

How to use Epson's RTC module

Supports low power consumption and CPU functions

MD Sales Department
Seiko Epson Corporation

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- (1) When using a wake-up timer function to reduce total system power consumption.
- (2) When maintaining timestamps of specific events while the system is stopped.
- (3) When designing battery-free applications or reducing battery size with energy-efficient backup power supply solutions.
- (4) When requiring highly accurate time data even during network outages for a long period of time.
- (5) When CPU or MCU requires additional GPIO pins.

Technical issues anticipated in product development

Need to reduce power consumption to improve product specs.



Benefits of using an Epson RTC module

Set the CPU in Deep Sleep for most of the time and use the RTC's wake-up timer to wake the CPU at regular time intervals.

Decrease overall system power consumption by optimizing the Sleep time and limiting the cumulative operating time of the CPU.

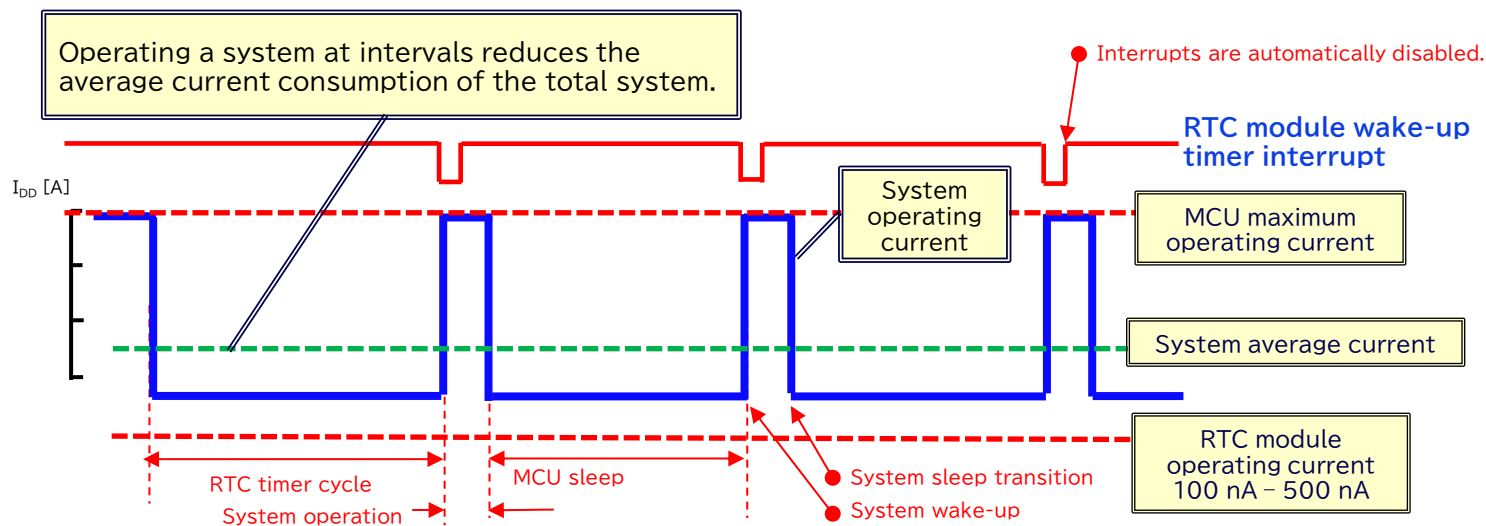
Usage situations

- Use when acquiring sensor output values at regular intervals
- Use when making regular self-checks at night or on weekends, etc.



Key points

- Epson's RTC modules have a variety of interrupt output functions.
- Total system power consumption is reduced by using the wake-up timer interrupt function to intermittently operate the CPU.
- Wakeup timer interrupts can be set to auto-repeat, and interrupt output is automatically released at fixed periods of time.



Technical issues anticipated in product development

Product specifications require that a timestamp be recorded for an emergency event or unexpected power interruption even while the system is down.



Benefits of using an Epson RTC module

Epson's RTC modules are capable of the following operations even in low-power backup mode:

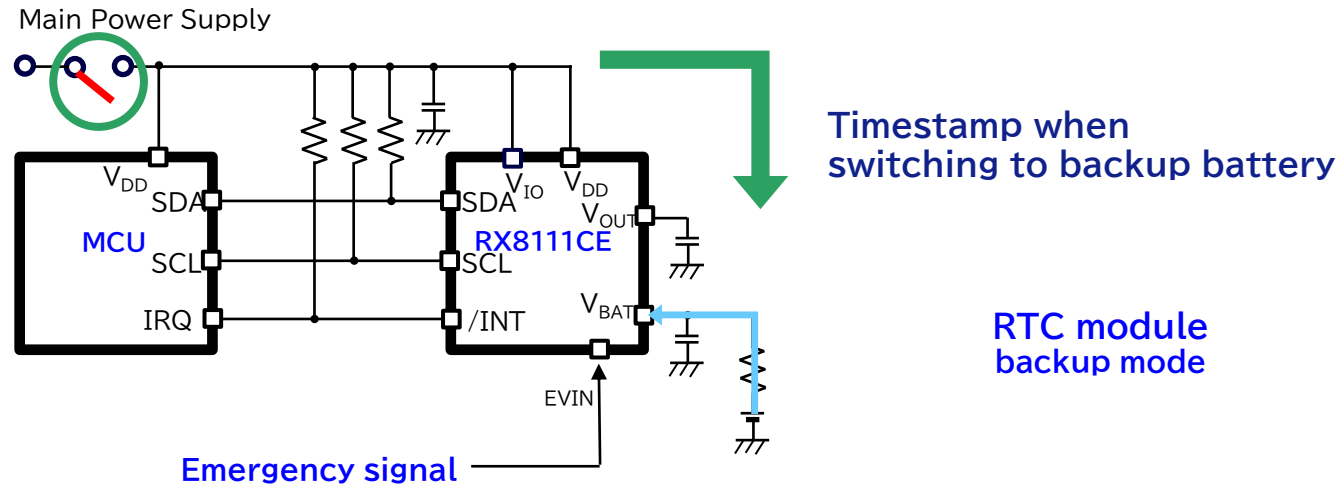
- Output timer interrupts at fixed periods with auto-repeat
- Record timestamps and output interrupts when switching the power supply from main power to backup battery
- Input event signals, record input detection timestamps, and output input detection interrupts
- These Interrupts reboot or set the MCU to sleep

When maintaining timestamps of specific events while the system is stopped



Key points

- Can record (timestamp) the date and time of a main power interruption and switch to backup mode and can output interrupts.
- Improves system anti-tampering performance by recording timestamps of unintended losses of main power and improves system redundancy performance by outputting emergency interrupts, etc.
- The event input function can be used to perform the same function when a designated sensor signal is detected.



Technical issues anticipated in product development

You are requested to downsize a system clock backup battery to reduce product size and cost.

In addition, you would like to use capacitors instead of batteries in order to meet national environmental regulations, but designing a new power supply peripheral circuit is a daunting task.



Benefits of using an Epson RTC module

Epson's RTC modules are the right solutions, featuring low-leakage, high-accuracy power supply switching circuitry, to replace primary or rechargeable backup batteries with capacitor devices such as EDLCs. Provide product design solutions that comply with environmental regulations in different countries.

- Automatically switch between charge mode and backup mode by accurately monitoring the power supply voltages. Some models can stop charging when a fully charged state is reached.
- In addition to automatic switching mode, control registers are provided that can be programmed to switch as needed depending on the design of the customer's power supply.



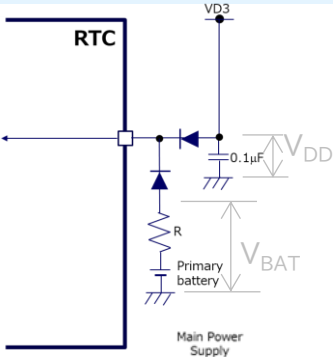
When designing battery-free applications or reducing battery size with energy-efficient backup power supply solutions



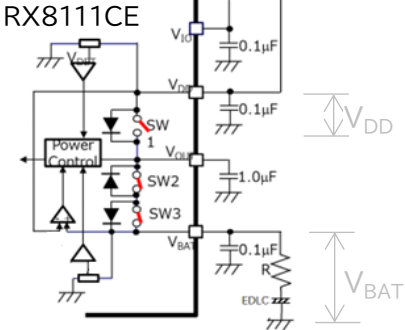
Key points

In a typical diode OR connection, the high-voltage power supply is always selected, so the battery is drained from the moment the main power supply drops below the battery voltage.
An RTC module switches to battery power only after the main power supply is sufficiently low, so the battery is not drained unnecessarily.
A power supply switching circuit can be designed with a MOS-SW installed in parallel with the diode to cancel the VF of the diode.

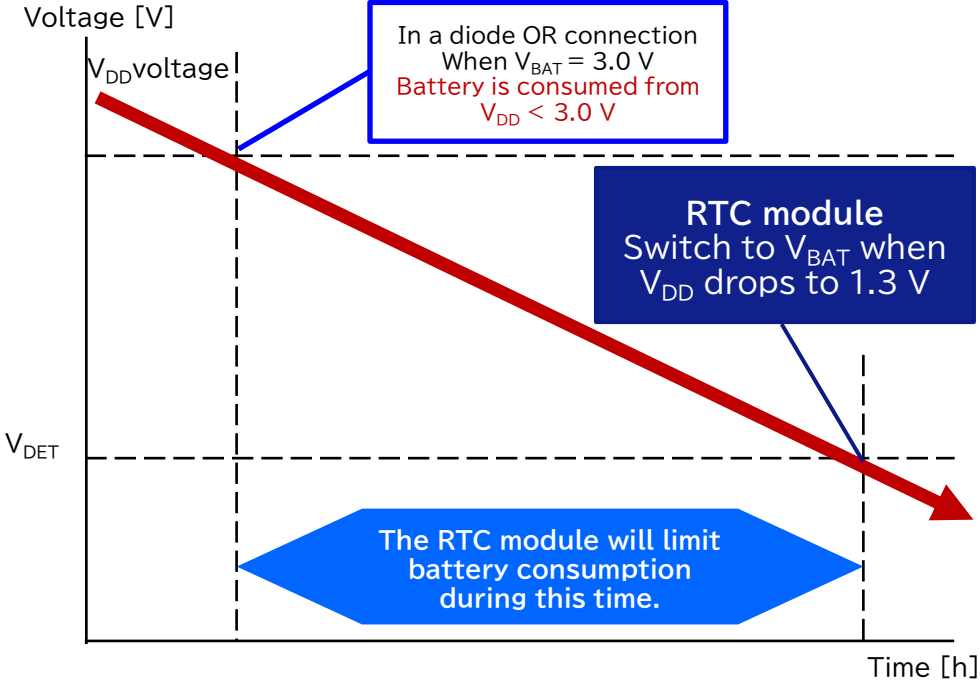
Diode OR connection



RTC module



Parallel MOS switches cancel diode VF



Technical issues anticipated in product development

System date and time are calibrated by periodically obtaining clock data from GNSS, but operating at the specified time accuracy during prolonged network downtime can be problematic.



Benefits of using an Epson RTC module

Epson's RTC modules incorporate an in-house crystal unit designed to match the IC and provide stable oscillation over a wide voltage and temperature range.

Epson RTC module equipped with a DTCXO (digital temperature compensated crystal oscillator) has temperature characteristic compensation values written in ROM at the factory to guarantee clock accuracy over the entire temperature range.

An RTC module equipped with a DTCXO was installed in the dashboard of a car and the clock accuracy was evaluated for about two and a half years. The module was found to be accurate to an average of +1.6 seconds per month*.

Sufficient clock accuracy is provided for a system date/time master in emergencies such as when a network is down.

* For the detailed results of this long-term clock accuracy evaluation, please see our technical data. See "[kHz-band DTCXO timekeeping accuracy in a temperature changing environment.](#)"

When requiring highly accurate time data even during network outages for a long period of time

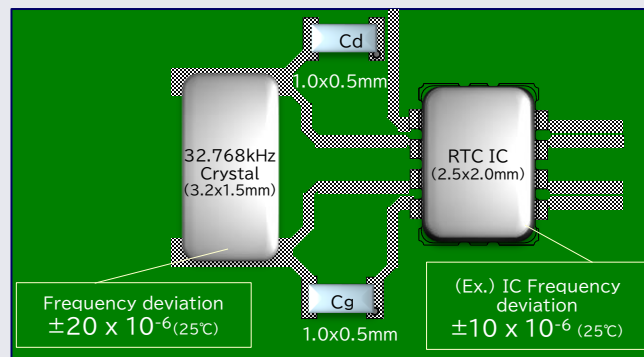


Key points

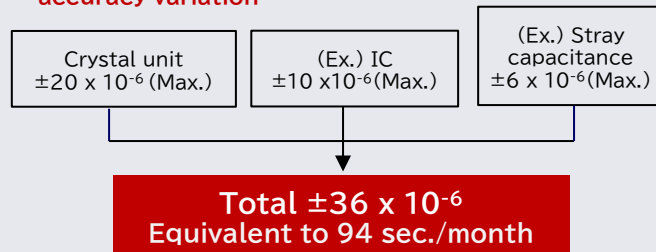
Frequency accuracy has been adjusted, eliminating the need for circuit evaluation matching, reducing the number of components, and enabling higher accuracy.

【 Comparison by Composition 】

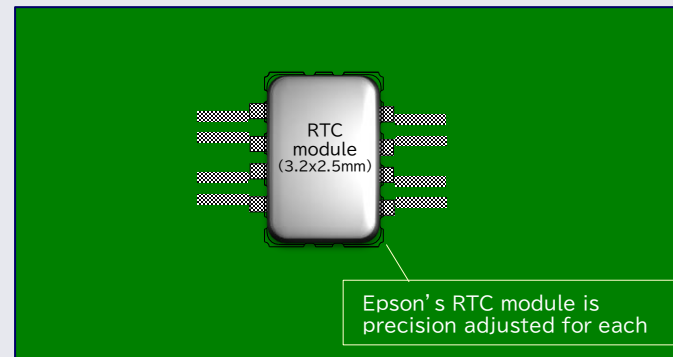
Crystal chip + RTC-IC



- Many factors contribute to frequency (clock) accuracy variation



RTC module equipped with a DTCXO



- Frequency (clock) accuracy adjusted
- No need to select & evaluate component or to evaluate circuits(matching)

Modules equipped with a DTCXO

(UA accuracy specs.)
 $\pm 3 \times 10^{-6}$ Max / -40°C to 85°C

Avg. monthly difference 1.6 sec.

Room temperature spec.
product (B accuracy spec.)
 $\pm 23 \times 10^{-6}$ Max / 25°C

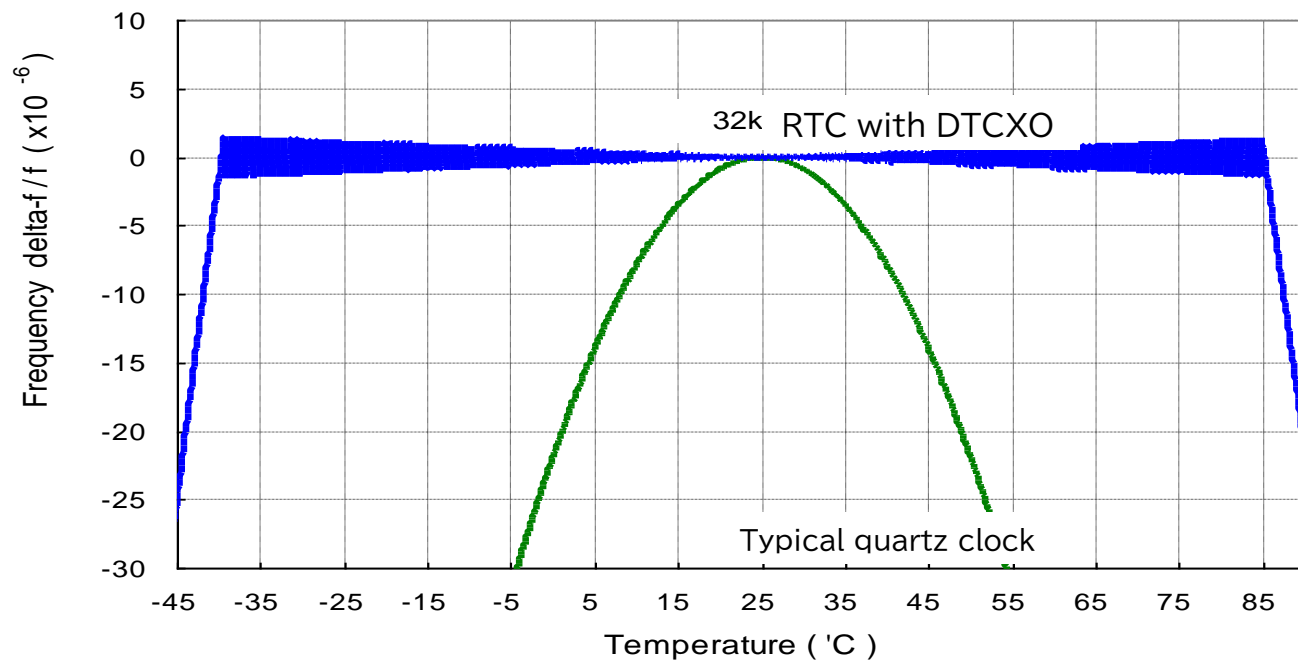
Equivalent to 60 sec./month, max.

When requiring highly accurate time data even during network outages for a long period of time

Green : Temperature characteristic of a typical quartz crystal clock

Blue : Temperature characteristic of an RTC module with DTCXO

The accuracy of a typical quartz clock varies significantly with temperature.



When CPU or MCU requires additional GPIO pins

Technical issues anticipated in product development

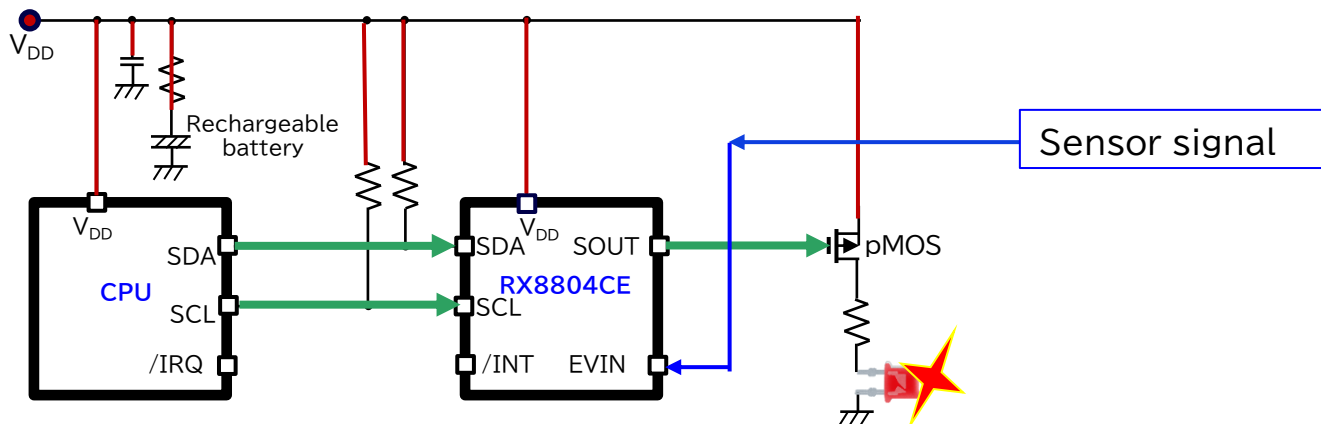
It may appear that GPIOs on the CPU will run out due to changes in product specifications or the addition of more functions.



Benefits of using an Epson RTC module

The SOUT pin of the Epson RTC module can have a HIGH/LOW output, controlled by the CPU via I2C.

There is also an RTC module that can monitor the HIGH/LOW level of the EVIN input pin via I2C.



Reference materials

- RTC module related information

<https://www.epsondevice.com/crystal/en/products/rtc/>

- Video contents

<https://www.epsondevice.com/crystal/en/techinfo/video/#rtc>

- Products list

<https://www.epsondevice.com/crystal/en/products/rtc/#productIndex>

Recommended products

Item	RX8901CE	RX4901CE	RA8000CE	RA4000CE	RX8804CE	RX8900CE	RX8111CE	RX4111CE	RX8130CE
With DTCXO	○	○	○	○	○	○	-	-	-
Interface	I ² C	SPI	I ² C	SPI	I ² C	I ² C	I ² C	SPI	I ² C
Maximum operating temperature	+105 °C	+105 °C	+125 °C	+125 °C	+105 °C	+85 °C	105 °C	105 °C	+85 °C
Backup current consumption Typ. /3 V	240 nA	240 nA	300 nA	300 nA	350 nA	700 nA	100 nA	100 nA	300 nA
Timestumps	○ 32 times	○ 32 times	○ 2 times	○ 2 times	○ 1 time	-	○ 8 times	○ 8 times	-
Event input terminal	○ 2 or 3 pin	○ 0 or 1 or 2 pin	○ 1 or 2 pin	○ 1 or 2 pin	○ 1 pin	-	○ 1 pin	-	-
Power switching	○	○	-	-	-	○	○	○	○
Reset output	-	-	○	○	-	-	-	-	○
Automotive	-	-	○	○	○ *RA8804CE	○ *RA8900CE	-	-	-

Learn more about Epson's RTCs...

If you're interested in use cases by function or application-specific examples, we have prepared some materials for you.

Epson's RTC modules provide solutions for three major issues

Epson's RTC module helps to solve issues below.

Technical challenge	Provided function	Overview
Extra time and procedures are required to reset the time information when the system is rebooting.	Power Self-m	The FA equipment with a backup battery will
Event detection and recording are required even when the system is stopped.	Time s	
Incorrect time caused by heat generated from FA equipment.	Built-i	

Power switching function

What is Power switching function

RTC module detects a voltage drop in the main power supply and automatically switches to a backup power supply and continue to provide accurate time.

Technical challenges

Even during a long power or ne accurate time and ensure the c immediately upon restart. To utilize the smallest capacity efficient power supply switchin

Propose Epson's RTC module as solution

Epson's RTC modules, equippe an automatic power switching f accuracy, enabling the design

2-2. Temperature compensation Use case : Infortainment

Issues

Vehicle clocks gradually lose time.

Configuration example : MCU with a built-in RTC + 32 kHz xtal

Tuning Fork crystal frequency-temperature coefficient

The 32-kHz crystal unit has a quadratic frequency-temperature characteristic. Temperature fluctuations inside vehicles are large, resulting in frequency fluctuations and clock deviations.

Accuracy : Frequency deviation at room temperature + Frequency-temperature coefficient (Quadratic curve)

Ex.) Operated continuously for one month

Environment	Monthly rate
+40°C	Equivalent to 1 min. 50 sec. / month
-10°C	Equivalent to 1 min. 50 sec. / month
-40°C	Equivalent to 8 min. / month

You can download all of these materials by requesting them.

Document Request >

•Functions and Use Case examples

This document introduces applications that can leverage RTC functionality, along with use cases addressing related challenges and solutions.

•Solving Time Data Issue in FA Equipment

Regarding the time data in FA devices: (1) It is difficult to determine whether the time needs resetting upon device startup. (2) Error signal detection and logging are required even when the system is stopped. (3) The time may deviate due to device heat generation. This material explains how to use the RTC module to address these three issues.

•Solving Technical Issues in Security Cameras

For security cameras, accurate date and time data must be maintained even in the event of a long power outage or network outage, and the occurrence history of high-priority event signals must be maintained even when power is lost. This material explains how to use RTC modules to solve the following three problems: (1) when installed outdoors, (2) the temperature changes rapidly, and (3) time accuracy cannot be maintained.

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