CBC34123 EnerChip™ RTC

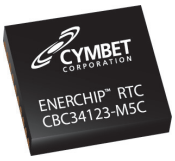
SPI Real-Time Clock/Calendar with Integrated Backup Power

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, weekday, 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.

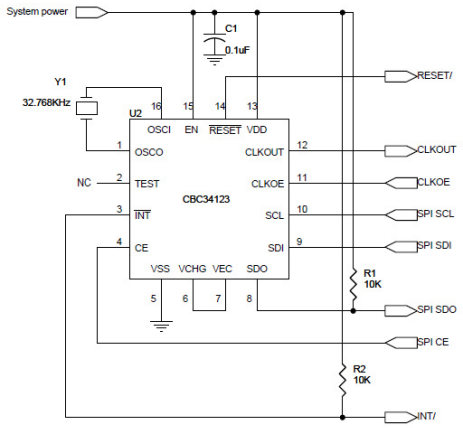


Figure 1: CBC34123 Pin-out Diagram

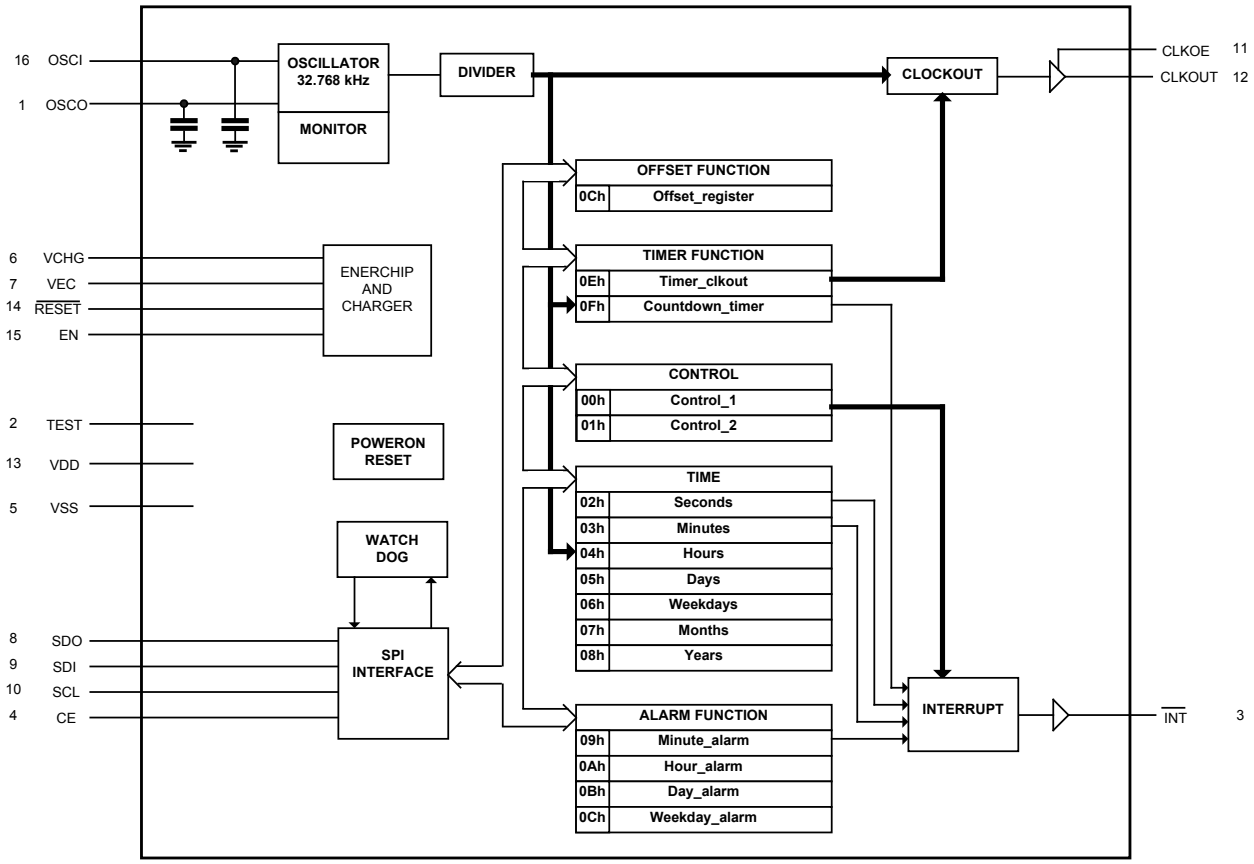


Figure 2: CBC34123 Block Diagram with Registers

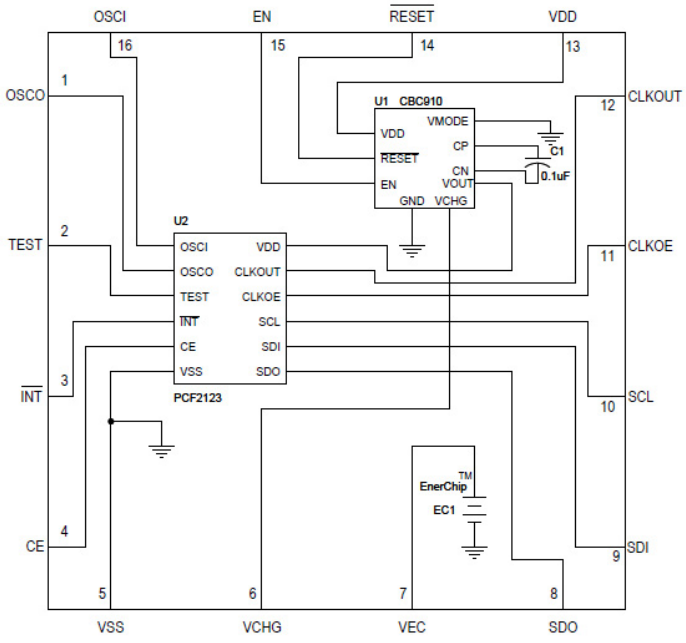


Figure 3: Internal Schematic of CBC34123 EnerChip RTC

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

Package Dimensions
5mm x 5mm x 1.4mm

Pad Pitch
0.8mm

Pad Dimensions
0.4mm x 0.3mm

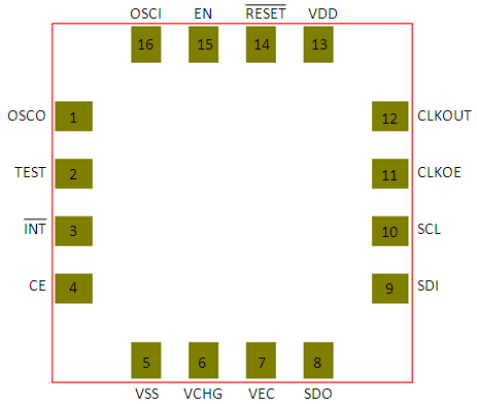


Figure 4: CBC34123 EnerChip RTC Package Pin-Out (top view, looking through package)

EnerChip Properties

Energy capacity (typical):	5µAh
Recharge time to 80%:	10 minutes
Charge/discharge cycles:	>5000 to 10% depth-of-discharge
Operating temperature:	-20°C to +70°C
Storage temperature:	-40°C to +125°C
Minimum VDD to charge EnerChip:	2.5V

Absolute Maximum Ratings

PARAMETER	CONDITION	MIN	TYPICAL	MAX	UNITS
V_{DD} with respect to GND	25°C	GND - 0.3	-	6.0	V
ENABLE Input Voltage	25°C	GND - 0.3	-	V_{DD}+0.3	V
V_{BAT} (1)	25°C	3.0	-	4.15	V
V_{CHG} (1)	25°C	3.0	-	4.15	V
$\overline{\text{RESET}}$ Output Voltage	25°C	GND - 0.3	-	V_{OUT}+0.3	V
CP, Flying Capacitor Voltage	25°C	GND - 0.3	-	6.0	V
CN	25°C	GND - 0.3	-	V_{DD}+0.3	V

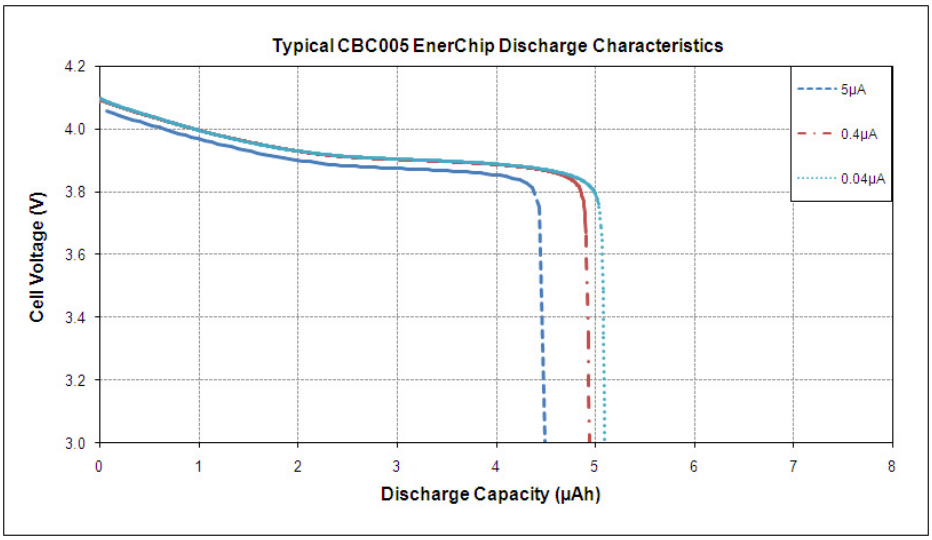
(1) *No external connections to these pins are allowed, except parallel EnerChips.*

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(1)	-	% per year
Operating Temperature		-	-20	25	+70	°C
Storage Temperature		-	-40	-	+125 (2)	°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		150nA discharge; 25°C	5	-	-	µAh

(1) *First month recoverable self-discharge is 5% average.*

(2) *Storage temperature is for uncharged EnerChip CC device.*



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

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' [1].

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
Control and status registers									
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
Time and date registers									
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)							
Alarm registers									
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)		
Offset register									
0Dh	Offset_register	MODE	OFFSET[6:0]						
Timer registers									
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
Ta = -20ºC to +70ºC

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_{QBATON} adds to RTC current when in backup mode)	$I_{QBATOFF}$	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 = -20ºC to +70ºC

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) *$\overline{RESET}$ tracks V_{DD}; $\overline{RESET}$ = V_{DD} - (I_{OUT} x R_{OUT}).*

$\overline{\text{RESET}}$ SIGNAL AC/DC CHARACTERISTICS
V_{DD} = 2.5V to 5.5V, Ta = -20ºC to +70ºC

CHARACTERISTIC	SYMBOL	CONDITION	MIN	MAX	UNITS
V_{DD} Rising to $\overline{RESET}$ Rising	t_{RESETH}	V_{DD} rising from 2.8V TO 3.1V in <10µs	60	200	ms
V_{DD} Falling to $\overline{RESET}$ Falling	t_{RESETL}	V_{DD} falling from 3.1V to 2.8V in <100ns	0.5	2	µs
TRIP Voltage V_{DD} Rising	V_{RESET}	V_{MODE}=GND	2.85	3.15	V
$\overline{RESET}$ Hysteresis Voltage (3) (V_{DD} to $\overline{RESET}$)	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 VMODE 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, Ta = -20ºC to +70ºC

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=+25ºC	4.075	4.125	V
V_{CHG} Temp. Coefficient	T_{CCP}	I_{OUT}=1µA, Temp=+25ºC	-2.0	-2.4	mV/ºC
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
Ta = -20ºC to +70ºC

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/ºC
V_{BAT} Cutoff Delay Time	t_{COOFF}	V_{BAT} from 40mV above to 20mV below V_{BATCO} I_{OUT}=1µA	40	-	ms

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

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

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