ZES ZIMMER precision power analyzer for Energy Star®

Rev. 1.01

Energy Star® is an international standard which has been defined in the United States of America in 1992. Since today countries like Canada, Japan, Taiwan and the European Union have adopted the standard. Energy Star® defines major groups of products:

Appliances * Computers & Electronics * Heating & Cooling * Lighting and Fans.

Attributes that have to be fulfilled by the test equipment:

***Characteristics taken from IEC62301*:**	*LMG95*	*LMG500*
Power resolution of 1mW or better	✔	✔
Meet current crest factor of 3 or better	✔	✔ 1)
Lower bound on the current ranges of 10mA or less	✔	✔ 2)
Frequency response of at least 3 kHz	✔	✔
Calibration with a standard that is traceable to the national institute of standards	✔	✔
Accuracy requirements taken from ENERGY STAR® program requirements for computers:		
Meet the power resolution requirements: 10mW @ ≤ 10W, 100mW @ ≤ 100W, 1W above 100W	✔	✔
Distributes uncertainty of less than or equal to 2% at the 95% confidence level for measurements of 0.5Watt or greater and less or equal to 10mW below 0.5W	✔	✔
Long–term measurements of energy requirements and average power over any user selected interval	✔	✔

1) The ZES ZIMMER® precision power analyzers LMG working principle is digital sampling at high sampling rate. This principle is not dependent from the current and voltage waveform and works as long as the signal peak value fits in the appropriate measuring range. The current signal has an effective value Ieff and a peak value Ipk and so a crest factor CF=Ipk/Ieff. The auto range logic ensures that the peak value of the LMG range is larger than the signal peak value, so independent from the meters nominal range names, the signal crest factor can be arbitrary.

2) The power tolerance for lowest currents in 115V systems of LMG500 is due to its excellent accuracy nearly ten times better than the ENERGY STAR® accuracy requirement. Despite a lower bound on the LMG500 current ranges of 20mA (instead of 10mA) and independently from the current drawn by the unit under test, the following error calculation shows that the accuracy of LMG500 is more than sufficient:
$\Delta P = 0.015\% * P + 0.01\% *$ power range
with power range = 200Vpk * 56mApk = 11.2VA (Urange: 130Vnom, 200Vpk; Irange: 20mAnom,56mApk)
$\Delta P = 0.015\% * P + 1.12mW$ << 10mW for P<0.5W

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ZES ZIMMER® Precision power analyzers LMG95 or LMG500 can be used for measurement of these attributes - in direct mode, using only one (the same) socket pair for the low standby as well as for high operation currents.

Using an additional external shunt increases the accuracy for low power measurements. ZES ZIMMER® provides these shunts with overload protection.

Power uncertainty sample calculation for LMG95

While
U=110V, CF=1.41 -> Upk=155.1Vpk
I=10mA, CF=8 -> Ipk=80mApk
PF=0.5; f=60Hz

for 130V range full scale is 200Vpk
for 150mA range full scale is 469mApk
-> power range =200Vpk*469mApk=93.8VApk

P=U*I*PF=110V*10mA*0.5= 0.55W

Measuring uncertainty for active power:

ΔP = 0.015% of measuring value + 0.01% of power range

ΔP = 0.015% * 0.55W + 0.01%*93.8VApk = 9.46mW

permissable uncertainty by ENERGY STAR®: 11mW

Note: despite a huge current crest factor and a low power factor as well low current the standard LMG95 fulfills the ENERGY STAR® requirements.

Power uncertainty sample calculation for LMG500

While
U=230V, CF=1.41 -> Upk=324.3Vpk
I=10mA, CF=5 -> Ipk=50mApk
PF=0.1; f=60Hz

for 250V range full scale is 400Vpk
for 20mA range full scale is 56mApk
-> power range =400Vpk*56mApk=22.4VApk

P=U*I*PF=230V*10mA*0.1= 0.23W

Measuring uncertainty for active power:

ΔP = 0.015% of measuring value + 0.01% of power range

ΔP = 0.015% * 0.23W + 0.01%*22.4VApk = 2.27mW

permissable uncertainty by ENERGY STAR®: 10mW

Note: despite a huge current crest factor and a very low power factor as well low current the standard LMG500 largely fulfills the ENERGY STAR® requirements.

ZES ZIMMER® provides a free of charge application note “Measurement of Standby Power and Power Efficiency (#102)” at http://www.zes.com/english/download.

At a glance

- **For standby power use the wiring: "load side current measurement"**
- **Use manual range selection whenever possible**
- **Measure the current in the phase**
- **Use external shunts for better scalability and for better protection**
- **Please do not use an instrument with 0.5% basic accuracy on power. It may NOT meet the attributes of Energy Star®.**