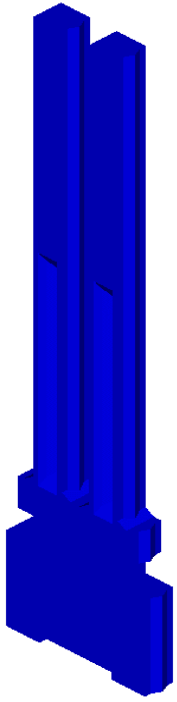
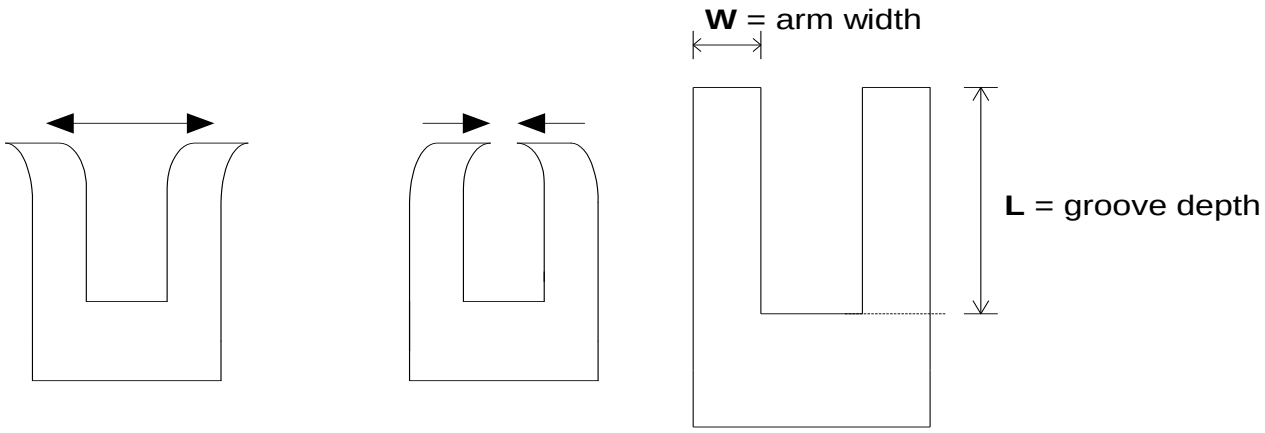
EPSON
EXCEED YOUR VISION

kHz Oscillator & RTC Workshop

Tuning Fork Crystal





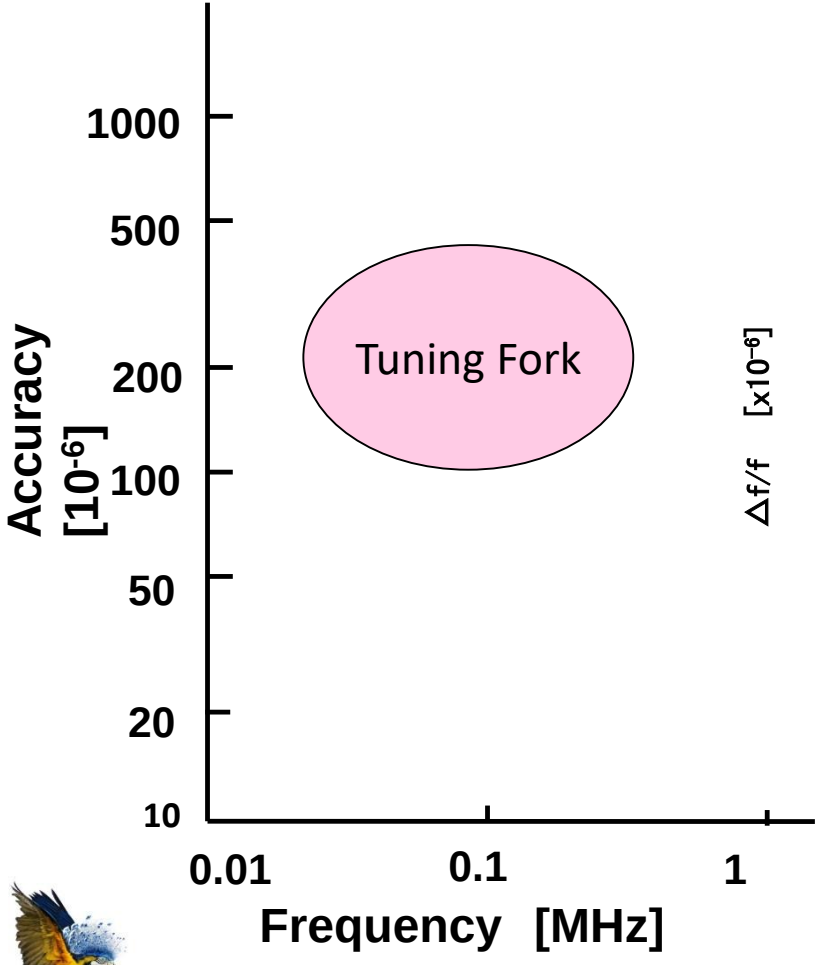
Flexure vibration

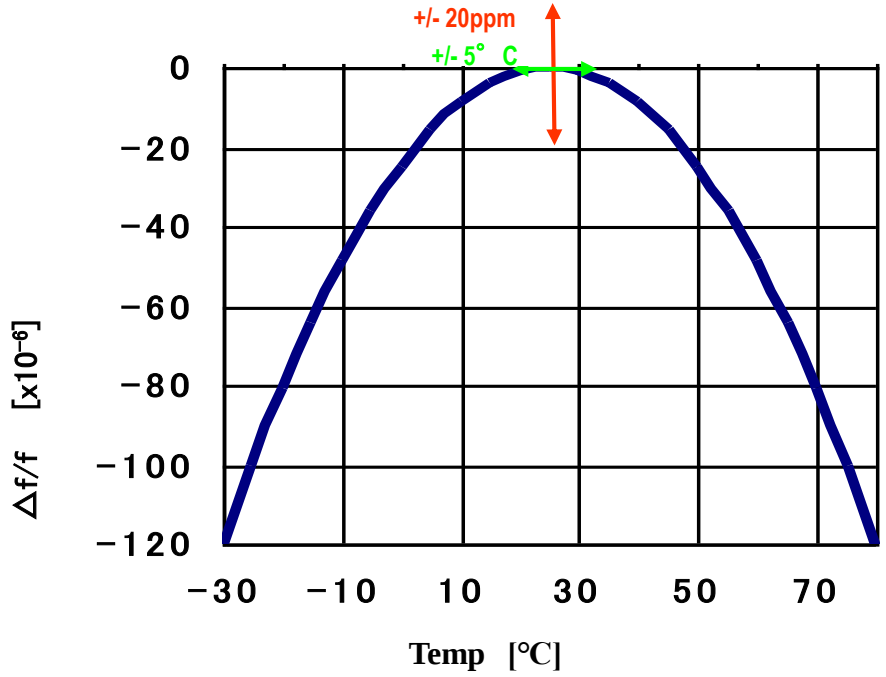
kHz frequencies

$$f = k \cdot \frac{W}{L^2}$$

k = constant

Tuning Fork Crystal



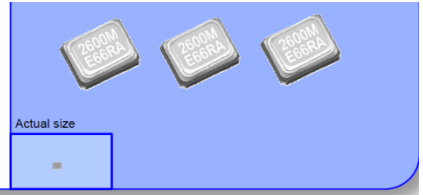


Frequency tolerance
+/-20 to +/-100ppm

TD Tolerance Specification

FA - 128

- Nominal frequency range : 16 MHz to 54 MHz
- External dimensions : 2.0 × 1.6 × 0.5 mm
- Overtone order : Fundamental
- Applications : Mobile phone, Bluetooth, W-LAN ISM band radio, Clock for MPU



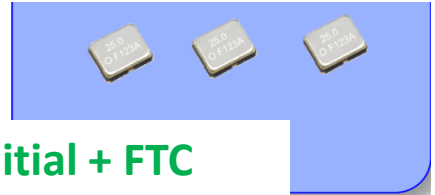
Specifications (characteristics)

Item	Symbol	Specifications		Conditions / Remarks
		For RF Reference	For Clock	
Nominal frequency range	f_nom	16.000 MHz to 54.000 MHz		Fundamental Please contact us about available frequencies.
Storage temperature range	T_stg	-40 °C to +125 °C		Storage as single product.
Operating temperature range	T_use	-40 °C to +85 °C (+105 °C)		Please contact us about +85 °C < T_use
Level of drive	DL	100 µW Max.	200 µW Max.	Recommended: 1 to 100 µW
Frequency tolerance (standard)	f_tol	±10 × 10^{-6} *1	±30 × 10^{-6}	+25 °C, Please contact us for requirements not listed in this specifications.
Frequency versus temperature characteristics (standard)	f_tem	±10 × 10^{-6} *1	±30 × 10^{-6}	-20 °C to +75 °C, Please contact us for requirements not listed in this specifications.

Initial & FTC seperate

SG-210 STF

- Frequency range : 1 MHz to 75 MHz
- Supply voltage : 1.6 V to 3.6 V
- Function : Standby($\overline{ST}$)
- External dimensions : 2.5 × 2.0 × 0.8 mm
- Operation temperature : -40 to +105 °C



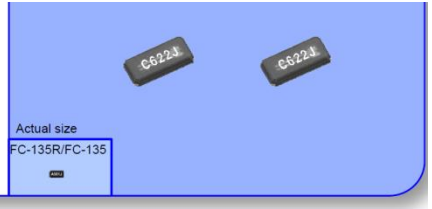
Initial + FTC

Specifications (characteristics)

Item	Symbol	Specifications			Conditions / Remarks
Output frequency range	f0	1MHz to 75MH			Please contact us about available frequencies.
Supply voltage	Vcc	1.6V to 3.6			
		1.8 V Typ. 1.6 V to 2.2 V	2.5 V T 2.2 V to	3.3 V Typ. 2.7 V to 3.6 V	
Storage temperature	T_stg	-40 °C to +125 °C			Storage as single product.
Operating temperature	T_use	-40 °C to +85 °C / -40 °C to +105 °C			
Frequency tolerance	f_tol	S: ±25 × 10^{-6}			-20 °C to +70 °C
		L:±50 × 10^{-6}			-40 °C to +85 °C
		Y:±50 × 10^{-6}, W:±100 × 10^{-6}			-40 °C to +105 °C

FC - 135R / FC - 135

- Frequency range : 32.768 kHz (32 kHz to 100 kHz)
- External dimensions : 3.2 × 1.5 × 0.80 mm ···FC-135R/FC-135
- Overtone order : Fundamental
- Applications : Small communications devices



Specifications (characteristics)

Item	Symbol	Specifications			Conditions / Remarks
		FC-135R	FC-135		
Nominal frequency range	f_nom	32.768 kHz	32.768 kHz	32 kHz to 77.5 kHz	Please contact us about available frequencies.
Storage temperature	T_stg	-55 °C to +125 °C			Storage as single product.
Operating temperature	T_use	-40 °C to +85 °C (+105 °C)			Please contact us about +85 °C < T_use
Level of drive	DL	0.5 µW (1.0 µW Max.)			Please contact us if you require 1.0µW Max.
Frequency tolerance (standard)	f_tol	±20 × 10^{-6}			+25 °C, DL=0.1 µW Please ask for tighter tolerance
Turnover temperature	Ti	+25 °C ±5 °C			
Parabolic coefficient	B	-0.04 × 10^{-6} / °C^2 Max.			

Initial only!

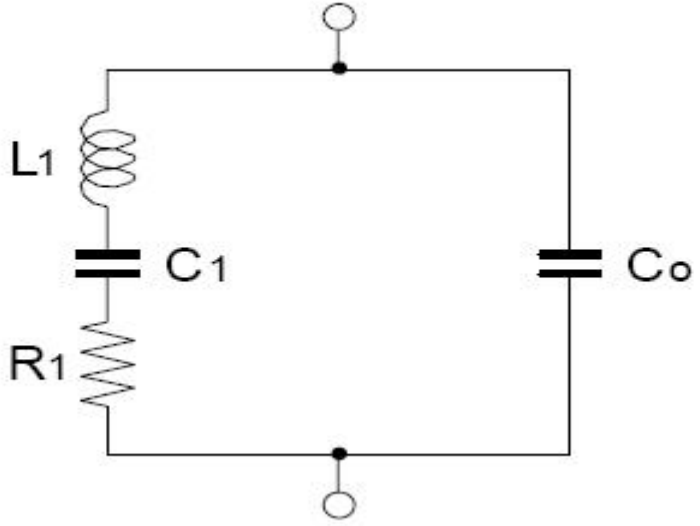
FTC via parabolic coefficients!

$\Delta f/f = B(Ti-\theta X)^2$ θX:specified temperature

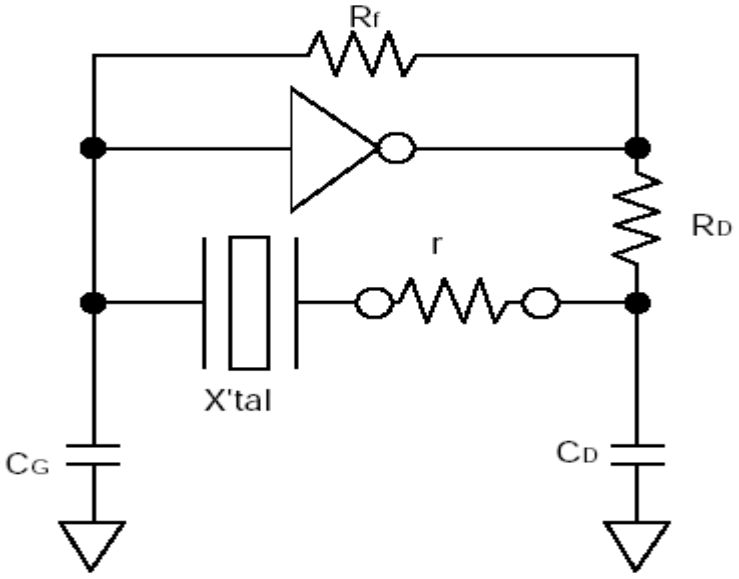
Equivalent Circuit

The Equivalent Circuit

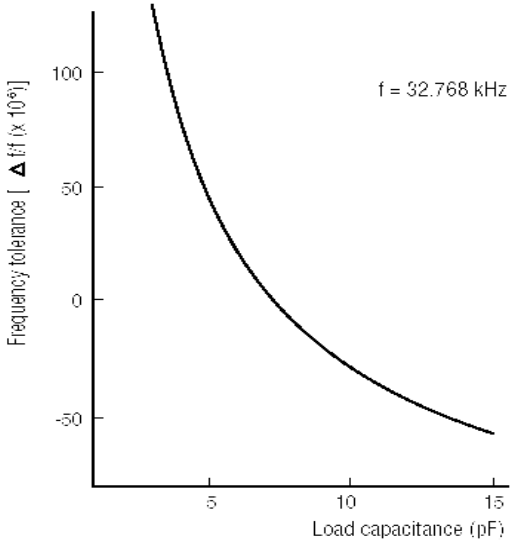
L_1 – Dynamic or Motional Inductance (mH)
C_1 – Dynamic or Motional Capacitance (fF)
R_1 – Equivalent Series Resistance (ohms)
C_o – Parallel or Static Capacitance (pF)

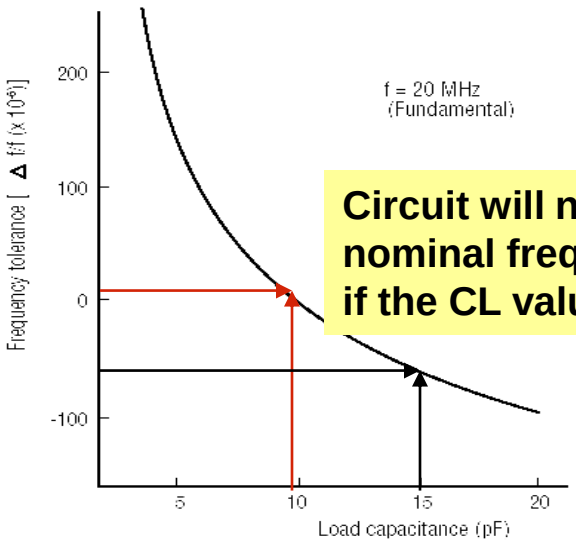


Basic Oscillation Circuit



Calculation of Load Capacitance





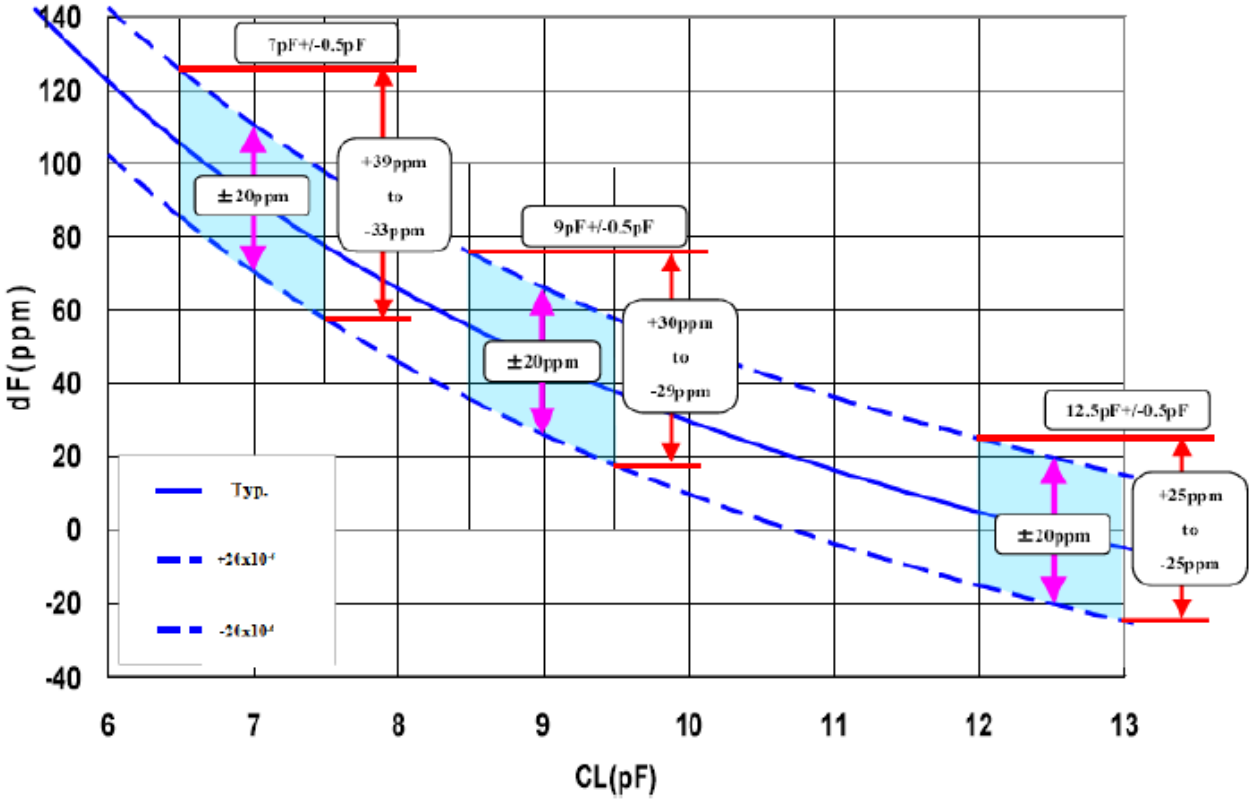
Circuit will not oscillate at its nominal frequency if the CL value is not suitable.

As shown in a left chart, the load capacity of the circuit changes when the value of C_G and C_D is changed, and the oscillation frequency of the oscillator is adjusted

The load capacity can calculate using the following formula.

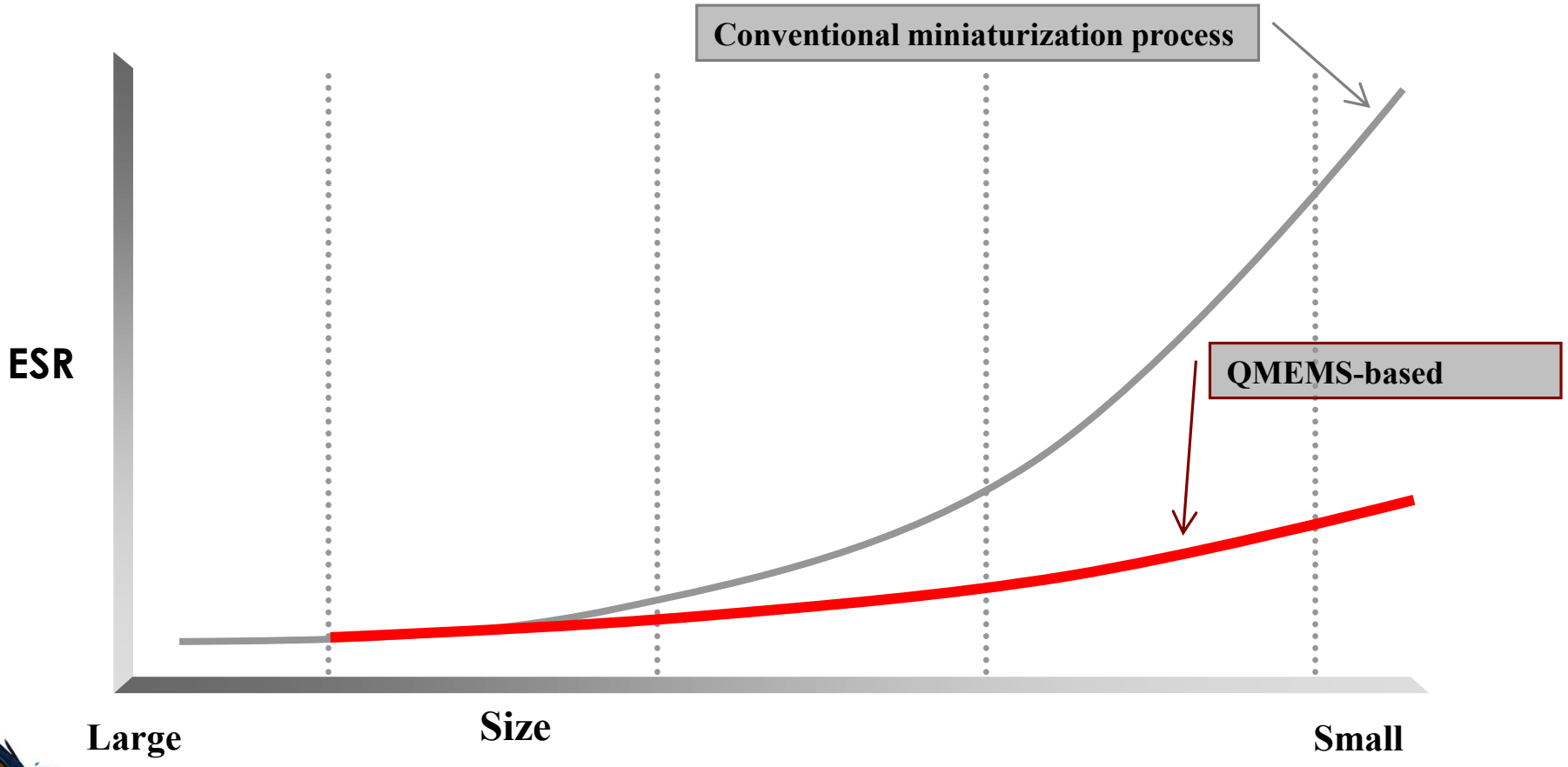
$$CL \fallingdotseq \frac{CG \times CD}{CG + CD} + CS \quad \text{(Stray capacity)}$$

Calculation of Load Capacitance

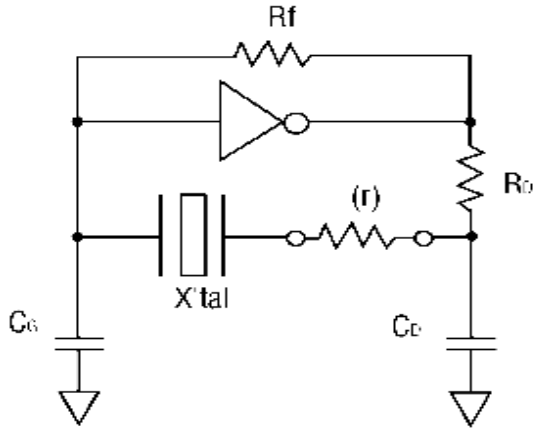


$$CL \fallingdotseq \frac{CG \times CD}{CG + CD} + CS$$ (Stray capacity)

kHz XTAL ESR vs. Size



Oscillation Start-up Allowance



Oscillation circuit with negative resistance

Unless adequate negative resistance is allocated in the oscillation circuit, oscillation start-up time may be increase, or NO OSCILLATION may occur. In order to avoid this, provide enough negative resistance in the circuitry design.

How to check the allowance for oscillation

(1) Connect the resistance (r) to the circuit in series with the crystal unit.

(2) Adjust (r) so that oscillation can start (or stop).

(3) Measure (r) when oscillation just starts (or stops) in (2) above.

(4) Recommended (r) > ESR x (5 to 10)

XTAL Drive Level

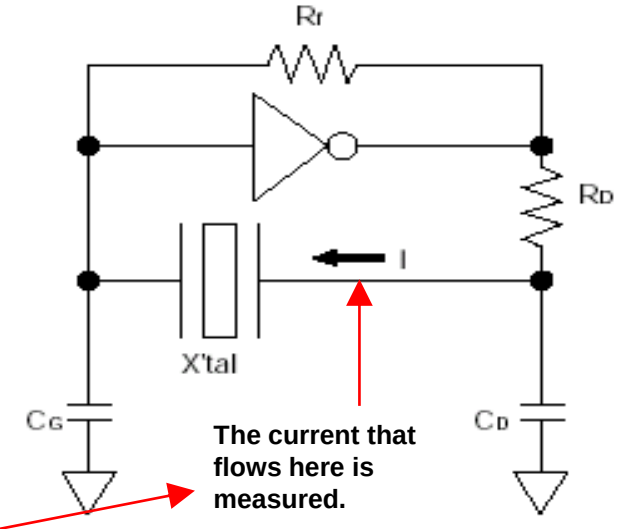
Influence of drive level

When the drive level is too large.

- **The characteristic is deteriorated.**
- **Crystal could be destroyed.**

When the drive level is too small.

- **There is no oscillation.**
- **Becomes unstable even if oscillating.**



Drive level (P) = I^2Re

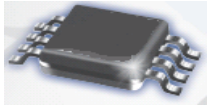
$$Re = R_1 \left(1 + \frac{C_0}{C_L}\right)^2 \ [\Omega]$$

XTAL Circuit parameters

RTC

Competition

RTC IC + Crystal



+

Epson

Integrated Module

=

EPSON RTC

EPSON
EXCEED YOUR VISION

Customer's request

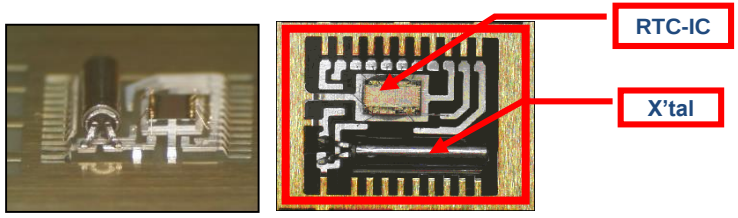
X'tal

Tuning folk

RTC
Clock
Calendar
Alarm
Timer

Interfaces
I^2C-BUS
3-Wire
4-Wire
4bit parallel

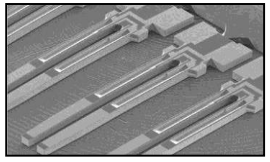
Other function
Built-in Memory
Voltage detect
Temp. sensor
Event-Detection
Power-switching
Battery charge control

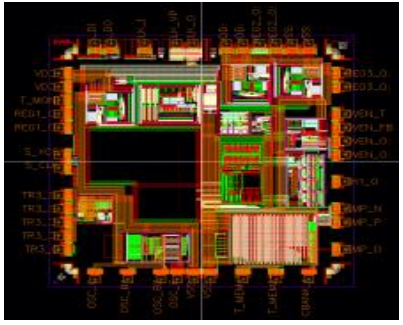


EPSON RTC

EPSON
EXCEED YOUR VISION

QMEMS





Good combination – EPSON's unique point!!

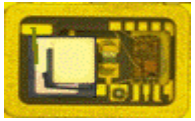
Epson is the most Vertically Integrated

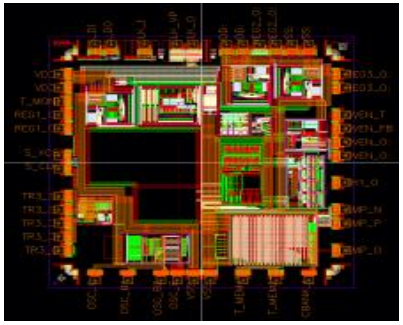
EPSON
EXCEED YOUR VISION

Epson is the only supplier who makes their own robots

Factory Automation → Final Test

Factory Automation → Module Assembly





Epson is 1 of very few who design their own ICs

Epson is 1 of 6 suppliers who grow their own Quartz

Crystal Fabrication ← IC Fabrication

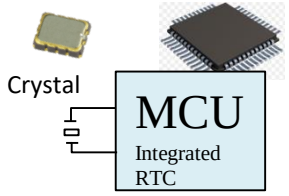
Raw Quartz Fabrication

Epson is the only supplier with our own IC foundry

Options to realize RTC-Functions

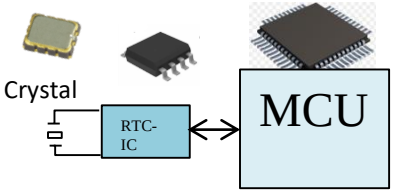
EPSON
EXCEED YOUR VISION

TRADITIONAL OPTIONS



The MCU processor features an integrated RTC software function

- Low cost, but runs the risk of higher power consumption, low stability, calibration issues and oscillator circuit design issues.



The crystal is connected to the RTC externally

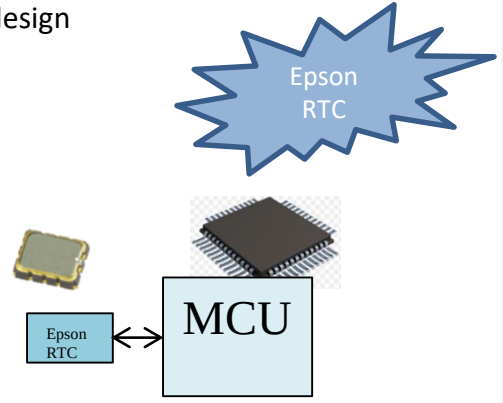
- Low power consumption, but requires circuit matching for stable oscillation

VS

TOTAL INTEGRATION

The crystal is integrated within the RTC module

- Low power consumption
- Extradentary accuracy
- High reliability
- Simple design



In most cases, the RTC is connected to MCU.

RTC Module Advantages

Which feature is the most important?

Easy Use / Tiny size / High reliability

Ultra low power consumption

Battery switching function with optional battery charge control

High accuracy for over temperature

Tiny Size

SA package
10.1x7.4x3.3mm

CE package
3.2x2.5x1.0mm

RX8900CE

RX8130CE

Easy Use

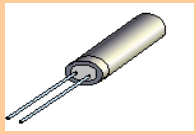
Since crystal matching has already been performed by us, there is no need for circuit evaluation to check the design and therefore customer can shorten development period.

Normal Guaranteed Frequency Accuracy

$5 \pm 23 \times 10^{-6}$ (at 25℃) ⇒ Equivalent to 1min/month

「RTC IC＋32k Xtal」cannot easily achieve the above accuracy.

Xtal Tolerance ±20ppm（Max） + **IC Tolerance ±10ppm（Max）** = **Total Tolerance ±30ppm（Best Case）**



Item	Symbol	Min.	Typ.	Max.	Unit
Oscillation start voltage	V_{STA}	1.1	–	5.5	V
Oscillation start time	t_{STA}	–	–	1	s
IC-to-IC frequency deviation*1	δIC	−10	–	+10	ppm

RTC IC Maker

Tolerance ±10ppm

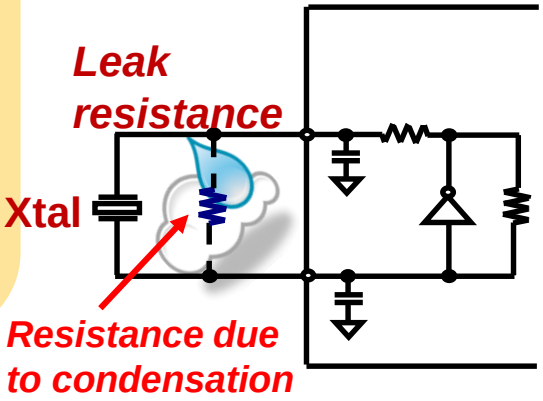
High Reliability

EPSON
EXCEED YOUR VISION

<RTCs operation environment>

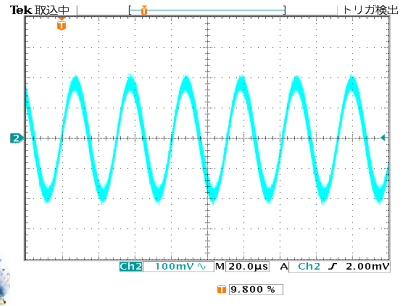
- ✓ RTC needs to run with very low voltage and current (power) and therefore **the circuit around Xtal is sensitive to the external environment (moisture,…).**
- ✓ In case of `RTC IC + 32k Xtal` or `MCU(ASIC) + 32k Xtal`, **the individual components are placed onto the PCB and thus influenced by external environment.**

i.e. condensation can cause failures such as unstable oscillation (2) or no oscillation (3).

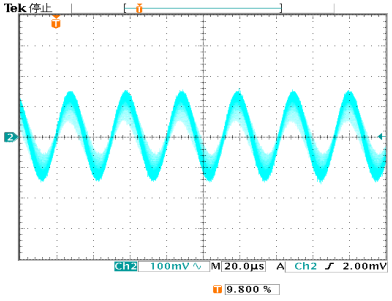


Epson RTC modules have all critical parts built into mostly and MSL 1 type package and thus provides high reliability !

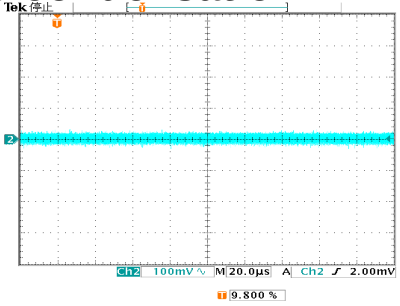
(1) Normal Oscillation



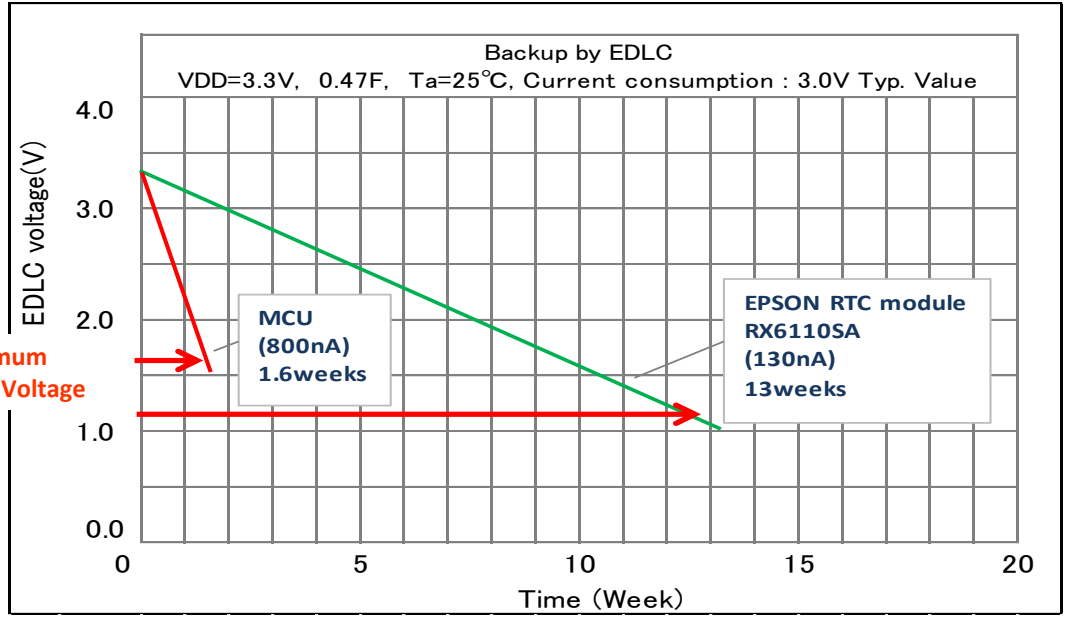
(2) Unstable Oscillation due to condensation.



(3) No Oscillation due to condensation



Low Power



RX6110SA
(Typ.130nA)

RX8010SJ
(Typ.160nA)

RTC Backup time simulation (Example)

※Back up by dual layer capacitor（Simulation）
（At 0.47F Typ value，not incl. self discharge.）

$$C = \frac{(I_{leakage} + I_{load})\,[A] \times t\,[s]}{(V_0 - V_1)[V]}$$

Backup Switching Function

	RX6110SA	RX8900SA/CE RX8111/4111CE	RX8130CE	RX-8035SA/LC RX-4035SA/LC
Primary Supply	Powerline – constant supply voltage (on/off)	Powerline – constant supply voltage (on/off)	Any! As well discharging batteries	Any! As well discharging batteries
Backup Supply	EDLC or capacitors.	EDLC or capacitors.	Any! As well Lithium batteries!	Non rechargeable battery or EDLC.
Backup Battery Charge Control	Trickle charge for EDLC or capacitors	Trickle charge for EDLC or capacitors	Sophisticated user programmable charge control suitable as well for Lithium batteries!	Trickle charge for EDLC if short circuit between VOUT and VBAT

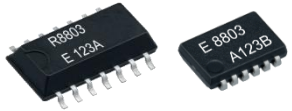
Other Power configurations are possible!

Please read white paper or contact us!!

RX6110SA

RX8900CE
RX8111CE

RX8130CE
（Safe function for Lithium secondary battery）

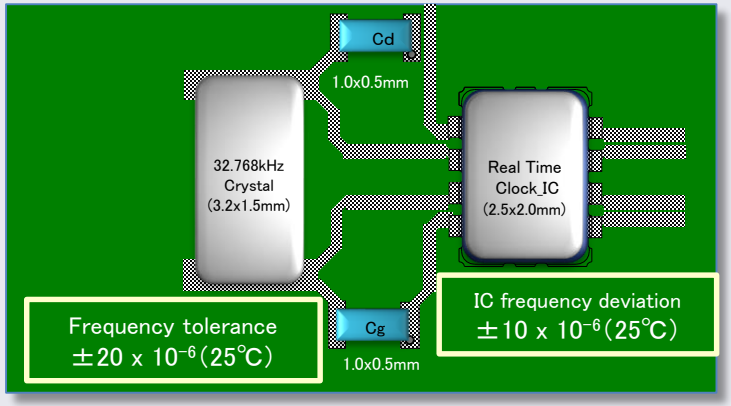


RX-8035SA/LC
RX-4035SA/LC

High Accuracy

EPSON
EXCEED YOUR VISION

Crystal + IC



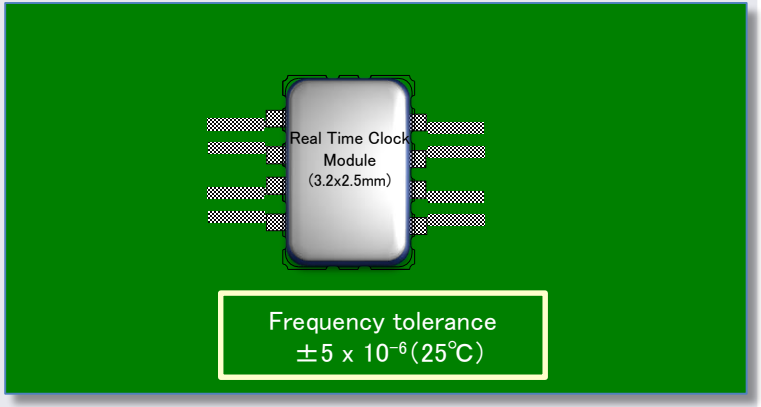
- There are many sources of variation in frequency (clock) accuracy

Crystal	IC	Stray Capacitor
±20 x 10^{-6} (Max)	±10 x 10^{-6} (Max)	±6 x 10^{-6} (Max)

Total ±36 x 10^{-6} (Max) (25℃)

Monthly difference: equivalent to 94 seconds

Real Time Clock Module



- Frequency (clock) accuracy has been adjusted
- Parts selection / evaluation, circuit evaluation (matching) also unnecessary

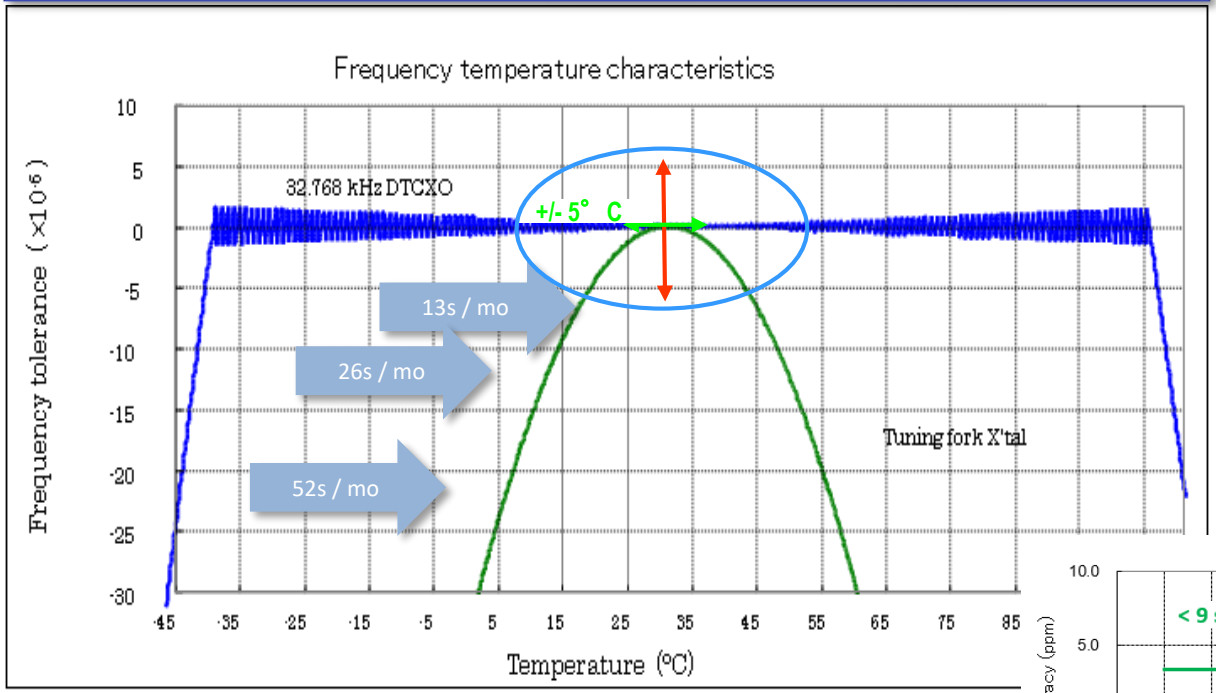
AA precision product
±5 x 10^{-6} (Max) (25℃)
Monthly difference: equivalent to 13 sec

B precision product
±23 x 10^{-6} (Max) (25℃)
Monthly difference: equivalent to 60 sec

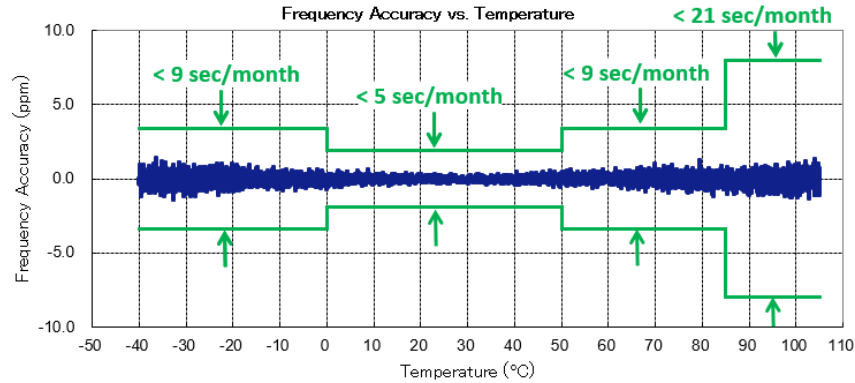
High Stability over Temperature Range

EPSON
EXCEED YOUR VISION

Typical Frequency vs. Temp Characteristic



RX/A8900
RX/A8804



Built-in Compensation: multi-point FTC measurement and D-TCXO

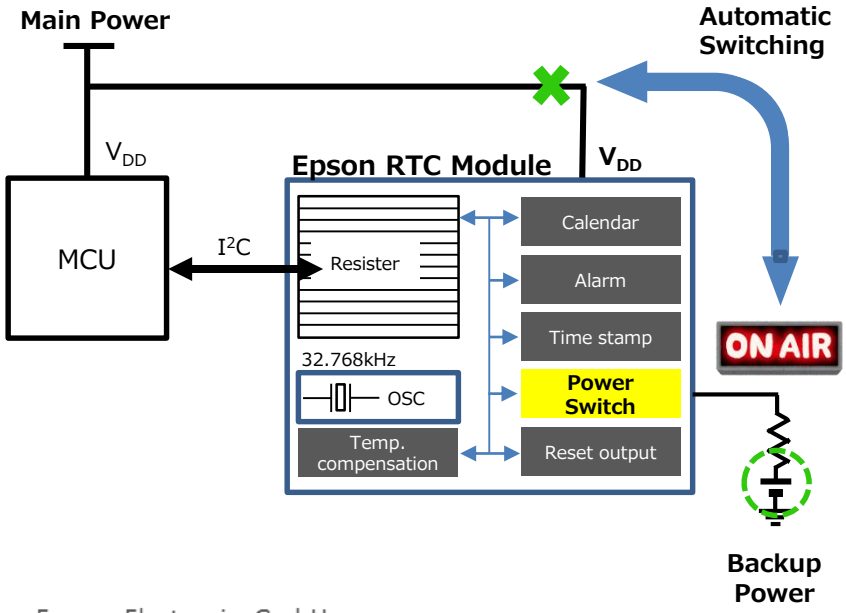
+/-1.9ppm over -0 to +50C	=	< 5 sec/mth	
+/-3.4ppm over -40 to +85C	=	< 9 sec/mth	
+/-5.0ppm over -40 to +85C	=	< 13 sec/mth	
+/-8.0ppm over +85 to +105C	=	< 21sec/mth	(RX8804CE)

EPSON
EXCEED YOUR VISION

RTC
Additional Feature Options

Power Switch

This function monitors the main power condition, and will automatically change the power source to a backup supply when the voltage on the main power drops.



Advantages vs Diode-OR circuit

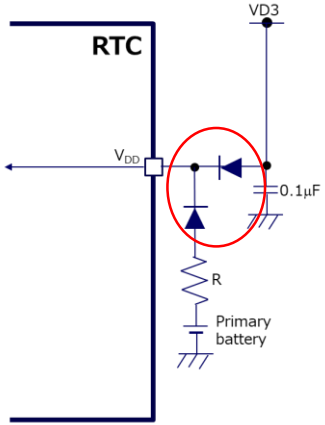
- Reduce leak current by using MOS switch inside RTC module.
  User doesn't need to care about VF/IR specification of Diode.

*Depends on backup battery type

Power Switch

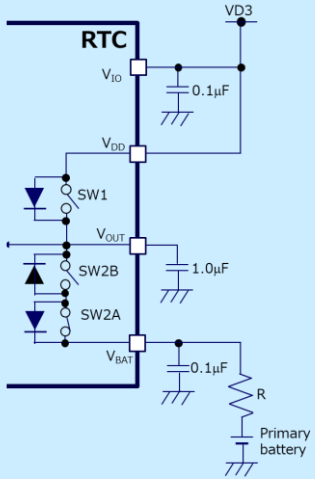
- Return to main power when the power returns
- Built in diode to prevent leakage current
- Recharging backup battery with low power consumption

External



- Schottky diode is recommended because of low voltage drop
- Schottky diode is expensive!
- Shorter battery life because of external diode

Internal



- No external diode
- Min leakage current
- Longer battery life

RX8111
RX4111
RX8130
RX8900
RX6110

Power Switch - Variants

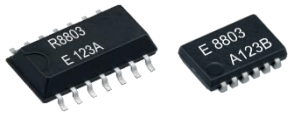
	RX6110SA	RX8900SA/CE RX4111CE	RX8130CE	RX8111CE RX-8035SA/LC RX-4035SA/LC
Primary Supply	Powerline – constant supply voltage (on/off)	Powerline – constant supply voltage (on/off)	Any! As well discharging batteries	Any! As well discharging batteries
Backup Supply	EDLC or capacitors.	EDLC or capacitors.	Any! As well Lithium batteries!	Non rechargeable battery or EDLC.
Backup Battery Charge Control	Trickle charge for EDLC or capacitors	Trickle charge for EDLC or capacitors	Sophisticated user programmable charge control suitable as well for Lithium batteries!	Trickle charge for EDLC if short circuit between VOUT and VBAT

Other Power configurations are possible!

RX6110SA

RX8900CE
RX8111CE

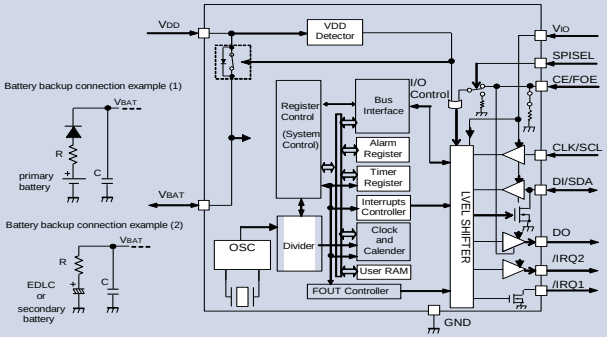
RX8130CE
（Safe function for Lithium secondary battery）



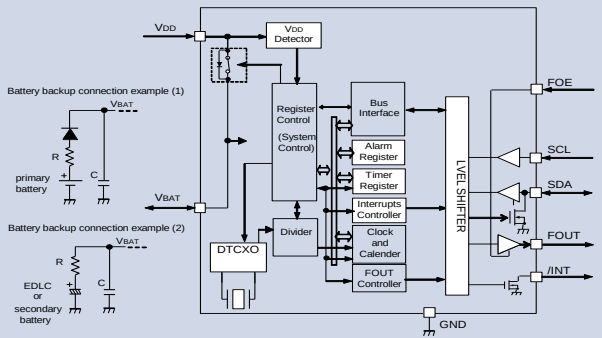
RX-8035SA/LC
RX-4035SA/LC

RTC with Power Switch – Backup Supply Connection Examples

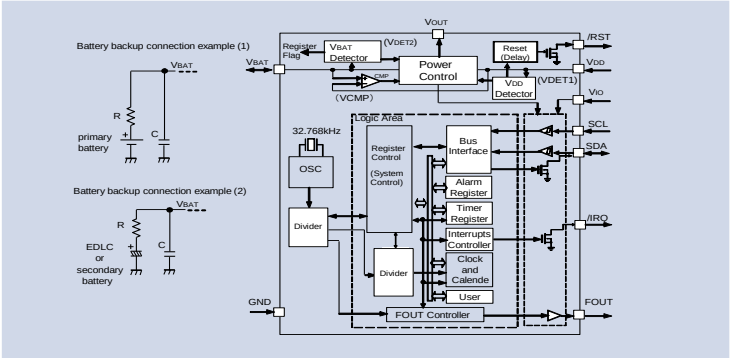
RX6110SA



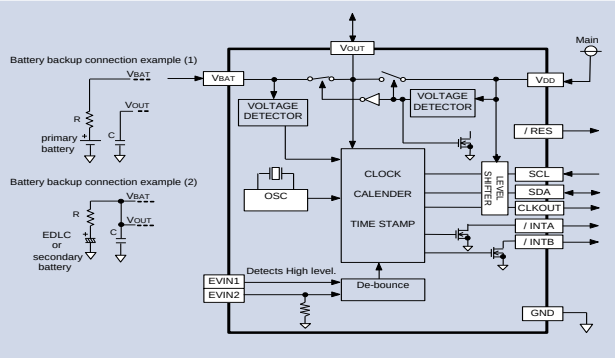
RX8900SA/CE



RX8130CE



RX-8035SA/LC, RX-4035SA/LC



Battery backup switchover function comparison

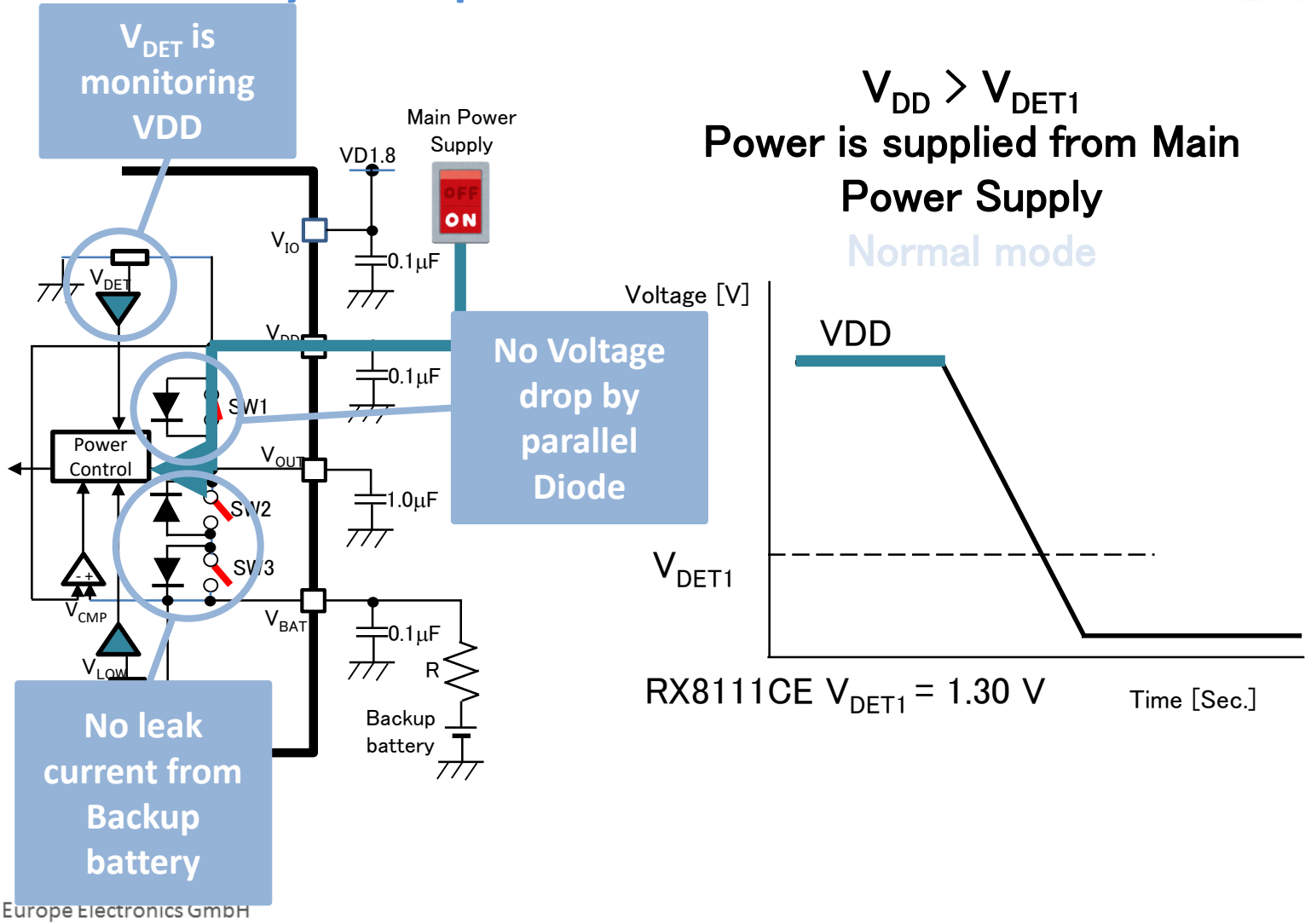
EPSON
EXCEED YOUR VISION

We have various types of circuits to realize the battery backup switchover function depending on the product

Detection voltage		RX8130CE	RX8111CE	RX4111CE	RX8900CE
Battery backup switchover function		Yes	Yes	Yes	Yes
Detection of V_{DD} voltage rise	Switch power supply from V_{BAT} to V_{DD}	Yes	Yes	Yes	Yes
Detection of V_{DD} voltage drop down	Switch power supply from V_{DD} to V_{BAT}	Yes When operation by main power supply Any time detection	Yes When operation by main power supply Any time detection	Yes When operation by main power supply Any time detection	Yes When operation by main power supply it is detected, every second
Detector threshold voltage rising edge of V_{BAT}	Charge stop voltage	Yes (3 level)	No	No	No
Detector threshold voltage falling edge of V_{BAT}	Recharge voltage	Yes (3 level)	No	No	No
Comparison of V_{BAT} and V_{DD}	When $V_{DD} \leq V_{BAT}$ Charge stop	Yes	Yes	No	No
Detection voltage of V_{BAT} low	Low V_{BAT} detection	Yes	Yes	No	No
Diode	V_{DD} side	Built-in	Built-in	Built-in	Built-in
	V_{BAT} side	Built-in	Built-in	External	External

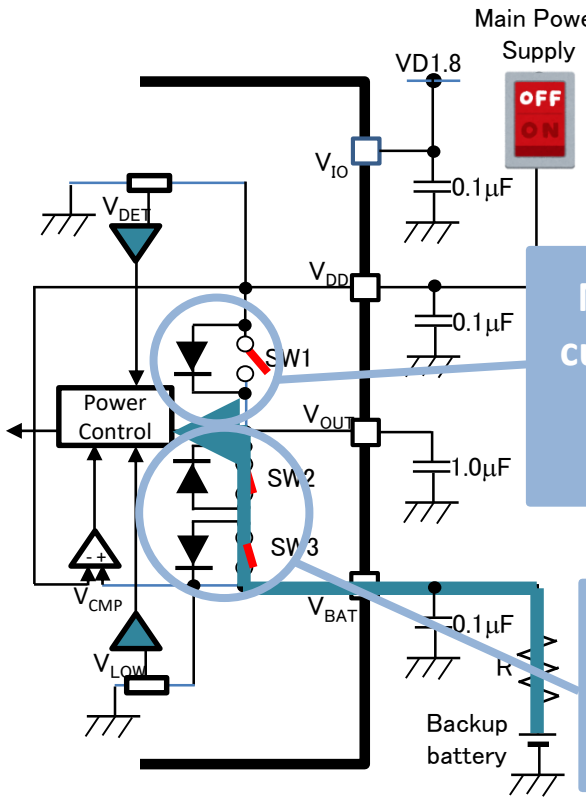
Designed to minimize leakage current and wasteful charging

RX8111CE battery backup switchover



RX8111CE battery backup switchover

EPSON
EXCEED YOUR VISION

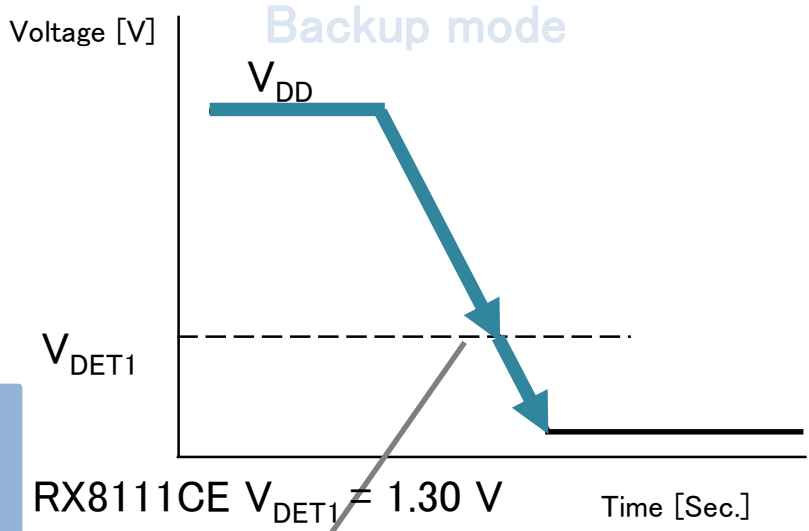


No reverse current from Backup battery

No Voltage drop by parallel Diode

When $V_{DD} \leq V_{DET1}$, SW1 from ON to OFF
SW2 from OFF to ON
SW3 from OFF to ON

When $V_{DD} \leq V_{DET1}$ Power supply changes from Main power supply to Backup battery

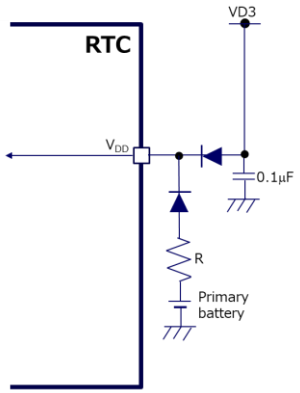


RX8111CE battery backup switchover

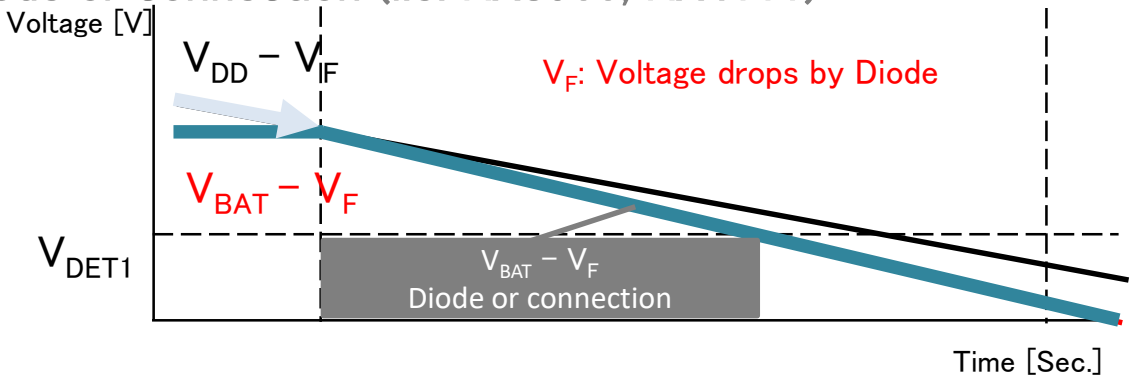
When Diode or connection: $V_{DD} - V_F \leq V_{BAT} - V_F$

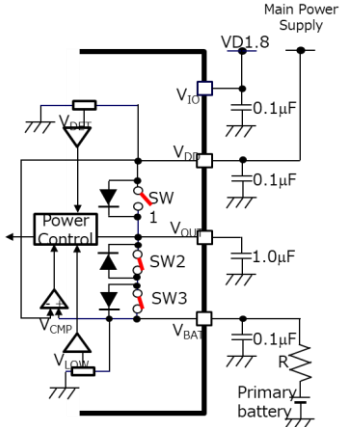
RX8111CE: $V_{DD} \leq V_{DET1}$

the power supply changes from V_{DD} to Backup battery

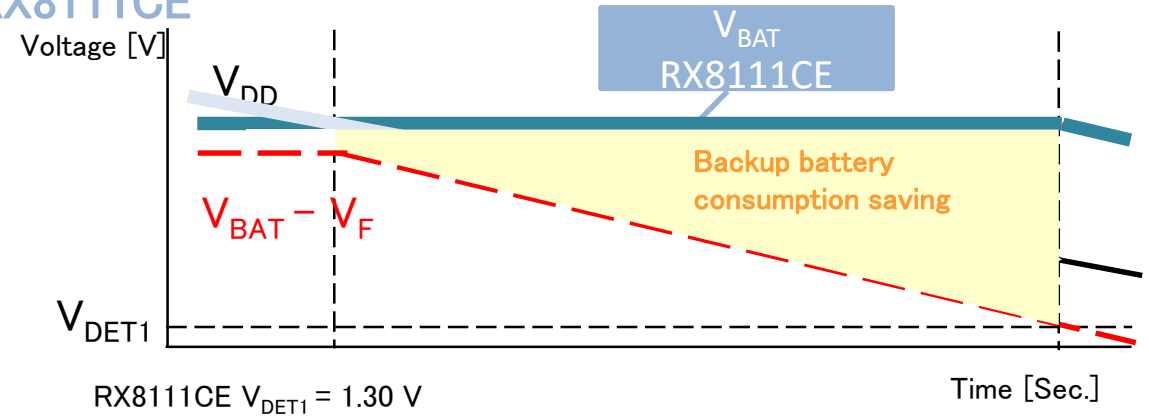


Diode or connection (i.e. RX8900, RX4111)

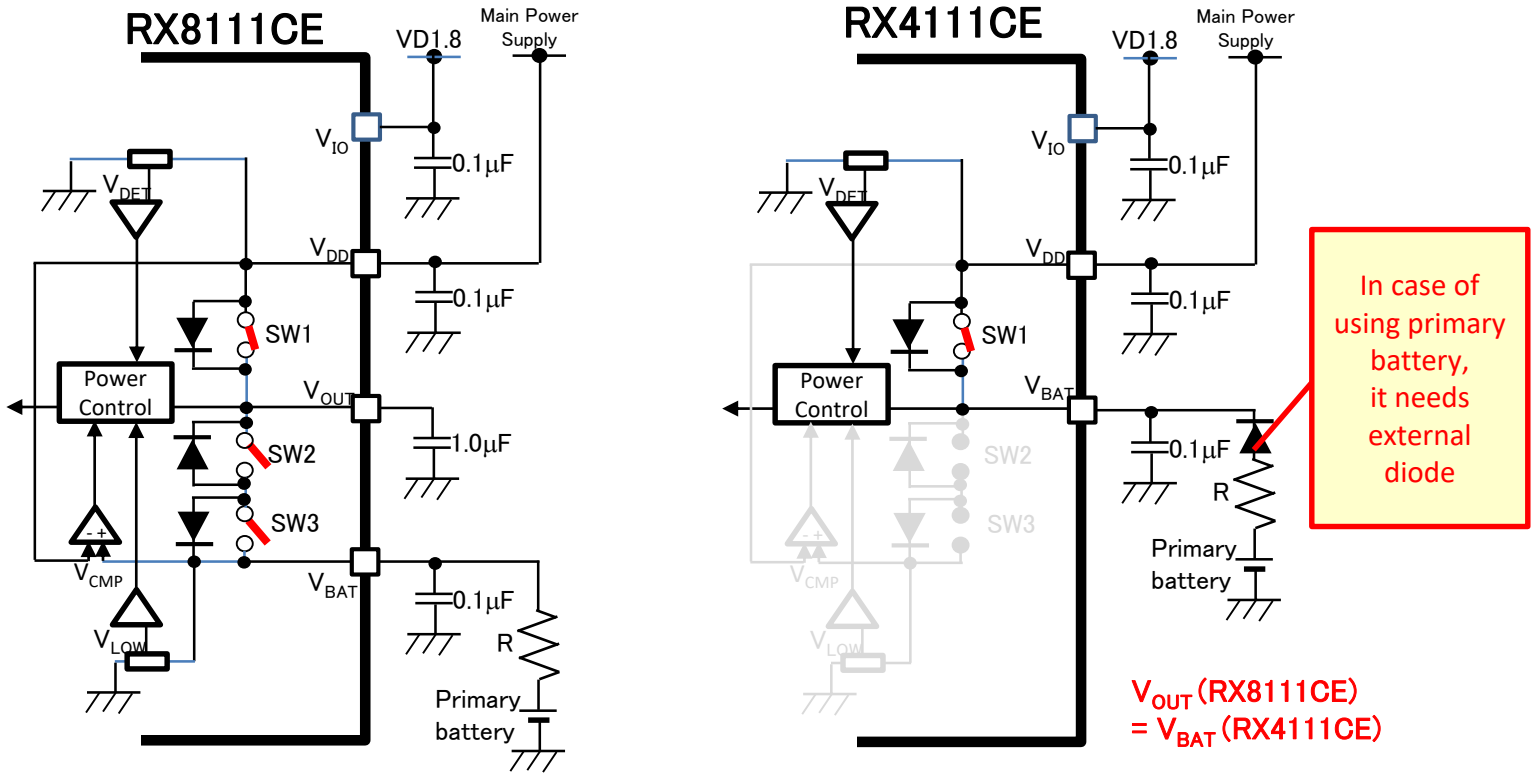




RX8111CE



Battery backup switchover function comparison

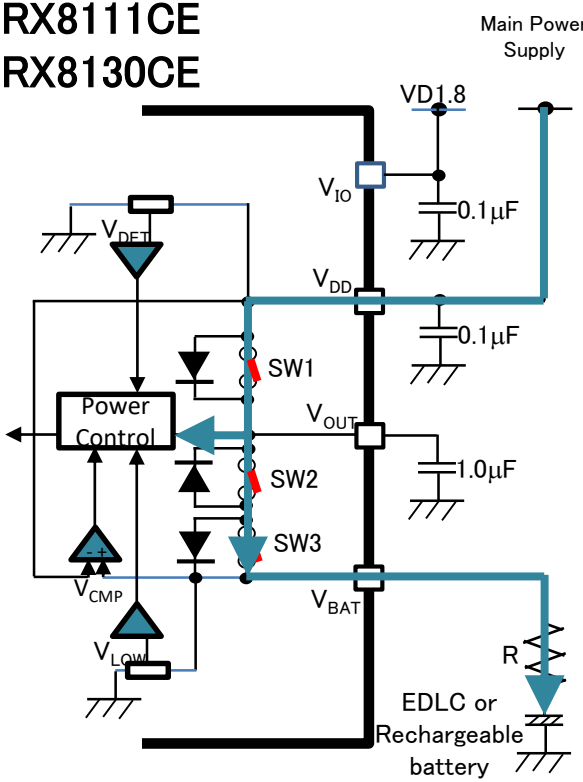


The interface of RX4111CE is SPI, so there are less pins compare to RX8111CE which is I2C. There is **no V_{OUT} pin** and differences are shown in the figure.
Please note for RX4111, that the backup battery will be consumed under the condition: $V_{DET1} < V_{DD} < V_{BAT}$

Battery backup switchover function comparison

EPSON
EXCEED YOUR VISION

RX8111CE
RX8130CE



Internal circuit of RX8111CE and RX8130CE for battery backup switchover function are the same.

RX8130CE:

Offers 3 levels of charge stop and recharge voltage:

Charge stop voltage = 2.92, 3.02, 3.08 V Typ.

Recharge voltage= 2.87, 2.97, 3.03 V Typ.

*You can set it by register

RX8111CE:

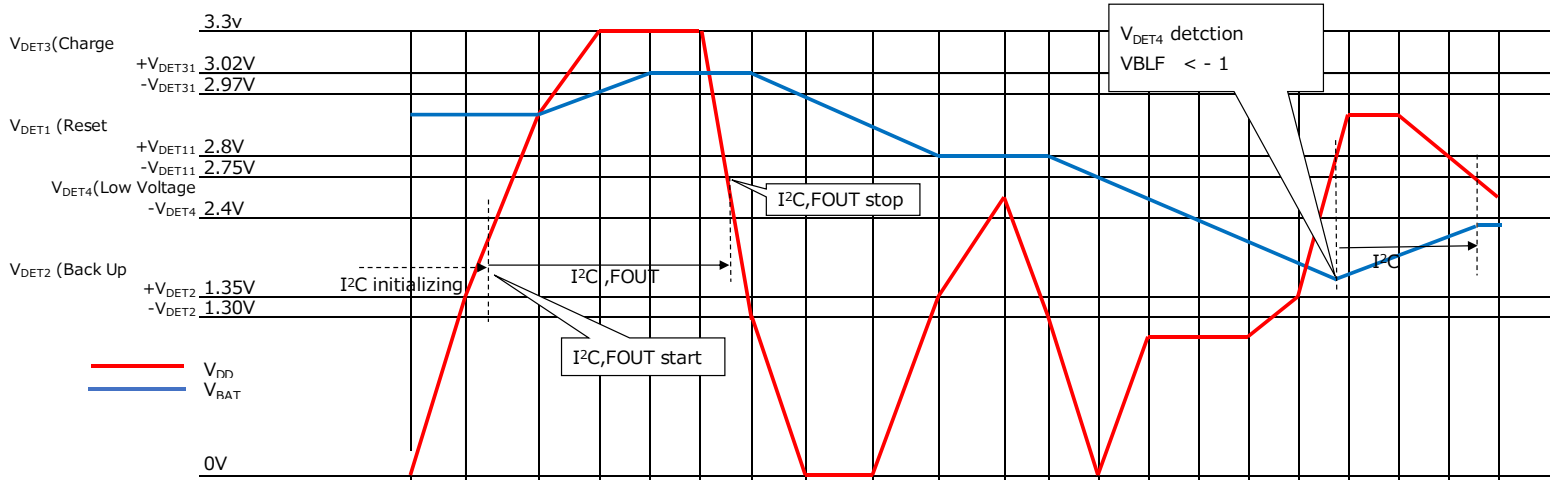
It only stops at VBAT $\geq$ VDD

Please see page 3

Charge stop voltage,
Recharge voltage,
$V_{DD} < V_{BAT}$ Charge stop

Li-Battery Charge Control – RX8130

RX8130CE can detect a full charge of secondary battery via a voltage detector on V_{BAT}. It furthermore switches the power supply to backup only if VDD dropped to min. voltage, which extends the available backup time and is especially suitable for battery-powered equipment.

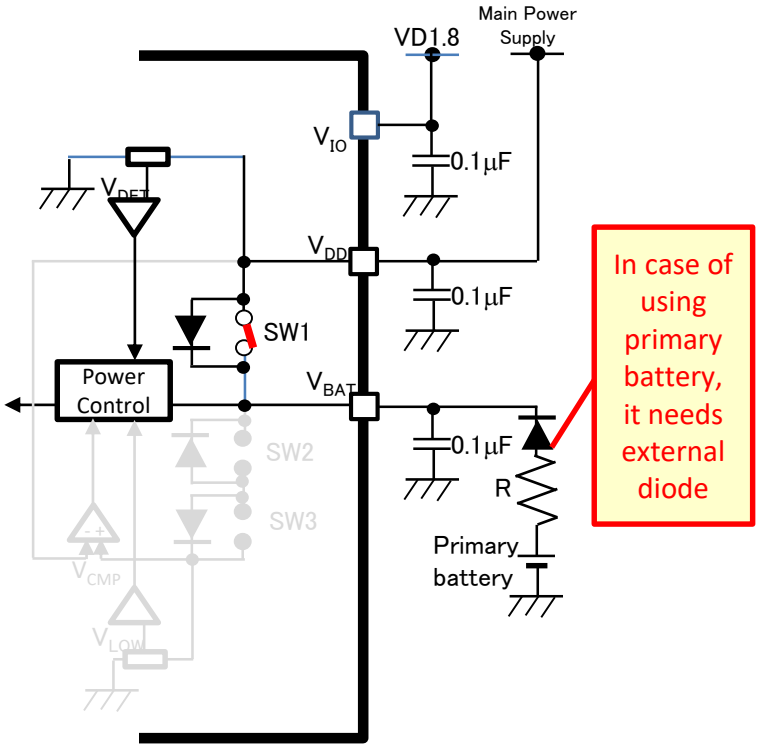


CHGEN		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
INIEN		0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SW1		OFF	ON	ON	ON	ON	ON	OFF	OFF	OFF	ON	ON	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
SW2		OFF	OFF	ON	ON	OFF	OFF	ON	ON	ON	OFF	OFF	ON	ON	ON	ON	ON	OFF	OFF	OFF
mode	status																			
Power On Reset	initializing																			
normal	battery charging																			
normal	battery full charge																			
backup	battery discharging																			
normal	V_{DD} drive																			

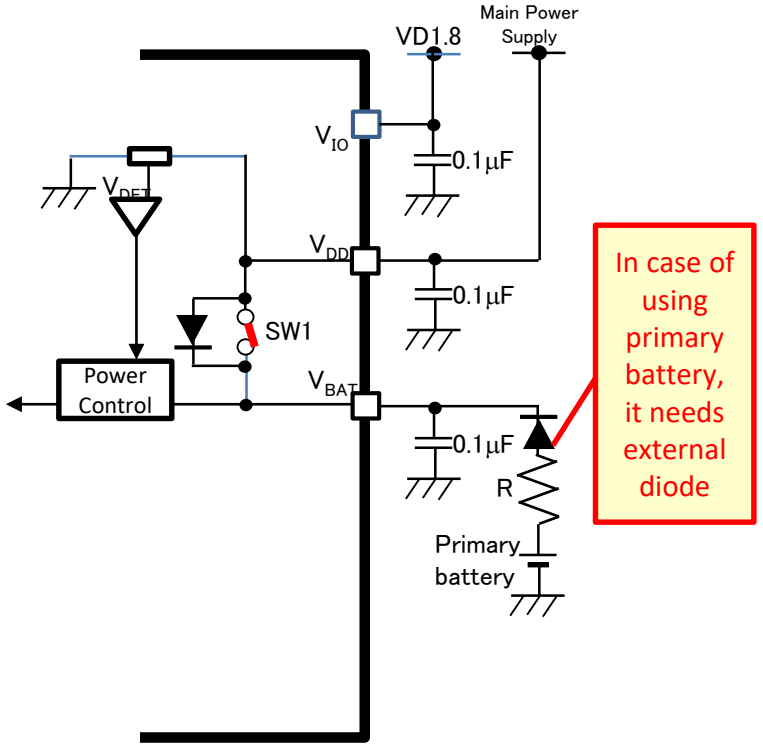
Battery backup switchover function comparison

EPSON
EXCEED YOUR VISION

RX4111CE



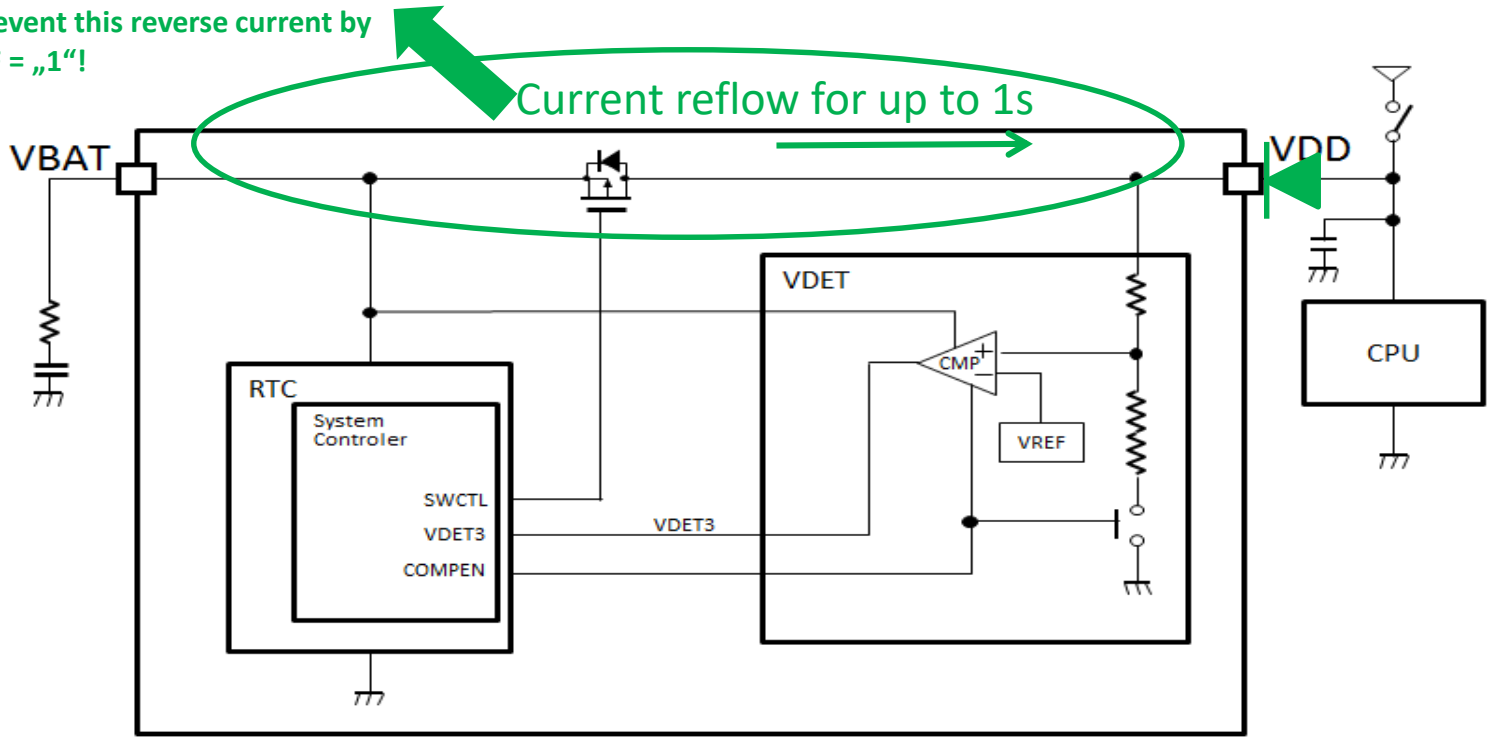
RX8900CE



Internal circuit of RX4111CE and RX8900CE for battery backup switchover function are the same.
RX8130CE, RX8111CE, RX4111CE operate V_{DD} detection all the time while in normal operation ($V_{DD} > V_{DET1}$)
V_{DET} of RX8900CE is intermittent detection.

Epson Power-Switch Options for RTCs – RX8900/4111/6110

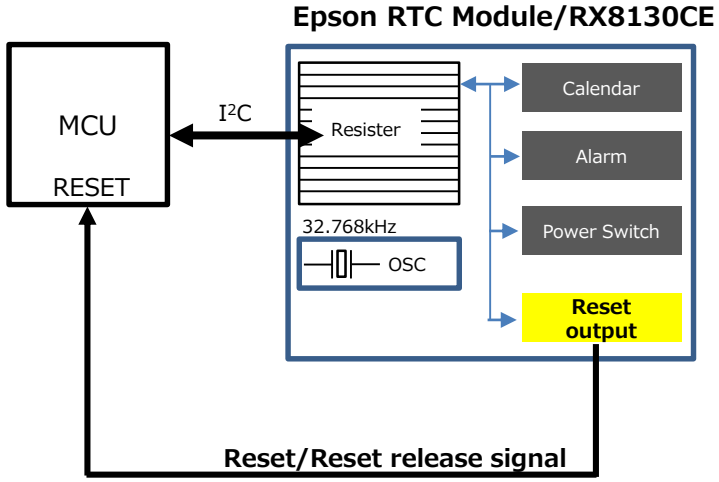
Current reflow for up to 1s till the Switch opens for the next VDET measurement!
→ Can be prevented with external diode right at VDD-pin (HF-filter C needs to be behind diode as it would buffer VDD for too long time!)!
RX6110 can prevent this reverse current by setting BKSOFF = „1“!



Optimized for use with a super-cap or capacitor as backup-power supply which needs to be charged from the main supply being a power-line.

Reset Output – RX8130CE

RX8130CE generates a Reset/Reset release signal depending on the VDD supply voltage. This Reset-control function prevents problems with toggling I/O ports of connected MCUs and thus eliminates the need for an external Reset IC, contributing to a reduction in the number of parts and cost.



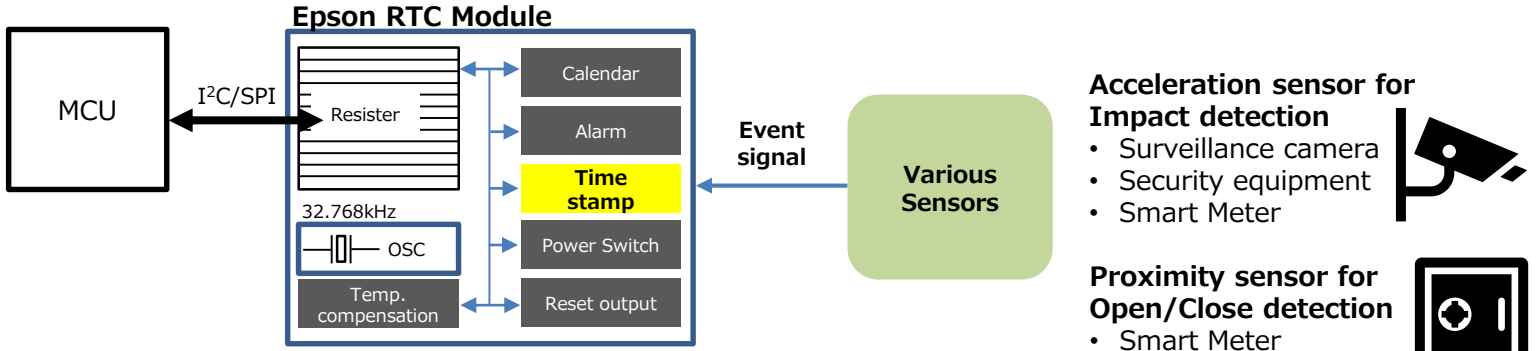
	Symbol	Detection voltage (typ.)	Setting
Reset	$+V_{DET11}$	2.75 V	RSVESEL "0" (default)
Reset Release	$-V_{DET11}$	2.80V	
Reset	$+V_{DET12}$ **(X1B000311000100)**	2.70 V	RSVESEL "1"
Reset Release	$-V_{DET12}$ **(X1B000311000100)**	2.75 V	
Reset	$+V_{DET12}$ **(X1B000311000200)**	1.60 V	RSVESEL "1"
Reset Release	$-V_{DET12}$ **(X1B000311000200)**	1.65 V	

Time Stamp / Even Recording – RX8111/RX8804

EPSON
EXCEED YOUR VISION

This function records the time data when an event (signal) is detected.

- RX8111CE and RX8804CE can receive event signals directly from the event input pin (EVIN), enabling RTC operation even when the MCU is in standby mode.
- RX8111CE and RX4111CE can record 8 times clock time data. (User can select first/last 8 even recording)

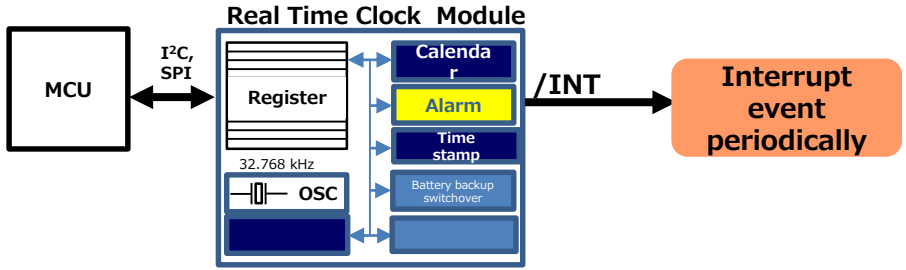


Event trigger options

- EVIN pin input (RX8111CE, RX8804CE)
- Interlock with RTC's internal operation
- Bus access

Wake-up Timer – RX8111

- Repeatedly outputs an interrupt signal at a specified fixed time interval.
- Can be used for regular activation and operation timing of CPU and peripheral devices.
- **Suitable for regular Wake up / Sleep solutions**

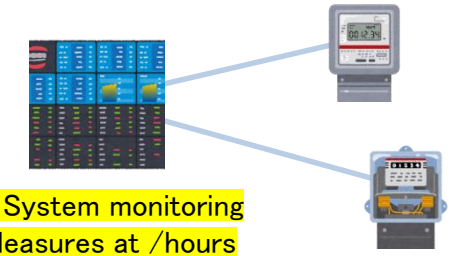


Timer source clock selectable from 4096 Hz, 64 Hz, 1 Hz, 1/60 Hz

Timer counter setting	Timer source clock			
	4096 Hz	64 Hz	1 Hz	1/60 Hz
1	244.14 µs	15.625 ms	1 s	1 min
:	:	:	:	:
16777216	1.13 h	72.81 h	4660 h	31.9 year

Ex. Maintenance notice
Filter cleaning
Oil change

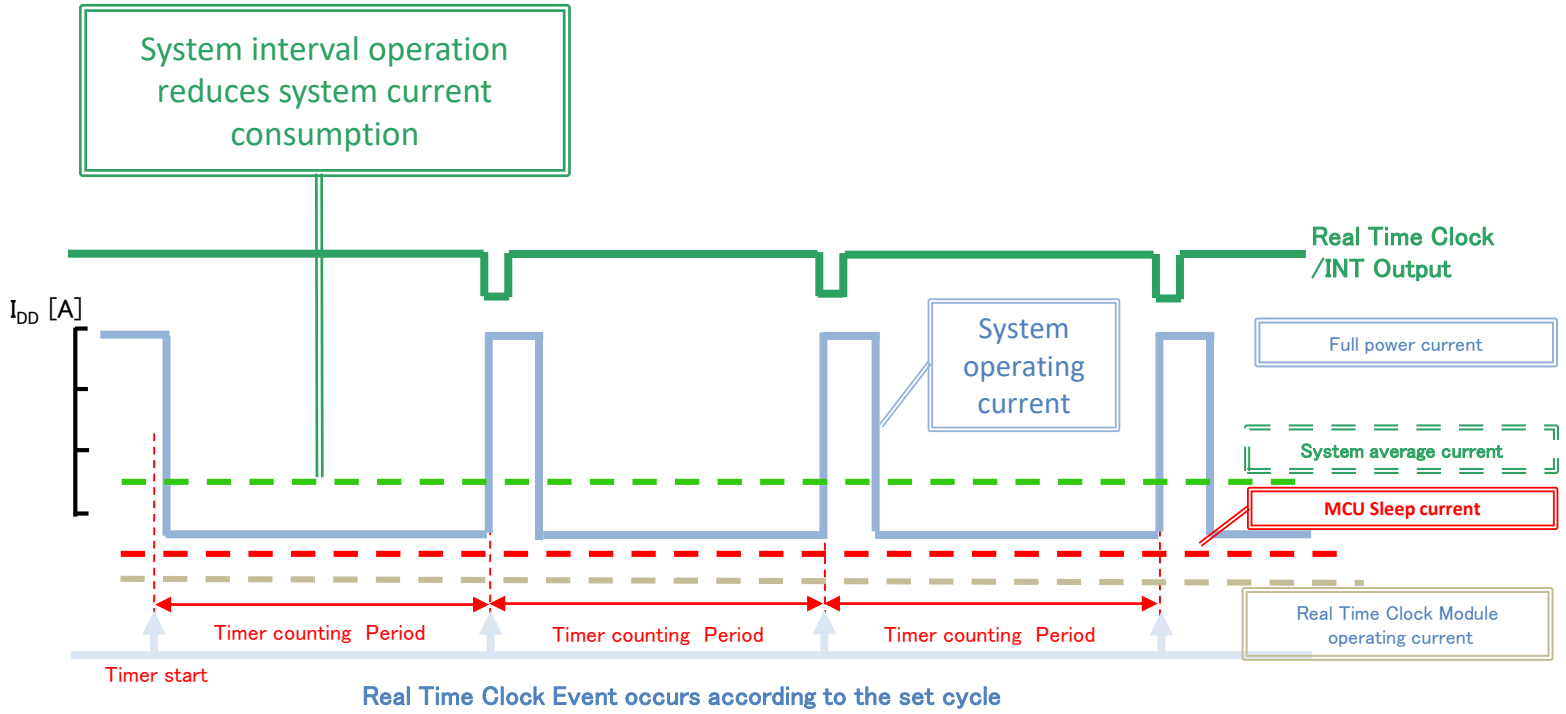
Auto release after interrupt output from /INT pin when timer completes:
This operation is auto repeated with a selected cycle;
It can be used like a Watchdog timer



Ex. System monitoring
Measures at /hours

Wake-up Timer – Power Saving

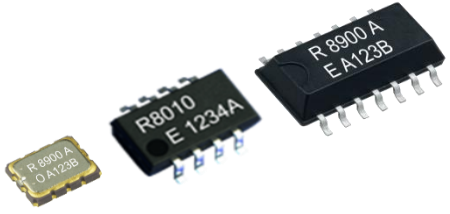
The Real Time Clock Modules wake-up timer function enables MCU to operate in interval mode and thus reduces system power consumption.



EPSON
EXCEED YOUR VISION

EPSON RTC

Lineup



Rev1.4

RTC Large Lineup

EPSON
EXCEED YOUR VISION

REAL TIME CLOCK MODULE

►SPI-Bus & I²C-Bus

Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
103	RX6110SA	 NEW	10.1×7.4×3.3	Low current consumption Power Switching	√	√	√	√	0.13	1.1 to 5.5

►SPI-Bus

Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
104	RX-4803SA		10.1×7.4×3.3	Built-in DTCXO	√	√	-	√	0.75	1.6 to 5.5
	RX-4803LC		3.6×2.8×1.2							
105	RX-4035SA		10.1×7.4×3.3	Built-in Timestamp and Power Switching	√	√	-	-	0.35	1.0 to 5.5
	RX-4035LC		3.6×2.8×1.2						0.4	
106	RX-4045SA		10.1×7.4×3.3	High-Stability	√	√	-	-	0.48	1.15 to 5.5
	RX-4045NB		6.3×5.2×1.4							
107	RX-4581NB		6.3×5.2×1.4	Built-in SRAM	√	√	√	√	0.4	1.6 to 5.5
108	RX-4571SA		10.1×7.4×3.3	Low Backup Voltage	√	√	-	√	0.32	1.0 to 5.5
	RX-4571NB		6.3×5.2×1.4							
	RX-4571LC		3.6×2.8×1.2							
109	RX-4701JE		7.3×6.2×1.5	Built-in Temperature Sensor	√	√	-	√	0.5	1.6 to 5.5
	RX-4701NB		6.3×5.2×1.4							
110	RX-4574SA		10.1×7.4×3.3	Simple Function	√	√	-	√	0.5	1.6 to 5.5
	RX-4574JE		7.3×6.2×1.5							
	RX-4574NB		6.3×5.2×1.4							
111	RX-4574LC		3.6×2.8×1.2		√	√	-	√	0.35	1.3 to 5.5
112	RX-4543SA		10.1×7.4×3.3		√	-	-	-	1.0	1.4 to 5.5
	RX-4543SB		11.6×8.0×2.0							
113	RX-4575LC		3.6×2.8×1.2	Built-in external event detection	√	√	-	√	0.35	1.3 to 5.5

►I²C-Bus

Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
114	RX8010SJ	NEW	7.0×6.0×2.65	Low current consumption	√	√	√	√	0.16	1.1 to 5.5
115	RX-8571SA		10.1×7.4×3.3	Low power consumption 128 bit User RAM Long-running timer (65000 hours)	√	√	√	√	0.2	1.3 to 5.5
	RX-8571NB		6.3×5.2×1.4							
	RX-8571LC		3.6×2.8×1.2						0.22	
116	RX-8564JE		7.3×6.2×1.5	Low current consumption	√	√	-	√	0.275	1.1 to 5.5
	RX-8564NB		6.3×5.2×1.4							
	RX-8564LC		3.6×2.8×1.2							1.3 to 5.5
117	RX-8803SA		10.1×7.4×3.3	Built-in DTCXO	√	√	-	√	0.75	1.6 to 5.5
	RX-8803LC		3.6×2.8×1.2							

REAL TIME CLOCK MODULE

►I²C-Bus

Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
118	RX-8035SA		10.1×7.4×3.3	Built-in Timestamp and Power Switching	√	√	-	-	0.35	1.0 to 5.5
	RX-8035LC		3.6×2.8×1.2						0.4	
119	RX-8025SA		10.1×7.4×3.3	High-Stability	√	√	-	-	0.48	1.15 to 5.5
	RX-8025NB		6.3×5.2×1.4							
120	RX-8731LC		3.6×2.8×1.2	ID-ROM + EEPROM	√	√	√	√	0.35	1.3 to 5.5
121	RX-8581SA		10.1×7.4×3.3	Simple Function	√	√	-	√	0.45	1.6 to 5.5
	RX-8581JE		7.3×6.2×1.5							
	RX-8581NB		6.3×5.2×1.4							

►Parallel Interface

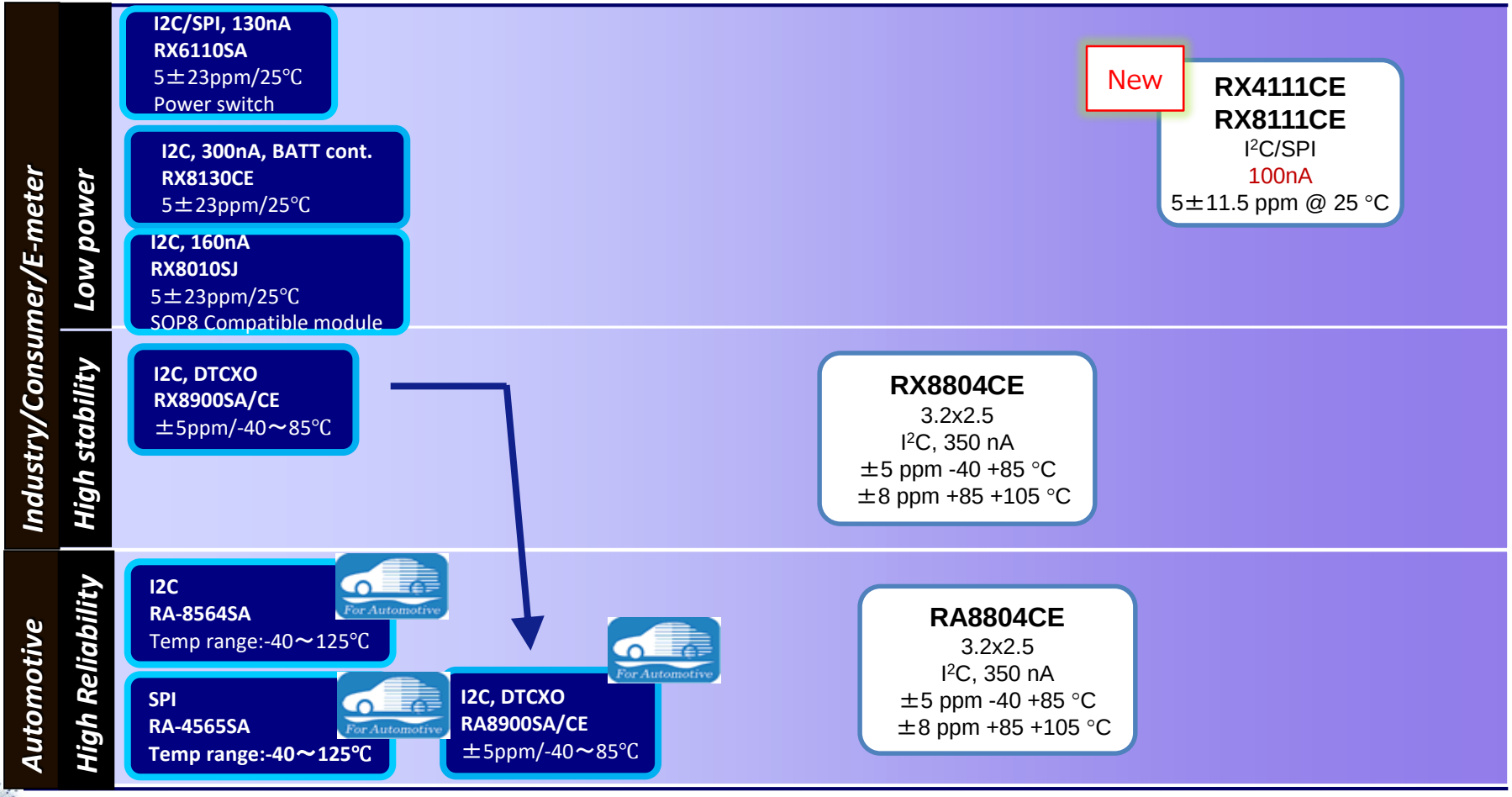
Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
122	RTC-7301SF		10.2×7.8×2.0	Built-in Temperature Sensor	√	√	-	√	0.6	1.6 to 5.5
	RTC-7301DG		DIP 18 pin	Available Alarm and Timer	√	√	-	√	0.6	1.6 to 5.5
123	RTC-72421		DIP 18 pin	4-bit Simple Function	√	√	-	√	0.9	2.0 to 5.5
	RTC-72423		16.3×12.2×2.8		√	√	-	√	0.9	2.0 to 5.5

►For Automotive SPI-Bus, I²C-Bus

Page	Model	External dimensions (mm) (t: Max.)		Features	FOUT	Alarm	Memory	Timer	Back up current [µA]	Voltage range [V]
124	RA4803SA	 NEW	10.1×7.4×3.3	AEC-Q200 SPI-Bus Built-in DTCXO	√	√	-	√	0.75	1.6 to 5.5
125	RA8803SA	NEW	10.1×7.4×3.3	AEC-Q200 I²C-Bus Built-in DTCXO	√	√	-	√	0.75	1.6 to 5.5
126	RA-4565SA		10.1×7.4×3.3	AEC-Q200 SPI-Bus Extended operating temperature range (+125°C)	√	√	-	√	0.5	1.5 to 5.5
127	RA-4574SA		10.1×7.4×3.3	AEC-Q200 SPI-Bus	√	√	-	√	0.5	1.6 to 5.5
128	RA-8565SA		10.1×7.4×3.3	AEC-Q200 I²C-Bus Extended operating temperature range (+125°C)	√	√	-	√	0.55	1.7 to 5.5
129	RA-8581SA		10.1×7.4×3.3	AEC-Q200 I²C-Bus	√	√	-	√	0.45	1.6 to 5.5

RTC Promotion Products

EPSON
EXCEED YOUR VISION



RTC New Products Summary

EPSON
EXCEED YOUR VISION

	RX8130CE	RX8900CE/SA	RX8804CE	RX81111CE	RX41111CE
Availability	MP	MP	MP	MP	MP
Size	✓✓✓ 3.2x2.5x1.0 (CE)	✓✓✓ 10.1x7.4x3.3 (SA) 3.2x2.5x1.0 (CE)	✓✓✓ 3.2x2.5x1.0 (CE)	✓✓✓ 3.2x2.5x1.0 (CE)	✓✓✓ 3.2x2.5x1.0 (CE)
Interface	I2C	I2C	I2C	I2C	SPI
Low Power	✓✓ 300nA	✓ 700nA	✓✓ 350nA	✓✓✓ 100nA	✓✓✓ 100nA
High Stability	✓ 5±23ppm / +25C	✓✓✓ UA:±3.4ppm/-40~85C UB:±5ppm/-40~85C	✓✓✓ UA:±3.4ppm/-40~85C UB:±5ppm/-40~85C	✓✓ 5±11.5ppm /+25C	✓✓ 5±11.5ppm /+25C
Power Switching	✓	✓	-	✓	✓
Time Stamp	-	-	✓ 1 TS	✓8 TS	✓8 TS
EVIN Pin	-	-	✓	✓	-
Reset Output	✓	-	-	-	-

•UA : ± 3.4 ppm／ -40℃～+85℃
± 8.0 ppm／ -40℃～+105℃

•UB : ± 5.0 ppm ／ -40℃～+85℃
± 8.0 ppm／ -40℃～+105℃

RTC Easy Selection Guide

EPSON
EXCEED YOUR VISION

		RX6110SA	RX8010SJ	RX8130CE	RX-8035SA/LC RX-4035SA/LC	RX8900CE	RX-8803SA/LC RX-4803SA/LC	RX8804CE RA8804CE	RX8111CE RX4111CE
Size		10.1×7.4×3.3mm (SA)	7.0×6.0×2.4mm (SJ)	3.2x2.5x1.0mm(CE)	10.1×7.4×3.3mm (SA) 3.6x2.8x1.2mm(LC)	3.2x2.5x1.0mm(CE)	10.1×7.4×3.3mm (SA) 3.6x2.8x1.2mm(LC)	3.2x2.5x1.0mm(CE)	3.2x2.5x1.0mm(CE)
Crystal		Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in	Built-in
Interface		I2C/SPI	I2C	I2C	I2C/SPI	I2C	I2C/SPI	I2C	I2C
Frequency tolerance		5±23ppm / +25℃	5±23ppm / +25℃	5±23ppm / +25℃	5±5ppm./+25℃ 5±23ppm / +25℃	UA:±3.4ppm/-40~85℃ UB:±5ppm/-40~85℃	UA:±3.4ppm/-40~85℃ UB:±5ppm/-40~85℃	±1.9ppm/0~50℃ ±3.4ppm/-40~85℃ ±8ppm/-40~105℃	5±11.5ppm / +25℃
Power voltage		1.6~5.5V	1.6~5.5V	1.6~5.5V	2.4~5.5V	1.6~5.5V	1.6~5.5V	1.6~5.5V	1.6~5.5V
Clock voltage		1.1~5.5V	1.1~5.5V	1.1~5.5V	1.0~5.5V	1.6~5.5V	1.6~5.5V	1.5~5.5V	1.1~5.5V
Current consumption	Typ.	130nA / 3V	160nA / 3V	300nA / 3V	350nA / 3V	700nA / 3V	750nA / 3V	350nA / 3V	100nA
	Max.	250nA / 3V	320nA / 3V	500nA / 3V	1200nA / 3V	1400nA / 3V	2100nA / 3V	1500nA	450nA
Clock, calendar		■	■	■	■	■	■	■	■
Alarm		■	■	■	■	■	■	■	■
Timer		■	■	■	■	■	■	■	■
Frequency output		■	■	■	■	■ Temp. Compensated	■ Temp. Compensated	■ Temp. Compensated	■
Digital offset function		■	-	■	■	-	-	-	-
Event Detection		-	-	-	2 EVIN	-	-	1 EVIN	1 EVIN
Reset-Controller		-	-	■	■	-	-	-	-
DTCXO		-	-	-	-	■	■	■	-
Battery power switching		■	-	■	■	■	-	-	■
User RAM		SRAM 128bit	SRAM 128bit	SRAM 32bit	-	-	-		512bit (dependent on used functions)
Remarks		-	-	Charge function for lithium secondary battery. Reset function with delay.	Event detection and Timestamp function	Temp sensor output function	1/100s time register.	Wide operating temp. range Event detection and Timestamp function High accuracy time reading function	Ultra low power with power switch function. Event detection and Timestamping function

RTC Promotion Products – Spec. Comparision

EPSON
EXCEED YOUR VISION

Interface	Product name	Status	Specifications & conditions									Functions					
			Size [mm]	Operating temperature Ta [°C]		Frequency tolerance [x 10^{-6}]				Backup current consumption [µA]		Time stamp	Power switch	Event pin	Memory	Timer	Others
				Min.	Max.	+25 °C	-40 to +85 °C	-40 to +105 °C	-40 to +125 °C	Typ. (3.0 V)	Max. (Ta)						
SPI 4 wire & I^2C	RX6110SA	MP	10.1 x 7.4	-40	+85	5±23	-	-	-	**0.13**	0.25	-	✓	-	SRAM 128 bit	16 bit x 1 ch. to 7.5 years	-
I^2C	**RX8111CE**	**sampling MP Q2 2020**	3.2 x 2.5	**-40**	**+85**	**±11.5 ±23**	**-**	**-**	**-**	**0.1**	**0.45**	**8**	**✓**	**1**	**SRAM 512 bit**	**24 bit x 1 ch. to 32 years**	-
	RX8804CE	MP		-40	+105	-	**±3.4 ±5.0**	**±8.0**	-	**0.35**	1.5	1	-	1	-	16 bit x 1 ch. to 7.5 years	SOUT
	RX8130CE	MP		-40	+85	5±23	-	-	-	0.3	0.5	-	✓	-	-	**16 bit x 1 ch. to 7.5 year**	**Li-Battery charge control, Reset with a delay**
	RX8900CE	MP		-40	+85	-	**±3.4 ±5.0**	-	-	0.7	1.4	-	✓	-	-	12 bit x 1 ch. to 2.8 days	**Temp. sensor**
SPI 4 wire	**RX4111CE**	**sampling MP Q2 2020**	**3.2 x 2.5**	**-40**	**+85**	**±11.5 ±23**	**-**	**-**	**-**	**0.1**	**0.45**	**8**	**✓**	**-**	**SRAM 512 bit**	**24 bit x 1 ch. to 32 years**	-
For Automotive																	
I^2C	RA8804CE (AEC-Q100)	MP	3.2 x 2.5	-40	+105	-	±3.4 ±5.0	±8.0	-	0.35	1.5	1	-	1	-	16 bit x 1 ch. to 7.5 years	SOUT
	RA8900CE (AEC-Q200)	MP		-40	+85	-	±3.4 ±5.0	-	-	0.7	1.4	-	✓	-	-	12 bit x 1 ch. to 2.8 days	Temp. sensor
SPI 4 wire	RA4803SA (AEC-Q200)	MP	10.1 x 7.4	-40	+85	-	±3.4 ±5.0	-	-	0.75	2.1	-	-	1	-	12 bit x 1 ch. to 2.8 days	-
	RA-4565SA (AEC-Q200)	MP		-40	+125	5±23	-	-	-	0.5	1.0	-	-	-	-	8 bit x 1 ch. to 4.25 hours	-

kHz TCXO & SPXO Road Map

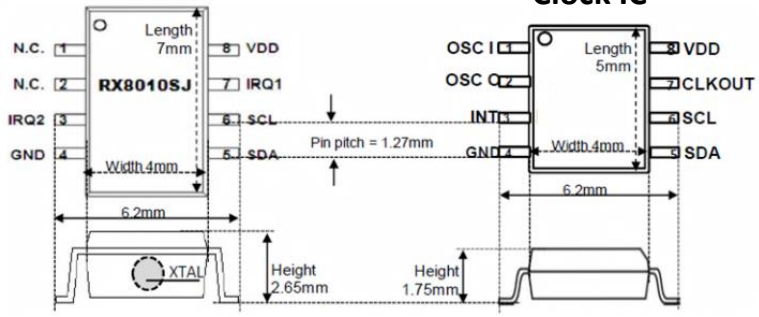
EPSON
EXCEED YOUR VISION

32 kHz DTCXO	**TG-3530SA** 10.1x5.0 ±5ppm -40 85 °C	**TG-3541CE** 3.2x2.5 ±5 ppm -40 +85 °C ±8 ppm +85 +105 °C **TG-3541CEA** 3.2x2.5 ±5 ppm -40 +85 °C ±8 ppm +85 +105 °C For Automotive
32 kHz SPXO	**SG-3030CM** 3.2x1.5 5 ±23 ppm @ 25°C -40 +85 °C	**SG-3031CM** 3.2x1.5 5±23 ppm @ 25 °C -40 +105 °C **SG-3031CMA** 3.2x1.5 5±23 ppm @ 25 °C -40 +105 °C For Automotive

SOP 8 packaged RX8010SJ

EPSON
EXCEED YOUR VISION

Dimensions



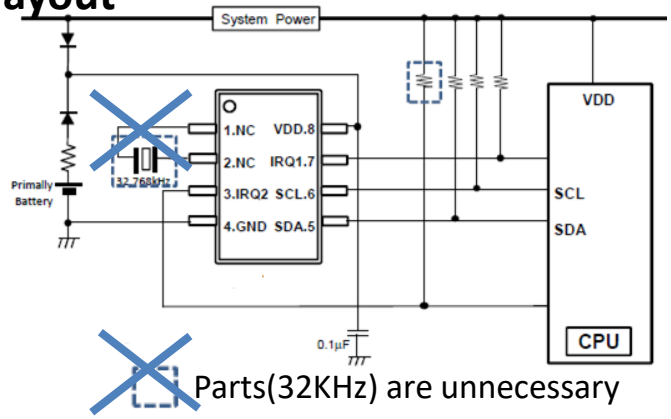
Real Time Clock IC

Replace RTC Ics like

Maxim DS1337S8+2
NXP PCF8563T/4F,118
Pericom PT7C4337A

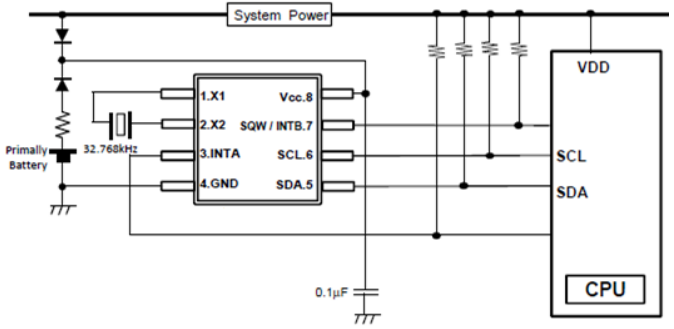
Simple layout
Pre-adjusted for clock accuracy
Pre-optimized design of oscillation
High reliability

Circuit layout



Parts(32KHz) are unnecessary

Real Time Clock IC + 32kHz crystal



RX-x803SA / LC Overview

Real time clock module with DTCXO

RX-x803SA / LC

■Feature

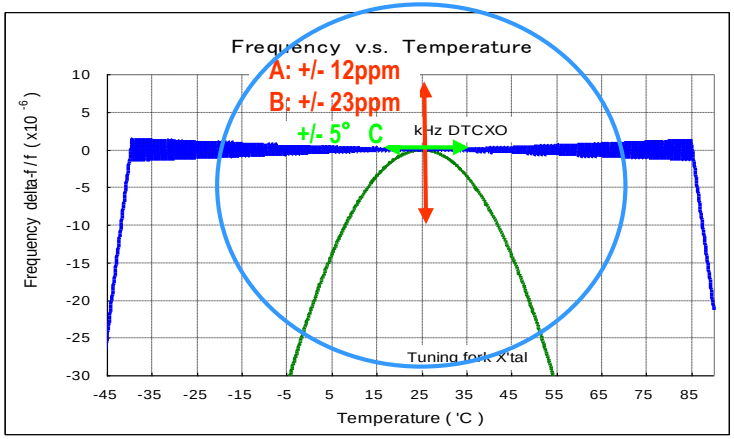
- ✓ Ultra High Stability
- ✓ Low current consumption : Typ. 0.8µA / 3V

■ Overview

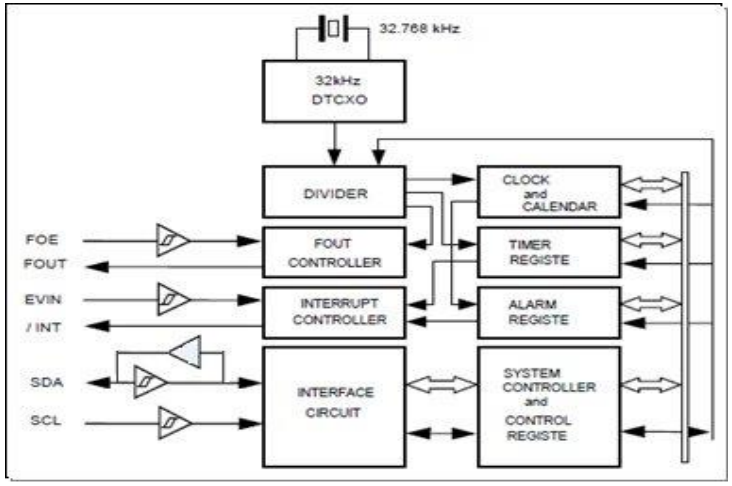
		RX- 4803	RX- 8803
Interface type		4-wire serial	I²C-bus
Stability	UA	±3.4 ×10⁻⁶ / - 40 to +85ºC *1	
	UB	±5.0 ×10⁻⁶ / - 40 to +85ºC *2	
	UC	±5.0 ×10⁻⁶ / -30 to +70ºC *2	
	AA	±5.0 ×10⁻⁶ / +25ºC *2	
Voltage range		1.6 ~ 5.5 V (Back up) 2.2 ~ 5.5 V (Temp. compensated)	
Current consumption		0.8 µA Typ. 2.1 µA Max. (3.0V)	
Package type		SA : 10.1 x 7.4mm t=3.3mm Max. LC : 3.6 x 2.8mm t=1.2mm Max.	

SA-PKG

LC-PKG



■Block diagram



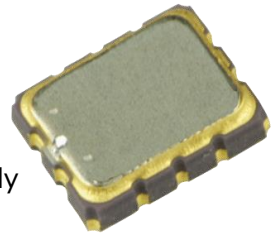
RX8900CE

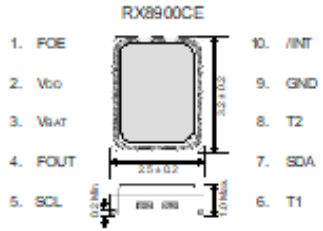
High Stability Tiny Switch

EPSON
EXCEED YOUR VISION

Built-in 32.768 kHz DTCXO, High Stability, Power switching

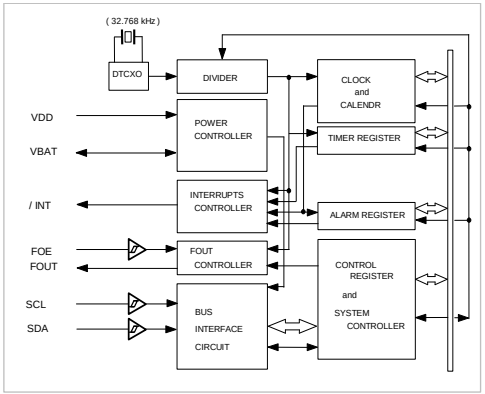
- Built-in frequency adjusted 32.768 kHz crystal unit and **DTCXO**
- Interface Type : I²C-Bus
- Selectable clock output : 32.768 kHz, 1024 Hz, 1 Hz
- Auto power switching function : Automatically switches to backup power supply by monitoring the VDD voltage
- Interrupt output : Wake up every minute or every second
- Alarm interruption : Day, date, hour, minute
- Auto repeat wakeup timer interruption (12 bit x 1ch.)
- Automotive grade available (RA8900CE)





Item		Symbol	Specs	
Operating Conditions	Operating supply voltage	V_{DD}	2.5 V to 5.5 V	
	V_{DD} detect voltage	V_{DET3}	2.3 V to 2.5 V	
	Operating temperature	T_a	-40 ° C to +85 ° C	
Characteristics	Stability	Δf/f	UA	±3.4 x 10^{-6} (−40 ° C to 85 ° C) *equiv. to ±9 s of mo. deviation
			UB	±5 x 10^{-6} (−40 ° C to 85 ° C) *equiv. to ±13 s of mo. deviation
	Current consumption	I_{DD2}	700 nA / Typ. 3 V 1,400 nA / Max. 3 V (Temp. Compensation interval: 2.0 s)	

■ Block diagram

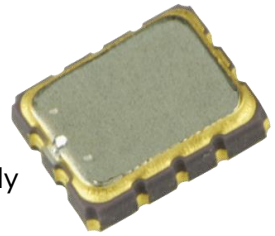


RX8130CE

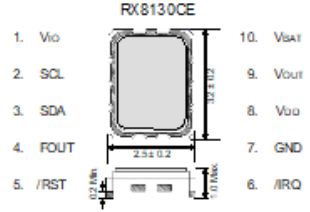
Tiny Switch Other Functions

EPSON EXCEED YOUR VISION

Built-in backup battery charge control function

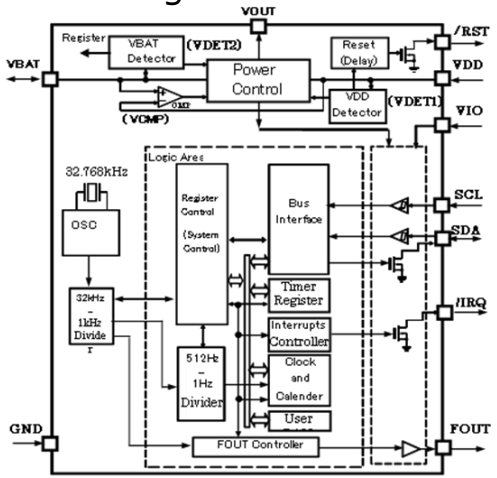


- Built in frequency adjusted 32.768 kHz crystal unit
- Interface Type : I^2C-Bus
- Low backup current : 300 nA Typ. / 3 V
- Auto power switching function : Automatically switches to backup power supply by monitoring the V_{DD} voltage
- **Backup battery charge control function : For the rechargeable battery**
- **Reset functions with a delay : Detect a main power supply and remove the reset**
- Interrupt output : Wake up every minute or every second
- Alarm interruption : Day, date, hour, minute, second
- Auto repeat wakeup timer interruption (16 bit x 1 ch.)
- Self-monitoring interruption : Crystal oscillation stop, V_{BAT} low, V_{DD} low



Item		Symbol	Specs
Operating Conditions	Operating supply voltage	V_{DD}	1.25 V to 5.5 V
	Operating temperature	T_a	-40 ° C to +85 ° C
	V_{DD} detect voltage	$-V_{DET2}$	1.2 V to 1.4 V (V_{DD}, Fall)
Characteristics	Frequency tolerance	$\Delta f/f$	B: +5±23 x 10^{-6} / +25 ° C
	Oscillation start-up time	t_{STA}	1 s Max. (V_{DD} = 2.75 V to 5.5 V)
	Current consumption	I_{BAT}	300 nA / Typ. 3 V 500 nA / Max. 3 V (T_a = -40 ° C to +85 ° C)

■ Block diagram



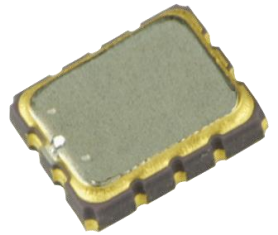
RX8804CE

High Stability · Tiny · Wider Temp. · Time Stamp

EPSON
EXCEED YOUR VISION

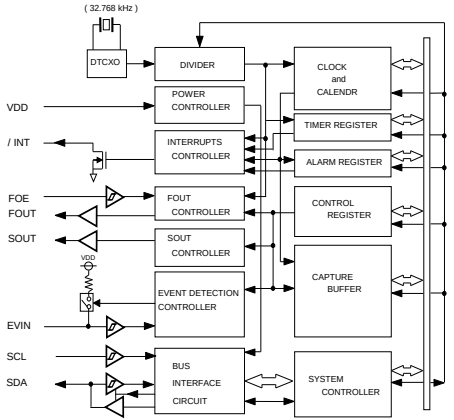
Built-in 32.768 kHz DTCXO, High Stability, up to +105 ° C

- Built-in frequency adjusted 32.768 kHz crystal unit and **DTCXO**
- Interface Type : I^2C-Bus
- Selectable clock output : 32.768 kHz, 1024 Hz, 1 Hz
- Time stamp function : **1 time stamped** from year to second
- Interrupt output : Wake up every minute or every second
- Alarm interruption : Day, date, hour, minute
- Auto repeat wakeup timer interruption (24 bit x 1 ch.)
- Self-monitoring interruption : Crystal oscillation stop, V_{BAT} low, V_{DD} low
- SOUT pin outputs that selected flag bit value (H or L)
- Automotive grade available (RA8804CE)



Item		Symbol	Specs	
Operating Conditions	Operating supply voltage	V_{DD}	1.6 V to 5.5 V	
	Operating temperature	T_a	-40 ° C to **+105 ° C**	
Characteristics	Stability	Δf/f	XA	±3.4 x 10^{-6} (−40 ° C to 85 ° C) *equiv. to ±9 s of mo. deviation ±8 x 10^{-6} (−40 ° C to 105 ° C)
			XB	±5 x 10^{-6} (−40 ° C to 85 ° C) *equiv. to ±13 s of mo. deviation ±8 x 10^{-6} (−40 ° C to 105 ° C)
	Current consumption	I_{DD2}	350 nA / Typ. 3 V 1,500 nA / Max. 3 V (Temp. Compensation interval: 2.0 s)	

■ Block diagram



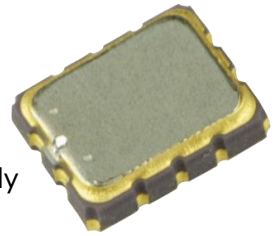
RX8111CE

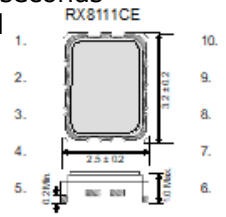
Low Power · Tiny · Switch · Time Stamp

EPSON
EXCEED YOUR VISION

Time stamp function and Low current consumption

- Built in frequency adjusted 32.768 kHz crystal unit
- Interface Type : I²C-Bus
- Low backup current : **100 nA Typ.** / 3 V
- Auto power switching function : Automatically switches to backup power supply by monitoring the V_{DD} voltage
- Time stamp function : **8 times stamped** from year to 1/256 seconds
- Interrupt output : Wake up every minute or every second
- Alarm interruption : Day, date, hour, minute, second
- Auto repeat wakeup timer interruption (24 bit x 1 ch.)
- Self-monitoring interruption : Crystal oscillation stop, V_{BAT} low, V_{DD} low

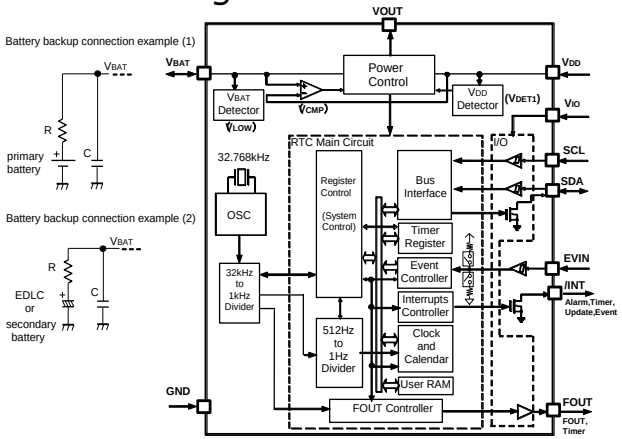




Pin	Connection
1	VDD
2	VOUT
3	VBAT
4	FOUT
5	SCL
6	EVIN
7	SDA
8	VIO
9	GND
10	/INT

Item		Symbol		Specs
Operating Conditions	Operating supply voltage	V_{DD}		1.6 V to 5.5 V
	Operating temperature	T_a		-40 ° C to +85 ° C
	V_{DD} detect voltage	$-V_{DET1}$		1.2 V to 1.6 V (V_{DD}, Fall)
Characteristics	Frequency tolerance	$\Delta f/f$	A	$\pm 11.5 \times 10^{-6}$ (+25 ° C)
			B	$\pm 23 \times 10^{-6}$ (+25 ° C)
	Oscillation start-up time	t_{STA}		0.3 s Typ. / 1 s Max. (V_{DD} = 2.75 V to 5.5 V)
	Current consumption	I_{BAT}		100 nA / Typ. 3 V 450 nA / Max. 3 V (T_a = -40 ° C to +85 ° C)

■ Block diagram

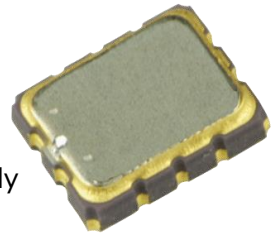


RX4111CE

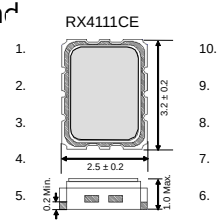
Low Power | Tiny | Switch | Time Stamp | SPI

EPSON EXCEED YOUR VISION

SPI, Time stamp function and Low current consumption



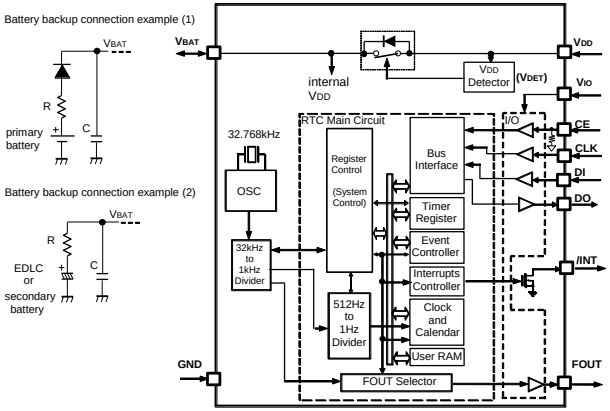
- Built in frequency adjusted 32.768 kHz crystal unit
- Interface Type : SPI-Bus (4 wire, 1 MHz)
- Low backup current : **100 nA Typ.** / 3 V
- Auto power switching function : Automatically switches to backup power supply by monitoring the V_{DD} voltage
- Time stamp function : **8 times stamped** from year to 1/256 seconds
- Interrupt output : Wake up every minute or every second
- Alarm interruption : Day, date, hour, minute, second
- Auto repeat wakeup timer interruption (24 bit x 1 ch.)
- Self-monitoring interruption : Crystal oscillation stop, V_{BAT} low, V_{DD} low



Pin	Connection
1	VDD
2	VBAT
3	DI
4	FOUT
5	CLK
6	DO
7	CE
8	VIO
9	GND
10	/INT

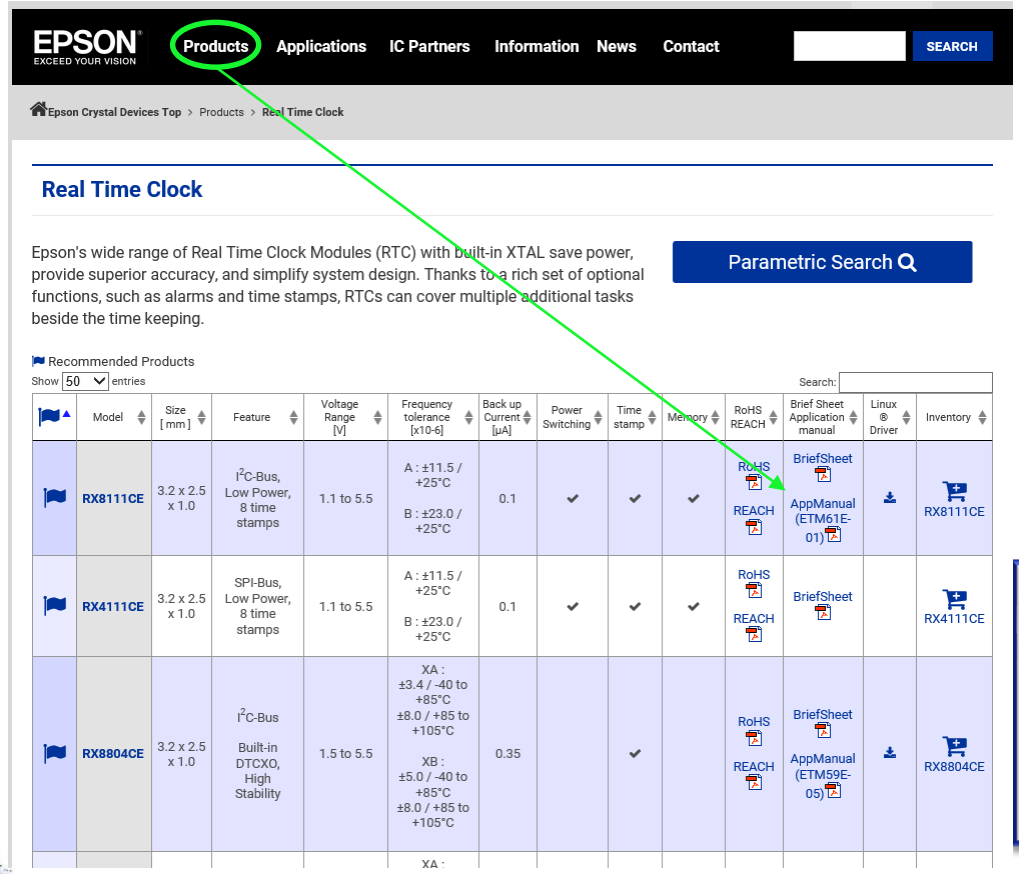
Item		Symbol		Specs
Operating Conditions	Operating supply voltage	V_{DD}		1.6 V to 5.5 V
	Operating temperature	T_a		-40 ° C to +85 ° C
	V_{DD} detect voltage	$-V_{DET1}$		1.2 V to 1.6 V (V_{DD}, Fall)
Characteristics	Frequency tolerance	$\Delta f/f$	A	$\pm 11.5 \times 10^{-6}$ (+25 ° C)
			B	$\pm 23 \times 10^{-6}$ (+25 ° C)
	Oscillation start-up time	t_{STA}		0.3 s Typ. / 1 s Max. (V_{DD} = 2.75 V to 5.5 V)
	Current consumption	I_{BAT}		100 nA / Typ. 3 V 450 nA / Max. 3 V (T_a = -40 ° C to +85 ° C)

■Block diagram



RTC Drivers, Documentation and Support Tools

https://www5.epsondevice.com/en/

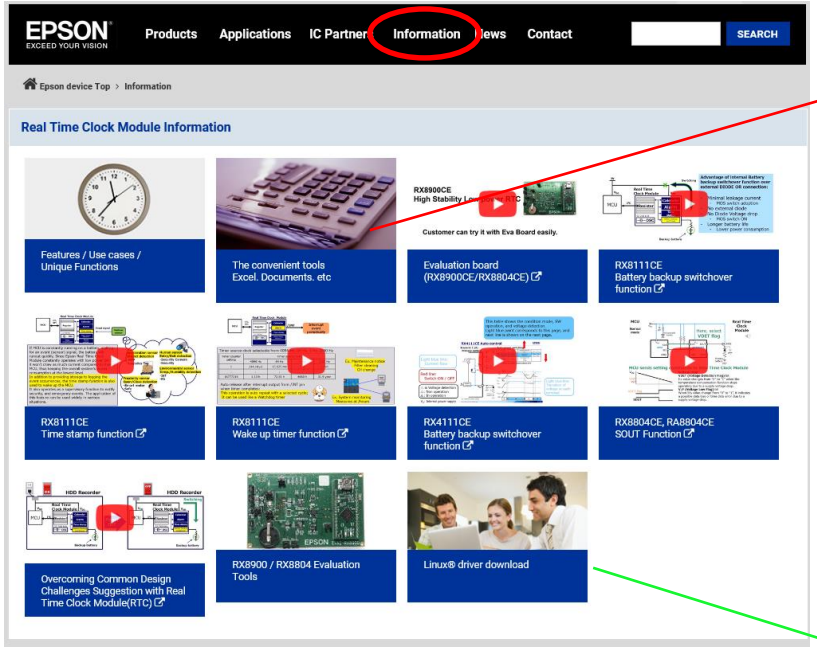


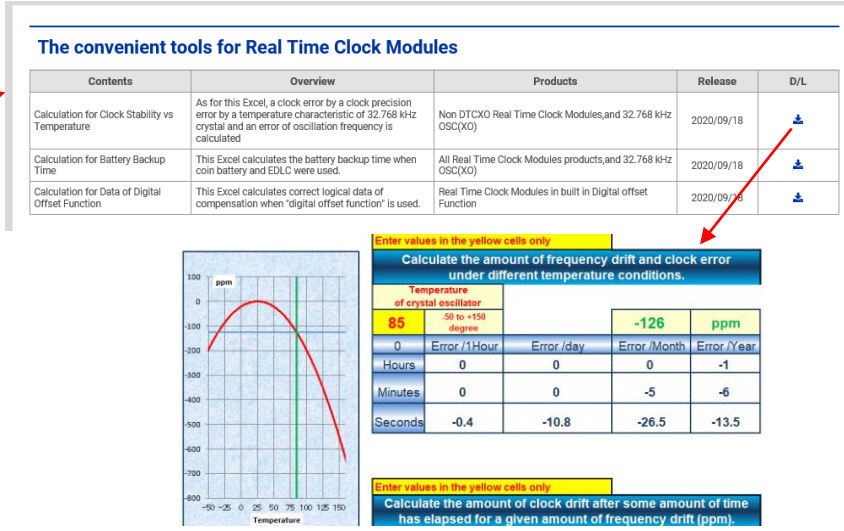
Application Manuals

- **Detailed Information**
- **Link to Application Manuals:** http://www5.epsondevice.com/en/quartz/product/rtc

RTC Drivers, Documentation and Support Tools

https://www5.epsondevice.com/en/





The convenient tools for Real Time Clock Modules

Contents	Overview	Products	Release	D/L
Calculation for Clock Stability vs Temperature	As for this Excel, a clock error by a clock precision error by a temperature characteristic of 32.768 kHz crystal and an error of oscillation frequency is calculated	Non DTCXO Real Time Clock Modules,and 32.768 kHz OSC(XO)	2020/09/18	
Calculation for Battery Backup Time	This Excel calculates the battery backup time when coin battery and EDLC were used.	All Real Time Clock Modules products,and 32.768 kHz OSC(XO)	2020/09/18	
Calculation for Data of Digital Offset Function	This Excel calculates correct logical data of compensation when "digital offset function" is used.	Real Time Clock Modules in built in Digital offset Function	2020/09/18	

Enter values in the yellow cells only

Calculate the amount of frequency drift and clock error under different temperature conditions.

Temperature of crystal oscillator: 85 (-50 to +150 degree)

-126 ppm

0	Error /1Hour	Error /day	Error /Month	Error /Year
Hours	0	0	0	-1
Minutes	0	0	-5	-6
Seconds	-0.4	-10.8	-26.5	-13.5

Enter values in the yellow cells only

Calculate the amount of clock drift after some amount of time has elapsed for a given amount of frequency drift (ppm).

Linux Drivers

- **Simplify Design IN**
- **Link to Drivers:** http://www5.epsondevice.com/en/quartz/tech/linux_for_rtc/index.html

EPSON
EXCEED YOUR VISION

EPSON
EXCEED YOUR VISION

Epson Europe Electronics GmbH
www.epson-electronics.de

Epson Europe Electronics GmbH