EnerChip™ CC Real-Time Clock Backup for K60 Microcontroller

Introduction

Cymbet EnerChips are solid state rechargeable batteries having distinguishing characteristics compared to conventional rechargeable batteries. EnerChips have a high charge/discharge cycle life; low self-discharge; simple voltage controlled charging; flat discharge voltage profile; have no flammable solvents to leak or catch fire; are solder reflow tolerant; and are offered in low profile surface mount packages.

The EnerChip CC is a surface mount package containing a rechargeable solid state battery - the EnerChip - with integrated battery management that includes charge control, discharge cutoff circuitry, and a battery switchover (i.e., supply supervisory) function. EnerChip storage (discharge) capacity varies by product. EnerChips are used in applications requiring backup, bridging, or transition power to maintain real-time clock (RTC) operation or SRAM data retention in the event of main power interruption; wireless sensing as the main power source when energy can be harvested from the ambient power and used to constantly trickle charge the EnerChip; and as a power source to perform housekeeping for microcontrollers (MCUs) and peripherals when main power is interrupted, to ensure an orderly shutdown or transition to low power modes.

Many applications demand ultra low power consumption from the various system components, particularly when system power is derived from primary or rechargeable batteries. In systems utilizing stand-alone or embedded RTCs, it is essential that the standby power of the RTC be very low in order to achieve maximum run time from the backup power source when main power is interrupted. A low power MCU now available from Freescale is the K60 family. The device has a VBAT auxiliary power pin to which a backup power source can be connected. This Application Note describes use of the surface mount EnerChip CC as the backup power source for the RTC embedded within the K60 MCU.

A typical application circuit is shown in Figure 1. Main power is fed to both the CBC31xx and K60 MCU. When the supply voltage drops below a specific threshold as detected by the CBC31xx, the EnerChip solid state battery embedded in the EnerChip CC delivers power to the MCU VBAT pin from the CBC31xx VOUT pin.
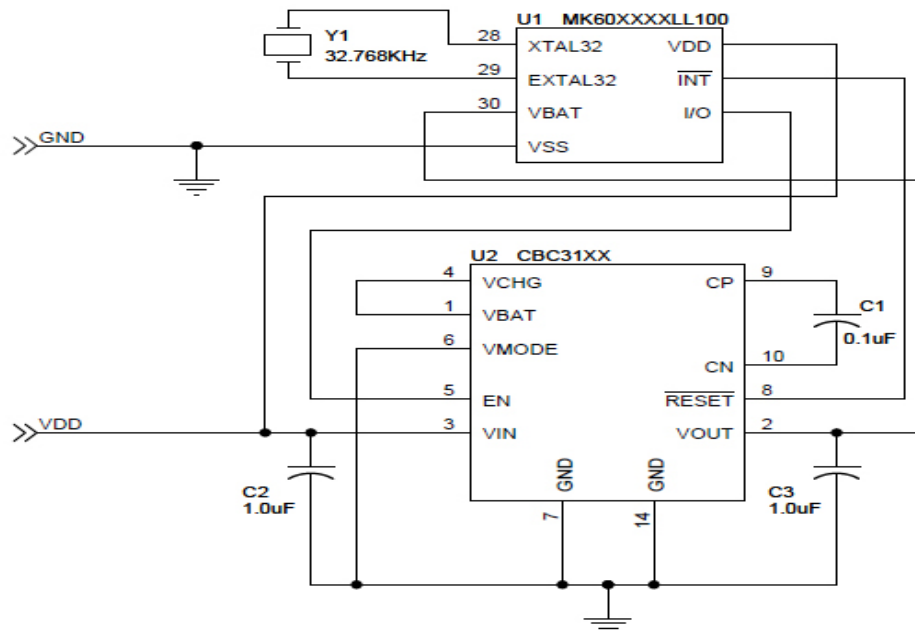

Figure 1. Application Circuit Using the EnerChip CC to Maintain the Real-Time Clock Within the K60 MCU.

AN-1047: EnerChip™ CC RTC Backup for K60 Microcontroller

Circuit Description and Operation

Under normal operation, the RTC derives its power from the main system supply, which might be a large coin cell, prismatic cell, cylindrical batteries, or indirectly from wall power through a voltage regulator. Because the EnerChip has very low self-discharge, it needs to be charged only after it has been used in the performance of its duty as a backup power source and periodically to compensate for the discharge cutoff current drain of 30nA (typical). Such a low charging duty cycle presents a negligible parasitic load to the main power source, as the EnerChip charges quickly and its charging current decays to just a few tens of nanoamperes when fully charged. The EnerChip CC controls the EnerChip charging function internally.

When main power is interrupted - as during line power outages or when the main battery is removed for recharging or replacement, the backup power source provides enough energy to maintain operation of the real-time clock.

The EnerChip CC is a surface mount device that contains a rechargeable battery with integrated battery management that performs the charge control, discharge control, threshold voltage detection, and supply supervisory functions all in one low profile package. It operates over the range of 2.5V to 5.5V and the switchover threshold voltage is adjustable. A block diagram of the EnerChip CC is shown in Figure 2.
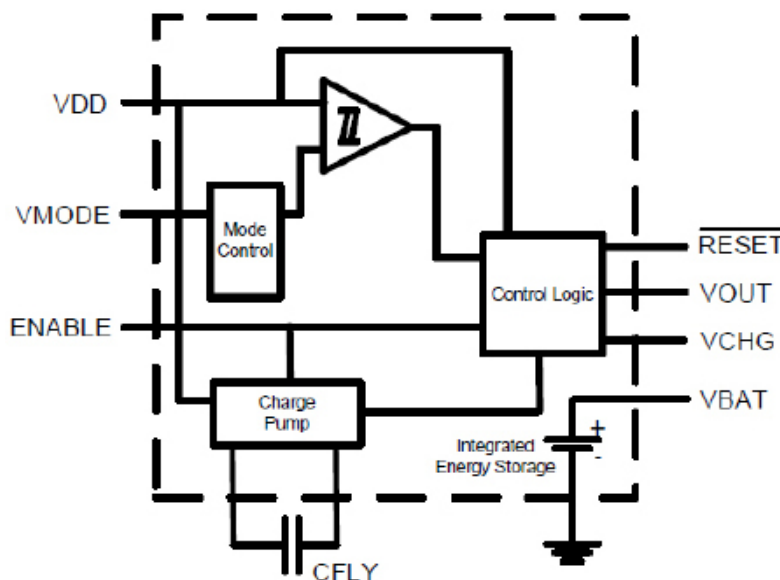

Figure 2. Block Diagram of the EnerChip CC Thin Film Battery with Integrated Battery Management.

EnerChip CC includes the following functional elements:

- Internal charge control circuit that converts a wide range of input voltages to a tightly regulated battery charging voltage;
- Battery cutoff circuit that disconnects the load from the embedded EnerChip when the discharge voltage reaches a preset limit;
- Output pin (RESET/) that can be used to drive an interrupt line on an MCU to indicate that the system is operating in battery-backed mode;
- A voltage detection circuit allowing a user-selectable threshold trip voltage;
- A control line (ENABLE) that enables and disables the internal charge pump. ENABLE can be tied directly to VDD or controlled by the system MCU to reduce power consumption when the internal EnerChip does not need to be charged.

All of these features have been combined to create a backup power solution that eliminates the need for a dedicated supply supervisory circuit, battery holder or socket, separate battery management circuitry, and a conventional power source such as a coin cell or supercapacitor. The result is a compact, single-chip solution to backup and bridging power. The power source - the EnerChip - is a component class, rechargeable solid state battery that has no organic solvents or harmful chemicals that accompany coin cells and supercapacitors.

Given the low operating current of many RTCs, the EnerChip CC can provide several hours to several days of backup time. Backup time is calculated based on the typical RTC current and the EnerChip CC battery cutoff circuit current of 30nA (typical). The following table illustrates the amount of backup time afforded by the various EnerChip CBC31xx devices when supporting the 32kHz oscillator current and RTC operation within the K60 MCU, at 550nA (typical).

EnerChip CC	DFN/QFN Package Size (mm)	RTC Backup Time (hours)
CBC3105	5 x 5 x 0.9	9
CBC3112	7 x 7 x 0.9	20
CBC3150	9 x 9 x 0.9	87

Given that the vast majority power interruptions - whether due to grid power outages in wall-powered systems or in mobile devices during main battery recharging and replacement - are less than one day, either EnerChip CC device can be used in most applications. Once the minimum backup run time specification is defined, device selection can be made accordingly and in conjunction with other considerations such as package footprint. The EnerChip CC is also configured to allow additional surface mount EnerChips to be connected to increase backup run time.

In cases where an MCU must also be maintained in a low power state (as opposed to being completely disconnected from the circuit) during battery-backed operation, the MCU sleep current must be factored into the backup run time equation. To maintain favorable backup run time, the designer can choose from a variety of MCUs, some having sleep currents as low as 20nA. When using MCUs with such exceptionally low sleep currents, the RTC backup run time is not reduced significantly. During operation, the MCU can also be programmed to drive the EnerChip CC ENABLE line low when EnerChip battery charging is not required. Doing so will reduce the overhead current associated with operating the charge pump internal to the EnerChip CC.

Conclusion

Many systems utilizing RTCs require backup power supply backup in the event of main power interruption. Conventional backup power sources are primary coin cells, rechargeable coin cells, and supercapacitors. Traditional backup power sources have long charge times, high self-discharge, require relatively high steady state parasitic charging current, and often require external components for charge control and discharge cutoff. The EnerChip - with its low self-discharge, low parasitic current draw when charged, and fast recharge time - is a superior solution to supercapacitors and coin cell batteries in backup power applications. When implemented in systems using real-time clocks, the EnerChip CC delivers a robust backup power source with high cycle life and integrated battery management in a low profile, compact surface mount package.