EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Assessment of iPod Touch as a Measurement / Diagnostic Device for Electric Utility Applications: Executive Summary

Summary
Portable electronic devices (PEDs) such as the iPod touch® or the Android® can serve as portable mini-computers where steady state data acquisition applications involving monitoring and analysis of Smart Grid performance could be possible. The Electric Power Research Institute (EPRI) recently set out to understand the capabilities, the limitations and the full electric power industry potential for state-of-the-art PED technology.

EPRI investigations have concluded that PED technology will present significant opportunities in the handheld meter/diagnostic device arena and will subsequently become a major component of the smart grid sensor market whereby data needs to be streamed, stored and selectively uploaded from a remote location to a centralized location.

EPRI has evaluated five potential applications that would be valuable to utilities. These applications were successfully demonstrated to the satisfaction of the researchers. The next step will be to work with electric service providers to roadmap the full potential of PEDs and demonstrate their applicability with a Smart Grid.

Overview
Portable electronic devices such as smart phones and gaming systems already find significant application with audio inputs for sound spectrum measurements – and with appropriate input signal conditioning, should find uses as across the utility industry as ultra low cost data management, acquisition and analysis devices.

On the surface, the possibilities for utility application of PEDs are tremendous. These miniature computers offer unique, cost effective means to record power signals, detect and discriminate incipient failure signals, locate (GPS) , measure vibration, and communicate information. Even without the input signal acquisition capability it is clear that PEDs are going to make any electric utility related inventorying function more effective, from asset inspections and mapping, to assisting customer in identifying the locations of EV charging and hydrogen filling stations in a given geographical region or utility service territory. If PED functions can be married into a complete system with power sensing capabilities, the opportunity exists to provide a versatile and low cost data acquisition and analysis platform tailored for the electric utility industry.

To that end, EPRI has funded a research effort aimed at fully understanding the capabilities, the limitations and the full electric power industry potential the state-of-the-art in advanced and inexpensive PED technology.

Objective
The primary project objective was to determine the technical capabilities of today's portable electronic device technologies and to then select several example applications that could be prototyped as a "proof-of-concept." To accomplish this objective, the project team set out to bound the research by choosing a selection of diverse applications (of perceived high interest for the electric power industry). The applications were evaluated in terms of feasibility with the iPod touch® – but with the upfront understanding that other PEDs like the Android®, the Palm Pre®, the Zune HD®, the Sony Instinct® and others may perform similar functions.

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3420 Hillview Avenue, Palo Alto, CA 94304-1395 USA • 650.855.2000 • Customer Service 800.313.3774 • www.epri.com

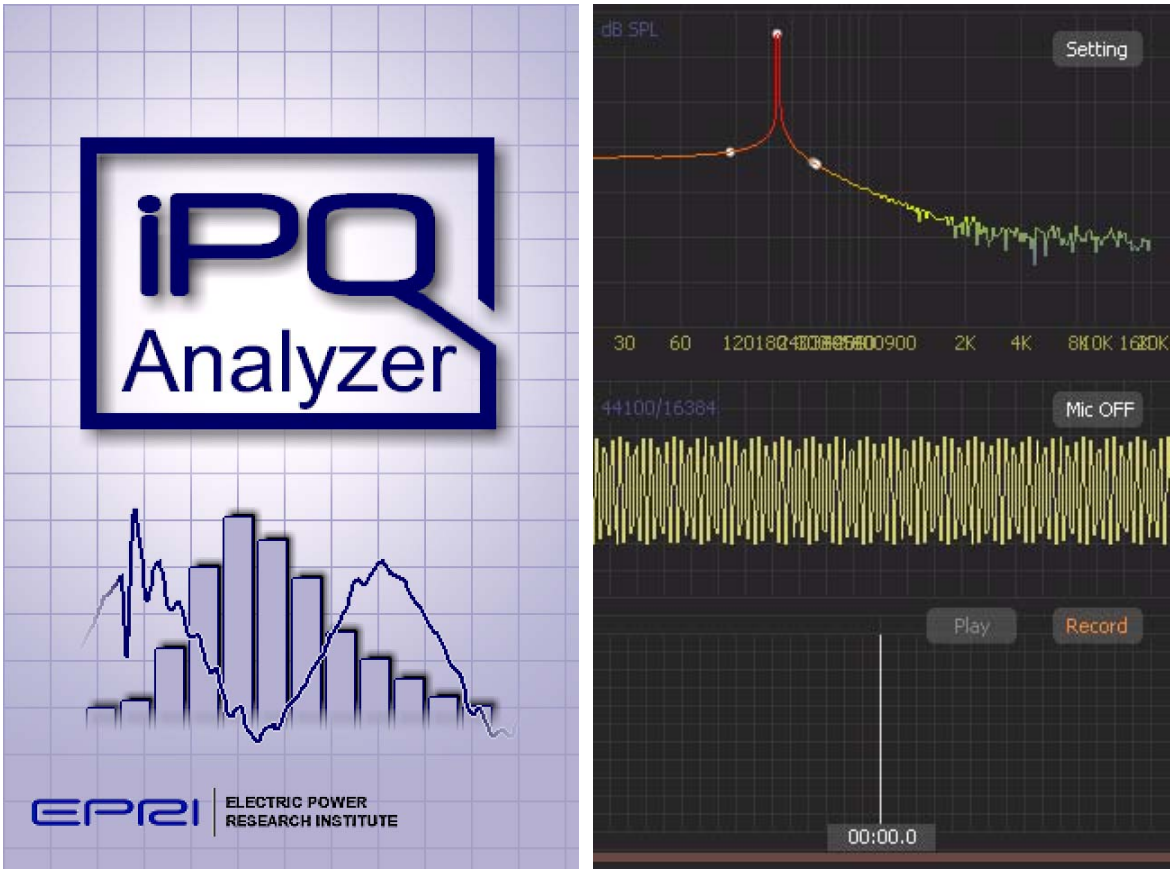

Figure 1
Screen captures from the prototype scope and meter application

Results
To summarize the data acquisition and analysis capabilities for PEDs, it is the opinion of the research team that the portable electronic device technology will present significant opportunities in the handheld meter/diagnostic device arena and will subsequently become a major component of the smart grid sensor market whereby data needs to be streamed, stored and selectively uploaded from a remote location to a centralized location.

Applications for PEDs within the power industry as a data acquisition and analysis device
With appropriate input signal conditioning, PEDs have the potential to be used for:

- Power quality monitoring
- Harmonics analysis
- Locating arcing utility hardware
- Magnetic and electric field measurements
- Handheld multimeter applications (Voltage, Current, Watts, VA, Power Factor etc.)
- Utility hardware condition and security monitoring
- Vibration and thermal noise measurements
- Vehicle charging station mapping
- Asset tracking and GPS locating
- Data logging and storage to supplement other monitoring systems and hardware

- Wireless data transmission

Even without the input signal acquisition capability it is clear that PED devices are going to make any electric utility related inventorying function more effective, from asset inspections and mapping, to assisting customer in identifying the locations of all EV charging and hydrogen filling stations in a given geographical region or utility service territory.

To accomplish preliminary proof of concept evaluation utilizing PEDs, EPRI evaluated five applications that could be of value to utilities.

Application 1 – Conversion of a non-contact handheld electric field directional and diagnostic device over to the iPod platform

Application 2 – Conversion of a standard handheld power quality meter with input isolation and contact probes over to the iPod platform

Application 3 – Conversion of a data logger with input isolation and contact probes over to the iPod platform

Application 4– GPS mapping application showing EV Charging Stations, Alternative Fuels, and Mapped Distance and Routes

Application 5– Three Axis Magnetometer

Conclusions

The primary project objective of this effort was to determine the technical capabilities of today's portable electronic device technologies and to then select several example applications that could be prototyped as a "proof-of-concept." These included Alpha test use as:

1. A non-contact voltage sensor
2. A handheld power analyzer
3. A long duration data logger
4. An asset mapping device
5. A magnetic field sensor (magnetometer)

Each of the applications was successfully demonstrated using the iPod touch® – but with the upfront understanding that other PEDs like the Android®, the Palm Pre®, the Zune HD®, the Sony Instinct® and others may perform similar functions.

In terms of signal stability and accuracy it was found that for all of the power analysis and monitoring applications, the only limitation is the requirement for an interface device that can connect to the PED and facilitate accurate signal input to the PED. The iPod touch device itself is highly suitable for oscilloscope grade acquisition and accuracy.

The need for unique interfaces, depending on the type of PED, is a current shortcoming for the industry as a whole. It is recommended that a series of application specific interfaces be prototyped by EPRI and the specifications for the interfaces provided to manufacturers willing to market a product for specific PED types. For the Apple devices, the interface would need to be the proprietary dock interface whereas for other PEDs this interface will likely be a USB input.

Presently the maximum number of input signals obtainable by a PED is one or two depending on the input, but it is believed that the previously described interface device could enable as many as six or eight input signals while maintaining waveform resolution in the 128 samples per cycle (60Hz) range.

In terms of computational data analysis and post data processing, PEDs do have that capability, but just like any other handheld data acquisition technology, it is more desirable to upload the information to a desktop environment before performing significant data analysis.

The basic requirements for developing “power industry specific” applications are familiarity with “objective c” programming and a clear understanding of unique coding aspects for the various PED types.

Key Findings from the EPRI Demonstrations

1. These portable devices are definitely capable of performing power measurements with the best in class meters.
2. There is a key need for EPRI to help specify and develop the “interface module” to isolate and or amplify the acquired signals – and insure better accuracy than that available via the commercially available interface devices tested to date.
3. There is a need to specify and develop customized application code.
4. Most PEDs have a one or two channel limitation, but this could be overcome with a properly designed interface device – enabling three-phase monitoring (six to eight channels).
5. All the PEDs use similar programming, so an application developed for the one PED could be converted (with moderate effort) to work with the others.

Key technical contacts for this research are Doug Dorr and Norm McCollough.

About EPRI
The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together experts from academia and industry as well as its own scientists and engineers to help address challenges in electricity generation, delivery and use, including health, safety and the environment. EPRI's members represent more than 90 percent of the electricity generated and delivered in the United States, and international participation extends to 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

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Contact:

Don Kintner
EPRI
Manager, Communications
dkintner@epri.com
704-595-2006