

# CBC34803 EnerChip™ RTC

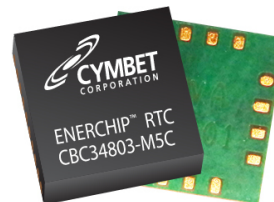
## I<sup>2</sup>C Real-Time Clock/Calendar with Integrated Backup Power

### Features

- Ultra low power Real Time Clock with Integrated rechargeable EnerChip™ solid state battery, power-fail detect and automatic switchover, **providing greater than 6 days of RTC backup**
- 5mm x 5mm x 1.4mm QFN package is the smallest commercially available RTC having integrated backup battery power
- Temperature-compensated charge control
- Integrated EnerChip™ recharged at VDD > 2.5V
- SMT assembly - lead-free reflow solder tolerant
- Counters for hundredths, seconds, minutes, hours, date, month, year, century, and weekday based on a 32.768 kHz oscillator
- Automatic leap year calculation
- Alarm capability on all counters
- 2 general purpose outputs
- 64 bytes of RAM
- Advanced crystal calibration to ± 2 ppm
- Advanced RC calibration to ± 16 ppm
- Automatic calibration of RC oscillator to crystal oscillator
- I<sup>2</sup>C-bus (up to 400kHz)
- Eco-friendly, RoHS compliant - tested

### 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.
- **Ultra Low Power Timers** using only 35nA can be implemented with the CBC34803
- **Wireless sensors and RFID tags** and other powered, low duty cycle applications.
- **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

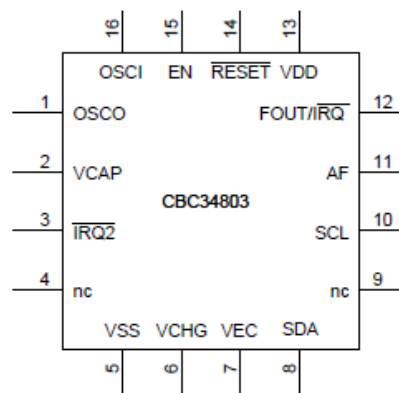


**5mm x 5mm x 1.4mm 16-pin QFN Package**

### General Description

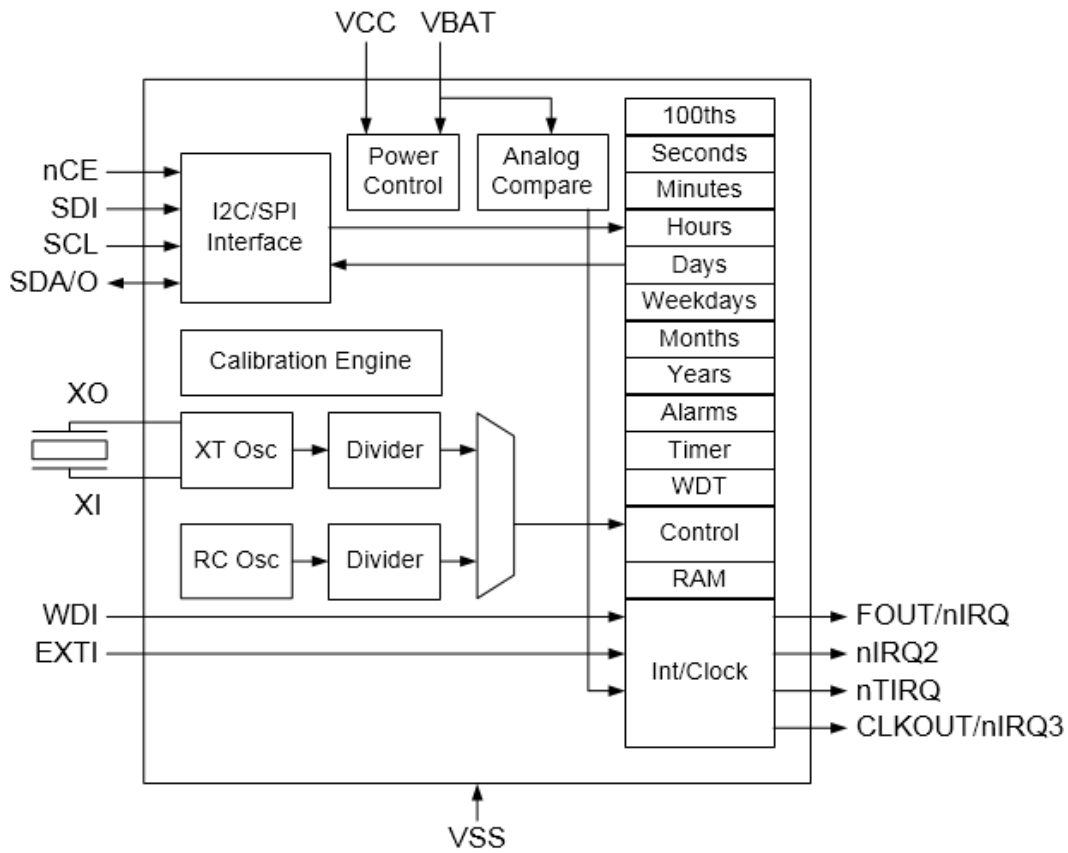
The EnerChip RTC CBC34803-M5C combines a Real-Time Clock (RTC) and calendar optimized for low power applications with an integrated rechargeable solid state backup battery and all power management functions. The EnerChip RTC ensures a seamless transition from main power to backup power in the event of 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 CBC34803 provides greater than 6 days of backup time in the event main power is interrupted. The integrated EnerChip recharges quickly, has extremely low self-discharge, is non-flammable, and RoHS-compliant. The EnerChip is charged automatically anytime VDD is above 2.5V.

Data is transferred serially via an I<sup>2</sup>C-bus. Alarm and timer functions provide the option to generate a wake-up signal on an interrupt pin.

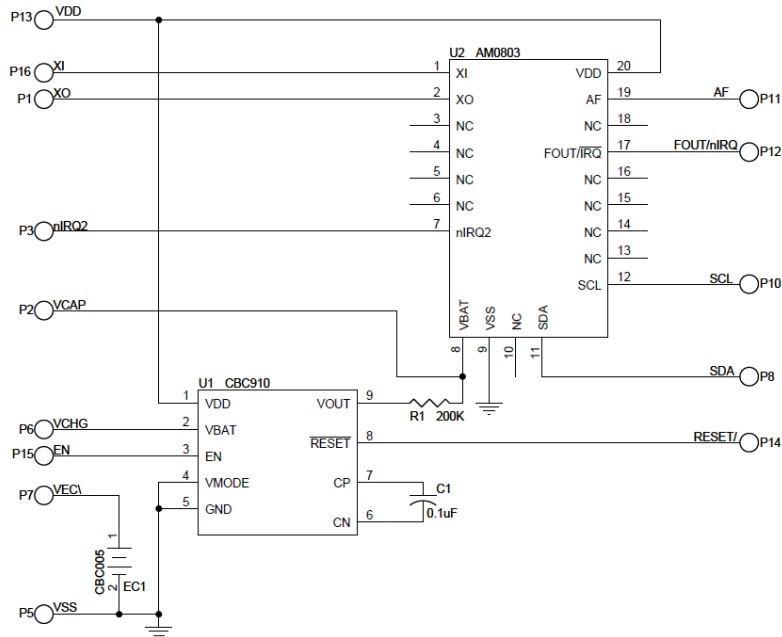


**Figure 1: CBC34803 Pin-out Diagram**

# CBC34803 EnerChip™ RTC



**Figure 2: Functional Block Diagram of CBC34803 (AM0803) Real-Time Clock**



**Figure 3: Internal Schematic of CBC34803 EnerChip RTC**

# CBC34803 EnerChip™ RTC

## CBC34803 Input/Output Descriptions

Pin Number	Label	Description
1	XO	Crystal output
2	VCAP	External capacitor connection to supply switchover current at cold temp. (optional)
3	nIRQ2	Interrupt 2 / Output
4	NC	No connection
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 only to VCHG via PCB trace
8	SDA	I <sup>2</sup> C data input / Output
9	NC	No connection
10	SCL	I <sup>2</sup> C clock input
11	AF	Autocalibration filter
12	FOUT/nIRQ	Interrupt 1 / Function output
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	XI	Crystal input

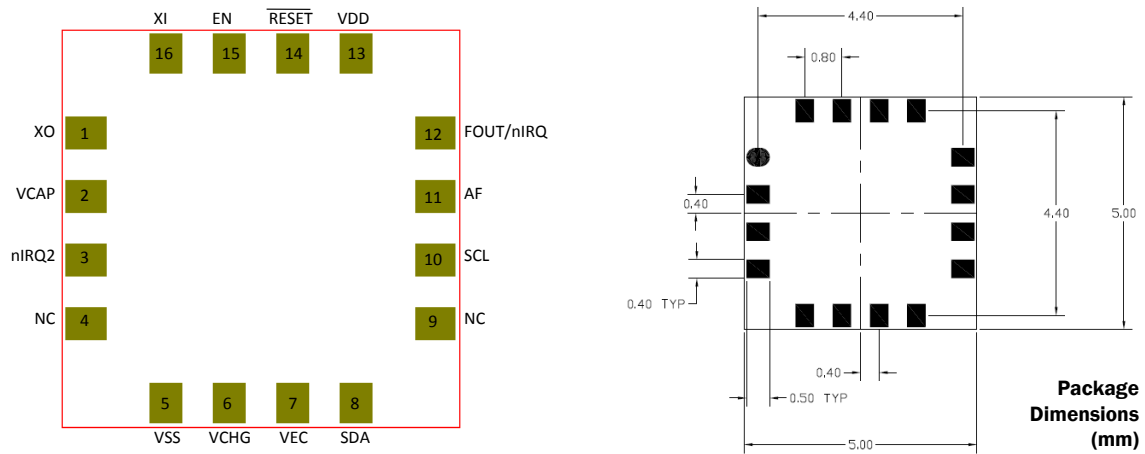


Figure 4: CBC34803 Package (left: top view, looking through package; right: pad dimensions)

### EnerChip Properties

Energy capacity (typical):	5µAh
Recharge time to 80%:	<15 minutes
Charge/discharge cycles:	>5000 to 10% depth-of-discharge
Operating temperature:	-10 °C to +70 °C
Storage temperature:	-40 °C to +125 °C
Minimum VDD to charge EnerChip:	2.5V

# CBC34803 EnerChip™ RTC

## Absolute Maximum Ratings

PARAMETER / PIN	CONDITION	MIN	TYPICAL	MAX	UNITS
VDD with respect to GND	25 °C	GND - 0.3	-	3.6	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
RESET Output Voltage	25 °C	GND - 0.3	-	2.7	V
VCAP	25 °C	GND - 0.3	-	3.6	V
XI, XO, SDA, SCL, AF, FOUT/nIRQ, nIRQ2	See Ambiq Micro AM0803 Data Sheet				

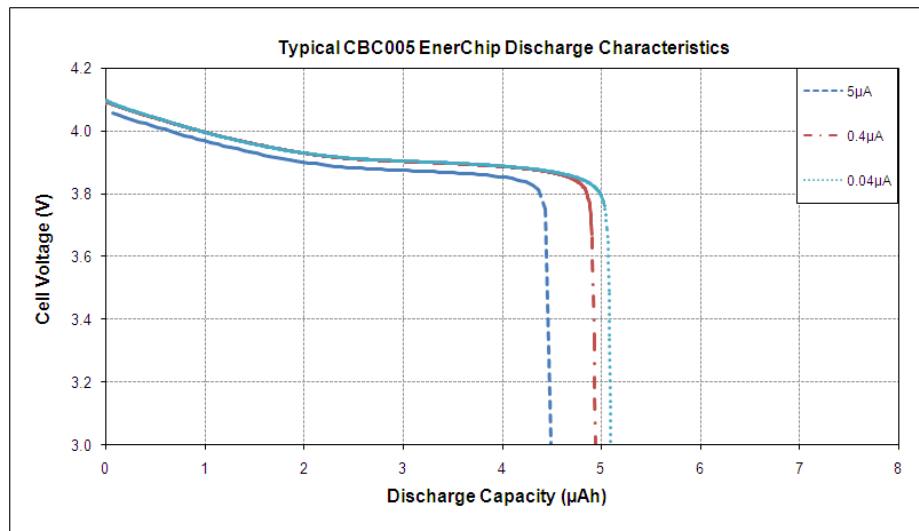
<sup>(1)</sup> No external connections to these pins are allowed, except parallel EnerChips.

## 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	-	-10	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)	Charge cycle 2	-	11	22	minutes	
	Charge cycle 1000	-	45	70		
Capacity	40nA discharge; 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.



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

## Important Reference Documents for Design Information

- For complete specifications of the integrated Ambiq Micro AM0803 Real-Time Clock, see here: <http://ambiqmicro.com/0800-series/>. To request the most recent datasheet email Ambiq Micro at: [support@ambiqmicro.com](mailto:support@ambiqmicro.com)
- 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 CBC34803 are configured Mode 1 (VMODE = GND) as described in the CBC3105 data sheet.
- For guidelines regarding crystal selection and other important information pertaining to the AM0803, see here: <http://ambiqmicro.com/resource-center/>

## Functional Description of Integrated AM0803 Real-Time Clock

The AM08xx serves as a full function RTC for host processors such as microcontrollers. The AM08xx includes 3 distinct feature groups: 1) baseline timekeeping features with 32.768 kHz oscillator and 2) advanced timekeeping features, and 3) basic power management features. Functions from each feature group may be controlled via memory mapped registers. These registers are accessed using either an I2C serial interface (e.g., in the AM0803) or a SPI serial interface (e.g., in the AM0813). For more information on the AM0803, see here: <http://ambiqmicro.com/0800-series> .

## Low Power Operation

Minimum power operation will be achieved by turning off the charge pump in the power management circuit by driving ENABLE low once the internal EnerChip has been charged - typically one hour to full charge at room temperature.

the RTC has 3 low power modes, allowing the designer to make appropriate tradeoffs between power consumption and timing accuracy. Operating current drawn by th RTC is as follows:

- <15 nA with RC oscillator
- <20 nA with RC oscillator and autocalibration
- <55 nA with crystal oscillator

In addition to the RTC current, the integrated power management circuit typically draws 20-25nA from the EnerChip storage device at room temperature.

**Crystal Oscillator Selection**

The AMX8XX should work with any standard 32.768kHz tuning fork crystal with a load capacitance rating from 0 - 12pF and an ESR from 0 – 90kohms. Recommendations are as follows:

- Crystal load capacitance rating: 0 - 12pF
- Crystal ESR rating: 0 – 90kohms max
- No additional loading capacitors on the board
- Stray PCB capacitance on XO/XI: 2pF or less (less is better)

Typically, an oscillator allowance (OA) of 260-290kohms is generated. Increasing the loading capacitance on the XI/XO pins will decrease the OA and using crystals with a higher ESR will reduce the OA margin. The crystal will not affect the AMX8XX RTC current because a fixed bias current to the crystal is used. No external load capacitance is required because the frequency offset from the crystal is digitally calibrated out, to within +/- 2ppm. Mainstream crystals (3.2mm x 1.5mm) generally have a maximum ESR rating of 70kohms. The smaller 2.0mm x 1.2mm crystals generally have a maximum ESR of 90kohms. Some crystal vendors, such as Epson or Micro Crystal, might have some of the smaller crystals with lower ESR. Below is a list of crystals from several vendors that have been tested:

Abracon: ABS07-32.768KHZ-7-T, ABS06-32.768KHZ-9-T, ABS25.32.768KHZ-T

Epson: C-002RX, FC-135, FC-12D, FC-12M

Micro Crystal: CC7V-T1A, CM7V-T1A

**CBC34803 (AM0803) Register Definitions (0x00 to 0x0F)**

Offset	Register	7	6	5	4	3	2	1	0
0x00	Hundredths	Seconds - Tens				Seconds - Hundredths			
0x01	Seconds	GP0	Seconds - Tens			Seconds - Ones			
0x02	Minutes	GP1	Minutes - Tens			Minutes - Ones			
0x03	Hours (24 hour)	GP3	GP2	Hours - Tens		Hours - Ones			
0x03	Hours (12 hour)	GP3	GP2	AM/PM	Hours - Tens	Hours - Ones			
0x04	Date	GP5	GP4	Date - Tens		Date - Ones			
0x05	Months	GP8	GP7	GP6	Months - Tens	Months - Ones			
0x06	Years	Years - Tens				Years - Ones			
0x07	Weekdays	GP13	GP12	GP11	GP10	GP9	Weekdays		
0x08	Hundredths Alarm	Hundredths Alarm - Tens				Hundredths Alarm - Hundredths			
0x09	Seconds Alarm	GP14	Seconds Alarm - Tens			Seconds Alarm - Ones			
0x0A	Minutes Alarm	GP15	Minutes Alarm - Tens			Minutes Alarm - Ones			
0x0B	Hours Alarm (24 hour)	GP17	GP16	Hours Alarm - Tens		Hours Alarm - Ones			
0x0B	Hours Alarm (12 hour)	GP17	GP16	AM/PM	Hours Alarm - Tens	Hours Alarm - Ones			
0x0C	Date Alarm	GP19	GP18	Date Alarm - Tens		Date Alarm - Ones			
0x0D	Months Alarm	GP22	GP21	GP20	Months Alarm - Tens	Months Alarm - Ones			
0x0E	Weekdays Alarm	GP27	GP26	GP25	GP24	GP23	Weekdays Alarm		
0x0F	Status	CB	BAT	WDT	BL	TIM	ALM	EX2	EX1

**The following register bits must be set prior to any switchover, even from VDD to the EnerChip.**

**BREF bits: The default value out of reset is 0000. This needs to be reprogrammed to 1111.**

**IOBM bit: The default value out of reset is 1. This needs to be reprogrammed to 0.**



**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>  $f_{CP} = 1/t_{CPPER}$ **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

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



# CBC34803 EnerChip™ RTC

## Typical CBC34803 EnerChip RTC Connection to Microcontroller

Figure 5 illustrates how the CBC34803 is typically connected to a microcontroller (MCU) in a system. For simplicity, only the MCU lines routed to/from the CBC34803 are shown. The I/O line from the MCU to the EN pin of the CBC34803 is optional for reducing power consumption of the CBC34803. 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. Capacitor C4 is optional for supplying switchover current during cold temperature operation.

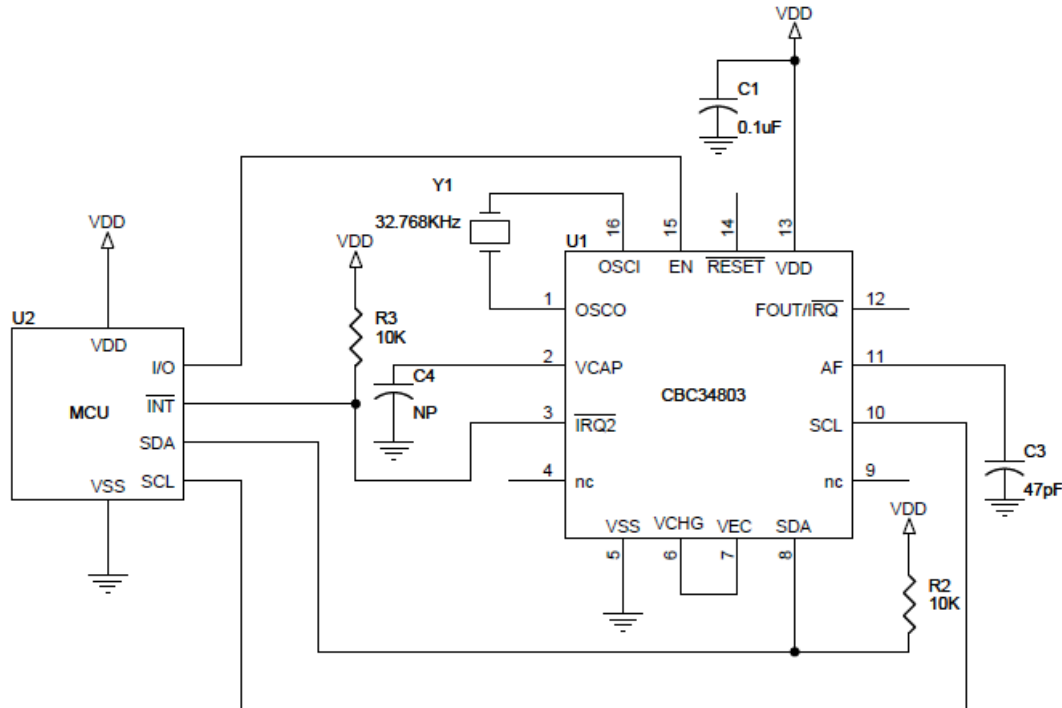


Figure 5: Typical Application Schematic Showing MCU Connections to CBC34803

## Ordering Information

EnerChip RTC Part Number	Description	Notes
CBC34803-M5C	EnerChip RTC in 5mm x 5mm x 1.4mm 16-QFN Land Grid Array	Shipped in Tube
CBC34803-M5C-TR1 CBC34803-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 CBC34803 tab board

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

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