Voltech

Standby Power Technical Article

Rev: 86-653/1

Date: 28 Oct 08

Your Power House
VP ELECTRONIQUE

Contents

1 What is Standby Power?

Standby power refers to the electric power consumed by electronic appliances while they are switched off or in a standby mode. Lawrence Berkeley National Laboratory (LBNL) has defined standby power as “Standby power is the power used while an electrical device is in its lowest power mode.” A very common user of standby power is a power adapter which has no power-off switch. Some such devices offer remote controls and digital clock features to the user, while other devices, such as power adapters for laptop computers and other electronic devices when in standby mode consume power without offering any visible features. These and many other devices are users of standby power.

2 Why is standby power important?

The wasted standby power of household electronic devices is typically very small, but the sum of all such devices within the household becomes significant. Standby power makes up a portion of homes offices and factories’ steadily rising miscellaneous electric load, which also includes small appliances, security systems, and other small power draws.

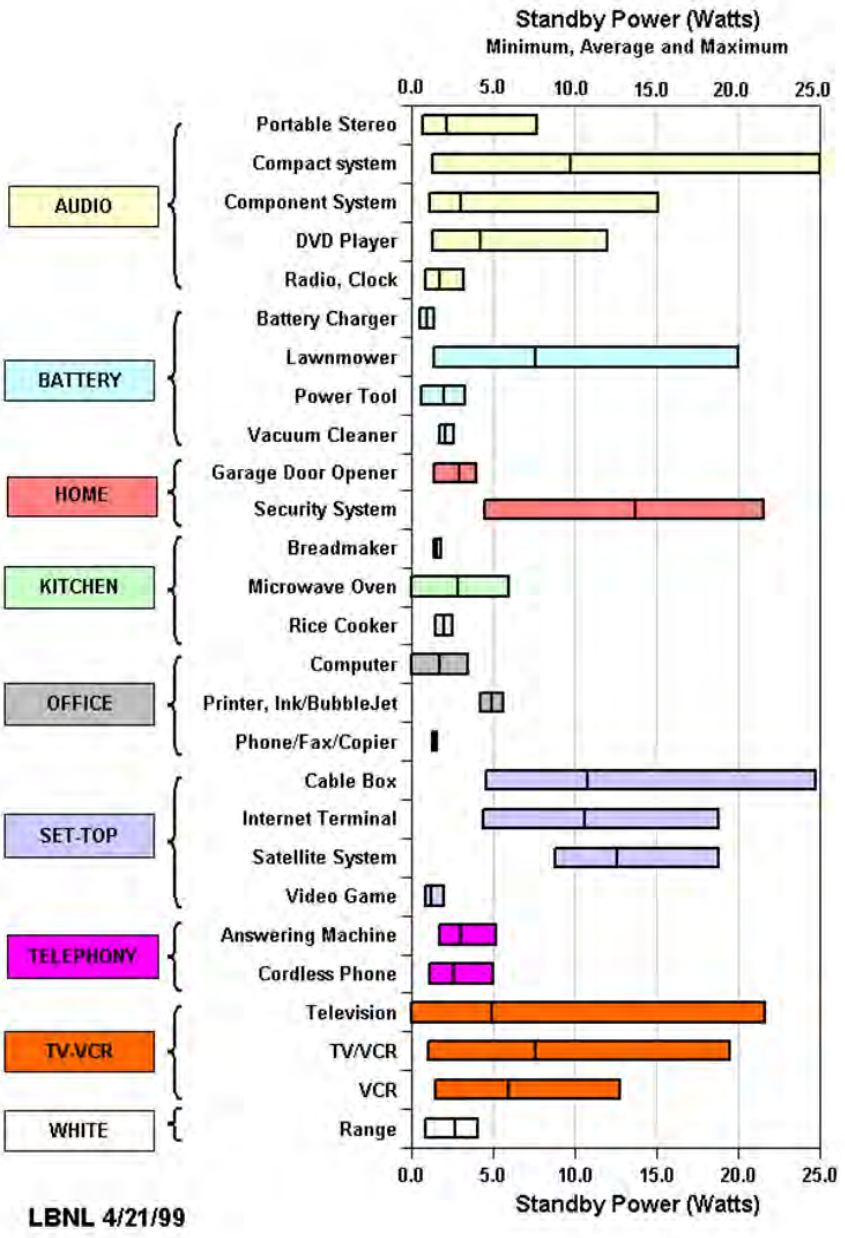
Standby power is typically 10 to 15 watts per device, and occasionally more. A 2005 study estimates the number of standby appliances in the EU at 3.7 billion. Although the power needed for functions like displays, indicators, and remote control functions is relatively small, the fact that the devices are continuously plugged in, and the number of such devices in the average household means that the energy usage can reach up to 22 percent of all appliance consumption, and around 10 percent of total residential consumption.

A study by Lawrence Berkeley National Laboratory (LBNL) in Berkeley, noted that many household appliances are never fully switched off, but spend most of the time in a standby mode. Their 2000 study showed that standby power accounted for around 10% of household power-consumption. According to America’s Department of Energy, national residential electricity consumption in 2004 was 1.29 billion megawatt hours (MWh)—10% of which is 129million MWh. The wasted energy, in other words, is equivalent to the output of 36 typical power stations.

The British Government’s 2006 Energy Review found that standby modes on electronic devices account for 8% of all British domestic power consumption. A similar study in France in 2000 found that standby power accounted for 7% of total residential consumption. Further studies have since come to similar conclusions in other developed countries, including the Netherlands, Australia and Japan. Some estimates put the proportion of consumption due to standby power as high as 13%.

3 Which appliances consume standby power?

In most countries, TVs and VCRs have the greatest total standby energy consumption. If you inspect your home and tally up the appliances, you may be surprised how many appliances use electricity all the time. And the appliances we focus on represent only a small fraction of those that exist. From remote control dog doors to automatic plant feeders, the opportunities for using standby power are nearly limitless. To get an idea of just how many appliances with standby power use are currently manufactured, check out the following chart from LBNL



4 How to measure standby power

To measure standby power accurately, you will need a suitable power analyzer. Unfortunately, few analyzers have sufficient resolution to measure standby power accurately. In addition, the analyzer must deal with equipment that draws standby power only in intermittent short bursts, or draws current having a very high ratio of peak to rms (crest factor).
Appendix A summarizes the essential requirements for measuring standby power to IEC 62301, and Appendix B for Energy Star measurements as required by Executive Order 13221
Appendix C describes how the Voltech PM1000+ Power Analyzer meets all the requirements for accurate standby power measurement.

Using the Voltech Low Power Measurement Solution

Voltech offer a complete solution to make testing to low power standards as easy as possible. The solution consists of:

1. A PM1000+ single phase power analyzer that meet the specification as defined in IEC 62301.

2. A universal breakout box that allows easy connection of the equipment under test to the power analyzer, no matter what type of plug you are using, with a few exceptions.

3. PC software that can control the power analyzer and can produce the reports required by the various standards authorities.

Connecting the Equipment Under Test

When trying to make low power measurements, the first task is to be able to connect the equipment under test to the power analyzer. While it is easy to make voltage connections, breaking the conductor to make a current measurement is more difficult. To make the process simpler, you should use the Universal Breakout Box. The box allows you to use either the internal shunt of the power analyzer, which is useful for current measurements above 50mArms, or to use the shunt within the breakout box for lower currents. The breakout box is fitted with a 1 Ohm precision shunt.

The following connections need to be made (see figure 1 below):

1. Provide the power supply that the equipment under test (EUT) will use. This is done via a standard IEC power socket that will allow you to attach a power cord suitable to your location. The other end of the power cord would be plugged in to an AC source.

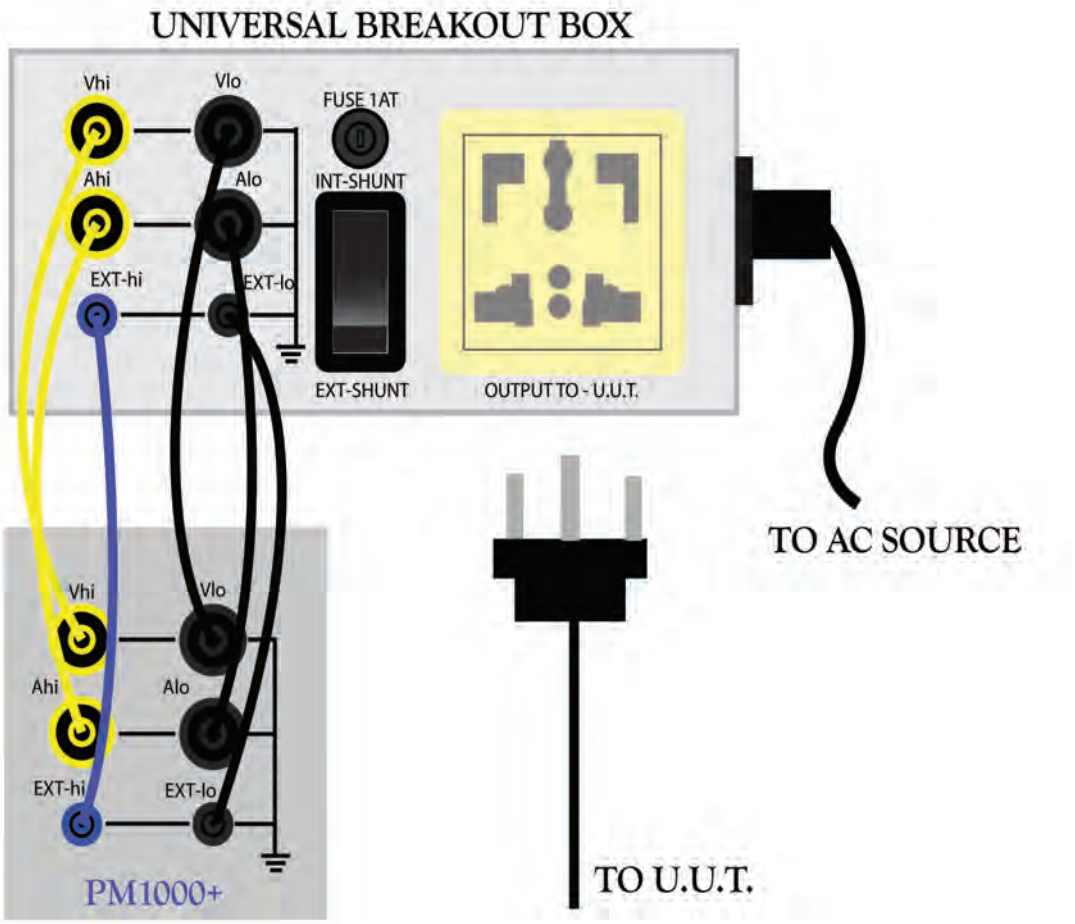
2. Connect the equipment under test to the breakout box. This is easily done by plugging the power cord of the EUT in to the universal socket on the top of the breakout box.

3. Connecting the breakout box to the power analyzer. Again, this is made to be straight forward. The layout of the connections on the breakout box are a replica of the connections on the front panel of the PM1000+. Using the yellow and black 4mm leads provided with the PM1000+, make the VHI, VLO, AHI and ALO connection. Using blue and black 2mm leads provided with the breakout box, make the EXT-HI and EXT-LO connections.

Installing the PC Software

The PC software is available on Voltech's web site in the "download software/firmware" section. Once the file is downloaded, double click on the file to run the installation program.

Figure 1 - Break out box connections



Depending on the current consumption of the EUT, you need to decided whether to use the PM1000+ internal shunt or the 1 Ohm shunt in the breakout box. If the current is greater than 1Arms, then PM1000+ internal shunt must be used.

If the equipment under test takes a large amount of current when power is first applied, and then automatically goes in to standby mode (very common on equipment such as a TV), then when power is first applied to the EUT, the breakout box should be switched to use the PM1000+ internal shunt (set switch to Internal). After the equipment has switched to standby mode, the breakout box can be switched to external shunt mode. Doing this avoids blowing the fuse that protects the 1 Ohm shunt.

Communicating with the Power Analyzer

While the PM1000+ can communicate via RS232 and USB as standard and optional via GPIB, the easiest way to communicate with the analyzer is USB. All this is required is a standard USB A plug to B plug cable available from most computer stores.

Using the PC Software

While the PC software can make many measurements, one of the main abilities is to be able to produce a report to satisfy IEC 62301, which is a measurement method standard. In order to produce a report to show how a piece of equipment measures up to IEC 62301 you should do the following with the Voltech IEC 62301 software

1. To start the PC software, go to Start -> All Programs -> Voltech Software -> IEC 62301 Software.

2. When first prompted, select either English or Simplified Chinese as a language.

3. Next, when prompted, select Yes to run the setup wizard.

4. The next step is to choose a PM1000+ (resource) to communicate with. This is the PM1000+ that you have connected to your PC. Select the appropriate one from the drop down box, and then click on Check to ensure communications are established. Now click on Finish.

5. On the next screen you will be asked to select an operating mode. This is for when you are using the software to log results and is not necessary to specify for IEC 62301. Click on Next > .

6. Next you will asked to setup up the inputs. Since you have connected your equipment under test via a break out box, the only choice to make is dependant on whether you are using the internal shunt on the PM1000+ or the external shunt inside the break out box. If you are using the internal shunt, then no changes are necessary. If you are using the 1 Ohm shunt inside the PM1000+, then in the Current Inputs section select External Shunt and set the Scaling Factor to 0.0125. Click Finish.

7. The final setup is the parameter wizard. Again, like the operational mode, this is for when you are using the software to log results. Click on Finish.

8. The software is now almost ready to run a test using the IEC 62301 method. Before a test is run, the report should be setup. To do this:

a. Click on IEC 62301 and select Export Report Setup.
b. Select a file name and location and click on OK.
c. Click on IEC 62301 and select Import Report Setup.
d. Fine the file name in the location that you previously exported to.
e. Right click on the file and select Open With… and select WordPad.
f. Fill in all the various details such as the tester name and lab. This file will be used in generating every report.
g. Save the WordPad file and close it.
h. Now select the file and click Open.

9. Click on IEC 62301 and select Standby Measurements.

10. When the EUT is ready, click on Launch Test. The test will take 5 minutes. The test report will then be shown including all the information you entered. This report can then be printed (click on the printer icon) or export to a PDF or Excel file (click on the disk icon).

If the details in the report are not correct then you can re-import them using the method detailed in step 8.

11. If the Watts results is returned as unstable (>5% variation), then you should close the report and the IEC 62301 window and then click on IEC 62301 and select Accumulated Energy (optional). This will give a more stable Watts reading as allowed by the standard. The test should then be repeated.

5 How standby power can be reduced

In spite of highly successful voluntary programs directed mainly at TVs and VCRs, overall standby use is probably still growing. The number of new appliances with electronic controls continues to grow rapidly. Based on international trends, we can expect electronic controls to be incorporated into many “white goods” -- such as refrigerators, dishwashers, and air conditioners -- within the next ten years.

Despite this, it is estimated that a 75% reduction in standby power consumption is possible in new equipment. The savings can be achieved through improvements in (1) hardware, such as power supplies, IC chips and I/O components, and (2) software, with the implementation of more efficient power management. In an effort to help manufacturers reduce standby power consumption in their products, LBNL have compiled a list of technologies presently available on their design help page. It is believed that nearly all domestic appliances can be designed to serve standby functions using no more than one quarter of what they presently use.

6 Summary

The amount of power consumed for ‘Standby Power’ is already a significant proportion of energy demand. If no action is taken, the energy consumed for standby purposes would continue to increase. This is considered unacceptable from an energy availability viewpoint and its environmental impact. This has stimulated significant legislation to reduce standby power demand.
The availability of energy efficient power control techniques in modern equipment, together with the availability of sophisticated power analyzers that make it easy to measure standby power, means that achieving lower standby power consumption is an objective that is very achievable fo us all.

Appendix A: Summary of IEC 62301-Measuring standby power

A method for testing standby power use in appliances is described in this test procedure. A summary of the key points is given below to introduce you to the general approach. However, you should consult the official document (available at webstore.iec.ch) before undertaking the test.

Scope

The test applies to all devices that are plugged into the electric mains by the end user. The test is designed to measure the energy consumption of devices while in their standby mode and other low-power modes.

Terminology

The standby power consumption is defined as the lowest power consumption while plugged into the mains power supply. Other defined terms include standby mode, rated power, voltage and frequency.

Testing Conditions

IEC 62301 defines testing conditions. The ambient temperature should be 23 (+/- 5) degrees C, with still air. The harmonic content of the supplied power shall not exceed 2% up to and including the 13th harmonic and the ratio of peak value to r.m.s. value of the test voltage (sometimes called the crest factor) shall be between 1.34 and 1.49.
The accuracy of the measuring equipment is also defined but depends on the amount of power being measured. Measurements above 0.5 W must be made with an uncertainty of less than to 2% at the 95% confidence level.
The power measurement instrument must be able to resolve:
- 0.01 W or less for power measurements below 10 W
- 0.1 W or less for power measurements above 10 W (up to 100 W)

Portable Appliances

IEC 62301 defines a “portable” appliance (that is, is intended to operate on rechargeable batteries when not connected to a power source.) For portable devices, the standby mode is measured on the charger or docking/base station with the appliance detached.

Measurement Procedure

If power consumption is stable (defined as less than 5% variation from the mean over an interval of 5 minutes), then the power consumption can be read directly from the meter; if power consumption fluctuates, then energy consumption should be measured over a period of time and then divided by the measurement period to determine average power.

IEC 62301 also lists information to be reported when making a measurement.

Appendix B: Guidelines to support Executive Order 13221 related to "Energy Efficient Standby Power Devices."

Introduction

These Guidelines have been developed to support Executive Order 13221 related to "Energy Efficient Standby Power Devices."
Please note that products covered by Energy Star standby specifications may be tested by those procedures and the results will be honored in lieu of the guidelines presented below.

Procedures for declaring the representative standby power value for a specific model are given in the submission forms.

1 Scope

This Guideline specifies methods of measurement of electrical power consumption in the standby mode. It is applicable to mains-powered electrical devices. However, it is limited to devices where the consumer is expected to connect the device to the mains with a standard plug at a standard outlet.
Note - This Guideline does not apply to "hard-wired" devices, such as smoke alarms.
This Guideline does not specify safety requirements. It does not specify minimum performance requirements nor does it set maximum limits on power or energy consumption.

This Guideline describes the measurement procedures for a single device.

2 Definitions

For the purpose of these guidelines the following definitions apply.

2.1 Standby mode

The lowest power consumption condition when the Equipment Under Test (EUT) is connected to the mains electricity supply and used in accordance with the manufacturer's instructions.
Standby power is expressed in Watts.
An EUT with a switch that completely disconnects the device from mains power will be considered to have zero standby power.

Note - Some devices may have an "off" or "power" switch, but continue to use power when switched "off."
Note - A separable "power strip" is not considered an integrated switch.
Note - The standby mode should not be confused with "sleep" mode or other reduced power modes that may be automatically initiated by the EUT. The standby mode is generally different (and consumes less power than self-initiated modes). Certain devices are not equipped with power switches but employ sleep modes to reduce power use during periods of inactivity. For these devices, the standby and sleep modes are the same.

2.2 Portable EUT

An EUT is considered "portable" if it can provide services while disconnected from mains electricity. A portable EUT typically consists of a station that plugs into mains electricity and a detachable, portable part.
Note - Examples of portable devices are: cordless telephones, rechargeable mobile telephones (or cellular phones), laptop and notebook computers, and battery-operated, rechargeable tools.

3 General conditions for measurements

3.1 General

Unless otherwise specified in the test report, the measurements shall be made under the following conditions:

3.2 Test room

The tests shall be carried out in room that has an air speed close to the appliance under test of 0.5 m/s. The ambient temperature shall be maintained at (20 ±5) °C throughout the test.

3.3 Power supply

The EUT shall be supplied at 115 Volts AC or 230 Volts AC and 50 or 60 Hertz frequency, whichever is closer to the specifications for the normal operation of the EUT. If the EUTs rated voltage differs significantly from the two specified voltages, then the EUT shall be tested at its rated voltage. The tests shall be carried out at the specified voltage ± 1% and the specified frequency ± 1%.
Any departures from these values, including the specified voltages, shall be stated in the report.

3.4 Supply voltage waveform

The total harmonic content of the supply voltage shall not exceed 5% (up to and including the 13th harmonic); harmonic content is defined as the root-mean-square (r.m.s.) summation of the individual components using the fundamental as 100%.

3.5 Measurement uncertainty and instrumentation accuracy

Power measurements shall be made with a meter capable of a resolution of less than 0.1W at 1.0W actual power consumption and accumulate into Watt-hours at a minimum power level of 20 milliwatts. The measurement period shall be no less than five minutes and as long as needed to achieve a resolution of ±0.1W in the calculation of average power use.
Instruments shall be capable of operating within their stated tolerances for input voltages at up to 5% Total Harmonic Distortion and shall be capable of operating at frequencies from 47 through 63 Hz . Power measurement instruments shall have a crest factor of not less than 5 at RMS currents of 2 amps or less.

Time measurements for each monitoring period shall be accurate to within 2 seconds.

4 Measurements

4.1 General

The purpose of this test method is the determination of the average power consumption in standby mode. The goal is to measure the energy consumption over a period of not less than 5 minutes and long enough to assure sufficient resolution in the calculation of average power.
Where the mode changes automatically, it may be necessary to operate a product through the automatic sequence several times on a trial basis to ensure that sequence is fully understood and documented before test results are recorded and reported.
Note - Some EUTs may enter a higher power state immediately after they are switched off (or after the power is first connected) before dropping back to their standby state. Some may delay their return to their standby state in “off” mode after they have finished a program or when switched to “off.”

4.2 Selection and preparation of EUT

The EUT shall be prepared and set up in accordance with the manufacturer's instructions, except where these conflict with the requirements of this test. If no instructions are given, then factory settings shall be used.
Note - If a fax machine has a hard-off switch, then it should be tested with this switch in the "on" position.

4.3 Procedure

4.3.1 Measurement procedure

Connect the EUT to the energy/power metering equipment. Select the conditions necessary to achieve operation in the standby mode. Monitor the power consumption but allow the EUT to stabilize for not less than 5 minutes. Commence energy consumption readings for a period of not less than a further 5 minutes, checking the power and equipment during the recording period to make sure that the EUT has not entered another mode. Continue measurement until the necessary measurement period is complete.
Note - Even when the EUT is in the standby mode, the instantaneous power readings may vary by a small amount during the recording period or the EUT may draw an energy pulse at regular intervals. These variations will be averaged by measuring the energy consumption over the monitoring period.

4.3.2 Measurement procedure for portable EUTs

The standby mode for a portable EUT is the lowest power requirement of the part of the EUT that is connected to mains power with the portable part detached. The measurement procedure is otherwise the same as described in 4.3.1.
Note - Cordless telephones should be tested according to the Energy Star test procedure, that is, with the handset connected to the station.

5 Evaluation

Calculate the average standby power by dividing the measured energy consumption by the duration of the measurement.
The duration of the measurement will depend on the resolution of the metering equipment.
Example - The minimum testing period (in minutes) is given by the following formula:
Minimum duration (in minutes) = [meter resolution (Wh) / required accuracy (W)] x 60 (min/h)
If the meter has a resolution of 0.01 Wh and the required accuracy is 0.1 W, then the minimum metering period is [(0.01/0.1) x 60] = 6 minutes.
The average power data shall be reported in Watts rounded to the nearest 0.1W.

6 Test report

The following information shall be recorded in the test report:

6.1 EUT details:

Manufacturer, bra
- nd, model, type, and serial number.
- description, as appropriate
- rated voltage and frequency range

6.2 Test Parameters

- ambient temperature (°C)
- test voltage (V) and frequency (Hz)
- total harmonic distortion of the electricity supply system
- information and documentation on the instrumentation, set-up and circuits used for electrical testing.

6.3 Measured data, for the standby mode:

- average power in Watts
- period of measurement (minutes)
- description of how the standby mode was achieved
- any notes regarding the operation of the EUT, including settings of software parameters and hardware switches that influence standby power use

6.4 Test and Laboratory Details

- test report number/reference
- date of test
- laboratory name and address
- test officer

Appendix C: Voltech PM1000 Power Analyzer for measurement of standby power

This document describes how the PM1000+ power analyzer fulfills the requirements of IEC62301 (2005) Household electrical appliances – Measurement of standby power, and other similar standards

IEC62301 is the European standard that describes how standby measurements are to be made, including the accuracy and resolution of the power measurement.

The PM1000 is a versatile low-cost power analyzer, ideally suited to standby power measurements. This is because the PM1000 has:

- An external shunt input that, when coupled to a simple shunt or current transducer provides the very accurate low current measurements required.
- A fast 900kHz sampling rate and a unique long-averaging mode which ensures that no data is missed and that stable measurements are achieved in the shortest possible time.
- Simple front-panel control and display of all measurements including watts, volts, amps, power factor and harmonics.

How the PM1000 Power Analyzer meets the requirements of IEC62301

IEC 62301 Clause 4.4 Voltage Supply Waveform:

Requirement	PM1000
THD: <2%	The PM1000 accurately measures THD using the rms summation formula.
	$thd = \frac{\sqrt{H2^2 + H3^2 + H4^2 + H5^2 + ...}}{H1} \text{X} 100\%$
Crest Factor: between 1.34 and 1.49	Automatic calculation of peak / rms up to CF =20

IEC 62301 Clause 4.4 Voltage Supply Waveform:

Requirement	PM1000
2% Accuracy at 0.5W or greater	The specification is 0.2% of reading +0.1% of range + 0.004 W at 50 / 60Hz. Example: A 230V load operates at 1W in standby. At a power factor of 1, the current is 1/230 = 4.3mA. The current is measured using a 10 Ohm shunt resistor, providing 10 x 4.3 = 43mV to the shunt input of the PM1000. This PM1000 automatically ranges to its 78mV range, the equivalent of 7.8mA. The voltage range is 900V, making the power range 900 x 0.0078= 7.02W Accuracy = (0.2% x 1) + (0.1% x 7.02) + 0.004 = 0.0130W Or (0.0130 / 1) x100% = 1.30%
0.01W accuracy at less than 0.5W	The specification is as above. Again, with the careful selection of the shunt, the PM1000 will meet the criteria. Example: A 230V load operates at 0.3W in standby. At a power factor of 1, the current is 0.3/230 = 1.3mA. The current is measured using a 10 Ohm shunt resistor, providing 10 x 1.3 = 13mV to the shunt input of the PM1000. This PM1000 automatically ranges to its 20mV range, the equivalent of 2mA. The voltage range is 900V, making the power range 900 x 0.002 = 1.8W Accuracy = (0.2% x 0.3) + (0.1% x 7.02) + 0.004 = 0.0064W
Resolution **Measured Power** 10mW ≤ 0.1W 0.1W ≤ 1W 1W ≤ 10W 10W ≤ 100W 100W ≤ 1000W	Resolution ≤ 10µ W ≤ 100µ W ≤ 0.001W ≤ 0.01 W ≤ 0.1 W Example: 123.45 mW 345.6 mW 1.2345 W 34.56 W 123.45 W The PM1000 displays with 4½ digit resolution: xxxx or 1.xxxx *Always better than the requirements of the standard.*

IEC 62301 Clause 5.3 Procedure:

Average power approach:
When set up with Voltech's Low Power Measurement Software, the PM1000 automatically produces average power measurements. The long-averaging mode is designed to provide accurate and stable measurements for most types of load.

Accumulated energy approach:
The integration function may be used, if desired, to provide accumulated W-h with a resolution of 0.1mW and 1s.

Conclusion and IEC 62301 Annex B. Notes on the measurement of low power modes:

When set up with Voltech's Low Power Measurement Software, the PM1000 comfortably meet the requirements of this standard. Range, resolution and accuracy requirements are easily achieved at low cost using the flexible external shunt inputs.
The PM1000 measures crest factors up to 20 and, by sampling at 900kHz, provides error-free harmonics measurements up to the 50th.

In particular, the long-averaging mode of the PM1000 has been specifically designed to enable measurements on the types of load described in B5 – Cyclic or pulsing load effects.

Declaration.
We hereby declare that the PM1000 Power Analyzer, when used in accordance with its user manual meets the requirements of IEC 62301 Ed1.0 2005.

28 Oct 2008 Dr. John Ford- President Voltech Instruments Inc

More Information

Please contact us directly via our email at: contact@vpelec.com

Voltech

Your Power House
VP ELECTRONIQUE

VP ELECTRONIQUE - 91300 MASSY - Tel 01 69 20 08 69 - contact@vpelec.com - www.vpelec.com