

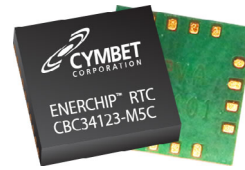
## SPI Real-Time Clock/Calendar with Integrated Backup Power

### Features

- Integrated rechargeable solid state battery with power-fail detect and automatic switchover, **providing greater than 30 hours of RTC backup**
- Smallest commercially available RTC with integrated backup power in compact 5mm x 5mm 1.4mm QFN package
- Temperature compensated charge control
- Integrated EnerChip™ recharged at VDD > 2.5V
- SMT assembly - lead-free reflow solder tolerant
- Real time clock provides year, month, day, week-day, hours, minutes, and seconds based on a 32.768 kHz quartz crystal
- Resolution: seconds to years
- Watchdog functionality
- Freely programmable timer and alarm with interrupt capability
- 3-line SPI-bus with separate, but combinable data input and output
- Integrated oscillator load capacitors for  $C_L = 7$  pF
- Internal Power-On Reset (POR)
- Open-drain interrupt and clock output pins
- Programmable offset register for frequency adjustment
- Eco-friendly, RoHS compliant - tested

### Applications

- **Wireless sensors and RFID tags** and other powered, low duty cycle applications.
- **Power bridging** to provide uninterruptible RTC function 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.
  - Time keeping application
  - Battery powered devices
  - Metering
  - High duration timers
  - Daily alarms
  - Low standby power applications

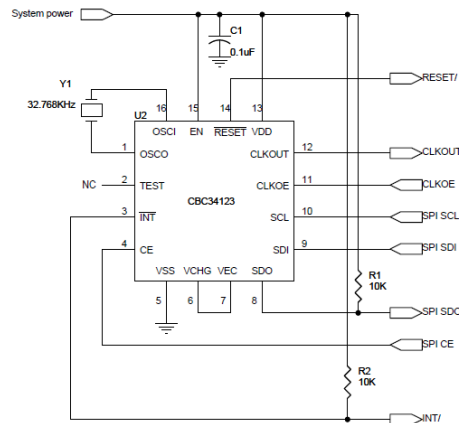


**5mm x 5mm x 1.4mm 16-QFN Package**

### General Description

The EnerChip RTC CBC34123-M5C combines a Real-Time Clock (RTC) and calendar optimized for low power applications with an integrated rechargeable solid state backup battery and all power management functions. The EnerChip RTC ensures a seamless transition from main power to backup power in the event of power loss. The integrated power management circuit ensures thousands of charge-discharge cycles from the integrated EnerChip and manages battery charging, discharge cutoff, power switchover, and temperature compensation to maximize the service life of the device. The CBC34123 provides greater than 30 hours of backup time in the event main power is interrupted. Typical blackout times are less than 4 hours. The EnerChip has extremely low self-discharge, recharges quickly, is non-flammable, and RoHS-compliant. The EnerChip is charged automatically anytime VDD is above 2.5V.

Data is transferred serially via a Serial Peripheral Interface (SPI-bus) with a maximum data rate of 6.25 Mbit/s. Alarm and timer functions provide the option to generate a wake-up signal on an interrupt pin. An offset register allows fine tuning of the clock.



**Figure 1: CBC34123 Pin-out Diagram**

# CBC34123 EnerChip™ RTC

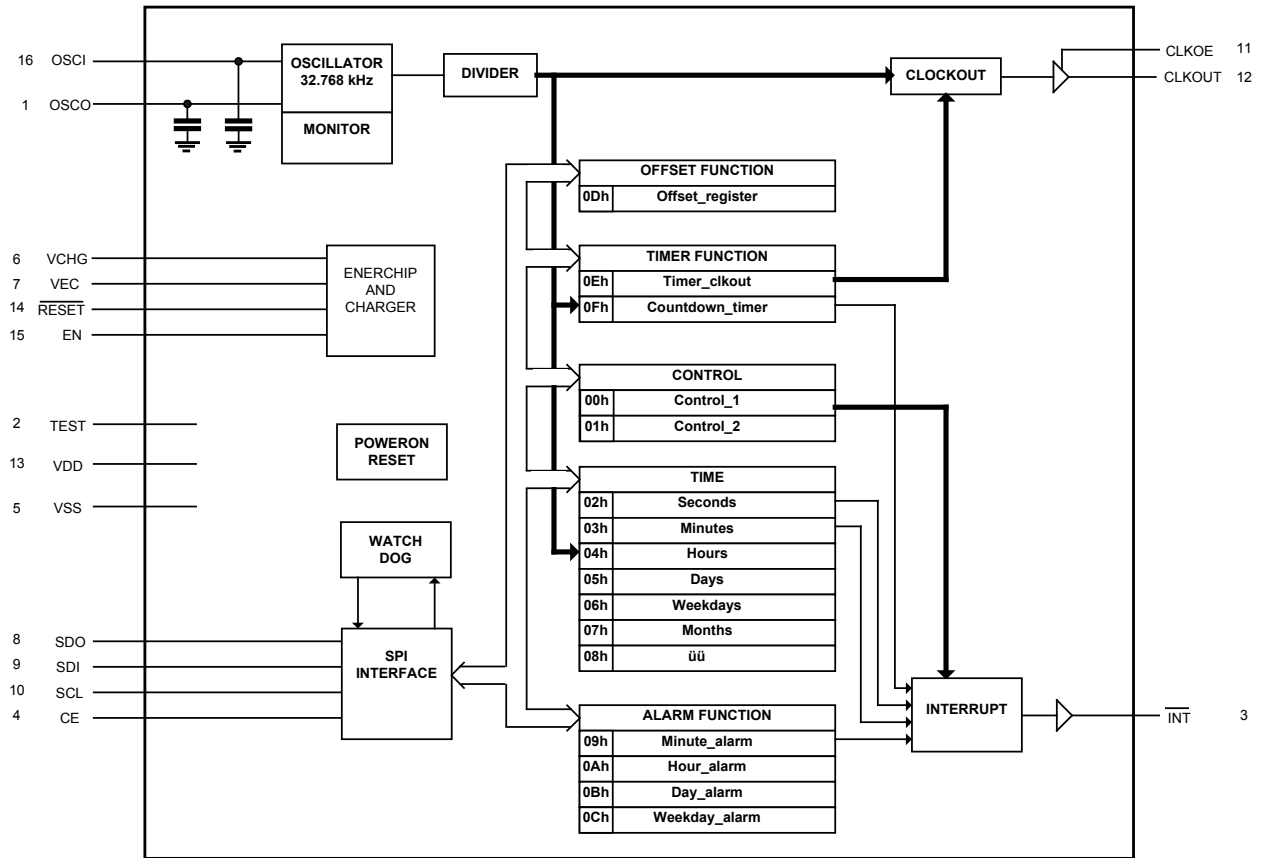


Figure 2: CBC34123 Block Diagram with Registers

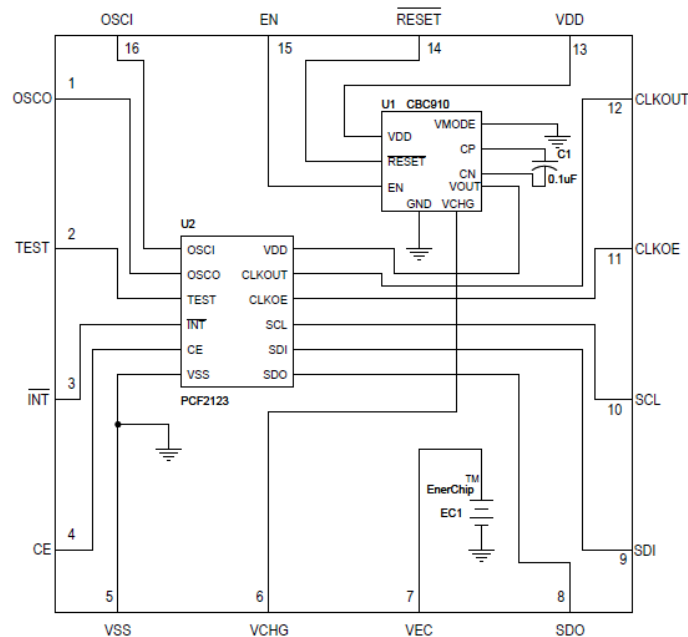


Figure 3: Internal Schematic of CBC34123 EnerChip RTC

# CBC34123 EnerChip™ RTC

## CBC34123 Input/Output Descriptions

Pin Number	Label	Description
1	OSCO	Oscillator output; high-impedance node; minimize wire length between quartz and package
2	TEST	Test pin; not user accessible; connect to VSS or leave floating (internally pulled down)
3	INT/	Interrupt output (open-drain; active LOW)
4	CE	Chip enable input (active HIGH) with internal pull down
5	VSS	Ground
6	VCHG	4.1V (typical) charging source - connect to VBAT and/or optional EnerChip(s)
7	VEC	Positive terminal of integrated thin film battery - connect to VCHG and nothing else
8	SDO	Serial data output, push-pull; high-impedance when not driving; can be connected to SDI for single wire data line
9	SDI	Serial data input; may float when CE is inactive
10	SCL	Serial clock input; may float when CE is inactive
11	CLKOE	CLKOUT enable or disable pin; enable is active HIGH; connect to VSS for low power operation
12	CLKOUT	Clock output (open-drain)
13	VDD	Supply voltage; positive or negative steps in VDD can affect oscillator performance; recommend 100nF decoupling close to the device (see Fig. 30)
14	RESET/	Output signal indicating RTC is operating in backup power mode
15	EN	Charge pump enable; activates VCHG 4.1V (typ.) charging source
16	OSCI	Oscillator input; high-impedance node; minimize wire length between quartz and package

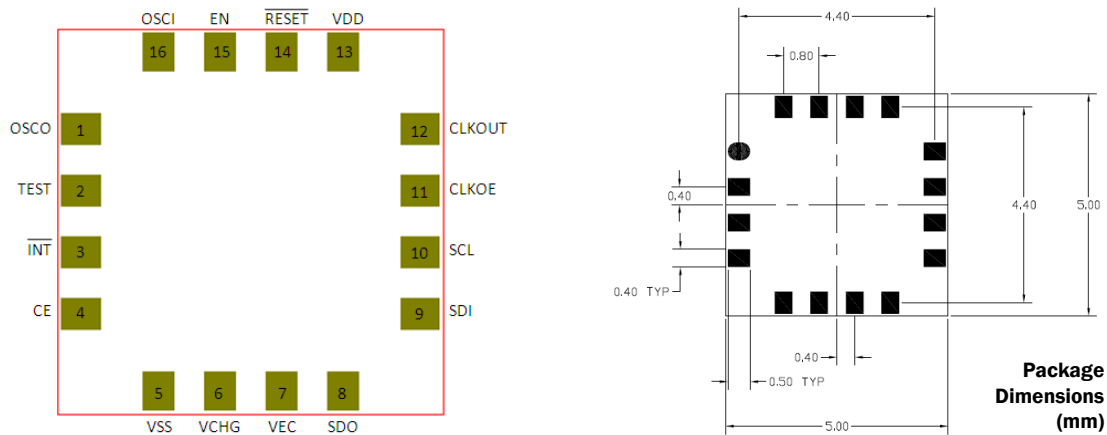


Figure 4: CBC34123 Package (left: top view, looking through package; right: pad dimensions)

### EnerChip Properties

Energy capacity (typical):	5µAh
Recharge time to 80%:	10 minutes
Charge/discharge cycles:	>5000 to 10% depth-of-discharge
Operating temperature:	-30 °C to +70 °C
Storage temperature:	-40 °C to +125 °C
Minimum VDD to charge EnerChip:	2.5V

# CBC34123 EnerChip™ RTC

## Absolute Maximum Ratings

PARAMETER / PIN	CONDITION	MIN	TYPICAL	MAX	UNITS
VDD with respect to GND	25 °C	GND - 0.3	-	6.0	V
ENABLE Input Voltage	25 °C	GND - 0.3	-	VDD+0.3	V
VEC <sup>(1)</sup>	25 °C	3.0	-	4.15	V
VCHG <sup>(1)</sup>	25 °C	3.0	-	4.15	V
$\overline{\text{RESET}}$ Output Voltage	25 °C	GND - 0.3	-	2.7	V
INT/, CE, TEST, OSC1, OSC0, SDO, SDI, SCL, CLKOE, CLKOUT	See NXP PCF2123 Data Sheet				

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

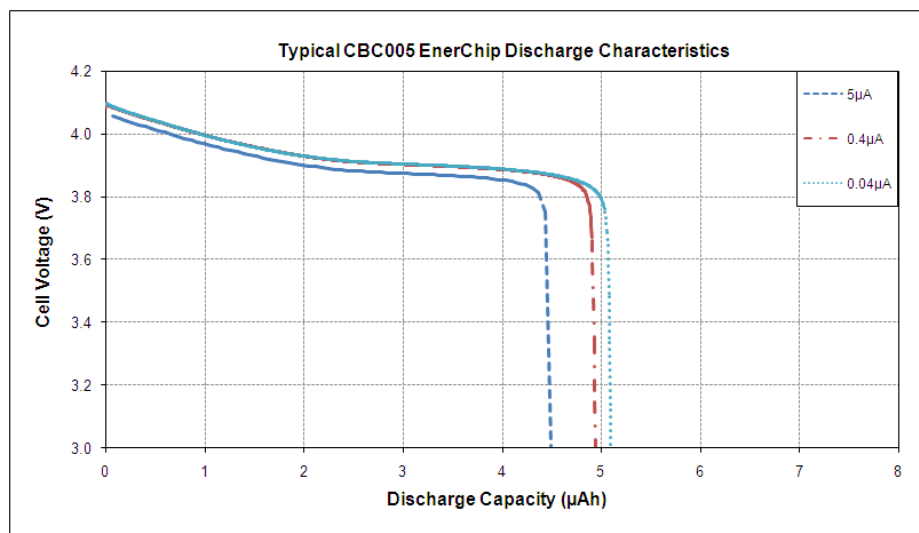
## Integrated EnerChip Thin Film Battery Operating Characteristics

PARAMETER	CONDITION	MIN	TYPICAL	MAX	UNITS	
Self-Discharge (5 yr. average)	Non-recoverable	-	2.5	-	% per year	
	Recoverable	-	1.5 <sup>(1)</sup>	-	% per year	
Operating Temperature	-	-30	25	+70	°C	
Storage Temperature	-	-40	-	+125 <sup>(2)</sup>	°C	
Recharge Cycles (to 80% of rated capacity)	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) <sup>(3)</sup>	Charge cycle 2	-	11	22	minutes	
	Charge cycle 1000	-	45	70		
Capacity (see Figure 5)	25 °C	5	-	-	μAh	

<sup>(1)</sup> First month recoverable self-discharge is 5% average.

<sup>(2)</sup> Storage temperature is for uncharged EnerChip CC device.

<sup>(3)</sup> EnerChip charging time increases approximately 2x per 10°C decrease in temperature.



**Figure 5: Typical Discharge Characteristics of the CBC005 EnerChip Within the CBC34123**

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

## Important Reference Documents

For complete specifications of the integrated PCF2123 Real-Time Clock, see here:  
[http://www.nxp.com/documents/data\\_sheet/PCF2123.pdf](http://www.nxp.com/documents/data_sheet/PCF2123.pdf) .

For complete specifications of the Cymbet 5μAh EnerChip and integrated power management circuit, see here:  
<http://www.cymbet.com/pdfs/DS-72-21.pdf> .

The EnerChip and power management functions within the CBC34123 are configured as in Mode 1 (VMODE = GND) described in the CBC3105 data sheet.

For guidelines regarding crystal selection and other important information pertaining to the PCF2123, see the UM10301 - User Manual for NXP Real Time Clocks, located here:  
[http://www.nxp.com/documents/user\\_manual/UM10301.pdf](http://www.nxp.com/documents/user_manual/UM10301.pdf)

## Functional Description of Integrated PCF2123 Real-Time Clock

The PCF2123 contains 16 8-bit registers with an auto-incrementing address counter, an on-chip 32.768 kHz oscillator with two integrated load capacitors, a frequency divider which provides the source clock for the Real Time Clock (RTC), a programmable clock output, and a 6.25 Mbit/s SPI-bus. An offset register allows fine tuning of the clock.

All 16 registers are designed as addressable 8-bit parallel registers although not all bits are implemented.

- The first two registers (memory address 00h and 01h) are used as control registers.
- The memory addresses 02h through 08h are used as counters for the clock function (seconds up to years). The registers Seconds, Minutes, Hours, Days, Weekdays, Months, and Years are all coded in Binary Coded Decimal (BCD) format. When one of the RTC registers is written or read the contents of all counters are frozen. Therefore, faulty writing or reading of the clock and calendar during a carry condition is prevented.
- Addresses 09h through 0Ch define the alarm condition.
- Address 0Dh defines the offset calibration.
- Address 0Eh defines the clock out and timer mode.
- Address registers 0Eh and 0Fh are used for the countdown timer function. The countdown timer has four selectable source clocks allowing for countdown periods in the range from 244 ms up to four hours. There are also two pre-defined timers which can be used to generate an interrupt once per second or once per minute. These are defined in register Control\_2 (01h).

## Low Power Operation

Minimum power operation will be achieved by reducing the number and frequency of switching signals inside the IC, i.e., low frequency timer clocks and a low frequency CLKOUT will result in lower operating power. A second prime consideration is the series resistance  $R_s$  of the quartz used.

## Power Consumption with Respect to Quartz Series Resistance

The series resistance acts as a loss element. Low  $R_s$  will reduce current consumption further.

**PCF2123 Register Overview**

16 registers are available. The time registers are encoded in the Binary Coded Decimal (BCD) format to simplify application use. Other registers are either bit-wise or standard binary.

Bit positions labeled as '-' are not implemented and will return a '0' when read. The bit position labeled as '--' is not implemented and will return a '0' or '1' when read. Bit positions labeled with N should always be written with logic '0' <sup>(1)</sup>.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
<b>Control and status registers</b>									
00h	Control_1	EXT_TEST	N	STOP	SR	N	12_24	CIE	N
01h	Control_2	MI	SI	MSF	TI_TP	AF	TF	AIE	TIE
<b>Time and date registers</b>									
02h	Seconds	OS	SECONDS (0 to 59)						
03h	Minutes	--	MINUTES (0 to 59)						
04h	Hours	-	-	AMPM	HOURS (1 to 12) in 12 h mode HOURS (0 to 23) in 24 h mode				
05h	Days	-	-	DAYS (1 to 31)					
06h	Weekdays	-	-	-	-	-	WEEKDAYS (0 to 6)		
07h	Months	-	-	-	MONTHS (1 to 12)				
08h	Years	YEARS (0 to 99)							
<b>Alarm registers</b>									
09h	Minute_alarm	AE_M	MINUTE_ALARM (0 to 59)						
0Ah	Hour_alarm	AE_H	-	AMPM	HOUR_ALARM (1 to 12) in 12 h mode HOUR_ALARM (0 to 23) in 24 h mode				
0Bh	Day_alarm	AE_D	-	DAY_ALARM (1 to 31)					
0Ch	Weekday_alarm	AE_W	-	-	-	-	WEEKDAY_ALARM (0 to 6)		
<b>Offset register</b>									
0Dh	Offset_register	MODE	OFFSET[6:0]						
<b>Timer registers</b>									
0Eh	Timer_clkout	-	COF[2:0]			TE	-	CTD[1:0]	
0Fh	Countdown_timer	COUNTDOWN_TIMER[7:0]							

[1] Except in the case of software reset, see [Section 8.3.1.1](#).

**POWER SUPPLY CURRENT CHARACTERISTICS OF INTEGRATED CBC910 POWER MANAGEMENT CIRCUIT ONLY**
**Ta = -20°C to +70°C**

CHARACTERISTIC	SYMBOL	CONDITION	MIN	MAX	UNITS	
Quiescent Current (CBC910 power management circuit only; V <sub>DD</sub> > V <sub>RESET</sub> ; RTC current not included)	I <sub>Q</sub>	ENABLE=GND	V <sub>DD</sub> =3.3V	-	3.5	μA
			V <sub>DD</sub> =5.5V	-	6.0	μA
		ENABLE=V <sub>DD</sub>	V <sub>DD</sub> =3.3V	-	35	μA
			V <sub>DD</sub> =5.5V	-	38	μA
EnerChip Cutoff Current (I <sub>QBATON</sub> adds to RTC current when in backup mode)	I <sub>QBATOFF</sub>	V <sub>BAT</sub> < V <sub>BATCO</sub> , V <sub>OUT</sub> =0	-	0.5	nA	
	I <sub>QBATON</sub>	V <sub>BAT</sub> > V <sub>BATCO</sub> , ENABLE=V <sub>DD</sub> , I <sub>OUT</sub> =0	-	42	nA	

**INTERFACE LOGIC SIGNAL CHARACTERISTICS**
**V<sub>DD</sub> = 2.5V to 5.5V, Ta = -20°C to +70°C**

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

<sup>(1)</sup>  $\overline{RESET}$  tracks V<sub>DD</sub>;  $\overline{RESET} = V_{DD} - (I_{OUT} \times R_{OUT})$ .

 **$\overline{RESET}$  SIGNAL AC/DC CHARACTERISTICS**
**V<sub>DD</sub> = 2.5V to 5.5V, Ta = -20°C to +70°C**

CHARACTERISTIC	SYMBOL	CONDITION	MIN	MAX	UNITS
V <sub>DD</sub> Rising to $\overline{RESET}$ Rising	t <sub>RESETH</sub>	V <sub>DD</sub> rising from 2.8V TO 3.1V in <10μs	60	200	ms
V <sub>DD</sub> Falling to $\overline{RESET}$ Falling	t <sub>RESETL</sub>	V <sub>DD</sub> falling from 3.1V to 2.8V in <100ns	0.5	2	μs
TRIP Voltage V <sub>DD</sub> Rising	V <sub>RESET</sub>	V <sub>MODE</sub> =GND	2.85	3.15	V
$\overline{RESET}$ Hysteresis Voltage (V <sub>DD</sub> to $\overline{RESET}$ )	V <sub>HYST</sub>	V <sub>MODE</sub> =GND	45	75	mV

**CHARGE PUMP CHARACTERISTICS (PERTAINS TO INTEGRATED CBC910 POWER MANAGEMENT CIRCUIT)**

(NOTE: THIS TABLE PROVIDES IMPORTANT INFORMATION WHEN CONNECTING ADDITIONAL ENERCHIPS TO VCHG.)

**V<sub>DD</sub> = 2.5V to 5.5V, T<sub>a</sub> = -20°C to +70°C**

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

<sup>(1)</sup> f<sub>CP</sub> = 1/t<sub>CPPER</sub>**ADDITIONAL CHARACTERISTICS****T<sub>a</sub> = -20°C to +70°C**

CHARACTERISTIC	SYMBOL	CONDITION	LIMITS		UNITS
			MIN	MAX	
V <sub>BAT</sub> Cutoff Threshold	V <sub>BATCO</sub>	I <sub>OUT</sub> =1μA	2.75	3.25	V
Cutoff Temp. Coefficient	T <sub>CCO</sub>	-	+1	+2	mV/°C
V <sub>BAT</sub> Cutoff Delay Time	t <sub>COFF</sub>	V <sub>BAT</sub> from 40mV above to 20mV below V <sub>BATCO</sub> I <sub>OUT</sub> =1μA	40	-	ms

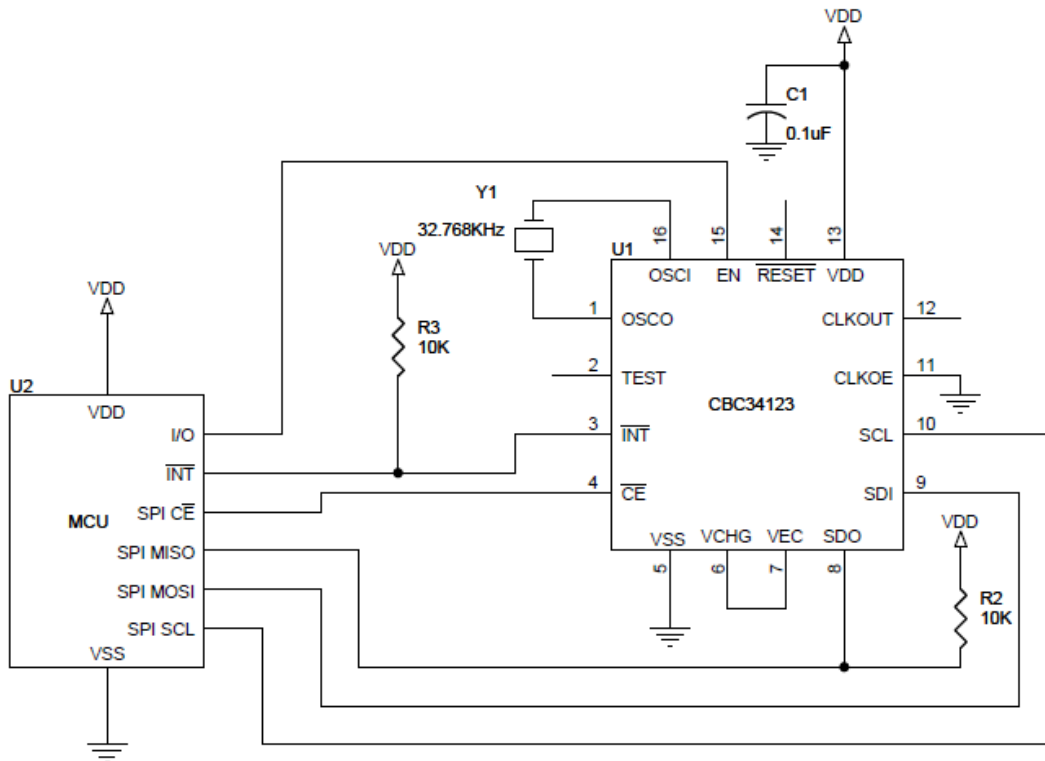
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# CBC34123 EnerChip™ RTC

## Typical CBC34123 EnerChip RTC Connection to Microcontroller

Figure 5 illustrates how the CBC34123 is typically connected to a microcontroller (MCU) in a system. For simplicity, only the MCU lines routed to/from the CBC34123 are shown. The I/O line from the MCU to the EN pin of the CBC34123 is optional for reducing power consumption of the CBC34123. The EN pin can be forced low by the MCU when the integrated EnerChip does not need to be charged. If EN is not connected to the MCU or otherwise controlled externally, it must be tied to VDD to ensure the EnerChip is charged when VDD is valid.



**Figure 5: Typical Application Schematic Showing MCU Connections to CBC34123**

## Ordering Information

EnerChip CC Part Number	Description	Notes
CBC34123-M5C	EnerChip RTC in 5mm x 5mm x 1.4mm 16-QFN Land Grid Array	Shipped in Tube
CBC34123-M5C-TR1 CBC34123-M5C-TR5	EnerChip RTC in 5mm x 5mm x 1.4mm 16-QFN Land Grid Array	Tape-and-Reel - 1000 pcs (TR1) or 5000 pcs (TR5) per reel
CBC-EVAL-12	EnerChip RTC Evaluation Kit	USB based Eval Kit with CBC34123 tab board

U.S. Patent No. 8,144,508. Additional U.S. and Foreign Patents Pending

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