ULTRALiFE
BATTERY & ENERGY PRODUCTS

Lithium Carbon Mono-fluoride / Manganese Dioxide Hybrid
Application Guide

Cylindrical Wound Format
Li-CF_x /MnO_2

Table of Contents

1. About Ultralife Lithium Carbon Mono-fluoride / Manganese Dioxide Hybrid Batteries

1.1 History

Ultralife Corporation has been providing the safest, highest quality Lithium batteries worldwide for over 20 years. Founded from a Kodak spinoff in 1991, Ultralife Corporation has an extensive product line across many Lithium battery chemistries. Our leading edge technologies offer the safest, highest energy densities available. Ultralife continues to invest in research and development to enhance current products and deliver new product advancements to the commercial marketplace. Recently, based on the proven Ultralife lithium manganese dioxide chemistry, Ultralife introduced a new series of Lithium Carbon Mono-fluoride Manganese Dioxide hybrid chemistry Li-CFx/MnO2 cells and products to meet the applications which require high energy, high power and light weight as well as long service life under high readiness.

1.2 Advantages

Ultralife Lithium Carbon Mono-fluoride / Manganese dioxide hybrid cells have the advantages from both Lithium Manganese Dioxide chemistry and Lithium Carbon Fluoride chemistry with improvements on low temperature performance and rate capability. As Ultralife Lithium Manganese Dioxide cells, the hybrid cells also offer excellent temperature characteristics, and a hermetically sealed nickel plated steel container for long term shelf life. Lithium Carbon Mono-fluoride / Manganese Dioxide cells also do not form a passivation layer, so after long storage periods without use they can deliver high current immediately. With more stable Carbon Mono-fluoride compound with Manganese Dioxide, our Lithium Carbon Mono-fluoride / Manganese Dioxide cells have improved shelf life for at least 15 years. The hybrid cells have a discharge curve with two unique plateaus which are respectively attributed to Lithium Manganese Dioxide and then Lithium Carbon Fluoride. The cells deliver 40% or more capacity than the same size of Lithium Manganese Dioxide cells at the same or less of its weight. The hybrid cells perfectly suit the applications that need immediate high current or high pulse power for long term service. Ultralife Lithium Carbon Mono-fluoride Manganese Dioxide hybrid cells provide the best performance combining high energy density, high capacity, high power, long shelf life and relatively low cost among all Lithium based battery chemistries.

1.3 Characteristics

- High Operational Safety (UL certified)
- High Cell Voltage (3.3V)
- Wide Temperature of Operation
- Low Self Discharge
- High Energy Density
- High Reliability
- Inorganic Electrolyte
- Non Pressurized System
- Solid Cathode

1.4 Part Numbers

The Lithium Carbon Mono-fluoride Manganese Dioxide hybrid HiRate product line from Ultralife has been assigned UHR-XR as the model designation. The part numbers are listed on the individual data sheets for ordering.

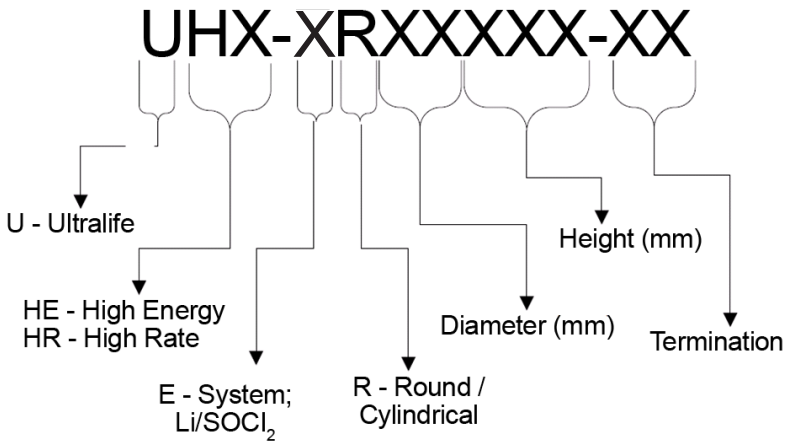


Figure 1: Part Number Schema

2. Cell Designs

2.2 Spiral Wound (HiRate)

A spiral cell design is utilized when high discharge rates are required. The spiral design allows for large surface areas between the anode and the cathode materials, increasing ionic transfer between the electrodes, resulting in higher rate discharge capability.

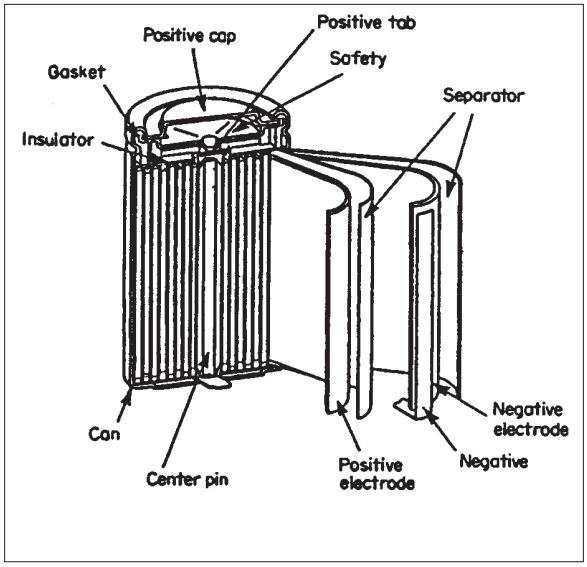


Figure 2: Spiral Wound Construction

3. Applications / Markets

3.1 Remote Metering

- Utility Meters: Water, Gas, Electric
- Automatic Meter Readers
- Industrial meters / valves

3.2 Safety / Security

- Alarm systems
- Safe / Door Lockers
- Detectors

3.3 Remote Monitoring

- RFID
- Asset Tracking / GPS Systems
- Personnel ID systems
- Patient Monitoring / Biotelemetry
- Seismic Monitoring
- High Voltage Line Fault Detectors

3.4 Automotive Power

- Navigational Systems
- Automotive sensors
- Taximeters
- Toll Pass Applications

3.5 Backup Power

- Memory Backup
- Encryption Keys

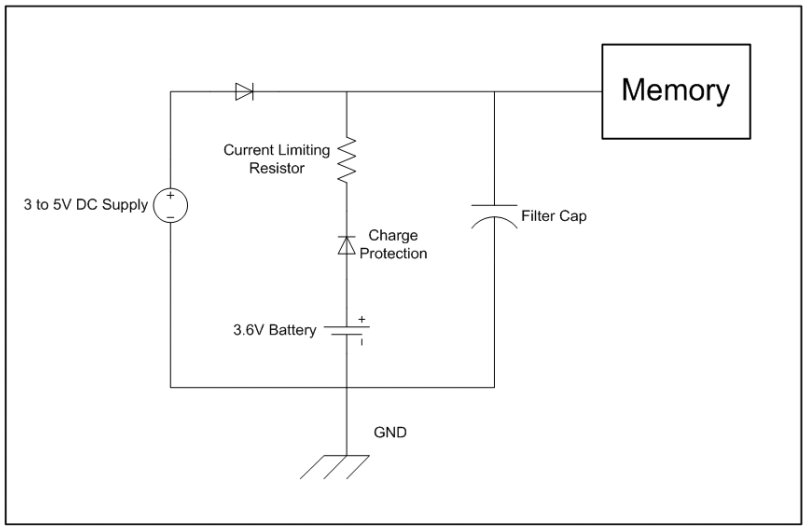
3.6 Industrial / Consumer

- Clocks / Timers
- Weather Stations
- Telemetry Equipment
- Vending Machines

4. Design Notes

4.2 Backup Power Application

A typical application of Lithium Carbon Mono-fluoride / Manganese Dioxide cells is to provide memory or microcontroller backup power in the event of a power failure or rechargeable battery depletion. A typical design circuit is provided in figure 3. Note that a current limiting resistor and series diodes (two for redundancy) are typically required to comply with safety requirements under most compliance certifications (UL, IEC, etc). Please refer to your required safety recognition specification for additional information.

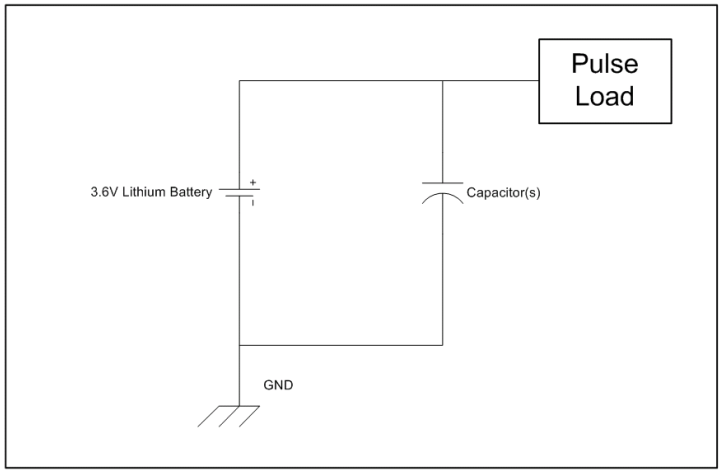


Typical Circuit Design for Backup Power

Figure 3: Backup Power Circuit Design

4.3 Pulse Load Applications

A typical pulse load design is included in Figure 4. This type of circuit would be prevalent in applications such as remote wireless meters, toll pass, or similar applications. If the current requirement of the application is less than the recommended discharge current of the cell, a capacitor is typically not required.



Typical Circuit Design for Low Duty Cycle Pulse Application

Figure 4: Pulse Power Circuit Design

5. Design Support

5.1 Battery Pack Assembly

Battery pack assembly should be completed by experienced and qualified battery manufacturers. Battery packs should be carefully constructed and fully tested to comply with all necessary regulations prior to shipment, installation, or use in any application or device. Lithium Carbon Mono-fluoride / Manganese Dioxide hybrid battery packs should be protected from charge, short circuit and over temperature conditions as well as over-heat situation especially during higher current discharge comparing to Lithium Manganese Dioxide battery packs. As well known, under higher constant discharge current, Lithium Carbon Mono-fluoride (the second discharge plateau) will generate lots of heat. Such heat will be accumulated in a closed pack and then potentially cause cells and battery thermal runaway. Therefore, when constructing large series packs, it is suggested to install thermal protection device such as thermal fuse, thermal switch or cooling system (liquid or air) beside fuse and diode in parallel with each series cell or string of cells to prevent over discharge and charge conditions. For custom Lithium Carbon Mono-fluoride / Manganese Dioxide hybrid battery pack assemblies, please contact Ultralife for safety and design assistance as well as manufacturing options.

5.2 Cell Orientation

Cell orientation should not affect performance of the Lithium Carbon Mono-fluoride / Manganese Dioxide cell performance. Consult Ultralife if there are questions about your specific application. Typical Orientations are below in figure 5.

Figure 5: Cell Orientation

5.3 Gamma Radiation

Many of the Ultralife HiRate cells have been thoroughly tested through the Gamma Irradiation process for sterilization for use in medical applications. Please contact Ultralife for your specific application and compatible products.

5.4 Terminations

Various cell terminals can be provided to facilitate cell mounting installation in the end use application. Custom wire harnesses can be provided to allow for easy replacement in end use applications. Please contact Ultralife for additional information on termination options.

5.5 Soldering

5.5.1 Hand Soldering

- Only skilled personnel should attempt to solder
- Wear all required personal protective gear
- Do not solder directly to the cell, solder to termination tab only
- Finish solder operation within 5 second time period
- Allow solder to fully cool prior to next solder operation
- Use proper heat sink practices when soldering to prevent cell heating

5.5.2 Wave Soldering

- Do not Expose cells directly to solder bath
- Keep solder bath temperature below 280ºC
- Solder time should be less than 5 seconds
- Do not overheat battery during soldering

6. General

6.1 Shipment

Many Lithium metal batteries are regulated and require specific compliance and testing prior to shipping. Please visit the Ultralife Corporation website for guidance on shipping information and links to requirements.

6.2 Safety

- Do not solder directly to cell body. Carefully solder only to cell end cap.
- Do not disassemble or open cells or expose contents to water
- Do not heat cells above recommended temperatures and dwell times
- Do not short circuit
- Do not discharge in excess of rated current or outside of temperature range
- Do not use multiple cells to form a new large battery without consulting with Ultralife
- See MSDS for additional information
- MnO2 / CFx cathode is exothermic and produces heat during discharge. Carefully manage as to not exceed cell temperature rating.

6.3 Disposal

Cells should be disposed of in accordance with all applicable local, state, federal or international regulations. Cells should be fully discharged prior to disposal if possible. Cells should be insulated prior to disposal to prevent inadvertent short circuits.

6.5 Legal

This document is provided as general guidance in utilizing and designs using Ultralife Lithium Carbon Mono-fluoride / Manganese Dioxide cells in various applications. New designs of multiple cells in series or parallel must be tested and certified with all local, state, federal, and international laws and regulations.

This document in no way replaces sound design practices and/or absolves the end user of responsibility to comply with the necessary laws and regulations.

6.5 Contact Information

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