

Portable fuel cell powers PC/104 platforms

By Amar Ganwani and Ted Prescop



New micro fuel cells are improving embedded PC/104 systems that require extended off-the-grid operation. Compared to the typical batteries used today, these fuel cells considerably enhance the runtime of PC/104 modules used in remote monitoring, field surveillance, robotics, and other applications.

PC/104's compact yet rugged form factor makes it ideal for use in portable equipment designs for applications such as remote surveillance, robotic systems, backup power, field deployable sensors, and more. The availability of off-the-shelf PC/104 modules accelerates equipment development time and deployment for these applications.

In many cases, these embedded computer systems often rely on rechargeable batteries such as lithium-ion for primary power, which can be replenished when an AC power source is accessible. However, for applications that require extended, off-the-grid operation such as remote surveillance, using these short duration rechargeable batteries may cause logistical problems.

The costs and associated risks involved with recharging or replacing these batteries may even exceed their runtimes. New portable micro fuel cells with higher runtimes are poised to replace the traditional batteries used in these embedded systems.

A maturing technology

Fuel cell technology, which has been under continuous R&D for some time

now, achieved commercialization in the past few years. Fuel cells produce electricity by causing hydrogen to react with air in a chemical process. The hydrogen required for the reaction may be fed directly or extracted from other fuels such as methanol via a process known as *reforming* (see Figure 1). Fuel cell systems are operationally safer than traditional batteries. Unlike batteries, which

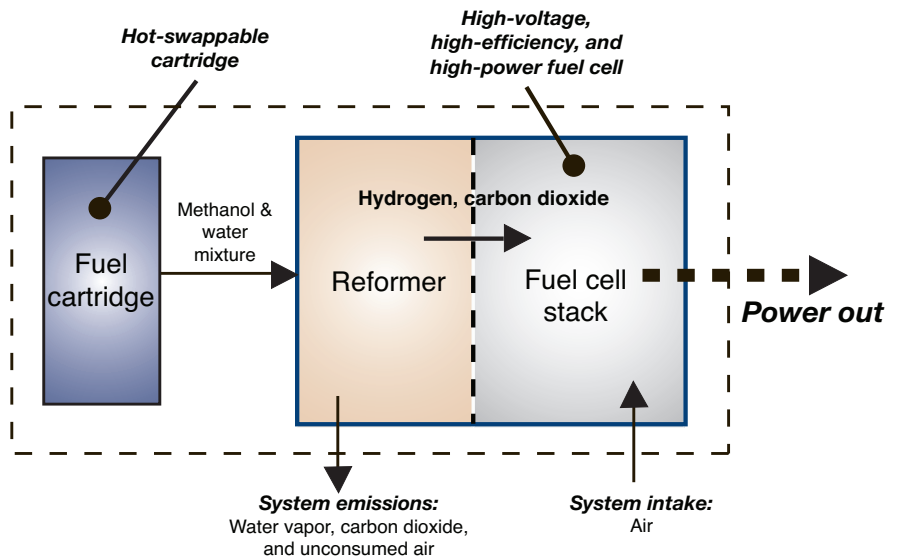


Figure 1

store all their energy within the package, fuel cells keep their reactants (fuel) and oxidizer separate from the reaction site. Only small amounts of fuel are used at a time in a controlled chemical reaction that produces electricity. Also, fuel cells do not require recharging, as do batteries, and provide electricity as long as fuel is available.

In the past few years, more military applications have been powered by micro fuel cells because of their higher energy density and lighter weight advantage over existing batteries. Fuel cell system manufacturers are now shipping products designed to be integrated with portable military equipment and other embedded systems.



Figure 3

Many of the military programs in development now that employ PC/104 embedded platforms would be good candidates for fuel cell use. Fuel cell manufacturers have already demonstrated fuel cell use to power rugged laptops (Figure 2) for extended runtimes.

System engineers working on embedded PC platforms have recently begun powering PC/104 stacks with fuel cells (Figure 3) to leverage the benefits of this technology for extended runtime operation.



Figure 2

Portable fuel cells

UltraCell Corporation manufactures a 25 W Reformed Methanol Fuel Cell (RMFC) system for portable electronics and embedded computer applications, the XX25 fuel cell. This system uses a revolutionary micro reformer to produce hydrogen from highly concentrated methanol, which then feeds the hydrogen into a fuel cell to generate electricity. The RMFC system provides the convenience of hot-swappable and inexpensive methanol fuel cartridges, combined with the high-power density and efficiency of a hydrogen fuel cell. The unit is very compact and provides 2-3x the energy density of lithium-ion batteries.

The fuel cartridges contain an unpressurized liquid methanol/water mixture. Additionally, the fuel cell system is designed to meet rigorous test standards, including MIL-STD 810F, 461E, 462D, OSHA emissions requirements, and IEC PAS 62282-6-1 safety standards for fuel cells and cartridges.



This system has undergone successful shock, drop, and vibration testing, including MIL-PRF-49471B (CR), IEC PAS 62282-6-1, shock and vibration per MIL-STD-810F, and cartridge crush test per UL 2265A. The systems have passed high-temperature operation, short circuit, and salt water immersion tests.

The XX25 is also the first commercial fuel cell system to receive a safety assessment report from the U.S. Army, which certifies that the 25 W mobile fuel cell is safe to use and may be worn by soldiers in the field to power portable devices.

Effective January 2007, the International Civil Aviation Organization agreed to a new provision allowing passengers and crew on commercial aircraft to carry onboard portable electronic devices powered by methanol-based fuel cell systems, along with spare fuel cartridges (105-96-PAS1). They are expected to be allowed on commercial aircraft in early 2008.

Battery hybridization for peak power

Fuel cells and batteries both have their benefits. While Reformed Methanol Fuel Cell (RMFC) systems excel at high-efficiency power generation and can run as long as fuel is available, batteries are better at responding quickly to changing power demands while providing high currents for power pulses. For multi-functional embedded systems with high-power requirements (> 25 W) the hybrid approach of coupling a rechargeable battery with a fuel cell will provide the best solution.

This hybrid system consists of three distinct components: an SMBus-enabled fuel cell, rechargeable battery, and power manager that intelligently manages power draw from the fuel cell system and battery to maximize efficiency (Figure 4). The ability to communicate to the fuel cell and control power draw simplifies this integration.

In a hybrid scenario, a 25 W fuel cell system can power any equipment requiring up to 25 W average power. When the equipment is using less than 25 W, the fuel cell charges the external battery. When the equipment uses greater than 25 W, the battery provides peak power above 25 W. If the equipment is only using a few watts, the power manager can shut off the fuel cell and run off the battery alone.

Available fuel cell systems can provide additional capabilities such as:

- Remote fuel cell system on/off
- Setting startup, standby, and shutdown modes
- Fuel- and power-level monitoring

In addition, the fuel cell is equipped with auto shutdown/restart features that can be enabled using the included Dashboard software. This simplifies fuel cell integration with an external battery without the need for a power manager. The system will automatically turn on/off based on the external battery's voltage level to continually maintain its charge, thus extending runtime for the application.

Expanding capabilities for more powerful applications

UltraCell is currently evaluating applications in which lengthy runtimes are required for unattended power in remote

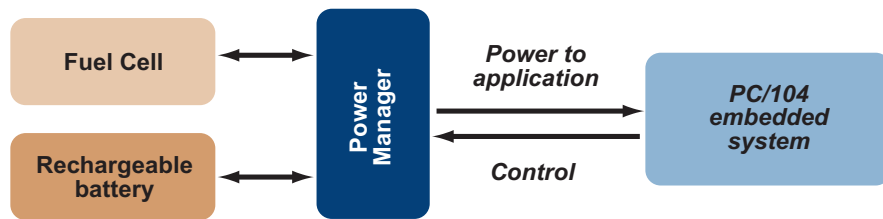


Figure 4

locations. In one case, engineers are combining larger fuel cartridges with a power manager to hybridize a fuel cell with a lead-acid battery. These units can power most applications that currently run on 12 V lead-acid batteries and have been tested to provide up to one month of continuous runtime at 10 W average power (> 8,000 Watt-hours). These systems can generally provide about 8x the runtime of a lead-acid battery and, when integrated, weigh about half as much as an equivalent power source based solely on lead-acid batteries.

“This reliable method of reducing weight while increasing runtime in both portable and stationary equipment is ideal for the COTS military and emergency responder markets driving these applications.”

These larger fuel cartridges satisfy the growing need for unattended power for applications such as mesh networks, satellite phones, video and audio surveillance equipment, and remote sensors for military applications, all for extremely long periods of time between re-supply. Additionally, they can be equipped to take input power from a solar panel array and can power more than one device or sensor simultaneously.

In summary, considering the increasing utilization and demand for portable electronics equipment by military and other

government programs, coupled with the significant weight of batteries required to run this equipment, fuel cells are becoming more attractive for system engineers seeking improved power sources. This reliable method of reducing weight while increasing runtime in both portable and stationary equipment is ideal for the COTS military and emergency responder markets driving these applications. ➤



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