



# Power Quality Testing using the WaveBook

Power Industry

## Application Note #19

Poor power quality and demand fluctuations are costly for electrical utilities and high volume electrical power users. One way that high volume users can reduce their utility costs is to determine their power and demand fluctuations and install equipment that prevents costly deviations. Generally, the equipment used for diagnosing power demand and deviations is bulky, costly, and difficult to use. One leading power industry supplier challenged the conventional approach by developing a compact, notebook PC-based power-demand and line-quality monitoring system. This unique solution is not only lightweight and easy-to-use, it also costs less than most traditional power-test equipment.

### Application Summary

Distribution inefficiencies, such as an improper factor, burden a power generation system. Also, customer-induced electrical disturbance can radiate back down the power grid and damage equipment in other grid locations. Many utilities offer rate reductions for customers who improve their power factor and correct their electrical disturbances.

To determine their power factor, users must measure RMS volts, line frequency, real power (watts), and reactive power (VARs), and then compute the ratio of real power to total volt-amps. Then, users may also need to measure other factors such as sag, swell, outage, voltage transient, flicker, and harmonic distortion.

Currently, most test equipment capable of making these data measurements costs in excess of \$15,000. In addition to being costly, this equipment is bulky and can be difficult to use because of its complicated front-panel controls.

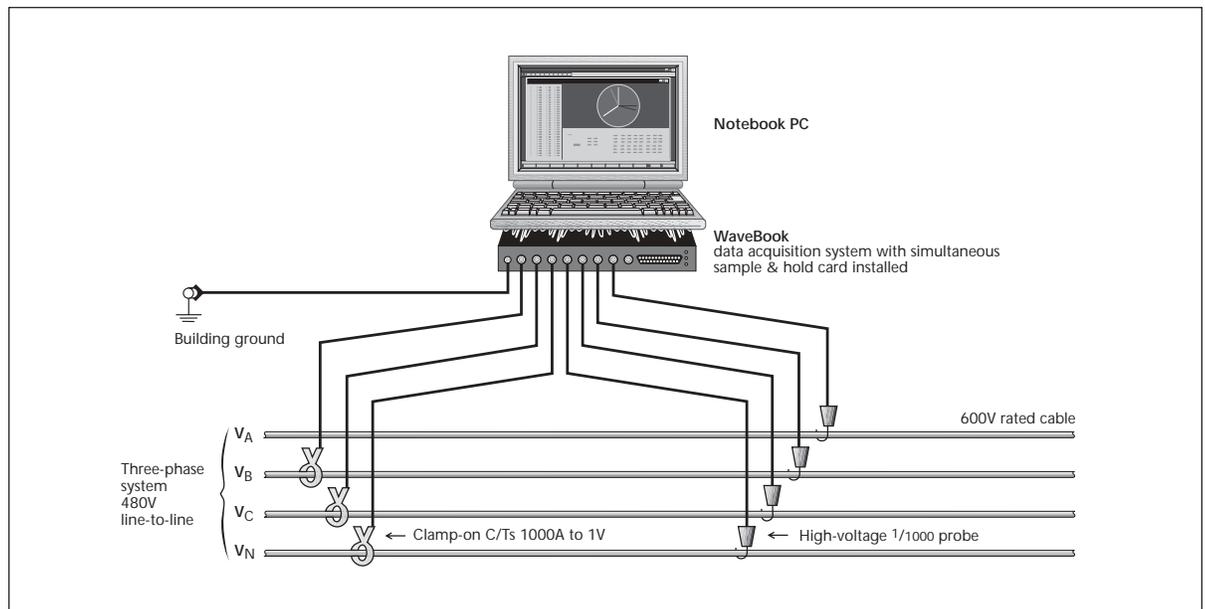
A major power industry supplier with years of software experience in simulation and analysis developed a smaller, lighter, more cost-effective solution using a portable PC supported by Windows-based software. Because Windows has become a de facto graphical user interface (GUI) standard of almost universal familiarity, it is ideal for the creation of an easy-to-use interface.

### Potential Solution

Initially, the supplier evaluated several plug-in A/D boards and rejected all of them because the boards required a "luggable" lunchbox-type computer, which was too bulky to be considered a truly portable solution.

### IOtech's Solution

After rejecting the plug-in board solution, the supplier searched for a portable digitizer. Only one portable digitizer had the speed required for the application — IOtech's WaveBook. At a mere 3.3 pounds and approximately the same size as a notebook PC, this 1 Msample/sec, 8-channel differential input digitizer provided exceptional value. Its raw



The portable power demand and quality test set-up



speed and high transfer rate allow for cycle-by-cycle over-digitization (128 samples/60 Hz cycle) on each channel, enabling real-time demand analysis. For power-quality measurements (sag, swell, outages, transients, etc.), the suppliers require a 50 kHz per channel rate, which is easily met by the **WaveBook's** maximum data sample rate per channel.

Accuracy is also a critical factor for this application and the **WaveBook** delivers less than 0.1% error. Since voltages and currents are measured on separate channels, the accuracy of the phase measurement is especially important.

A multiplexing digitizer sampling at 1 Msample/sec can easily deliver an acceptable 0.15 degree of error (0.04%) at 60 Hz. However, with higher harmonics, this error becomes unacceptable. For example, in thyristor drive systems, where a 17th harmonic is common, the phase error would increase to an unacceptable 2.57 degrees. At the 50th harmonic, this error would further increase to 7.56 degrees. These problems are completely eliminated by the **WaveBook's** simultaneous sample-and-hold option, which reduces the interchannel skew from 1  $\mu$ s to 100 ns.

## Conclusion

The **WaveBook's** low-noise, light-weight analog front end, fast 1-MHz A/D, high data transfer rate to PC, and add-in options make it perfect for power analysis and many other applications in the physical test area. It is a digitizer of uncompromising performance.

## WaveBook Series

The WaveBook™ series of portable and desktop digitizers offer multi-channel waveform acquisition and analysis for portable or laboratory applications. All WaveBook models include 8 built-in channels expandable up to 72 channels of voltage, accelerometer, microphone, strain gage, thermocouple, position encoder, frequency, high voltage, and other signal types. For applications beyond 72 channels, up to four WaveBooks can be combined within one measurement system, for a total capacity of 288 channels. WaveBooks are available with either an Ethernet or parallel connection to a PC.

### Features

- PC connection via Ethernet, parallel, PC-Card, or PCI card
- 1  $\mu$ s/channel scanning of any combination of channels
- Expandable up to 288 high-speed channels
- SYNC connection allows multiple units to measure synchronously
- Add up to 224 lower-speed thermocouple channels
- DSP-based design provides real-time digital calibration on all channels
- Single and multichannel analog triggering with programmable level and slope
- Digital TTL-level and pattern triggering
- Pulse trigger and external clock
- Programmable pre- and post-trigger sampling rates
- Sixteen 1-MHz digital inputs
- Operable from AC line, a 10 to 30 VDC source, such as a car battery, or optional compact rechargeable battery module



Using WaveView software's spreadsheet-style interface, you can easily set up your application and begin taking data within minutes of connecting your hardware, with no programming required.

eZ-Analyst™, WaveBook™, WaveView™, and Out-of-the-Box™ are the property of IOtech; all other trademarks and tradenames are the property of their respective holders.

### Included Software

- WaveView™ for *Out-of-the-Box*™ setup, acquisition, and real-time display:
  - Scope mode for real-time waveform display
  - Logger mode for continuous streaming to disk
- eZ-Analyst™ for real-time spectrum analysis
- Export data in third-party formats
- Includes drivers for Visual Basic®, Delphi™, C++ for Windows®, DASYLab®, and LabVIEW®
- ActiveX/COM development tools