ZES ZIMMER

LMG611

Precision Power Analyzer with Dual Path

The Most Precise in its Class

As Compact Desktop Device with Touch Screen

LMG611 – powerful, convenient, flexible

Featrues

Harmonics
- Harmonics and interharmonics up to 2000th order, in compliance with EN61000-4-7

Script Editor
- Flexible scripting tool for special applications
- Convenient calculation of all derived variables in the power analyzer

Custom Menu
- Creation of customer specific application oriented menus

Simultaneity
- Simultaneous measurement of I, U and P-variables and harmonics
- Presentation in tabular or graphical form

Flexible Filters
- Signal filters freely configurable by frequency, type and characteristics

Plug 'n' Measure
- Connected current transducers are automatically configured and supplied with power
- Convenient commissioning with zero risk of misconfiguration

Synchronization
- Synchronize on different frequency sources

Flicker
- Interactions between grid and loads according to EN61000-4-15

Sample Values
- Direct access to high-resolution sample values and harmonics via interfaces

Event Triggering
- Event based recording of sample values

Smart Vision
- Smart add-on functions for convenient evaluation of measurements

GUI

Touch Screen
- 7 inch display (1024x600)
- Flat operating hierachy for rapid access to all important menu items

Remote Control
- Real-time display of all device functions, remote operation and data visualization
- No rethinking required, thanks to the new unified GUI

Storage & Periphery

CAN bus
- Simple provision of measured values via CAN bus

Memory
- Internal storage even of long-term measurements with the shortest cycle time, thanks to high-capacity mass-storage device

Interfaces
- Excellent connectivity provided by USB 3.0, Gigabit Ethernet, RS2.1.132, DVI

Setting the bar in power analysis

For more than three decades, ZES ZIMMER has been focused solely on high-precision power measurement technology – so we know there is more to it than simply measuring current and voltage. Anyone who has tried to use generic systems for power measurement will have rapidly run up against their limits. What's the situation with common-mode rejection? Is the measurement result still reliable for power factors in the range of 0.01? Is the earth capacitance low enough to avoid interference by leakage currents? In what frequency ranges does the manufacturer guarantee the stated measuring accuracy? It quickly becomes clear that only a device designed specifically for power measurement can really satisfy these ambitious requirements. The ZES ZIMMER LMG611 stands out in the market for its extreme reliability, best-in-class accuracy, and maximum frequency range – the ideal prerequisites for excellent results.

LMG90

1985
The first digital power analyzer

LMG95

1997
Highest precision

LMG610

2016
Modern operation & DualPath

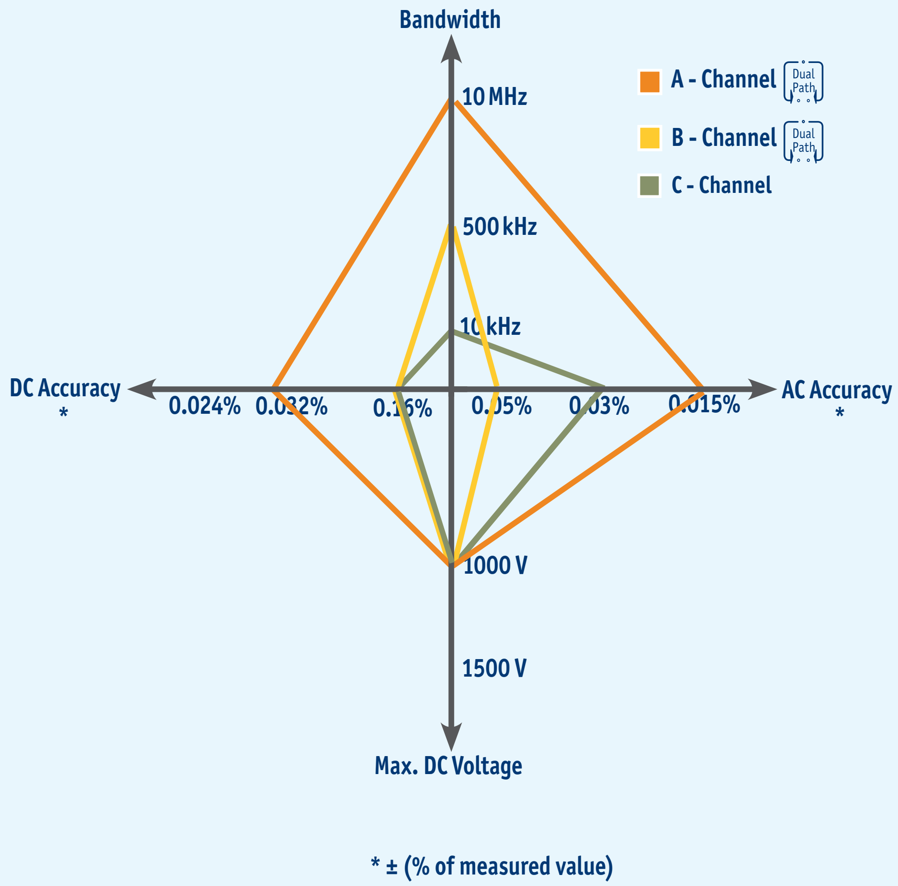
LMG611

2020
Improved design & interfaces

Measurement Channels	**DualPath**	• Narrowband-, wideband RMS values and harmonics in a single measurement, simultaneously and free of aliasing
	Sampling Rate	• High sampling rate of up to 1.2 MS/s
	Resolution	• Calculation of RMS values with a minimum cycle time of 10 ms
	Accuracy	• Extremely high measurement accuracy of 0.015 % of the measured value + 0.01 % of the measuring range limit
	Dynamic Range	• Full dynamic range continuously available from 500 µA to 32 A and 3 mV to 1000 V • Power measurement from standby to full load (max. 32 A) possible without mechanical changes
	Bandwidth	• Analog frequency range from DC up to 10 MHz • Analysis of 1000 harmonics in the GUI and 2000 via interface
	Continuity	• Gapless sampling at 18 bit A/D converter resolution and a cycle time of 10 ms • No discontinuities in recorded measurements and complete capturing of all relevant events
	U-I-Synchronicity	• Time offset between current and voltage input adjustable in steps < 3 ns • Very precise measurements at small power factors (PF) and/or high frequencies
	Immunity	• Reliable even in areas with difficult electromagnetic conditions
	3 Types	• The right analyzer for any task — LMG611-A: 0.025% accuracy, up to 10 MHz LMG611-B: 0.07% accuracy, up to 500 kHz LMG611-C: 0.04 % accuracy, up to 10 kHz
	Ground Capacitance	• Particularly low earth capacitance of < 90 pF avoids interference by leakage currents
Misc.	**Calibration**	• 12-month calibration interval guarantees low maintenance costs and optimum device availability • Includes calibration certificate upon delivery, free of charge
	Warranty	• 24 months warranty

For every application the adequate combination of bandwidth, accuracy and costs

Power analyzers are available in different accuracy classes to allow the user to choose the right tool for the job at hand. After all, not all applications require maximum precision; often lower resolutions and frequency ranges are sufficient. Unfortunately, not all measuring applications observe this distinction. It is entirely possible, for instance, to have need of different frequency ranges and accuracy levels at different points in the same measurement configuration. This is why the LMG611 is offered in three different types, which ensures that you always have a measuring device tailored to your needs for your particular application, without having to accept trade-offs in accuracy or take a sledgehammer to crack a nut, if a lower price solution could have served your purposes equally well.



Gapless/zero-blind measurement

In the course of stricter monitoring of the consumption and efficiency of electrical devices, new standards and procedures are continuously being introduced (e.g. SPECpower_ssj2008, IEC 62301, EN 50564), in order to enable an impartial comparison of products from different manufacturers. Be it an office computer, server or household appliance, the same principle applies: the procedure always requires long term analysis of the power consumption, taking into account all relevant operating conditions. The differences between minimum load - e.g. in standby - and full load can be of a significant magnitude, which makes precise measurement very challenging (see also application report no. 102 „Measurement of standby power and energy efficiency“ at www.zes.com). Some of the measurements required must be performed over several hours, yet without gaps. By selecting a sufficiently high measurement range, changing ranges and the inevitably associated losses in data can be avoided. The high basic accuracy of the LMG611 ensures precise measurement results, even near the lower limit of a range.

Measuring in two bandwidths at the same time, thanks to DualPath - no compromises, no doubts

On conventional power analyzers, a signal first undergoes analog conditioning, followed by optional anti-aliasing filters, to then be fed into an A/D converter. The resulting signal can afterwards be used for the calculation of cycle-based rms values, or alternatively serve as the base for an FFT or further digital filtering. Due to the limitation to a single A/D converter, there are inherently some downsides to be factored in with conventional devices. If measurements are carried out with filters active, in order to avoid aliasing with FFTs, then the wide-band values are lost. With the filters switched off, strictly speaking, FFTs should not be used. If, in spite of this, FFTs are used without an anti-aliasing filter for measurements across the full frequency range, then the quality of the calculated values is questionable. An aliasing error of 50 %, for instance, is easily detected, however a deviation of 0.5 % could go unnoticed. Ultimately, when you alternate filtered and non-filtered measurements, the validity of the results is equally in question, as this involves the assumption that the signal does not change over time, which is in practice hardly ever the case. In addition, this procedure is especially time consuming.

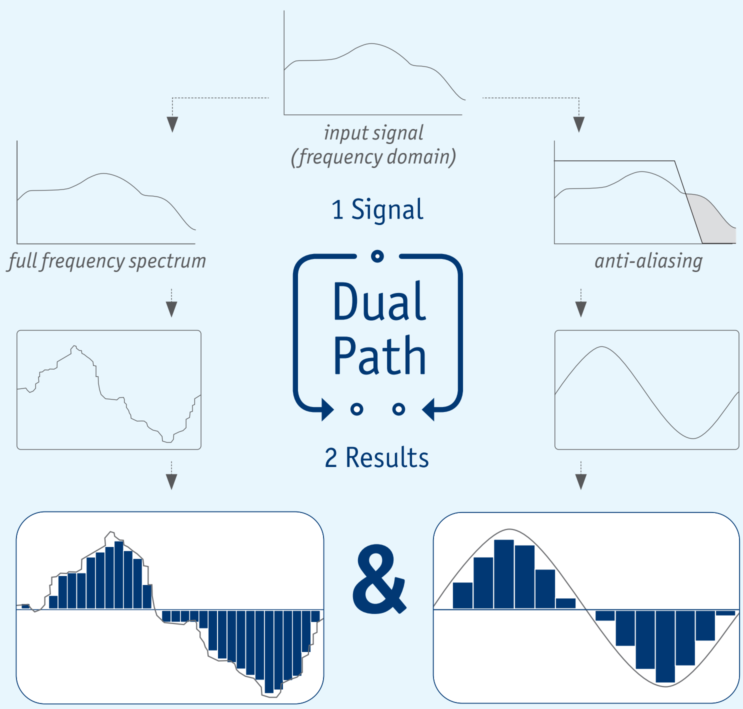
LMG611

- ✓ Fast results
- ✓ Complete broadband values
- ✓ Correct FFT
- ✓ Precise results

Conventional analyzers

- ⊖ Aliasing risk
- ⊖ Loss of broadband values
- ⊖ Waiving of FFT
- ⊖ Suspicious staggered values
- ⊖ Lengthy measurements

In the end, this makes all of the measurement methods presented an unsatisfactory compromise. This is why ZES ZIMMER has fundamentally redesigned signal processing and developed the DualPath architecture. The analog side is the same as in conventional measuring devices, however the subsequent digital processing has been revolutionized. The LMG611 is the first power analyzer to have two A/D converters in two independent signal paths; One, for the filterless measurement of the wideband signal, and another, for the narrow-band signal at the output of the anti-aliasing filter. The parallel processing of the digitized sample values gives the user access to both measurements of the same signal, without risking aliasing effects. This unique procedure avoids all of the downsides of previous approaches and guarantees the most precise result in the shortest time possible.



Precise measurements thanks to minimal delay differences

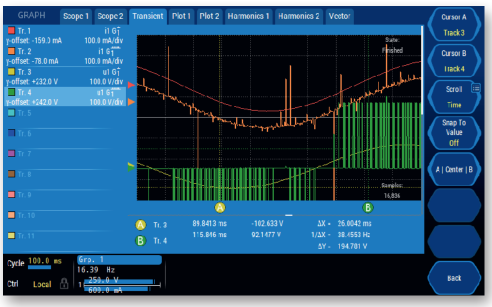
The fast-switching semiconductors used in modern frequency converters to improve efficiency produce extremely steep voltage edges. The resulting capacitive currents put strain on the bearings and the insulation of the motors – this can lead to premature failure.

Motor filters (e.g. dU/dt filters) attenuate the steep voltage gradient, although they generate power losses themselves due to the transient oscillation with the filter's own frequencies (typically > 100 kHz).

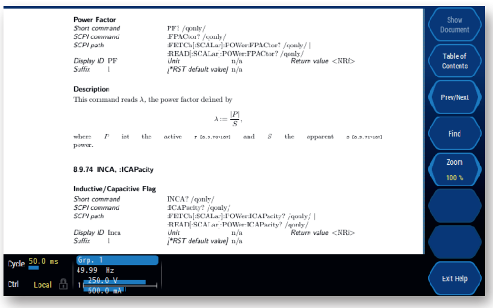
The broad frequency range and the minimal delay between current and voltage on the LMG611 allow extremely precise power loss measurements on the filters at these frequencies, including longitudinal measurements at low power factors. This also applies to power measurements with high frequency ranges of up to 10 MHz, which require the current and voltage channels to be designed for the smallest delay differences. On the LMG611 the offset is less than 3 ns, corresponding to a phase error <1 µrad at 50 Hz. This makes the devices best suited to measure the power losses at low phase angles for transformers, chokes, capacitors and ultrasonic generators. No additional options or adjustments are required; the LMG611 is already fully capable of this measurement task with the standard factory settings. Usually current and voltage transducers are used for measurements on high-power circuits. The phase angle of these transducers can be corrected to improve measurement accuracy.

Easy to use – with or without touchscreen

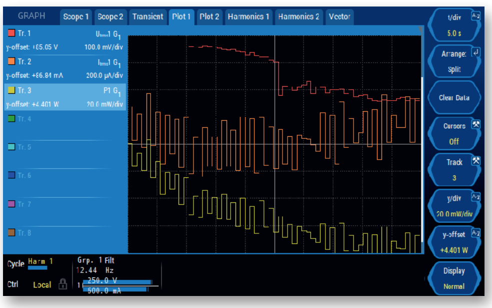
To ensure that the LMG611 can be used in all conditions, particular attention has been paid to universal operability. All display modes and setting options can be operated both with the touchscreen or the keypad, without exception. The optimized design consistently produces a direct reference between the keypad and the associated views and setting options on the screen. To use the device effectively requires practically no familiarization. The graphical user interface directs the user precisely to the required results, without detours. Be it effective values for voltage or current, associated harmonics or cumulative values, they are only a single press of a button away. In addition, user-defined views allow to group together measured values of one's choice, so that all the parameters that are important are always available at a glance. This ergonomic means of operation and the associated time savings contribute directly to the productive use of the LMG611. The eight context-specific double softkeys to the right of the display, whose function always corresponds to their on-screen counterparts on the right-hand side of the screen, are especially important for ease-of-use. One can determine the function assigned to a given softkey at a glance. The double softkey design enables the respective parameter to be rapidly configurable; switching through views that are not relevant is no longer necessary. Should there be questions as to function and control while operating the device, the relevant sections of the manual can be displayed at any time.



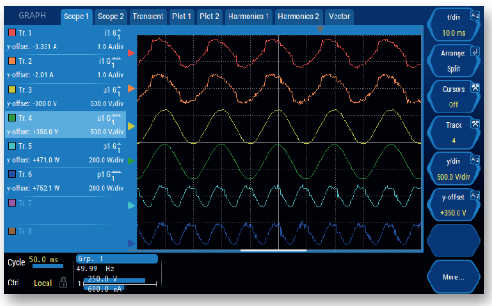
Simultaneous measurement of narrow and broadband values



Superimposed help text from manual



Display of measured RMS values



Display of sampling values of 8 signals in two scopes

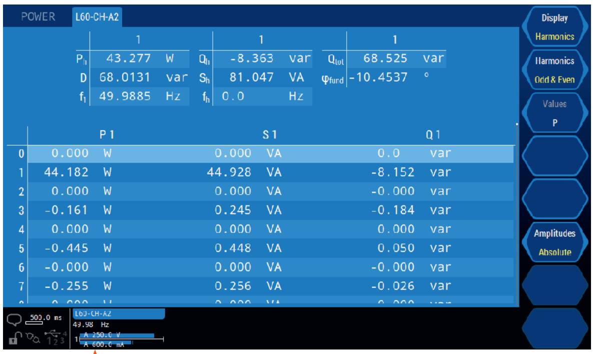
Range extension with sensors? Plug 'n' Measure!

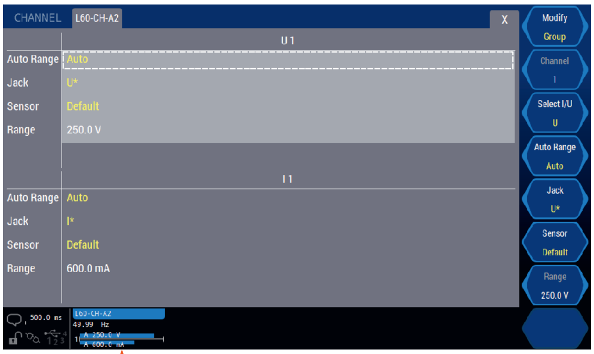
Although the LMG611 offers unmatched dynamic range, both for voltage and current, there are always applications with extraordinary requirements in terms of measurement ranges. Whether you are dealing with currents of several hundred amps or voltages of several kilovolts, ZES ZIMMER has the right solution at the ready. We offer a wide range of current and voltage sensors, which work perfectly in unison with the LMG611 precision power analyzer and extend the measurement ranges of the device by the required amount. The sensors of our Plug 'n' Measure series are equipped with a bus system, which enables automatic configuration of the LMG611. This allows for all of the important parameters, such as the precise scaling factor, the delay compensation variable, the last calibration date, and the sensor type, to be read and used automatically by the power analyzer. Moreover, the sensors are actively supplied with power by the LMG611, separate power supplies are no longer required.

With Plug 'n' Measure there is no need for fine tuning by the user to improve the results. There is no difference between direct and sensor-supported measurements. Of course, other commercially available sensors can also be used with the LMG611.

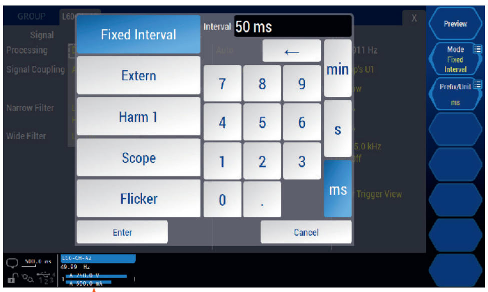
Sensor Type PCT

Everything important just a click away



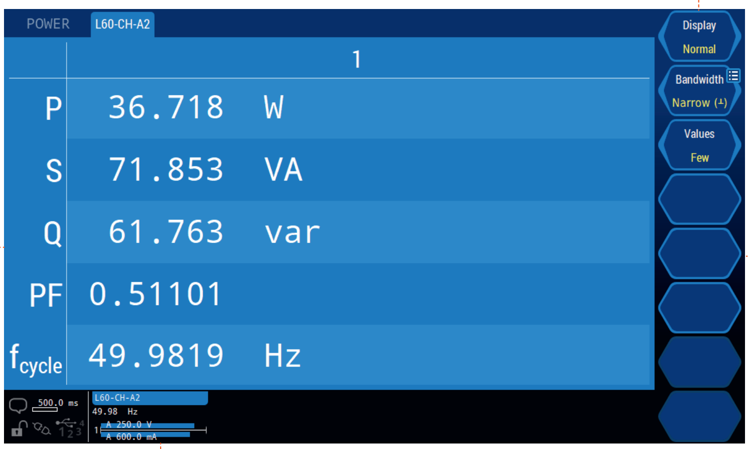


Click on the level indicator: configuration of channel specific measurement ranges and sensor settings



Click on softkey <Display>: toggling between RMS values and harmonics

Click on Cycle: Configuration of cycle time or reference

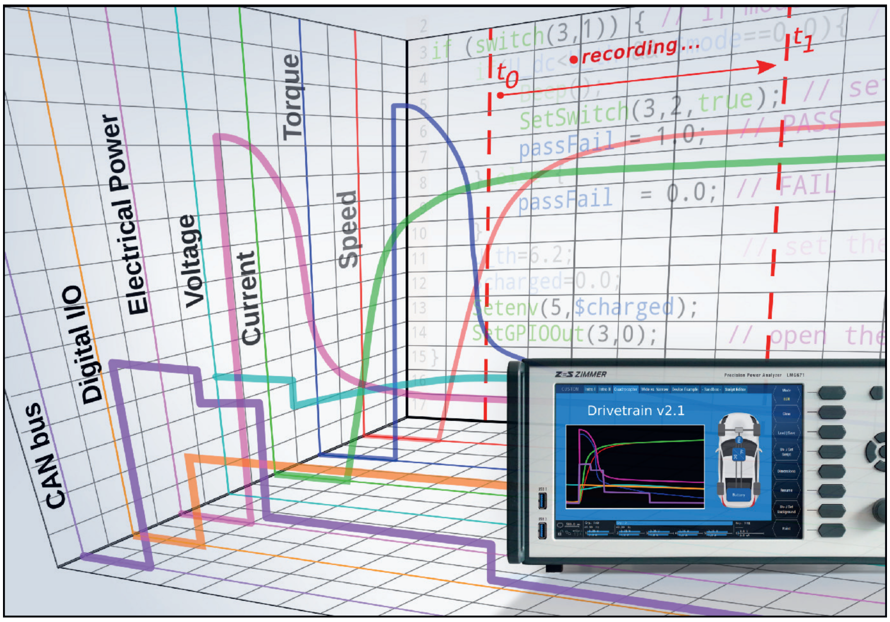


Click on the group: configuration of activation, synchronization, filters, etc.

LMG600 series: Testing without disruption – five in one

In a typical test scenario, the way from raw signals to the final pass/fail indication is a long and winding path stretching over five distinct phases. Computing RMS power is only one piece of the puzzle, and data from other sources might need to be integrated into the calculations. This can lead to a complex assortment of data sources and processing tools with many handover points. The discontinuities in the flow of data may require manual intervention, which demands time and effort and increases the risk of introducing errors.

The LMG600 is designed to combine all five phases of testing into a single instrument, thus eliminating unnecessary complexity, streamlining the testing process, making test engineers' life easier and keeping cost down.



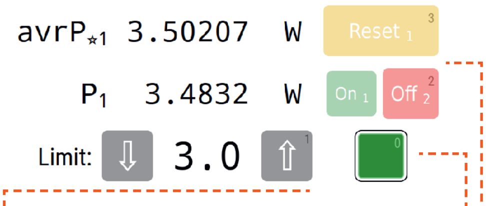
1. **Signal acquisition**: the LMG600 goes beyond voltage and power. The versatile Process Signal Interface (PSI) can read virtually any analog or digital signal source, thus allowing e.g. temperature, pressure, speed, torque and other data to be collected together with voltage and current. No need to reconcile data points from different sources later on, no issues with inconsistent timestamps between variables.

2. **Timing control**: for the test results to be meaningful, the DUT needs to be observed in specific, predefined modes of operation. The LMG600 can control beginning and end of the measurements via the versatile Event Trigger option. In addition, it can react to external trigger inputs or CANbus commands to start recording data. The LMG600 can also control external devices via a number of analog and digital outputs in the optional PSI.

3. **Integration**: to calculate RMS voltage, current and power as well as harmonic values, the samples need to be summed over entire signal periods – this is the traditional domain of power analysis. (Outsourcing the calculation to PC environments already at this step renders the integrity of RMS values and harmonics vulnerable and makes calibration of the setup rather difficult.)

4. **Derivation**: in many applications, the measurement of electrical quantities is just a means to an end and not the final goal. An illustrative example is the qualification of inductive components: measuring voltage and current ultimately yields core losses and the peak values of magnetic field strength and flux density. Rather than exporting electric measurements to 3rd party applications for the calculation of the desired results, the LMG600 offers a powerful built-in programming language with a vast number of mathematical functions to carry out all required calculations in one fell swoop. No handover, no disruptions, no risk of additional errors.

5. **Pass/fail decision**: In case the DUT is tested against defined standards or previously established benchmarks, the pass/fail limits can be programmed into the LMG600 in order to allow the instrument to display the outcome of the test directly. Should there be different pass/fail criteria for consecutive DUTs, applicable limits can even be adjusted on-screen by the test engineer use the touchscreen GUI's input boxes or arrow keys. Some tests require additional information (like e.g. magnetic path length, core diameter etc.) on the DUT that varies between tests and also needs to be considered for calculation. Also this kind of data can be entered and changed directly on-screen using a number of available input elements. These built-in decision-support features allow even less experienced or less well-trained users to reliably judge success or failure of the test.

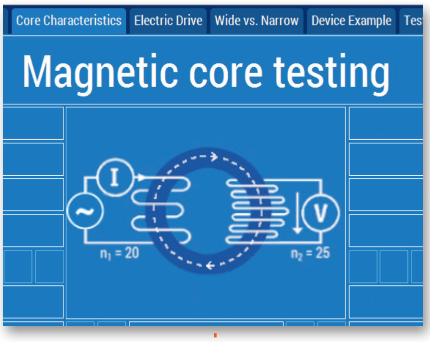


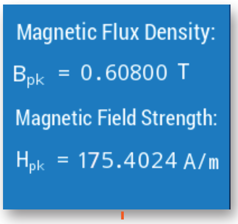
Environment variables
In the example above, power P1 is compared to environment variable 1, which can be adjusted on-screen using the depicted arrow softkeys.

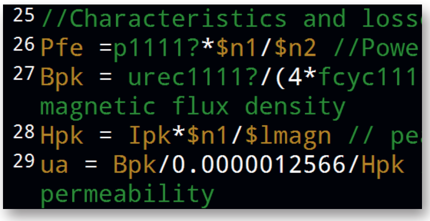
Signals
The values assumed by enviroment variables can be color-coded to alert the user to the status of the DUT or to indicate the outcome of the measurement e.g. pass/fail.

Switching keys
The status of the softkeys can be queried by the script. Those keys can act as push button, toggle or latching switches.

Five in one example: automated magnetic core testing

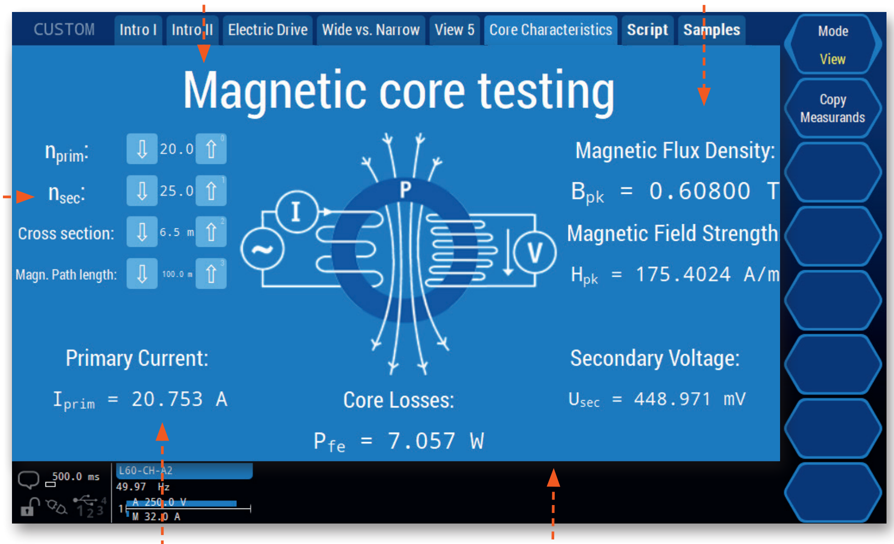






In this example the magnetic field strength and flux density from voltage, current and frequency measurements are calculated. The script editor offers a vast variety of mathematical, logical and procedural programming functions like loops and conditional execution of commands.

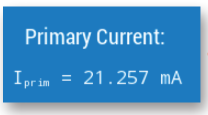
Make it easier to recognize your application: Add a meaningful title for your measurement. Use graphical elements like drawings or photographs to depict your setup and freely arrange them. Add your brand logo and reflect your corporate style in the choice of colors and design elements.

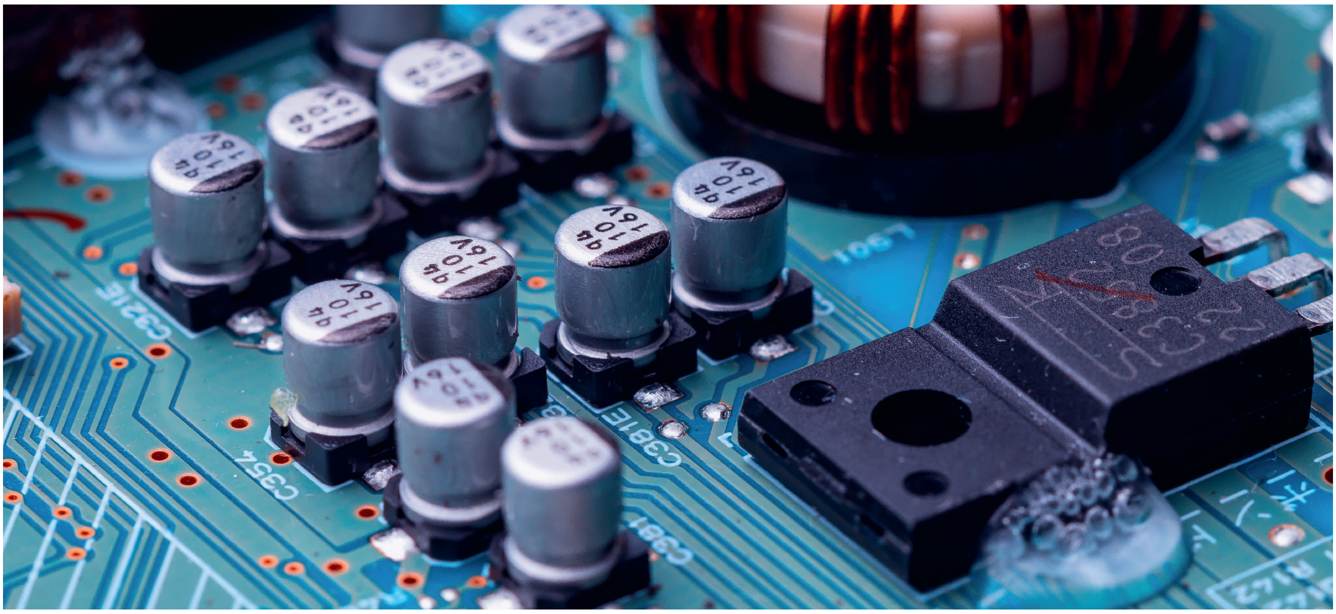


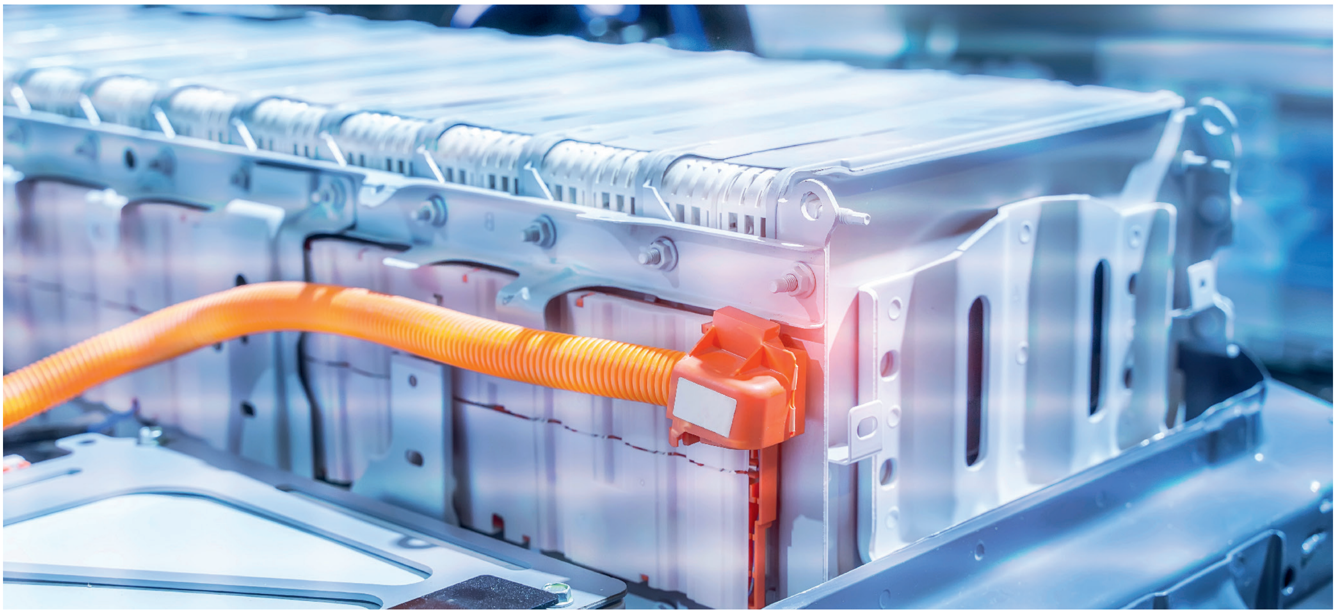
Sometimes, the formulae stored in the script editor require additional input, e.g. parameters that vary with every individual DUT, like material constants. No need to edit the stored scripts – these parameters can easily be entered on-screen by the executing engineer during testing. Arrow soft keys allow for in-/decrementing the chosen variables, and the number can be entered directly as well.

Pass or fail criteria can be established in order to judge the suitability of the DUT for its intended purpose. The LMG611 allows to automate this decision based on the measured and calculated properties. The results of the test can be displayed in easily readable form to allow less skilled users to carry out testing without additional supervision.

Add measurement values you are interested in, and only show what you need. You can display any electric quantity measured by the power channels as well as values from any I/O interface (CAN, GPIO).







Application Switched-mode power supplies

Already years ago, advances in power electronics have caused relatively large and heavy transformer power supplies to be replaced by smaller, lighter and more efficient switched mode power supplies. Today those can be found in practically all grid-powered electrical devices. While avoiding many of the downsides of their predecessors, they also bring new challenges: for one, the conducted emissions due to harmonics are not insignificant and must be limited by standards (EN61000-3-2, EN61000-3-12). Secondly, the high switching frequencies of up to several hundred kilohertz can lead to problems with electromagnetic compatibility, both on the grid side and on the consumers' part. The role of power measurement technology is to support the manufacturer in optimizing their products.

CHALLENGES

- Gapless, standards-compliant measurement of harmonics
- High frequency range for analysis of conditions at pulse frequencies >300 kHz
- Quick and gapless sampling for measuring steep switching flanks
- Reliable measurement even at power factors $\lambda < 0.01$

LMG611

- High Bandwidth
- Continuity
- Flexible Filters
- High Sampling Rate
- U-I-Synchronicity
- Harmonics

Application Solid & laminated magnetic cores

Under the influence of changing fields, the ferromagnetic components of an electrical machine are subject to losses due to continuous remagnetization and eddy currents, which are ultimately converted into heat or vibrations. The total losses are frequency-dependent and should be minimized as far as possible, as they have a significant effect (for example) on the range of the batteries in electric vehicles. The core power loss can be calculated directly from the excitation current of a test winding and the magnetization voltage of a sensor winding. The magnetic flux density in the core material can be derived from the rectified value of the voltage induced in the sensor winding. The magnetic field strength is proportional to the current flowing in the test winding. While the high-frequency currents in solid cores can be measured directly, the high amp values occuring in laminated cores usually demand high-precision transducers.

CHALLENGES

- Precise determination of the active power, even at lowest power factors ($\lambda < 0.01$) and very low voltages
- Calculation of a multitude of derived variables such as peak value of field strength (H_{pk}), magnetic flux density (B_{pk}), and amplitude permeability (μ_a)
- Convenient integration of transducers for high currents

LMG611

- High Bandwidth
- Accuracy
- Script Editor
- Plug 'n' Measure
- U-I-Synchronicity

Application Batteries

With the significance of battery efficiency playing a dominant role in electrical vehicles and renewable energy systems, careful design as well as accurate monitoring of the electrical properties of a battery is crucial during their development. In addition to continuous monitoring and recording of the electrical characteristics during entire and consecutive charging/discharging cycles, the LMG611 allows for easy an integration in test benches, by intuitive user defined control panels with the Custom Menu and direct control of the entire test bench using the Script Editor and the GPIO interface.

CHALLENGES

- Highly precise DC measurement
- Monitoring and logging of long charge - discharge cycles
- Calculation of advanced parameters with custom formulas
- Full test bench automation

LMG611

- Accuracy
- Dynamic Range
- Continuity
- Interfaces
- Custom Menu
- Script Editor


e-mobility

Application

CE compliance testing for harmonics and flicker

Electrical equipment, systems and devices must satisfy the directives and ordinances of the EU on the permitted level of electromagnetic emissions and immunity to electromagnetic effects, if they are put on the market inside the European Union (EU). Two different types of grid emissions are tested: harmonics and flicker. Any electrical device with a non-linear load characteristic produces current harmonics. Due to the impedance of the grid, these cause drops in voltage and resulting distortions. In addition, certain devices (e.g. continuous-flow heaters, heating furnaces, et cetera) control their power consumption by abruptly switching on and off, which destabilizes the voltage level due to the grid impedance. This produces fluctuations in voltage, which trigger variations in brightness in the electric lighting ("flicker"). In combination with a suitable AC source and reference impedance, the LMG611 is the tool of choice for the qualified assessment of harmonics and flicker. The LMG Test Suite (see accessories) is providing a user-friendly software solution for this, which turns performing conformity tests for electromagnetic compatibility into child's play.

CHALLENGES

- Verification of absence of distortions and voltage stability of the source
- Measurement of signals at significantly different levels
- Clearly organized management of a multitude of measured values

LMG611

C Channel	Accuracy
Harmonics	Flicker
Dynamic Range	Test Suite

Application

Energy metering

The advancing proliferation of DC charging stations for electric vehicles - where the DC energy transferred needs to be accurately measured for accounting purposes – is driving the demand for DC meters. To ensure proper verification, calibration and certification of the DC meter used (e.g. E-VDE-AR-E 2418-3-100), the LMG611 captures and synchronizes its measuring cycle to the DC meter's pulse output to provide a meaningful conformity test, customizable to the requirements utilizing the in-built script editor.

CHALLENGES

- Highly precise DC energy measurement
- Synchronization to the energy meter's pulse output
- Customization of test settings and sequences
- Provision and logging of meaningful results

LMG611

A Channel	Accuracy
Synchronization	Custom Menu
Script Editor	Remote Control

Application

Lighting technology

In an effort to reduce energy consumption, light bulbs are being replaced with ever more efficient light sources all around the world. While on the consumer end all that is required is to insert a new product into the existing fitting, the differences on the electrical level are considerable – in contrast to conventional bulbs, LED lights and compact fluorescent lights ("low-energy light-bulbs") are controlled by special electronic ballasts. Some of these ballasts work with switching frequencies of up to 200 kHz and produce signal distortions at frequencies of up to 1 MHz. The manufacturers are required first and foremost to prevent damaging circuit feedback, and secondly, to ensure optimum service life for their products. To achieve the aforementioned objectives, often a controlled warm start is performed, whose proper execution has to be verified by making appropriate measurements.

CHALLENGES

- Broad frequency range of the measurement, hand-in-hand with a high level of precision
- Verification of standby power of ballasts even for $\lambda < 0.01$
- Minimal earth capacitance to avoid leakage currents during the measurement

LMG611

High Bandwidth	Accuracy
Flexible Filters	Ground Capacitance
U-I-Synchronicity	

Accuracy specification

A channel **Accuracy**	± (% of measured value + % of maximum peak value)									
	DC	DC [e]	0.05 Hz … 45 Hz 65 Hz … 3 kHz	45 Hz … 65 Hz	3 kHz … 10 kHz	10 kHz … 50 kHz	50 kHz … 100 kHz	100 kHz … 500 kHz	500 kHz…1 MHz	1 MHz … 2 MHz	2 MHz … 10 MHz
Voltage U*	0.02+0.08	0.02+0.06 [e]	0.015+0.03	0.01+0.02	0.03+0.06	0.2+0.4		0.5+1.0	0.5+1.0	f/1 MHz*1.5 + f/1 MHz*1.5	
Voltage U_{SENSOR}	0.02+0.08	0.02+0.06 [e]	0.015+0.03	0.01+0.02	0.03+0.06	0.2+0.4		0.4+0.8	0.4+0.8	f/1 MHz*0.7 + f/1 MHz*1.5	
Current I* 5 mA…5 A	0.02+0.1	0.02+0.06 [e]	0.015+0.03	0.01+0.02	0.03+0.06	0.2+0.4		0.5+1.0	0.5+1.0	f/1 MHz*1.0 + f/1 MHz*2.0	-
Current I* 10 A…32 A	0.02+0.1[1]	-	0.015+0.03[3]	0.01+0.02[3]	0.1+0.2[3]	0.3+0.6[3]	f/100 kHz*0.8 + f/100 kHz*1.2[3]		-	-	-
Current I_{SENSOR}	0.02+0.08	0.02+0.06 [e]	0.015+0.03	0.01+0.02	0.03+0.06	0.2+0.4		0.4+0.8	0.4+0.8	f/1 MHz*0.7 + f/1 MHz*1.5	
Power U* / I* 5 mA…5 A	0.032+0.09	0.032+0.06 [e]	0.024+0.03	0.015+0.01	0.048+0.06	0.32+0.4		0.8+1.0	0.8+1.0	f/1 MHz*2.0 + f/1 MHz*1.8	-
Power U* / I* 10 A…32 A	0.032+0.09[2]	-	0.024+0.03[4]	0.015+0.01[4]	0.104+0.13[4]	0.4+0.5[4]	f/100 kHz*0.8+ f/100 kHz*0.8[4]	f/100 kHz*1.0 + f/100 kHz*1.1[4]	-	-	-
Power U* / I_{SENSOR}	0.032+0.08	0.032+0.06 [e]	0.024+0.03	0.015+0.01	0.048+0.06	0.32+0.4		0.72+0.9	0.72+0.9	f/1 MHz*1.8 + f/1 MHz*1.5	
Power U_{SENSOR} / I* 5 mA…5 A	0.032+0.09	0.032+0.06 [e]	0.024+0.03	0.015+0.01	0.048+0.06	0.32+0.4		0.72+0.9	0.72+0.9	f/1 MHz*1.4 + f/1 MHz*1.8	-
Power U_{SENSOR} / I* 10 A…32 A	0.032+0.09[2]	-	0.024+0.03[4]	0.015+0.01[4]	0.104+0.13[4]	0.4+0.5[4]	f/100 kHz*0.8+ f/100 kHz*0.8[4]	f/100 kHz*1.0 + f/100 kHz*1.0[4]	-	-	-
Power U_{SENSOR} / I_{SENSOR}	0.032+0.08	0.032+0.06 [e]	0.024+0.03	0.015+0.01	0.048+0.06	0.32+0.4		0.64+0.8	0.64+0.8	f/1 MHz*1.1 + f/1 MHz*1.5	

B channel **Accuracy**	± (% of measured value + % of maximum peak value)						
	DC	0,05 Hz … 45 Hz 65 Hz … 1 kHz	45 Hz … 65 Hz	1 kHz … 5 kHz	5 kHz … 20 kHz	20 kHz … 100 kHz	100 kHz … 500 kHz
Voltage U*	0.1+0.1	0.1+0.1	0.03+0.03	0.2+0.2	0.3+0.4	0.4+0.8	f/100 kHz*0.8 + f/100 kHz*1.2
Current I* 5 mA…5 A Current I_{SENSOR}	0.1+0.1	0.1+0.1	0.03+0.03	0.2+0.2	0.3+0.4	0.4+0.8	f/100 kHz*0.8 + f/100 kHz*1.2
Current I* 10 A…32 A	0.1+0.1[1]	0.1+0.1[3]	0.03+0.03[3]	0.2+0.2[3]	0.6+1.2[3]	1.5+1.5[3]	f/100 kHz*2.0 + f/100 kHz*2.0[3]
Power U* / I* 5 mA…5 A Power U* / I_{SENSOR}	0.16+0.1	0.16+0.1	0.05+0.02	0.32+0.2	0.48+0.4	0.64+0.8	f/100 kHz*1.28 + f/100 kHz*1.2
Power U* / I* 10 A…32 A	0.16+0.1[2]	0.16+0.1[4]	0.05+0.02[4]	0.32+0.2[4]	0.72+0.8[4]	1.52+1.15[4]	f/100 kHz*2.24 + f/100 kHz*1.6[4]

C channel **Accuracy**	± (% of measured value + % of maximum peak value)						
	DC	0,05 Hz … 45 Hz 65 Hz … 200 Hz	45 Hz … 65 Hz	200 Hz … 500 Hz	500 Hz … 1 kHz	1 kHz … 2 kHz	2 kHz … 10 kHz
Voltage U*	0.1+0.1	0.02+0.05	0.02+0.02	0.05+0.05	0.2+0.1	1.0+0.5	f/1 kHz*1.0 + f/1 kHz*1.0
Current I*	0.1+0.1[1]	0.02+0.05[3]	0.02+0.02[3]	0.05+0.05[3]	0.2+0.1[3]	1.0+0.5[3]	f/1 kHz*1.0 + f/1 kHz*1.0[3]
Current I_{SENSOR}	0.1+0.1	0.02+0.05	0.02+0.02	0.05+0.05	0.2+0.1	1.0+0.5	f/1 kHz*1.0 + f/1 kHz*1.0
Power	0.16+0.1[2]	0.032+0.05[4]	0.03+0.01[4]	0.08+0.05[4]	0.32+0.1[4]	1.6+0.5[4]	f/1 kHz*1.6 + f/1 kHz*1.0[4]

Accuracies valid for:	1. Sinusoidal voltages and currents 2. Ambient temperature (23±3) °C 3. Warm-up time 1 h 4. The maximum peak value for power is the product of the maximum peak value for voltage and the maximum peak value for current.	5. 0 ≤ λ ≤ 1 (power factor) 6. Current and voltage 10 % … 110 % of nominal value 7. Adjustment carried out at 23 °C 8. Calibration interval 12 months
Other values	All other values are calculated from current, voltage and power. Accuracy resp. error limits are derived according to context (e.g. S = I * U, ΔS / S = ΔI / I + ΔU / U).	

[1) 2) 3) 4)] only valid in range 10 … 32 A:

[1)] additional uncertainty $\pm \frac{80\,\mu A}{A^{2.1.1}} * I_{trmS}^{2.1.1}$ [2)] additional uncertainty $\pm \frac{80\,\mu A}{A^{2.1.1}} * I_{trmS}^{2.1.1} * U_{trms}$ [3)] additional uncertainty $\pm \frac{80\,\mu A}{A^{2.1.1}} * I_{trmS}^{2.1.1}$ [4)] additional uncertainty $\pm \frac{80\,\mu A}{A^{2.1.1}} * I_{trmS}^{2.1.1} * U_{trms}$

[e)] Accuracy specification after non-persistent zero adjustment, temperature change after zero adjustment max. ±1 °C

Voltage measuring ranges U*										
Nominal value (V)	3	6	12.5	25	60	130	250	400	600	1000
Max. trms value (V)	3.3	6.6	13.8	27.5	66	136	270	440	660	1000
Max. peak value (V)	6	12	25	50	100	200	400	800	1600	3200
Overload protection	1000 V + 10 % continuously, 1500 V for 1 s, 2500 V for 20 ms									
Input impedance	2.69 MΩ, 4 pF									
Earth capacitance	< 90 pF									

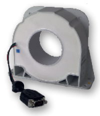
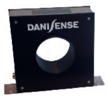
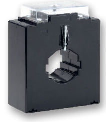
Current measuring ranges I*														
Nominal value (A)	0.005	0.01	0.02	0.04	0.08	0.15	0.3	0.6	1.2	2.5	5	10	20	32
Max. trms value (A)	0.0055	0.011	0.022	0.044	0.088	0.165	0.33	0.66	1.32	2.75	5.5	11	22	32
Max. peak value (A)	0.014	0.028	0.056	0.112	0.224	0.469	0.938	1.875	3.75	7.5	15	30	60	120
Input impedance	ca. 2.2 Ω		ca. 600 mΩ			ca. 80 mΩ			ca. 20 mΩ			ca. 10 mΩ		
Overload protection permanent (A)	LMG in operation 10 A								LMG in operation 32 A					
Overload protection short-time (A)	150 A for 10 ms													
Earth capacitance	< 90 pF													

Sensor inputs U_{SENSOR}, I_{SENSOR}								
Nominal value (V)	0.03	0.06	0.12	0.25	0.5	1	2	4
Max. trms value (V)	0.033	0.066	0.132	0.275	0.55	1.1	2.2	4.4
Max. peak value (V)	0.0977	0.1953	0.3906	0.7813	1.563	3.125	6.25	12.5
Overload protection	100 V continuously, 250 V for 1 s							
Input impedance	100 kΩ, 34 pF							
Earth capacitance	< 90 pF							

Isolation	All current and voltage inputs are isolated against each other, against remaining electronics and against earth. Max. 1000 V / CAT II resp. 600 V / CAT III resp. 300 V / CAT IV
Synchronization	Measurements are synchronized on the signal period. The period is determined based on „external", u(t) or i(t), in combination with configurable filters. Therefore readings are very stable, especially with PWM controlled frequency converters and amplitude modulated electronic loads.
Scope function	Graphical display of sample values over time in two scopes with 8 signals each
Plot function	Two time (trend-) diagrams of max. 8 parameters each, max. resolution 10 ms
External graphics interface (L6X1-OPT-DVI)	DVI interface for external screen output
Harmonics at device level (L6-OPT-HRM)	Harmonics and interharmonics up to 2000th order, independent and simultaneously
CE Harmonics (L6-OPT-HRM)	According to IEC EN 61000-4-7
Flicker (L6-OPT-FLK)	According to IEC EN 61000-4-15
LMG Remote	LMG600 expansion software, basic module for remote configuration and operation via PC
LMG Test Suite	LMG600 software for conformity tests according to: IEC EN 61000-3-2 & 61000-3-12 for harmonics (LMG-TEST-CE-HRM) IEC EN 61000-3-3 & 61000-3-11 for flicker (LMG-TEST-CE-FLK) IEC 62301 & EN 50564 for standby power (LMG-TEST-CE-STBY)
Miscellaneous Touch screen Dimensions Weight Protection class Electromagnetic compatibility Temperature Climatic category Line input	 7 inch display (1024x600) LMG611: Table-top version: (WxHxD) 433 mm x 177 mm x 200 mm Depending on installed options: max. 7.2 kg EN 61010 (IEC 61010, VDE 0411), protection class I / IP20 in accordance with EN 60529 EN 61326 5 … 40 °C (operation) / -20 … 50 °C (storage) Normal environmental conditions according to EN 61010 100 … 230 V, 47 … 63 Hz, max. 200 W

Accessories program (excerpt)

Current sensors

Type	Ring-type transducers					Current clamps		Shunt
								
Name	PCT	Hallxxx-L6	DS	WCT	LMG-Z5XX	L60-Z406, L60-Z60/66	L60-Z68	LMG-SH (-P)
Signal type	AC+DC			AC		AC	AC+DC	AC+DC
Current ranges	200…2000 A_{rms}	100…2000 A_{rms}	50…7000 A_{rms}	100 … 1000 A_{rms}	750 A_{rms} … 10 kA_{rms}	40…3 kA_{rms}	1 kA_{rms}	22 mA_{rms}…1 A_{rms}
Best accuracy	0.01 %	0.5 %	0.01 %	0.25 %	0.02 %	0.2 %	2.0 %	0.15 %
Max. bandwidth	DC…1 MHz	DC…100 kHz	DC…1 MHz	30 Hz…1 MHz	15 Hz…5 kHz	5 Hz…50 kHz	DC…2 kHz	DC…100 kHz
Power supply by LMG611	PCT200/600/1200	Yes	No	Not required		Yes		Not required
Plug 'n' Measure	PCT200/600/1200	Yes	No	No		Yes		No

High-voltage dividers

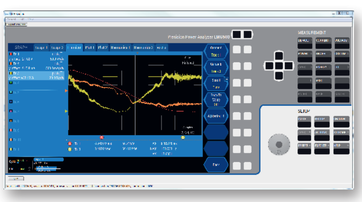
Name	HST3	HST6	HST9	HST12
Signal type	AC+DC			
Max. voltage	3.5 kV_{eff}	7 kV_{eff}	10,5 kV_{eff}	14 kV_{eff}
Best accuracy	0.05 %			
Max. bandwidth	0 Hz…300 kHz			
# of phases	1 to 3			
Plug 'n' Measure	No			

Breakout box

Name	LMG-MAS	LMG-MAK1
Nominal voltage	250 V	300 V
Category	CAT III	
Safety standard	IEC / EN61010-1	
Socket for load connection	16 A 250 V CEE 7/4	10 A 250 V IEC 60320-C14

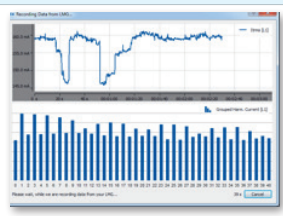
The Breakout Boxes enable access to the individual lines in a connector for measurement and provides an easy and elegant way to take measurements on single-phase loads.

LMG Remote



The LMG Remote PC software allows to easily control the LMG600 series remotely from a Windows PC. Since this software mimicks the measuring device itself down to the last detail, the LMG600 series can be operated as usual, even from the PC - no rethinking required, no familiarization time.

LMG Test Suite



The tests performed by LMG Test Suite are in accordance with the currently valid edition of EN 61000-3-2/-12, EN 61000-3/-11, IEC 62301 and EN 50564. Measurements according to ECE R-10.4 Annex 11 (electromagnetic compatibility of vehicles), for example, are also possible.

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