

# Test systems for CE-compliance



## **CE-Test61k**

**Harmonic test**

(incl. 2 kHz to 9 kHz band)

**and Flicker acc. to EN 61000-3**

## **CE-Test-Standby**

**Standby power consumption**

**test acc. to IEC/EN 62301**

# Requirements for the CE mark

Electrical installations, systems and devices which are to be marketed within the European Union (EU) must comply with the European Union directives and regulations. The manufacturer resp. the importer is obliged to verify and mandatorily declare this with the CE mark.

Amongst others, directives concerning electromagnetic compatibility and environmentally suitable designs of energy-using products (e.g. the European Directive 2009/125/EC on ecodesign) have to be adhered and implemented.

## Harmonics and flicker test

(pages 2-4)

The **ZES ZIMMER** compliance test system **CE-Test61k** allows to test products interferences towards the power distribution system caused by current harmonics in accordance with EN 61000-3-2/-12 and flicker in accordance with EN 61000-3-3/-11 (directive 2004/108/EU).

Additionally it is possible to measure and document perturbations of the public power system in the frequency range from 2 kHz to 9 kHz according to EN 61000-4-7 annex B.

## Stand-by power compliance test

(pages 6-7)

The **ZES ZIMMER CE-Test-Standby system** offers monitoring the power consumption in standby mode of home appliances, IT devices and similar equipment. The system tests conformity with the requirements of the EU directive on ecodesign 2009/125/EU, in conjunction with regulation 1275/2008 and in accordance with IEC/EN 62301. The different components of the system – the precision power measurement devices **LMG95** and **LMG500**, current and voltage sensors as well as power sources – can easily be integrated into other test systems such as dedicated efficiency or consumption measurement in more general operations.

## CE-compliance test system for current harmonics and flicker

Standards concerning the electromagnetic compatibility of a product classify the permissible degree of electromagnetic interference emission as well as immunity to it. Two different types of electromagnetic interference emissions that affect the public power system are considered: current harmonics and flicker.

Even with a purely sinusoidal voltage, an electrical device with a non-linear load characteristic creates current harmonics. Through the impedance of the mains, these harmonics cause voltage drops and distort the line voltage. These device generated harmonics are therefore the cause for a reduced line voltage and quality of the AC power network.

In addition to that, certain devices such as stoves, instant water heaters, etc. operate by switching the power repeatedly on and off. These sudden load changes result in line voltage variations perceived as fluctuations in the brightness of electric illumination, technically-called flicker. This is as well an undesired perturbation of the power network quality.

Measuring methods and limits for these low-frequency perturbations on the mains caused by current harmonics and flicker are specified in various standards. A product may only bear the CE mark if conformity to these standards has been verified and documented.

The standards distinguish between frequency ranges and current ranges. The standards EN 61000-3-2 and -12 apply to current harmonics up to the 40th order. The compliance test regarding flicker is specified in the standards 61000-3-3 and -11 (see adjacent table). For example, standard EN 61000-3-2 for devices of a nominal current up to 16 A defines the measuring and evaluation methods as well as the limits for permissible current harmonics in the frequency range up to 2 (2.4) kHz. There are 4 different classes (A, B, C, and D) for equipment under test that have different limit values for current harmonics.

**ZES ZIMMER** provides the system **CE-Test61k** for compliance tests corresponding to standards EN 61000-3-2, -3, -11 and -12. The precision power analyzers **LMG95** and **LMG500** comply with the standards for measurement devices EN 61000-4-7 for harmonic analyzers and standard EN 61000-4-15 for flicker meters. For validating the confirmation to the standards for current harmonics, the device under test must be fed by a power source with a purely sinusoidal and stable output voltage. This is essential in order to prove that the measured current harmonics are generated by the device under test and do not originate from the source. Therefore the **ZES ZIMMER LMG** devices test the voltage stability and that distortions by harmonics are within permissible limits during each analysis interval.

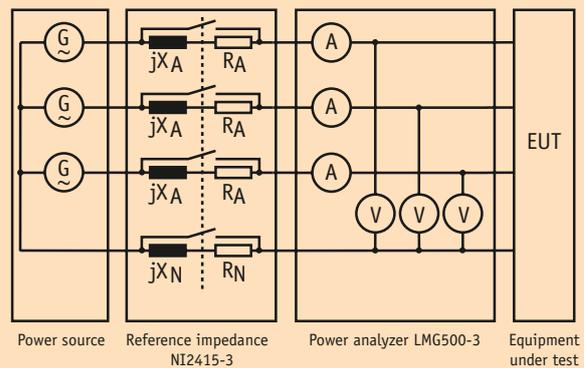
In addition to a power source, the flicker test requires a well-defined reference impedance. Flicker is determined by the amplitude and occurrences of line voltage fluctuations. Voltage fluctuations are the result of current variations induced by the consuming device at the reference impedance. In order to obtain results which can be compared with others, a normalized line impedance must be inserted between the feeding source and the test sample when measuring flicker. The impedance values for these reference impedances are defined as  $(0.24+j0.15) \Omega$  in the phases and  $(0.16+j0.10) \Omega$  in the neutral. The test software allows to record all device settings and measured data and to process them into a test protocol that is mandatory for the CE declaration.

		Current Harmonics		Flicker	
Current range	Frequency range	Test standard	Measurement device standard for current harmonics analyzers	Test standard	Measurement device standard for flicker meter
up to 16 A	up to 2 (2.4) kHz, i.e. up to the 40th harmonics at 50 (60) Hz	EN 61000-3-2	EN 61000-4-7	EN 61000-3-3	EN 61000-4-15
16 A to 75 A		EN 61000-3-12		---	
0 to 75 A	2 (2.4) to 9 kHz	---	EN 61000-4-7 Annex B	EN 61000-3-11	

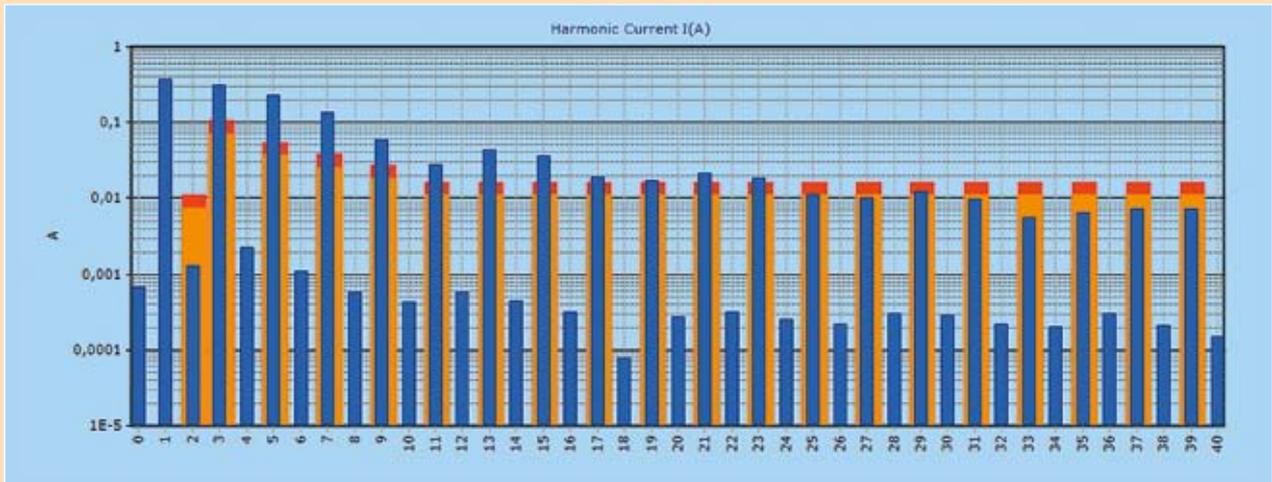
Standards for testing and measurement devices for line interferences caused by current harmonics, depending on current and frequency range, and by flicker, depending on current range

Device class	Type of device
Class A	<ul style="list-style-type: none"> <li>• Symmetric three-phase devices</li> <li>• Home appliances, except devices that belong to class D</li> <li>• Electrical tools, except portable electrical tools</li> <li>• Dimmer for bulbs</li> <li>• Audio equipment</li> <li>• Devices that do not match classes B, C or D</li> </ul>
Class B	<ul style="list-style-type: none"> <li>• Portable electrical tools</li> <li>• Arc-welding equipment for private use</li> </ul>
Class C	<ul style="list-style-type: none"> <li>• Lighting equipment</li> </ul>
Class D	<ul style="list-style-type: none"> <li>• Devices of the following type of which the power goes below or equals 600 W: <ul style="list-style-type: none"> <li>- PCs and monitors for PCs</li> <li>- TV sets or radio receivers</li> </ul> </li> </ul>

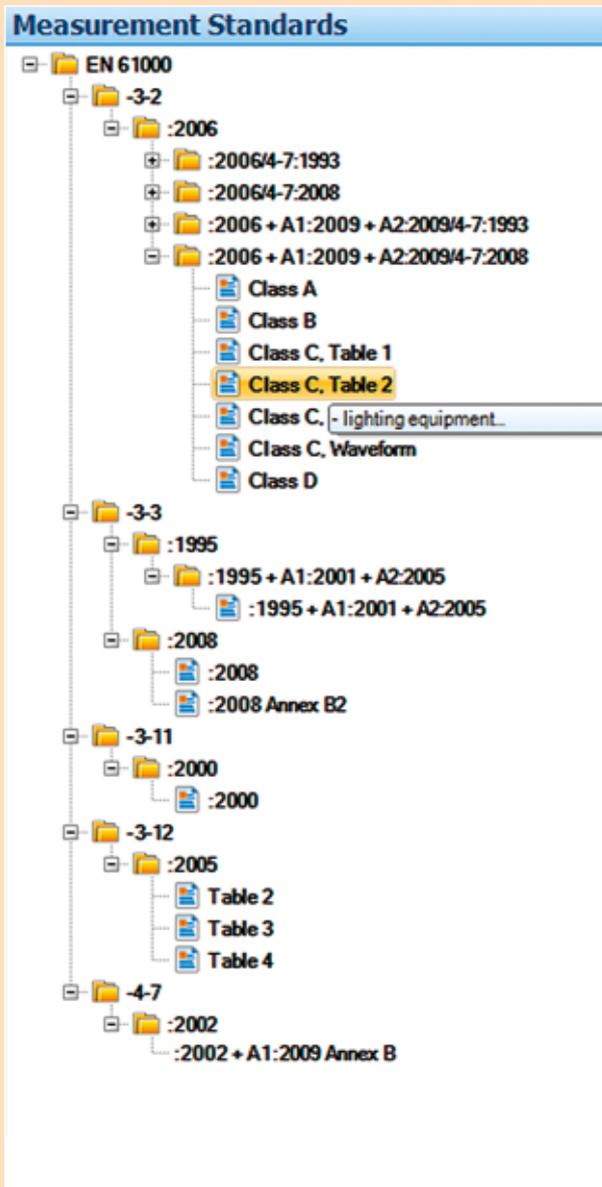
Device classes according to EN61000-3-2



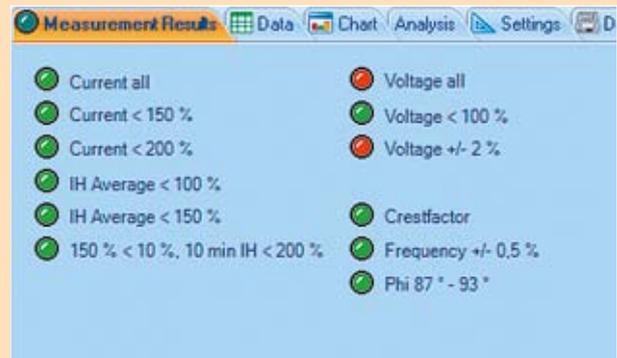
Test set-up for measurements according to EN61000-3, 3-phase



CE-Test61k: display of results of the just completed analyzing window as bar diagram. The measurement values are displayed in blue, the 100% limit values in yellow, and 150% limit exceeds in orange.



CE-Test61k: standards of both current and still valid norms. The clearly arranged tree structure facilitates selecting a standard. According to the chosen test standard, the type of device is assigned to the respective class and displayed (here: class C, lighting equipment).



CE-Test61k: Display of a measurement in progress. The left column contains a summarization for current harmonics; the characteristics of the test voltage from the power source are displayed in the right column.

Order no.	Description
CETEST61K-1PL95	Hard-/software package for test system CE-Test61k, single-phase with LMG95, reference impedance, without power source.
CETEST61K-1PL50	Hard-/software package for test system CE-Test61k, single-phase with LMG500-1, reference impedance, without power source.
CETEST61K-3PL50	Hard-/software package for test system CE-Test61k, three-phase with LMG500-3, reference impedance, without power source.
CETEST61K-SOFT	Software for test system CE-Test61k
CETEST61K-SW-01	Option 01 for CETEST61k-SOFT, current harmonics analysis 2-9 kHz according to EN 61000-4-7, Annex B
NI2415-1	Reference impedance for CE-Test61k, single-phase
NI2415-3	Reference impedance for CE-Test61k, three-phase
CETEST-STBY-SW	Software for measurement of standby power according to IEC/EN 62301

Products for CE test systems

# Disturbances to the public power system caused by current harmonics in the frequency range from 2 kHz to 9 kHz

Current harmonics caused by home appliances are measured and evaluated up to the 40th harmonic (2 kHz for a line frequency of 50 Hz) according to EN 61000-3-2 and -12. For frequencies of 9 kHz and higher the common EMC standards apply. The frequency range from 2 kHz to 9 kHz is, however, to a large extent not standardized so far. Distortions in this frequency range originate for example from decentralized sustainable energy sources such as photo voltaic or wind power stations. Therefore these effects in the frequency range from 2 kHz to 9 kHz are already existent and will certainly increase in future, necessitating appropriate measurement methods.

The standard EN 61000-4-7, Annex B, describes a process to measure the parts of the signal above the 40th harmonic and to cluster the output. In summary, the standard stipulates the fulfillment of the following points:

- DFT with 200ms rectangular window
- No gaps, no overlapping
- Groups of 200 Hz, each with 40 lines in intervals of 5 Hz:
  - In 50 Hz systems, the first group begins at 2005 Hz, the 35th group finishes at 9 kHz.
  - In 60 Hz systems, the first group begins at 2405 Hz, the 33rd group finishes at 9 kHz.
  - The groups are named by their center frequency. For example the current of the first group at a line frequency of 50 Hz is called  $I_{2100}$  and the voltage of the last group  $U_{8900}$

The system **ZES ZIMMER CE-Test61k** allows measurements in the frequency range from 2 kHz to 9 kHz in full compliance with this standard. Future updates for software and firmware will enable the system to remain compliant. In comparison with the fundamental oscillation, the signals to

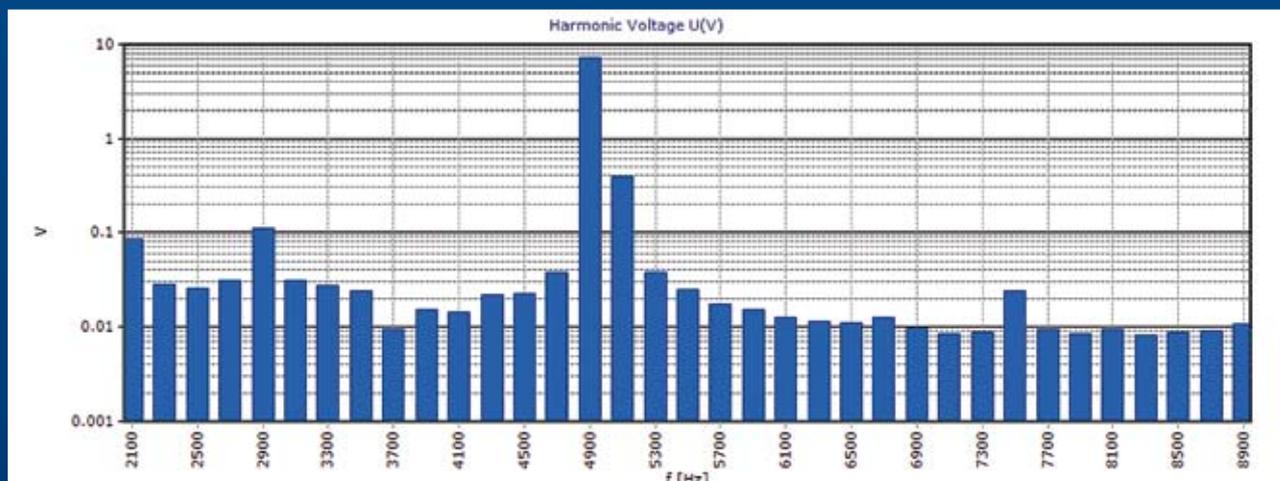
be measured in the above frequency range usually have a very low level. The high precision of both the precision power analyzers **ZES ZIMMER LMG95** and **LMG500** and our power and voltage sensors come to an advantage here by offering a direct measurement of these signals.

Type of sensor	Nominal value	Error at 9 kHz
Current clamp LMG-Z406	40 A	1%
High Current Wideband AC Measuring Transformer WCT100	100 A	0.25%
Precision Wideband High Voltage Divider HST12	12 kV	0.2%
Precision Wideband High Voltage Divider HST30	26 kV	0.5%

**Available ZES ZIMMER Current- and Voltage Transformers, each with nominal value and error rate at 9 kHz**

In order to improve the reproducibility of tests, the line impedance viewed by the EUT (equipment under test) must be exactly defined. An artificial-mains network with a impedance in the frequency range from 2 kHz to 9 kHz according to the standard above needs to be inserted between the device under test and the power source. Not mandatory – but highly recommended – is the use of a programmable AC power source (see page 8).

However, for currents in the range of 16A to 75A the construction of an artificial power line is quite complex, hence, the testing devices are normally being connected directly to the power system. If users also want to analyze the voltage harmonics, they can use a wide-band precision high voltage divider of the series **ZES ZIMMER HST** to directly measure at the medium-voltage grid.



**CE-Test61k:** Current harmonics measurement result of a 200 ms time frame in the frequency range from 2 kHz to 9 kHz. Please note the distinct perturbation at 5 kHz.

# CE-compliance test systems for ecodesign requirements

The directive 2009/125/EU establishes a framework for the setting of ecodesign requirements for energy-related products. The goal of this initiative is to reduce the effects of products on the environment and to achieve energy savings during their whole life cycle.

For many energy-consuming products, regulations have been issued by the EU in order to accomplish directive 2009/125/EU. These are guidelines regarding the environmentally suitable design of the respective product, the conformity assessment and the review procedure of the surveillance authority.

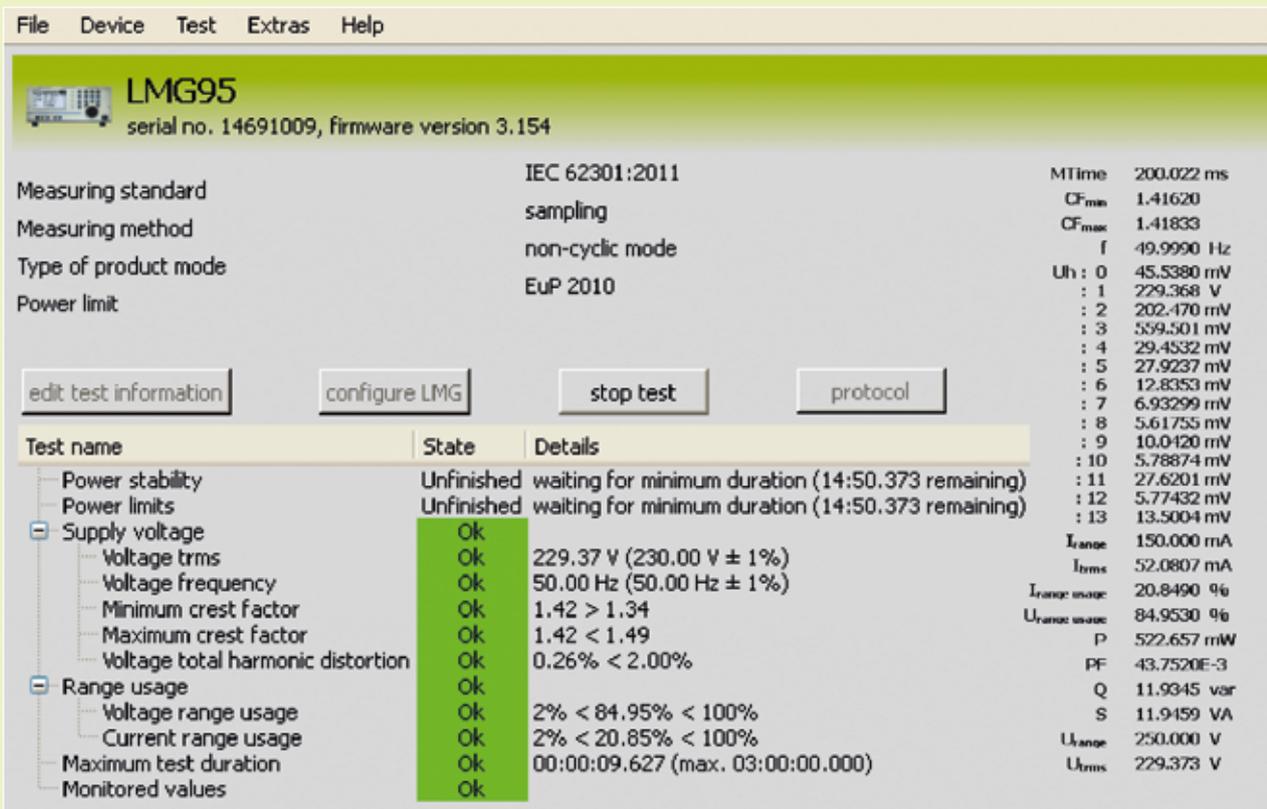
Depending on the product, parameters like efficiency, consumption and standby performance have to be measured. For example, minimum energy efficiency is set for electric motors and lamps. For television sets and refrigerators, the maximum power input is defined depending on the size of the screen or the cooling capacity.

The **ZES ZIMMER precision power meters** measure the related electrical parameters with very high accuracy and – by utilizing an AC power source (see page 8) – the test results become reproducible.

Standby- and off-mode electric power consumption are regulated by the EU regulation 1275/2008. It covers a broad range of equipment from home appliances, certain IT devices for private use, consumer electronics, electric toys, and up to equipment for sports and leisure.

Application categories	EU regulation no.	Efficiency	Consumption	Standby losses
Standby losses	1275/2008			X
Set top boxes	107/2009		X	X
Household lamps	244/2009	X		
Luminescent screen tubes, high intensity discharge lamps, chokes	245/2009	X		
Power supplies	278/2009	X		
Electric motors	640/2009	X		
Glandless circulators	641/2009	X		
Television receivers	642/2009		X	X
Household refrigerating appliances	643/2009		X	
Household washing machines	1015/2010		X	
Household dishwashers	1016/2010		X	

Regulations to implement the directive 2009/125/EU for of ecodesign requirements for energy-related products



CE-Test-Standby: Display of a test in progress. Shown are the aggregated test results in the center as well as the measuring values of the last time frame on the right-hand side.

This regulation defines strong requirements for both the products to be tested and on the test equipment. For example, the power consumption of a home appliance or an office machine without displaying the status in the off-mode may not exceed 1 W. As of 2013 the power consumption ought to be further reduced to less than 0.5 W. The power consumption shall be determined reliably, accurately and reproducibly with state-of-the-art test equipment and procedures. The measurement uncertainty of power of 0.5 W or higher may not exceed 2 %, and for less than 0.5 W it shall not more than 0.01 W. As standby circuits mostly have very low power factors and very high crest factors, the accuracy of the measurement device must be up to two magnitudes higher than the accuracy defined in the standard (see also **ZES ZIMMER application note no. 102** under [www.zes.com](http://www.zes.com)).

## Standby power compliance certification made easy

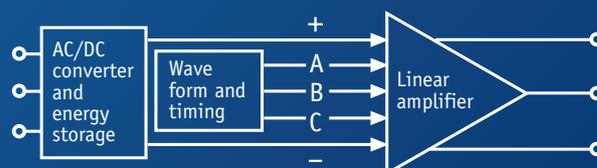
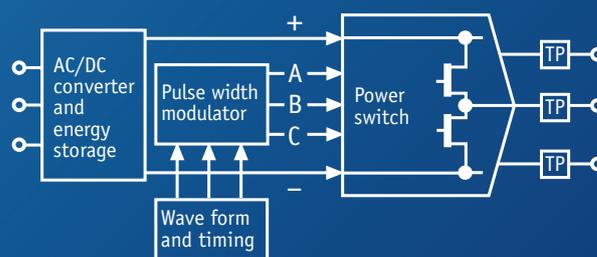
The **ZES ZIMMER** test software **CE-Test-Standby** in connection with a precision power meter **LMG95** or **LMG500** measures the power consumption in compliance with the standard IEC/EN 62301. The software allows for configuring the measuring device, defining the test procedure and issuing a test protocol compliant with the standard. For fluctuating power consumption, the standard specifies averaging of the measuring values; in cases of very constant power consumption, the measuring values can be directly used as a quick test result. The software records the current power consumption as well as the average, the average time and the duration of the test. It surveys the frequency, voltage and wave form (crest factor and THD) of the feeding source as well as the input range utilization of the power meter.

# Power sources

Because of their technology, switched power sources are highly efficient, more compact and even cheaper than linear power sources. Therefore they are quite often being used in compliance test systems for harmonics and flicker. They can supply the maximum current even under reactive loads with low or even very low power factors and are superior in this aspect to linear power sources.

ZES ZIMMER, however, offers linear power sources as well, if – due to the type of the device under test, respectively the test to be performed – the output signal ought to fulfill the following requirements:

- Minimal distortion of the output voltage
- Very high frequency band-width
- Very low output impedance
- Very high current range without distortion of the output voltage
- Exclusion of any possible interaction (resonances or oscillations) between the (low pass) output filter of the switched power source and the device under test.



Simplified diagram of switched and linear AC power sources. The unregulated and distorted AC voltages of the single- or three-phase input are being converted to regulated and undistorted AC through PWM resp. linear amplifiers.

Type of AC source	Model	Apparent power output $S_{cont}$	No. of phases	Continuous current $I_{cont}$ (per phase, 0 ... 270 V)	Frequency range (0 ... 300 V)
PWM AC sources	801 RP	0.8 kVA	1	3 A	16 ... 500 Hz
	1251 RP	1.25 kVA	1	4.6 A	16 ... 500 Hz
	2001 RP	2 kVA	1	6.7 A	16 ... 5 kHz
	2003 RP	2 kVA	3	2.5 A	16 ... 5 kHz
	3001 i	3 kVA	1	11 A	DC, 16 ... 500 Hz
	5001 i-400	5 kVA	1	18.5 A	DC, 16 ... 500 Hz
	9003 i	9 kVA	3	11 A	DC, 16 ... 500 Hz
	15001 i-400	15 kVA	1	55.5 A	DC, 16 ... 500 Hz
	15003 i-400	15 kVA	3	18.5 A	DC, 16 ... 500 Hz
Linear AC sources (4-quadrant amplifier)	LAS 1000	1 kVA	1	3.7 A	DC ... 5 kHz (-3db)
	LAS 2000	2 kVA	1	7.4 A	DC ... 5 kHz (-3db)
	LAS 5000	5 kVA	1	18.5 A	DC ... 5 kHz (-3db)
	LAS 15000	15 kVA	3	18.5 A	DC ... 5 kHz (-3db)
	LAS 60000	60 kVA	3	74 A	DC ... 5 kHz (-3db)

Synchronized and linear power sources for various test environments

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