following pixels with a line. This function can be set to ‘on’ or ‘off’.

Please note that the grid is always displayed with integer numbers. The cursor positions are calculated from the sample values and have not to fit to the grid.

5.4.6.2 Plot function

Above this graph you see the two plot values, the Y scalings (y/div) and the Y offset y0. Under the graph you see the X scaling (x/div). The 't0=' value is the time oft the most right visible pixel in relation to the last measuring cycle. You can do the following settings:

Chn Here you select which plot function (A or B) should be set-up (with **Set**) or readout with the cursors.

Set Sets all values of one plot function:

fit This function takes the biggest and smallest recorded value and calculates from this two a new 'y0' and 'y/div' value, so that the signal fits into the screen. Please note, that the fit function takes all values into account, also the values you could see if moving the window!

Chn Here you select which plot function (A or B) should be set-up

signl Here you select the signal to be plot. See chapter 4.5, 'Entering identifiers' for details.

y/div Here you select the scaling factor of the Y axis.

y0 Here you select the value of the mid of the graph. If you for example select y0=200V and y/div=10V then you will see a window from 180V to 220V on the screen.

back Returns to last menu.

dot The dot joiner connects two following pixels with a line. This function can be set to 'on' or 'off'.

move If you press several times to this button you see the second line changing:

x-pos The signal is moved if you use the rotary knob. So it is possible to see other parts of the waveform.

c1 The first cursor is moved when using the rotary knob. In the second line below the graph you see the X position in seconds and the value of the waveform at this position.

c2 Same as c1

c1&c2 Both cursors are moved at the same time. In the second line under the graph you see the time difference and the Y value distance between the two cursors.

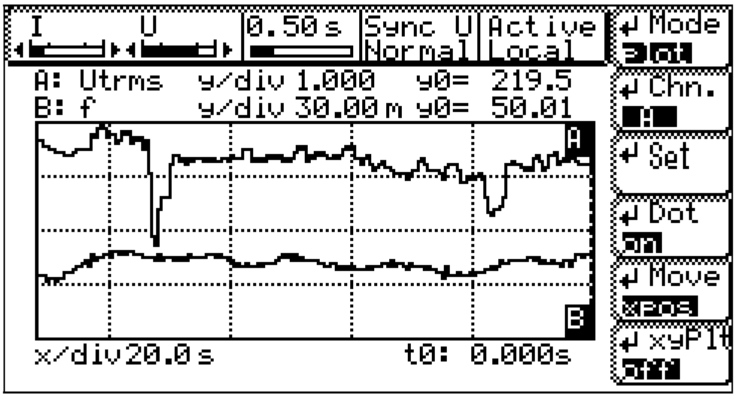


Figure 20: Plot display

xyPlt This selects the XY plot function. If this is set to 'on', signal 'A' is displayed on X axis, signal 'B' on Y axis. Displayed are all values between the cursors which have to be set while B=f(A) is 'off'. With this function you can for example display current vs. voltage, power vs. rotation speed or current vs. temperature.
Usually this function is only used in freeze mode. But it can also be used in non freeze mode.

If you want to print or log the plot menu and choose the ASCII format, you get a list of all measuring values between the cursors.

5.4.7 Custom menu

With *Custom* you see the custom menu. You have the 8 variables 'var0' to 'var7'. This variables can be set with the formula editor (see 4.4.3, 'Formula editor') after pressing **Forml** or **Reset**.

5.5 Storage of values to memory card and printer

You change to the menu you want to print out or to store and press *Print* (exact handling see 11, 'Logging of values to drives, printer and interfaces'). All the values you see in this menu are printed out.

6 CE-Harmonic measuring mode

In the CE-Harmonic measuring mode the LMG95 works as an high precision harmonic analyser according to IEC61000-4-7. The number of settings has been reduced to the needed ones to avoid fail handling.

Note!
In this measuring mode the standards define a special number of periods which have to be used for measurement. The synchronisation is fixed to U. For this reason it is important to have a valid signal for synchronisation to get measuring results. **The valid frequency range is from 45 to 65Hz!**

6.1 Measuring configuration (Measuring)

When you came to this menu by pressing *Measure* you first have to choose **CEhrm** to enter this mode. The synchronisation is fixed to the voltage channel. With the rotary knob you can select two record cards ('CE-Harmonics' and 'class spec'). With **Set** you can do several settings:

6.1.1 CE-Harmonics record

Here the general settings are done.

Eval Selects how the measuring results have to be evaluated (depends on the selected standard):

Class A	The signal is judged according class A of EN61000-3-2:1995 or EN61000-3-2:2000
Class B	The signal is judged according class B of EN61000-3-2:1995 or EN61000-3-2:2000
Class C-1	The signal is judged according class C, Table 1 of EN61000-3-2:1995 or EN61000-3-2:2000
Class C-2	The signal is judged according class C, Table 2 of EN61000-3-2:1995 or EN61000-3-2:2000
Class C-3	The signal is judged according class C, Table 3 of EN61000-3-2:1995 or EN61000-3-2:2000
Class C-W	The signal is judged according class C, special waveform according 7.3 b) of EN61000-3-2:2000
Class D	The signal is judged according class D of EN61000-3-2:1995 or EN61000-3-2:2000
Table 2	The signal is judged according table 2 of EN61000-3-12:2005

Table 3	The signal is judged according table 3 of EN61000-3-12:2005
Table 4	The signal is judged according table 4 of EN61000-3-12:2005

EN... This selects the standard which defines the exact measuring mode of the harmonic analyser:

2:95/-4-7:93	The combination EN61000-3-2:1995 and EN61000-4-7:1993 is active
2:95/-4-7:02	The combination EN61000-3-2:1995 and EN61000-4-7:2002 is active
2:00/-4-7:93	The combination EN61000-3-2:2000 and EN61000-4-7:1993 is active
2:00/-4-7:02	The combination EN61000-3-2:2000 and EN61000-4-7:2002 is active
12:05/-4-7:02	The combination EN61000-3-12:2005 and EN61000-4-7:2002 is active

Systm This selects the system which is used for the measurement. There are several possible values:
220V/50Hz, 230V/50Hz, 240V/50Hz
220V/60Hz, 230V/60Hz, 240V/60Hz
120V/50Hz
120V/60Hz
The system is required for example for checking the correct frequency of the measuring set-up.

Intv This selects the measuring time for a long time evaluation, for example if you have devices with fluctuation harmonics. The result you can see in the *Int.Value* menu.

Smooth Here you can switch the 1.5s low pass filters for smoothing the fluctuating harmonics on or off. With EN61000-3-2:2000 this point is always on!

Back returns you to main menu.

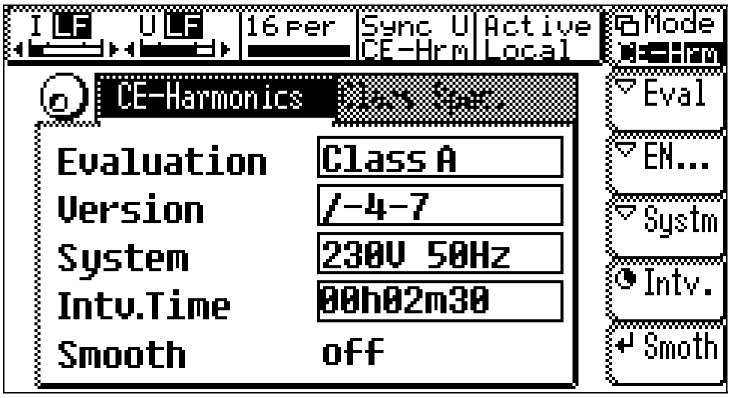


Figure 21: Measuring menu in CE-Harm mode

6.1.2 Class spec. record

This record is only accessible if you have chosen EN61000-3-2:2000 with Class C or D or EN61000-3-12:2005!
Here you have to set-up the setting which are required for EN61000-3-2:2000 resp. EN61000-3-12:2005. For class C you have to enter the fundamental current and the power factor or your device. For class D you have to enter the active power.

This values are used to calculate the limits. For each value the average measured one is compared to the entered one. If there is a difference of more than 10% all the limits are calculated again with the measured values. In this case it might be, that you have to compare all the measuring results again against the new limits. For this purpose we recommend to use a special test and evaluation software (like for the SYS61K system).

Class C

With **PF** and **Curr** you can enter the power factor and the fundamental current.

Class D

With **Pow** you can enter the active power.

EN61000-3-12

With **Rsce** you enter the R_{sce} value of the system.

6.2 Measuring ranges (Range)

The settings are the same like in 5.2 ‘Measuring ranges (Range)’. Please note that the standards require a continuous measuring without gaps. For that reason the auto range function should be deactivated to prevent a range change, because this will cause a short measurement with invalid values.

6.3 Definition of measuring values

The following basic definitions are used:

n The harmonic order.

T The time of an integer number of the periods of the synchronisation signal. The integer factor depends on the standard IEC61000-4-7. Depending on the publishing date, 16, 12 or 10 periods are measured.

Voltage and current

true root mean square: $Utrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} u(t)^2\, dt}$ $Itrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} i(t)^2\, dt}$

DC root mean square: $Udc = \frac{1}{T}\int_{t=0}^{T} u(t)dt$ $Idc = \frac{1}{T}\int_{t=0}^{T} i(t)dt$

AC root mean square: $Uac = \sqrt{Utrms^2 - Udc^2}$ $Iac = \sqrt{Itrms^2 - Idc^2}$

crest factor: $Ucf = \frac{Upk}{Utrms}$ $Icf = \frac{Ipk}{Itrms}$

total harmonic distortion: $Uthd = \sqrt{\sum_{n=2}^{40}\left(\frac{U_n}{U_1}\right)^2}$ $Ithd = \sqrt{\sum_{n=2}^{40}\left(\frac{I_n}{I_1}\right)^2}$

The harmonic values ‘I(n)’ and ‘U(n)’ are calculated by using a DFT algorithm. The limit values ‘Limit (n)’ are calculated according to IEC61000-3-2/-12.

Power

active power: $P = \left(\frac{1}{T}\int_{t=0}^{T} u(t)i(t)dt\right) - U(0) * I(0)$ with EN61000-4-7:2002

$P = \frac{1}{T}\int_{t=0}^{T} u(t)i(t)dt$ in all other cases

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

apparent power: $S = Utrms * Itrms$

power factor: $\lambda = \frac{|P|}{S}$

Impedances

apparent impedance: $Z = \frac{Utrms}{Itrms}$

active impedance: $Rser = \frac{P}{Itrms^2}$

reactive impedance: $Xser = \frac{Q}{Itrms^2}$

6.4 Display of values

For the display of the values you can choose several menus.

6.4.1 Default

With *Default* you see the most important values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

6.4.2 Voltage

With *Voltage* you see the harmonic values of the measured voltage and in the second row the allowed limits in this voltage. A '!' between the two rows shows that the measuring value is bigger than the limit. In this menu you see always the evaluation of the actual measured window!

With the arrow keys or with the shuttle knob you can scroll through the list to see all harmonics.

In the top line you see the total trms value of the signal and the frequency of the synchronisation source.

Below the softkeys you see the result of the complete voltage judgement: a '✓' indicates that all requirements of the standard are met. A '×' indicates a fault measuring result. This result is only the result of the actual measuring and not influenced by earlier measurements.

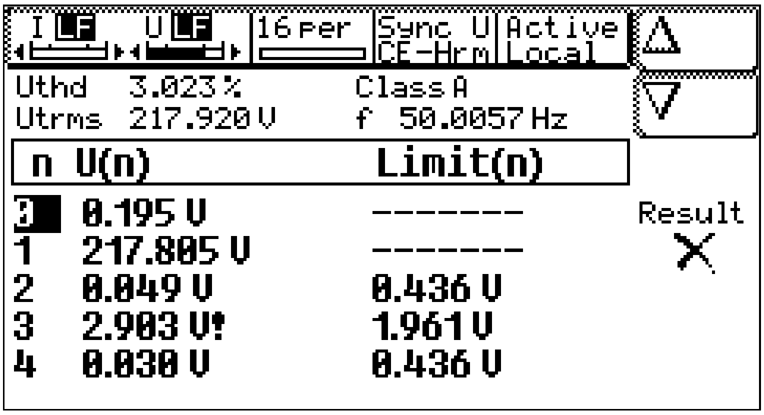


Figure 22: Display of voltages in CE-harm mode

All voltage characteristics according to EN61000-3-2/-12 resp. EN61000-4-7 are checked:

- amplitude
- frequency
- harmonics
- crest factor
- phase angle of peak value

6.4.3 Current

With *Current* you see the harmonic values of the measured current and in the second row the allowed limits in this current. A ‘!’ between the two rows shows that the measuring value is bigger than the limit. A ‘?’ between the two rows shows that the measuring value is bigger than 100%, but smaller than 150% of the limit (which is important for fluctuating harmonics!). This special evaluation is only valid for the harmonics of order 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 17 and 19. The ‘?’ indicates that the harmonic might be outside the standard if the ‘?’ appears for more than 10% of a any 2.5min windows.

If the current is <5mA or <0.6% of I_{trms} there is no judgement of the current. For this reason ‘------’ is displayed for the limit.

With the arrow keys or with the shuttle knob you can scroll through the list to see all harmonics.

In the top line you see the total trms value of the signal and the frequency of the synchronisation source.

Below the softkeys you see the result of the complete current judgement: a ‘✓‘ indicates that all requirements of the standard are met. A ‘×‘ indicates a fault measuring result. This result is only the result of the actual measuring and not influenced by earlier measurements.

Please note:
If only ‘?’ appear and no ‘!’ then the result will be ‘✓‘, because this is only the short term result, which might be correct.

6.4.4 Power

With *Power* you see the most important power values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

6.4.5 Long time evaluation (Energy)

In this menu you see the result of the long time evaluation. This is started with *Start* and can be cancelled with the *Stop* button. You see in the first row the order of the harmonics, followed by the maximum measured current.

The third row shows the evaluation for fluctuating harmonics. According to the standard it is allowed that some defined harmonics have values up to 1.5 times the limit for maximum 10% of a 2.5 minute window. The maximum percentage out of this window is displayed here. If the value is bigger than 10% you have a ‘!’ behind this value.

In the fourth row you see if the current harmonics have violated any point of the standard anytime while the complete long time measuring. If you have here a ‘!’ the device under test does not fulfil the standard!

In the last row you see if the test voltage has ever violated the harmonic limits.

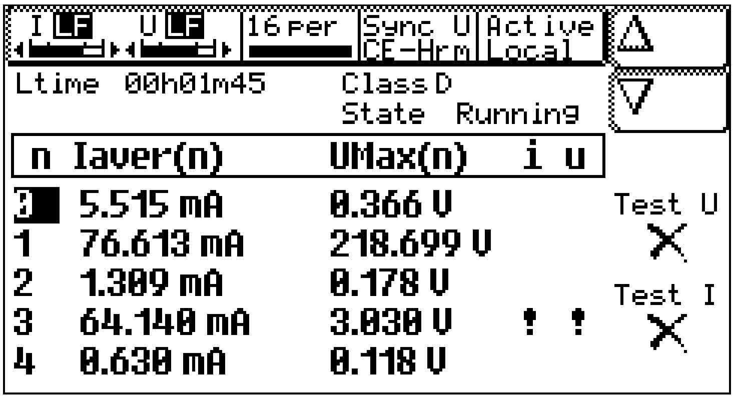


Figure 23: Long time evaluation of harmonics

Below the softkeys you see the total evaluation of the measurement. If any current harmonic has violated the standard at any time, or the differences between control and the measured values of power (Class D) or of current and power factor (Class C) were more than 10% (only A14) you have ‘Test I ×‘. If any voltage harmonic or the amplitude or the frequency have violated the standard you have ‘Test U ×‘. The printing and logging of this menu is only possible in single mode (see 4.4.2.1 ‘Interfaces for remote control’) and with ASCII format.

6.4.6 Graphical display

With *Graph* you reach the graphical displays in the CE-Harm mode. With the softkey right at the top you can choose different displays:

6.4.6.1 Class D

The graphical display of the class D judgement. On the left side you see the waveform of the current and the envelop defined in the standard (if you selected A14, there’s no envelope). On the right side you see if all three requirements are met:

The waveform has to be under the positive envelop for 95%
The waveform has to be under the negative envelop for 95%
The power has to be lower or same 600W

The last line is the total class D judgement.

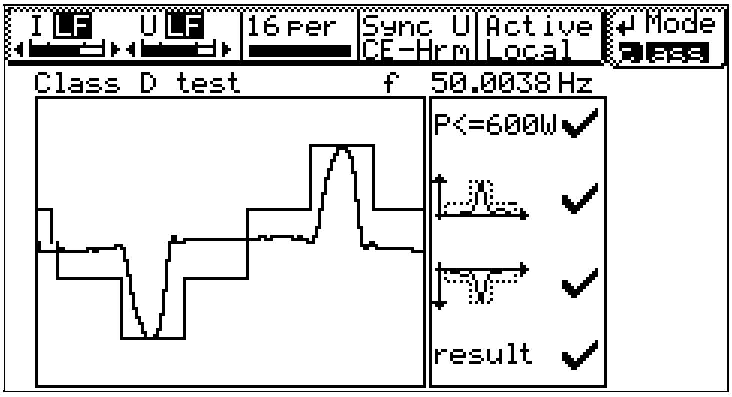


Figure 24: Class D envelop test

6.4.6.2 Spectrum

The graphical display of the voltage, the current and the limits of the harmonics. On the left side you see one or two values as bargraph. At the top you see the scaling of the y-axis. The display is 'value/div' for linear display. That means that you have 'value' volt or ampere per division line. An other possible display is 'value 1:10' for logarithmic display. That means that the top line has 'value' volt or ampere and the lower lines each have ten times less.

On the very left in the box you see the order number of the harmonic at cursor position. Beside you see the actual zooming factor. At the right side you have the values at the cursor position. 'Ln=' is the value of the limit, 'yn=' is the value of the voltage or the current.

With **Signal** you can choose 4 displays:

-U- The voltage is displayed with one thick bar.

U-Lim The voltage and the voltage limits are displayed. For the display you have always one thin bar with the limit, one thin bar with the measuring value and again one thin bar with the limit. So the value is covered by the limits.

-I- The current is displayed with one thick bar.

I-Lim The current and the current limits are displayed. For the display you have always one thin bar with the limit, one thin bar with the measuring value and again one thin bar with the limit. So the value is covered by the limits.

You can imagine that the limits are displayed like a cup filled with water (which represents the values). If you have too much in the cup you have a problem.

Log changes between linear scaling (=off) and logarithmic scaling (=on) for the y-axis.

With **yzoom** you can zoom into the signal. **Move** is reserved for later usage.

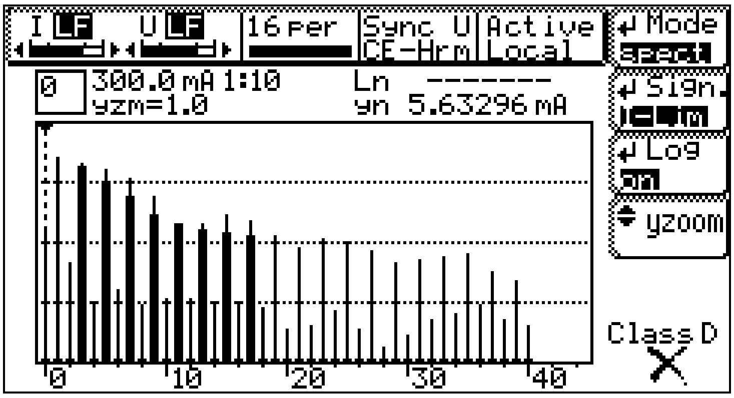


Figure 25: Graphical display of harmonics

6.4.7 Custom menu

With *Custom* you see the custom menu. You have the 8 variables 'var0' to 'var7'. This variables can be set with the formula editor (see 4.4.3, 'Formula editor').

6.5 Storage of values to memory card and printer

You change to the menu you want to print out or to store and press *Print* (exact handling see 11, 'Logging of values to drives, printer and interfaces'). All the values you see in this menu are printed out. In the menus with harmonic values you get all harmonics (not only the ones you see!)

6.6 Tests according EN61000-3-2

For tests according to this standard you first have to change the *Range* to 'Manual' mode. This is necessary because the test has to be done without any gaps.

Go to the *Measuring* menu, change to the wanted version with **EN** and select with **Eval** the class you want to test.

Now you can switch on the voltage. When the LMG95 is synchronised you can switch on the equipment under test (EUT). To check the special waveform of class D please notice the display in *Graph* menu.

If you want to make long time evaluations you can start them with *Start*.

For this application we offer the special software 'SYS61K'. Further information you get at www.zes.com from ZES ZIMMER Electronic Systems.

7 CE-Flicker measuring mode (option L95-O4)

In the CE-Flicker measuring mode the LMG95 works as an high precision flicker analyser according to IEC61000-4-15. The number of settings has been reduced to the needed ones to avoid fail handling.

Note!
In this measuring mode the valid frequency range is from **45 to 65Hz!**

7.1 Measuring configuration (Measuring)

When you came to this menu by pressing *Measure* you first have to choose **CEflk** to enter this mode. This mode bases on the CEharm mode. The synchronisation is fixed to the voltage channel. With the rotary knob yu can select two record cards (Globals and Ztest/Zref). With **Set** you can do several settings:

7.1.1 Globals record

dmax Here you have to enter the dmax limit in % which is valid for your special measuring. It depends on the measuring conditions and is specified in the standard.

EN... Here you have to specify, which standard should be used:

3/-4-15	EN61000-3-3:1995 with EN61000-4-15:1998/A1:2003
3-A1/-4-15	EN61000-3-3:1995/A1:2001 with EN61000-4-15:1998/A1:2003
3-A1B2/-4-15	EN61000-3-3:1995/A1:2001 with EN61000-4-15:1998/A1:2003 This one is especially for tests according annex B.2
-11:2000	EN61000-3-11:2000 with EN61000-4-15:1998/A1:2003

Systm This selects the system which is used for the measurement. There are four possible values:
230V/50Hz
230V/60Hz
120V/50Hz
120V/60Hz
The system is required for example for checking the correct frequency of the measuring set-up.

Intv This is the interval time of the short term flicker measuring. The standard value is 10min.

Per This is the number of short term periods for the long term measurement. The standard value is 12 periods for a long term time of 2 hours.

back returns you to main menu.

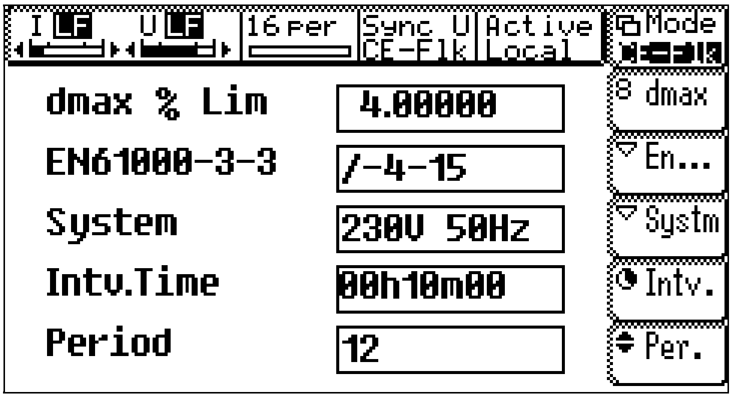


Figure 26: Measuring menu in CE-Flicker mode

7.1.2 Ztest/Zref record

This is only available when EN61000-3-11 is selected.

With **Ztest** you have to enter your actual used test impedance in Ω.

With **Zref** you have to choose, if your reference impedance is (0.24+j0.15)Ω or (0.4+j0.25)Ω.

The values for d_c, d_{max}, P_{st} and P_{lt} are recalculated as described in EN61000-3-11:2000

7.2 Measuring ranges (Range)

The settings are the same like in 5.2 ‘Measuring ranges (Range)’. Please note that the standards require a continuous measuring without gaps. For that reason the auto range function should be deactivated to prevent a range change, because this will cause a short measurement with invalid values.

7.3 Definition of measuring values

The following basic definitions are used:

n The harmonic order.

T The time of an integer number of the periods of the synchronisation signal. The integer factor depends on the standard IEC61000-4-7. Actually 16 periods are measured.

Voltage and current

true root mean square: $Utrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} u(t)^2\, dt}$ $Itrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} i(t)^2\, dt}$

total harmonic distortion: $Uthd = \sqrt{\sum_{n=2}^{40}\left(\frac{U_n}{U_1}\right)^2}$ $Ithd = \sqrt{\sum_{n=2}^{40}\left(\frac{I_n}{I_1}\right)^2}$

The harmonic values ‘I(n)’ and ‘U(n)’ are calculated by using a DFT algorithm.

The values ‘Pmom’, ‘Pst’ and ‘Plt’ are calculated using a flicker meter according to IEC868/IEC61000-4-15. ‘dc’ and ‘dmax’ are calculated according to IEC61000-3-3.

Power

active power: $P = \frac{1}{T}\int_{t=0}^{T} u(t)i(t)dt$

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

apparent power: $S = Utrms * Itrms$

power factor: $\lambda = \frac{|P|}{S}$

Impedances

apparent impedance: $Z = \frac{Utrms}{Itrms}$

active impedance: $Rser = \frac{P}{Itrms^2}$

reactive impedance: $Xser = \frac{Q}{Itrms^2}$

7.4 Display of values

For the display of the values you can choose several menus.

7.4.1 Default

With *Default* you see the most important values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

7.4.2 Voltage

With *Voltage* you see the most important voltage values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

7.4.3 Current

With *Current* you see the most important current values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

7.4.4 Power

With *Power* you see the most important power values of the instrument. With **Disp** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

7.4.5 Flicker (Energy)

In this menu you see the flicker values of the equipment under test (EUT). You see the short term flicker level P_{st}, the long term flicker level P_{lt}, the actual flicker level P_{mom}, the relative steady-state voltage change d_c, the maximum relative voltage change d_{max}, the remaining long term time, the remaining short term time and the state of the flicker measuring.

The state can be ‘starting’ (8s from pressing *START*), ‘running’ (while the long term interval) and ‘stooped’ after the measuring.

Figure 27: Evaluation of flicker measurement

d_{max} is measured over the long term time.

d_c is the relative voltage change between two ‘constant’ voltages. Therefore it can have different values:

d_c=------- means that there was no constant voltage.
d_c=0.000% means that there was exactly one constant voltage.
Any other value is the biggest difference between two constant voltages.

P_{lt} is calculated at the end of the long term measuring. Until then it is displayed as '-------'.

7.4.6 Graphical display

With *Graph* you see the graphical display of the flicker measuring mode. The first softkey changes to the different functions:

Plot Changes to the plot function.

7.4.6.1 Plot function

The handling of this menu is identical to the plot menu of the normal measuring mode (see 5.4.6.2 'Plot function'). But there are some things to know concerning the displayed values:

In the other modes, all values are measured in the same time interval. In the flicker mode there are two main time intervals: 10ms and 320ms. Most values are updated every 320ms, but some come every 10ms: They are the momentary flicker level (ID is Pml) and the half wave trms value (ID is Uhwl). As said above, this values come every 10ms. The Pmoml and Utrms values are the average values of Pml and Uhwl. So you can see Pmoml and Pml in one graph as function 'A' and 'B'. Because Pmoml has a slower time base, it is plotted with 32 same values.

7.4.7 Custom menu

With *Custom* you see the custom menu. You have the 8 variables 'var0' to 'var7'. This variables can be set with the formula editor (see 4.4.3, 'Formula editor').

7.5 Storage of values to memory card and printer

You change to the menu you want to print out or to store and press *Print* (exact handling see 11, 'Logging of values to drives, printer and interfaces'). All the values you see in this menu are printed out.

7.6 Tests according EN61000-3-3

For tests according to this standard you first have to change the *Range* to 'Manual' mode. This is necessary because the test has to be done without any gaps.

Switch on the voltage of the EUT. Start the flicker process with *Start*. After a delay of 8s the real measuring is started. Now you can switch on the EUT to get the different values. If you want to stop the measuring before the end of the long term time just press *Stop*.

For this application we offer the special software ‘SYS61K’. Further information you get at www.zes.com from ZES ZIMMER Electronic Systems.

Annex B.2

Usually the values d_c and d_{max} run for the whole observation period (Plt-time). To simplify tests according annex B.2 of EN61000-3-3:1995/A1:2001, you can choose, that these values are reset after each short term observation periode. To do this, please select the B2 item in measuring menu, softkey **EN**.

8 100 Harmonics measuring mode (option L95-O10)

In the 100 Harmonics measuring mode the LMG95 works as an high precision harmonic analyser. The difference to the **CEhrm** mode is, that 100 harmonics, the phase angles and the power harmonics are measured. The frequency range is much wider. There is no check against any limits.

8.1 Measuring configuration (Measuring)

When you came to this menu by pressing *Measure* you first have to choose **HM100** to enter this mode. With **Set** you can do several settings:

Sync Selects the signal which is used for synchronisation. There are four possible settings:

- U The voltage signal is used
- I The current signal is used
- X Extended Trigger. See **Xtrig**.
- Line The line signal is used
- Extn The signal at the external synchronisation jack is used.

Coupl Selects how the voltage or current signal is coupled to the following trigger stage. This setting has **no** influence to the measured signals!

AC+DC The signal is directly coupled, including all signal parts.

BP The low frequency parts (<10Hz) and the high frequency parts (>300Hz) of the signal are cut off.

AM The signal will be demodulated when measuring AM signals. Only the envelope is used.

Xtrig Here you reach a menu where you can define very precise, what should be your trigger condition. This menu should only be used from very experienced users, because if you select wrong conditions, you might get wrong measuring results.

Signl Here you define the signal you want to trigger on. Available are: us, is, ps, us^2, is^2, u, i, p. For the meaning of this values please watch the functional diagram in 14.5, ‘Functional block diagram computing unit’

Filt Here you can define a digital filter which influences the signal to be triggered on. Please note 2 points:
1. For example: You have a 50Hz signal and select p, you have a 100Hz p-wave! So a 87.5Hz filter will influence this signal!!!

2. You should always try to switch the HF-Rejection filter on (see point **Filter/S-Cpl**, **Filt** below) to prevent aliasing in the trigger signal.

Level Here you select the trigger level. If you for example select ‘u’ and a level of 100.0 the instrument will be triggered each time the voltage crosses the 100V line. Please note: If you select u² the level is 100V²!!

Hyst Usually you have a small noise on the signal. Without a hysteresis you might get several level crossings at a single ‘real’ crossing. With the hysteresis you can prevent this. For example you have a **Level** of 100V and a **Hyst** of 5V. If your signal comes from a value smaller than 95 V it has to climb up to 105V to get a positive crossing. If it comes from a value greater than 105V it has to fall below 95V to get a negative crossing.

back returns to the last menu.

FDiv This defines a frequency divider for the basic wave. With a value of 1 the measured frequency is identical to the basic wave. With a value of 2 the fundamental has only the half frequency of the measured frequency (e.g. A 50Hz signal with **FDiv** = 4 is analysed on a 12.5Hz base. So you get 3 interharmonic between the 50Hz Harmonics) Only with **FDIV** set to 1 you get the THD values of the signals.

back returns you to main menu.

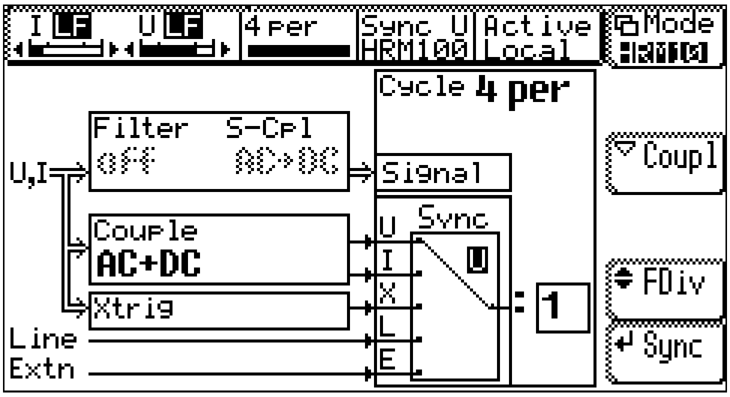


Figure 28: Measuring menu in Harm100 mode

8.2 Measuring ranges (Range)

The settings are the same like in 5.2 ‘Measuring ranges (Range)’.

8.3 Definition of measuring values

The following basic definitions are used:

n The harmonic order.

T	The time of an integer number of the periods of the synchronisation signal. The integer factor depends on the frequency of the basic wave:

Basic wave range / Hz	Number of measured periods	Sample frequency divider	Automatically selected filter
640-1280	32	1	HF-Rejection
320-640	16	1	HF-Rejection
160-320	8	1	HF-Rejection
80-160	4	1	HF-Rejection
40-80	4	2	18kHz
20-40	4	4	6kHz
10-20	4	8	2.8kHz
5-10	4	16	1.4kHz
2.5-5	4	32	700Hz
1.25-2.5	4	64	350Hz
0.625-1.25	4	128	175Hz
0.3125-0.625	4	256	87.5Hz
0.15625-0.3125	2	256	87.5Hz
0.078125-0.15625	1	256	87.5Hz

The 'sample frequency divider' defines, how the sampling frequency of about 100kHz is divided for this measuring.

Voltage and current

true root mean square: $Utrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} u(t)^2\,dt}$ $Itrms = \sqrt{\frac{1}{T}\int_{t=0}^{T} i(t)^2\,dt}$

total harmonic distortion: $Uthd = \sqrt{\sum_{n=2}^{99}\left(\frac{U_n}{U_1}\right)^2}$ $Ithd = \sqrt{\sum_{n=2}^{99}\left(\frac{I_n}{I_1}\right)^2}$

Only with **FDIV** set to 1 you get the THD values of the signals.

The harmonic components are calculated to meet the following:

$$u(t) = \sum_{n=0}^{99} \sqrt{2}U_n \sin(n\omega t + \varphi_{un}) \qquad i(t) = \sum_{n=0}^{99} \sqrt{2}I_n \sin(n\omega t + \varphi_{in})$$

The harmonic values 'I(n)', 'U(n)' and 'Phase(n)' are calculated by using a DFT algorithm. With this values also the values of 'P(n)', 'S(n)' and 'Q(n)' are calculated. This 'Q(n)' is only the reactive power, caused by a phase shift of a voltage and current component with the same frequency. Therefore it is in this mode possible to calculate also the reactive power which is caused by voltage and current components with different frequencies. This value is called D:

$D = \sqrt{S^2 - P^2 - Qshift^2}$ with $Qshift = \sum_{n=0}^{99} Q(n)$, P and S see below.

Power

active power: $P = \frac{1}{T}\int_{t=0}^{T} u(t)i(t)dt$

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

apparent power: $S = Utrms * Itrms$

power factor: $\lambda = \frac{|P|}{S}$

Impedances

apparent impedance: $Z = \frac{Utrms}{Itrms}$

active impedance: $Rser = \frac{P}{Itrms^2}$

reactive impedance: $Xser = \frac{Q}{Itrms^2}$

8.4 Display of values

For the display of the values you can choose several menus.

Harmonic values (amplitude, phase, frequency, ...) can just be displayed constant in steady state condition due to the nature of FFT. While signal changes (frequency and/or amplitude) you will get unexpected signals (they are not wrong, but due to the special calculation method 'FFT' they might look different than you expect).

8.4.1 Default

With *Default* you see the most important values of the instrument. With **4 Val** and **8 Val** you can choose a 4 measuring values display in big letters or 8 measuring values display in smaller letters.

8.4.2 Voltage

With *Voltage* you see the harmonic values of the measured voltage and in the second row the phase of the harmonic component.

With the softkey **Ref** you can select the reference signal (voltage, current or none). The fundamental of this signal is always set to 0°. When selected ‘none’, the time window is the reference.

With the arrow keys or with the shuttle knob you can scroll through the list to see all harmonics.

In the top line you see the total trms value of the signal and the frequency of the synchronisation source.

8.4.3 Current

With *Current* you see the harmonic values of the measured current and in the second row the phase of the harmonic component.

With the arrow keys or with the shuttle knob you can scroll through the list to see all harmonics.

In the top line you see the total trms value of the signal and the frequency of the synchronisation source.

With the softkey **Ref** you can select the reference signal (voltage, current or none). The fundamental of this signal is always set to 0°. When selected ‘none’, the time window is the reference.

8.4.4 Power

With *Power* you see the harmonic values of the measured powers. With **List** you can choose several lists with the different combinations of the different powers.

With the arrow keys or with the shuttle knob you can scroll through the list to see all harmonics.

In the top line you see the total power value of the different powers.

8.4.5 Custom menu

With *Custom* you see the custom menu. You have the 8 variables ‘var0’ to ‘var7’. This variables can be set with the formula editor (see 4.4.3, ‘Formula editor’).

8.4.6 Graphical display

With *Graph* you reach the graphical displays in the Harm100 mode.

8.4.6.1 Spectrum

The graphical display of the voltage and the current. On the left side you see one or two values as bargraph. At the top you see the scaling of the y-axis. The display is ‘value/div’ for linear display. That means that you have ‘value’ volt or ampere per division line. An other possible display is ‘value 1:10’ for logarithmic display. That means that the top line has ‘value’ volt or ampere and the lower lines each have ten times less.

On the very left in the box you see the order number of the harmonic at cursor position. Beside you see the actual zooming factor. At the right side you have the values at the cursor position. ‘fn=‘ is the frequency of the component, ‘yn=‘ is the value of the voltage or the current.

With **Signal** you can choose 2 displays:

-U- The voltage is displayed with one thick bar.
-I- The current is displayed with one thick bar.
Log changes between linear scaling (=off) and logarithmic scaling (=on) for the y-axis.

With **yzoom** you can zoom into the signal. **Move** is used to select if you want to move the window (to see the other Harmonics) or if you want to move the cursor.

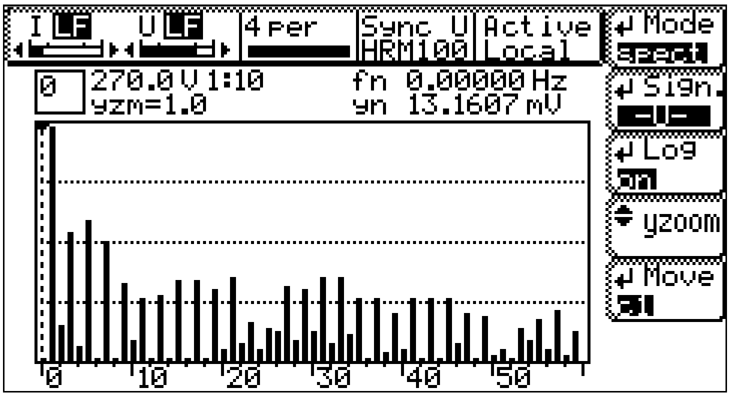


Figure 29: Graphical display of harmonics

8.5 Storage of values to memory card and printer

You change to the menu you want to print out or to store and press *Print* (exact handling see 11, ‘Logging of values to drives, printer and interfaces’). All the values you see in this menu are printed out. In the menus with harmonic values you get all harmonics (not only the ones you see!)

9 Transient mode (option L95-O5)

In the transient measuring mode the LMG95 works as a transient recorder. You can define special events. If they occur the measuring is stopped and you can analyse the signal.

9.1 Measuring configuration (Measuring)

When you came to this menu by pressing *Measure* you first have to choose **Trans** to enter this mode. You have 3 tabs with several settings. You can select another tab by the rotary knob.

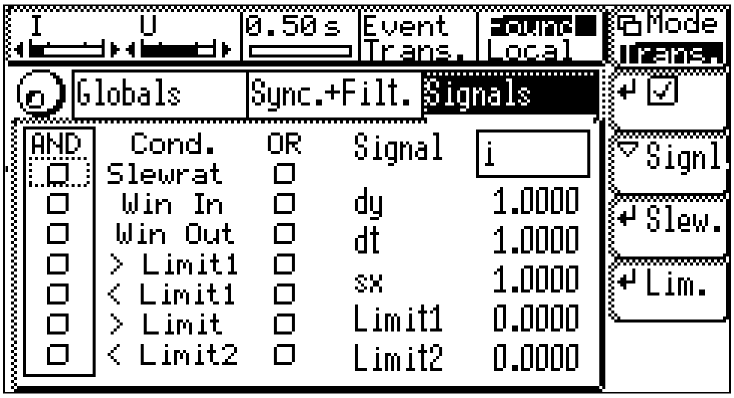


Figure 30: Measuring menu in transient mode

9.1.1 Globals tab

TDur This is the minimum duration of the event. If you for example set this value to 5ms and check for an over limit, the signal has to be over the limit for 5 seconds until the event is generated.

TRec This is the recording time. The signal is recorded for this time to the memory. If you have more memory, it might be recorded for a longer time.
Please note: If your memory is too small and/or you want to record too much signals the recording rate might be reduced. This has no influence to the sampling rate or to the event detection.
You can set-up the record time in 10ms steps from 50ms to 60s.

PreTr This is the pretrigger duration in %. If you for example have a record time of 200ms and 50% pretrigger you will get at minimum 100ms before the event and exact 100ms after the event.

9.1.2 Sync.+Filt. tab

Sync Selects the signal which is used for synchronisation. There are four possible settings:

U The voltage signal is used

I The current signal is used

Line The line signal is used

Extn The signal at the external synchronisation jack is used.

Coupl Selects how the voltage or current signal is coupled to the following trigger stage. This setting has **no** influence to the measured signals!

AC+DC The signal is directly coupled, including all signal parts.

BP The low frequency parts (<10Hz) and the high frequency parts (>300Hz) of the signal are cut off.

AM The signal will be demodulated when measuring AM signals. Only the envelope is used.

Filt Here you can select if the filters in the signal path of voltage and current are active or not. This filters are only in the signal way and don't influence the synchronisation. For the possible settings see 5.1 'Measuring configuration (Measuring)'

The settings for **Coupl** and **Sync** you did in this menu are not used for the transient search itself but for continuously measuring the TRMS and peak values of voltage and current. This values are used to update the over- and under range display in the status line.

9.1.3 Signals tab

Signl This defines which signal should be watched for the transient event. Following settings are possible: is, is^2, us, us^2, ps, i, u, p. For the meaning of this values please watch the functional diagram in 14.5, 'Functional block diagram computing unit'.

Limit Here you can set-up the limits for the events. The instantaneous value of the signal to be watched is checked against the limit if it is bigger (or smaller) an event is generated. If a function needs two limits (e.g. Win In) **Lim1** is the upper limit and **Lim2** the lower limit.

Slewr Here you can set-up the maximum allowed slewrate of the signal. For this you have 3 possible settings:

dSig This is the required signal change in the time interval **dt**.

dt This is the time interval.

overx This is the width of the slewrate watch window in number of sample values.

For example you have a signal with a typical rise time of 3.5V in 450µs. In this case you have to enter 3.5 with **dSig** and 450µ with **dt**. Herewith you have defined the steep of the signal: 7.777V/ms or 7.777mV/µs. With a sample interval of about 10µs (10µs *7.777mV/µs = 77.77mV) this is only about 2 bit (in 600V range; 1 bit = 1600Vpeak/32768 = 48.8mV) of the converter resolution. That means, if the difference between two sample values is bigger than 2 bit you would get an event. But from several sources you have a small noise on the signal. This would cause fail events. To prevent this you can use the parameter **overx**. With it you can define, that the slewrate is not calculated over one sample period but over up to 15. If you for example choose 15 (15*10µs*7.777mV/µs=1.166V), the signal has to change 24 bit in this example! So you can use **overx** to suppress noise effects.

While you are in the **Set** mode you can use the rotary knob to define the trigger condition. Move to the desired position and press *Enter* to mark/unmark a condition. In the left column you can set-up the AND condition. Only if all of the marked events happen at the same time the result of the AND condition will be true. In the right column you can set-up the OR condition. If one or more of the marked events happen or the result of the AND condition is true you will get an event.

An event is generated depending on the event type if:

Slewrate	the slew rate of the signal is bigger than defined by the **Slewr** menu.
Win In	the signal is <Limit1 <u>and</u> >Limit2
Win Out	the signal is >Limit1 <u>or</u> <Limit2
>Limit1	the signal is >Limit1
<Limit1	the signal is <Limit1
>Limit2	the signal is >Limit2
<Limit2	the signal is <Limit2

If you enter the transient mode the instrument is always in the ‘Idle’ state (see status line). To start a transient search press *Start*. In the status line changes to ‘Start’. This state lasts until the pretrigger time is over. While this time no events are detected. Now the status changes to ‘Search’. Now an event would be detected. To end a search press the *Stop* key. In this case an event is simulated and you can check if for example your trigger time definitions are okay. Pressing the *Stop* key is same like generating an event. The instrument changes to ‘PostTr’ state to record the posttrigger values. If this has finished, the last status will be ‘Finish’. Now you can watch the values and start a new search.

If you are searching a transient, you see the record time in the status line. The bar below blinks.

9.2 Measuring ranges (Range)

The settings are the same like in 5.2 ‘Measuring ranges (Range)’.

9.3 Display of values

For the display of the values you can choose only one menu.

9.3.1 Graphical display

The settings are the same like in 5.4.6 ’Graphical display’, but there is no plot function in the transient mode.

The second exception is the **Min.Div.** softkey in the graphical menu (**more**). It is similar to the **Cycls** softkey in the normal mode (see 5.4.6.1, ‘Scope function’). By it you can define, that the sample rate should be divided at least by this number. So you can get a longer time duration onto one screen of the scope.

9.4 Storage of values to memory card and printer

You change to the menu you want to print out or to store and press *Print* (exact handling see 11, ‘Logging of values to drives, printer and interfaces’). All the values you see in this menu are printed out.

10 Interfaces (option L95-O1)

With exception of the IEEE interface all interfaces could also be used for data logging (see 11, ‘Logging of values to drives, printer and interfaces’). To remote control the LMG please reserve first the wished interface for this job (see 4.4.2.1, ‘Interfaces for remote control’). This chapter includes all commands and a short general syntax description. A much more detailed syntax description with a lot of examples and further programming explanations can be found in our ***Programmer’s Guide*** on the CD which is included in the printed version of this manual. If this is missing or you have just a PDF version of this manual you can request the ***Programmer’s Guide*** by email from ‘sales@zes.com’.

10.1 Short syntax description

There are two implemented languages: SCPI and SHORT. When switching on the instrument SCPI is selected. To change to SHORT you have to send:

SYST:LANG SHORT

For further differences between SCPI and SHORT command set see also 10.2.4, ‘:FETCh and :READ commands’

The general syntax for both command sets is identical. The most important syntax rules are:

- A message to the instrument has to be terminated with an EOS character.
- brackets [..] are showing optional part of commands. There is no need to send them to the device, but you can do it, if you need this function. The brackets are just informative and should not be sent.
- The number of the measuring channel (further on called ‘suffix’) follows directly (without any space) after the identifier. If you don’t specify one, ‘1’ is assumed.
- If you request a value you have to add a ‘?’ directly behind the suffix (or the identifier, if no suffix is specified), without any space.
- All parameters following the commands have to be separated from the command with at least one space character.
- The group number is usually an optional parameter in the format [,<NRi>]. If you don’t specify it, group A (=0) is assumed as default value.
- ‘/qonly/’ indicates, that this is a value which can only be demanded, but not set. Do not send the ‘/qonly/’ string to the device, it is just written in this manual to explain the command. For example you can’t send a measuring value.

- '/nquery/' indicates that this value can only be set, and not demanded. Do not send the '/nquery/' string to the device, it is just written in this manual to explain the command. For example you can't request a trigger command.
- All commands without '/qonly/' and '/nquery/' can be read and set.
- <NRf> are float numbers
- <NRi> are integer numbers
- <list> stands for <(<NRf>:<NRf>)>. With this construct you can request several values which are stored in an array, for example harmonic values. To get the 3rd to 11th harmonic of the voltage of the second measuring channel you have to write in SHORT command set: HUAM2? (3:11)

For the complete syntax rules please take a look at the ***Programmer's Guide***!

Examples showing the syntax

Equivalent SCPI commands for reading the TRMS value of the 1st measuring channel:

:FETCh:CURRent:TRMS?

:FETC:CURR:TRMS?

:FETC:CURR:TRMS1?

As SHORT command it would be

ITRMS? or ITRMS1?

Please note that there is no space before the '1' and no space before the '?'!

Command for reading the harmonic voltages from the 2nd to the 4th harmonic (3 values):

:FETC:HARM:VOLT:AMPL? (2:4)

Please notice that there is at least one space between the question mark and the parameters!

Command for setting the 250V range:

:SENS:VOLT:RANG 250

Please notice that there is at least one space before the parameter 250!

Command for setting the 250V range in the 3rd channel:

:SENS:VOLT:RANG3 250

Please notice that there is no space before the suffix and at least one space before the 250!

Commands for setting and reading a filter in group B (short language):

FILT 5,1

FILT? 1

For group A you can write:
FILT 5,0 or FILT 5

FILT? 0 or FILT?

For more examples please take a look at the ***Programmer's Guide***!

10.2 Commands

Here you find all commands the instrument can handle. The commands are ordered like in the SCPI tree structure. The description is always the same:

SCPI: *The SCPI syntax of the command*

SHORT: *The SHORT syntax of the command*

ID:	*The ID for script editor and similar*	Mode:	*The valid measuring modes*
Type:	*The data type*	Suffix:	*The valid suffix range*
Value:	*The value range*	List:	*The valid list range*
Unit:	*The physical unit*	Group:	*The valid group range*

An 'n/a' means 'not applicable'. If you for example see an 'n/a' in the 'Value:' field, then this command has no value at all. Or it is a float number with all valid codes according IEEE754.

The titles of the useable commands are in a box. There you find from left to right: SCPI command, SHORT command and the ID if existing.

Please see also 10.1, 'Short syntax description'.

For all this commands there is a separated index. See chapter 17, 'Interface command and identifier index'.

10.2.1 IEEE488.2 common commands

10.2.1.1 *CLS *CLS

SCPI: *CLS/nquery/
SHORT: *CLS/nquery/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a

Unit: n/a Group: n/a

Clears the event registers of all status data structures in a device and the error/event queue.

10.2.1.2 *ESE *ESE

SCPI: *ESE <NRi>
SHORT: *ESE <NRi>

ID:	n/a	Mode:	n/a
Type:	long int	Suffix:	n/a
Value:	0...255	List:	n/a
Unit:	n/a	Group:	n/a

Used to set up or read out the Event Status Enable Register.

10.2.1.3 *ESR? *ESR?

SCPI: *ESR? /qonly/
SHORT: *ESR? /qonly/

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a
Value:	0...255	List:	n/a
Unit:	n/a	Group:	n/a

Reads out and clears the Event Status Register.

10.2.1.4 *IDN? *IDN?

SCPI: *IDN? /qonly/
SHORT: *IDN? /qonly/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads out the identification of the device. There are 4 fields separated by commas:

Field 1 Manufacturer

Field 2 Model

Field 3 Serial number

Field 4 Firmware level

10.2.1.5 *IST? *IST?

SCPI: *IST? /qonly/
SHORT: *IST? /qonly/

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a

Value: 0, 1 List: n/a
Unit: n/a Group: n/a

Individual Status Query. This returns the status of the ‘ist’ local message in the device.

10.2.1.6 *OPC *OPC

SCPI: *OPC/nquery/
SHORT: *OPC/nquery/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Causes the device to set the operation complete bit in the Standard Event Status Register, when all pending selected device operations have been finished.

10.2.1.7 *OPC? *OPC?

SCPI: *OPC? /qonly/
SHORT: *OPC?/qonly/

ID:	n/a	Mode:	all
Type:	char	Suffix:	n/a
Value:	‘1’	List:	n/a
Unit:	n/a	Group:	n/a

Causes the device to place a „1“ (=31h) in the output queue, when all pending selected device actions have been finished (=operation complete). This is independent from the output format!

10.2.1.8 *PRE *PRE

SCPI: *PRE <NRi>
SHORT: *PRE <NRi>

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Used to set up or read out the Parallel Poll Enable Register

10.2.1.9 *RST *RST

SCPI: *RST/nquery/
SHORT: *RST/nquery/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

This performs a device reset. A lot of internal settings (like measuring mode, ranges, ...) are set to their default values. In this chapters the default value is indicated by '[*RST Default value]'. All time dependent measurements are stopped (energy, flicker, harmonics).

The interface and it's parameters are not reset! If you want to reset it, please use a BREAK with RS232 interface or a 'device clear' with IEEE interface.

Hint

The execution of this command can take up to several seconds. The LMG works internally with a watchdog protection. To prevent that the watchdog becomes active, the '*RST' command should be send as the only command in a message. Just the '*OPC?' can be added to get a feedback, if the command has finished ('*RST;*OPC?'). In this case wait until the '1' returns before sending the next commands!

10.2.1.10 *SRE *SRE

SCPI: *SRE <NRi>
SHORT: *SRE <NRi>

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a
Value:	0...255	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the Service Request Enable Register

10.2.1.11 *STB? *STB?

SCPI: *STB? /qonly/
SHORT: *STB? /qonly/

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a
Value:	0...255	List:	n/a
Unit:	n/a	Group:	n/a

Queries the Status Byte Register.

10.2.1.12 *TRG *TRG

SCPI: *TRG/nquery/
SHORT: *TRG/nquery/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Triggers the same action that happens when programmer sends DT1 via IEEE488.1 interface or '&TRG<cr><lf>' via RS232 interface. Actually nothing is performed.

10.2.1.13 *TST? *TST?

SCPI: *TST? /qonly/ <NRi>
SHORT: *TST?/qonly/ <NRi>

ID:	n/a	Mode:	all
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Initiates a self test. Returns a value depending on <NRi>. This command should only be used by ZES and not by customers.

10.2.1.14 *WAI *WAI

SCPI: *WAI/nquery/
SHORT: *WAI/nquery/

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Waits until all pending selected device operations have been finished. Note: The instrument handles commands in a queue, so when executing the *WAI all previous commands have been executed. Thus the instrument is doing nothing when receiving the *WAI command. It has been implemented to follow the standard IEEE488.2.

10.2.2 :CALCulate commands

Here you find commands which influence the script editor (formulas) or limits.

:CALCulate →	**:ENVironment**
:DISPlay	:FORMula
:FETCh	:LIMit
:FORMat	
:INITiate	
:INPut	
:INSTrument	
:MEMory	
:READ	
:SENSe	
:SOURce	
:STATus	
:SYSTem	
:TRIGger	

10.2.2.1.1 ENVironment ENV Env

SCPI: :CALCulate:ENVironment <NRf>[,<NRi>]

SHORT: ENV <NRf>[,<NRi>]

ID:	Env	Mode:	all
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries an environment variable.

10.2.2.2 :FORMula

:CALCulate	→	:ENVironment		
:DISPlay		:**FORMula**	→	[:DEFine]
:FETCh		:LIMit		
:FORMat				
:INITiate				
:INPut				
:INSTrument				
:MEMory				
:READ				
:SENSe				
:SOURce				
:STATus				
:SYSTem				
:TRIGger				

10.2.2.2.1 [:DEFine] FORM

SCPI: :CALCulate:FORMula[:DEFine]<string program data>
SHORT: FORM<string program data>

ID:	n/a	Mode:	all
Type:	string	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the script of the script editor. There is no *RST default value.

For example ‘FORM „a=1;“<lf>‘ sets the internal variable a to 1.

10.2.2.3 :LIMit:

:CALCulate	→	:ENVironment		
:DISPlay		:FORMula		
:FETCh		**:LIMit**	→	:CLASs
:FORMat				:DMAX
:INITiate				:FCURrent
:INPut				:PFACtor
:INSTrument				:POWer
:MEMory				:SYSTem
:READ				:VERSion
:SENSe				
:SOURce				
:STATus				
:SYSTem				
:TRIGger				

10.2.2.3.1 :CLASs EVAL

SCPI: :CALCulate:LIMit:CLASs <NRi>
SHORT: EVAL <NRi>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	0...6, 10..12	List:	n/a
Unit:	n/a	Group:	n/a

Sets the evaluation of the harmonics in the CE mode:

0: Class A (EN61000-3-2) [*RST default value]
1: Class B (EN61000-3-2)
2: Class C-2 (EN61000-3-2)
3: Class D (EN61000-3-2)
4: Class C-3 (EN61000-3-2)
5: Class C-W (EN61000-3-2)
6: Class C-1 (EN61000-3-2)
10: Table 2 (EN61000-3-12:2005)
11: Table 3 (EN61000-3-12:2005)
12: Table 4 (EN61000-3-12:2005)

10.2.2.3.2 :DMAX FLDL

SCPI: :CALCulate:LIMit:DMAX <NRf>
SHORT: FLDL <NRf>

ID:	n/a	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Sets the allowed limit for d_{max} for the device under test according to the standardin the flicker mode.

10.2.2.3.3 :FCURrent ISO

SCPI: :CALCulate:LIMit:FCURrent <NRf>
SHORT: ISO <NRf>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1.0	List:	n/a
Unit:	A	Group:	n/a

Sets or reads the fundamental current for the EN61000-3-2:2000 limit calculation in the CE mode.

10.2.2.3.4 :FVERsion FNRM

SCPI: :CALCulate:LIMit:FVERsion <NRi>
SHORT: FNRM <NRi>

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	0...3	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the edition of the flicker standard:

0: EN61000-3-3:1995 [*RST default value]

1: EN61000-3-3:1995/A1:2001

2: EN61000-3-3:1995/A1:2001 Annex B.2

3: EN61000-3-11:2000

10.2.2.3.5 :PFACtor PFSO

SCPI: :CALCulate:LIMit:PFACtor <NRf>
SHORT: PFSO <NRf>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1.0	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the power factor for the EN61000-3-2:2000 limit calculation in the CE mode.

10.2.2.3.6 :POWer PSO

SCPI: :CALCulate:LIMit:POWer <NRf>
SHORT: PSO <NRf>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1.0	List:	n/a
Unit:	W	Group:	n/a

Sets or reads the power for the EN61000-3-2:2000 limit calculation in the CE mode.

10.2.2.3.7 :RSCE RSCE

SCPI: :CALCulate:LIMit:RSCE <NRf>
SHORT: RSCE <NRf>

ID:	n/a	Mode:	CE
Type:	float	Suffix:	n/a
Value:	33...10000, [*RST default value] = 33	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the R_{sce} for the EN61000-3-12:2005 limit calculation in the CE mode.

10.2.2.3.8 :SYSTem SYSD

SCPI: :CALCulate:LIMit:SYSTem <NRi>
SHORT: SYSD <NRi>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	0...3	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the supply system for the harmonics and flicker:

0: 230V/50Hz [*RST default value]

1: 230V/60Hz

2: 120V/50Hz

3: 120V/60Hz

4: 220V/50Hz

5: 220V/60Hz

6: 240V/50Hz

7: 240V/60Hz

10.2.2.3.9 :VERSion EDIT

SCPI: :CALCulate:LIMit:VERSion <NRi>
SHORT: EDIT <NRi>

ID:	n/a	Mode:	CE
Type:	long int	Suffix:	n/a
Value:	0...4	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the edition of the harmonic standard:

0: EN61000-3-2:1995 and EN61000-4-7:1993 [*RST default value]

1: EN61000-3-2:1995 and EN61000-4-7:2002

2: EN61000-3-2:2000 and EN61000-4-7:1993

3: EN61000-3-2:2000 and EN61000-4-7:2002

4: EN61000-3-12:2005 and EN61000-4-7:2002

10.2.2.3.10 :ZREF ZREF

SCPI: :CALCulate:LIMit:ZREF <NRf>
SHORT: ZREF <NRf>

ID:	n/a	Mode:	Flicker
Type:	int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the Z_{ref} for the EN61000-3-11:2000 limit calculation.

0: (0.24+j0.15)Ω [*RST default value]

1: (0.40+j0.25)Ω

10.2.2.3.11 :ZTESt ZTST

SCPI: :CALCulate:LIMit:ZTESt <NRf>
SHORT: ZTST <NRf>

ID:	n/a	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	0.05...1, [*RST default value] = 0.283	List:	n/a
Unit:	Ω	Group:	n/a

Sets or reads the Z_{test} for the EN61000-3-11:2000 limit calculation.

10.2.3 :DISPlay commands

:CALCulate		
:DISPlay	→	:BRIGhtness
:FETCh		:CONTrast
:FORMat		:RESet
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus		
:SYSTem		
:TRIGger		

10.2.3.1 :BRIGhtness DISB

SCPI: :DISPlay:BRIGhtness <NRf>
SHORT: DISC <NRf>

ID:	n/a	Mode:	all
Type:	float	Suffix:	n/a
Value:	0...100 in %, [*RST default value] = 80	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the brightness of the display.

10.2.3.2 :CONTrast DISC

SCPI: :DISPlay:CONTrast <NRf>
SHORT: DISC <NRf>

ID:	n/a	Mode:	all
Type:	float	Suffix:	n/a
Value:	0...100 in %, [*RST default value] = 65	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the contrast of the display.

10.2.3.3 :RESet DISR

SCPI: :DISPlay:RESet
SHORT: DISR

ID:	n/a	Mode:	all
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Resets the display to the default values.(e.g. small fonts...).

10.2.4 :FETCh and :READ commands

These both commands are used to get measuring values from the instrument. With :FETCh you get the values which are actually in the copied buffer for the interface. With :READ there are internally two commands executed: :INITiate:IMMediate and :FETCh (see also 10.2.6.3, ':IMMediate INIM' for further details).

If you request the same value twice with two :READ commands (e.g. :READ:DC?;:READ:DC?) you get two different values of two different cycles. This can cause problems for example with following request:
:READ:VOLTAGE:DC?;:READ:CURRENT:DC?
The two values you get for Udc and Idc are measured in different cycles!

If you request the same value twice with two :FETCh commands you get the same values of the same cycle. For example :FETC:DC?;:FETC:DC? would not make any sense, because you will get the same value.

A usual request looks like this:
:READ:VOLTAGE:DC?;:FETC:CURRENT:DC?
In this case the instrument finishes the actual cycle, copies the values for the interface and returns the two requested values. This two values are measured in the same cycle!

The SHORT commands perform equal to the :FETCh commands (which means there is no INIM performed!). So if you want to perform the last example with SHORT commands you have to enter
INIM;UDC?;IDC?

10.2.4.1 [:SCALar]

10.2.4.1.1 :CURRent

:CALCulate

:DISPlay			
:FETCh →	**[:SCALar]** →	**:CURRent** →	:AC
:FORMat		:CYCLe	:CFACtor
:INITiate		:DINPut	:DC
:INPut		:ENERgy	:FFACtor
:INSTrument		:FLICker	:INRush
:MEMory		:FREQuency	:MAXPk
:READ →		:HARMonics	:MINPk
:SENSe		:POWer	:PPEak
:SOURce		:RESistance	:RECTify
:STATus		:SSYStem	:RUSed
:SYSTem		:VARiable	[:TRMS]
:TRIGger		[:VOLTage]	

10.2.4.1.1.1 :AC? IAC? Iac

SCPI: :FETCh[:SCALar]:CURRent:AC? /qonly/ | :READ[:SCALar]:CURRent:AC? /qonly/
SHORT: IAC?/qonly/

ID:	Iac	Mode:	Normal, prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the AC value of the current.

10.2.4.1.1.2 :CFACtor? ICF? Icf

SCPI: :FETCh[:SCALar]:CURRent:CFACtor? /qonly/ | :READ[:SCALar]:CURRent:CFACtor? /qonly/
SHORT: ICF?/qonly/

ID:	Icf	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the crest factor of the current.

10.2.4.1.1.3 :DC? IDC? Idc

SCPI: :FETCh[:SCALar]:CURRent:DC? /qonly/ | :READ[:SCALar]:CURRent:DC? /qonly/
SHORT: IDC? /qonly/

ID:	Idc	Mode:	Normal, prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the DC value of the current.

10.2.4.1.1.4 :FFACtor? IFF? Iff

SCPI: :FETCh[:SCALar]:CURRent:FFACtor?/qonly/ | :READ[:SCALar]:CURRent:FFACtor? /qonly/
SHORT: IFF? /qonly/

ID:	Iff	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the form factor of the current.

10.2.4.1.1.5 :FSCale? FSI?

SCPI: :FETCh[:SCALar]:CURRent:FSCale? /qonly/ | :READ[:SCALar]:CURRent:FSCale? /qonly/
SHORT: FSI? /qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the full scale value of the current.

10.2.4.1.1.6 :INRush? IINR? Iinr

SCPI: :FETCh[:SCALar]:CURRent:INRush? /qonly/ | :READ[:SCALar]:CURRent:INRush? /qonly/
SHORT: IINR? /qonly/

ID:	Iinr	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the value of the inrush current. To reset this value see 10.2.14.2, „IINC“

10.2.4.1.1.7 :MAXPk? IMAX? Ipkp

SCPI: :FETCh[:SCALar]:CURRent:MAXPk? /qonly/ | :READ[:SCALar]:CURRent:MAXPk? /qonly/
SHORT: IMAX? /qonly/

ID:	Ipkp	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the biggest sample value of the current.

10.2.4.1.1.8 :MINPk? IMIN? Ipkn

SCPI: :FETCh[:SCALar]:CURRent:MINPk? /qonly/ | :READ[:SCALar]:CURRent:MINPk? /qonly/
SHORT: IMIN? /qonly/

ID:	Ipkn	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the smallest sample value of the current.

10.2.4.1.1.9 :PHASe? IPHI? Iphi

SCPI: :FETCh[:SCALar]:CURRent:PHASe? /qonly/ | :READ[:SCALar]:CURRent:MINPk? /qonly/
SHORT: IPHI? /qonly/

ID:	n/a	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	°	Group:	n/a

Reads the phase angle of the current like displayed in the Fresnel diagram.

10.2.4.1.1.10 :PPEak? IPP? Ipp

SCPI: :FETCh[:SCALar]:CURRent:PPEak? /qonly/ | :READ[:SCALar]:CURRent:PPEak? /qonly/
SHORT: IPP? /qonly/
\f if

ID:	Ipp	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the peak peak value of the current.

10.2.4.1.1.11 :RECTify? IREC? Irect

SCPI: :FETCh[:SCALar]:CURRent:RECTify? /qonly/ | :READ[:SCALar]:CURRent:RECTify? /qonly/
SHORT: IREC? /qonly/

ID:	Irect	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the rectified value of the current.

10.2.4.1.1.12 :RUSed? OVRI? OvrI

SCPI: :FETCh[:SCALar]:CURRent:RUSed? /qonly/ | :READ[:SCALar]:CURRent:RUSed? /qonly/
SHORT: OVRI? /qonly/

ID:	OvrI	Mode:	All
Type:	float	Suffix:	n/a
Value:	0...100 in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the usage of the current range.

10.2.4.1.1.13 [:TRMS?] ITRMS? Itrms

SCPI: :FETCh[:SCALar]:CURRent[:TRMS]? /qonly/ | :READ[:SCALar]:CURRent[:TRMS]? /qonly/
SHORT: ITRMS? /qonly/

ID:	Itrms	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the TRMS value of the current.

10.2.4.1.2 :CYCLe

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar]** →	:CURRent	
:FORMat		**:CYCLe** →	:COUNt
:INITiate		:DINPut	:TIME
:INPut		:ENERgy	
:INSTrument		:FLICker	
:MEMory		:FREQuency	
:READ →		:HARMonics	
:SENSe		:POWer	
:SOURce		:RESistance	
:STATus		:SSYStem	
:SYSTem		:VARiable	
:TRIGger		[:VOLTage]	

10.2.4.1.2.1 :COUNt? COUNT? Cnr

SCPI: :FETCh[:SCALar]:CYCLe:COUNt? /qonly/ | :READ[:SCALar]:CYCLe:COUNt? /qonly/
SHORT: COUNT? /qonly/

ID:	Cnr	Mode:	All
Type:	float	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads an individual number of the measuring cycle counter which is copied into memory. This value runs up to 65535 and starts then again at 0.

10.2.4.1.2.2 :SNUMber? SCTC?

SCPI: :FETCh[:SCALar]:CYCLe:SNUMber? /qonly/ | :READ[:SCALar]:CYCLe:SNUMber? /qonly/
SHORT: SCTC? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	$0...2^{31}-1$	List:	n/a
Unit:	n/a	Group:	n/a

Reads the number of the last sample value of a cycle. The sample values of the instrument are counted. At the end of each cycle this counter is stored and can be read by this command. The counter runs up to 2^{31}-1 and starts then again at 0. See also 10.2.10.12.5, ':SCTRigger? SCTT?'

10.2.4.1.2.3 :TIME? CYCR? Mtime

SCPI: :FETCh[:SCALar]:CYCLe:TIME? /qonly/ | :READ[:SCALar]:CYCLe:TIME? /qonly/
SHORT: CYCR? /qonly/

ID:	Mtime	Mode:	Normal, prCE, Flicker, HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	s	Group:	n/a

Reads the real measuring time of the measuring cycle.This is the time for an integer number of periods of the measured signal (in average this is the cycle time, but it depends on the signal!).

10.2.4.1.3 :DINPut? DIST?

SCPI: :FETCh[:SCALar]:DINPut? /qonly/ | :READ[:SCALar]:DINPut? /qonly/
SHORT: DIST? /qonly/

ID:	digin(), see 4.4.3.2.7, 'Functions'	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...64	List:	n/a
Unit:	n/a	Group:	n/a

Reads the status of the digital inputs. The bits in the answer have following meanings:

Bit 0: Input 1
Bit 1: Input 2
Bit 2: Input 3
Bit 3: Input 4
Bit 4: Input 5
Bit 5: Input 6

10.2.4.1.4 :ENERgy

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar]** →	:CURRent	
:FORMat		:CYCLe	
:INITiate		:DINPut	
:INPut		**:ENERgy** →	[:ACTive]
:INSTrument		:FLICker	:APPArent
:MEMory		:FREQuency	:CHARge
:READ →		:HARMonics	:REACtive
:SENSe		:POWer	:TIME
:SOURce		:RESistance	
:STATus		:SSYStem	
:SYSTem		:VARiable	
:TRIGger		[:VOLTage]	

10.2.4.1.4.1 [:ACTive]? EP? EP

SCPI: :FETCh[:SCALar]:ENERgy[:ACTive]? /qonly/ | :READ[:SCALar]:ENERgy[:ACTive]? /qonly/
SHORT: EP? /qonly/

ID:	EP	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Wh	Group:	n/a

Reads the active energy (integrated active power).

10.2.4.1.4.2 :APParent? ES? ES

SCPI: :FETCh[:SCALar]:ENERgy:APPArent? /qonly/ | :READ[:SCALar]:ENERgy:APParent? /qonly/
SHORT: ES? /qonly/

ID:	ES	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	VAh	Group:	n/a

Reads the apparent energy (integrated apparent power).

10.2.4.1.4.3 :CHARge? EI? q

SCPI: :FETCh[:SCALar]:ENERgy:CHARge? /qonly/ | :READ[:SCALar]:ENERgy:CHARge? /qonly/
SHORT: EI? /qonly/

ID:	q	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Ah	Group:	n/a

Reads the charge (integrated DC current).

10.2.4.1.4.4 :REACtive? EQ? EQ

SCPI: :FETCh[:SCALar]:ENERgy:REACtive? /qonly/ | :READ[:SCALar]:ENERgy:REACtive? /qonly/
SHORT: EQ? /qonly/

ID:	EQ	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	varh	Group:	n/a

Reads the reactive energy (integrated reactive power).

10.2.4.1.4.5 :TIME? INTR?

SCPI: :FETCh[:SCALar]:ENERgy:TIME? /qonly/ | :READ[:SCALar]:ENERgy:TIME? /qonly/

SHORT: INTR? /qonly/

ID:	LoadOK	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	0...2^{31}-1	List:	n/a
Unit:	ms	Group:	n/a

Reads the time of the running integration.

10.2.4.1.5 :FLICker

10.2.4.1.5.1 [:EUTest]

Selects the equipment under test measuring results. They are measured at the voltage input jacks.

:CALCulate				
:DISPlay				
:FETCh →	**[:SCALar]** →	:CURRent		
:FORMat		:CYCLe		
:INITiate		:DINPut		
:INPut		:ENERgy		
:INSTrument		**:FLICker** →	**[:EUTest]** →	:APMoment
:MEMory		:FREQuency	:LTRemain	:DC
:READ →		:HARMonics	:PHWave	:DELTat
:SENSe		:POWer	:SOURce	:DMAX
:SOURce		:RESistance	:STATe	:HWTRms
:STATus		:SSYStem	:STRemain	:PLT
:SYSTem		:VARiable		:PMOMentary
:TRIGger		[:VOLTage]		:PST
				:RESult

10.2.4.1.5.1.1 :APMoment? FLMO? Pmoml

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:APMoment? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:APMoment? /qonly/
SHORT: FLMO? /qonly/

ID:	Pmoml	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the averaged momentary flicker level of the equipment under test. It is averaged over 16 periods.

10.2.4.1.5.1.2 :DC? FLDC? dcl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:DC? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:DC? /qonly/
SHORT: FLDC? /qonly/

ID:	dcl	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a

Unit: n/a Group: n/a

Reads the d_c value of the equipment under test.

10.2.4.1.5.1.3 :DELTat? FLDT? dtl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:DELTat? /qonly/ <list>|
:READ[:SCALar]:FLICker[:EUTest]:DELTat? /qonly/ <list>
SHORT: FLDT? /qonly/ <list>

ID:	dtl	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	0...31
Unit:	n/a	Group:	n/a

Reads the d(t) values of the equipment under test. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.1.4 :DMAX? FLDX? dmaxl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:DMAX? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:DMAX? /qonly/
SHORT: FLDX? /qonly/

ID:	dmaxl	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the d_{max} value of the equipment under test.

10.2.4.1.5.1.5 :DTMViolation? FLMV?

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:DTMViolation? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:DTMViolation? /qonly/
SHORT: FLMV? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the maximum number of half waves for which the d(t) of the equipment under test was bigger than allowed in the standard.

10.2.4.1.5.1.6 :HWTRms? FLRM? Uhwl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:HWTRms? /qonly/ <list> |
:READ[:SCALar]:FLICker[:EUTest]:HWTRms? /qonly/ <list>
SHORT: FLRM? /qonly/ <list>

ID:	Uhwl	Mode:	Flicker
Type:	float	Suffix:	n/a

Value:	n/a	List:	0...31
Unit:	V	Group:	n/a

Reads the half wave TRMS values of the equipment under test. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.1.7 :PLT? FLLT? Pltl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:PLT? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:PLT? /qonly/
SHORT: FLLT? /qonly/

ID:	Pltl	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the P_{lt} value of the equipment under test.

10.2.4.1.5.1.8 :PMOMentary? FLMS? Pml

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:PMOMentary?/qonly/ <list> |
:READ[:SCALar]:FLICker[:EUTest]:PMOMentary? /qonly/ <list>
SHORT: FLMS? /qonly/ <list>

ID:	Pml	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31
Unit:	n/a	Group:	n/a

Reads the momentary flicker level of the equipment under test. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.1.9 :PST? FLST? Pstl

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:PST? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:PST? /qonly/
SHORT: FLST? /qonly/

ID:	Pstl	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the P_{st} value of the equipment under test.

10.2.4.1.5.1.10 :RESult? FLRE? LoadOK

SCPI: :FETCh[:SCALar]:FLICker[:EUTest]:RESult? /qonly/ |
:READ[:SCALar]:FLICker[:EUTest]:RESult? /qonly/
SHORT: FLRE? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the result of the flicker measuring at the equipment under test.

Bit 0: Set if the total evaluation of the flicker fails (=if any of the sub evaluation fails). Cleared otherwise.
Bit 1: Set if at least one P_{st} value was >1.0, cleared otherwise.
Bit 2: Set if the P_{lt} value was >0.65 at the END of the measuring interval, cleared otherwise.
Bit 3: Set if d_{max} was bigger than limit, cleared otherwise.
Bit 4: Set if d(t) was >3% for more than allowed time, cleared otherwise.
Bit 5: Set if d_c was > 3%, cleared otherwise.

10.2.4.1.5.2 :LTRemain? FLTR?

SCPI: :FETCh[:SCALar]:FLICker:LTRemain? /qonly/ |
:READ[:SCALar]:FLICker:LTRemain? /qonly/
SHORT: FLTR? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	s	Group:	n/a

Reads the remaining long time for the flicker measurement.

10.2.4.1.5.3 :PHWave? FLPH? Phw

SCPI: :FETCh[:SCALar]:FLICker:PHWave? /qonly/ <list> |
:READ[:SCALar]:FLICker:PHWave? /qonly/ <list>
SHORT: FLPH? /qonly/ <list>

ID:	Phw	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31
Unit:	W	Group:	n/a

Reads the half wave power values. After each measuring cycle over 16 periods you can get 32 values. To get a correct value it is necessary to measure the current with the current channel and not the voltage of a source!

10.2.4.1.5.4 :SOURce

Selects the source’s measuring results. They are measured at the current input jacks.

:CALCulate		
:DISPlay		
:FETCh →	**[:SCALar]** →	:CURRent
:FORMat		:CYCLe
:INITiate		:DINPut

:INPut	:ENERgy		
:INSTrument	**:FLICker** →	[:EUTest]	
:MEMory	:FREQuency	:LTRemain	
:READ →	:HARMonics	:PHWave	
:SENSe	:POWer	**:SOURce** →	:APMoment
:SOURce	:RESistance	:STATe	:DC
:STATus	:SSYStem	:STRemain	:DELTat
:SYSTem	:VARiable		:DMAX
:TRIGger	[:VOLTage]		:HWTRms
			:PLT
			:PMOMentary
			:PST
			:RESult

10.2.4.1.5.4.1 :APMoment? FSMO? Pmoms

SCPI: :FETCh[:SCALar]:FLICker:SOURce:APMoment? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:APMoment? /qonly/
SHORT: FSMO? /qonly/

ID:	Pmoms	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the averaged momentary flicker level of the source. It is averaged over 16 periods.

10.2.4.1.5.4.2 :DC? FSDC? dcs

SCPI: :FETCh[:SCALar]:FLICker:SOURce:DC? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:DC? /qonly/
SHORT: FSDC? /qonly/

ID:	dcs	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the d_c value of the source.

10.2.4.1.5.4.3 :DELTat? FSDT? dts

SCPI: :FETCh[:SCALar]:FLICker:SOURce:DELTat? /qonly/ <list>|
:READ[:SCALar]:FLICker:SOURce:DELTat? /qonly/ <list>
SHORT: FSDT? /qonly/ <list>

ID:	dts	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	0...31
Unit:	n/a	Group:	n/a

Reads the d(t) values of the source. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.4.4 :DMAX? FSDX? dmaxs

SCPI: :FETCh[:SCALar]:FLICker:SOURce:DMAX? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:DMAX? /qonly/
SHORT: FSDX? /qonly/

ID:	dmaxs	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the d_{max} value of the source.

10.2.4.1.5.4.5 :DTMViolation? FSMV?

SCPI: :FETCh[:SCALar]:FLICker:SOURce:DTMViolation? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:DTMViolation? /qonly/
SHORT: FSMV? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the maximum number of half waves for which the d(t) of the source was bigger than allowed in the standard.

10.2.4.1.5.4.6 :HWTRms? FSRM? Uhws

SCPI: :FETCh[:SCALar]:FLICker:SOURce:HWTRms? /qonly/ <list> |
:READ[:SCALar]:FLICker:SOURce:HWTRms? /qonly/ <list>
SHORT: FSRM? /qonly/ <list>

ID:	Uhws	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31
Unit:	V or A depending on measured signal	Group:	n/a

Reads the half wave TRMS values of the source. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.4.7 :PLT? FSLT? Plts

SCPI: :FETCh[:SCALar]:FLICker:SOURce:PLT? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:PLT? /qonly/
SHORT: FSLT? /qonly/

ID:	Plts	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the P_{lt} value of the source.

10.2.4.1.5.4.8 :PMOMentary? FSMS? Pms

SCPI: :FETCh[:SCALar]:FLICker:SOURce:PMOMentary? /qonly/ <list>|
:READ[:SCALar]:FLICker:SOURce:PMOMentary? /qonly/ <list>
SHORT: FSMS? /qonly/ <list>

ID:	Pms	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31
Unit:	n/a	Group:	n/a

Reads the momentary flicker level of the source. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.5.4.9 :PST? FSST? Psts

SCPI: :FETCh[:SCALar]:FLICker:SOURce:PST? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:PST? /qonly/
SHORT: FSST? /qonly/

ID:	Psts	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the P_{st} value of the source.

10.2.4.1.5.4.10 :RESult? FSRE? SrcOK

SCPI: :FETCh[:SCALar]:FLICker:SOURce:RESult? /qonly/ |
:READ[:SCALar]:FLICker:SOURce:RESult? /qonly/
SHORT: FSRE? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the result of the flicker measuring at the source.

Bit 0: Set if the total evaluation of the flicker fails (=if any of the sub evaluation fails). Cleared otherwise.
Bit 1: Set if at least one P_{st} value was >1.0, cleared otherwise.
Bit 2: Set if the P_{lt} value was >0.65 at the END of the measuring interval, cleared otherwise.
Bit 3: Set if d_{max} was bigger than limit, cleared otherwise.
Bit 4: Set if d(t) was >3% for more than allowed time, cleared otherwise.
Bit 5: Set if d_c was > 3%, cleared otherwise.

10.2.4.1.5.5 :STATe? FSTA?

SCPI: :FETCh[:SCALar]:FLICker:STATe? /qonly/ | :READ[:SCALar]:FLICker:STATe? /qonly/
SHORT: FSTA? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the state of the flicker measuring.

0: Reset

1: Wait

2: Run

3: Stop

10.2.4.1.5.6 :STRemain? FSTR?

SCPI: :FETCh[:SCALar]:FLICker:STRemain? /qonly/ |
:READ[:SCALar]:FLICker:STRemain? /qonly/
SHORT: FSTR? /qonly/

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	s	Group:	n/a

Reads the remaining short time for the actual short term measurement.

10.2.4.1.6 FREQuency

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar]** →	:CURRent	
:FORMat		:CYCLe	
:INITiate		:DINPut	
:INPut		:ENERgy	
:INSTrument		:FLICker	
:MEMory		**:FREQuency** →	: FINPut
:READ →		:HARMonics	:SAMPle
:SENSe		:POWer	[:SSOurce]
:SOURce		:RESistance	
:STATus		:SSYStem	
:SYSTem		:VARiable	
:TRIGger		[:VOLTage]	

10.2.4.1.6.1 :FINPut? DIFQ? DigFrq

SCPI: :FETCh[:SCALar]:FREQuency:FINPut? /qonly/ |
:READ[:SCALar]:FREQuency:FINPut? /qonly/
SHORT: DIFQ?/qonly/

ID:	DigFrq	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Hz	Group:	n/a

Reads the value of frequency input of the processing signal interface.

10.2.4.1.6.2 :SAMPle? SMPL?

SCPI: :FETCh[:SCALar]:FREQuency:SAMPle? /qonly/ |
:READ[:SCALar]:FREQuency:SAMPLe? /qonly/
SHORT: SMPL? /qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Hz	Group:	optional [,<NRi>], 0=A, 1=B, ...

Reads the sampling frequency of the LMG.

10.2.4.1.6.3 :SSOurce? FREQ? f

SCPI: :FETCh[:SCALar]:FREQuency[:SSOurce]? /qonly/ |
:READ[:SCALar]:FREQuency[:SSOurce]? /qonly/
SHORT: FREQ? /qonly/

ID:	f	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Hz	Group:	n/a

Reads the frequency of the synchronisation source

10.2.4.1.7 :HARMonics

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar] →**	:CURRent	
:FORMat		:CYCLe	
:INITiate		:DINPut	
:INPut		:ENERgy	
:INSTrument		:FLICker	
:MEMory		:FREQuency	
:READ →		**:HARMonics →**	:AMPower
:SENSe		:POWer	:APFactor
:SOURce		:RESistance	:CDResult
:STATus		:VARiable	:CURRent
:SYSTem		[:VOLTage]	:LTRemain
:TRIGger			:POWer
			[:VOLTage]

10.2.4.1.7.1 :AMPFactor? HPFM?

SCPI: :FETCh[:SCALar]:HARMonics:AMPFactor? /qonly/ |
:READ[:SCALar]:HARMonics:AMPFactor? /qonly/
SHORT: HPFM? /qonly/

ID:	n/a	Mode:	CE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the maximum smoothed power factor of the harmonic measuring.

10.2.4.1.7.2 :AMPower? HPM?

SCPI: :FETCh[:SCALar]:HARMonics:AMPower? /qonly/ |
:READ[:SCALar]:HARMonics:AMPower? /qonly/
SHORT: HPM? /qonly/

ID:	n/a	Mode:	CE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	W	Group:	n/a

Reads the maximum smoothed power of the harmonic measuring.

10.2.4.1.7.3 :APFactor? HPFA?

SCPI: :FETCh[:SCALar]:HARMonics:APFactor? /qonly/ |
:READ[:SCALar]:HARMonics:APFactor? /qonly/
SHORT: HPFA? /qonly/

ID:	n/a	Mode:	CE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the smoothed power factor of the harmonic measuring.

10.2.4.1.7.4 :APOWer? HPAV?

SCPI: :FETCh[:SCALar]:HARMonics:APOWer? /qonly/ |
:READ[:SCALar]:HARMonics:APOWer? /qonly/
SHORT: HPAV? /qonly/

ID:	n/a	Mode:	CE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	W	Group:	n/a

Reads the smoothed power of the harmonic measuring.

10.2.4.1.7.5 :CDResult? HENS?

SCPI: :FETCh[:SCALar]:HARMonics:CDResult? /qonly/ |
:READ[:SCALar]:HARMonics:CDResult? /qonly/
SHORT: HENS? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the class C and D result of the harmonic measuring:

Bit 0: Set if the total class D evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.

Bit 1: Set if the current was for <95% of time under the positive special envelop, cleared otherwise.
Bit 2: Set if the current was for <95% of time under the negative special envelop, cleared otherwise.
Bit 3: Set if P>600W, cleared otherwise.
Bit 4: Set if the total class C evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.
Bit 5: Set if the 60° condition failed in first halfwave. Cleared otherwise.
Bit 6: Set if the 65° condition failed in first halfwave. Cleared otherwise.
Bit 7: Set if the 90° condition failed in first halfwave. Cleared otherwise.
Bit 8: Set if the peak value in first halfwave is negative. Cleared otherwise.
Bit 9: Set if the 60° condition failed in second halfwave. Cleared otherwise.
Bit 10: Set if the 65° condition failed in second halfwave. Cleared otherwise.
Bit 11: Set if the 90° condition failed in second halfwave. Cleared otherwise.
Bit 12: Set if the peak value in second halfwave is negative. Cleared otherwise.

10.2.4.1.7.6 :CURRent

:CALCulate				
:DISPlay				
:FETCh →	**[:SCALar]** →	:CURRent		
:FORMat		:CYCLe		
:INITiate		:DINPut		
:INPut		:ENERgy		
:INSTrument		:FLICker		
:MEMory		:FREQuency		
:READ →		**:HARMonics** →	:AMPower	
:SENSe		:POWer	:APFactor	
:SOURce		:RESistance	:CDResult	
:STATus		:SSYStem	**:CURRent** →	:AAMPlitude
:SYSTem		:VARiable	:LTRemain	:AFUNdamental
:TRIGger		[:VOLTage]	:POWer	:AMPLitude
			[:VOLTage]	:FPRotz
				:FRESult
				:GFResult
				:LIMit
				:LTResult
				:OLIMit
				:PHASe
				:POHarmonics
				:POLimit
				:SAVerage
				:SMOothed
				:STATe
				:THARmonic
				:THDistortion

10.2.4.1.7.6.1 :AAMPlitude? HIAV? Iaver

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:AAMPlitude? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:AAMPlitude? /qonly/ <list>
SHORT: HIAV? /qonly/ <list>

ID: Iaver Mode: prCE

Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40 for harmonic order
Unit:	A	Group:	n/a

Reads the average amplitude of the harmonics of the current.

10.2.4.1.7.6.2 :AFUNdamental? HIFM?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:AFUNdamental? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:AFUNdamental? /qonly/
SHORT: HIFM? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the maximum averaged fundamental current of the harmonics.

10.2.4.1.7.6.3 :AMPLitude? HIAM? Ih

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:AMPLitude? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:AMPLitude? /qonly/ <list>
SHORT: HIAM? /qonly/ <list>

ID:	Ih	Mode:	prCE, HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40/99 (prCE/HARM100) for order
Unit:	A	Group:	n/a

Reads the amplitude of the harmonics of the current.

10.2.4.1.7.6.4 :FPRotz? HFMX?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:FPRotz? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:FPRotz? /qonly/ <list>
SHORT: HFMX? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	in %	List:	0...40 for harmonic order
Unit:	n/a	Group:	n/a

Reads the maximum duration in percent of a 2.5 minute window while each harmonic was over the 100% limit.

10.2.4.1.7.6.5 :FRESult? HIFL?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:FRESult? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:FRESult? /qonly/ <list>
SHORT: HIFL? /qonly/ <list>

ID:	n/a	Mode:	prCE

Type:	long int	Suffix:	n/a
Value:	$0...2^{41}-1$	List:	0, 1 for array element
Unit:	n/a	Group:	n/a

Reads the long time result of the fluctuating harmonics of the current. This is an array of 2 long numbers, so that you get a 64 bit result, if you read out both elements. Each bit from 0 to 40 indicates, if the corresponding harmonic has at least one time while the measuring violated the limit for more than 10% of a 2.5 minute window.

10.2.4.1.7.6.6 :GFResult? HIGF?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:GFResult? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:GFResult? /qonly/
SHORT: HIGF? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the global final result of the current check.

Bit 0: Set if the total current evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.
Bit 1: Set if any of the harmonics was > 100% of the allowed limit, cleared otherwise.
Bit 2: Set if the fluctuating harmonics were for more than 10% of the 2.5 minute window between 100% and 150% of the limit. Cleared otherwise.
Bit 3: Set if questionable vales (with ‘?’) have occurred. Cleared otherwise.
Bit 4: Set if measured power was > 110% of defined power. Cleared otherwise. This is only a warning, not an error.
Bit 5: Set if measured power factor was > 110% of defined power factor. Cleared otherwise. This is only a warning, not an error.
Bit 6: Set if measured fundamental current was > 110% of defined fundamental current. Cleared otherwise. This is only a warning, not an error.
Bit 7: Set if measured power was < 90% of defined power. Cleared otherwise.
Bit 8: Set if measured power factor was < 90% of defined power factor. Cleared otherwise.
Bit 9: Set if measured fundamental current was < 90% of defined fundamental current. Cleared otherwise.
Bit 10: Set if any harmonic is > 150% of limits. Cleared otherwise.
Bit 11: Set if the THD condition of EN61000-3-12 failed. Cleared otherwise.

10.2.4.1.7.6.7 :LIMit? HILM? IL

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:LIMit? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:LIMit? /qonly/ <list>
SHORT: HILM? /qonly/ <list>

ID:	IL	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40 for order
Unit:	A	Group:	n/a

Reads the limits of the harmonics of the current.

10.2.4.1.7.6.8 :LTResult? HILT?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:LTResult? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:LTResult? /qonly/ <list>
SHORT: HILT? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	$0...2^{41}-1$	List:	0, 1 for array element
Unit:	n/a	Group:	n/a

Reads the long time result of the harmonics of the current. This is an array of 2 long numbers, so that you get a 64 bit result, if you read out both elements. Each bit from 0 to 40 indicates, if the corresponding harmonic has at least one time while the measuring violated the limit.

10.2.4.1.7.6.9 :OLIMit? HIOV?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:OLIMit? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:OLIMit? /qonly/ <list>
SHORT: HIOV? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	$0...2^{41}-1$	List:	0...3 for array element
Unit:	n/a	Group:	n/a

Reads the over limit status of the harmonics of the current. This is an array of 4 long numbers, so that you get two 64 bit results, if you read out the elements 0/1 or 2/3.
For array element 2/3 each bit from 0 to 40 indicates, if the corresponding harmonic has violated the limit in the actual window (‘!’ on LMG display).
For array element 0/1 each bit from 0 to 40 indicates, if the corresponding harmonic has violated the 100% limit but is within the 150% limit in the actual window (‘?’ on LMG display).

10.2.4.1.7.6.10 :PHASe? HIPH? IP

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:PHASe? /qonly/ <list> |
:READ[:SCALar]:HARMonics:CURRent:PHASe? /qonly/ <list>
SHORT: HIPH? /qonly/ <list>

ID:	IP	Mode:	HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...99 for order
Unit:	°	Group:	n/a

Reads the phase of the harmonics of the current.

10.2.4.1.7.6.11 :POHarmonic? HPOC? Ipohc

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:POHarmonic? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:POHarmonic? /qonly/
SHORT: HPOC? /qonly/

ID:	Ipohc	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the Partial Odd Harmonic Current.

10.2.4.1.7.6.12 :POLimit? HLIP?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:POLimit? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:POLimit? /qonly/
SHORT: HLIP? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the partial odd harmonic current which is calculated from the limits at the end of a measuring.

10.2.4.1.7.6.13 :SAVerage? HIAS?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:SAVerage? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:SAVerage? /qonly/
SHORT: HIAS? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the smoothed averaged TRMS current.

10.2.4.1.7.6.14 :SMOothed? HIMA?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:SMOothed? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:SMOothed? /qonly/
SHORT: HIMA? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the smoothed TRMS current in this measuring mode.

10.2.4.1.7.6.15 :STATe? HIST?

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:STATe? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:STATe? /qonly/
SHORT: HIST? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the actual result of the current check:

Bit 0: Set if the total current evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.
Bit 1: Set if any of the harmonics was > 100% of the allowed limit, cleared otherwise.
Bit 2: Set if the fluctuating harmonics were for more than 10% of the 2.5 minute window between 100% and 150% of the limit. Cleared otherwise.
Bit 3: Set if questionable vales (with ‘?’) have occurred. Cleared otherwise.
Bit 10: Set if any harmonic is > 150% of limits. Cleared otherwise.

10.2.4.1.7.6.16 :THARmonic? HTHC? Ithc

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:THARmonic? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:THARmonic? /qonly/
SHORT: HTHC? /qonly/

ID:	Ithc	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads the Total Harmonic Current.

10.2.4.1.7.6.17 :THDistort? HIHD? Ithd

SCPI: :FETCh[:SCALar]:HARMonics:CURRent:THDistort? /qonly/ |
:READ[:SCALar]:HARMonics:CURRent:THDistort? /qonly/
SHORT: HIHD? /qonly/

ID:	Ithd	Mode:	prCE, Flicker, HARM100
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the THD of the current.

10.2.4.1.7.7 :LTRemain? HLTR?

SCPI: :FETCh[:SCALar]:HARMonics:LTRemain? /qonly/ |
:READ[:SCALar]: HARMonics:LTRemain? /qonly/
SHORT: HLTR? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	s	Group:	n/a

Reads the remaining long time for the harmonic measurement.

10.2.4.1.7.8 :POWer

:CALCulate				
:DISPlay				
:FETCh →	**[:SCALar]** →	:CURRent		
:FORMat		:CYCLe		
:INITiate		:DINPut		
:INPut		:ENERgy		
:INSTrument		:FLICker		
:MEMory		:FREQuency		
:READ →		**:HARMonics** →	:AMPower	
:SENSe		:POWer	:APFactor	
:SOURce		:RESistance	:CDResult	
:STATus		SSYStem	:CURRent	
:SYSTem		:VARiable	:LTRemain	
:TRIGger		[:VOLTage]	**:POWer** →	:ACTive
			[:VOLTage]	:APParent
				:REACtive

10.2.4.1.7.8.1 :ACTive? HPAM? Ph

SCPI: :FETCh[:SCALar]:HARMonics:POWer:ACTive? /qonly/ <list> |
:READ[:SCALar]:HARMonics:POWer:ACTive? /qonly/ <list>
SHORT: HPAM? /qonly/ <list>

ID:	Ph	Mode:	HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...99 for order
Unit:	W	Group:	n/a

Reads the harmonics of the active power.

10.2.4.1.7.8.2 :APParent? HSAM? Sh

SCPI: :FETCh[:SCALar]:HARMonics:POWer:APParent?/qonly/ <list> |
:READ[:SCALar]:HARMonics:POWer:APParent? /qonly/ <list>
SHORT: HSAM? /qonly/ <list>
.

ID:	Sh	Mode:	HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...99 for order
Unit:	VA	Group:	n/a

Reads the harmonics of the apparent power.

10.2.4.1.7.8.3 :REACtive? HQAM? Qh

SCPI: :FETCh[:SCALar]:HARMonics:POWer:REACtive? /qonly/ <list> |
:READ[:SCALar]:HARMonics:POWer:REACtive? /qonly/ <list>
SHORT: HQAM? /qonly/ <list>

ID:	Qh	Mode:	HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...99 for order
Unit:	var	Group:	n/a

Reads the harmonics of the reactive power.

10.2.4.1.7.9 [:VOLTage]

:CALCulate				
:DISPlay				
:FETCh →	**[:SCALar] →**	:CURRent		
:FORMat		:CYCLe		
:INITiate		:DINPut		
:INPut		:ENERgy		
:INSTrument		:FLICker		
:MEMory		:FREQuency		
:READ →		**:HARMonics →**	:AMPower	
:SENSe		:POWer	:APFactor	
:SOURce		:RESistance	:CDResult	
:STATus		:SSYStem	:CURRent	
:SYSTem		:VARiable	:LTRemain	
:TRIGger		[:VOLTage]	:Power	
			[:VOLTage] →	:AMPLitude
				:GFResult
				:LIMit
				:LTResult
				:MAMPlitude
				:OLIMit
				:PHASe
				:STATe
				:THDistortion

10.2.4.1.7.9.1 :AMPLitude? HUAM? Uh

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:AMPLitude? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:AMPLitude? /qonly/ <list>
SHORT: HUAM? /qonly/ <list>

ID:	Uh	Mode:	prCE, HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40/99 (prCE/HARM100) for order
Unit:	V	Group:	n/a

Reads the amplitude of the harmonics of the voltage.

10.2.4.1.7.9.2 :GFResult? HUGF?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:GFResult? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]:GFResult? /qonly/
SHORT: HUGF? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the global final result of the voltage check.

Bit 0: Set if the total voltage evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.
Bit 1: Set if any of the harmonics was > 100% of the allowed limit, cleared otherwise.
Bit 2: Set if the voltage amplitude was not within the limit, cleared otherwise.
Bit 3: Set if the frequency was not within the limit, cleared otherwise.
Bit 4: Set if the crest factor was not within the limit, cleared otherwise.

10.2.4.1.7.9.3 :HWCFactor? FLCF?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: HWCFactor? /qonly/ <list>|
:READ[:SCALar]:HARMonics[:VOLTage]: HWCFactor? /qonly/ <list>
SHORT: FLCF? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31 for half wave number
Unit:	n/a	Group:	n/a

Reads the voltage crest factor of the half waves. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.7.9.4 :LIMit? HULM? UL

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:LIMit? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:LIMit? /qonly/ <list>
SHORT: HULM? /qonly/ <list>

ID:	UL	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40 for order
Unit:	V	Group:	n/a

Reads the limits of the harmonics of the voltage.

10.2.4.1.7.9.5 :LTResult? HULT?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:LTResult? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:LTResult? /qonly/ <list>
SHORT: HULT? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	0...2^{41}-1	List:	0, 1 for array element
Unit:	n/a	Group:	n/a

Reads the long time result of the harmonics of the voltage. This is an array of 2 long numbers, so that you get a 64 bit result, if you read out both elements. Each bit from 0 to 40 indicates, if the corresponding harmonic has at least one time while the measuring violated the limit.

10.2.4.1.7.9.6 :MAMPlitude? HUMX? UMax

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:MAMPlitude? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:MAMPlitude? /qonly/ <list>
SHORT: HUMX? /qonly/ <list>

ID:	UMax	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...40 for order
Unit:	V	Group:	n/a

Reads the maximum amplitude of the harmonics of the voltage.

10.2.4.1.7.9.7 :MAXCfactor? FLCX?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: MAXCfactor? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]: MAXCfactor? /qonly/
SHORT: FLCX? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the maximum crestfactor of the voltage.

10.2.4.1.7.9.8 :MAXPhi? FLPX?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: MAXPhi? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]: MAXPhi? /qonly/
SHORT: FLPX? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	°	Group:	n/a

Reads the maximum phase of peak value of the voltage.

10.2.4.1.7.9.9 :MINCfactor? FLCN?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: MINCfactor? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]: MINCfactor? /qonly/

SHORT: FLCN? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the minimum crestfactor of the voltage.

10.2.4.1.7.9.10 :MINPhi? FLPN?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: MINPhi? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]: MINPhi? /qonly/
SHORT: FLPN? /qonly/

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	°	Group:	n/a

Reads the minimum phase of peak value of the voltage.

10.2.4.1.7.9.11 :OLIMit? HUOV?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:OLIMit? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:OLIMit? /qonly/ <list>
SHORT: HUOV? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	$0...2^{41}-1$	List:	0...3 for array element
Unit:	n/a	Group:	n/a

Reads the over limit status of the harmonics of the voltage. This is an array of 4 long numbers, so that you get two 64 bit results, if you read out the elements 0/1 or 2/3.
For array element 2/3 each bit from 0 to 40 indicates, if the corresponding harmonic has violated the limit in the actual window (‘!’ on LMG display).
Array elements 0/1 are not used.

10.2.4.1.7.9.12 :PHASe? HUPH? UP

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:PHASe? /qonly/ <list> |
:READ[:SCALar]:HARMonics[:VOLTage]:PHASe? /qonly/ <list>
SHORT: HUPH? /qonly/ <list>

ID:	UP	Mode:	HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...99 for order
Unit:	°	Group:	n/a

Reads the phase of the harmonics of the voltage.

10.2.4.1.7.9.13 :PPHase? FLUP?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]: PPHase? /qonly/ <list>|
:READ[:SCALar]:HARMonics[:VOLTage]: PPHase? /qonly/ <list>
SHORT: FLUP? /qonly/ <list>

ID:	n/a	Mode:	prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...31 for half wave number
Unit:	°	Group:	n/a

Reads the phase angle of the voltage peak value of the half waves. After each measuring cycle over 16 periods you can get 32 values.

10.2.4.1.7.9.14 :STATe? HUST?

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:STATe? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]:STATe? /qonly/
SHORT: HUST? /qonly/

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	$0...2^5-1$	List:	n/a
Unit:	n/a	Group:	n/a

Reads the actual result of the voltage check

Bit 0: Set if the total voltage evaluation failed (=if any of the sub evaluation failed). Cleared otherwise.
Bit 1: Set if any of the harmonics was > 100% of the allowed limit, cleared otherwise.
Bit 2: Set if the voltage amplitude was not within the limit, cleared otherwise.
Bit 3: Set if the frequency was not within the limit, cleared otherwise.
Bit 4: Set if the crest factor was not within the limit, cleared otherwise.

10.2.4.1.7.9.15 :THDistort? HUHD? Uthd

SCPI: :FETCh[:SCALar]:HARMonics[:VOLTage]:THDistort? /qonly/ |
:READ[:SCALar]:HARMonics[:VOLTage]:THDistort? /qonly/
SHORT: HUHD? /qonly/

ID:	Uthd	Mode:	prCE, Flicker, HARM100
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the THD of the voltage.

10.2.4.1.8 :POWer

:CALCulate		
:DISPlay		
:FETCh →	**[:SCALar]** →	:CURRent
:FORMat		:CYCLe

:INITiate	:DINPut	
:INPut	:ENERgy	
:INSTrument	:FLICker	
:MEMory	:FREQuency	
:READ →	:HARMonics	
:SENSe	**:POWer** →	:AACTive
:SOURce	:RESistance	:AAPParent
:STATus	:SSYStem	[:ACTive]
:SYSTem	:VARiable	:APParent
:TRIGger	[:VOLTage]	:AREactive
		:FSCale
		:ICAPacity
		:PFACtor
		:PHASe
		:REACtive

10.2.4.1.8.1 :AACTive? PM? Pm

SCPI: :FETCh[:SCALar]:POWer:AACTive? /qonly/ | :READ[:SCALar]:POWer:AACTive? /qonly/
SHORT: PM? /qonly/

ID:	Pm	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	W	Group:	n/a

Reads the average active power.

10.2.4.1.8.2 :AAPParent? SM? Sm

SCPI: :FETCh[:SCALar]:POWer:AAPParent? /qonly/ |
:READ[:SCALar]:POWer:AAPParent? /qonly/
SHORT: SM? /qonly/

ID:	Sm	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	VA	Group:	n/a

Reads the average apparent power.

10.2.4.1.8.3 [:ACTive]? P? P

SCPI: :FETCh[:SCALar]:POWer[:ACTive]? /qonly/ | :READ[:SCALar]:POWer[:ACTive]? /qonly/
SHORT: P? /qonly/

ID:	P	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	W	Group:	n/a

Reads the active power.

10.2.4.1.8.4 :APParent? S? S

SCPI: :FETCh[:SCALar]:POWer:APParent? /qonly/ | :READ[:SCALar]:POWer:APParent? /qonly/
SHORT: S? /qonly/

ID:	S	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	VA	Group:	n/a

Reads the apparent power.

10.2.4.1.8.5 :AREactive? QM? Qm

SCPI: :FETCh[:SCALar]:POWer:AREactive? /qonly/ |
:READ[:SCALar]:POWer:AREactive? /qonly/
SHORT: QM? /qonly/

ID:	Qm	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	var	Group:	n/a

Reads the average reactive power.

10.2.4.1.8.6 :FSCale? FSP?

SCPI: :FETCh[:SCALar]:POWer:FSCale? /qonly/ | :READ[:SCALar]:POWer:FSCale? /qonly/
SHORT: FSP? /qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	W	Group:	n/a

Reads the full scale value of the power.

10.2.4.1.8.7 :ICAPacity? INCA? Inca

SCPI: :FETCh[:SCALar]:POWer:ICAPacity? /qonly/ | :READ[:SCALar]:POWer:ICAPacity? /qonly/
SHORT: INCA? /qonly/

ID:	n/a	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	-1, 0, +1	List:	n/a
Unit:	n/a	Group:	n/a

Reads the status of the inca flag. It shows, if the system is inductive or capacitive:

+1 inductive

0 undefined

-1 capacitive

10.2.4.1.8.8 :PFACtor? PF? PF

SCPI: :FETCh[:SCALar]:POWer:PFACtor? /qonly/ | :READ[:SCALar]:POWer:PFACtor? /qonly/
SHORT: PF? /qonly/

ID:	PF	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the power factor.

10.2.4.1.8.9 :PHASe? PHI? PHI

SCPI: :FETCh[:SCALar]:POWer:PHASe? /qonly/ | :READ[:SCALar]:POWer:PHASe? /qonly/
SHORT: PHI? /qonly/

ID:	PHI	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	°	Group:	n/a

Reads the phase angle in degree between current and voltage.

10.2.4.1.8.10 :REACtive? Q? Q

SCPI: :FETCh[:SCALar]:POWer:REACtive? /qonly/ | :READ[:SCALar]:POWer:REACtive? /qonly/
SHORT: Q? /qonly/

ID:	Q	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	var	Group:	n/a

Reads the reactive power.

10.2.4.1.9 :RESistance

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar] →**	:CURRent	
:FORMat		:CYCLe	
:INITiate		:DINPut	
:INPut		:ENERgy	
:INSTrument		:FLICker	
:MEMory		:FREQuency	
:READ →		:HARMonics	
:SENSe		:POWer	
:SOURce		**:RESistance →**	:ASResist
:STATus		:SSYStem	:IMPedance
:SYSTem		:VARiable	:RSIMpedance
:TRIGger		[:VOLTage]	

10.2.4.1.9.1 :ASResist? RSER? Rser

SCPI: :FETCh[:SCALar]:RESistance:ASResist? /qonly/ |
:READ[:SCALar]:RESistance:ASResist? /qonly/
SHORT: RSER? /qonly/

ID:	Rser	Mode:	Normal, prCE, Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Ω	Group:	n/a

Reads the active serial resistance.

10.2.4.1.9.2 :IMPedance? Z? Z

SCPI: :FETCh[:SCALar]:RESistance:IMPedance? /qonly/ |
:READ[:SCALar]:RESistance:IMPedance? /qonly/
SHORT: Z? /qonly/

ID:	Z	Mode:	Normal, prCE, Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Ω	Group:	n/a

Reads the impedance (apparent resistance).

10.2.4.1.9.3 :RSIMpedance? XSER? Xser

SCPI: :FETCh[:SCALar]:RESistance:RSIMpedance? /qonly/ |
:READ[:SCALar]:RESistance:RSIMpedance? /qonly/
SHORT: XSER? /qonly/

ID:	Xser	Mode:	Normal, prCE, Flicker
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	Ω	Group:	n/a

Reads the reactive serial impedance.

10.2.4.1.10 :VARiable? VAR?

SCPI: :FETCh[:SCALar]:VARiable? /qonly/ <list> | :READ[:SCALar]:VARiable? /qonly/ <list>
SHORT: VAR? /qonly/ <list>

ID:	The name a user has defined. With script ‘abc=Utrms*2;’ then ID would be ‘abc’	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	0...7 for array element
Unit:	n/a	Group:	n/a

Reads value of the user defined variables. They are stored as an array.

10.2.4.1.11 :VNAMe? NVAR?

SCPI: :FETCh[:SCALar]:VNAMe? /qonly/ <string program data> | :READ[:SCALar]:VNAMe? /qonly/ <string program data>
SHORT: NVAR? /qonly/ <string program data>

ID:		Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the value of the user defined variable whose name was sent as <string program data>.
Example: You have a variable ‘abc’. This can be read by NVAR? „abc“.

10.2.4.1.12 [:VOLTage]

:CALCulate			
:DISPlay			
:FETCh →	**[:SCALar]** →	:CURRent	
:FORMat		:CYCLe	
:INITiate		:DINPut	
:INPut		:ENERgy	
:INSTrument		:FLICker	
:MEMory		:FREQuency	
:READ →		:HARMonics	
:SENSe		:POWer	
:SOURce		:RESistance	
:STATus		:SSYStem	
:SYSTem		:VARiable	
:TRIGger		**[:VOLTage]** →	:AC
			:AINPut
			:CFACtor
			:DC
			:FFACtor
			:INRush
			:MAXPk
			:MINPk
			:PPEak
			:RECTify
			:RUSed
			[:TRMS]

10.2.4.1.12.1 :AC? UAC? Uac

SCPI: :FETCh[:SCALar][:VOLTage]:AC? /qonly/ | :READ[:SCALar][:VOLTage]:AC? /qonly/
SHORT: UAC? /qonly/

ID:	Uac	Mode:	Normal, prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the AC value of the voltage.

10.2.4.1.12.2 :AINPut? AIVA? Ain

SCPI: :FETCh[:SCALar][:VOLTage]:AINPut? /qonly/ | :READ[:SCALar][:VOLTage]:AINPut? /qonly/

SHORT: AIVA? /qonly/

ID:	Ain	Mode:	All
Type:	float	Suffix:	1...4
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the voltage of the analogue input of the processing signal interface.

10.2.4.1.12.3 :CFACtor? UCF? Ucf

SCPI: :FETCh[:SCALar][:VOLTage]:CFACtor? /qonly/ |
:READ[:SCALar][:VOLTage]:CFACtor? /qonly/
SHORT: UCF? /qonly/

ID:	Ucf	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the crest factor of the voltage.

10.2.4.1.12.4 :DC? UDC? Udc

SCPI: :FETCh[:SCALar][:VOLTage]:DC? /qonly/ | :READ[:SCALar][:VOLTage]:DC? /qonly/
SHORT: UDC? /qonly/

ID:	Udc	Mode:	Normal, prCE
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the DC value of the voltage.

10.2.4.1.12.5 :FFACtor? UFF? Uff

SCPI: :FETCh[:SCALar][:VOLTage]:FFACtor? /qonly/ |
:READ[:SCALar][:VOLTage]:FFACtor? /qonly/
SHORT: UFF? /qonly/

ID:	Uff	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the form factor of the voltage.

10.2.4.1.12.6 :FSCale? FSU?

SCPI: :FETCh[:SCALar][:VOLTage]:FSCale? /qonly/ |
:READ[:SCALar][:VOLTage]:FSCale? /qonly/
SHORT: FSU? /qonly/

ID:	n/a	Mode:	All

Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the full scale value of the voltage.

10.2.4.1.12.7 :MAXPk? UMAX? Upkp

SCPI: :FETCh[:SCALar][:VOLTage]:MAXPk? /qonly/ |
:READ[:SCALar][:VOLTage]:MAXPk? /qonly/
SHORT: UMAX? /qonly/

ID:	Upkp	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the biggest sample value of the voltage.

10.2.4.1.12.8 :MINPk? UMIN? Upkn

SCPI: :FETCh[:SCALar][:VOLTage]:MINPk? /qonly/ | :READ[:SCALar][:VOLTage]:MINPk? /qonly/
SHORT: UMIN? /qonly/

ID:	Upkn	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the smallest sample value of the voltage.

10.2.4.1.12.9 :PHASe? UPHI? Uphi

SCPI: :FETCh[:SCALar][:VOLTage]:PHASe? /qonly/ | :READ[:SCALar][:VOLTage]:MINPk? /qonly/
SHORT: UPHI? /qonly/

ID:	n/a	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	°	Group:	n/a

Reads the phase angle of the voltage like displayed in the Fresnel diagram.

10.2.4.1.12.10 :PPEak? UPP? Upp

SCPI: :FETCh[:SCALar][:VOLTage]:PPEak? /qonly/ | :READ[:SCALar][:VOLTage]:PPEak? /qonly/
SHORT: UPP? /qonly/

ID:	Upp	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the peak peak value of the voltage.

10.2.4.1.12.11 :RECTify? UREC? Urect

SCPI: :FETCh[:SCALar][:VOLTage]:RECTify? /qonly/ |
:READ[:SCALar][:VOLTage]:RECTify? /qonly/
SHORT: UREC? /qonly/

ID:	Urect	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the rectified value of the voltage.

10.2.4.1.12.12 :RUSed? OVRU? OvrU

SCPI: :FETCh[:SCALar][:VOLTage]:RUSed? /qonly/ |
:READ[:SCALar][:VOLTage]:RUSed? /qonly/
SHORT: OVRU? /qonly/

ID:	OvrU	Mode:	All
Type:	float	Suffix:	n/a
Value:	in %	List:	n/a
Unit:	n/a	Group:	n/a

Reads the usage of the range in percent.

10.2.4.1.12.13 [:TRMS?] UTRMS? Utrms

SCPI: :FETCh[:SCALar][:VOLTage][:TRMS]? /qonly/ |
:READ[:SCALar][:VOLTage][:TRMS]? /qonly/
SHORT: UTRMS? /qonly/

ID:	Utrms	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads the TRMS value of the voltage.

10.2.5 :FORMat commands

Here you can set-up the output format.

:CALCulate	
:DISPlay	
:FETCh	
:FORMat →	:DATA
:INITiate	
:INPut	
:INSTrument	
:MEMory	
:READ	

:SENSe	
:SOURce	
:STATus	
:SYSTem	
:TRIGger	

10.2.5.1 :DATA FRMT

SCPI: :FORMat:DATA/nquery/ <NRi>
SHORT: FRMT/nquery/ <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Defines the data output format. Parameter is:
‘0’ or ‘ASCII’ for ASCII output [*RST default value]
‘1’ or ‘PACKED’ for a packed output.

In the packed output format the data are transmitted as ‘defined length arbitrary block response data’. If the available buffer memory size is too small for the amount of data the LMG wants to send, the data flow will be split in several sequential blocks of data. There are three kinds of data in the blocks: ASCII data, long data (4 Byte) and float data (4 Byte). The numeric data are transferred, so that the receiving PC program can store the data directly in memory. The number 0x11223344 is arranged inside the block as 0x44 0x33 0x22 0x11. This is the order Intel based computers store the number. So if you want to read the number you can simply use a pointer to the input buffer and read the contents of the pointer.

The output changes after the end of the actual program message.

10.2.6 :INITiate commands

Here you can start or stop special actions.

:CALCulate	
:DISPlay	
:FETCh	
:FORMat	
:INITiate →	:CONTinuous
:INPut	:COPY
:INSTrument	:IMMediate
:MEMory	
:READ	
:SENSe	
:SOURce	
:STATus	
:SYSTem	
:TRIGger	

10.2.6.1 :CONTinuous CONT

SCPI: :INITiate:CONTinuous <NRi>

SHORT: CONT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

This activates or deactivates the continuous execution of the string defined with :TRIGger:ACTion or ACTN. The programmer should only use :FETCh commands, because when CONT is switched to 'ON', automatically an :INITiate:IMMediate is executed at the end of each cycle.

Parameter:
'ON' or '1' activates this mode
'OFF' or '0' deactivates this mode [*RST default value]

The standard defines, that instruments with sequential commands can only exit the 'ON' state by the device clear command of the interface. This works also with this instrument. But additionally you can exit the 'ON' state by setting it to 'OFF' with :INITiate:CONTinuouse or CONT.

10.2.6.2 :COPY COPY

SCPI: :INITiate:COPY/nquery/
SHORT: COPY/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

This forces an actualisation of the values to be read with the :FETCh commands. The copying of the data is done immediately and not at the end of the measuring cycle (see also 10.2.6.3, ':IMMediate INIM').

10.2.6.3 :IMMediate INIM

SCPI: :INITiate:IMMediate/nquery/
SHORT: INIM/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

This forces an actualisation of the values to be read with the :FETCh commands. In general the instrument measures continuous. After each cycle the measured values are copied into the display memory. The values read by the :FETCh commands are taken from another copy of the values. This copy is updated, whenever the :INITiate:IMMediate or INIM command is executed. By this it is sure, that all values read with sequential :FETCh commands are from one measuring cycle and belong together.

Please note, that the execution of this command lasts until the end of the cycle. This can take up to one complete cycle. Please keep this in mind when setting any time-out for expecting the answer of a following command.

Please take care to follow this rules:

1. Use just one INIM in one command string to the instrument.
2. Send a second INIM just when the request of the first INIM is answered.

10.2.7 :INPut commands

:CALCulate	
:DISPlay	
:FETCh	
:FORMat	
:INITiate	
:INPut →	:COUPling
:INSTrument	
:MEMory	
:READ	
:SENSe	
:SOURce	
:STATus	
:SYSTem	
:TRIGger	

10.2.7.1 :COUPling SCPL

SCPI: :INPut:COUPling<NRi>[,<NRi>]
SHORT: SCPL <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	optional [,<NRi>]; 0=A, 1=B

Sets or queries the setting of the signal coupling. Allowed values are:

‘0’ or ‘ACDC’ for AC+DC coupling [*RST default value]
‘1’ for AC coupling

10.2.8 :INSTrument commands

Here general set-ups of the instrument are done.

:CALCulate
:DISPlay
:FETCh
:FORMat
:INITiate

:INPut
:INSTrument → :SELect
:MEMory
:READ
:SENSe
:SOURce
:STATus
:SYSTem
:TRIGger

10.2.8.1 :SELect MODE

SCPI: :INSTrument:SELect <NRi>
SHORT: MODE <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...4	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the measuring mode:
‘0’ or ‘NORML’ for normal measuring mode [*RST default value]
‘1’ or ‘CEHRM’ for CE harmonic measuring mode
‘2’ or ‘CEFLK’ for CE flicker measuring mode
‘3’ or ‘HRMHUN’ for 100 harmonics measuring mode
‘4’ or ‘TRANS’ for transient measuring mode

Hint

The execution of this command can take up to few seconds. The LMG works internally with a watchdog protection. To prevent that the watchdog becomes active, the ‘MODE’ command should be send as the only command in a message. Just the ‘*OPC?’ can be added to get a feedback, if the command has finished (‘MODE x;*OPC?’).

10.2.9 :MEMory commands

:CALCulate
:DISPlay
:FETCh
:FORMat
:INITiate
:INPut
:INSTrument
:MEMory → :FREeze
:READ :SSIZe
:SENSe
:SOURce
:STATus
:SYSTem
:TRIGger

10.2.9.1 :FREeze FRZ

SCPI: :MEMory:FREeze <NRi>

SHORT: FRZ <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Freezes the scope RAM. The scope has too much memory so it can't be copied each cycle into a separate buffer. For this reason you should set FRZ to ON when you want to readout the sample values of the scope. Parameter:
'ON' or '1' activates the freeze mode
'OFF' or '0' deactivates the freeze mode [*RST default value]

10.2.9.2 :SSIZe GMEM

SCPI: :MEMory:SSIZe? /qonly/
SHORT: GMEM? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 2^{16}, 2^{22}, 2^{23}	List:	n/a
Unit:	n/a	Group:	n/a

Reads the size of the sample value memory.

10.2.10 :SENSe commands

10.2.10.1 :AINPut

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	**:AINPut →**	:FSCale
:SOURce	:ARON	:ZERO
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.1.1 :FSCale	AIHI

SCPI: :SENSe:AINPut:FSCale <NRf>
SHORT: AIHI <NRf>

ID:	n/a	Mode:	All
Type:	float	Suffix:	1...4
Value:	n/a, [*RST default value] = 10	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the full scale of the analogue inputs.

10.2.10.1.2 :ZERO	AILO

SCPI: :SENSe:AINPut:ZERO <NRf>
SHORT: AILO <NRf>

ID:	n/a	Mode:	All
Type:	float	Suffix:	1...4
Value:	n/a, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the zero position of the analogue inputs.

10.2.10.2 :AVERage

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	**:AVERage** →	:COUNt
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.2.1 :COUNt	AVER	Aver

SCPI: :SENSe:AVERage:COUNt <NRf>
SHORT: AVER <NRf>

ID:	Aver	Mode:	Normal
Type:	float	Suffix:	n/a

Value:	1...999, [*RST default value] = 1	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the average parameter.

10.2.10.3 :CURRent

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	**:CURRent →**	:DETector
:TRIGger	:FILTer	:IDENtify
	:FINPut	:RANGe
	:FLICker	:SCALe
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.3.1 :DETector IEXT

SCPI: :SENSe:CURRent:DETector <NRi>
SHORT: IEXT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets internal or external shunt input:
‘0’ or ‘INT’ for internal shunt (current input) [*RST default value]
‘1’ or ‘EXT’ for external shunt input (voltage input)

10.2.10.3.2 :IDENtify? IDNI?

SCPI: :SENSe:CURRent:IDENtify? /qonly/
SHORT: IDNI? /qonly/

ID:	n/a	Mode:	All
Type:	string	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the type of the external current sensor. The LMG95 will always return „No clamp“.

10.2.10.3.3 :RANGe

:CALCulate			
:DISPlay			
:FETCh			
:FORMat			
:INITiate			
:INPut			
:INSTrument			
:MEMory			
:READ			
:SENSe →	:AINPut		
:SOURce	:ARON		
:STATus	:AVERage		
:SYSTem	**:CURRent** →	:DETector	
:TRIGger	:FILTer	**:RANGe** →	:AUTO
	:FINPut	:SCALe	:LINTern
	:FLICker		[:UPPer]
	:HARMonics		
	:INTegral		
	:SWEep		
	:TRANsient		
	:VOLTage		
	:WAVeform		
	:WIRing		
	:ZPReject		

10.2.10.3.3.1 :AUTO IAM

SCPI: :SENSe:CURRent:RANGe:AUTO <NRi>
SHORT: IAM <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the status of the auto range function:
‘0’ or ‘MANUAL’ for manual range selection
‘1’ or ‘AUTO’ for automatic range selection [*RST default value]

10.2.10.3.3.2 :LINTern? IILS?

SCPI: :SENSe:CURRent:RANGe:LINTern?/qonly/
SHORT: IILS/qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads a list with the available ranges. You get several numbers which are separated by colons ‘,’. The first number defines the number of following numbers. If you have selected external sensors, you get the list of their ranges.

10.2.10.3.3.3 [:UPPer] IRNG RngI

SCPI: :SENSe:CURRent:RANGe[:UPPer] <NRf>
SHORT: IRNG <NRf>

ID:	RngI	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	A	Group:	n/a

Reads and sets the range for the current measurement. The parameter is the nominal value of the range.

10.2.10.3.4 :SCALe ISCA Iscal

SCPI: :SENSe:CURRent:SCALe <NRf>
SHORT: ISCA <NRf>

ID:	Iscal	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1.0	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the scaling of the current range.

10.2.10.4 :FILTer

10.2.10.4.1 :AFILter FAAF

SCPI: :SENSe:FILTer:AFILter <NRi>
SHORT: FAAF <NRi>

ID:	n/a	Mode:	HARM100
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the anti-aliasing-filter settings:

0: Filter off

1: Filter on [*RST default value]

10.2.10.4.2 [:LPASs]

:CALCulate
:DISPlay
:FETCh

:FORMat			
:INITiate			
:INPut			
:INSTrument			
:MEMory			
:READ			
:SENSe →	:AINPut		
:SOURce	:ARON		
:STATus	:AVERage		
:SYSTem	:CURRent		
:TRIGger	**:FILTer** →	**[:LPASs]** →	[:STATe]
	:FINPut		
	:FLICker		
	:HARMonics		
	:INTegral		
	:SWEep		
	:TRANsient		
	:VOLTage		
	:WAVeform		
	:WIRing		
	:ZPReject		

10.2.10.4.2.1 [:STATe] FILT

SCPI: :SENSe:FILTer[:LPASS][:STATe] <NRi>[,<NRi>]
SHORT: FILT <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, Transient
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the filter settings:

0: Filter off
1: HF Rejection filter on [*RST default value]
2: Low pass ‘2kHz’ on
3: Low pass ‘9.2kHz’ on
4: Low pass ‘60Hz’ on
5: Low pass ‘18kHz’ on
6: Low pass ‘6kHz’ on
7: Low pass ‘2.8kHz’ on
8: Low pass ‘1.4kHz’ on
9: Low pass ‘700Hz’ on
10: Low pass ‘350Hz’ on
11: Low pass ‘175Hz’ on
12: Low pass ‘87.5Hz’ on
13: Low pass ‘30Hz’ on

10.2.10.5 :FINPut

:CALCulate
:DISPlay
:FETCh

:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut →	:SCALe
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.5.1 :SCALe DIFS

SCPI: :SENSe:FINPut:SCALe <NRf>
SHORT: DIFS <NRf>

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] is 1.0	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the scale of the frequency input.

10.2.10.6 :FLICker

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker →	:PERiods
	:HARMonics	:STIMe
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.6.1 :PERiods FLPS FlkPer

SCPI: :SENSe:FLICker:PERiods <NRf>
SHORT: FLPS <NRf>

ID:	FlkPer	Mode:	Flicker
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 12	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the number of periods for flicker measuring.

10.2.10.6.2 :STIMe FTIM

SCPI: :SENSe:FLICker:STIMe <NRi>
SHORT: FTIM <NRi>

ID:	n/a	Mode:	Flicker
Type:	long int	Suffix:	n/a
Value:	n/a, [*RST default value] = 600	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the short term flicker measuring time.

10.2.10.7 :HARMonics

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics →	:FDIV
	:INTegral	:REFerence
	:SWEep	:SMOoth
	:TRANsient	:TIME
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.7.1 :FDIV FDIV

SCPI: :SENSe:HARMonics:FDIV <NRf>[,<NRi>]
SHORT: FDIV <NRf>[,<NRi>]

ID:	n/a	Mode:	HARM100
Type:	float	Suffix:	n/a

Value:	1...50, [*RST default value] = 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the frequency divider ratio.

10.2.10.7.2 :REFerence HREF

SCPI: :SENSe:HARMonics:REFerence <NRi>[,<NRi>]
SHORT: HREF <NRi>[,<NRi>]

ID:	n/a	Mode:	HARM100
Type:	long int	Suffix:	n/a
Value:	0, 1, 20	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the state of the phase reference for the harmonics and the Fresnel diagram. That defines if the basic wave of U, I or the synchronisation source is set to 0° as reference for the system:

‘0’ for U as reference [*RST default value]
‘1’ for I as reference
‘20’ for none (= synchronisation source) as reference

10.2.10.7.3 :SMOoth

SCPI: :SENSe:HARMonics:SMOoth <NRi>
SHORT: SMOO <NRi>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the state of the smoothing:
‘0’ or ‘OFF’ for direct measuring [*RST default value]
‘1’ or ‘ON’ for smoothed measuring

10.2.10.7.4 :TIME HTIM

SCPI: :SENSe:HARMonics:TIME <NRi>
SHORT: HTIM <NRi>

ID:	n/a	Mode:	prCE
Type:	long int	Suffix:	n/a
Value:	n/a, [*RST default value] = 150	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the harmonics measuring time.

10.2.10.8 :INTegral

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral →	:DATE
	:SWEep	:INTerval
	:TRANsient	:MODE
	:VOLTage	:STATe
	:WAVeform	:TIME
	:WIRing	
	:ZPReject	

10.2.10.8.1 :DATE INTD

SCPI: :SENSe:INTegral:DATE <NRf>,<NRf>,<NRf>
SHORT: INTD <NRf>,<NRf>,<NRf>

ID:	n/a	Mode:	Normal
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the start date for an energy measurement. Example: INTD 2003,02,09 sets the date to the 9th February, 2003.

10.2.10.8.2 :INTerval INTI

SCPI: :SENSe:INTegral:INTerval <NRi>
SHORT: INTI <NRi>

ID:	n/a	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the time interval for an energy measurement.

10.2.10.8.3 :MODE INTM

SCPI: :SENSe:INTegral:MODE <NRi>
SHORT: INTM <NRi>

ID:	n/a	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	0...4	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the integration mode:

0=off [*RST default value]

1=continuous

2=interval

3=periodic

4=summing

10.2.10.8.4 :STATe? INTS?

SCPI: :SENSe:INTegral:STATe? /qonly/
SHORT: INTS? /qonly/

ID:	n/a	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	0...5	List:	n/a
Unit:	n/a	Group:	n/a

Reads the state of the energy measurement:

0=Reset

1=Wait

2=Start

3=Run

4=Stop

5=Hold

10.2.10.8.5 :TIME INTT

SCPI: :SENSe:INTegral:TIME <NRf>,<NRf>,<NRf>
SHORT: INTT <NRf>,<NRf>,<NRf>

ID:	n/a	Mode:	Normal
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the start time for an energy measurement. Example: INTT 19,26,49 sets the time to 19:26:49.

10.2.10.9 :SWEep

:CALCulate
:DISPlay
:FETCh
:FORMat
:INITiate

:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep →	:TIME
	:TRANsient	
	:VOLTage	
	:WAVeform	
	:WIRing	
	:ZPReject	

10.2.10.9.1 :TIME CYCL Cycle

SCPI: :SENSe:SWEep:TIME <NRf>
SHORT: CYCL <NRf>

ID:	Cycle	Mode:	Normal
Type:	float	Suffix:	n/a
Value:	0, 0.05...60, [*RST default value] = 0.5	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the cycle time.

10.2.10.10 :TRANsient

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient →	:ACRegister
	:VOLTage	:LIMita
	:WAVeform	:LIMitb
	:WIRing	:CHANnels
	:ZPReject	:DURation
		:OCRegister
		:PRETrigger

:RTIMe
:SIGNal
:SRDT
:SRDY
:SROVer

10.2.10.10.1 :ACRegister TACR

SCPI: :SENSe:TRANsient:ACRegister <NRi>
SHORT: TACR <NRi>

ID:	n/a	Mode:	Transient
Type:	long int	Suffix:	n/a
Value:	0...127, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the AND Condition Register:

Bit 0: Slewrate condition is checked if bit is set

Bit 1: Win In condition is checked if bit is set

Bit 2: Win Out condition is checked if bit is set

Bit 3: >Limit1 condition is checked if bit is set

Bit 4: <Limit1 condition is checked if bit is set

Bit 5: >Limit2 condition is checked if bit is set

Bit 6: <Limit2 condition is checked if bit is set

10.2.10.10.2 :ALIMit TLIA

SCPI: :SENSe:TRANsient:ALIMit <NRf>
SHORT: TLIA <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	±1e9, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the limit 1.

10.2.10.10.3 :BLIMit TLIB

SCPI: :SENSe:TRANsient:BLIMit <NRf>
SHORT: TLIB <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	±1e9, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the limit 2.

10.2.10.10.4 :DURation TDUR

SCPI: :SENSe:TRANsient:DURation <NRf>
SHORT: TDUR <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	2*10^{-5}...10, [*RST default value]=2*10^{-5}	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the duration of the event.

10.2.10.10.5 :OCRegister TOCR

SCPI: :SENSe:TRANsient:OCRegister <NRi>
SHORT: TOCR <NRi>

ID:	n/a	Mode:	Transient
Type:	long int	Suffix:	n/a
Value:	0...127, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the OR Condition Register:

Bit 0: Slewrate condition is checked if bit is set

Bit 1: Win In condition is checked if bit is set

Bit 2: Win Out condition is checked if bit is set

Bit 3: >Limit1 condition is checked if bit is set

Bit 4: <Limit1 condition is checked if bit is set

Bit 5: >Limit2 condition is checked if bit is set

Bit 6: <Limit2 condition is checked if bit is set

10.2.10.10.6 :PRETrigger TPRE

SCPI: :SENSe:TRANsient:PRETrigger <NRf>
SHORT: TPRE <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	0...100 in %, [*RST default value] = 50	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the pretrigger.

10.2.10.10.7 :RTIMe TREC

SCPI: :SENSe:TRANsient:RTIMe <NRf>
SHORT: TREC <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	0.01...60, [*RST default value] = 0.5	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the record time.

10.2.10.10.8 :SIGNal TSRC

SCPI: :SENSe:TRANsient:SIGNal <NRi>
SHORT: TSRC <NRi>

ID:	n/a	Mode:	Transient
Type:	long int	Suffix:	n/a
Value:	1, 3, 5...7, [*RST default value] = 5	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the trigger signal source:

1: i^2

3: u^2

5: i

6: u

7: p

10.2.10.10.9 :SRDT TDT

SCPI: :SENSe:TRANsient:SRDT <NRf>
SHORT: TDT <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	$2*10^{-5}$...1, [*RST default value] = $2*10^{-5}$	List:	n/a
Unit:	s	Group:	n/a

Reads and sets the slew rate dt

10.2.10.10.10 :SRDY TDU

SCPI: :SENSe:TRANsient:SRDY <NRf>
SHORT: TDU <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the slew rate dy of selected signal.

10.2.10.10.11 :SROVer TDX

SCPI: :SENSe:TRANsient:SROVer <NRf>
SHORT: TDX <NRf>

ID:	n/a	Mode:	Transient
Type:	float	Suffix:	n/a

Value: 1...15, [*RST default value] = 1 List: n/a
Unit: n/a Group: n/a

Reads and sets the slew rate over x value.

10.2.10.11 :VOLTage

10.2.10.11.1 :IDENTify IDNU

SCPI: :SENSe:VOLTage:IDENtify? /qonly/
SHORT: IDNU? /qonly/

ID: n/a Mode: All
Type: string Suffix: n/a
Value: n/a List: n/a
Unit: n/a Group: n/a

Reads the type of an external voltage sensor. The LMG95 will always return „No sensor input“.

10.2.10.11.2 :RANGe

:CALCulate			
:DISPlay			
:FETCh			
:FORMat			
:INITiate			
:INPut			
:INSTrument			
:MEMory			
:READ			
:SENSe →	:AINPut		
:SOURce	:ARON		
:STATus	:AVERage		
:SYSTem	:CURRent		
:TRIGger	:FILTer		
	:FINPut		
	:FLICker		
	:HARMonics		
	:INTegral		
	:SWEep		
	:TRANSient		
	:VOLTage →	**:RANGe** →	:AUTO
	:WAVeform	:SCALe	:LINTern
	:WIRing		[:UPPer]
	:ZPReject		

10.2.10.11.2.1 :AUTO UAM

SCPI: :SENSe:VOLTage:RANGe:AUTO <NRi>
SHORT: UAM <NRi>

ID: n/a Mode: All
Type: long int Suffix: n/a
Value: 0, 1 List: n/a
Unit: n/a Group: n/a

Reads and sets the status of the auto range function:
'0' or 'MANUAL' for manual range selection.
'1' or 'AUTO' for automatic range selection [*RST default value].

10.2.10.11.2.2 :LINTern? UILS?

SCPI: :SENSe:VOLTage:RANGe:LINTern?/qonly/
SHORT: UILS?/qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads a list with the available ranges. You get several float numbers which are separated by colons ','. The first number defines the number of following numbers.

10.2.10.11.2.3 [:UPPer] URNG RngU

SCPI: :SENSe:VOLTage:RANGe[:UPPer] <NRf>
SHORT: URNG <NRf>

ID:	RngU	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	V	Group:	n/a

Reads and sets the range for the voltage measurement. The parameter is the nominal value of the range.

10.2.10.11.3 :SCALe USCA Uscal

SCPI: :SENSe:VOLTage:SCALe <NRf>
SHORT: USCA <NRf>

ID:	Uscal	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a, [*RST default value] = 1	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the scaling of the voltage range.

10.2.10.12 :WAVeform

:CALCulate
:DISPlay
:FETCh
:FORMat
:INITiate
:INPut
:INSTrument

:MEMory		
:READ		
:SENSe →	:AINPut	
:SOURce	:ARON	
:STATus	:AVERage	
:SYSTem	:CURRent	
:TRIGger	:FILTer	
	:FINPut	
	:FLICker	
	:HARMonics	
	:INTegral	
	:SWEep	
	:TRANsient	
	:VOLTage	
	:WAVeform →	:CYCLes
	:WIRing	:IUPDate
	:ZPReject	:SATRigger
		:SBTRigger
		:SCTRigger
		:SRATe
		:SSAMples
		:WAVE

10.2.10.12.1 :CYCLes GMUL

SCPI: :SENSe:WAVeform:CYCLes <NRf>
SHORT: GMUL <NRf>

ID:	n/a	Mode:	Normal, Transient
Type:	float	Suffix:	n/a
Value:	1...999	List:	n/a
Unit:	n/a	Group:	n/a

Reads or sets the number of cycles for which sample values are stored. In transient mode this number is the divider for the sampling frequency.

10.2.10.12.2 :IUPDate SACT

SCPI: :SENSe:WAVeform:IUPDate/nquery/
SHORT: SACT/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Requests new information about the scope data. Before this command you should set ‘:MEMory:FREeze ON’. After this command you can use ‘:SENS:WAV:SATR’, ‘:SENS:WAV:SBTR’, ‘:SENS:WAV:SSAM’ and ‘:SENS:WAV:SCTR’.

10.2.10.12.3 :SATRigger? SATR?

SCPI: :SENSe:WAVeform:SATRigger? /qonly/
SHORT: SATR? /qonly/

ID:	n/a	Mode:	All

Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads how many sample values are available after the trigger event. See also ':SENS:WAV:IUPD' for further information.

10.2.10.12.4 :SBTRigger? SBTR?

SCPI: :SENSe:WAVeform:SBTRigger? /qonly/
SHORT: SBTR? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads how many sample values are available before the trigger event. See also ':SENS:WAV:IUPD' for further information.

10.2.10.12.5 :SCTRigger? SCTT?

SCPI: :SENSe:WAVeform:SCTRigger? /qonly/
SHORT: SCTT? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	$0...2^{31}-1$	List:	n/a
Unit:	n/a	Group:	n/a

Reads the number of the sample value at the trigger. See also ':SENS:WAV:IUPD' for further information.
The sample values of the instrument are counted. At the end of each cycle this counter is stored and can be read by this command. The counter runs up to 2^{31}-1 and starts then again at 0. See also 10.2.4.1.2.2, ':SNUMber? SCTC?'

10.2.10.12.6 :SRATe? GFRQ?

SCPI: :SENSe:WAVeform:SRATe? /qonly/
SHORT: GFRQ? /qonly/

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the record rate of the sampled values.

10.2.10.12.7 :SSAMples SSAM

SCPI: :SENSe:WAVeform:SSAMples <NRi>
SHORT: SSAM <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	see below	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets which sample values are stored in the memory. See also ':SENS:WAV:IUPD' for further information. The parameter has following meaning:

Bit 3: i

Bit 4: u

Bit 5: p

The Bits are counted from 0!

10.2.10.12.8 :WAVE? WAVE?

SCPI: :SENSe:WAVeform:WAVE? /qonly/ <NRi>,<list>
SHORT: WAVE? /qonly/ <NRi>,<list>

ID:	n/a	Mode:	All
Type:	float	Suffix:	n/a
Value:	n/a	List:	see below
Unit:	n/a	Group:	n/a

Before using this command you should freeze the memory with :MEMory:FREeze, to avoid data losses while long transfer duration. Reads out sample values specified with <NRi>:

4: i

5: u

6: p

The first allowed value in <list> is the value read by :SENSe:WAVeform:SBTRigger?, the last allowed value that read by :SENSe:WAVeform:SATRigger?

10.2.10.13 :ZPReject ZSUP

SCPI: :SENSe:ZPReject <NRi>
SHORT: ZSUP <NRi>

ID:	n/a	Mode:	Normal
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

By this you can deactivate the zero point rejection. It is a long number with following meaning:

0: Zero point rejection is switched off

1: Zero point rejection is switched on [*RST default value]

:CALCulate
:DISPlay
:FETCh

:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce →	:DIGital	
:STATus	:VOLTage	
:SYSTem		
:TRIGger		

10.2.11 :SOURce commands

10.2.11.1 :DIGital

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce →	**:DIGital** →	:CONDition
:STATus	:VOLTage	:LIMit
:SYSTem		:VALue
:TRIGger		

10.2.11.1.1 :CONDition DOCO

SCPI: :SOURce:DIGital:CONDition <NRi>
SHORT: DOCO <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	1...4
Value:	0...3	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the condition of the digital outputs. Possible parameters are:

0: off [*RST default value]

1: on

2: >=

3: <

10.2.11.1.2 :LIMit DOLI

SCPI: :SOURce:DIGital:LIMit <NRf>
SHORT: DOLI <NRf>

ID:	n/a	Mode:	All
Type:	float	Suffix:	1...4
Value:	n/a, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the limits of the digital outputs.

10.2.11.1.3 :VALue DOIX

SCPI: :SOURce:DIGital:VALue <string>
SHORT: DOIX <string>

ID:	n/a	Mode:	All
Type:	string	Suffix:	1...4
Value:	n/a, [*RST default value] = ‘Utrms’	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the value of the digital outputs. As <string> you have to enter the same string as you would enter when using the instrument without interface. So you have to sent a valid ID!

10.2.11.2 :VOLTage

10.2.11.2.1 :SCALe

:CALCulate			
:DISPlay			
:FETCh			
:FORMat			
:INITiate			
:INPut			
:INSTrument			
:MEMory			
:READ			
:SENSe			
:SOURce →	:DIGital		
:STATus	**:VOLTage** →	**:SCALe** →	:FSCale
:SYSTem		:VALue	:ZERO
:TRIGger			

10.2.11.2.1.1 :FSCale AOHI

SCPI: :SOURce:VOLTage:SCALe:FSCale <NRf>
SHORT: AOHI <NRf>

ID:	n/a	Mode:	All
Type:	float	Suffix:	1...4
Value:	n/a, [*RST default value] = 10	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the full scale of the analogue outputs.

10.2.11.2.1.2 :ZERO AOLO

SCPI: :SOURce:VOLTage:SCALe:ZERO <NRf>
SHORT: AOLO <NRf>

ID:	n/a	Mode:	All

Type:	float	Suffix:	1...4
Value:	n/a, [*RST default value] = 0	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the zero position of the analogue outputs.

10.2.11.2.2 :VALue AOIX

SCPI: :SOURce:VOLTage:VALue <string>
SHORT: AOIX <string>

ID:	n/a	Mode:	All
Type:	string	Suffix:	1...4
Value:	n/a, [*RST default value] = 'Utrms'	List:	n/a
Unit:	n/a	Group:	n/a

Sets or queries the setting of the value of the analogue outputs. As <string> you have to enter the same string as you would enter when using the instrument without interface. So you have to send a valid ID!

10.2.12 :STATus commands

10.2.12.1 :OPERation

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus →	**:OPERation** →	:CONDition
:SYSTem	:PRESet	:ENABle
:TRIGger	:QUEStionable	[:EVENt]
		:NTRansition
		:PTRansition

10.2.12.1.1 :CONDition? SOC?

SCPI: :STATus:OPERation:CONDition? /qonly/
SHORT: SOC? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads the Operation Status Condition Register.

10.2.12.1.2 :ENABle SOEN

SCPI: :STATus:OPERation:ENABle <NRi>
SHORT: SOEN <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Operation Status Enable Register.

10.2.12.1.3 [:EVENt]? SOE?

SCPI: :STATus:OPERation[:EVENt]? /qonly/
SHORT: SOE? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads the Operation Status Event Register and clears it.

10.2.12.1.4 :NTRansition SONT

SCPI: :STATus:OPERation:NTRansition <NRi>
SHORT: SONT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Operation Status Negative Transition Register.

10.2.12.1.5 :PTRansition SOPT

SCPI: :STATus:OPERation:PTRansition <NRi>
SHORT: SOPT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Operation Status Positive Transition Register.

10.2.12.2 PRESet PRES

SCPI: :STATus:PRESet/nquery/
SHORT: PRES/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Presets the operation and the query registers. The p-transition registers are filled with 0x7FFF, the n-transition registers with 0x0000 and the enable registers with 0x0000.

10.2.12.3 :QUEStionable

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus →	:OPERation	
:SYSTem	:PRESet	
:TRIGger	**:QUEStionable** →	:CONDition
		:ENABle
		[:EVENt]
		:NTRansition
		:PTRansition

10.2.12.3.1 :CONDition? SQC?

SCPI: :STATus:QUEStionable:CONDition? /qonly/
SHORT: SQC? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads the Questionable Status Condition Register.

10.2.12.3.2 :ENABle SQEN

SCPI: :STATus:QUEStionable:ENABle <NRi>
SHORT: SQEN <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Questionable Status Enable Register.

10.2.12.3.3 [:EVENt]? SQE?

SCPI: :STATus:QUEStionable[:EVENt]? /qonly/
SHORT: SQE? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads the Questionable Status Event Register and clears it.

10.2.12.3.4 :NTRansition SQNT

SCPI: :STATus:QUEStionable:NTRansition <NRi>
SHORT: SQNT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Questionable Status Negative Transition Register.

10.2.12.3.5 :PTRansition SQPT

SCPI: :STATus:QUEStionable:PTRansition <NRi>
SHORT: SQPT <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0...65535	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the Questionable Status Positive Transition Register.

10.2.13 :SYSTem commands

10.2.13.1 :BEEPer

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus		
:SYSTem →	**:BEEPer** →	:IMMediate
:TRIGger	:DATE	
	:ERRor	

```
:HELP
:KEY
:LANGuage
:OPTions
:PHEADER
:TIME
:VERSion
```

10.2.13.1.1 :IMMediate BEEP

SCPI: :SYSTem:BEEPer:IMMediate/nquery/
SHORT: BEEP/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Forces the internal beeper to beep a short sound.

10.2.13.2 :DATE DATE

SCPI: :SYSTem:DATE <NRf>,<NRf>,<NRf>
SHORT: DATE <NRf>,<NRf>,<NRf>

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the system date. Format is DATE yyyy,mm,dd. Example: DATE 2003,02,09 sets the date to the 9th February, 2003.

10.2.13.3 :ERRor

Following errors can occur:

No.	Name	Possible reason; what to do
8	Overrun error at CONT ON	Too many values were requested in a too short time
7	Nested TRIGger:ACTion not allowed	
6	Action Buffer Overrun	Too many commands after the TRIGger:ACTion command
5	Command header error; (or maybe wrong path before)	Not existing or misspelled command or wrong SCPI path
4	Formatter output has overrun	Internal error, please contact ZES
2	Parser output has overrun	Internal error, please contact ZES
1	Parser deadlocked	Internal error, please contact ZES
0	No error	-

No.	Name	Possible reason; what to do
-101	Invalid character	A ‘(‘ or ‘)’ is missing in a <list>
-103	Invalid separator	A wrong character instead of the expected separator (‘,’, ‘;’, ‘:’, ‘<EOS>‘, ...)
-110	Command header error	Not existing or misspelled command
-113	Undefined header	There are no default commands to complete the header automatically. You have to enter the complete command
-120	Numeric data error	A number was expected but not send
-123	Exponent too large	Exponent is > 37
-124	Too many digits	Number has more than 9 digits
-131	Invalid suffix	Suffix too big or small
-150	String data error	A’“’ is missing
-221	Settings conflict	Setting at the moment impossible. For example to change a measuring range while auto range is active
-222	Data out of range	Happens for example at invalid <list> entries
-224	Illegal parameter value	Happens for example if you want to change to the (not existing) measuring mode 27
other	Illegal error, please inform your supplier	An error in the internal error handling. Please contact ZES

```
:CALCulate
:DISPlay
:FETCh
:FORMat
:INITiate
:INPut
:INSTrument
:MEMory
:READ
:SENSe
:SOURce
:STATus
:SYSTem  →     :BEEPer
:TRIGger       :DATE
               :ERRor  →     :ALL
               :HELP         :COUNt
               :KEY          [:NEXT]
               :LANGuage
               :OPTions
               :PHEADER
               :TIME
               :VERSion
```

10.2.13.3.1 :ALL? ERRALL?

SCPI: :SYSTem:ERRor:ALL? /qonly/
SHORT: ERRALL? /qonly/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads all errors, including error code and error description, separated by colons out of the error/event queue.

10.2.13.3.2 :COUNt? ERRCNT?

SCPI: :SYSTem:ERRor:COUNt? /qonly/
SHORT: ERRCNT? /qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the number of errors in the error/event queue.

10.2.13.3.3 [:NEXT]? ERR?

SCPI: :SYSTem:ERRor[:NEXT]? /qonly/
SHORT: ERR? /qonly/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads the oldest entry from the error/event queue, including error code and error description, separated by colons (‘,’).

10.2.13.4 :HELP

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus		
:SYSTem →	:BEEPer	
:TRIGger	:DATE	
	:ERRor	
	:HELP →	:HEADers
	:KEY	:SHEaders
	:LANGuage	
	:OPTions	
	:PHEADER	

:TIME
:VERSion

10.2.13.4.1 :HEADers? HEAD?

SCPI: :SYSTem:HELP:HEADers? /qonly/
SHORT: HEAD? /qonly/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Returns a list of all SCPI headers. This list is a <defined length arbitrary block response data>. Because this command has a very special output format it should only be used stand alone.

10.2.13.4.2 :SHEaders? SHEAD?

SCPI: :SYSTem:HELP:SHEaders? /qonly/ [<NRi>]
SHORT: SHEAD? /qonly/ [<NRi>]

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Returns a list of all SHORT headers. This list is a <defined length arbitrary block response data>. Because this command has a very special output format it should only be used stand alone.

If the optional NRi is ‘0’, then the output is according to SCPI standard. If it is ‘1’ there are additional information in the format ‘x;y t’:
x, if specified, is the maximum suffix
;y, if specified, is the maximum index
t, if specified, is the data type

10.2.13.5 :KEY KEY

SCPI: :SYSTem:KEY <NRi>
SHORT: KEY <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Queries the last pressed key or simulates the pressing of a key. Valid key numbers are:

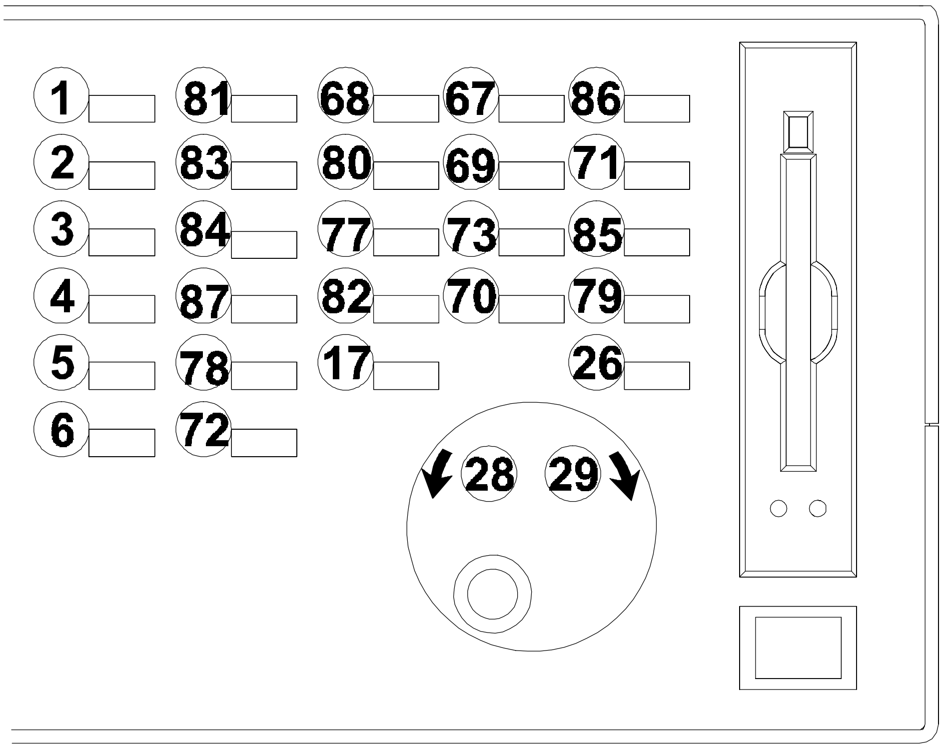


Figure 31: Key numbers

Please note, that the rotary knob can just be set but not queried!

10.2.13.6 :LANGuage LANG

SCPI: :SYSTem:LANGuage/nquery/ <NRi>
SHORT: LANG/nquery/ <NRi>

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a
Value:	0, 1	List:	n/a
Unit:	n/a	Group:	n/a

Changes the command set to be used. Parameter can be:
‘0’ or ‘SCPI’ to go to the SCPI command set
‘1’ or ‘SHORT’ to go to the SHORT command set

The new language will be used beginning with the following command header.

There is no *RST default value! The language at power up will be SCPI. A ‘device clear’ or ‘BREAK’ will also select SCPI.

10.2.13.7 :OPTions? OPTN?

SCPI: :SYSTem:OPTions? /qonly/
SHORT: OPTN/qonly/

ID:	n/a	Mode:	All
Type:	long int	Suffix:	n/a

Value: $0...2^{23}-1$ List: n/a
Unit: n/a Group: n/a

Reads the installed options inside the LMG. The return value is a long parameter where the bits have following function (bit set = option installed):
Bit 0: COM A interface
Bit 1: COM B interface
Bit 2: Printer interface
Bit 3: IEEE488.2 interface
Bit 4: Memory card drive
Bit 6: Processing signal interfaceBit 8: Flicker
Bit 9: Harm100
Bit 10: Transients
Bit 11: Extended memory
Bit 12: voltage channel in 500kHz version
Bit 13: voltage channel with modified ranges
Bit 14: current channel in 500kHz version
Bit 15: current channel with modified ranges

10.2.13.8 :PHEader PHDR

SCPI: :SYSTem:PHEader <string program data>
SHORT: PHDR <string program data>

ID: n/a Mode: All
Type: string Suffix: n/a
Value: n/a List: n/a
Unit: n/a Group: n/a

Sets or reads the printer header. At *RST this value is deleted.

For example
PHDR „HELLO“

would cause to output „HELLO“ before each printing.

10.2.13.9 :TIME TIME

SCPI: :SYSTem:TIME <NRf>,<NRf>,<NRf>
SHORT: TIME <NRf>,<NRf>,<NRf>

ID: n/a Mode: All
Type: n/a Suffix: n/a
Value: n/a List: n/a
Unit: n/a Group: n/a

Reads and sets the system time. Format is TIME hh,mm,ss. Example: TIME 10,26,46 sets the time to 10:26:46.

10.2.13.10 :VERSion? VER?

SCPI: :SYSTem:VERSion? /qonly/
SHORT: VER? /qonly/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	1999.0	List:	n/a
Unit:	n/a	Group:	n/a

Returns the version of the SCPI implementation. Returns always ‘1999.0’.

10.2.14 :TRIGger commands

:CALCulate	
:DISPlay	
:FETCh	
:FORMat	
:INITiate	
:INPut	
:INSTrument	
:MEMory	
:READ	
:SENSe	
:SOURce	
:STATus	
:SYSTem	
:TRIGger →	:ACTion
	:ICURrent
	:INTerval
	[:SEQuence]

10.2.14.1 :ACTion ACTN

SCPI: :TRIGger:ACTion/nquery/
SHORT: ACTN/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Defines an action which has to be performed, when :INIT:CONT is set to ON and a trigger event occurs. All program headers which follow behind the ‘;’ after TRIG:ACT will be used, until the end of the program message.

Example: ACTN;UTRMS?;ITRMS?
This defines that each time a trigger event occurs in the INIT:CONT ON state, the TRMS values of voltage and current are returned. See also 10.2.6.1, ‘:CONTinuous CONT’. The

same example in SCPI syntax would be.
:TRIG:ACT;:FETC:TRMS?;:FETC:CURR:TRMS?

There is no *RST default value!

10.2.14.2 :ICURrent IINC

SCPI: :TRIGger:ICURrent/nquery/
SHORT: IINC/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Triggers the measuring of the inrush current. The value for the inrush current is reset to 0. See 10.2.4.1.1.6

10.2.14.3 :INTerval

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus		
:SYSTem		
:TRIGger →	:ACTion	
	:ICURrent	
	:INTerval →	:RESet
	[:SEQuence]	:STARt
		:STOP

10.2.14.3.1 :RESet RESET

SCPI: :TRIGger:INTerval:RESet/nquery/
SHORT: RESET/nquery/

ID:	n/a	Mode:	Normal
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Resets the energy measurement.

10.2.14.3.2 :STARt START

SCPI: :TRIGger:INTerval:STARt/nquery/

SHORT: START/nquery/

ID:	n/a	Mode:	Normal, prCE, Flicker, Transient
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Starts a time dependent measuring (e.g. energy, flicker, ...)

10.2.14.3.3 :STOP STOP

SCPI: :TRIGger:INTerval:STOP/nquery/
SHORT: STOP/nquery/

ID:	n/a	Mode:	Normal, prCE, Flicker, Transient
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Stops a time dependent measuring (e.g. energy, flicker, ...)

10.2.14.4 [:SEQuence]

:CALCulate		
:DISPlay		
:FETCh		
:FORMat		
:INITiate		
:INPut		
:INSTrument		
:MEMory		
:READ		
:SENSe		
:SOURce		
:STATus		
:SYSTem		
:TRIGger →	:ACTion	
	:ICURrent	
	:INTerval	
	[:SEQuence] →	:COUPle
		:EXTend
		:SOURce

10.2.14.4.1 :COUPle COUPL

SCPI: :TRIGger[:SEQuence]:COUPle <NRi>[,<NRi>]
SHORT: COUPL <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient
Type:	long int	Suffix:	n/a
Value:	see below	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the coupling mode for the trigger (synchronisation) signal. Possible values are:
‘0’ or ‘ACDC’ for AC/DC coupling mode [*RST default value]

‘1’ or ‘BP’ for BP coupling mode
‘2’ or ‘AM’ for AM coupling mode

10.2.14.5 :EXTend

:CALCulate			
:DISPlay			
:FETCh			
:FORMat			
:INITiate			
:INPut			
:INSTrument			
:MEMory			
:READ			
:SENSe			
:SOURce			
:STATus			
:SYSTem			
:TRIGger →	:ACTion		
	:ICURrent		
	:INTerval		
	[:SEQuence] →	:COUPle	
		:EXTend →	:FILTer
		:SOURce	:HYSTeresis
			:LEVel
			:SOURce

10.2.14.5.1 :FILTer TRDF

SCPI: :TRIGger[:SEQuence]:EXTend:FILTer <NRi>[,<NRi>]
SHORT: TRDF <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient
Type:	long int	Suffix:	n/a
Value:	0...13	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the filter of the extended trigger.

0: Filter off [*RST default value]
1: HF rejection filter on
2: Low pass ‘2kHz’ on
3: Low pass ‘9.2kHz’ on
4: Low pass ‘60Hz’ on
5: Low pass ‘18kHz’ on
6: Low pass ‘6kHz’ on
7: Low pass ‘2.8kHz’ on
8: Low pass ‘1.4kHz’ on
9: Low pass ‘700Hz’ on
10: Low pass ‘350Hz’ on
11: Low pass ‘175Hz’ on
12: Low pass ‘87.5Hz’ on
13: Low pass ‘30Hz’ on

10.2.14.5.2 :HYSTeresis TRDH

SCPI: :TRIGger[:SEQuence]:EXTend:HYSTeresis <NRf>[,<NRi>]
SHORT: TRDH <NRf>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the hysteresis of the extended trigger.

10.2.14.5.3 :LEVel TRDL

SCPI: :TRIGger[:SEQuence]:EXTend:LEVel <NRf>[,<NRi>]
SHORT: TRDL <NRf>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient
Type:	float	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the level of the extended trigger.

10.2.14.5.4 :SOURce TRDE

SCPI: :TRIGger[:SEQuence]:EXTend:SOURce <NRi>[,<NRi>]
SHORT: TRDE <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient
Type:	long int	Suffix:	n/a
Value:	0...7	List:	n/a
Unit:	n/a	Group:	n/a

Reads and sets the source of the extended trigger.

Valid values are:

‘0’ = is

‘1’ = is*is

‘2’ = us

‘3’ = us*us

‘4’ = ps

‘5’ = i

‘6’ = u

‘7’ = p

10.2.14.5.5 :SOURce SYNC

SCPI: :TRIGger[:SEQuence]:SOURce <NRi>[,<NRi>]
SHORT: SYNC <NRi>[,<NRi>]

ID:	n/a	Mode:	Normal, HARM100, Transient

Type:	long int	Suffix:	n/a
Value:	0...4	List:	n/a
Unit:	n/a	Group:	n/a

Sets or reads the synchronisation source. Possible values are:
‘0’ or ‘LINE’ for line synchronisation
‘1’ or ‘EXTS’ for external synchronisation
‘2’ or ‘U’ for synchronisation to the voltage signal [*RST default value]
‘3’ or ‘I’ for synchronisation to the current signal
‘4’ or ‘XTRIG’ for synchronisation to the Extended trigger

10.2.15 Special commands

10.2.15.1 :GTL GTL

SCPI: :GTL /nquery/
SHORT: GTL/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Sets the instrument back to the local state (**g**o **t**o **l**ocal). This should be the last command of a remote control sequence

10.2.15.2 :LEN LEN

SCPI: :LEN/nquery/
SHORT: LEN/nquery/

ID:	n/a	Mode:	All
Type:	n/a	Suffix:	n/a
Value:	n/a	List:	n/a
Unit:	n/a	Group:	n/a

Initiates the LMGs remote state but adjustments made via the front panel keyboard of the meter will also be accepted (**l**ocal **en**able). It depends on the applications if it is useful or not.

10.2.16 Example 1

Following you find a small example for periodic data exchange via RS232 interface:

```
' QBasic 1.1
' Example for reading data from a LMG95
' LMG95 should be set to following:
' MEASURING Menu
' Normal measuring mode, 500ms cycle time
' IF/IO (OPTIONS) Menu
' Rmote Device: COM1 RS232
' Dev.: COM1: 9600 Baud, EOS <lf>, Echo off, Protocol None
' Connect COM1 of your PC to COM1 of LMG95 with a 1:1 cable (all pins
' connected, no NULL modem).
```

```
DECLARE FUNCTION readans$ ()

OPEN "COM1:9600,N,8,1,ASC,CD0,CS0,DS0,OP0,RS,TB2048,RB4096" FOR RANDOM AS #1
PRINT #1, "syst:lang short" + CHR$(10);    ' Change command set
PRINT #1, "actn;utrms?;itrms?" + CHR$(10); ' Request Utrms and Itrms
PRINT #1, "cont on" + CHR$(10);            ' Continue output
DO
   answer$ = readans$                      ' Read answer from LMG95
   val1 = VAL(answer$)                     ' Calculate values
   val2 = VAL(MID$(answer$, 1 + INSTR(1, answer$, ";")))
   PRINT USING "Answer:& Value1: ###.###V Value2: ##.#####A"; readans$; val1; val2
LOOP UNTIL INKEY$ = CHR$(32)               ' Loop, until SPACE bar pressed
PRINT #1, "cont off" + CHR$(10);           ' Stop continue output
SLEEP 1
PRINT #1, "gtl" + CHR$(10);               ' Go back to local mode
CLOSE #1

FUNCTION readans$
   answer$ = ""
   DO
      a$ = INPUT$(1, 1)                 ' Read character from interface
      IF a$ <> CHR$(10) THEN            ' If it is not the EOS character
         answer$ = answer$ + a$         ' add character to answer string
      END IF
   LOOP WHILE a$ <> CHR$(10)            ' Loop until EOS is reached
   readans$ = answer$                   ' return answer
END FUNCTION
```

10.2.17 Example 2

Following you find a small example for one time data exchange via RS232 interface.
Additionally to the SCPI commands you find the same functionality in SHORT syntax.

```
' QBasic 1.1
' Example for reading data from a LMG95
' LMG95 should be set to following:
' MEASURING Menu
' Normal measuring mode, 500ms cycle time
' IF/IO (OPTIONS) Menu
' Rmote Device: COM1 RS232
' Dev.: COM1: 9600 Baud, EOS <lf>, Echo off, Protocol None
' Connect COM1 of your PC to COM1 of LMG95 with a 1:1 cable (all pins
' connected, no NULL modem).

DECLARE FUNCTION readans$ ()

OPEN "COM1:9600,N,8,1,ASC,CD0,CS0,DS0,OP0,RS,TB2048,RB4096" FOR RANDOM AS #1
PRINT #1, "READ:CURRENT:TRMS;:FETCH:VOLTAGE:TRMS" + CHR$(10); 'Request values
(SCPI)
'PRINT #1, "SYST:LANG SHORT" + CHR$(10);       'Change Language to SHORT
'PRINT #1, "INIM;ITRMS?;UTRMS?" + CHR$(10);    'Request values (SHORT)
DO
   answer$ = readans$                      ' Read answer from LMG95
   val1 = VAL(answer$)                     ' Calculate values
   val2 = VAL(MID$(answer$, 1 + INSTR(1, answer$, ";")))
   PRINT USING "Answer:& Value1: ##.####A Value2: ###.###V"; readans$; val1; val2
LOOP UNTIL INKEY$ = CHR$(32)               ' Loop, until SPACE bar pressed
PRINT #1, "gtl" + CHR$(10);                ' Go back to local mode
CLOSE #1

FUNCTION readans$
   answer$ = ""
   DO
      a$ = INPUT$(1, 1)                 ' Read character from interface
      IF a$ <> CHR$(10) THEN            ' If it is not the EOS character
         answer$ = answer$ + a$         ' add character to answer string
      END IF
   LOOP WHILE a$ <> CHR$(10)            ' Loop until EOS is reached
   readans$ = answer$                   ' return answer
END FUNCTION
```

10.2.18 Testing the interface using a terminal program

For testing if the interface works, or how any commands work it is recommended to use a terminal program (e.g. Hyperterminal under WIN95).

Set-up the LMG450 pressing *IF/IO* several times until you reach the IF/IO menu. With **IF** you reach the set-up menu. If the instrument should be in the remote state switch it back to local by **Goto Local**. Choose the profile ‘ComA: Terminal’ and connect the ComA jack with a 1:1 cable to your PC.

Now set-up you computer. Start you terminal program and set it up to 9600Baud, 8Data Bit, 1Stop Bit, No Parity and No Protocol. Select the correct com port of your computer.

Now connect COM1 of your computer with COM A of the LMG95 with a 1:1 cable without any crossings or null modem functions.

If you now type in ‘*IDN?’ and press Return, the status bar of LMG95 should change from ‘Active Local’ to ‘Active Remote’. If not, check if the characters you typed in are echoed on your screen or not.

If everything is ok, then you get an answer string with the manufacturer, the device, the serial number and the software version.

If all this fails, check all settings and cables and try again.

10.2.19 SCPI command Example

This shows you as an example (in SCPI language), what you could send, what the instrument should answer and some comments about this. Some of the responses like measuring values depend on measured signals, so they may be different, if you try this examples. This examples work with a new powered on instrument (no commands before!). For testing some functions we recommend to use the RS232 interface, because it is much more simple to use than the IEEE interface. In principal the example works with both interfaces. This should help you to program your requests and to understand how to communicate with the instrument.

Two comments on the syntax in the ‘Send’ column: A ‘∪’ stands for a space character, a ‘↵‘ for the <cr> (carriage return) character (which is the enter key, if you use for example a RS232 terminal-program on your PC).

No.	Sent	Received	Comments
1	*rst↵		Reset the instrument to it’s default values. After this first command the instrument changes to the remote state.

No.	Sent	Received	Comments
2	*idn?↵	ZES ZIMMER Electronic Systems GmbH, LMG95, Serialnumber, Version	You ask the instrument for it's identification.
3a	fetc:volt:trms?↵	0	Reads out the voltage. You don't get the actual value, because there has been no values copied to the interface buffer
3b	read:volt:trms?↵	220.34	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage
3c	fetc:volt:trms?↵	220.34	No values were copied to the interface buffer, so you get the same result!
4a	read:volt:trms?;:read :curr:trms?↵	220.21;0.6437	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage. Then the instrument waits until the end of the next measuring cycle, copies the values to the interface buffer and outputs the actual current. The voltage and current are from **different** measuring cycles!!
4b	read:volt:trms?;:fetc: curr:trms?↵	221.13;0.6432	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage and current. The voltage and current are from the **same** measuring cycle!!
4c	read:volt:trms?↵ fetc:curr:trms?↵	217.75;0.6135	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage and current. The voltage and current are also from the **same** measuring cycle!!
5a	calc:form∪„Bpk=Urect/(4*f*3*0.0000916);↵ Hpk=Ipp/2*3/0.085608;↵ Ua=Bpk/1.2566e-6/Hpk;"↵		Enters the formula between the „" signs. This formula is stored in the formula editor and executed from the next measuring cycle.
5b	read:var?∪(0:1)↵	3.4567,2.8405	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the variables 0 to 1 (Bpk and Hpk). Both are from the **same** measuring cycle!!
6a	fetc:volt:trm?↵		You misspelled the request
6b	syst:err:all?↵	command header error:TRM	You ask the error queue what happened and get the answer. If you have misspelled more than this command, you get more answers.
7a	inst:sel∪1; *opc?↵		Switch to the CE harmonics mode

No.	Sent	Received	Comments
7b	read:harm:curr:ampl ?∪(3:5)↵	1.2346,00034,0.9984	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the amplitudes of the current harmonics of order 3 to 5. All are from the **same** measuring cycle!!
7c	inst:sel∪norml; *opc?↵		switch back to the normal measuring mode
8a	trig:act;:fetc:volt:trm s?;:fetc:pow?↵		Defines that the voltage and the power should be output after every measuring cycle, without any further request.
8b	init:cont∪on↵	220.34;15.345 220.19;15.217	Activates this continuous output of the values defined with 'actn'. (until the CONT OFF command!)
8c	init:cont∪off↵		stops the continuous output
9a	mem:fre∪on		freezes the scope memory
9b	sens:wav:iupd;:sens: wav:ssam?;:sens :wav:sbtr?;:sens:wav :satr?↵	56, -3204, +4506	calculates new information to the sampled values, reads which values are stored and how much values are stored before and after the trigger
9c	sens:wav:wave?∪5, (-100:100)↵	220.45, 221.36 ... (komma separated one dimensioned array with the size 201)	Reads out the sampled values of the voltage
9d	mem:fre∪off↵		deactivates the scope memory
10	gtl		Changes from the remote to the local state. So the instrument can be controlled manually

10.2.20 SHORT command Example

This shows you as an example (in SHORT language), what you could send, what the instrument should answer and some comments about this. Some of the responses like measuring values depend on measured signals, so they may be different, if you try this examples. This examples work with a new powered on instrument (no commands before!). For testing some functions we recommend to use the RS232 interface, because it is much more simple to use than the IEEE interface. In principal the example works with both interfaces. This should help you to program your requests and to understand how to communicate with the instrument.

Two comments on the syntax in the 'Send' column: A '∪' stands for a space character, a '↵' for the <cr> (carriage return) character (which is the enter key, if you use for example a RS232 terminal-program on your PC).

No.	Sent	Received	Comments

No.	Sent	Received	Comments
1	*rst↵		Reset the instrument to it’s default values. After this first command the instrument changes to the remote state.
2	*idn?↵	ZES ZIMMER Electronic Systems GmbH, LMG95, Serialnumber, Version	You ask the instrument for it’s identification.
3	syst:lang short↵		Switch to the SHORT command set
4a	utrms?↵	0	Reads out the voltage. You don’t get the actual value, because there has been no values copied to the interface buffer
4b	inim;utrms?↵	220.34	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage
4c	utrms?↵	220.34	No values were copied to the interface buffer, so you get the same result!
5a	inim;utrms?;inim;itrms?↵	220.21;0.6437	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage. Then the instrument waits until the end of the next measuring cycle, copies the values to the interface buffer and outputs the actual current. The voltage and current are from **different** measuring cycles!!
5b	inim;utrms?;itrms?↵	221.13;0.6432	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage and current. The voltage and current are from the **same** measuring cycle!!
5c	inim;utrms?↵ itrms?↵	217.75;0.6135	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the actual voltage and current. The voltage and current are also from the **same** measuring cycle!!
6a	form◡„Bpk=Urect/(4*f*3*0.0000916);↵ Hpk=Ipp/2*3/0.085608;↵ Ua=Bpk/1.2566e-6/Hpk;“↵		Enters the formula between the „“ signs. This formula is stored in the formula editor and executed from the next measuring cycle.
6b	inim;var?◡(0:1)↵	3.4567,2.8405	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the variables 0 to 1 (Bpk and Hpk). Both are from the **same** measuring cycle!!
7a	utrm?↵		You misspelled the request

No.	Sent	Received	Comments
7b	erall?↵	command header error:UTRM	You ask the error queue what happened and get the answer. If you have misspelled more than this command, you get more answers.
8a	mode∪1; *opc?↵		Switch to the CE harmonics mode
8b	INIM;HIAM?∪(3:5)↵	1.2346,00034,0.9984	Waits until the end of the measuring cycle, copies the values to the interface buffer and outputs the amplitudes of the current harmonics of order 3 to 5. All are from the **same** measuring cycle!!
8c	mode∪norml↵		switch back to the normal measuring mode
9a	actn;utrms?;p?↵		Defines that the voltage and the power should be output after every measuring cycle, without any further request.
9b	cont∪on↵	220.34;15.345 220.19;15.217	Activates this continuous output of the values defined with ‘actn’. (until the CONT OFF command!)
9c	cont∪off↵		stops the continuous output.
10a	frz∪on		freezes the scope memory
10b	sact;ssam?; sbtr?;satr?↵	56, -3204, +4506	calculates new information to the sampled values, reads which values are stored and how much values are stored before and after the trigger
10c	wave?∪5, (-100:100)↵	220.45, 221.36 ... (colon separated one dimensioned array with the size 201)	Reads out the sampled values of the voltage
10d	frz∪off↵		deactivates the scope memory
11	gtl		Changes from remote to the local state. So the instrument can be controlled manually

10.3 Physical devices

The physical devices are the jacks at the rear panel of the instrument.

10.3.1 COM A, RS232

At older instruments this jack was called ‘COM1’. To prevent confusion with the PC side name of this connector it is now ‘ComA’. In this jack a null modem is implemented. That means if you want to connect ComA of the LMG95 to a PC you have to use a cable which connects 1:1 (without a null modem function).

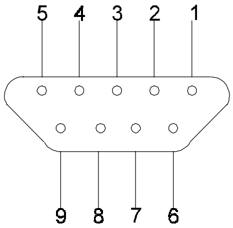


Figure 32: ComA connector

Pin	1	2	3	4	5	6	7	8	9
Comment	nc	TxD	RxD	nc	GND	nc	CTS	RTS	nc

10.3.2 COM B, RS232

At older instruments this jack was called ‘COM2’. To prevent confusion with the PC side name of this connector it is now ‘ComB’. In this jack no null modem is implemented. That means if you want to connect ComB of the LMG95 to a PC you have to use a cable with null modem function.

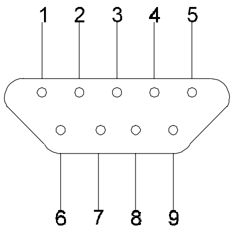


Figure 33: ComB connector

Pin	1	2	3	4	5	6	7	8	9
Comment	DCD	RxD	TxD	DTR	GND	DSR	RTS	CTS	RI

10.3.3 IEEE488.2

This port has the pinout defined in the standard IEEE488. You can use the standard cables.

10.3.4 Parallel Port

This port has the same pinout like a PC parallel port. You can use the same cables.

10.3.5 Set-up using DIP switches

Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
IEEE	1	0	1	Mode								IEEE Address				
other	Device			Mode				Echo	Protocol		EOS			Baud		

For the remote control the set-up of the physical device can be done with the DIP switches at the rear of the instrument. This setting are set-up each time the instrument powers up. They can be changed in the menus while the instrument is working. When switching on again, the DIP switch settings are used again! The ‘on’ position is equal to ‘1’.

Device

Bit 16	Bit 15	Bit 14	
0	0	0	**Set-up only from menu. All other switches are ignored. This should be chosen if you only want to set-up the interface from the menu.**
0	0	1	Select COM A
0	1	1	Select COM B
1	0	1	Select IEEE488 port

Mode

Bit 13	Bit 12	
0	0	Local mode
1	0	Remote mode. The instrument starts up in remote mode and can’t be handled from the front side at all!

Echo

Bit 9	
0	Echo off
1	Echo on

Protocol

Bit 8	Bit 7	
0	0	No Protocol
0	1	RTS/CTS

EOS

Bit 6	Bit 5	Bit 4	
0	0	0	<lf>
0	0	1	<cr>
0	1	0	<cr><lf>
0	1	1	Terminal

Baud

Bit			
3	2	1	
0	0	0	1200
0	0	1	2400
0	1	0	4800
0	1	1	9600
1	0	0	19200
1	0	1	38400
1	1	0	57600
1	1	1	115200

IEEE Address

Here you have to specify the IEEE address from 1 to 30 as binary number. For this you have to use the switches from 1 to 5. Switch 1 is the LSB, 5 the MSB.

11 Logging of values to drives, printer and interfaces(options L95-O1 and L95-O2)

All menus you see can be stored to a memory card, interfaces or can be printed out. In principal you get what you see. Some exceptions are described in the individual chapters (e.g. you get all harmonics, not only the visible). If you want to record in single mode you get the values you see. That means when you have frozen the display you get the frozen values. If you are in a periodic mode then you get the actual values, also if you have frozen the display.

The data logging is handled in a way that you have to press as few keys as possible to get the result: To output the measured values periodically or one time to an interface or storage media.

There are no menus where you have to choose the values you want to output. Choose just one of the available menus and press *Print/Log.*

You get an dialog box where you can choose the destination of the logging (with **Dest.**). This can be a file, an interface or a printer.

Each single destination entry in this menu describes an output device and its most important setting. For storage media this is the file name, for the printer the printer type and for the interfaces the baud rate. This and other settings you can change at any time by pressing **Set.** Your changes are stored in so called ‘profiles’. This profiles are stored in the memory. They are just valid in their environment: If you change the baud rate of ComA for logging, the baud rate of ComA for remote control is not changed!

In the dialog box you see further on the state of the chosen destination device. For storage media you see here also the available size and the number of stored files. For printers you can get ‘printer ready’, ‘printer busy’ or ‘paper empty’.

11.1 Start of logging

The logging itself starts, if you close the dialog box with *Enter*. (if you press *Esc* you close the box without storing). In the status bar you get at the right side a red/green flashing log display while the logging is active.

If you want to output to a serial interface it could happen, that this interface is already reserved for remote control. In this case you are asked, if you want to change the usage of this interface from remote control to logging. If you say 'Yes' the usage is changed. Please make sure, that you don’t have any remote controlled data transfer before you press *Enter*.

11.2 End of logging

To stop an periodic output (one time outputs are stopped automatically) you have to press *Print/Log* again. By pressing *Enter* you stop the logging, with *Esc* you leave the dialog box

11.3 Logging profiles (output devices)

Following profiles are accessible after pressing **Dest.**:

Disk(Data): filename

Writes the data of the actual menu to the file ‘filename’. As default this is ‘LOG’, but you can choose any other name with up to 6 characters. This name is expanded by a two digit number which is incremented with each new logging. The extension is always '.DAT'. Some examples for filenames are (the number is generated by the LMG):

LOG00.DAT
LOG01.DAT
MYDAT05.DAT
MOTOR_01.DAT
MOTOR_02.DAT

If you want to know, which files already exist on a media, how much space is available or if you want to set-up anything press **Set.**

Here you can choose a new name for the next logging with **File**. By pressing **Mark*** you can mark/unmark files and delete them with **Del***. With **Clear Disk** you format a media.

Typ. lets you choose another output format (see 11.4, ‘Output formats’)

Caution
Do never remove the media, while a logging is in progress. This can corrupt the files and destroy your measuring results!

Disk(Scr): filename

Saves a screen shot of the displayed menu as a PCX file at the media. All settings are identical to ‘Disk(Data)’, except the **Typ.** is fixed to ‘PCX’.

ComA: baudrate

The measuring values are transferred in the chosen ‘Output as’ format via ComA with the displayed baud rate. With **Set** you can change baud rate, protocol or the format. For the connection to the PC you have to use a 1:1 cable.

ComB: baudrate

Same like ‘ComA: baudrate’, but another jack and you have to use a null-modem cable.

ComA: BMP2PC

If you don’t have a storage media but want to get screen shots, you can use this profile. Use our program BMP2PC (available on our homepage www.zes.com) and connect your PC with a 1:1 cable with ComA. Then you can transfer a screen shot to the PC and the receiving program stores it as a bitmap file.

Lpt: printer

On a connected printer you can output measuring values as well as hardcopies of the actual screen. The 'output as displayed' is pure text, so that you can connect almost every printer. For a graphical output you have to set-up the correct printer type. Due to the growing number of printers it’s not possible to write a driver for each type. So we implemented 5 generic drivers which can drive most available printers:

EPSON 9-Pin
EPSON ESP/P
EPSON ESP/P2
HP DeskJet
HP LaserJet

In case of any doubts please contact your local computer shop.

After pressing **Set** you can set-up the model (**Prn**) and the output format (**Output as**). Further on you can create a comment (**Rem**) which is also printed (see 11.5, ‘Remarks, header lines’).

Some models try to get a complete image of a page in their RAM before they start printing. Therefore you might think, the printer is not working, if you send it just some few lines.

It’s not a good idea to output a page after just few lines. Therefore we send as default no form feed to the printer. But you can change this with **At end**: instead of 'None' set-up 'paper out'. Or you can press **Page out** to do this manually, when you like.

11.3.1 Output intervals

With **Mode** you can set-up how often the values should be output:

every cycle — The values are periodically output after each measuring cycle. Please make sure, that the output device is fast enough!

periodic — The values are output after the interval you set up. The minimum time is 10s. After you have chosen 'periodic' you get this time in a highlighted box. If the value is ok, you press just *Enter*. If not press **Per.** and change it. Leave the box with *Enter*.

every integral — The output interval depends on the settings of the *Int. Time* menu. The outputs starts, if you have started an integration. For the different integration modes you get:

continuous	Output at end of measuring cycle
interval	One time output after the integration time is over.
periodic	Periodic after each integration time
summing	Output at end of measuring cycle

by script — The output is done, when the `print()` function in the script editor is called (see 4.4.3.2.7, ‘Functions’).

11.4 Output formats

Output as displayed

As default the values are output in the same position like at the display. A one-time output of default menu, 1st channel could look like this:

```
Itrms:1= 0.0270 A
Utrms:1= 0.1414 V
P:1=-0.004 W
Q:1= 0.000 var
S:1= 0.004 VA
PF:1= 0.9992
```

Output as table

At periodic output it is an advantage, if the values are ordered by time. To do this choose the 'table' format.

```
TYPE=NORMAL
DATE=18.06.2002
X0=13:22:43
DX= 500.00E-03
YCOL0=dt/s
YCOL1=Itrms:1/A
YCOL2=Utrms:1/V
YCOL3=P:1/W
YCOL4=Q:1/var
YCOL5=S:1/VA
YCOL6=PF:1/
```

```
DATA_ASCII=
0.0000E+00 0.0000E+00 135.26E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
500.00E-03 0.0000E+00 135.26E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
1.0000E+00 0.0000E+00 135.27E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
1.5000E+00 0.0000E+00 135.29E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
2.0000E+00 0.0000E+00 135.29E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
2.5000E+00 0.0000E+00 135.27E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
3.0000E+00 0.0000E+00 135.27E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
3.5000E+00 0.0000E+00 135.27E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
4.0000E+00 0.0000E+00 135.25E-03 0.0000E+00 0.0000E+00 0.0000E+00 -------
```

The measuring values are written in scientific format without identifier or unit into a table. By this it is very easy to load such data into for example EXCEL. Invalid values are marked as '-------'. Each line ends with <CR><LF>. The data itself begin after the ‘DATA ASCII=‘ identifier. The identifiers before it defines, which values are stored in which column, date and time of the storage, ...

All identifiers are described in 11.6, ‘Identifiers for table’.

The first column is always the time in seconds after the start of the logging. In general this is an integer multiple of the cycle time. In the harmonic and flicker modes you find here the number of signal periods which were used for analysis. So if you know the signal frequency you can calculate the real time (an exception is the Harm100 mode, because here the measuring has to be done with gaps!)

11.5 Remarks, header lines

At the start of each output (floppy disk, memory card, printer, ...) you can place several comment/header lines. When logging periodically, this header lines are just printed at the start of logging.

When editing this field (see 11.3, ‘Logging profiles (output devices)’) you can use a pre defined example with **Exmp**. You can modify and delete this example by **Edit**. If you have finished, press **End**.

You can see standard text and some special identifiers with a leading ‘$’. They will be replaced when logging the header by their real value. In the case of ‘$Cycle’ the real cycle time will be inserted at this position. You can select every identifier. For a list of this identifiers please refer chapter 10.2, ‘Commands’. The ‘ID’ field specifies the useable values. They are the same identifiers like for the formula editor.

If you log the *Default* menu with the example header you get following result:

```
My Company
Printed at 22.04.2003 14:22:13
Cycletime 500.00 ms
Voltage at channel 2: 136.99mV

Itrms:1  0.0320 A
Utrms:1  212.01 V
```

```
P:1     -0.14 W
Q:1      6.78 var
S:1      6.78 VA
PF:1     20.646 m
```

Like in the formula editor you can call the pre-defined lists (see chapter 4.5, ‘Entering identifiers, characters and text’). Just remember to use the ‘$’ in front of the identifier.

When „Output as table“ in front of each comment line a ‘REM’ is written to simplify evaluation.

11.6 Identifiers for table

On the one hand it is necessary to store all values without identifiers and units in a file to work without any problems with them on your PC.

If you would for example store the values ‘as displayed’ you would get following:

```
Itrms:1= 0.0247 A
Utrms:1= 210.40 V
P:1=-0.10 W
Q:1= 5.20 var
S:1= 5.20 VA
PF:1= 0.0194

Itrms:1= 0.0245 A
Utrms:1= 210.42 V
P:1=-0.10 W
Q:1= 5.15 var
S:1= 5.16 VA
PF:1= 0.0203
...
Itrms:1= 0.0246 A
Utrms:1= 210.47 V
P:1=-0.10 W
Q:1= 5.17 var
S:1= 5.17 VA
PF:1= 0.0193
```

To extract from this list all ‘Itrms:1’ values is for example in Excel not a simple job!

In the ‘output as table’ or ‘output as binary’ the values are grouped in columns, so it is very simple to import them into a program.

To have the information present, which column is filled with which value and in which unit, we have added an header. Here you find information about the stored data, ...

If you want to import such a file for example into EXCEL, you just can ignore the header.

Following identifiers exist:

DATA_ASCII= After the <CR><LF> closing this line, the ASCII data follow. Data from the same time are separated with one or more spaces, data from different times are separated with <CR><LF>. The valid data are stored in floating point format until end of file (EOF). Empty columns have <>, invalid values are represented by '--------'. The time in the first column is relative to the start time X= (see down).

DATE=dd.mm.yy Date when logging started.

DX=sec sec is the time between two loggings in seconds. This information is used with binary data to get the time between two sample values. DX is ignored when XN is set.

REMark Is the start of a comment. All characters including the closing YSEP belong to this comment.

TYPE= Specifies the type of stored values:
NORMAL or HARMONIC.

VAL_LEN=8 Defines how much bytes are used to define one value.

X0=hh.mm.ss The time when logging started.

YCOLnr=Value/Unit This command describes the data in the column nr in ASCII format. Value is identical to the normal screen display, unit is the physical dimension. In empty columns after the '=' a <CR><LF> follows

11.7 Storage media

Storage media are used to store single or periodic measuring data. The data format is equal to the data format of the serial or parallel interface. But this data are written immediately and evaluated later on.

Equivalent to a screen dump to a printer you can make a screen shot and store it in the popular PCX file format.

The LMG450 can have either a memory card drive or a floppy disk drive

11.7.1 Memory card drive

Also the memory card drives use the MSDOS (FAT) format. But they are much faster. And you can get memory cards with several Mbytes capacity.

A big advantage of memory cards is the immunity against electromagnetic distortions.

If you have a laptop with PCMCIA card (equal to PC card) drive you can read the memory card directly. For other PCs you can use external drives

11.7.1.1 Reading memory cards with a laptop

The used memory cards are SRAM cards according to the PCCard standard (identical to PCMCIA). On some laptops the memory card reader has to be configured first, to read memory cards. Please ask your computer supplier for details and check the user manual of the memory card reader.

A general description for WIN95/98

Open the file config.sys with an editor and add the following two lines at the end:

device=c:\windows\system\csmapper.sys
device=c:\windows\system\carddrv.exe /slot=n

n means the number of PCCard slots of the laptop. Check that both files csmapper.sys and carddrv.exe exist in the c:\windows\system directory.

Now restart the laptop with fitted memory card. The Windows Explorer will show the SRAM card as a separate drive.

11.8 Import of data into PC programs

To get the measuring values into your PC you have two possibilities: You can store them on a storage media or you can send them via the serial interface.

11.8.1 Data exchange via storage media

For the memory card you need a laptop with a free PCMCIA (PC-Card) slot or an external card reader. ZES also offers such card readers.

11.8.2 Data exchange via serial interface

For this you just need a 1:1 cable (or a null modem cable if you are using ComB) and an installed terminal program. On each Windows PC you should have the program ‘Hyperterm’ already installed.

1. Start Hyperterm and enter any name for the new connection.
2. Choose the COM port which is connected to your PC.
3. Set up this port with following parameters:

Baud rate	115200
Databit	8
Parity	None
Stopbit	1
Protocol	None

4. Hyperterm is now ready to receive data. To test the connection press *Print/Log* at LMG, choose ‘ComA: 115200’ as destination. If the baud rate should not be 115200 please set it via **Set.** If you are using ComB do the same for it..
   The mode should be set to 'one-time' and ‘output as table’.
5. Press *Enter* to start the transfer.
6. Hyperterm should now display the values. If not, check the correct ports, cable and all settings. Check also that Hyperterm is ‘on-line’. If not, open the connection.
7. Hyperterm receives correct data. You can save the following data into a file via menu ‘transfer’ and ‘save text’
8. Press at LMG *Print/Log* again and choose now 'every cycle'. Start logging with *Enter*.
   In Hyperterm you see now the received data which are stored in background.
9. To stop the logging press *Print/Log* and *Enter*.
10. Stop the recording of Hyperterm by closing the text file. If you open this file with any text editor you see the logged data.

11.8.3 Country dependent numbers

Float numbers are output with a dot '.' as decimal separator. This can cause problems, when your computer is set up to use ‘,’ as separator (like for example in Germany). In this case set up your operating system to use the dot ‘.’ as separator.

11.8.4 Reading data into EXCEL

First make sure, that the decimal separator is set up correctly. Then start Excel and load the file. Choose the number of lines Excel should skip to reject the header.

As column separator select a space.

Now the data from the file are read into Excel without any problems.

11.9 Error messages

Drive not ready

You have chosen a storage media as destination, but this media is not plugged in. Press *Esc* until the message vanishes. Choose another destination or insert the storage media

Operation not permitted

An error occurred while storing. For example the storage media was removed.

Output device too slow - stopped!

The chosen output device is too slow to handle the data in real time. In this case the logging is stopped. Press *Esc* until the message vanishes. Choose a faster output device or reduce the data volume for example by choosing a longer cycle time.

All values until this message are stored correctly.

12 Miscellaneous

12.1 Frequent asked questions

12.1.1 Accuracy of measured and computed values

The accuracy of the directly measured values I, U and P can be found in the tables in 13.4.3 ‘Accuracy’. The following calculations illustrate how to use these tables and how to calculate the error for other values (λ).

The read value of device should be:
U_{trms}=230.000V, range 250V, peak range 400V
I_{trms}=0.95000A, range 1.2A, peak range 3.75A
λ=0.25000
f=50.0000Hz
P=54.625W, range 300W, peak range 1500W
AC coupling mode for the signal

From the table for the general accuracies, the following errors for voltage and current can be determined (using the peak values of the respective measuring range):

$$\Delta U = \pm(0.01\% \text{ of } Rdg. + 0.02\% \text{ of } Rng.) = \pm(0.023V + 0.08V) = \pm 0.103V$$

$$\Delta I = \pm(0.01\% \text{ of } Rdg. + 0.02\% \text{ of } Rng.) = \pm(0.095mA + 0.75mA) = \pm 0.845mA$$

$$\Delta P = \pm(0.015\% \text{ of } Rdg. + 0.02\% \text{ of } Rng.) = \pm(8.194mW + 300mW) = \pm 308.2mW$$

The power factor is computed as follows:

$$\lambda = \frac{P}{S} = \frac{P}{U * I}$$

The absolute maximum error for power factor is calculated corresponding to the rules of error computation using the total differential:

$$\Delta\lambda = \frac{\partial\lambda}{\partial P} * \Delta P + \frac{\partial\lambda}{\partial U} * \Delta U + \frac{\partial\lambda}{\partial I} * \Delta I$$

$$\Delta\lambda = \frac{\Delta P}{U * I} - \frac{P * \Delta U}{I * U^2} - \frac{P * \Delta I}{I^2 * U}$$

$$\Delta\lambda = \frac{308.2mW}{230V * 0.95A} - \frac{54.625W * 0.103V}{0.95A * (230V)^2} - \frac{54.625W * 0.845mA}{(0.95A)^2 * 230V}$$

$\Delta\lambda = 0.00107$

This is the absolute maximum error (worst case) that can occur in the calculation of the power factor. The typical error is two to five times better!

The relative measuring errors are:

$$U\%_{measure} = \frac{\Delta U}{U} = 0.045\%$$

$$I\%_{measure} = \frac{\Delta I}{I} = 0.089\%$$

$$P\%_{measure} = \frac{\Delta P}{P} = 0.564\%$$

$$\lambda\%_{measure} = \frac{\Delta\lambda}{\lambda} = 0.44\%$$

To get the real error, the inaccuracy of display (1 digit) has to be taken into account:

$$U\%_{display} = \frac{0.001V}{230.0V} = 0.0004\%$$

$$I\%_{display} = \frac{0.00001A}{0.95A} = 0.001\%$$

$$P\%_{display} = \frac{0.001W}{54.625W} = 0.002\%$$

$$\lambda\%_{display} = \frac{0.00001}{0.25} = 0.004\%$$

This results in the following measuring values:

U_{trms} = (230.000 ± 0.103)V
I_{trms} = (0.95000 ± 0.00085)A
P = (54.625 ± 0.308)W
λ = 0.25000 ± 0.00107

When using the AC+DC coupling instead of the AC coupling, you get different errors. In this case you might get an additional DC current of ΔI_{DC}=±(10µV/Ri)= ±(10µV/5mΩ)=±2mA. This error influences the TRMS value in the following way:

$$I_{trms} = \sqrt{I_{ac}^2 + I_{dc}^2}$$

$$\Delta I_{trms} = \pm\left(\frac{\partial I_{trms}}{\partial I_{ac}} * \Delta I_{ac} + \frac{\partial I_{trms}}{\partial I_{dc}} * \Delta I_{dc}\right)$$

$$\Delta I_{trms} = \pm\left(\frac{I_{ac}}{I_{trms}} * \Delta I_{ac} + \frac{I_{dc}}{I_{trms}} * \Delta I_{dc}\right)$$

With a reading of I_{dc}=0.00112A you get:

$$\Delta I_{trms} = \pm\left(\frac{0.95A}{0.95A} * 0.845mA + \frac{1.12mA}{0.95A} * 2mA\right) = \pm 0.847mA$$

For the active power you have an additional error of ±(10µV²/Ri/V_{DC})=
±(10µV²/5mΩ/V_{DC})=±2mW/V_{dc}. So with a reading of U_{DC}=0.013V you get a total error of

$$\Delta P_{tot} = \pm\left(\Delta P + 2\frac{mW}{V} * U_{DC}\right) = \pm\left(308.2mW + 2\frac{mW}{V} * 13mV\right) = \pm 308.226mW$$

For the apparent power you get:

$$\Delta S = \pm\left(\frac{\partial S}{\partial U} * \Delta U + \frac{\partial S}{\partial I} * \Delta I\right)$$

$$\Delta S = \pm(I * \Delta U + U * \Delta I) = \pm(0.95A * 0.103V + 230V * 0.847mA) = \pm 292.66mVA$$

Please note that in this case you have to use ΔI_{trms} for ΔI!

12.1.2 Accuracy of non sinusoidal signals

The standard accuracies are just given for sinusoidal signals. The reason is, that the national standards usually work just with sinusoidal signals.

To estimate the error of non sinusoidal signals you can use the following system.

Let’s assume you want to measure a square signal with 5V peak value, 50% duty cycle, no DC value and a frequency of 100Hz.

First the signal has to be divided into its frequency components. Then the errors of the rms-values of each frequency component have to be calculated. The used error is the standard error of reading at the specific frequency according to the technical specification. All these errors have to be added geometrically (because they are rms values with different frequencies). Further on you have to add the error of the measuring range of the fundamental once (once because it includes common errors like offset, ...). With this sum you can calculate the total error.
The values in the columns of the following table are:

Frequency (f / Hz)
rms value at this frequency (U / V)
Percentage error of frequency component according to technical data (% of value)

- Absolute error of frequency component (ΔU / mV)

f / Hz	U / V	Error in % of U	Error ΔU / mV
100	4.501	0.015	0.675
300	1.500	0.015	0.225
500	0.900	0.015	0.135
700	0.636	0.015	0.095
900	0.499	0.015	0.074
1100	0.408	0.03	0.122
1300	0.346	0.03	0.104
1500	0.300	0.03	0.090

For this example only the harmonics from 1 (100Hz) to 15 (1500Hz) have been used. Harmonics of a higher order cause just barely greater errors not affecting the total error very much like shown in the table.

The geometrical sum of all errors results in an error of 0.757mV.

To that you have to add the error of the range (0.03% of 12.5V (peak-value) = 3.75mV).

The total error is 4.507mV which is 0.09% of 5V.

12.1.3 Accuracy with external sensors

If you are using external sensors you have additional errors in your measuring path. The calculations illustrate how to calculate the errors of U, I or P when using an external sensor.

The clamp with which is measured is the LMG-Z322 with an accuracy of:

	Amplitude error at 30Hz-10.000Hz (% of reading)	Phase difference
Current (10A...200A)	±1.5%	2°
Current (200A...1000A)	±0.75%	0.75°
Current (1000A...1200A)	±0.5%	0.5°

Ratio of 1000:1.

At the I channel we are using a scaling of 1000 to get the correct currents at the display. In the following examples all values are calculated for the primary side, what means on measured signal level. The readings are:

U_{trms}: 230.000V, range 250V ⇒ range peak value 400V
I_{trms}: 400.000A primary ⇒ 0.4A secondary; range 600mA ⇒ range peak value 1875mA
calculated back to the primary side: range 600A ⇒ range peak value 1875A
f: 50Hz
φ: 45° (voltage and current are sinusoidal)
P: 64.054kW, range 150kW ⇒ range peak value 750kW
AC coupling mode for the signal is selected (what means you have no errors because of the DC offset of the signal).

From the technical data the following errors of the LMG itself for voltage and current can be determined (using the peak values of the respective measuring range):

$$\Delta U = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.023V + 0.08V) = \pm 0.103V$$

$$\Delta I_{LMG95} = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.04A + 0.375A) = \pm 0.415A$$

$$\Delta P_{LMG95} = \pm(0.015\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.010kW + 0.150kW) = \pm 0.160kW$$

Additional to these three errors there is the error caused by the current clamp. First the amplitude error which will be added to the ΔI_{LMG95}:

$$\Delta I_{clamp} = \pm(0.75\%\ \text{of rdg.}) = \pm 3A$$

So you get a total current error of:

$$\Delta I_{total} = \Delta I_{LMG95} + \Delta I_{clamp} = \pm 3.415A$$

The second error which is caused by the clamp is the error of the additional phase shift of 0.75°. This error will influence the active power. In this example the power can be calculated as:

$$P = U * I * \cos\varphi$$

So the total differential gives you the error:

$$\Delta P_{clamp} = \left|\frac{\partial P}{\partial U} * \Delta U\right| + \left|\frac{\partial P}{\partial I} * \Delta I\right| + \left|\frac{\partial P}{\partial \varphi} * \Delta\varphi\right|$$

you get:

$$\Delta P_{clamp} = \left|I * \cos\varphi * \Delta U\right| + \left|U * \cos\varphi * \Delta I_{total}\right| + \left|-U * I * \sin\varphi * \Delta\varphi\right|$$

At this point only the errors of the clamp are used, the errors of the LMG are already calculated:

$$\Delta U = 0!$$
$$\Delta I = \Delta I_{clamp}$$
$$\Delta\varphi = \frac{0.75° * 2\pi}{360°} = 0.013 rad$$

For the angles you have to use the radiant: 45° = $\frac{\pi}{4}$ rad

$$\Delta P_{clamp} = \left|400A * \cos\frac{\pi}{4} * 0V\right| + \left|230V * \cos\frac{\pi}{4} * 3\text{A}\right| + \left|-230\text{V} * 400\text{A} * \sin\frac{\pi}{4} * 0.013\right|$$
$$= |0W| + |487.90W| + |-845.70W| = 1333.6\text{W}$$

The amplitude error of the clamp causes 487.90W and the phase shift causes 845.70W power error.

The total error of the active power is:

$$\Delta P_{total} = \Delta P_{LMG95} + \Delta P_{clamp} = \pm(0.160kW + 1.334kW) = 1.494kW$$

The relative error of the active power is:

$$\Delta P_{relative} = \frac{\Delta P_{total}}{P} = 0.0233 \mathrel{\hat{=}} 2.33\%$$

Improving the accuracy

If you use a current clamp like in this example with a nominal current of 1000A and your current is only 40% what means 400A a simple trick to increase the accuracy is to wind the conductor several times through the clamp. In the example the accuracy of the clamp changes with three windings to 0.5%, because of the primary current of 1200A, the phase shift is 0.5°. The next example of calculation is done for three windings:

U_{trms}: 230.000V, range 250V ⇒ range peak value 400V

I_{trms}: Scaling $\frac{1000}{3} = 333.333$, what means all current values are divided by 3, <u>even the errors</u>! The ratio of the clamp stays at 1000:1!

Values: 1200.000A primary ⇒ 1.2A secondary; range 1.2A ⇒ range peak value 3.75A calculated back to the primary side: range 400A ⇒ range peak value 1250A f: 50Hz

φ: 45°

P: 64.054kW, range 100kW ⇒ range peak value 500kW

$$\Delta U = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.023V + 0.08V) = \pm 0.103V$$

$$\Delta I_{LMG95} = \pm(0.01\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.04A + 0.25A) = \pm 0.29A$$

$$\Delta P_{LMG95} = \pm(0.015\%\ of\ Rdg. + 0.02\%\ of\ Rng.) = \pm(0.010kW + 0.100kW) = \pm 0.110kW$$

$\Delta I_{clamp} = \pm(0.5\%\ \text{of primary current} = \text{in this case the "reading"}) = \pm 6A$, now with the scaling this error is divided by 3 as well, what means:

$$\Delta I_{clamp} = \pm(0.75\%\ of\ Rdg.) = \pm 2A$$

$$\Delta I_{total} = \Delta I_{LMG95} + \Delta I_{clamp} = \pm 2.29A$$

Again the total differential has to be used, but now with following values:

$$\Delta U = 0!$$
$$\Delta I = \Delta I_{clamp}$$
$$\Delta\varphi = \frac{0.5° * 2\pi}{360°} = 0.009rad$$

With this the error of the clamp for active power is:

$$\Delta P_{clamp} = \left|400A * \cos\frac{\pi}{4} * 0V\right| + \left|230V * \cos\frac{\pi}{4} * 2\text{A}\right| + \left|-230\text{V} * 400\text{A} * \sin\frac{\pi}{4} * 0.009\right|$$
$$= |0W| + |325.27W| + |-585.48W| = 910.75\text{W}$$

$$\Delta P_{total} = \Delta P_{LMG95} + \Delta P_{clamp} = \pm(0.110kW + 0.911kW) = 1.021kW$$

The relative error of the active power is:

$$\Delta P_{relative} = \frac{\Delta P_{total}}{P} = 0.016 \mathrel{\hat{=}} 1.6\%$$

With this simple trick the error of the current amplitude and the active power could be reduced by 30%!

12.2 Function fault

If you think you have found an error or function fault in a LMG95 please fill out the following page and send it to ZES. If you think the measuring result are wrong, please also fill out the second page. For this purpose connect the measuring circuit, freeze the screen with the values and fill out the paper with the frozen values.

On the attached CD you find a tool called ‘LMG CONFIG’. One feature of this tool is, that it can store all measuring values and a complete configuration in a report file. You can also use this tool to generate a function fault report.

Function fault at a LMG95

To:	From:
	Name:
Z E S ZIMMER Electronic Systems GmbH	Company:
Tabaksmühlenweg 30	Street:
61440 Oberursel	City:
Germany	Country:
Tel. ++49 (0)6171 / 628750	Tel:
Fax ++49 (0)6171 / 52086	Fax:

Information about the instrument:

Type Plate:

Serial number: ________________ Supply Voltage: ________________

IF/IO Menu (*Option* on older instruments): **List** detail

Program Version: ________________

Interface:	________________	Transient:	________________
Process Signal:	________________	extended memory:	________________
Flicker:	________________	SYS61K	________________
Harmonic 100:	________________	Term_L5	________________

mod. channel U:	________________	mod. channel I:	________________
500kHz:	________________	500kHz:	________________
mod. range	________________	mod. range	________________

Exact error description:

Range menu

U range:	________V	I range:	________A
U range:	auto/manual	I range:	auto/manual
U scale:	________	I scale:	________
		Shunt:	intern/extern

Measuring menu

Filter:	________
Couple:	________
SCoupl:	________
Sync:	________
Cycle:	________
Aver:	________

Voltage menu		Current menu		Power menu	
Utrms:	________	Itrms:	________	P:	________
Uac:	________	Iac:	________	Q:	________
Udc:	________	Idc:	________	S:	________
Upp:	________	Ipp:	________	PF:	________
Urect:	________	Irect:	________	f:	________
Ucf:	________	Icf:	________		
Uff:	________	Iff:	________		

If you have the interface option you can directly print out this menus.

12.3 Maintenance

12.3.1 Calibration

It is recommended that the calibration of the Precision Power Meter LMG95 will be performed with the manufacturer ZES ZIMMER. ZES ZIMMER has the necessary reference instruments traceable to national standards of the PTB (Physikalisch Technische Bundesanstalt in Braunschweig) according to ISO9000.

Especially, if a new adjustment is necessary or wanted by the customer, the instrument has to be sent back to the manufacturer for this purpose.
The adjustment is totally done by software, but this software runs only in combination with the special calibration means of the manufacturer.

12.3.1.1 Requirements for reference instruments

As generally known the references, calibration sources and/or reference power meters, have to be in an accuracy class, which is at least 3 time better than the LMG95. An optimal value is from 5 to 10 times better.

For the allowed error of the LMG to be calibrated please refer also to chapter 12.1.1, ‘Accuracy of measured and computed values’

12.3.2 Zero adjustment of the instrument

The DC components of the LMG95 can be adjusted without sending the instrument back to the factory. For this purpose remove **ALL** measuring cables from the instrument and switch to the normal measuring mode. Select internal or external current measurement ranges. Only the selected ones are adjusted. Now short circuit the voltage input (U* and U) and the external shunt input (Ext. shunt and I). Short circuit means, not to connect the inputs with any wire but to connect the as short as possible to get a minimised loop area!

Warm the instrument up for a minimum of 2h.

Now press **Z-Adj** in the *Range* menu (see 5.2 Measuring ranges (Range)).

Answer the warning with *Enter* if you have set-up the instrument correctly. After about 1 minute the instrument is adjusted and a message appears.

If you are in doubt about any detail of this adjustment please contact the manufacturer.

The adjustment is active, while the instrument is switched on. If you switch off and on the instrument, the factory values are loaded.

12.3.3 Battery

In the instrument is a lithium battery for holding several data. It should be checked after 8 years or when any problems occur.

12.3.4 Software update

The software of the LMG95 can be updated by the customer. You get the actual software from our homepage http://www.zes.com or directly by ZES. You need a PC and a serial cable to connect COM1 of your PC to the Service jack of the LMG95. It has to be a 1:1 cable without any crossings or null modem functions, where all wires are connected (see 12.3.5 'Service connector').

You get further information after starting the software.

Please note!
A software update will reset all setting to the default values. So if you want to keep for example formulas or similar, please write down the data or print them out.

12.3.5 Service connector

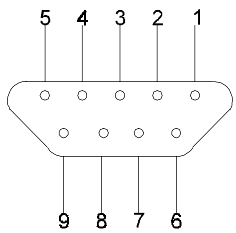


Figure 34: Service connector

Pin	1	2	3	4	5	6	7	8	9
Comment	nc	TxD	RxD	nc	GND	nc	CTS	RTS	nc

12.4 Use with an inverter

The power meters of the LMG series accord to the protection class 1. A use without an earthed protective conductor is not permitted. Inverters mostly have no protective conductor. In this case the LMG has to be wired with a protective conductor at the rear panel. Refer the safety rules of the working area.

13 Technical data

13.1 General

Display:	Monochrome display, resolution 256x128 Pixel
Mains supply:	90...250V, 45...65Hz, ca. 30W, Fuse 5x20mm T1A/250V IEC127-2/3
Storage temperature:	-20°C to +55°C
Safety:	EN61010-1:2001 Normal environmental condition: Indoor use, altitude up to 2000m, temperature 5°C to 40°C, maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C Mains supply: Measurement category II, pollution degree 2 Measuring inputs: Measurement category III, pollution degree 2 **Please note!** If you have another measurement category, the allowed voltages might change (see 0, ‘Figure 36: Dimensions of 1 HU instrument instrument Operating voltages’) IP20 according EN60529
EMC:	EN61326-1:2006 EN61000-3-2:2006 EN61000-3-3:1995+A1:2001+A5:2005
Dimensions:	Desktop: 320mm (W) x 148mm (H) x 275mm (D) 19“ rack: 63DU x 3HU x 315mm
Weight:	6.5kg

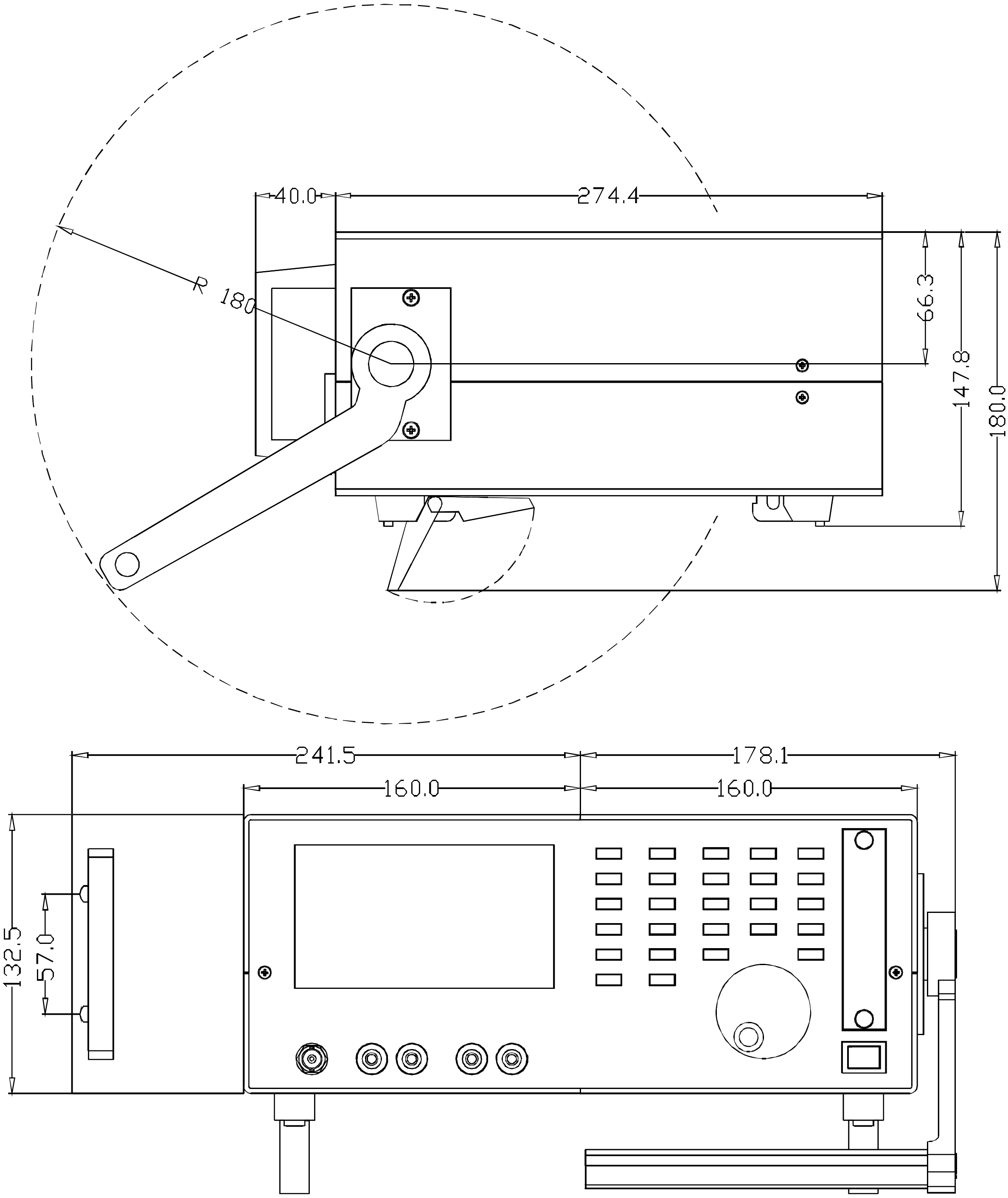


Figure 35: Dimensions of standard instrument

In the above picture you see the desktop instrument in combination with the rack mounting kit and the handle bar.

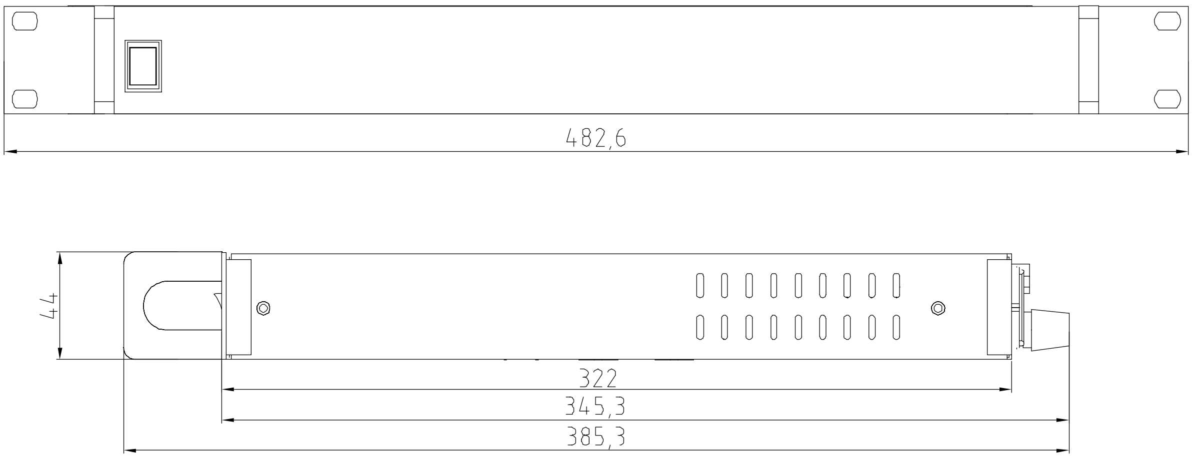


Figure 36: Dimensions of 1 HU instrument instrument

13.2 Operating voltages

The allowed operating voltage of the signals at the measuring inputs depends on the overvoltage category of the signals:

CAT II: Instruments with BNC connector:
Current inputs: 1000V
Voltage inputs: 1500V
Instruments without BNC connector:
Current inputs: 1500V
Voltage inputs: 1500V

CAT III: Instruments with BNC connector:
Current inputs: 600V
Voltage inputs: 1000V
Instruments without BNC connector:
Current inputs: 1000V
Voltage inputs: 1000V

13.3 Display of values

The measured values are displayed with 6 digits. The position of the decimal point is set to the position which is required to display the maximum allowed TRMS value.

If the TRMS value of a measuring channel is lower than 0.75% of the measurable TRMS value of the range, all channel values are displayed as 0.0. For example in the 0.15A current range you get values from 2.250mA...469.000mA and 0.000mA. This zero rejection can be switched off, see 4.4.1, ‘Misc.’

13.4 Standard measuring channel

13.4.1 Sampling

The sampling is done synchronously at all channels with about 100kHz per channel.

13.4.2 Ranges

Voltage ranges

Rated range value / V	6	12.5	25	60	130	250	400	600
Measurable TRMS value / V	7.2	14.4	30	60	130	270	560	720
Permissible peak value / V	12.5	25	50	100	200	400	800	1600

Overload capability 600V continuously, 1500V for 1s, max. $1.5*10^8$VHz

Input resistance 1MΩ, 23pF

Capacitance against earth 45pF

Common mode rejection >140dB (measured with 100V at 100kHz)

⚠ **Note!**
The 'Measurable TRMS value' is the biggest TRMS value which can be measured. That does not mean that it is allowed to measure with that value, if any security standards define other values!

Current ranges

Rated range value / A	0.15	0.3	0.6	1.2	2.5	5	10	20	120	240	480	960
Measurable TRMS value / A	0.3	0.6	1.3	2.6	5.2	10	21	21	21	21	21	21
Permissible peak value / A	0.469	0.938	1.875	3.75	7.5	15	30	60	120	240	480	960

Overload capability 24A continuously, 160A for 1s

Input resistance Ri 5mΩ

Capacitance against earth 51pF

Common mode rejection >150dB (measured with 100V at 100kHz)

Capacitance between U and I 5pF

Channel separation >140dB (measured with 100V at 100kHz)

Voltage inputs for current measuring with shunt / transducer

Rated range value / V	0.03	0.06	0.12	0.25	0.5	1	2	4
Measurable TRMS value / V	0.06	0.13	0.27	0.54	1	2	4	8
Permissible peak value / V	0.0977	0.1953	0.3906	0.7813	1.563	3.125	6.25	12.5

Overload capability 100V continuously, 250V for 1s

Input resistance 100kΩ, 28pF

Common mode rejection >134dB (measured with 100V at 100kHz)

13.4.3 Accuracy

An example, how to handle this values, you find in 12.1.1, ‘Accuracy of measured and computed values’

Measuring accuracy

The values are in ±(% of measuring value + % of measuring range)

Frequency/Hz	DC	0.05-15	15-45, 65-1k	45-65	1k-3k	3k-15k	15k-50k
Voltage	0.02+0.06	0.02+0.03	0.015+0.03	0.01+0.02	0.03...0.06	0.1+0.2	0.5+1.0
Current	0.02+0.07	0.02+0.03	0.015+0.03	0.01+0.02	0.03...0.06	0.1+0.2	0.5+1.0
Active Power	0.03+0.07	0.035+0.03	0.025+0.03	0.015+0.02	0.05...0.06	0.2+0.2	1.0+1.0

By this the phase error between voltage and current channel is <0.012° at 50Hz!

Accuracies based on:

1. sinusoidal voltages and currents
2. ambient temperature 23°C, no additional heating or cooling (i.e. by sunlight or current of air)
3. warm up time 1h
4. power range is the product of current and voltage range, $0 \leq |\lambda| \leq 1$
5. Voltage and current are ≥ 10% and ≤110% of rated range
6. calibration interval 1 year

Temperature effect: 0.01% of measuring value / K

Influence of coupling mode

Coupling AC: No influence

Coupling AC+DC, DC: Current: additional DC current of up to ±(10µV/Ri)

Active Power: additional DC error of $\pm(10\mu V^2/Ri/V_{DC})$

Ri is the input resistance of the current channel. This influence has to be taken into calculation, if you use the direct current input of a current channel!

13.5 500kHz version (option L95-O6)

13.5.1 Accuracy

An example, how to handle this values, you find in 12.1.1, ‘Accuracy of measured and computed values’

Measuring accuracy

The values are in ±(% of measuring value + % of measuring range)

Frequency/Hz	DC	0.05-15	15-45, 65-1k	45-65	1k-3k	3k-15k
Voltage	0.02+0.06	0.02+0.03	0.015+0.03	0.01+0.02	0.025...0.05	0.03+0.06
Current	0.02+0.07	0.02+0.03	0.015+0.03	0.01+0.02	0.025...0.05	0.03+0.06
Active Power	0.03+0.07	0.035+0.03	0.025+0.03	0.015+0.02	0.04...0.05	0.05+0.06

Frequency/Hz	15k-100k	100k-200k	200k-300k	300k-400k	400kHz-500kHz
Voltage	0.1+0.2	0.5+1.0	1.0+2.0	3.0+3.0	4.0+4.0
Current	0.1+0.2	0.5+1.0	1.0+2.0	3.0+3.0	4.0+4.0
Active Power	0.2+0.2	1.0+1.0	2.0+2.0	6.0+3.0	7.0+4.0

By this the phase error between voltage and current channel is <0.012° at 50Hz!

Accuracies based on:

1. sinusoidal voltages and currents
2. ambient temperature 23°C, no additional heating or cooling (i.e. by sunlight or current of air)
3. warm up time 1h
4. power range is the product of current and voltage range, $0 \leq |\lambda| \leq 1$
5. Voltage and current are ≥ 10% and ≤110% of rated range
6. calibration interval 1 year

Temperature effect: 0.01% of measuring value / K

Influence of coupling mode

Coupling AC: No influence

Coupling AC+DC, DC: Current: additional DC current of up to ±(10µV/Ri)
Active Power: additional DC error of $\pm(10\mu V^2/Ri/U_{DC})$
Ri is the input resistance of the current channel. This influence has to be taken into calculation, if you use the direct current input of a current channel!

13.6 Special modified channels (options L95-O7 and L95-O8)

13.6.1 3V Channel

Instead of the standard 600V voltage channel we can implement this channel with following technical data:

Rated range value / V	0.025	0.05	0.1	0.2	0.4	0.8	1.5	3
Measurable TRMS value / V	0.03	0.06	0.12	0.24	0.48	0.96	1.8	3.6
Permissible peak value / V	0.049	0.098	0.195	0.391	0.781	1.563	3.125	6.25

Overload capability 100V continuously, 250V for 1s

Input resistance 100kΩ, 70pF

13.6.2 12V Channel

Instead of the standard 600V voltage channel we can implement this channel with following technical data:

Rated range value / V	0.1	0.2	0.4	0.8	1.5	3	6	12
Measurable TRMS value / V	0.16	0.33	0.67	1.33	2.5	5	10	20
Permissible peak value / V	0.24	0.47	0.94	1.88	3.75	7.5	15	30

Overload capability 100V continuously, 250V for 1s

Input resistance 100kΩ, 70pF

13.6.3 60V Channel

Instead of the standard 600V voltage channel we can implement this channel with following technical data:

Rated range value / V	0.4	0.8	1.5	3	6	12	25	60
Measurable TRMS value / V	0.48	0.96	1.8	3.6	7.2	14.4	30	60
Permissible peak value / V	0.781	1.563	3.125	6.25	12.5	25	50	100

Overload capability 250V continuously, 600V for 1s

Input resistance 330kΩ, 40pF

13.6.4 650V Channel

Rated range value / V	12.5	25	60	130	250	400	600	650
Measurable TRMS value / V	14.4	30	60	130	270	560	720	1000
Permissible peak value / V	25	50	100	200	400	800	1600	3200

Overload capability 1000V continuously, 1500V for 1s

Input resistance 2MΩ, 14pF

13.6.5 80mA Channel

Instead of the standard 960A current channel we can implement this channel with following technical data:

Rated range value / mA	0.6	1.2	2.5	5	10	20	40	80	500	1000	2000	4000
Measurable TRMS value / mA	1.2	2.4	5	10	20	40	80	160	320	640	800	800
Permissible peak value / mA	2	4	8	16	32	65	130	250	500	1000	2000	4000

Overload capability 0.8A continuously, 2A for 1s

Input resistance Ri 0.5Ω

13.6.6 1.2A Channel

Instead of the standard 960A current channel we can implement this channel with following technical data:

Rated range value / A	0.01	0.02	0.04	0.08	0.15	0.3	0.6	1.2	7.5	15	30	60
Measurable TRMS value / A	0.02	0.04	0.08	0.16	0.3	0.6	1.3	2.0	2.0	2.0	2.0	2.0
Permissible peak value / A	0.0293	0.0585	0.1171	0.2343	0.469	0.938	1.875	3.75	7.5	15	30	60

Overload capability 2A continuously, 5A for 1s

Input resistance Ri 0.1Ω

13.6.7 5A Channel

Instead of the standard 960A current channel we can implement this channel with following technical data:

Rated range value / A	0.04	0.08	0.15	0.3	0.6	1.2	2.5	5	30	60	120	240
Measurable TRMS value / A	0.08	0.16	0.3	0.6	1.3	2.6	5	6	6	6	6	6
Permissible peak value / A	0.1171	0.2343	0.469	0.938	1.875	3.75	7.5	15	30	60	120	240

Overload capability 6A continuously, 15A for 1s

Input resistance Ri 20mΩ

13.7 Filter

13.7.1 HF-Rejection filter (HF-Rej)

The analogue HF-Rejection filter has the following characteristics:

Frequency / Hz	Rejection / dB
10	0.0019
20	0.0005
50	0
100	-0.0004
200	-0.0014
500	-0.0086
1000	-0.0319
2000	-0.1459
5000	-0.8350
10000	-3.16
20000	-14.45
50000	-49.45

13.8 CE Harmonics

Relative deviation between f_1 and frequency f_{syn}, to which the sampling rate is synchronised is <0.015% of f_1 under steady-state conditions. The attenuation of HF-Rejection filter is >50dB.

Accuracy

According EN61000-4-7 Ed. 2.0:

U:	$U_m \geq 1\% U_{nom}$:	$\pm 5\% U_m$
	$U_m < 1\% U_{nom}$:	$\pm 0.05\% U_{nom}$
I:	$I_m \geq 3\% I_{nom}$:	$\pm 5\% I_m$
	$I_m < 3\% I_{nom}$:	$\pm 0.15\% I_{nom}$

With
m = measuring value
nom = nominal value of the range

Please note

The influence of the HF-Rejection filter is compensated for the amplitudes of the harmonics. The values for U, I and P are not recalculated from the harmonics, but are calculated from the sampling values to get for example interharmonics. So it is not possible to compensate the influence of the filters for this values!

13.9 CE Flicker

Accuracy

Flickermeter: ±5% according EN61000-4-15

d-meter: ±0.15% of nominal voltage according to EN61000-3-3

13.10 HARM100 Mode

Amplitude error

The error of the harmonic with the biggest amount H_{max} (usually the fundamental) and of the DC part (H_{00}) is calculated as if each part is measured alone (refer error specifications of the normal measuring mode).

The errors of the harmonics (H_{01}, H_{02}, ...) except H_{max} is calculated as follows:

$\pm(0.5 * error_{Hmax} + 0.02\%$ from $H_{max}/kHz)$

This errors are valid if the amplitude of the harmonics are higher than 0.1% of the full scale peak value.

Phase error

±(0.15° + 0.25° / kHz)

This errors are valid if the amplitude of the harmonics are higher than 0.1% of the full scale peak value.

13.11 Processing signal interface (option L95-O3)

The following functional groups are isolated against each other (for details please refer 14.7, ‘Functional block diagram processing signal interface’). The allowed working voltage is 25V between the groups. The testing voltage is 500V. The analogue inputs and outputs have nominal ±10V signal range, but in fact they are able to handle 11V resp. 12V.

- Four analogue outputs with ±10V. The outputs are updated with each measuring cycle for normal values or with the sampling rate for sample values. So this option can be used as a measuring converter. The four analogue outputs have one common ground (AOut_GND) which is isolated from all other grounds.

- Four analogue inputs with ±10V. This values are displayed after each measuring cycle. The four analogue inputs have one common ground (AIn_GND) which is isolated from all other grounds.

- Four digital outputs (open collector outputs). They are updated with each measuring cycle. The four digital outputs have one common ground (DOut_GND)which is isolated from all other grounds.

- Four digital inputs. The four digital inputs have one common ground (DIn_GND)which is isolated from all other grounds.

- Two frequency inputs. They can measure frequency and direction of a rotation speed converter. The two frequency inputs have one common ground which is isolated from all other grounds but common to the ground of the auxiliary supply (Aux_F_GND). F_In1 is used to measure the frequency, F_In2 to detect the direction.

- One auxiliary supply. Here you can get an auxiliary voltage of ±5V. The ground is common with the ground of the frequency inputs (Aux_F_GND).

The connector has the following pinout:

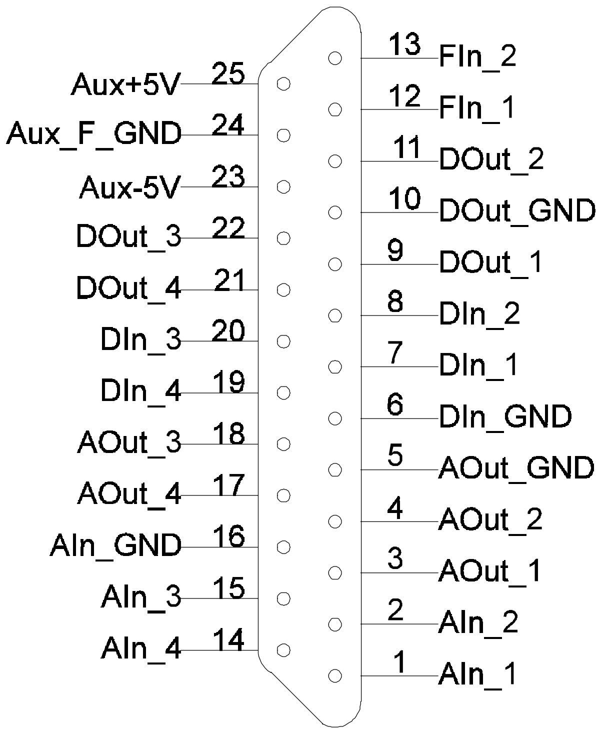


Figure 37: Processing Signal Interface Connector

For information how to set-up this values see 4.4.2.2, ‘Processing signal interface’.

13.11.1 Analogue inputs

Resolution: 16Bit

Accuracy: ±(0.05% of measuring value + 0.05% of full scale)

Input signal: ±12V

Overload capability: -25...+25V

Input resistance: 100kΩ

13.11.2 Analogue outputs

Update rate: 100kHz

Resolution: 16Bit

Accuracy: ±(0.05% of measuring value + 0.05% of full scale)

Output signal: ±11V

Output load: load resistance > 2kΩ

13.11.3 Digital inputs

Input signal: U_{low}max=1V, U_{high}min=4V@2mA, U_{high}max=60V@3mA

13.11.4 Frequency inputs

Input signal: U_{low}max=1V, U_{high}min=4V, U_{high}max=10V

Input resistance: 1MΩ

Maximum frequency: 5MHz

Accuracy: ±100ppm of measuring value

13.11.5 Digital outputs

Open collector outputs, see 14.7, ‘Functional block diagram processing signal interface’

Output high impedance: max 30V@100µA

Output low impedance: max. 1.5V@100mA

13.11.6 Auxiliary supply

Output voltage: ±5V, 10% @ 50mA

13.11.7 Frequency/direction input

Incremental sensors without direction information

Connect them to FIn_1 only. Let FIn_2 open!

Incremental sensors with direction information

Connect the frequency track (usually track A) to FIn_1.

Connect the direction track (usually track B) to FIn_2.

A positive frequency is displayed, if the direction signal is high at the rising edge of the frequency signal.

A negative frequency is displayed, if the direction signal is low at the rising edge of the frequency signal.

If this is opposite to what you want, change the tracks or use a negative frequency scaling.

13.12 Auxiliary transducer supply

This output delivers two voltages:

+15V, ±10%, I_{max}=0.4A

-15V, ±10%, I_{max}=0.2A

With a special cable you can directly supply a PSU600 current transducer. Do not use a 1:1 cable!

This output is protected by two fuses 5x20mm T1A/250V IEC127-2/3. They can be accessed, if you remove the bottom part of the case. They are placed near the auxiliary supply connector. Please **ignore** the text on the PCB which says that they are 0.5A fuses!

13.13 Timebase

The time base which controls the energy measuring and the internal clock has an accuracy of ±25ppm.

13.14 Frequency Measuring

0.05Hz...500kHz, ±100ppm of measuring value

13.15 Scope memory

Size: 65536 words for u, i and p together
With option L95-O11 or L95-O5 :
4194304 words for u, i and p together

14 System design

14.1 Further connectors

14.1.1 External Synchronisation (Sync.)

The sync connector has the following features:

- You can use it for the external synchronisation of the LMG95. For this purpose you can use the pins 1 and 2.
- You can use it for controlling and sensing the energy measurement. For this purpose you can use the pins 6, 7 and 9.

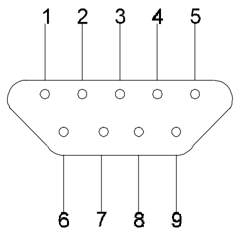


Figure 38: Sync. connector

Pin	Usage
1	Ground for external sync
2	+5V signalling input for external sync
6	Ground for Control
7	Control Out
9	Control In

The external sync is a 5V input which is used to synchronise the LMG95 to the signal. For this purpose the LMG95 uses the rising edge of this signal to simulate a positive zero crossing and the falling edge to simulate a negative zero crossing. The signal has to drive a LED with a series resistor of 1.5kΩ.

The ‘Control In’ is a 5V input which is used to control the energy measuring of the LMG95. The falling edge simulates a pressing of the *Start* button, the rising edge simulates a pressing of the *Stop* button (see 5.4.5.1 Integral menu). The signal has to drive a LED with a series resistor of 1.5kΩ.

The ‘Control Out’ is an open collector output. It is in the low impedance state while the LMG95 is integrating. Without integrating the output has high impedance.

14.1.2 Synchronisation with LMG310 (L31-L95-Z16)

To measure at the same time together with an LMG310 at one measuring object (e.g. efficiency of a frequency converter), the two instruments have to be set-up and connected in following way.

14.1.2.1 Connection

The master slave adapter L31-L95-Z16 is connected to the sync jack at LMG310. The added cable is used to connect the other end of the adapter to the sync jack of LMG95. Please note the direction of the adapter (the LMG310 side has to be connected to LMG310!).

14.1.2.2 Set-up

The LMG95 works as master, you don’t have to set-up something special. You should just use such cycle times which also exist in LMG310.

LMG310 is working as slave. Here you have to set-up in the measuring menu ‘single cycle’. The cycle time has to be the same like in LMG95. ‘Ext. Trigger’ has to be released.

For energy measurings the LMG95 mode ‘summing’ is equal to LMG310 mode ‘continuous’.

14.1.2.3 Synchronisation

Both instruments measure with the same cycle time (synchronous) as well as the same integration time.

To control an energy measuring you have to start/stop only the LMG95. Just the reset of the measuring has to be done independent at both instruments.

14.1.3 Auxiliary transducer supply

With this jack you can supply external current sensors (e.g. PSU600).

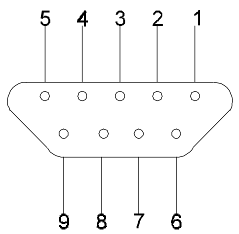


Figure 39: Supply of external current sensors

Pin	Usage
1, 2, 6	-15V
3, 7, 8	GND

Pin	Usage
4, 5, 9	+15V

You find the exact technical specification in chapter 13.11.7, ‘Frequency/direction input

Incremental sensors without direction information

Connect them to FIn_1 only. Let FIn_2 open!

Incremental sensors with direction information

Connect the frequency track (usually track A) to FIn_1.

Connect the direction track (usually track B) to FIn_2.

A positive frequency is displayed, if the direction signal is high at the rising edge of the frequency signal.

A negative frequency is displayed, if the direction signal is low at the rising edge of the frequency signal.

If this is opposite to what you want, change the tracks or use a negative frequency scaling.

Auxiliary transducer supply’.

14.2 Functional block diagram LMG95

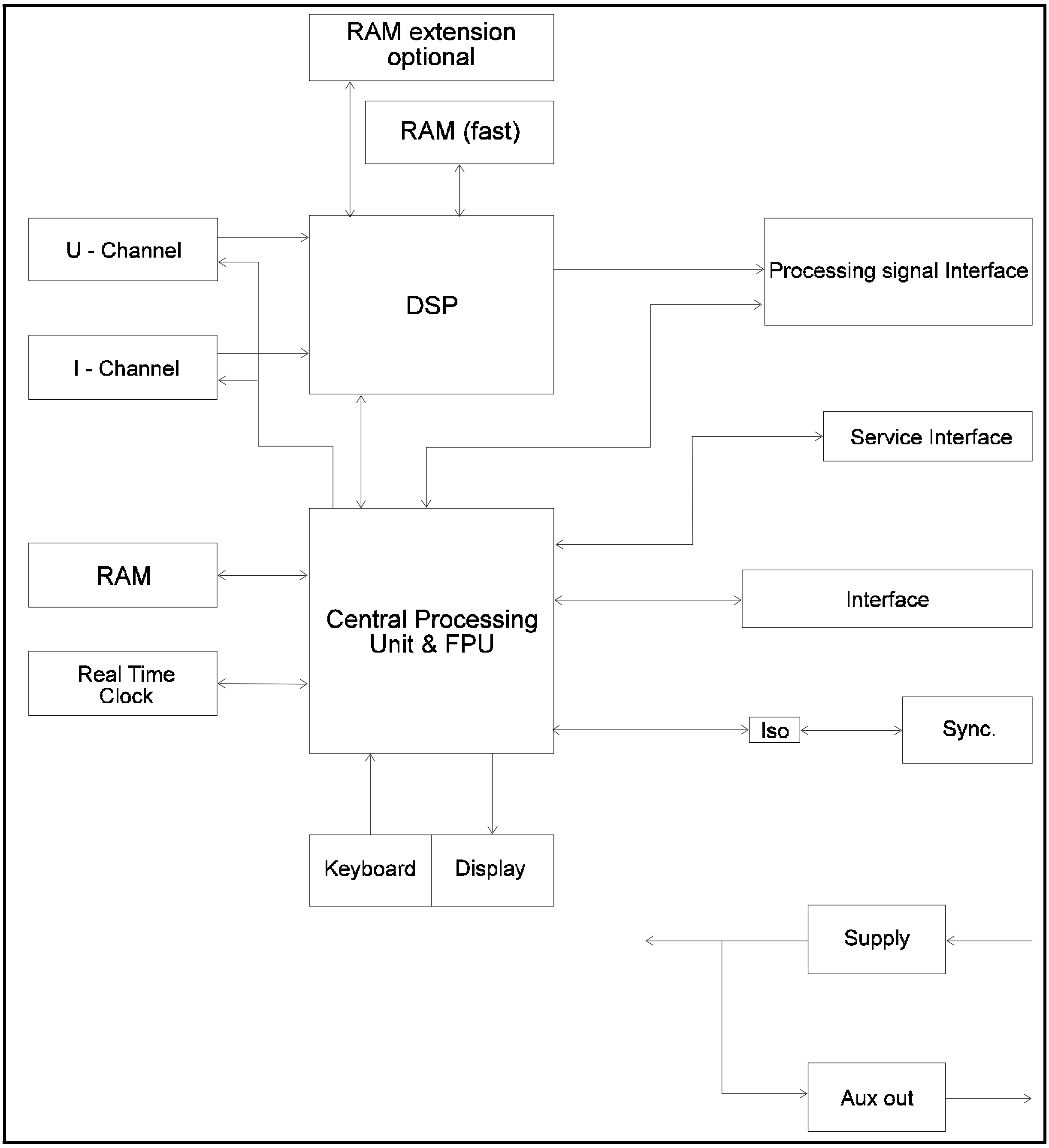


Figure 40: Functional block diagram LMG95

14.3 Functional block diagram voltage channel

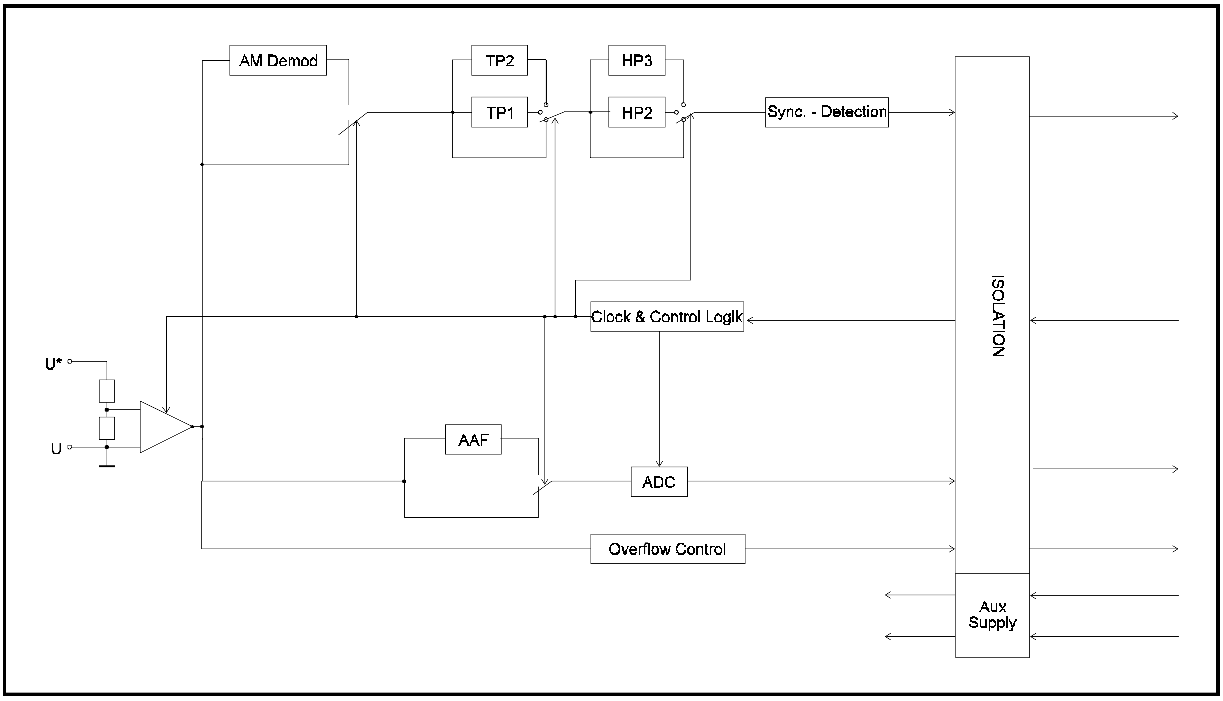


Figure 41: Functional block diagram voltage channel

14.4 Functional block diagram current channel

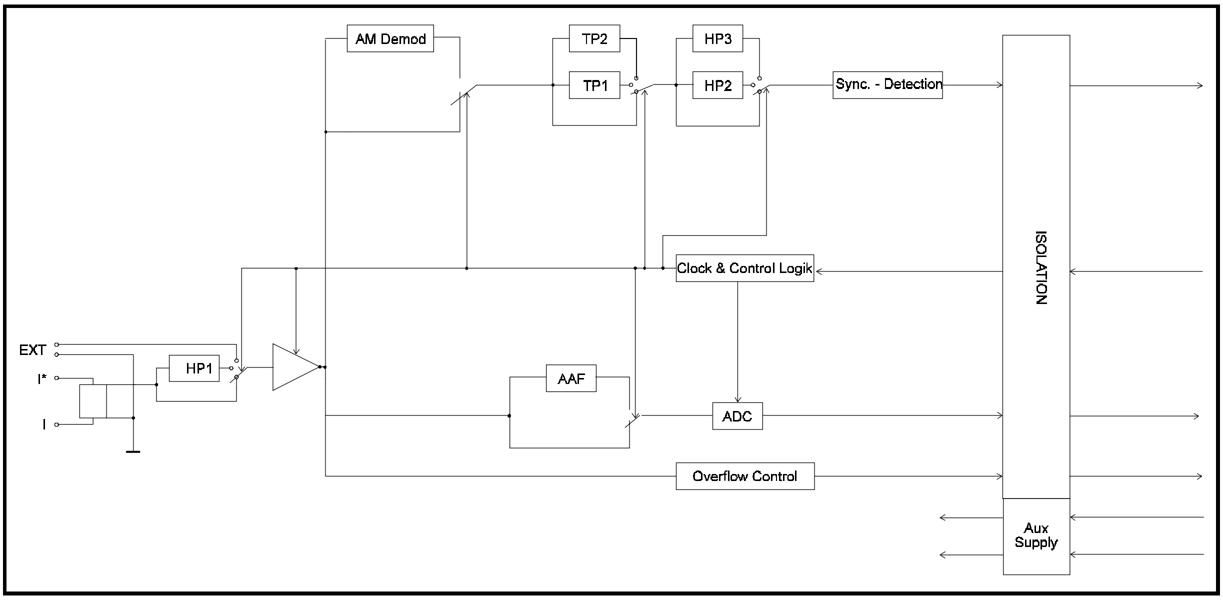


Figure 42: Functional block diagram current channel

14.5 Functional block diagram computing unit

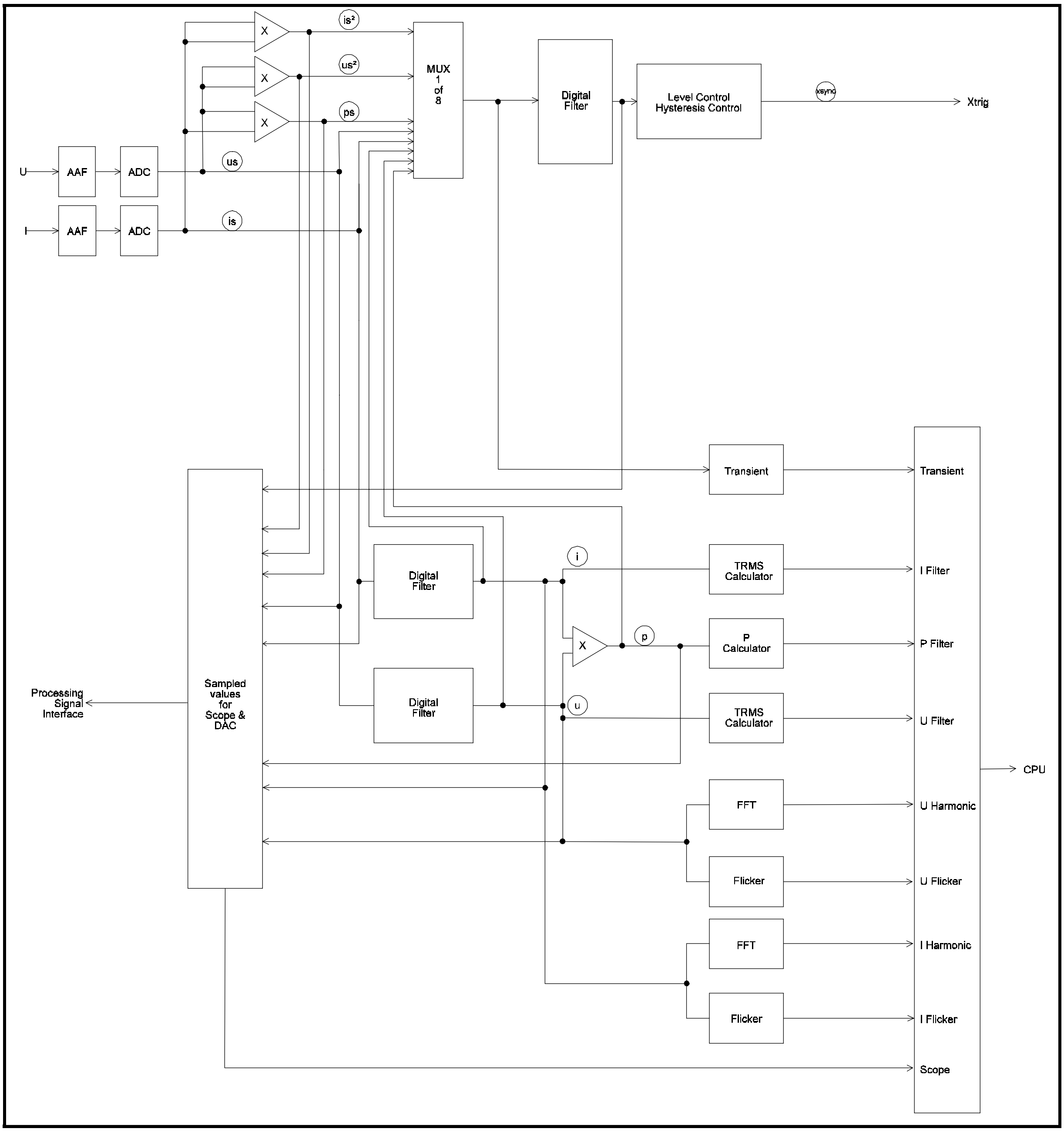


Figure 43: Functional block diagram computing unit

The labels in the circles define the signals you can select in different menus, for example extended trigger, scope, ...

14.6 Functional block diagram computer interface

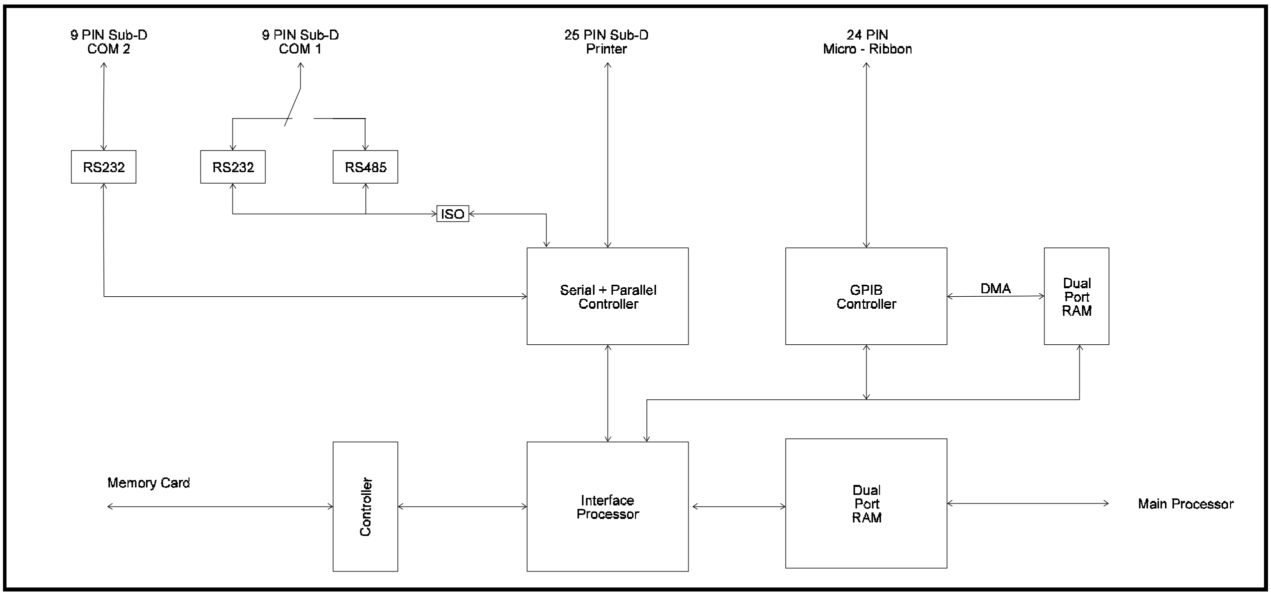


Figure 44: Functional block diagram computer interface

14.7 Functional block diagram processing signal interface

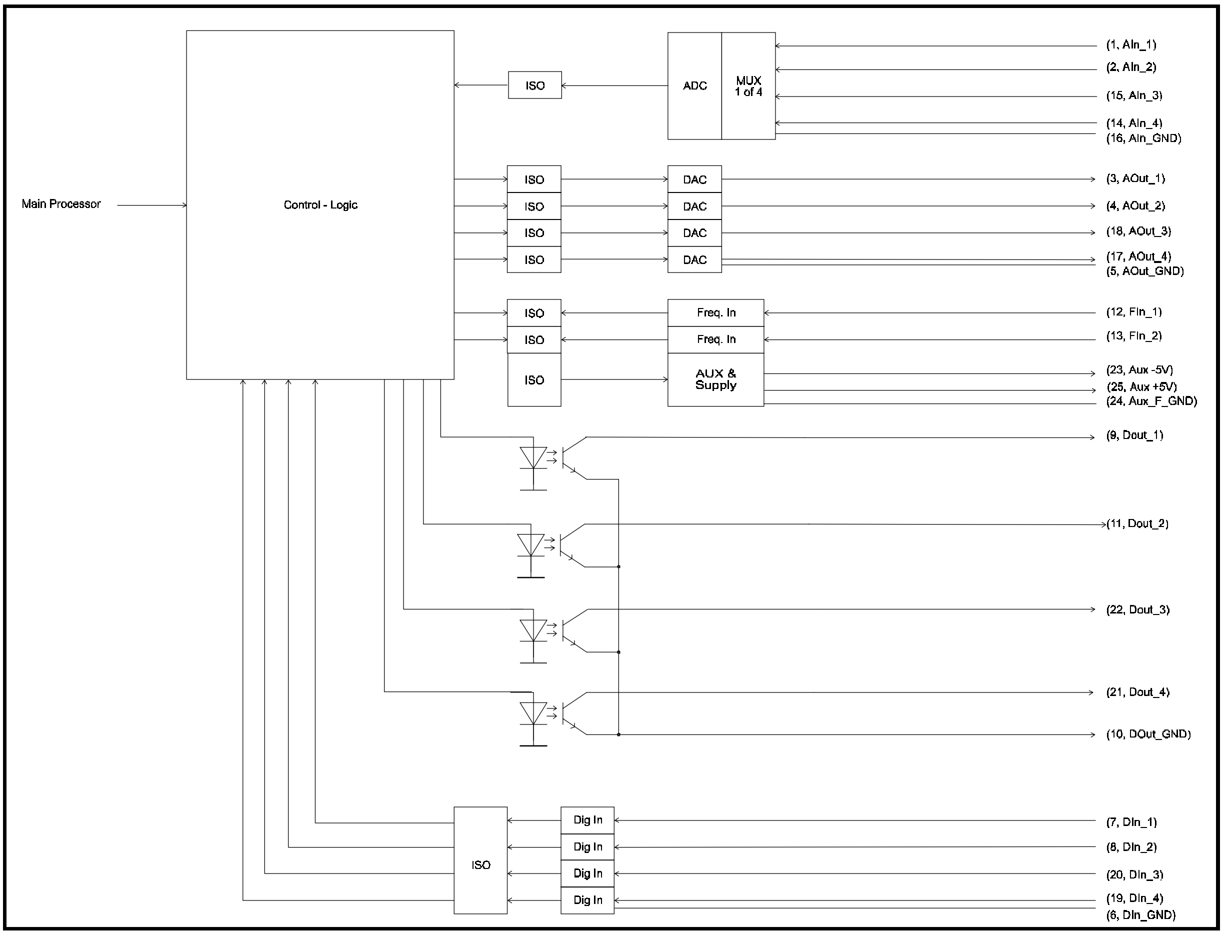


Figure 45: Functional block diagram processing signal interface

15 Glossary

Catchword	Meaning
100 Harmonics	Mode in which 100 harmonics + DC - Part of U, I and P are calculated.
A	
AAF	⇒ Anti Aliasing Filter.
AC	Alternating current; instantaneous values of voltage and current are time depending signals which have positive and negative values.
AC coupling	Used to remove the DC parts of a signal by using a high pass filter.
AC+DC coupling	Couples the complete signal without rejecting any parts.
Accuracy	Declaration of the errors which will be made in measuring.
Active energy	Energy which is consumpted by the load (ohmic part).
Active power	Power which is consumpted in the load (ohmic part).
Actual flicker level Pmom	⇒ Instantaneous flicker level.
Aliasing	Distortion caused by signal parts, which are created through the violation of the sampling (Nyquist, Shannon) theorem (bandwidth ≥ 1/2 sampling frequency). This can be prevented by using ⇒ Anti Aliasing Filter.
Allowed limits	Limits which are declared in standards.
AM	Amplitude modulation; one signal is multiplied with another one; A typical example is a burst fire control, where a 50Hz sine wave is modulated with a slower rectangular signal.
Amplitude error	Error in the modulus of a measuring result.
Amplitude modulation	⇒ AM.
Analogue I/O	Analogue input and output, the LMG series supplies eight separated inputs and outputs for analogue signals: 0-10V.
Analogue Input	⇒ Analogue I/O.
Analogue Output	⇒ Analogue I/O.
AND Condition Register	Register in which a flag is set, if two conditions are true.
Anti-Aliasing-Filter	Filter which cuts off signal parts which might produce aliasing.
Apparent energy	Energy which seems to be consumpted by the load; ⇒ Apparent power. It is the integration of the apparent power.
Apparent power	Power which seems to be consumpted; it is calculated by U_{TRMS} * I_{TRMS} without taking care on the phase angle between them.
Application note	Several measuring or wiring problems are described in application notes of ZES ZIMMER; available also at the ZES homepage: www.zes.com.
Arbitrary block response data	⇒ Defined length arbitrary block response data.

ASCII format	Format which bases on the American standard code of information interchange with 128 symbols.
Auto range	Function which changes the ranges of the current and voltage inputs automatically, depending on the signal.
Auxiliary transducer supply	Some transducers need a separate supply. The LMG can provide this supply.
Averaged values	This values are averaged over a constant number of measuring cycles, more stable display.
B	
Bandwidth	Frequency range from the lowest to the highest frequency, which can be measured or used.
Bargraph	Display of the values symbolised by bars; A typical bargraph is the spectrum display.
Basic wave	The signal part with the lowest frequency in the signal (except DC part). Also called ⇒ fundamental.
Baud rate	Transfer speed of the bits in a serial data stream (Bits per second).
Binary	Numerical system based only on to values: 0 and 1, the data is represented only by this two binary values.
Bitmap	Format of drawing or photos (*.bmp).
Burden	Maximum resistance of a current transducer including wiring and input resistance.
C	
Calibration according to ISO9000	Testing of the meter accuracy traceable to national or international standards.
Capacitance against earth	Each channel has a capacitance against the earth ; this can cause systematically measuring errors which can be corrected.
CAT II	Overvoltage class for usage in normal building nets.
CAT III	Overvoltage class for usage at the PCC (point of common coupling)
CE harmonics	Harmonics measured according to EN61000-3-2; this test is requested for the CE sign.
CE-Flicker	Flicker measured according to EN61000-3-3; this test is requested for the CE sign.
Channel	Hardware which acts as an interface between the test circuit and the instrument, these are U, I and P channels (P=U*I).
Charge	The integration of the current over the time; this charge can be stored for example in an accumulator the unit is Ah or As.
Class A, B, C, D	Different kinds of equipment under test for EN61000-3-2 tests are assigned to this test classes.
COM interfaces	Serial Interface, mostly 9 pole SUB-D socket or 25 pole SUB-D socket.
Comma separated	Data format in which each value is separated by a ‘,’ e.g. par1, par2.

Command set	A couple of commands to remote control the instrument
Common mode rejection	Relation of the displayed value to a common floating signal on all inputs of a measuring channel; a high common mode rejection is necessary for high accuracy.
Condition instruction	Instruction which will only be executed if a condition has been fulfilled.
Constant	Value which will not change over time.
Continuous measuring	Measuring without any gaps.
Core parameter measuring circuit	The core parameters, like hysteresis and magnetic flux, can be determined through power measuring.
Correct current Correct voltage measuring	You can only measure one of these parameters in the correct way, because the impedance of the voltage / current channel has an influence on the measuring channel. This is a systematically measuring error, which can be corrected.
Coupling	This defines which parts of a signal are fed into the next stage. ⇒ AC coupling.
Crest factor	Ratio of peak value to TRMS value; very important when using analogue instruments.
Current clamp	Tool to measure currents; work like a removable transformer.
Current transducer	Similar to current clamps, but placed unremovable in the measurement circuit.
Cursor	Representation of the place on which the next text input will follow; in graphics the cursor marks a special point of the waveform.
Custom menu	Menu defined by the customer himself.
Cycle time	Time which defines a measuring cycle must be higher than the period time of the basic wave.
D	
D. U. T.	‘Device under test’: equipment which should be measured.
Data output format	Format which is used to transfer data from the meter to a PC or data logger.
DC value	‘Direct current’; signal without alternating components. This signal is constant over the time.
Default parameters	Parameters defined by the manufacturer; the instrument is set to this parameters when it leaves the factory.
Defined length arbitrary block response data	Data transfer in blocks with a defined length and random contents inside the blocks; there can be for example the ⇒ EOS character which will be interpreted as data instead of EOS. The fastest way to get data.
Demodulation	Inverse function to ⇒ modulation; remove the carrier and you get the signal you want.
Desired integration time	Time in which the power is integrated, set by the user.
Device	Every meter or equipment take place in the measurement (Printer, PC ...).
Device under test	⇒ D. U. T.

DFT algorithm	Discrete Fourier transformation; operation with discrete values using the Fourier integral to get the harmonics of a signal.
Digital filter	Filter built up with digital components and software.
Digital Input	Like ⇒ Analogue inputs the LMG series provides digital inputs, to read external states.
Digital Output	Like ⇒ Analogue outputs the LMG series provides digital outputs, which can be used to signalise states (e.g. alarm outputs).
DIP switches	Small hardware switches to set up a meter parameter, like communication speed.
Direction input	Input for motor testing to measure the rotary direction of the motor.
Dot joiner	Connects the dots of the measured graph; it improves the look of a graph.
E	
E. U. T.	⇒ D. U. T.
Echo	Repetition of characters sent via the RS232 to the instrument.
Edit line	Line in which you can change a value or text.
Efficiency measurement	Efficiency is the relation between the output power and the input power of an E. U. T.
EN61000-3-2, EN61000-4-7 EN61000-3-3, EN61000-4-15	Standards which describe the harmonic measuring Standards which describe the flicker measuring.
End of string character	‘<lf>‘, ‘<cr>, <cr><lf>‘ are examples for EOS characters.
Energy	Integration of the power which is consumpted by a consumer or a device in a defined time.
Envelope	It is the curve which covers a mixed frequency signal connecting the peak values of the fast frequency; a curve defined by EN61000-3-2 to define if a device belongs to Class D or not.
EOS	⇒ End of string.
Equipment under test	⇒ D. u. t.
ESC key	Key used to cancel an entering mode and to quit an error message.
Extended Trigger	Mode in which the trigger conditions can be set up very differentiated to measure even modulated signal.
External current transformer	Device to transform high currents to lower ones.
External shunt	Changes currents into voltage with defined ratio.
External synchronisation jack	Input for an external synchronisation source.
F	
Falling edge	Opposite of rising edge; the logic signal turns from the high potential to the lower one.
FIFO	First in first out; method how the in- and output of memory is handled.

Filter	Device which cuts off frequencies which are not useful; e.g. high pass filter cut off low frequencies.
Flicker meter	Device to measure flicker levels.
Fluctuating harmonics	Harmonics not constant over time.
Form factor	Ratio of TRMS value to rectified value; older meters could only measure the rectified value and multiply it with the form factor to get the TRMS value. The problem is, that the form factor depends on the waveform. So with other waveform you get an error. Modern instruments like the LMGs measure independent to the form factor, so you measure always correct.
Formula editor	Here you can set up formulas which will calculate different parameters from the measured values.
Freeze	The display values are not updated any more.
Frequency	Speed in which the period of an alternating signal repeats.
Frequency divider	Changes a high frequency into lower frequency by division with an integer number.
Frequency range	⇒ Bandwidth.
Full scale value	Highest measurable instantaneous value in the chosen range.
Fundamental	⇒ Basic wave.
G	
GPIB interface	General Purpose Interface Bus socket to transfer data from meter to PC and opposite ⇒ IEEE.
Graphical display	Representation of the measured values via time or frequency.
H	
Half wave value	Values measured over the half time of the signals period.
HARM100	⇒ 100 Harmonics.
Harmonic analyser	Device to measure harmonics.
Harmonic order	Describes which order the harmonic has; e.g. of a 50Hz signal the order of the 100Hz harmonic is 2, its the second harmonic.
High impedance state	The digital output has a high impedance; the transistor is in blocking mode.
Hyperterminal	Software to exchange data between a PC and a device; included in Microsoft Windows.
Hysteresis	A retardation of the effect when the forces acting upon a body are changed (as if from viscosity or internal friction); e.g. a lagging in the values of resulting magnetisation in a magnetic material (as iron) due to a changing magnetising force.
I	
I/C indication	Indication if the load is inductive or capacitive.
Identifier	Text string representing a measuring value.
IEC61000-3-2, 2-3	⇒ EN61000-3-2.

IEC61000-4-7, -4-15	⇒ EN61000.
IEEE488.2 interface	⇒ GPIB interface.
IF/IO	Key for the set - up menus of interface and processing signal interface.
Inaccuracy of display	Because of the limited numbers on the display the displayed values have an error caused by the display (this is always ± 1 digit).
InCa flag	Flag which is set depending if the load is inductive or capacitive.
Input resistance Ri	Resistance of the input of the measuring channel.
Inrush current	Very high current at the start of a device or appliance; this can be up to 100 times bigger than the current at normal operation.
Instantaneous flicker level	Time-dependent output signal of a flickermeter (output 5), which simulates an actual reaction of men's brain to the variations of light brightness caused by fluctuation of the supply voltage.
Instantaneous value	The value of a signal at one point of time.
Int. Time	Interval time; for example for integration.
Int. Value	Interval value; they are measured while the ⇒ Int. Time.
Integer number	Number without decimal position.
Integration mode	Mode in which the energy is calculated.
Interface	Adapter for the connection between two devices.
Interharmonic	Sinusoidal components with a frequency which is not an integer time of the fundamental.
Internal beeper	Like the PC speaker; to signalise errors.
Interval	Fixed time period.
ISO9000	Standard to guarantee the quality of devices or appliances.
L	
Level	Height of a value.
Logical devices	Log or remote; if log printer, RS232 or MCM is meant, is the question of the physical device.
Limit	Border of a value.
Linefeed	<lf>, hex0A, dec10; jump to the next line; historical from a typewriter, is the most common ⇒ EOS character.
Local	In this mode the LMG can be controlled directly by the user at its keyboard; ⇒ Remote control.
Logarithmic display	Display scaled with logarithmic axis.
Logging	Store data to memory, printer or any other storage device.
Long number	4 Bytes.
Long term flicker level Plt	A result of weighted averaging of short term flicker levels over a time period which typically equals to 2h.
Loop area	Inner area of a circle is a loop area.
Low-Pass Filter	Cuts off high frequencies.

M	
Mains	Line supply.
Mains switch	Switch to start up the instrument.
Manual range	The range settings have to be done by the user.
Measuring converter	Adapter to connect a meter to the ⇒ D. U. T.
Measuring cycle	Cycle set up from the user. After this time the meter calculates new values. The exact time depends on the synchronisation frequency.
Measuring settings	All parameters of the meter which influence the measurement.
Memory card	Random access memory card to store data.
Menu	The whole measurement settings are divided in menus to get a better survey.
Miscellaneous	In this menu you can set up several parameters which have no direct influence on the power measurement, like contrast time and date.
Multimeter	Meter which can measure several values like voltage, current and resistance.
N	
Nibble	Half of a byte; upper or lower 4bit.
Noise	Usually random signals with a high bandwidth which are superposed to the useful signal.
Nondecimal numeric program data	Data which can be represented as string instead of a number; e. g. ‘Cont on’ instead of ‘Cont 1’.
Null modem	Type of serial connection between a PC and another device; the connection cable has two crossed conductor pairs.
O	
Open collector outputs	Passive outputs where the user has access to the collector of the output transistor. You have to connect an external voltage supply to this collector to use the output.
Operator	Instruction which is taken into the calculation: +, -, *, /.
Option Key	A string which can be used to implement software options when the LMG is at the customer.
OR Condition Register	Register which becomes true if an or condition is fulfilled.
Order	⇒ Harmonic order.
Overload capability	A value how much a channel can be overloaded for a certain time.
Overload condition	The instrument is in overload condition while the applied signal is too big for the selected range.
P	
Packed	Data are transferred binary instead of ASCII format
Parallel interface	⇒ Serial interface; here the data is transferred in parallel.
Parity	Even or odd number of 1’s in a binary data block; The LMG works without parity.

Parsing	The LMG tries to interpret a formula or interface string and to react correctly.
Partial odd harmonic current	The harmonic content of order 21, 23 ...
PCMCIA memory cards	⇒ Memory card; PCMCIA is the old name for the PC - Card standard.
Peak current ranges	Ranges with quiet small allowed TRMS values (because of the heating up of the shunt) but very big allowed peak values; very useful to measure ⇒ Inrush currents.
Peak value	Value measured from the zero line to the highest peak of the signal.
Peak-peak value	Measured from the lowest to the highest peak of a signal.
Periodic integration mode	In this mode the integration interval is repeated periodically.
Phase	Conductor of the high potential; typically marked with L.
Phase angles	Usually the angle between current and voltage.
Phase error	The error in power caused by an additional phase shift in the measuring equipment, for example the additional phase shift of a current clamp.
Physical device	Hardware, device (RS232, printer, GPIB...).
Plot function	Mode in which cycle values (e.g. voltage, frequency, ...) are displayed over time.
Power	The energy of a time interval divided by the internal time (e.g. cycle time); so the power is always an averaged value!!
Power factor	Relation between active and apparent power.
Power measuring channel	⇒ Channel.
Power supply	Source which provides the necessary voltage.
Pretrigger	Time before the trigger condition, while which sample values are stored.
Printer header	Upper line of the printer like a title or headline.
Printer output	Socket to connect a printer.
Processing signal interface	Board with Analogue or Digital outputs.
Protocol	Arrangements for communication between devices.
Pulse controlled currents	A modulated current controls the device’s power; like in a hot air fan the rapid fire control.
R	
RAM	Random access memory; you can read and write to this memory.
Range	The measuring range defines the biggest measurable signal. For best accuracy the range should be used for at least 66%.
Reactive energy	Energy which oscillates between source and load without being consumpted.
Reactive power	Average ⇒ Reactive energy.
Real measuring time	Time in which the measuring is made, depends on ⇒ cycle time and ⇒ synchronisation frequency.
Record rate	Ratio in which the sampled values are stored in memory.

Rectified value	The average value of a rectified signal; measured by many analogue instruments ⇒ form factor.
Remote control	You can control the LMG via a connection to a PC.
Resolution	Resolution is not ⇒ Accuracy!!! In the LMG are two resolutions important: the analogue to digital converter has 16bit resolution, the display has 5 or 6 digit resolution.
Rise time	Time in which the signal rises from zero to the maximum (in practice from 10% to 90%).
Rotary knob	Knob used to set up parameters in the meter or move the ⇒ Cursor.
Rotation speed	Speed of the shaft of a motor; rpm.
RS232 interface	⇒ Serial interface.
RTS/CTS	⇒ Protocol to control the data flow of a ⇒ Serial interface.
S	
Safety socket	Connection with high safety against electric shock.
Sample memory	Memory to store the sampled measurement values.
Sample value	Value of a signal measured at a defined time ⇒ Instantaneous Value.
Sampling frequency	Frequency with which the samples of a signal are taken.
Scaling	Resolution of an axis or factor which has an influence on the measured value.
Scope function	In this mode the LMG works like an oscilloscope and displays ⇒ Sample values.
SCPI commands	A standardised set of commands to remote control the LMG.
Sensors	A small external device which converts a current or voltage to a signal the LMG can measure.
Serial poll	A PC program can ask every connected instrument in series if it has data to send. Used by ⇒ GPIB.
SHORT headers	Shorter set of commands, equivalent to ⇒ SCPI.
Short term flicker level	A result of statistical processing of instantaneous flicker level quantities over a time period, which typically equals to 10 min.
Shunt input	Special socket to connect the small voltages of an external shunt to the correct channel.
Shuttle knob	⇒ Rotary knob.
Signal coupling	⇒ AC coupling; This coupling affects the measured values.
Signal source	Where you get a signal from; e.g. frequency generator.
Slewrate	Relation between the voltage risen and the used time.
Softkey	This keys change the meaning depending on the menu.
Software options	Options which can be installed with software.
Software update	Updates your software of the LMG. Available on the homepage: www.zes.com.
Status byte register	Register in which several flags are set according to the status of the LMG.

String	Characters lined up in a row.
Sub menu	A subdivision of a menu.
Synchronisation	Periodic signals have to be measured for an integer number of periods. So the LMG must synchronise it's measuring to the signal to get stable values.
System time	Main time of the meter.
T	
Table	Special format for output of measuring values in a table.
Terminal	Each device which takes an account on a data transfer.
Terminal program	⇒ Hyperterminal.
THD values	Total harmonic distortion, relation of the harmonics of a signal to the fundamental.
Time depended signals	Signal of which the values change depending on the time.
Time domain views	Values are displayed over time.
Total Harmonic Current	Sum of all harmonics starting with 2nd order.
Total harmonic distortion	⇒ THD.
Total harmonic distortion factor including noise (THD+N)	⇒ THD with included noise.
Transient	A short, unusual event on a signal.
Transient mode	Mode in which events can be recorded.
Trigger condition	The trigger starts depending on this condition.
Trigger level	Level on which the trigger starts.
Trigger signal	Signal which gives the trigger event.
TRMS	⇒ True root mean square.
True root mean square	The average of a squared signal.
V	
Variables	Values calculated by ⇒ Formula Editor.
Visual display	Display what you can see in the moment.
Voltage transformers	Changes voltage levels.
Z	
Zero crossing	When the signal passes the zero axis. The positive zero crossing is usually used for ⇒ Synchronisation.
Zoom	Zoom in: enlarge the display Zoom out: reduce the visual display.

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