

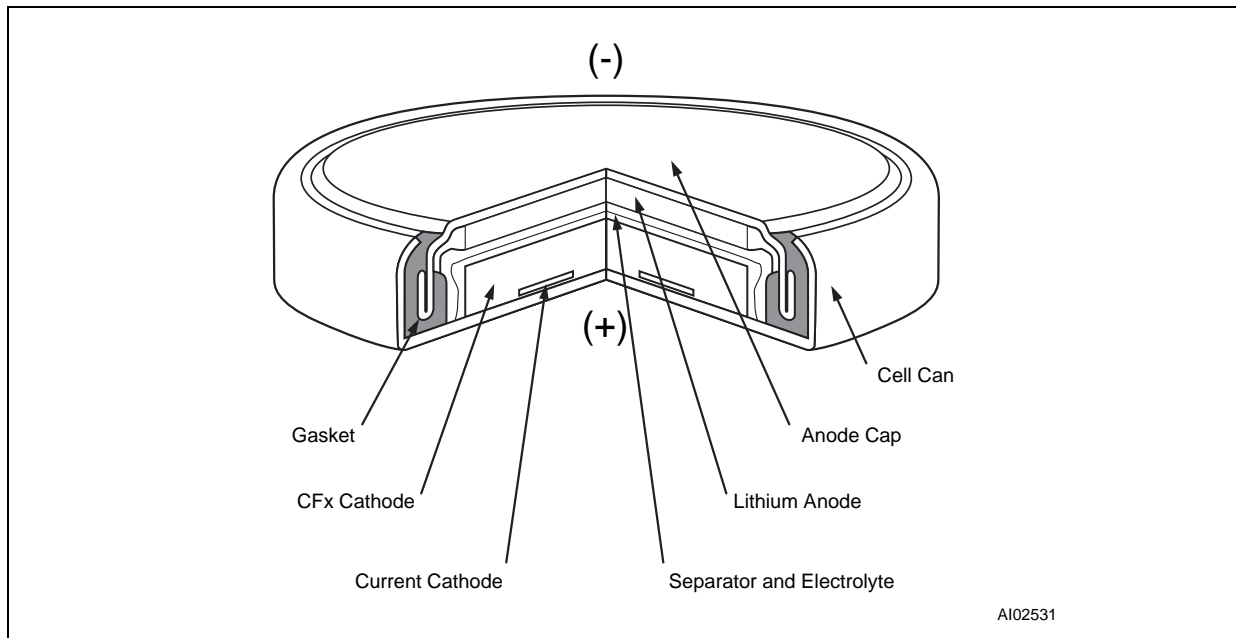
## Battery Technology Used in NVRAM Products from ST

Lithium Carbon MonoFluoride (LiCFx) batteries are used by STMicroelectronics in their line of ZERO-POWER® and TIMEKEEPER® devices. These are used to provide the battery backup for the static RAM array, and to maintain the running of the real-time clock in the TIMEKEEPER devices.

When the discharge rates are low, these non-rechargeable lithium batteries are capable of maintaining a highly reliable voltage level for many years. Moreover, when discharge rates are substantially higher, these batteries are capable of supplying a moderate or high continuous power, and are able to cope with widely varying intermediate pulses. Lithium batteries, therefore, have found use for a variety of applications that require battery backup.

To be used in electronic components, these cells also need to be composed of constituents that are non-toxic, non-corrosive, and non-explosive. They also must be chemically and thermally stable before, during and after discharge. STMicroelectronics utilizes the 49 mAh BR1225X cell, and the 130 mAh BR1632 cell. The electrolyte of these cells (see Figure 1) is based on an organic solvent, instead of a corrosive alkaline or acidic solution found in most conventional batteries. This greatly improves the cell's leakage resistance, and guards against the negative effects caused by leakage.

**Figure 1. Cell Cross-Section**



**CHARACTERISATION AND MODELING**

STMicroelectronics has conducted extensive tests on these cells, a great proportion being destructive testing. Three main mechanisms of battery degradation were modeled, to establish the effects under various loads, temperatures (up to 85 °C) and other environmental variables:

- Active lifetime of the cell, as a result of the consumption of the lithium anode
- Shelf life (storage lifetime) of the cell, as a result of the electrolyte drying up (evaporation)
- Self-discharge, as a result of small leakage currents inherent to the battery chemistry

The weight loss proved to be a valuable measure of electrolyte evaporation. Self-discharge is specified by the battery manufacturer, from 0 °C to 85 °C, not to exceed 0.3% per year.

Models were then developed to predict the rate of electrolyte loss and what effect encapsulation of the cell would have. Tests on the cells, when encapsulated in the epoxy used in the SNAPHAT process, have demonstrated a significant reduction in electrolyte evaporation.

**Figure 2. (A) BR1225X Discharge Rate**

**(B) BR1632 Discharge Rate**

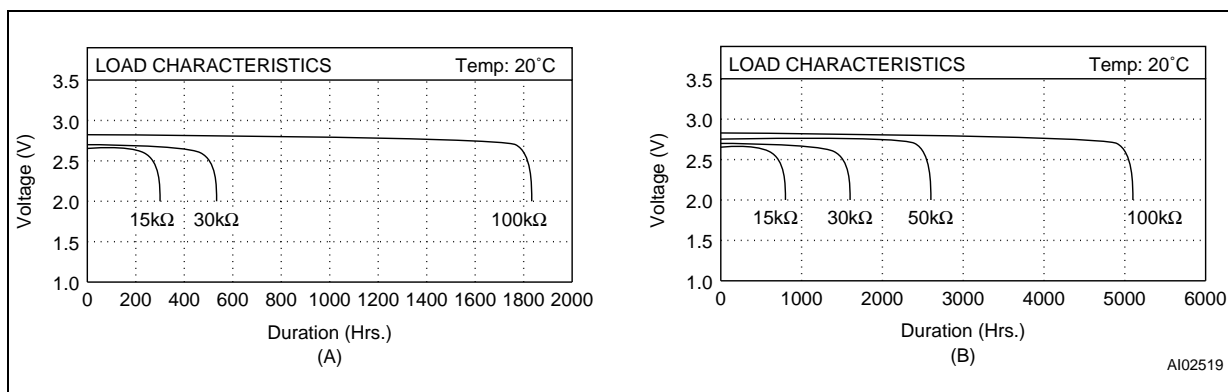


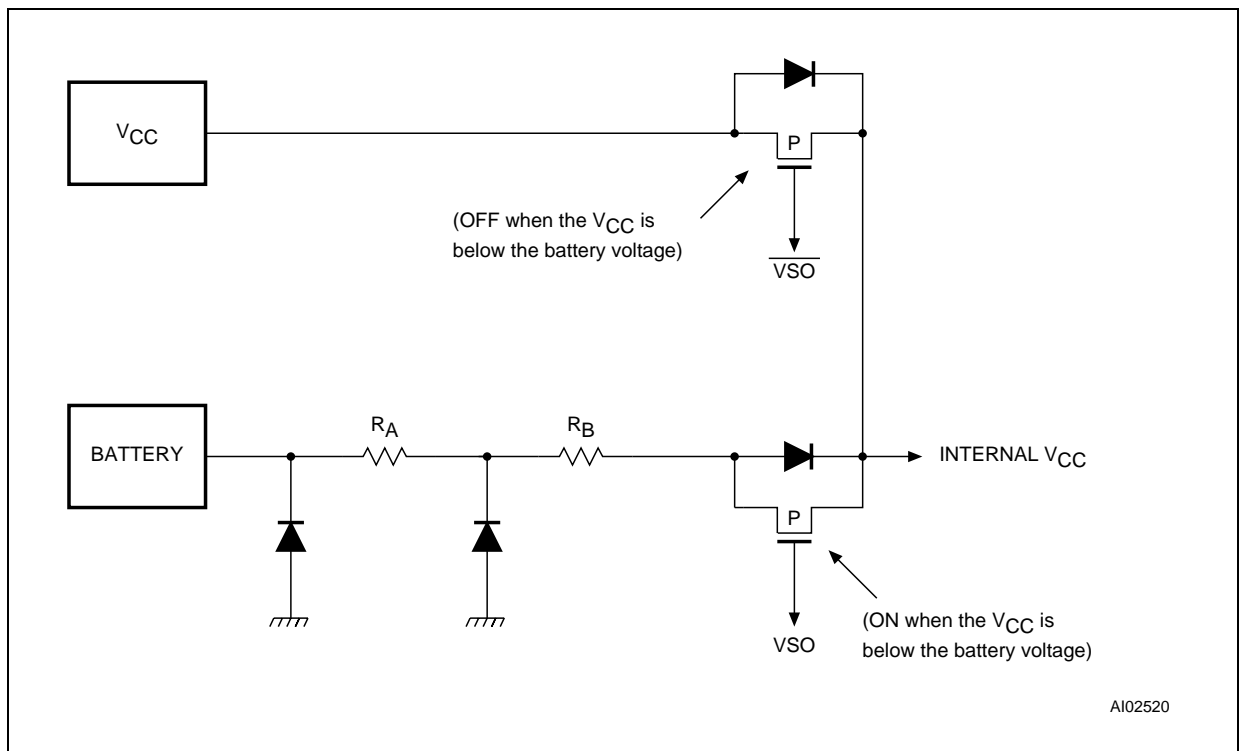
Figure 2 shows the load discharge graphs taken at 20 °C. As can be seen, both cells produce a nominal 3 V output with a flat discharge curve until the end of their effective lives, and so confirms that both are suitable for providing battery backup to low leakage CMOS SRAMs.

The battery lifetime of individual ZEROPOWER and TIMEKEEPER devices, as described in AN1012, is a function of the current load, the battery selected and the system duty cycle. System life, which even with 100% duty cycle can still be greater than ten years, is specified in the data sheet for each device.

**UL 1950 VALIDATION**

All ZEROPOWER and TIMEKEEPER devices, with a self-contained lithium cell, are recognised by the Underwriters Laboratory Inc. UL 1950 specification. The conditions for acceptance under this include the following:

1. That the devices are intended for use as components where the replacement of the battery can be performed by the operator or a trained technician.
2. That the devices are intended for use as components in low voltage, isolated, secondary circuits; where the case temperature does not exceed 100 °C, and the voltage on any pin, relative to ground, does not exceed  $7V_{DC}$ .
3. That the devices are intended to be mounted on a printed wiring board, flame rated to a minimum of 94V-1.
4. That the devices are provided with an appropriate on-chip, reverse current protection circuit. (See Figure 3 for the circuit diagram.)

**Figure 3. Battery Control Circuit**

Notes: 1.  $R_A$  is the ESD protection resistor, and  $R_B$  is the Battery protection resistor required by UL

## AN1011 - APPLICATION NOTE

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If you have any questions or suggestions concerning the matters raised in this document, please send them to the following electronic mail addresses:

*apps.nvram@st.com* (for application support)  
*ask.memory@st.com* (for general enquiries)

Please remember to include your name, company, location, telephone number and fax number.

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