AN-1002
Application Note

Guidelines for Charging Cymbet™ EnerChip™ Batteries

Introduction

Cymbet™ EnerChip™ thin film, solid state batteries feature all solid state construction, are packaged in standard integrated circuit packages, and can be reflow soldered for high volume PCB assembly. They are ideal as rechargeable backup power sources for clocks, memories, microcontrollers and other low-power circuits where data or timing information must be retained in the absence of primary power.

The charging time of EnerChip batteries is short compared to that of conventional rechargeable batteries. *Figure 1* shows the typical percentage of full charge vs. time during constant voltage charging.

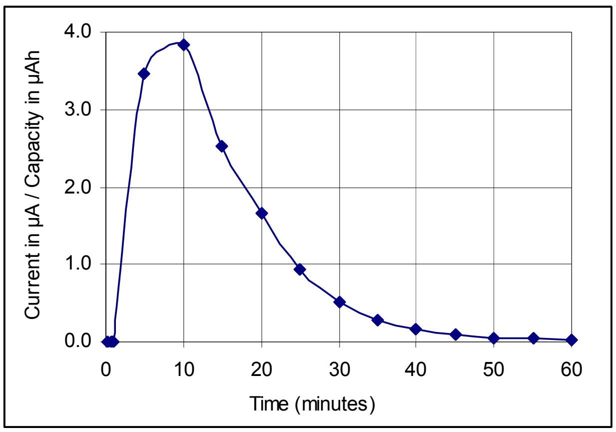

Figure 1. Typical battery charging profile; Vc = 4.1V.

Charging Guidelines

As with other rechargeable batteries, discharge capacity and cycle life are a function of charge voltage, discharge cutoff voltage, depth-of-discharge, temperature, and other factors. The system designer must understand the effect of these factors when designing the charge control circuit.

- Never apply more than 4.3V across the battery terminals. There is no need to externally limit the charging current of small surface-mount batteries. The intrinsic cell resistance is sufficient to limit the current to an acceptable level as long as the applied voltage does not exceed 4.3V.
- The charging voltage and charge time determine the amount of charge delivered to, and accessible from, the battery. A higher charging voltage will deliver more charge, but will also result in greater long-term capacity fade as a function of charge/discharge cycling. *Figure 2* shows tradeoffs between charging voltage, charge capacity and cycle fade.
- The batteries may be charged at a constant current (CC) followed by a constant voltage (CV). During the CC phase, the current may be set to any value that results in an acceptable charging time and does not cause the battery voltage to exceed 4.3V.
- CV charging will normally result in faster charging times than the combined CC-CV approach. The latter may become necessary with future, larger batteries with lower intrinsic cell resistance. Please refer to the data sheets of these batteries.

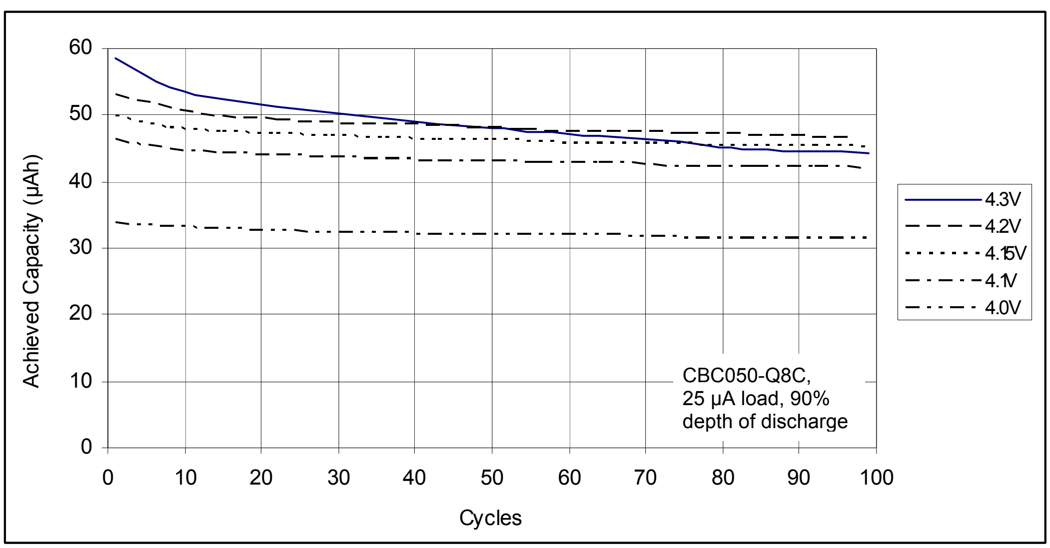

Figure 2. Effect of charging voltage on battery charge and cycle fade.

Charging Circuits

EnerChip thin film rechargeable batteries are conducive to a variety of charge control circuits. The recommended charging voltage is a constant 4.1V. The range from 4.1V to 4.3V is acceptable, but the number of life charge cycles will be reduced toward the top of the range. The range from 4.1V to 4.0V is also acceptable, but the full charge will be reduced toward the bottom of the range. The range of acceptable charging voltages is illustrated in *Figure 3*.

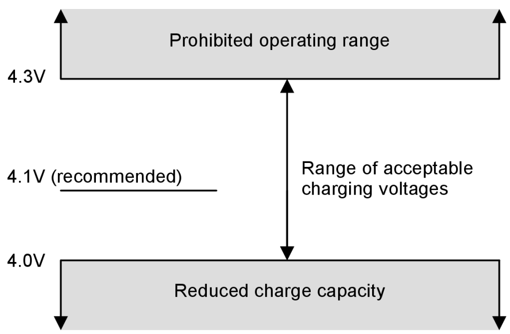

Figure 3. Allowable charging voltages.

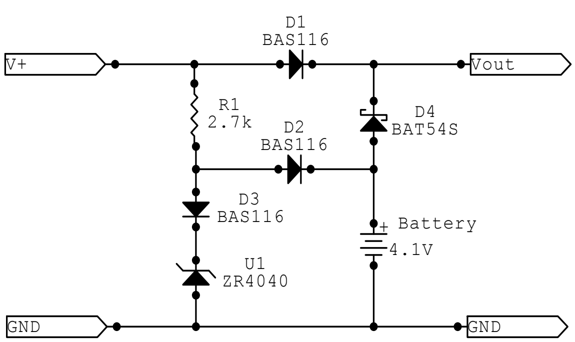

Figure 5. Charging circuit with a voltage reference.

Circuits consisting of one or more diodes and a fixed power supply may be used; however, fluctuations in the power supply voltage and part-to-part variability in the diode voltage drop will affect the voltage across the battery terminals.

Figure 4 shows the simplest of charge circuits, where the voltage applied to the battery terminals is the power supply voltage less the forward voltage drop of a diode. The purpose of the diode is to prevent the battery from discharging through the power supply line when main power is lost. The reverse bias leakage of the diode must be very low.

Figure 5 provides a 4.1V reference to accommodate a wider range of power supply voltages. *Figure 6* uses a linear regulator to achieve the same end.

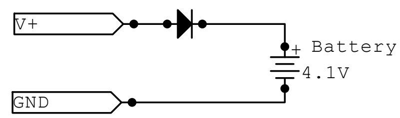

Figure 4. Simple charging circuit.

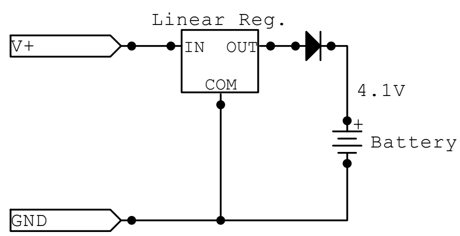

Figure 6. Charging circuit with a linear regulator.

Discharge Cutoff

In order to preserve the cycle life and other important characteristics of the EnerChip, it is important to terminate the battery discharge when the battery voltage reaches 3V. This is particularly important when discharging at very low current – for example, below a few microAmperes. Although > 90% of the battery capacity will have been depleted when the battery voltage reaches 3V at low drain current, the battery will nevertheless continue to supply current below 3V. If discharged continuously below that voltage, the battery will be damaged.

Simple circuits utilizing a discrete or MCU-embedded reference voltage to control a series FET switch, for example, could be used to disconnect the load when the battery voltage reaches 3V.