XiTRON TECHNOLOGIES
Manufacturers of Engineering and Production Test Equipment
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The Importance, and Difficulties, in Measuring Standby Power and Efficiency

Every time I read one of my electronics trade magazines, or e-newsletters, or one blog or another, I read something about Energy Star (or one of a multitude of other organizations) and how they are working towards improving the standby power and operating efficiency of one product or another. If you read the statistics on products such as external power supplies, it is no wonder they are starting to receive the attention they are.

- Over 3 billion external AC/DC power supplies are currently in use in the United States alone.
- About 8 to 10 billion are in use worldwide.
- More than 1 billion external power supplies are now shipped per year.
- The average American home has five to ten of these components powering devices in their homes.

The standby power of even poorly performing external power supplies may not seem that severe, but it is the shear volume of such units that compounds this problem.

- The total electricity flowing through all types of external power supplies is about 207 billion kWh/year, or approximately $17 billion a year, or 6 percent of the national electric bill.

- The external AC/DC power supply market is more than five times larger than the embedded AC/DC power supply market in unit terms and more than fifteen times larger than the DC/DC converter market. [1]
- Overall, the worldwide external AC/DC market is projected to rise from $5,023 million in 2005 to $7,656 million in 2010, a compound annual growth rate of 8.8%. [1] ([1]Darnell Group, August 2005)

While the best power supplies are more than 90% efficient, many are only 20% to 40% efficient, wasting the majority of the electricity that passes through them. As a result, today's power supplies consume a significant percentage of all U.S. electricity production. More efficient power supply designs could cut that usage in half, saving nearly $3 billion and about 24 million tons of carbon dioxide emissions per year.

In addition to running efficiency, the standby power consumption of such devices is also critical. In the electromechanical era, appliances had two operating modes: “on” (or “active”) and “off”, with “off” meaning zero power consumption. With the advent of electronics, devices could be “off” and yet still draw power. This new mode is often called “standby.” An increasing number of devices have multiple modes — such as “sleep” and “deep sleep” between standby and active. Future devices are likely to have many different operational modes between “unplugged” and “active”, each with a different level of electricity use and functionality. Many products today, such as printers and cable/satellite boxes do not even have a power switch.

Each watt consumed by an appliance in standby mode totals 8.76 kWh per annum, and costs about one US dollar (approximately one Euro) on average throughout IEA countries. ($1/W/year) In a typical Japanese or Danish home, standby losses correspond to 10% of total residential electrical consumption, while in the United States, standby losses account for about 5% (or about 50 Watts per home). Estimates of standby losses in the European Union are between 5 to 10% of total residential electrical consumption. Standby power waste may account for 1% of the World energy related CO2 emission.

The rise in standby power consumption of external power supplies could be likened to the power consumption of the modern refrigerator. Thomas Moore invented the first electric refrigerator in 1803. The first commercial refrigerator designed to keep food cold was sold in 1911 by the General Electric

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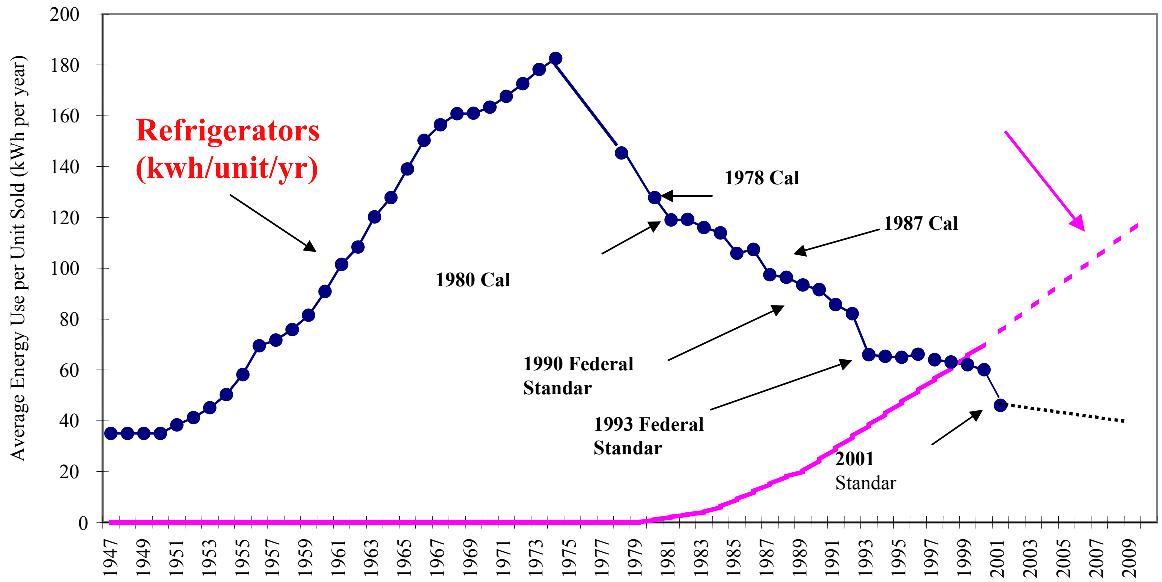
Company. Starting after World War II, the size and features of refrigerators started increasing. By the 1970s, the power consumption growth of these appliances was getting out of hand. Manufacturers realized this, but more importantly, different state and federal agencies started imposing standards on the energy usage of this popular and omnipresent device. The following graph from Ecos Consulting shows what then happened to the power consumption of the common reefer. The basic external power supply, or brick, is showing a similar energy growth curve, but there are many organizations already attempting to stem this growth before it gets out of hand.



Now that we are convinced, hopefully, as to the importance of improving efficiency and standby power, how to we test such parameters? There are many different groups, just in the US, that are working on, or have already released, standby power and efficiency test procedures, protocols or standards. Groups in the US such as Energy Star, California Energy Commission, Public Interest Energy Research (PIER), Electric Power Research Institute (EPRI), and others have released test specifications for power supplies. Often, two or more groups work together to produce the test specifications. Nonetheless, these efforts have resulted in numerous standards and test specifications for manufacturers to wade through.

Internationally, there are several countries working in conjunction with Energy Star on these initiatives such as Australia (The Australian Greenhouse Office, AGO), Canada (Natural Resources Canada, NRCan), the European Union (The European Commission, EC), Japan (The Energy Conservation Centre, ECCJ), New Zealand (The Energy Efficiency and Conservation Authority, EECA), and Taiwan (The Environment and Development Foundation, EDF).

Most of these test procedures specify the parameters to be tested, and the conditions under which the tests are to take place. Some of them go so far as to specify the exact procedures such as warm-up time, load levels, and various modes of operation, plus the accuracy or capabilities of the equipment to be used for the measurements. See Table 1.

Table 1 Topics Addressed by Test and Measurement Procedures

Topic	Comments
Purpose / Scope	Reason for creating the procedure
Basic Power Characteristics	Voltage, frequency
Power Quality	Total harmonic distortion, current, crest factor
Other Conditions	Air speed, temperature, humidity
Accuracy	Accuracy and resolution of metering equipment
Configuration	Settings, attached hardware, information environment
Usage Patterns	Percent of time in each operating mode
Mode Definitions	What to name modes, what characteristics they have
Mode Derivation	How to determine what modes a product has
Controls	Controls (e.g. switches, automatic) within the device or attached to it
Procedure Steps / Timing	Over what time interval to integrate power use
Sampling	How many units to measure
Reporting	What to record / report
Whole-house Measurements	Entire house and all devices within it

These test procedures and specifications vary from tens of pages to hundreds of pages in length. Many of the conditions or methods of measurements can be particularly challenging. As standby power continues to decrease in the best products, the power levels that must be accurately measured obviously continue to drop. This presents a challenge for many of today's power analyzers that were designed for much higher average power levels. And, as efficiencies increase and specifications get tighter, the accuracies of these same analyzers, at both standby levels and the sometimes-high running levels, are being challenged.

Some analyzer manufacturers recommend using an external current transducer (CT) for measuring the low standby levels, while still needing to measure often-high startup and running levels. As the best products get better, they are often the benchmark against which others are measured. The accuracies of such external CTs are often insufficient.

In addition, as these products increase in the complexity of their power management schemes, there is a growing need to be able to test a wide variety of parameters in many different modes. Very few power analyzers on the market today, especially at price points that make sense for such low margin, competitive markets as external power supplies, have features conducive to capturing this information.

XiTRON's 2801 and 2802 Advanced One- and Two-Channel Power Analyzers were designed specifically for these types of measurements. With basic voltage and current accuracies of better 0.08%, and accuracies of better than 0.2% at 1V or 1mA, these analyzers are well suited for these standby power levels. Even levels as low as 100mV or 150uA are supported.

On the other hand, they also support 2000Vpk and 150Apk measurement levels, harmonic measurements to the 100th, and bandwidths of 200kHz. Add to these measurement capabilities features such as harmonics bar charts, history and startup charting of most parameters with zoom and scroll capability, DC charge and discharge measurements, wiring compensation modes, and efficiency measurements, and you have analyzers uniquely suited for these tests. Startup profiling of most every electrical parameter allows both designers and manufacturers to understand exactly what their products are doing under sometimes non-ideal startup conditions. This can allow for complete product startup profiling, identifying potential product lifetime shortening conditions or undesirable operating conditions.

These analyzers even include integrated line switches and inrush waveform displays with zoom and scroll for unparalleled inrush measurement capabilities plus PASS/FAIL testing to user-defined limits to facilitate production testing. It is one thing to be able to test every conceivable situation and parameter in R&D with a very high-end, expensive analyzer. It is another thing completely to do the same on each and every production line, in a very quick and automated manner, and at a price point, that makes sense (and cents). If you plan to perform ANY standby power or efficiency testing, you need a XiTRON power analyzer.

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