



**THE DATASHEET OF
CBC3112-D7C**



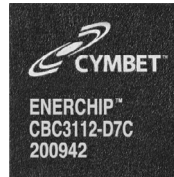
EnerChip CC with Integrated Power Management

Features

- Power Manager with Charge Control
- Integrated 12μAh Thin Film Energy Storage
- Built-in Energy Storage Protection
- Temperature Compensated Charge Control
- Adjustable Switchover Voltage
- Charges Integrated EnerChip Over a Wide Supply Range
- Low Standby Power
- SMT - Solder Reflow Tolerant
- Thousands of Recharge Cycles
- Low Self-Discharge
- Eco-Friendly, RoHS Compliant

Applications

- **Standby supply** for non-volatile SRAM, Real-time clocks, controllers, supply supervisors, and other system-critical components.
- **Wireless sensors and RFID tags** and other powered, low duty cycle applications.
- **Localized power source** to keep microcontrollers and other devices alert in standby mode.
- **Power bridging** to provide back-up power to system during exchange of main batteries.
- **Consumer appliances** that have real-time clocks; provides switchover power from main supply to backup battery.
- **Business and industrial systems** such as: network routers, point-of-sale terminals, single-board computers, test equipment, multi-function printers, industrial controllers, and utility meters.
- **Energy Harvesting** by coupling the EnerChip with energy transducers such as solar panels.



7 mm x 7 mm
DFN SMT Package:

The EnerChip CC is the world's first Intelligent Thin Film Energy Storage Device. It is an integrated solution that provides backup energy storage and power management for systems requiring power bridging and/or secondary power. A single EnerChip CC can charge up to 10 additional EnerChips connected in parallel.

During normal operation, the EnerChip CC charges itself with a controlled voltage using an internal charge pump that operates from 2.5V to 5.5V. An ENABLE pin allows for activation and deactivation of the charge pump using an external control line in order to minimize current consumption and take advantage of the fast recharge time of the EnerChip.

When the primary power supply dips below a user-defined threshold voltage, the EnerChip CC will signal this event and route the EnerChip voltage to VOUT. The EnerChip CC also has energy storage protection circuitry to enable thousands of recharge cycles.

The CBC3112 is a 20-pin, 7 mm x 7 mm Dual Flat No-lead (DFN) package, available in tubes, trays, or tape-and-reel for use with automatic insertion equipment.

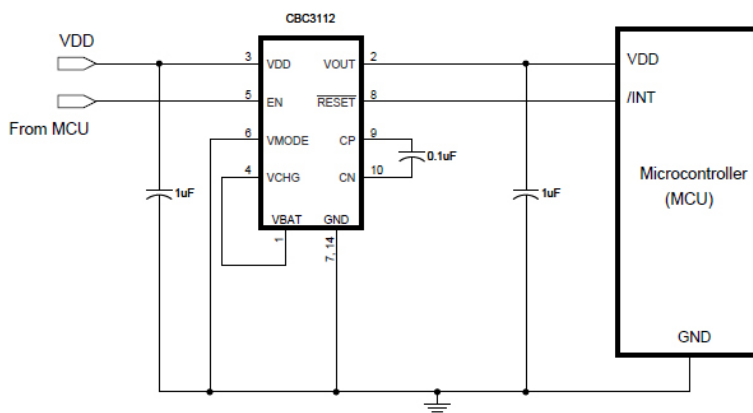


Figure 1 - Typical EnerChip CC Application Circuit

Electrical Properties

| | |
|---------------------------------|------------------------|
| EnerChip Backup Output voltage: | 3.3V |
| Energy Capacity (typical): | 12 μ Ah |
| Recharge time to 80%: | 10 minutes |
| Charge/Discharge cycles: | >5000 to 10% discharge |

Physical Properties

| | |
|------------------------|---|
| Package size: | 7 mm x 7 mm |
| Operating temperature: | -20 °C to +70 °C |
| Storage temperature: | -40 °C to +125 °C (prior to 1st charge) |

Functional Block Diagram

The EnerChip CC internal schematic is shown in Figure 2. The input voltage from the power supply (V_{DD}) is applied to the charge pump, the control logic, and is compared to the user-set threshold as determined by the voltage on V_{MODE} . V_{MODE} is an analog input ranging from 0V to V_{DD} . The ENABLE pin is a digital input that turns off the charge pump when low. V_{OUT} is either supplied from V_{DD} or the integrated EnerChip. \overline{RESET} is a digital output that, when low, indicates V_{OUT} is being sourced by the integrated EnerChip.

C_{FLY} is the flying capacitor in the voltage doubler circuit. The value of C_{FLY} can be changed if the output impedance of the EnerChip CC needs to be modified. The output impedance is dictated by $1/fC$, where f is the frequency of oscillation (typically 100kHz) and C is the capacitor value (typically 0.1 μ F). GND is system ground.

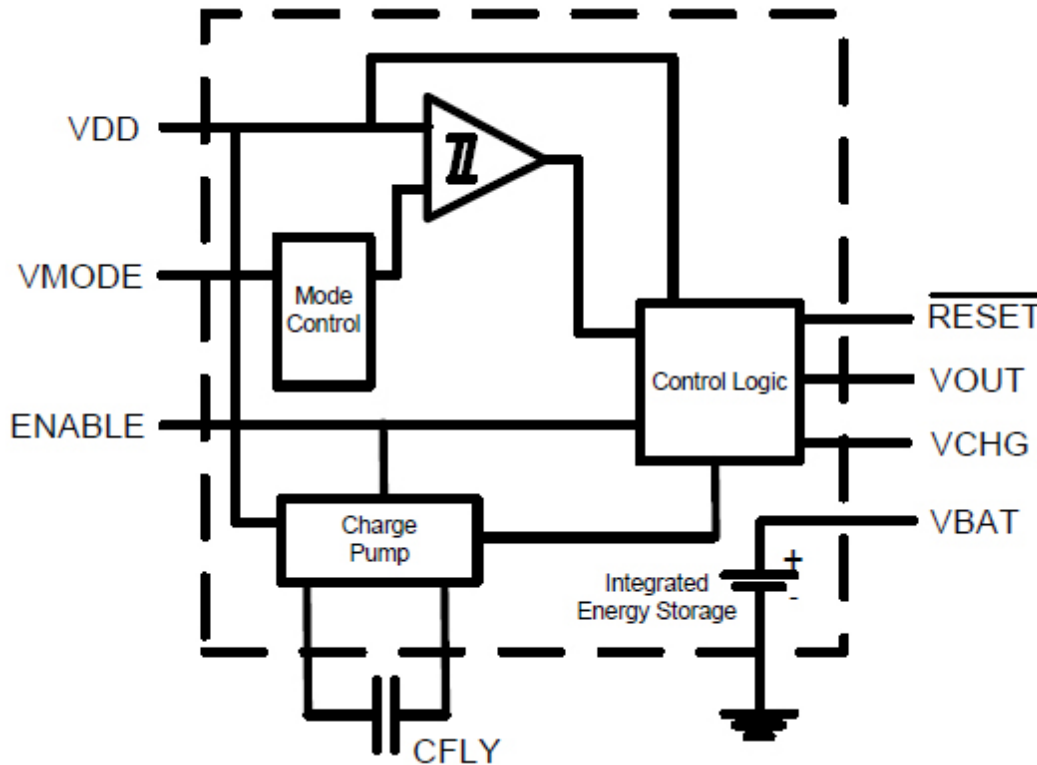


Figure 2: EnerChip CC CBC3112 Internal Block Diagram

Device Input/Output Descriptions

| Pin Number(s) | Label | Description |
|---------------|---------------------------|--|
| 1 | V _{BAT} | Positive EnerChip Terminal - Tie to Pin 4 |
| 2 | V _{OUT} | System Voltage |
| 3 | V _{DD} | Input Voltage |
| 4 | V _{CHG} | EnerChip Charge Voltage - Tie to Pin 1 and/or Optional EnerChip(s) |
| 5 | ENABLE | Charge Pump Enable |
| 6 | V _{MODE} | Mode Select for Backup Switchover Threshold |
| 7 | GND | System Ground |
| 8 | $\overline{\text{RESET}}$ | Reset Signal (Active Low) |
| 9 | C _P | Flying Capacitor Positive |
| 10 | C _N | Flying Capacitor Negative |
| 11 | NC | No Connection |
| 12 | NC | No Connection |
| 13 | NC | No Connection |
| 14 | GND | System Ground |
| 15 | NC | No Connection |
| 16 | NC | No Connection |
| 17 | NC | No Connection |
| 18 | NC | No Connection |
| 19 | NC | No Connection |
| 20 | NC | No Connection |

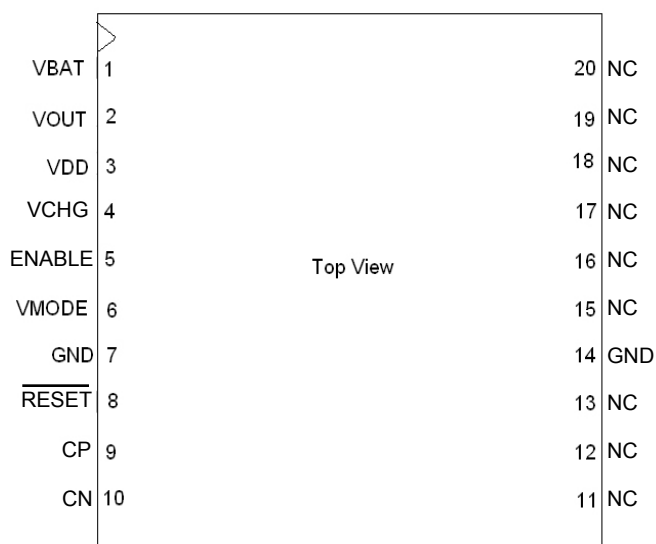


Figure 3: EnerChip CC CBC3112 Package Pin-out

Absolute Maximum Ratings

| PARAMETER | CONDITION | MIN | TYPICAL | MAX | UNITS |
|--------------------------------|-----------|-----------|---------|----------|-------|
| VDD with respect to GND | 25 °C | GND - 0.3 | - | 6.0 | V |
| ENABLE and VMODE Input Voltage | 25 °C | GND - 0.3 | - | VDD+0.3 | V |
| VBAT ⁽¹⁾ | 25 °C | 3.0 | - | 4.15 | V |
| VCHG ⁽¹⁾ | 25 °C | 3.0 | - | 4.15 | V |
| VOUT | 25 °C | GND - 0.3 | - | 6.0 | V |
| RESET Output Voltage | 25 °C | GND - 0.3 | - | VOUT+0.3 | V |
| CP, Flying Capacitor Voltage | 25 °C | GND - 0.3 | - | 6.0 | V |
| CN | 25 °C | GND - 0.3 | - | VDD+0.3 | V |

⁽¹⁾ No external connections to these pins are allowed, except parallel EnerChips.

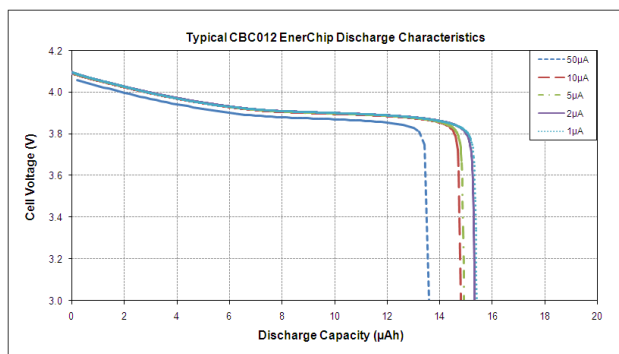
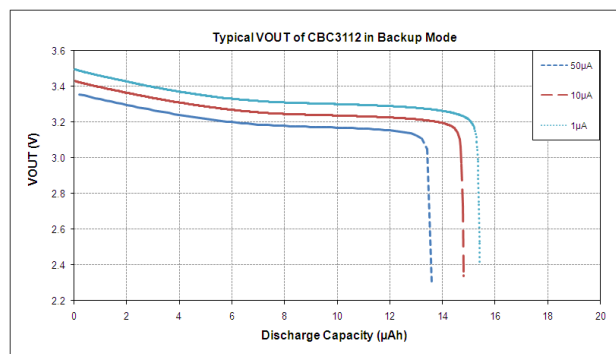
Operating Characteristics

| PARAMETER | CONDITION | MIN | TYPICAL | MAX | UNITS | |
|---|-----------------------|-------------------------------|--------------------|---------------------|------------|--------|
| Output Voltage VOUT | VDD > VTH | - | VDD | - | V | |
| Output Voltage VOUT (backup mode) | VDD < VTH | 2.2 | 3.3 | 3.6 | V | |
| EnerChip Pulse Discharge Current | - | Variable - see App. Note 1025 | | | - | |
| Self-Discharge (5-yr. average; 25 °C) | Non-recoverable | - | 2.5 | - | % per year | |
| | Recoverable | - | 1.5 ⁽¹⁾ | - | % per year | |
| Operating Temperature | - | -40 ⁽²⁾ | 25 | +70 | °C | |
| Storage Temperature | - | -40 | - | +125 ⁽³⁾ | °C | |
| Cell Resistance (25 °C) | Charge cycle 2 | - | 2.15 | 5.35 | kΩ | |
| | Charge cycle 1000 | - | 10.7 | 21.3 | | |
| Recharge Cycles (to 80% of rated capacity; 4.1V charge voltage) | 25 °C | 10% depth-of-discharge | 5000 | - | - | cycles |
| | | 50% depth-of discharge | 1000 | - | - | cycles |
| | 40 °C | 10% depth-of-discharge | 2500 | - | - | cycles |
| | | 50% depth-of-discharge | 500 | - | - | cycles |
| Recharge Time (to 80% of rated capacity; 4.1V charge; 25 °C) | Charge cycle 2 | - | 10 | 22 | minutes | |
| | Charge cycle 1000 | - | 45 | 70 | | |
| Capacity | 50µA discharge; 25 °C | 12 | - | - | µAh | |

⁽¹⁾ First month recoverable self-discharge is 4% average.

⁽²⁾ Cell resistance and charging time increase with decreasing temperature.

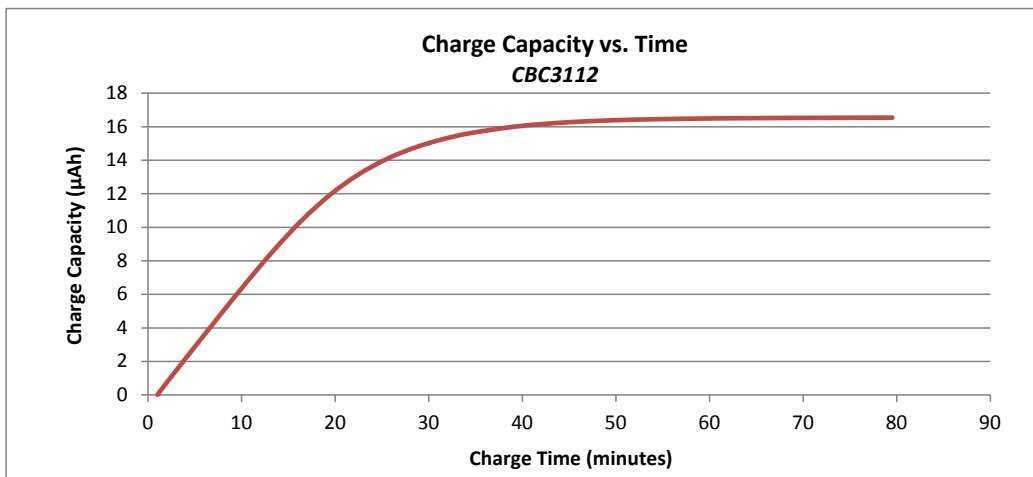
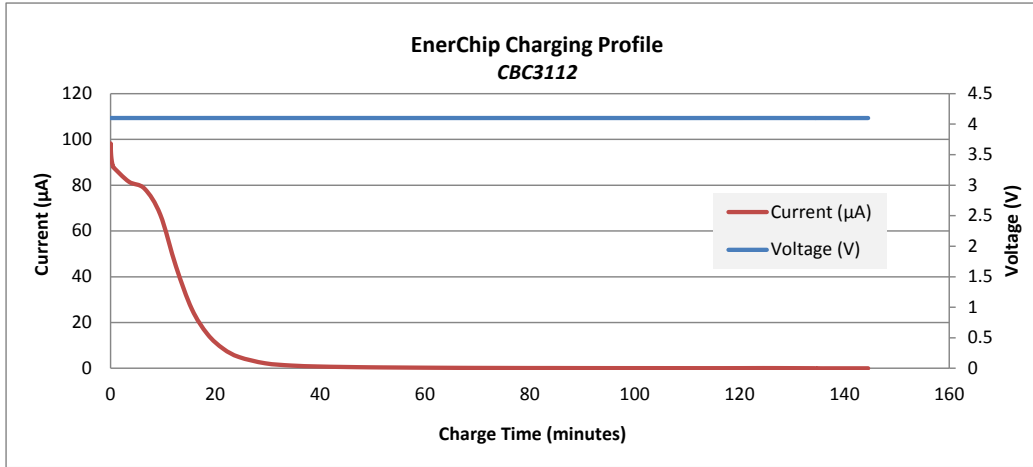
⁽³⁾ Storage temperature is for EnerChip CC device before 1st charge is applied.



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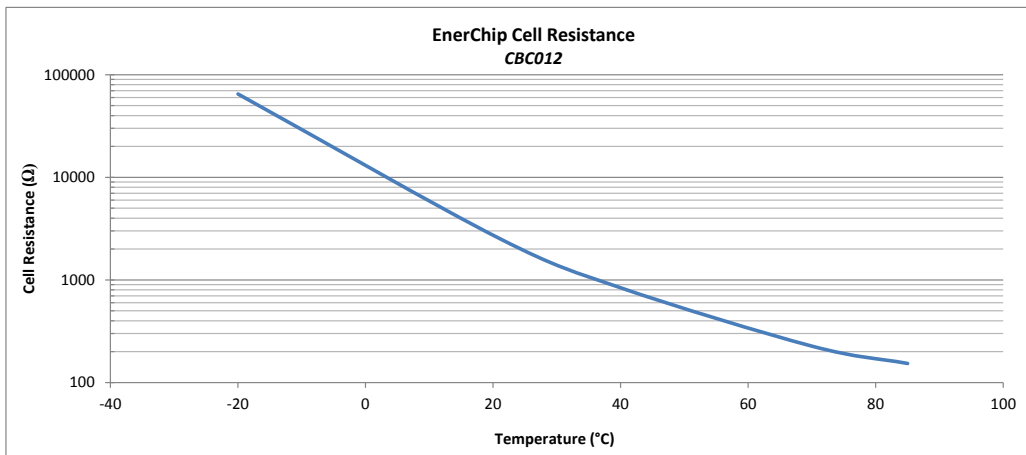
EnerChip Charging Characteristics

The EnerChip can be recharged quickly. The following graphs illustrate the correlation between charging time and charging current into a discharged cell, and also the cumulative charge vs. charging time. Both graphs are typical based on constant 4.1V charging at room temperature. Charging time increases at lower temperature.



EnerChip Temperature Characteristics

EnerChip cell resistance increases (decreases) with decreasing (increasing) temperature. The following graph represents typical cell resistance over the rated operating temperature range.



POWER SUPPLY CURRENT CHARACTERISTICS

Ta = -20°C to +70°C

| CHARACTERISTIC | SYMBOL | CONDITION | MIN | MAX | UNITS | |
|-------------------------|----------------------|---|-----------------------|-----|-------|----|
| Quiescent Current | I _Q | ENABLE=GND | V _{DD} =3.3V | - | 3.5 | μA |
| | | | V _{DD} =5.5V | - | 6.0 | μA |
| | | ENABLE=V _{DD} | V _{DD} =3.3V | - | 35 | μA |
| | | | V _{DD} =5.5V | - | 38 | μA |
| EnerChip Cutoff Current | I _{QBATOFF} | V _{BAT} < V _{BATCO} , V _{OUT} =0 | - | 0.5 | nA | |
| | I _{QBATON} | V _{BAT} > V _{BATCO} , ENABLE=V _{DD} , I _{OUT} =0 | - | 42 | nA | |

INTERFACE LOGIC SIGNAL CHARACTERISTICS

V_{DD} = 2.5V to 5.5V, Ta = -20°C to +70°C

| CHARACTERISTIC | SYMBOL | CONDITION | MIN | MAX | UNITS |
|-----------------------------|-----------------|--|--|------|-------|
| High Level Input Voltage | V _{IH} | - | V _{DD} - 0.5 | - | Volts |
| Low Level Input Voltage | V _{IL} | - | - | 0.5 | Volts |
| High Level Output Voltage | V _{OH} | V _{DD} > V _{TH} (see Figures 4 and 5) I _L =10μA | V _{DD} - 0.04V ⁽¹⁾ | - | Volts |
| Low Level Output Voltage | V _{OL} | I _L = -100μA | - | 0.3 | Volts |
| Logic Input Leakage Current | I _{IN} | 0 < V _{IN} < V _{DD} | -1.0 | +1.0 | nA |

⁽¹⁾ RESET tracks V_{DD}; RESET = V_{DD} - (I_{OUT} x R_{OUT}).

RESET SIGNAL AC/DC CHARACTERISTICS

V_{DD} = 2.5V to 5.5V, Ta = -20°C to +70°C

| CHARACTERISTIC | SYMBOL | CONDITION | MIN | MAX | UNITS |
|--|---------------------|---|------|------|-------|
| V _{DD} Rising to RESET Rising | t _{RESETH} | V _{DD} rising from 2.8V TO 3.1V in <10μs | 60 | 200 | ms |
| V _{DD} Falling to RESET Falling | t _{RESETL} | V _{DD} falling from 3.1V to 2.8V in <100ns | 0.5 | 2 | μs |
| Mode 1 TRIP V V _{DD} Rising | V _{RESET} | V _{MODE} = GND | 2.80 | 3.20 | V |
| Mode 2 TRIP V ⁽²⁾ V _{DD} Rising | V _{RESET} | V _{MODE} = V _{DD} /2 | 2.25 | 2.60 | V |
| RESET Hysteresis Voltage ⁽³⁾ (V _{DD} to RESET) | V _{HYST} | V _{MODE} =V _{DD} | 60 | 100 | mV |
| | | V _{MODE} =GND | 45 | 75 | |
| | | V _{MODE} = V _{DD} /2 | 30 | 50 | |

⁽²⁾ User-selectable trip voltage can be set by placing a resistor divider from the V_{MODE} pin to GND. Refer to Figure 8.

⁽³⁾ The hysteresis is a function of trip level in Mode 2. Refer to Figure 9.

CHARGE PUMP CHARACTERISTICS

V_{DD} = 2.5V to 5.5V, T_a = -20°C to +70°C

| CHARACTERISTIC | SYMBOL | CONDITION | MIN | MAX | UNITS |
|--|---------------------|--|-------|-------|--------------------|
| ENABLE=V _{DD} to Charge Pump Active | t _{CPON} | ENABLE to 3rd charge pump pulse, V _{DD} =3.3V | 60 | 80 | μs |
| ENABLE Falling to Charge Pump Inactive | t _{CPOFF} | - | 0 | 1 | μs |
| Charge Pump Frequency | f _{CP} | | - | 120 | KHz ⁽¹⁾ |
| Charge Pump Resistance | R _{CP} | Delta V _{BAT} , for I _{BAT} charging current of 1μA to 100μA C _{FLY} =0.1μF, C _{BAT} =1.0μF | 150 | 300 | Ω |
| V _{CHG} Output Voltage | V _{CP} | C _{FLY} =0.1μF, C _{BAT} =1.0μF, I _{OUT} =1μA, Temp=+25°C | 4.075 | 4.125 | V |
| V _{CHG} Temp. Coefficient | T _{CCP} | I _{OUT} =1μA, Temp=+25°C | -2.0 | -2.4 | mV/°C |
| Charge Pump Current Drive | I _{CP} | I _{BAT} =1mA C _{FLY} =0.1μF, C _{BAT} =1.0μF | 1.0 | - | mA |
| Charge Pump on Voltage | V _{ENABLE} | ENABLE=V _{DD} | 2.5 | - | V |

⁽¹⁾ $f_{CP} = 1/t_{CPPER}$

ADDITIONAL CHARACTERISTICS

T_a = -20°C to +70°C

| CHARACTERISTIC | SYMBOL | CONDITION | LIMITS | | UNITS |
|--|--------------------|--|--------|------|-------|
| | | | MIN | MAX | |
| V _{BAT} Cutoff Threshold | V _{BATCO} | I _{OUT} =1μA | 2.75 | 3.25 | V |
| Cutoff Temp. Coefficient | T _{CCO} | - | +1 | +2 | mV/°C |
| V _{BAT} Cutoff Delay Time | t _{COOFF} | V _{BAT} from 40mV above to 20mV below V _{BATCO} I _{OUT} =1μA | 18 | - | ms |
| V _{OUT} Dead Time, V _{DD} Rising ⁽²⁾ | t _{RSBR} | I _{OUT} =1mA V _{BAT} =4.1V | 0.2 | 2.0 | μs |
| V _{OUT} Dead Time, V _{DD} Falling ⁽²⁾ | t _{RSBF} | V _{BAT} =4.1V | 0.2 | 2.0 | μs |
| Bypass Resistance | R _{OUT} | - | - | 2.5 | Ω |

⁽²⁾ Dead time is the time period when the V_{OUT} pin is floating. Size the holding capacitor accordingly.

Note: All specifications contained within this document are subject to change without notice

Important timing diagrams for the EnerChip CC relationship between EnerChip Switchover Timing and EnerChip Disconnect from Load Timing are shown in Figure 4.

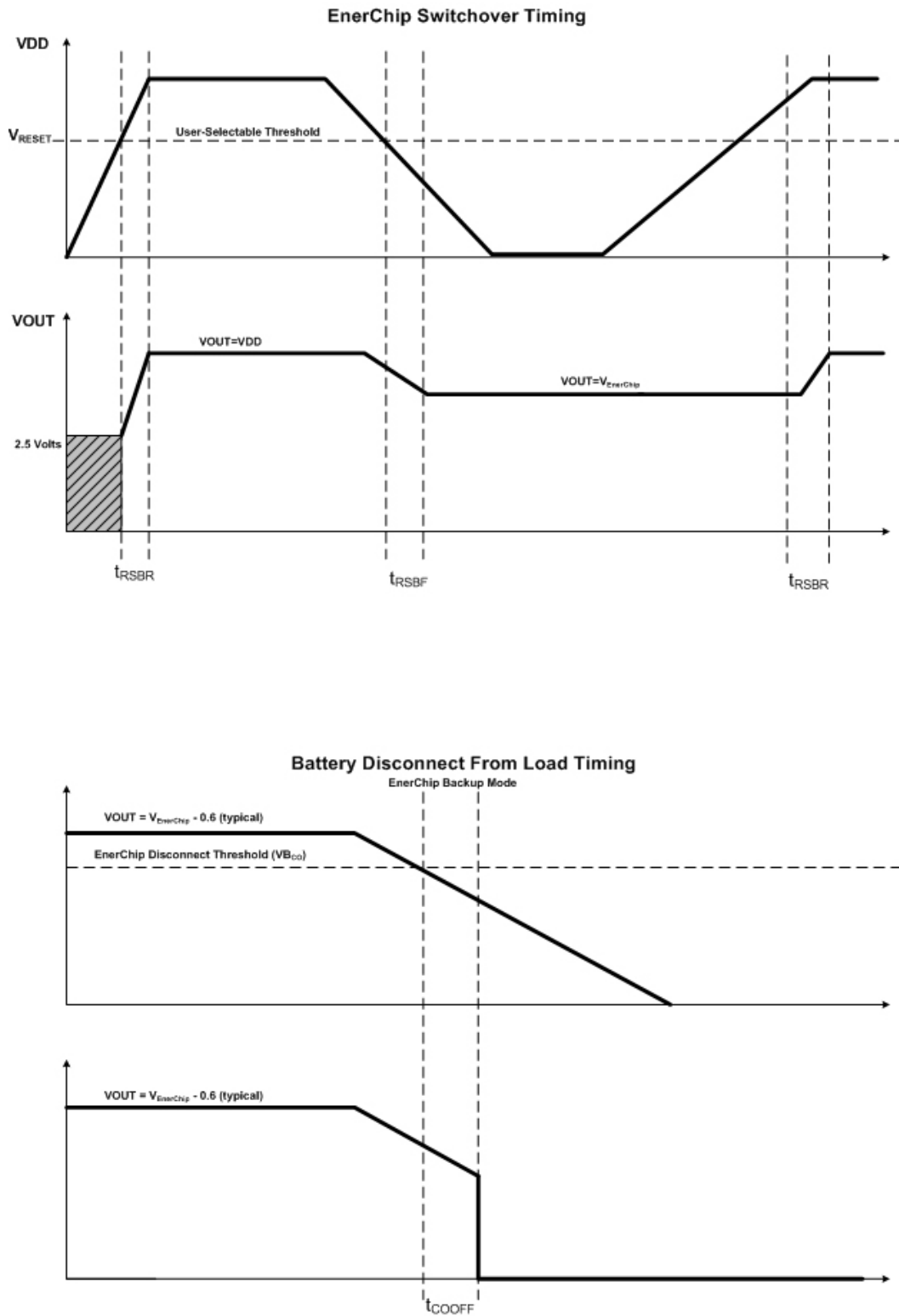


Figure 4: EnerChip CC Switchover and Disconnect Timing Diagrams

Timing diagrams for the EnerChip CC relationship between V_{DD} to $\overline{\text{RESET}}$ and ENABLE high to charge pump becoming active are shown in Figure 5.

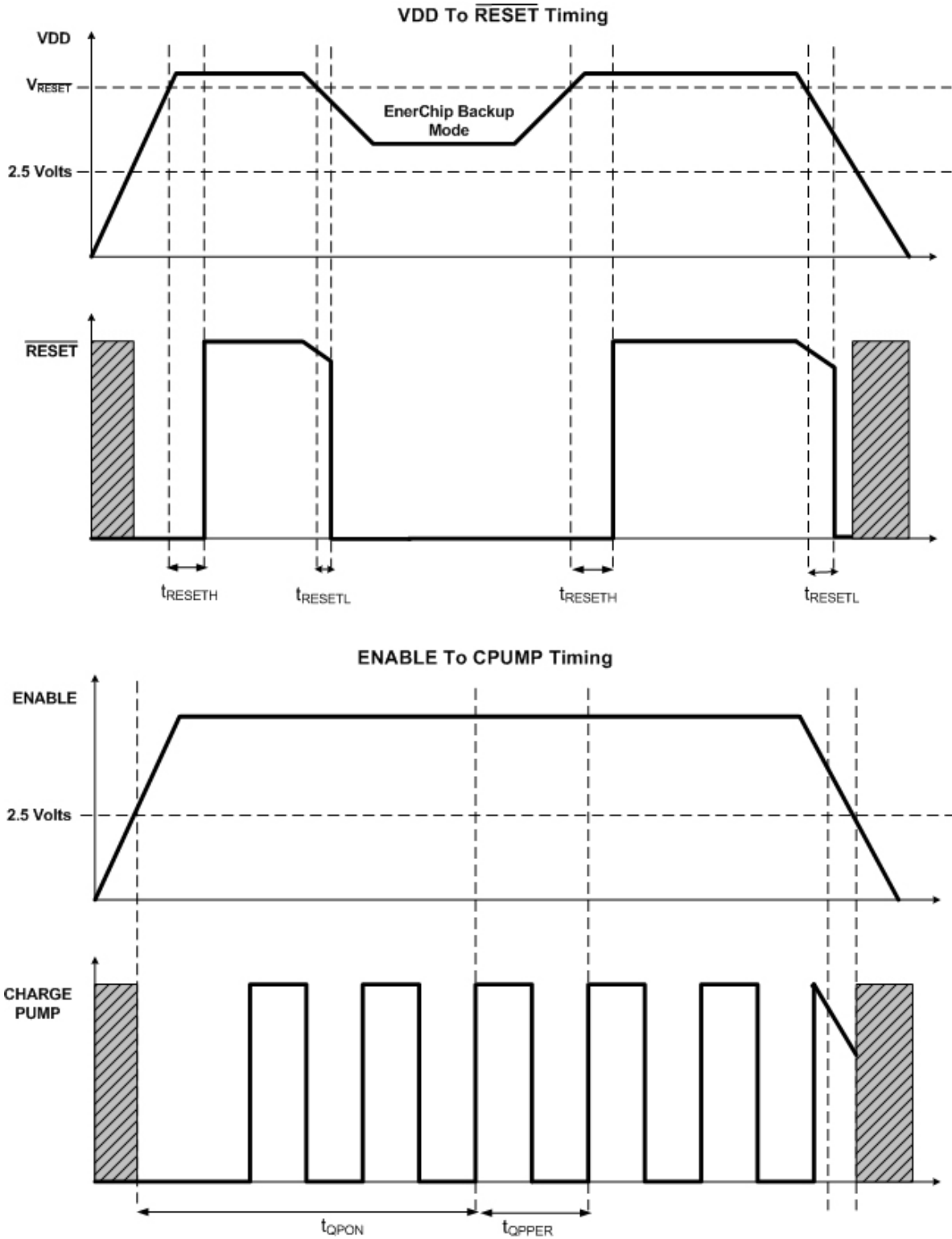


Figure 5: Timing Diagrams for V_{DD} to $\overline{\text{RESET}}$ and Enable to Charge Pump Active.

EnerChip CC Detailed Description

The EnerChip CC uses a charge pump to generate the supply voltage for charging the integrated energy storage device. An internal FET switch with low $R_{DS(on)}$ is used to route V_{DD} to V_{OUT} during normal operation when main power is above the switchover threshold voltage. When V_{DD} is below the switchover threshold voltage, the FET switch is shut off and V_{OUT} is supplied by the EnerChip. An interrupt signal is asserted low prior to the switchover.

Operating Modes

The EnerChip CC can be operated from various power supplies such as a primary source or a non-rechargeable battery. With the ENABLE pin asserted high, the charge pump is active and charges the integrated EnerChip. The EnerChip CC will be 80% charged within 10 minutes. Due to the rapid recharge it is recommended that, once the EnerChip CC is fully charged, the user de-assert the ENABLE pin (i.e., force low) to reduce power consumption. A signal generated from the MCU could be used to enable and disable the EnerChip CC.

When controlling the ENABLE pin by way of an external controller - as opposed to fixing the ENABLE line to VDD - ensure that the ENABLE pin is forced low by the controller anytime the \overline{RESET} line is low, which occurs when the switchover threshold voltage is reached and the device is placed in backup mode. Although the internal charge pump is designed to operate below the threshold switchover level when the ENABLE line is active, it is recommended that the ENABLE pin be forced low whenever \overline{RESET} is low to ensure no parasitic loads are placed on the EnerChip while in this mode. If ENABLE is high or floating while VDD is in an indeterminate state, bias currents within the EnerChip CC could flow, placing a parasitic load on the EnerChip that could dramatically reduce the effective backup operating time.

The EnerChip CC supports 2 operational modes as shown in Figures 6 and 7.

Mode 1 Operation

For use in 3.3 volt systems. The V_{MODE} pin should be tied directly to GND, as shown in Figure 6. This will set the switchover threshold at approximately 3.0 volts.

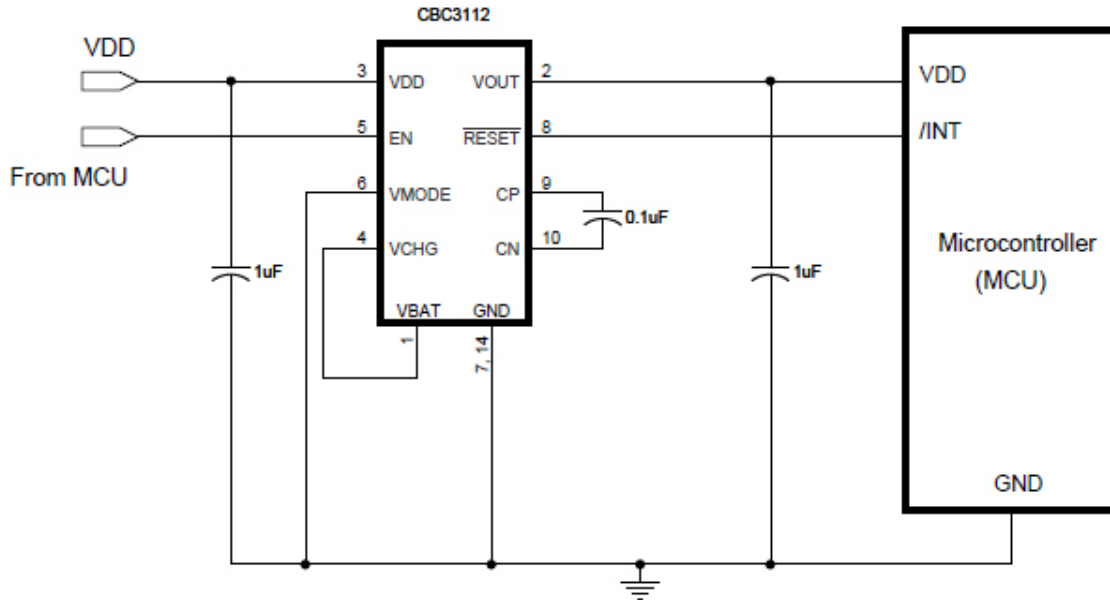


Figure 6: CBC3112 Typical Circuit for Mode 1 Operation

Mode 2 Operation

Figure 7 shows the circuitry for user-selectable switchover threshold to a value between 2.5 and 5.0 volts. Use Figure 8 to determine the value of R₁. To determine the amount of hysteresis from the EnerChip switchover threshold, use Figure 9.

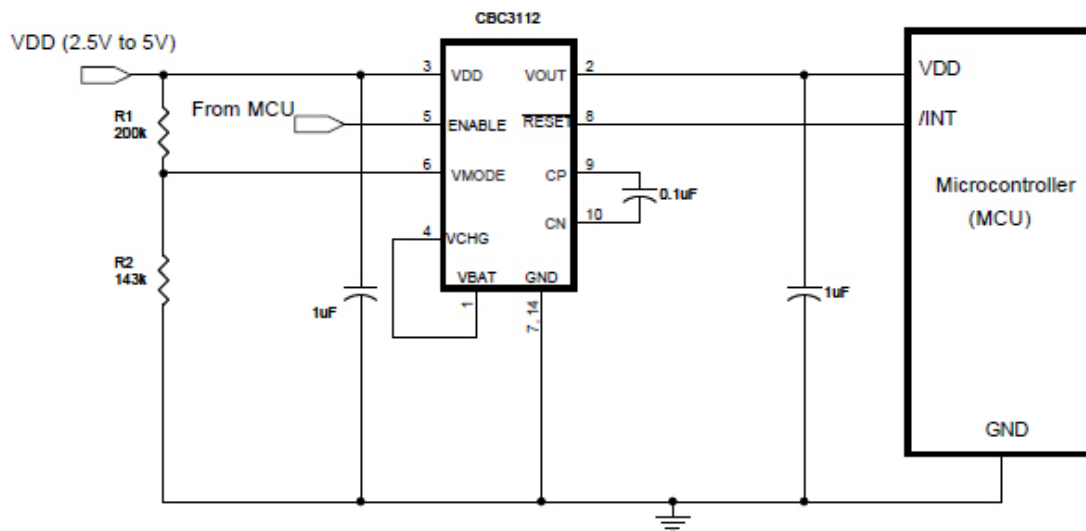


Figure 7: CBC3112 Typical Circuit for Mode 2 Operation

EnerChip charging and backup power switchover threshold for 2.5 to 5.5 volt operation is selected by changing the value of R2 (see Figure 7). To determine the backup switchover point, set the value of R1 to 200kΩ and choose the value of R2 according to Figure 8. For example, to set a 3.0V trip point: If R1=200 kΩ then R2 = R1 x 0.72 = 144kΩ. Figure 7 shows a Mode 2 circuit with standard value resistors of 200kΩ and 143kΩ.

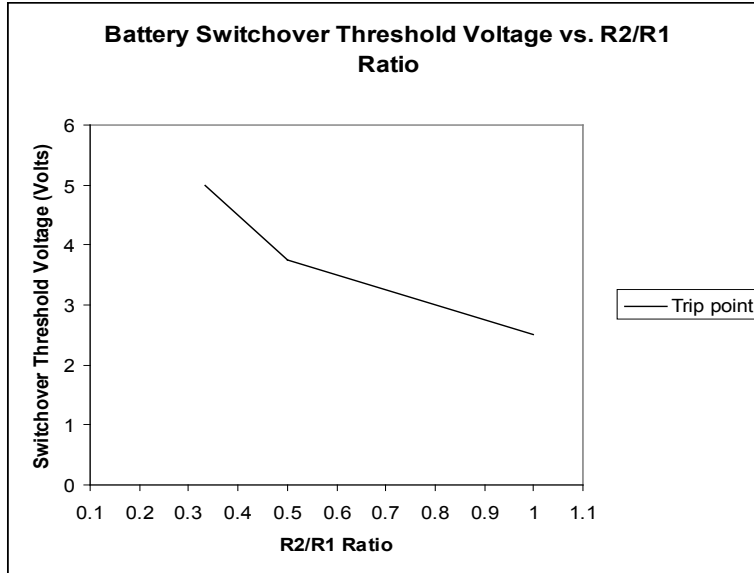


Figure 8: Mode 2 Resistor Selection Graph

To determine the backup switchover hysteresis for Mode 2 operation, use Figure 9.

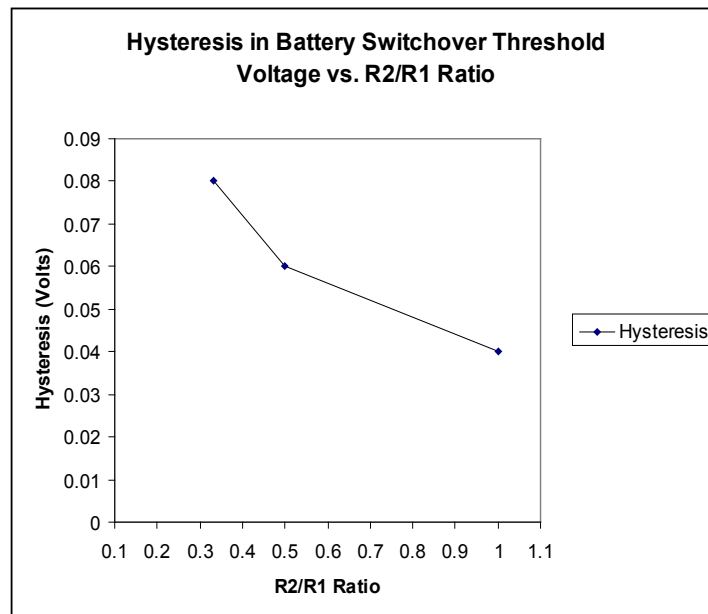
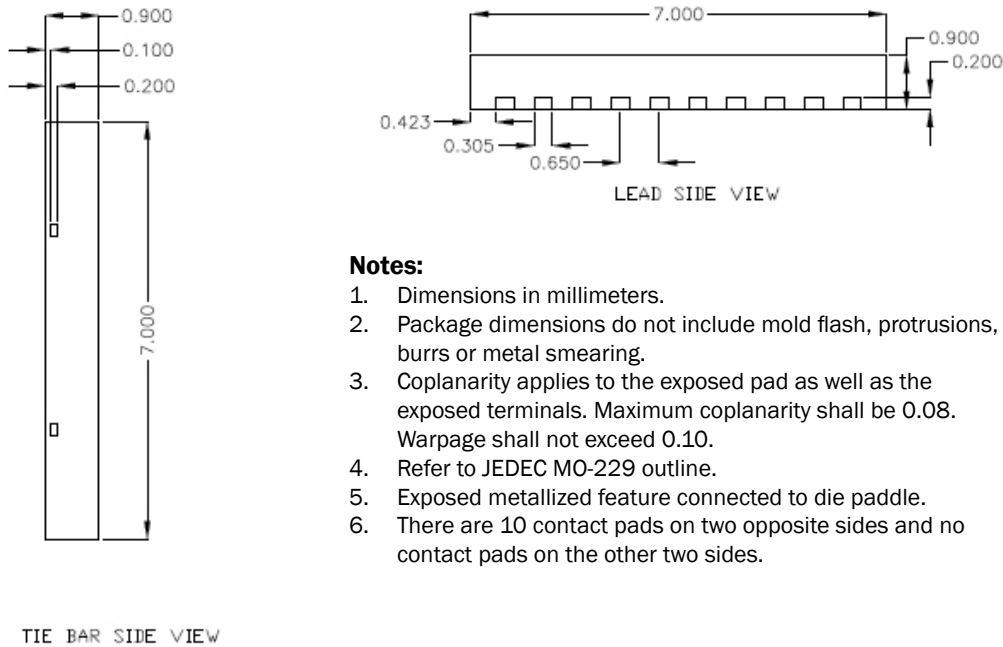
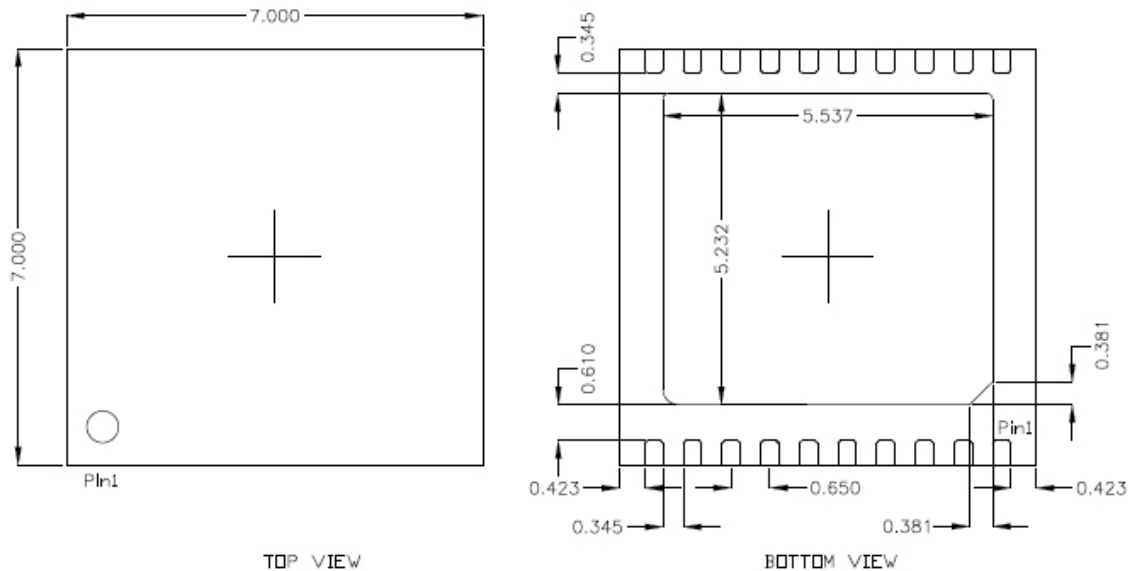


Figure 9: Mode 2 Hysteresis as a Function of R2/R1

CBC3112 7mm x 7mm DFN Package Drawing and Dimensions



Notes:

1. Dimensions in millimeters.
2. Package dimensions do not include mold flash, protrusions, burrs or metal smearing.
3. Coplanarity applies to the exposed pad as well as the exposed terminals. Maximum coplanarity shall be 0.08. Warpage shall not exceed 0.10.
4. Refer to JEDEC MO-229 outline.
5. Exposed metallized feature connected to die paddle.
6. There are 10 contact pads on two opposite sides and no contact pads on the other two sides.

Handling EnerChips as MSL 3 Devices



EnerChip CBC050 devices are rated Moisture Sensitivity Level 3 and must be mounted and reflowed within 168 hours of being removed from the moisture barrier antistatic bag.

Soldering, Rework, and Electrical Test

Refer to the Cymbet User Manual AN-1026 for soldering, rework, and replacement of the EnerChip on printed circuit boards, and for instructions on in-circuit electrical testing of the EnerChip.

Energy Harvesting with the EnerChip CC

The EnerChip CC can be configured to collect energy from transducers such as low power photovoltaic (PV) cells and use that harvested energy to charge the integrated EnerChip and deliver self-sustaining power to components such as microcontrollers, sensors, and radios in wireless systems. The schematic of Figure 13 illustrates the feedback connection made from RESET to EN to implement the energy harvesting function with the CBC3150. In order to make most efficient use of the power available from the transducer (for example, a PV cell), it is necessary to know the electrical characteristics including voltage and peak power point of the transducer being used. For assistance in designing your system to effectively harvest energy from a power transducer in a specific environment, contact Cymbet Applications Engineering.

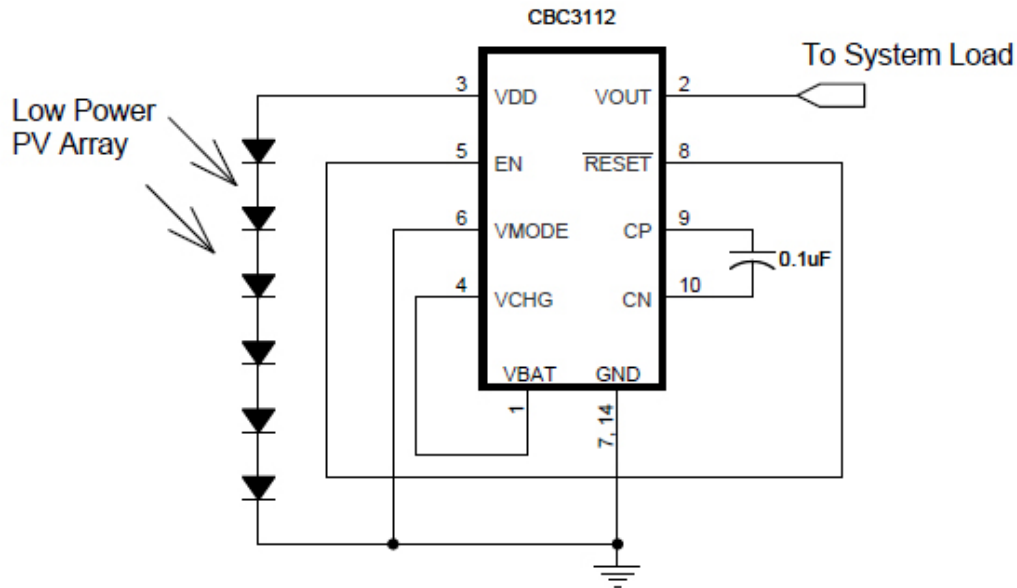


Figure 13: Implementing Energy Harvesting with the EnerChip CC

Ordering Information - available for Last Time Buy until September 12, 2014

| EnerChip CC Part Number | Description | Notes |
|------------------------------------|--|---|
| 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 |

U.S. Patent No. 8,044,508. Additional U.S. and Foreign Patents Pending

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