

Battery technology used in NVRAM and real-time clock (RTC) products from ST

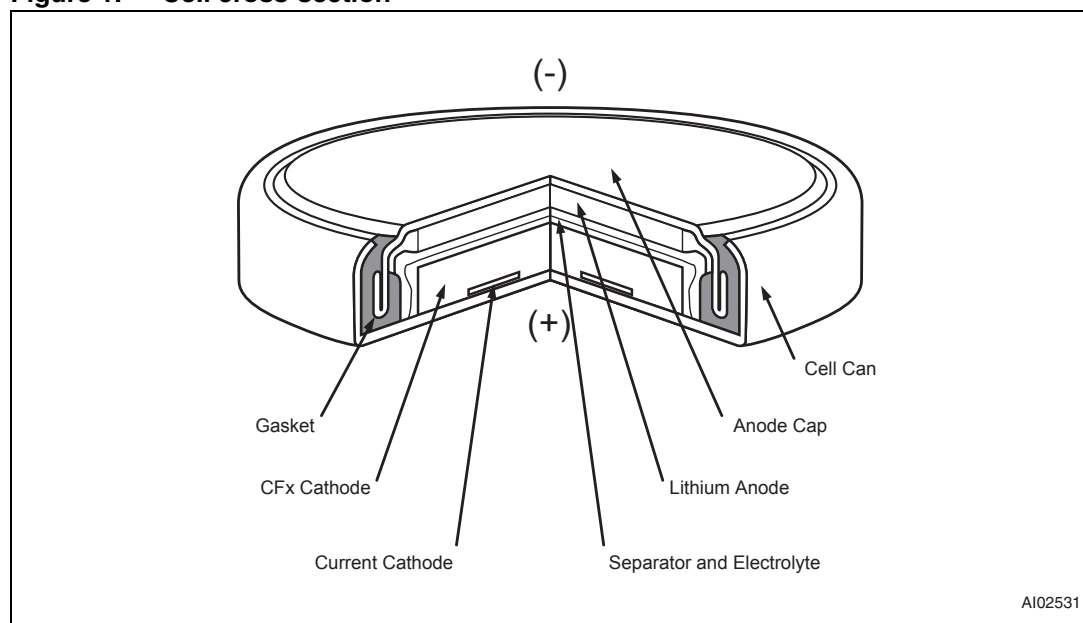
Introduction

Lithium Carbon MonoFluoride (LiCFx) batteries are used by STMicroelectronics in their ZEROPOWER® and TIMEKEEPER® NVRAM devices and in their serial real-time clock (RTC) devices. The batteries provide the backup power to maintain the static RAM arrays and to keep the oscillators running in the TIMEKEEPER and serial RTC devices.

When the discharge rates are low, these non-rechargeable lithium batteries are capable of maintaining a highly reliable voltage level for many years. Lithium batteries, therefore, are used for a variety of applications that require battery backup without need of maintenance for many years.

To be used in electronic components, these cells also need to be composed of constituents that are nontoxic, non-corrosive, and non-explosive. They also must be chemically and thermally stable before, during and after discharge. STMicroelectronics utilizes the 48 mAh BR1225X cell, and the 120 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



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Characterization 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 to be less than 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

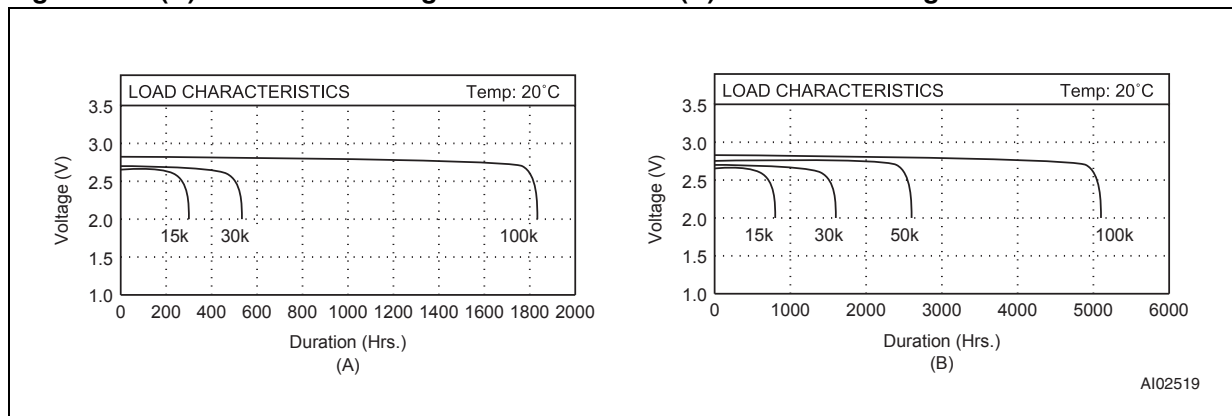


Figure 3 shows the load discharge graphs taken at 20 °C. As can be seen, both cells produce a nominal 3 V output with a flat discharge curve until the end of their effective lives, and so confirms that both are suitable for providing battery backup to low leakage CMOS SRAMs.

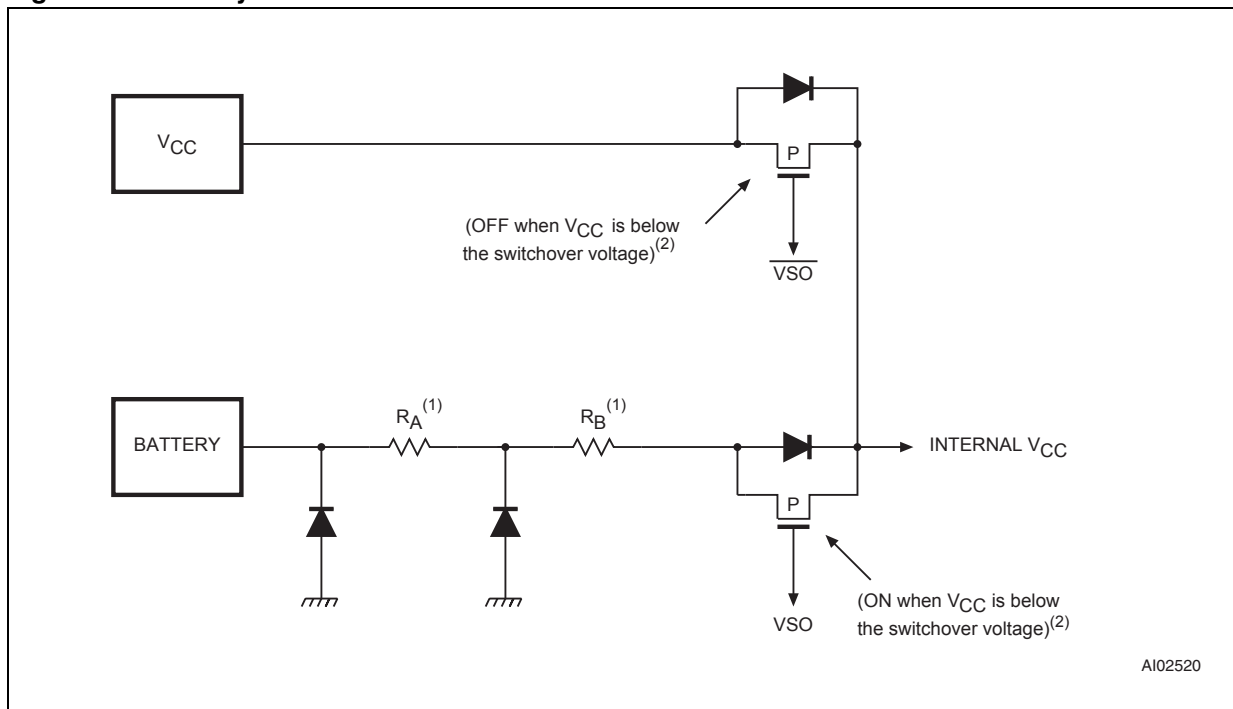
The battery lifetime of individual ZEROPOWER, TIMEKEEPER and RTC devices, as described in AN1012, is a function of the current load, the battery selected and the system duty cycle. System life, which even with 100% duty cycle can still be greater than ten years, is specified in the datasheet for each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

UL 1950/60950 validation

All ZEROPOWER, TIMEKEEPER and RTC devices are recognized by the Underwriters Laboratory Inc. UL 1950/60950 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 7 V_{DC} .
3. That the devices are intended to be mounted on a printed wiring board, flame rated to a minimum of 94 V-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



1. R_A is the ESD protection resistor and R_B is the battery protection resistor required by UL.
2. Depending on the device, switchover will be a function of battery voltage or set by a fixed reference.

Battery status for NVRAMs and serial RTCs

For the devices listed in [Table 1](#) and [2](#), the battery can be internal or external to the IC package. In the external cases, the battery will either be a user-supplied battery or it may be incorporated into ST's SNAPHAT package which mates to the underlying IC as depicted in [Figure 6 on page 6](#).

[Figure 4](#) shows the CAPHAT IC package with the battery integrated with the IC. In this package, the battery is encapsulated within the device.

[Figure 5](#) is representative of several IC packages all of which use a customer-supplied, external battery. None of these device types include the battery in the IC package.

[Figure 6 on page 6](#) shows ST's SNAPHAT SOH28 (SOIC) package with mating SNAPHAT battery top. Here, there is no battery in the IC package. Instead, it is a separate, removable/replaceable unit stacked on top of the IC which reduces board space.

Figure 4. CAPHAT IC package

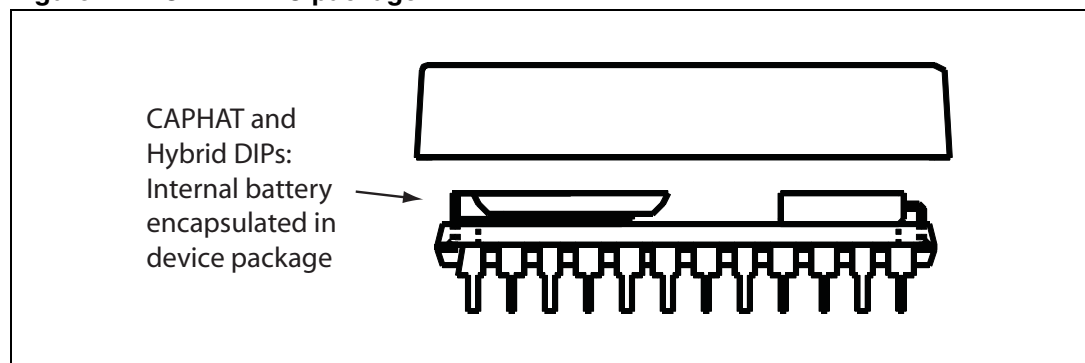


Figure 5. External battery, user supplied

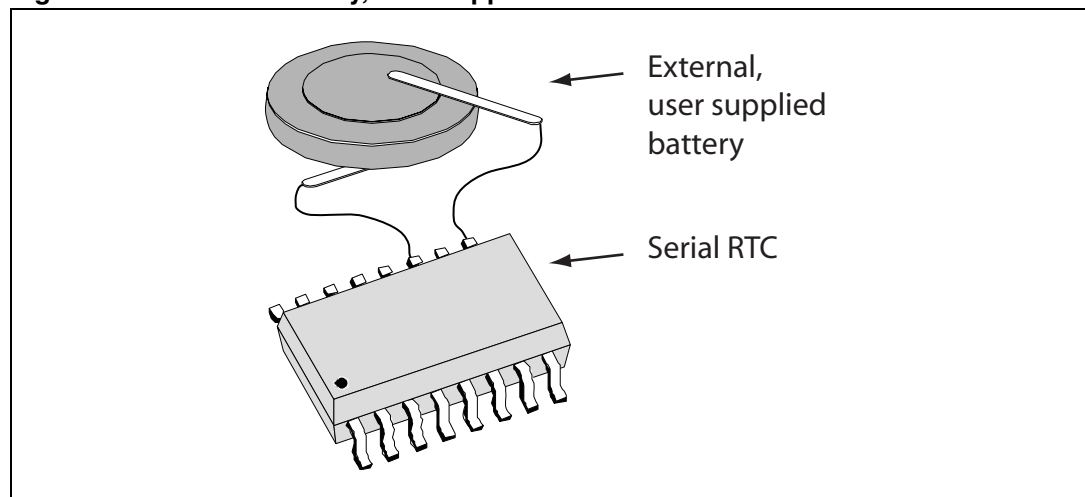


Figure 6. External battery, SNAPHAT battery top

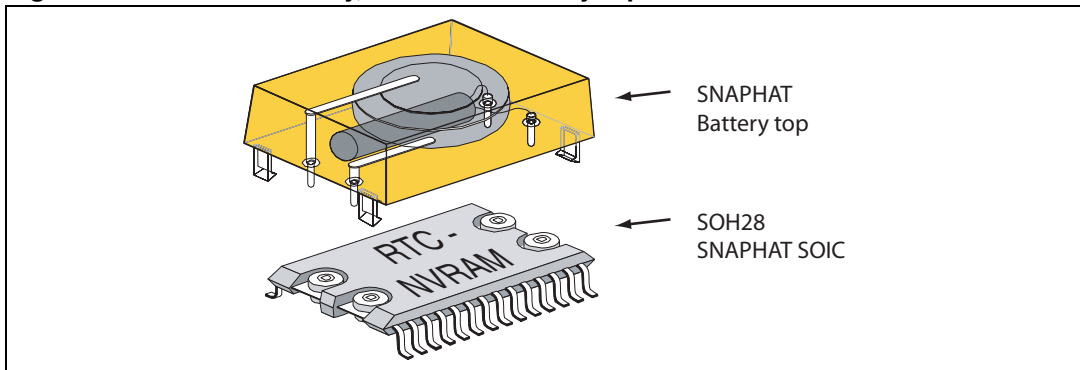


Table 1. Battery status for serial RTCs

Part number	Package	Battery status
M41ST84WMQ6E	SO-16	External, user supplied
M41ST84WMQ6F		
M41ST85WMH6E	SOH28 (330 mil)	External, SNAPHAT
M41ST85WMH6F		
M41ST85WMX6	SOX28 (300 mil)	External, user supplied
M41ST85WMX6TR		
M41ST87WMX6	SOX28 (300 mil)	External, user supplied
M41ST87WMX6TR		
M41ST87WSS6F	SSOP20	External, user supplied
M41ST87YMX6	SOX28 (300 mil)	External, user supplied
M41ST87YMX6TR		
M41ST95WMX6	SOX28 (300 mil)	External, user supplied
M41ST95WMX6TR		
M41T00AUDD1F	DFN16	External, user supplied
M41T00CAPPC1	CAPHAT DIP-24	Internal, BR1632
M41T00M6E	SO-8	External, user supplied
M41T00M6F		
M41T00SM6E	SO-8	External, user supplied
M41T00SM6F		
M41T11M6E	SO-8	External, user supplied
M41T11M6F		
M41T11MH6E	SOH28 (330 mil)	External, SNAPHAT
M41T11MH6F		
M41T56M6E	SO-8	External, user supplied
M41T56M6F		

Table 1. Battery status for serial RTCs (continued)

Part number	Package	Battery status
M41T81M6E	SO-8	External, user supplied
M41T81M6F		
M41T81SM6E	SO-8	External, user supplied
M41T81SM6F		
M41T81SMY6E	SOX18 (300 mil)	External, user supplied
M41T81SMY6F		
M41T82RM6E	SO-8	External, user supplied
M41T82RM6F		
M41T82SM6E		
M41T82SM6F		
M41T82ZM6E		
M41T82ZM6F		
M41T83RMY6E	SOX18 (300 mil)	External, user supplied
M41T83RMY6F		
M41T83RQA6F	QFN16	External, user supplied
M41T83SMY6E	SOX18 (300 mil)	External, user supplied
M41T83SMY6F		
M41T83SQA6F	QFN16	External, user supplied
M41T83ZMY6E	SOX18 (300 mil)	External, user supplied
M41T83ZMY6F		
M41T83ZQA6F	QFN16	External, user supplied
M41T93RMY6E	SOX18 (300 mil)	External, user supplied
M41T93RMY6F		
M41T93RQA6F	QFN16	External, user supplied
M41T93SMY6E	SOX18 (300 mil)	External, user supplied
M41T93SMY6F		
M41T93SQA6F	QFN16	External, user supplied
M41T93ZMY6E	SOX18 (300 mil)	External, user supplied
M41T93ZMY6F		
M41T93ZQA6F	QFN16	External, user supplied
M41T94MH6E	SOH28 (330 mil)	External, SNAPHAT
M41T94MH6F		
M41T94MQ6E	SO-16	External, user supplied
M41T94MQ6F		

Table 2. Battery status for TIMEKEEPER and ZEROPOWER NVRAMs

Part number	Package	Battery status
M40Z111MH6E	SOH28 (330 mil)	External, SNAPHAT
M40Z111MH6F		
M40Z111WMH6E		
M40Z111WMH6F		
M40Z300AVMQ6TR	SO-16	External, user supplied
M40Z300WMH6E	SOH28 (330 mil)	External, SNAPHAT
M40Z300WMH6F		
M40Z300WMQ6E	SO-16	External, user supplied
M40Z300WMQ6F		
M48T02-150PC1	CAPHAT DIP-24	Internal, BR1225
M48T02-70PC1		
M48T08-100PC1	CAPHAT DIP-28	Internal, BR1225
M48T08-150PC1		
M48T08Y-10MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T08Y-10MH1F		
M48T12-150PC1	CAPHAT DIP-24	Internal, BR1225
M48T12-70PC1		
M48T128Y-70PM1	Hybrid DIP-32	Internal, BR1632
M48T129V-85PM1		
M48T129Y-70PM1		
M48T18-100PC1	CAPHAT DIP-28	Internal, BR1632
M48T18-150PC1		
M48T201V-85MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T201V-85MH1F		
M48T201Y-70MH1E		
M48T201Y-70MH1F		
M48T35-70PC1	CAPHAT DIP-28	Internal, BR1632
M48T35Y-70PC1		
M48T35AV-10MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T35AV-10MH1F		
M48T35AV-10PC1	CAPHAT DIP28	Internal, BR1632
M48T35Y-70MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T35Y-70MH1F		

Table 2. Battery status for TIMEKEEPER and ZEROPOWER NVRAMs (continued)

Part number	Package	Battery status
M48T37V-10MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T37V-10MH1F		
M48T37Y-70MH1E		
M48T37Y-70MH1F		
M48T512Y-70PM1	Hybrid DIP-32	Internal, BR1632
M48T58-70PC1	CAPHAP DIP-28	Internal, BR1225
M48T58Y-70PC1		
M48T58Y-70MH1E	SOH28 (330 mil)	External, SNAPHAT
M48T58Y-70MH1F		
M48Z02-150PC1	CAPHAP DIP-28	Internal, BR1225
M48Z02-70PC1		
M48Z08-100PC1	CAPHAP DIP-28	Internal, BR1632
M48Z12-150PC1	CAPHAP DIP-28	Internal, BR1225
M48Z12-70PC1		
M48Z128-70PM1	Hybrid DIP-32	Internal, BR1632
M48Z128Y-70PM1		
M48Z128Y-85PM1		
M48Z129V-85PM1		
M48Z18-100PC1	CAPHAP DIP-28	Internal, BR1632
M48Z2M1V-85PL1	Hybrid DIP-36	Internal, BR1632 (two)
M48Z2M1Y-70PL1		
M48Z35-70PC1	CAPHAP DIP-28	Internal, BR1225
M48Z35Y-70PC1		
M48Z35AV-10MH1E	SOH28 (330 mil)	External, SNAPHAT
M48Z35Y-70MH1E		
M48Z35Y-70MH1F		
M48Z512A-70PM1	Hybrid DIP-32	Internal, BR1632
M48Z512AV-85PM1		
M48Z512AY-70PM1		
M48Z512BV-85PM1		
M48Z58-70PC1	CAPHAP DIP-28	Internal, BR1225
M48Z58Y-70PC1		
M48Z58Y-70MH1E	SOH28 (330 mil)	External, SNAPHAT
M48Z58Y-70MH1F		

Revision history

Table 3. Document revision history

Date	Revision	Changes
Dec-1998	1	Initial release.
28-Dec-2007	2	Reformatted document; updated UL 1950/60950 validation and technical support URL.
02-Nov-2009	3	Updated Introduction ; Characterization and modeling ; Figure 3 ; reformatted document.
07-Mar-2012	4	Added Battery status for NVRAMs and serial RTCs , Figure 4 , 5 , 6 Table 1 , 2 ; updated title of datasheet; minor textual updates.

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