Capacitance to EnerChip Battery Charge Conversion Guide

Introduction

EnerChips are solid state rechargeable batteries that have a high charge-discharge cycle life, very low self-discharge, and are constructed with solid state materials, making them durable, non-toxic, and safe to use in a range of environments. EnerChip CC products include an EnerChip battery management circuit co-packaged in low profile solder reflowable, surface mount QFN and DFN-style packages. EnerChips are often used as a real-time clock (RTC) and memory backup power source. Supercapacitors are also used in these applications, although there are significant differences in the operating characteristics of these two categories of energy storage devices. An important distinction to understand when comparing effective charge storage capacity is that the EnerChip delivers charge at a relatively fixed voltage, while supercapacitors deliver charge at an ever-declining voltage, the voltage-charge slope being a function of discharge current.

A frequently asked question is: **"If I'm using a supercapacitor as a backup power source for an RTC and want to replace it with a solid state battery, what battery capacity is equivalent to the supercapacitor rating?"**

In answering the question, one must recognize the differences in discharge profiles between EnerChips and supercapacitors. In relative terms, the percentage of supercapacitor storage capacity available to the load is linearly dependent on the minimum voltage at which the load device (e.g., RTC) will continue to operate. In contrast, the EnerChip CC output voltage is nearly constant over the entire discharge, as depicted in Figure 1. EnerChip CC products have a self-contained battery management circuit that controls battery charging and delivers >95% of the stored energy at a relatively steady output voltage of 3.3V before going into cutoff.

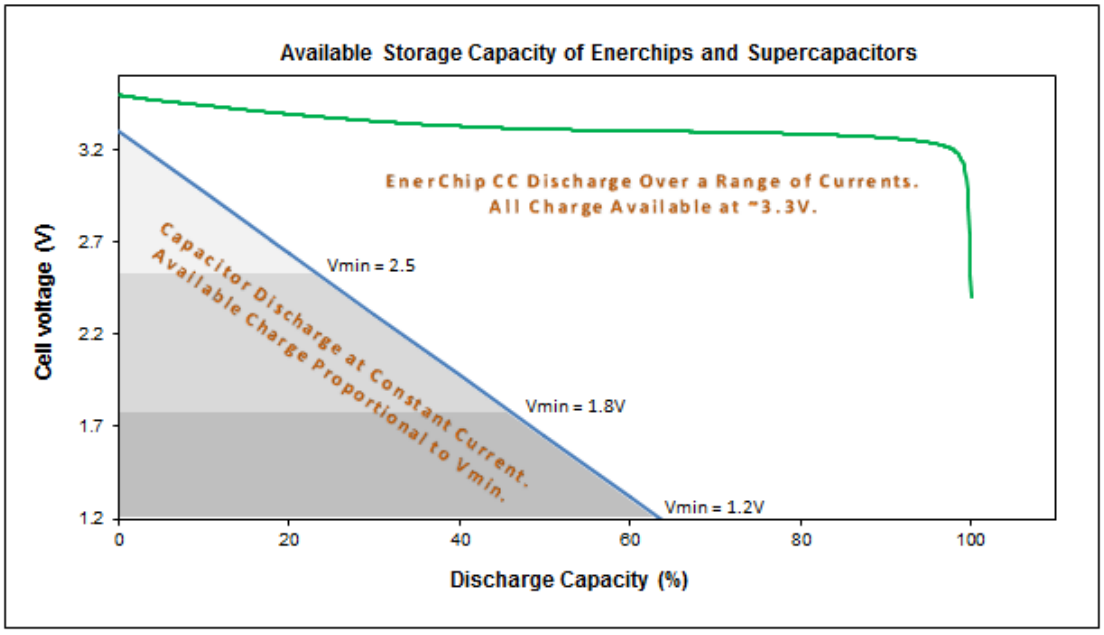

Figure 1: Relative Charge Capacity Delivered to a Load - Green Line Represents the EnerChip CC; Blue Line Represents a Supercapacitor.

Figure 1 Notes:
1) Capacitor charge voltage = 3.3V. 2) Constant current discharge. 3) Assumes negligible self-discharge of capacitor and EnerChip 4) EnerChip CC voltage derived from 3.8V terminal voltage, less 0.5V diode drop to Vout.

Figure 1 profiles do not account for the effects of self-discharge, which are measurably worse for supercapacitors than for the EnerChip solid state battery.

Another frequently asked question is: **"How much storage capacity do I need for my application?"**

The simplest calculation involves multiplying the RTC/MCU/SRAM operating current (at the backup power source voltage) times the number of hours needed for backup. The product is the amount of charge capacity needed, in ampere-hours. When calculating the device run time in backup mode, it is sometimes necessary to include de-rating factors such as storage device characteristics vs. temperature and aging, as well as load current consumption over temperature and voltage. This is particularly true if precise knowledge of minimum available backup time over life of product is required.

Comparing - in absolute terms - EnerChip storage capacity to supercapacitors in a comparable energy storage range, we turn to Figure 2. Recalling the state-of-charge dependence typical of supercapacitors, three lines are drawn, representing the minimum operating voltage (Vmin) at which the load can operate. Note that as Vmin rises, a diminishing amount of useful charge is available from the supercapacitor. (Again, the relatively high self-discharge of supercapacitors has been ignored here for the sake of clarity.) For reference, EnerChips range from a few microampere-hours to several tens of microampere-hours, corresponding to equivalent capacitance of tens to hundreds of millifarads.

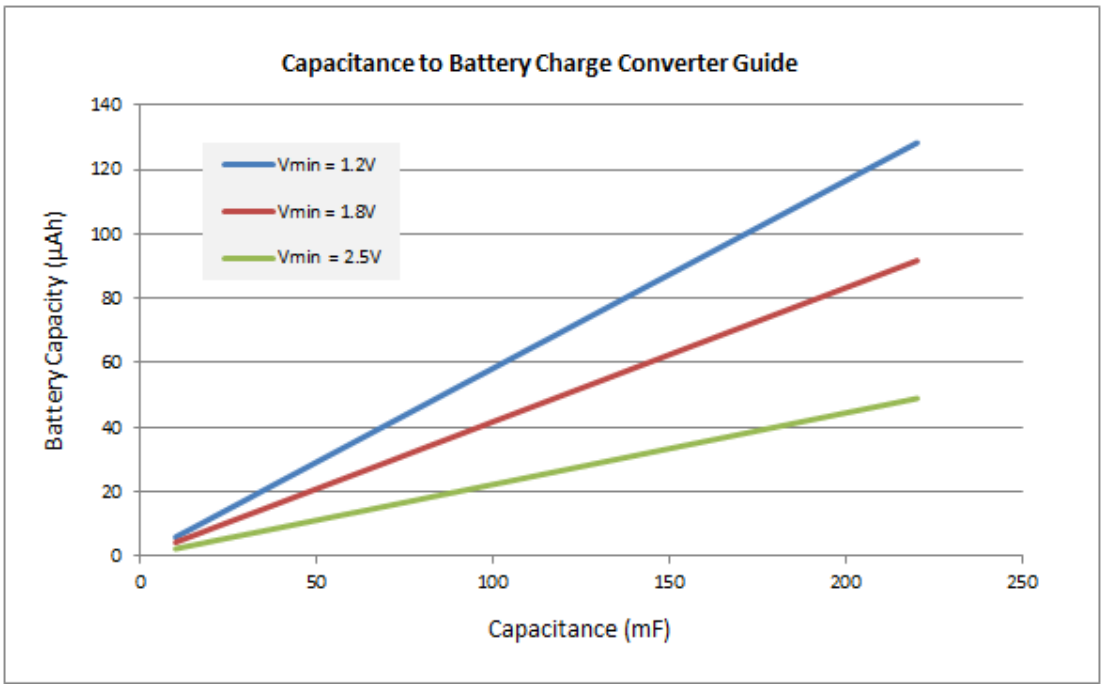

Figure 2: Charge Capacity of EnerChips vs. Supercapacitors at Several Discharge Cutoff Voltage Levels.

In addition to the battery (EnerChip) management functions, the EnerChip CC has additional functions that are useful and often necessary in backup power applications - such as supply voltage threshold detection and a power-good indicator. EnerChip CC devices also have temperature-dependent battery charge compensation included to improve the service life of the product. For more technical information related to the EnerChip and EnerChip CC products, refer to the Cymbet Corporation web site: www.cymbet.com.

Cymbet Product Ordering Information

EnerChip CC Part Number	Description	Notes
CBC3105-R4C	EnerChip CC 5µAh in 16-pin DFN	Shipped in Tube
CBC3105-R4C-TR1 CBC3105-R4C-TR5	EnerChip CC 5µAh in 16-pin DFN	Tape-and-Reel - 1000 pcs (TR1) or 5000 pcs (TR5) per reel
CBC3105-R4C-WP	EnerChip CC 5µAh in 16-pin DFN	Waffle Pack
CBC3112-D7C	EnerChip CC 12µAh in 20-pin D7 DFN Package	Shipped in Tube
CBC3112-D7C-TR1 CBC3112-D7C-TR5	EnerChip CC 12µAh in 20-pin D7 DFN Package	Tape-and-Reel - 1000 pcs (TR1) or 5000 pcs (TR5) per reel
CBC3112-D7C-WP	EnerChip CC 12µAh in 20-pin D7 DFN Package	Waffle Pack
CBC3150-D9C	EnerChip CC 50µAh in 20-pin D9 DFN Package	Shipped in Tube
CBC3150-D9C-TR1 CBC3150-D9C-TR5	EnerChip CC 50µAh in 20-pin D9 DFN Package	Tape-and-Reel - 1000 pcs (TR1) or 5000 pcs (TR5) per reel
CBC3150-D9C-WP	EnerChip CC 50µAh in 20-pin D9 DFN Package	Waffle Pack