CBC34523 EnerChip™ RTC

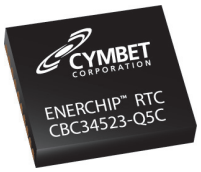
I2C Real-Time Clock/Calendar with Integrated Backup Power

Features

- Integrated rechargeable solid state battery with power-fail detect and automatic switchover, providing greater than 24 hours of backup
- Smallest commercially available RTC with integrated backup power in compact 5mm x 6mm 1.4mm QFN package
- Temperature compensated charge control
- Integrated EnerChip™ recharged at VDD > 2.5V
- SMT - lead-free reflow 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
- 2-line I2C-bus with separate, but combinable data input and output
- Selectable integrated oscillator load capacitors for C_L = 7 pF or C_L = 12.5 pF
- Internal power-on reset (POR)
- Open-drain interrupt or 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 uninterrupted 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 6mm x 1.4mm 16-QFN Package

General Description

The EnerChip RTC CBC34523-Q5C combines a Real-Time Clock (RTC) and calendar optimized for low power applications with an integrated rechargeable solid state backup power source 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 provides thousands of charge-discharge cycles from the integrated the EnerChip and manages battery charging, discharge cutoff, power switchover, and temperature compensation to maximize the service life of the device. The CBC34523 provides greater than 24 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 an I2C-bus with a maximum data rate of 1000 Kbits/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.

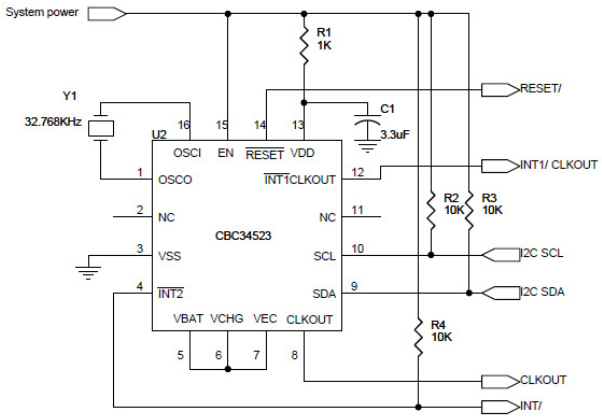


Figure 1: CBC34523 Pin-out Diagram

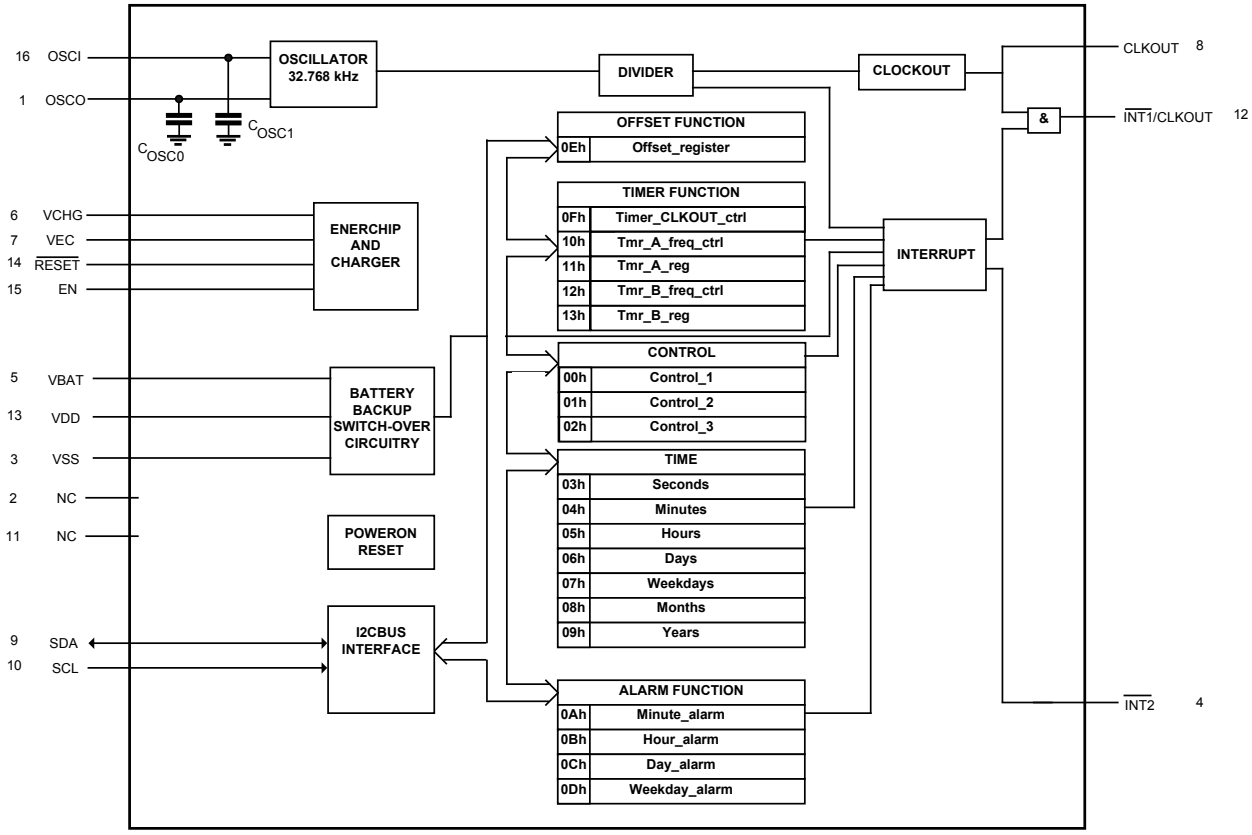


Figure 2: CBC34523 EnerChip RTC Block Diagram with Registers

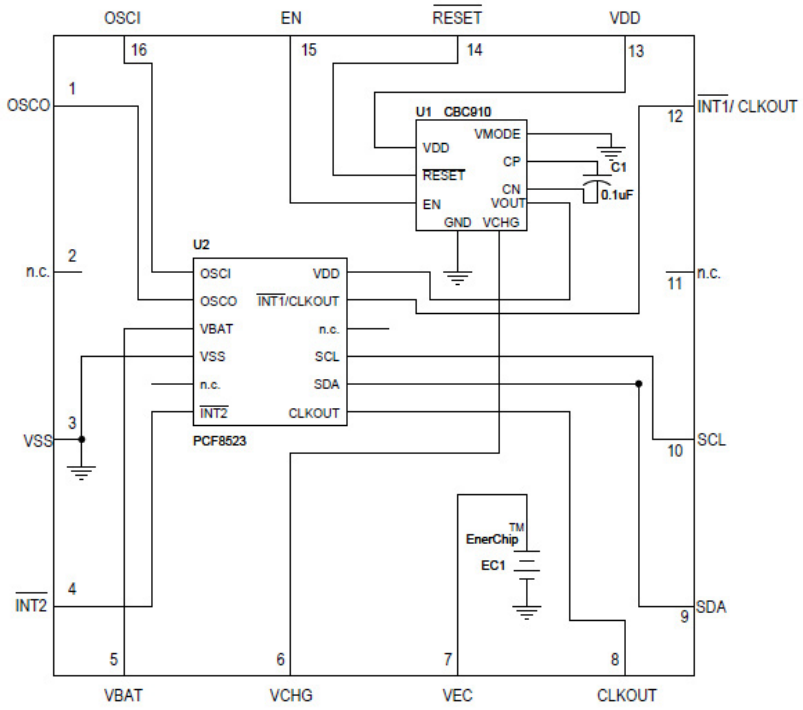


Figure 3: Internal Schematic of CBC34523 EnerChip RTC

CBC34523 Input/Output Descriptions

Pin Number	Label	Description
1	OSCO	Oscillator output; high-impedance node; minimize wire length between quartz and package
2	NC	Not connected; do not connect and do not use it as feed through
3	VSS	Ground
4	INT2/	Interrupt 2 output (open-drain; active LOW)
5	VBAT	Backup battery supply input
6	VCHG	4.1V (typical) charging source - connect to VBAT only, or VBAT and optional EnerChip(s)
7	VEC	Positive terminal of integrated thin film battery - connect to VCHG and nothing else
8	CLKOUT	Clock output (open-drain)
9	SDA	Serial data input/output
10	SCL	Serial clock input
11	NC	Not connected; do not connect and do not use it as feed through
12	INT1/ CLKOUT/	Interrupt 1 / clock output (open-drain)
13	VDD	Supply voltage
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 6mm x 1.4mm

Pad Pitch
0.8mm

Pad Dimensions
0.4mm x 0.3mm

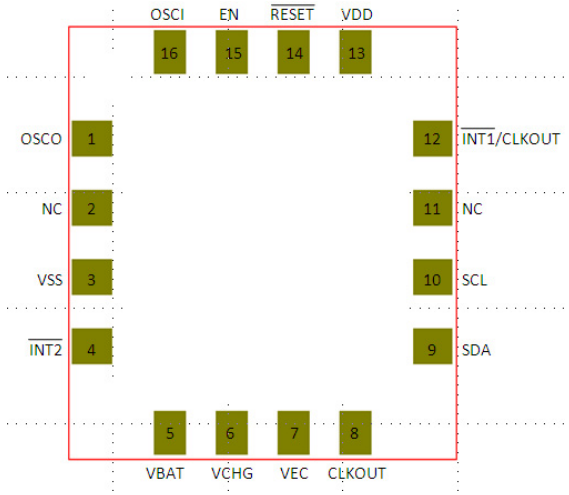


Figure 4: CBC34523 EnerChip RTC Package Pin-Out (top view, looking through package)

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

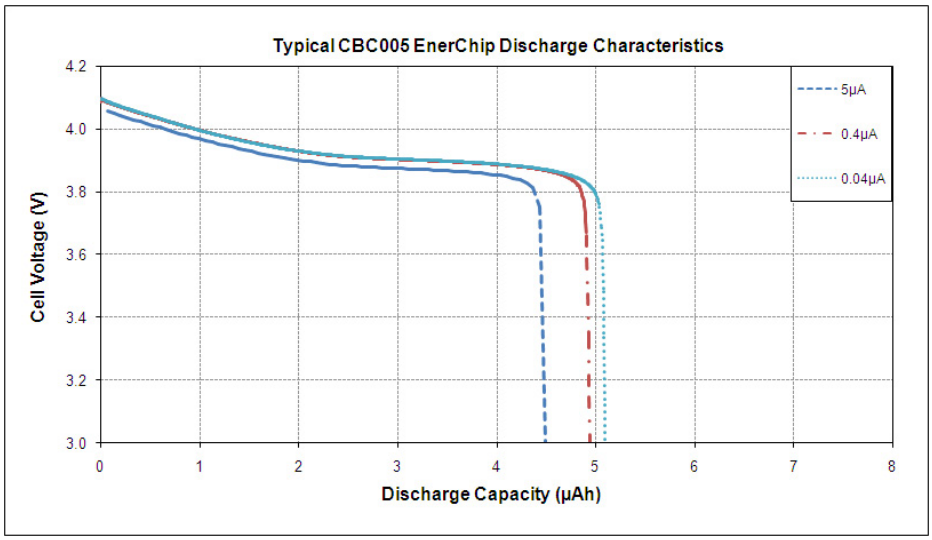
(1) *No external connections to these pins are allowed, except parallel EnerChips.*

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 PCF8523 Real-Time Clock

The PCF8523 contains:

- 20 8-bit registers with an auto-incrementing address register
- 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
- A 1 Mbit/s I^2C-bus interface
- An offset register, which allows fine-tuning of the clock

All 20 registers are designed as addressable 8-bit registers although not all bits are implemented.

- The first three registers (memory address 00h, 01h, and 02h) are used as control and status registers
- The addresses 03h through 09h are used as counters for the clock function (seconds up to years)
- Addresses 0Ah through 0Dh define the alarm condition
- Address 0Eh defines the offset calibration
- Address 0Fh defines the clock-out mode and the addresses 10h and 12h the timer mode
- Addresses 11h and 13h are used for the timers

Standby Mode

When the device is first powered up from the battery (V_{BAT}) but without a main supply (V_{DD}), the PCF8523 automatically enters the standby mode. In standby mode, the PCF8523 does not draw any power from the backup battery until the device is powered up from the main power supply V_{DD}. Thereafter, the device switches over to battery backup mode whenever the main power supply V_{DD} is lost.

It is also possible to enter into standby mode when the chip is already supplied by the main power supply V_{DD} and a backup battery is connected. To enter the standby mode, the power management control bits PM[2:0] have to be set logic 111. Then the main power supply V_{DD} must be removed. As a result of it, the PCF8523 enters the standby mode and does not draw any current from the backup battery before it is powered up again from main supply V_{DD}.

The interface is disabled in battery backup operation:

- Interface inputs are not recognized, preventing extraneous data being written to the device
- Interface outputs are high-impedance

PCF8523 Register Overview

The 20 registers of the PCF8523 are auto-incrementing after each read or write data byte up to register 13h. After register 13h, the auto-incrementing will wrap around to address 00h.

Bit positions labeled as '-' are not implemented and will return a '0' when read. Bit 'T' must always be written with logic '0'.

Address	Register name	Bit							
		7	6	5	4	3	2	1	0
Control registers									
00h	Control_1	CAP_SEL	T	STOP	SR	12_24	SIE	AIE	CIE
01h	Control_2	WTAF	CTAF	CTBF	SF	AF	WTAIE	CTAIE	CTBIE
02h	Control_3	PM[2:0]			-	BSF	BLF	BSIE	BLIE
Time and date registers									
03h	Seconds	OS	SECONDS (0 to 59)						
04h	Minutes	-	MINUTES (0 to 59)						
05h	Hours	-	-	AMPM	HOURS (1 to 12 in 12 hour mode)				
				HOURS (0 to 23 in 24 hour mode)					
06h	Days	-	-	DAYS (1 to 31)					
07h	Weekdays	-	-	-	-	-	WEEKDAYS (0 to 6)		
08h	Months	-	-	-	MONTHS (1 to 12)				
09h	Years	YEARS (0 to 99)							
Alarm registers									
0Ah	Minute_alarm	AE_M	MINUTE_ALARM (0 to 59)						
0Bh	Hour_alarm	AE_H	-	AMPM	HOUR_ALARM (1 to 12 in 12 hour mode)				
			-	HOUR_ALARM (0 to 23 in 24 hour mode)					
0Ch	Day_alarm	AE_D	-	DAY_ALARM (1 to 31)					
0Dh	Weekday_alarm	AE_W	-	-	-	-	WEEKDAY_ALARM (0 to 6)		
Offset register									
0Eh	Offset	MODE	OFFSET[6:0]						
CLOCKOUT and timer registers									
0Fh	Tmr_CLKOUT_ctrl	TAM	TBM	COF[2:0]			TAC[1:0]		TBC
10h	Tmr_A_freq_ctrl	-	-	-	-	-	TAQ[2:0]		
11h	Tmr_A_reg	TIMER_A_VALUE[7:0]							
12h	Tmr_B_freq_ctrl	-	TBW[2:0]			-	TBQ[2:0]		
13h	Tmr_B_reg	TIMER_B_VALUE[7:0]							

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

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Important Reference Documents

For complete specifications of the integrated PCF8523 Real-Time Clock, see here:
http://www.nxp.com/documents/data_sheet/PCF8523.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
CBC34523-Q5C	EnerChip RTC in 5mm x 6mm x 1.4mm 16-QFN Land Grid Array	Shipped in Tube
CBC34523-Q5C-TR1 CBC34523-Q5C-TR5	EnerChip RTC in 5mm x 6mm x 1.4mm 16-QFN Land Grid Array	Tape-and-Reel - 1000 pcs (TR1) or 5000 pcs (TR5) per reel