



**Electro Standards Laboratories**  
ADVANCED SYSTEMS DESIGN & SERVICES

## Hybrid Power Management Unit - HPMU

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### Introduction

**HPMU, Hybrid Power Management Unit** combines the strength of a high-power capacitor and a high energy battery. A power management board integrates the two energy-storage devices and provides the user with a light-weight, high performance, and safe power source. The hybrid technology pairs the energy dense battery system with the power dense ESL Hybrid Power Management Unit (HPMU) to improve overall system performance. This HPMU technology not only supports pulsed power loads, but also absorbs pulsed power waveforms from an external source, such as with wind, solar, wave or other energy harvesting applications.



### Power Problem: Batteries Technologies & Alternative Energy

When battery power alone cannot meet power requirements, the batteries are stressed beyond their limits. Battery technologies are inherently energy dense systems with limited power capability. Where energy transfer to the load is equal, primary and secondary chemistries have shown reduced performance when subjected to pulsed loading as compared to operation at low constant rates. Primary chemistries exhibit reduced discharge time or usable capacity while secondary chemistries suffer from both reduced usable capacity as well as reduced cycle life.

Alternative Energy Sources alone cannot meet the demand of power requirements. The energy needs to be harvested from an external source and stored to provide an equal distribution of power load when needed.

### Research

The scientists and engineers at ESL have developed hybrid power management circuitry and a high-power Super Capacitor (SCap) element. The combined technology enables the battery system to operate at a reduced rate supporting the baseline load and the recharge of the SCap while the SCap is utilized to support peak pulse requirements of the load. The result is improved lifetime, reduced battery heating, and extended cycle life of the battery system.

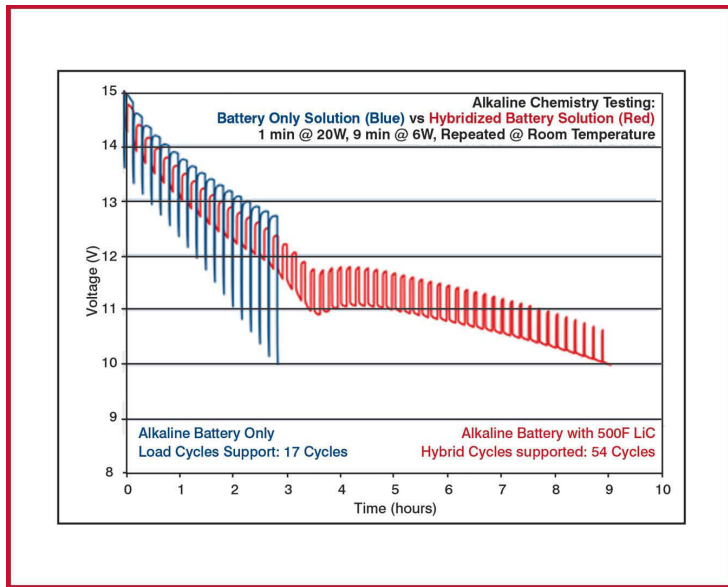


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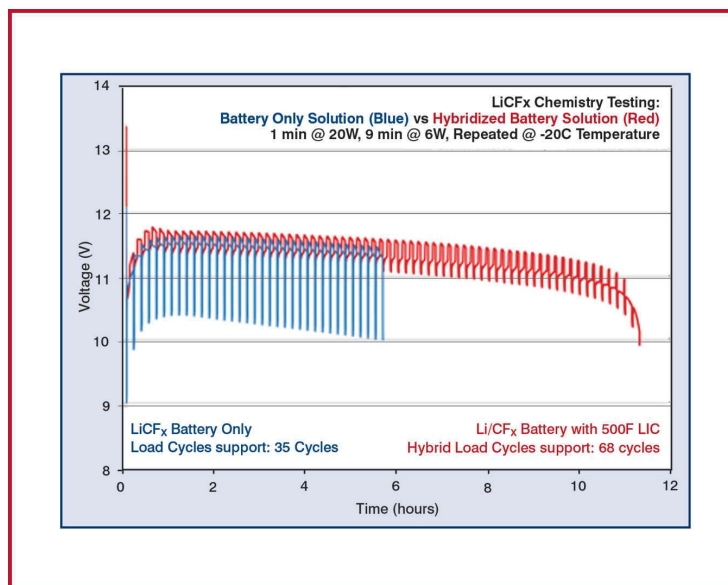
## Alkaline Chemistry Test

- Battery Only solution (Blue) versus Hybridized Battery Solution (RED).
- 1 min @20W, 9 min @ 6W, Repeated @ Room Temperature
- Alkaline Battery Only Load Cycles Support 17 Cycles.
- Alkaline Battery with 500F LiC Hybrid Cycles supported 54 Cycles.



## LiCFx Chemistry Test

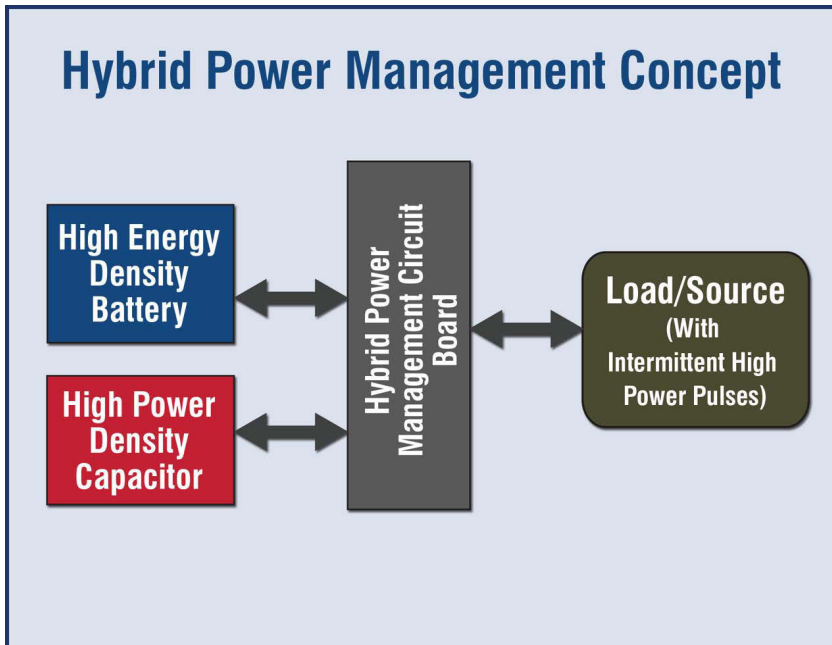
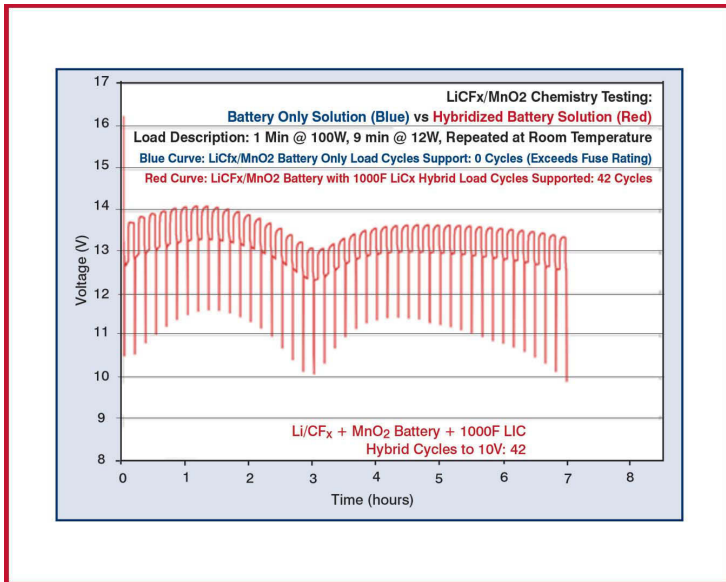
- Battery Only solution (Blue) versus Hybridized Battery Solution (RED).
- 1 min @20W, 9 min @ 6W, Repeated @ -20C Temperature
- LiCFx Battery Only Load Cycles Support 35 Cycles.
- LiCFx Battery with 600F LiC Hybrid Cycles supported 68 Cycles.





## LiCFx/MnO2 Chemistry Test

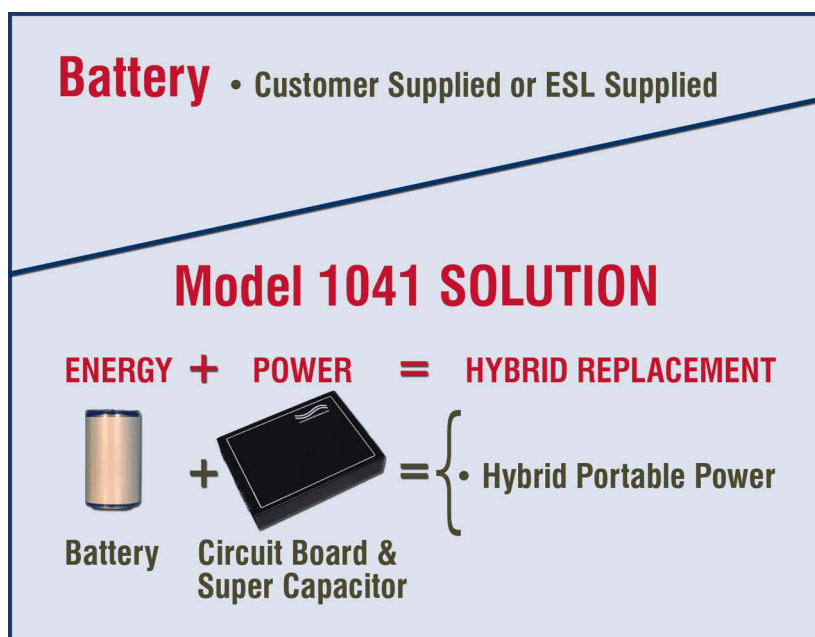
- Battery Only solution (Blue) versus Hybridized Battery Solution (RED).
- Load Description: 1 min @ 100W, 9 min @ 12 W, Repeated at room temperature
- Blue Curve: LiCFx/MnO2 Battery only load cycles support 0 (Exceeds Fuse Rating)
- Red Curve: LiCFx/MnO2 Battery with 1000F LiCx Hybrid Load Cycles Supported: 42 Cycles





## Portable Power Solution

Hybrid Power Management Unit is particularly applicable to portable communication devices. The hybrid power unit allows batteries to operate at lower current level so that the operation can be achieved and the battery life is extended. Once the batteries are exhausted, they can be replaced, while the hybrid unit can be used again, repeatedly. Electro Standards Laboratories can produce a hybrid unit customized for whatever Super Capacitor (SCap) element is required. The battery is sold separately allowing use of a customer supplied battery. Time extensions will vary with power requirements. Custom systems are available to meet specific power extension requirements.



## Military Communications and Other Applications

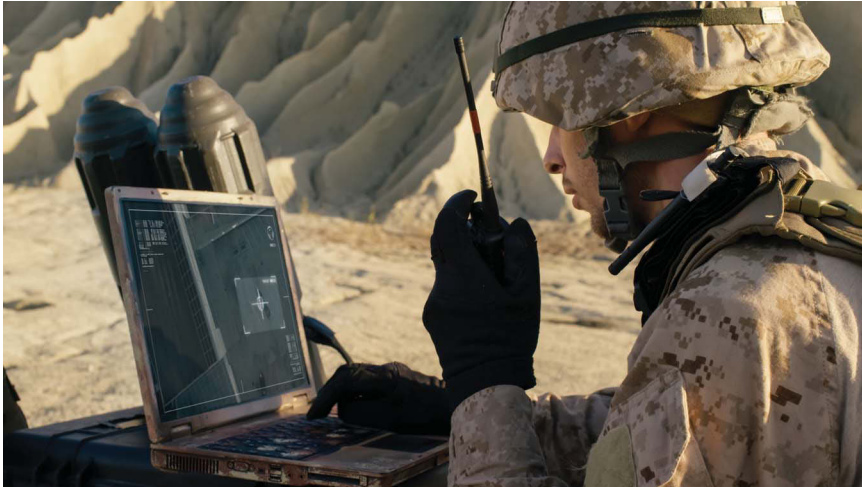
Currently, extensive work has been done supporting military communications load profiles such as SATCOM (1min @ 100W, 9min @ 12W) and SINCGARS (1min @ 20W, 9min @ 6W). Additionally, the HPMU has been integrated into unmanned underwater vehicles hybridizing the thruster load used for station keeping or depth control which experiences pulsed loading on the order of 100W to 150W. Further applications with larger systems upwards of 250kW which use the lithium ion capacitors in a different hybrid architecture to provide load leveling support have been successfully completed.



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### **Other Applications Include:**

- Wave Energy Harvesting
- Recharging stations for UUV (Unmanned Underwater Vehicles)
- Augmentation of solar power
- Sonar listening stations
- Weather monitoring buoys
- Wave monitoring buoys
- Tsunami warning stations
- Port monitoring buoys

### **For More Information**

Dr. Raymond Sepe, Jr., is the program's lead scientist at ESL. For more information on Hybrid Power opportunities with ESL, visit <http://www.electrostandards.com/technologies/>, call 401-943-1164, or email [eslab@electrostandards.com](mailto:eslab@electrostandards.com).