Benefits of RTC Module in an Automotive Battery Management System

【Abstract】

The automotive industry is currently going through a period of great change, and the keyword is "CASE". CASE is an acronym that stands for Connectivity, Autonomous, Shared, and Electric. It indicates the direction of the car maker's strategy in an increasingly digital world. The market of electric vehicles is growing fast and expected help to reduce CO2 emissions and fight against global warming.

In this article, I will explain the benefits of utilizing a Real Time Clock (RTC) module in the electric vehicle's Battery Management System (BMS).

【Electric vehicles and BMS】

Automotive is shifting from gasoline cars to electric cars worldwide. In order to comply with the Paris Agreement of 2016, which was issued to reduce greenhouse gas emissions after 2020 and to achieve the Sustainable Development Goals, governments around the world are aiming for a "carbon free society" with "ban sales of new gas-powered vehicles". Car makers are also announcing and releasing their policies to shift to electric vehicles. Since, electric vehicles have more electronic parts and fewer mechanical parts that require different know-how than engine cars, many IT companies and consumer electronics manufacturers have announced their entry into the automotive industry. The electric vehicle market is expected to see significant growth over the next decade. (Fig.1)

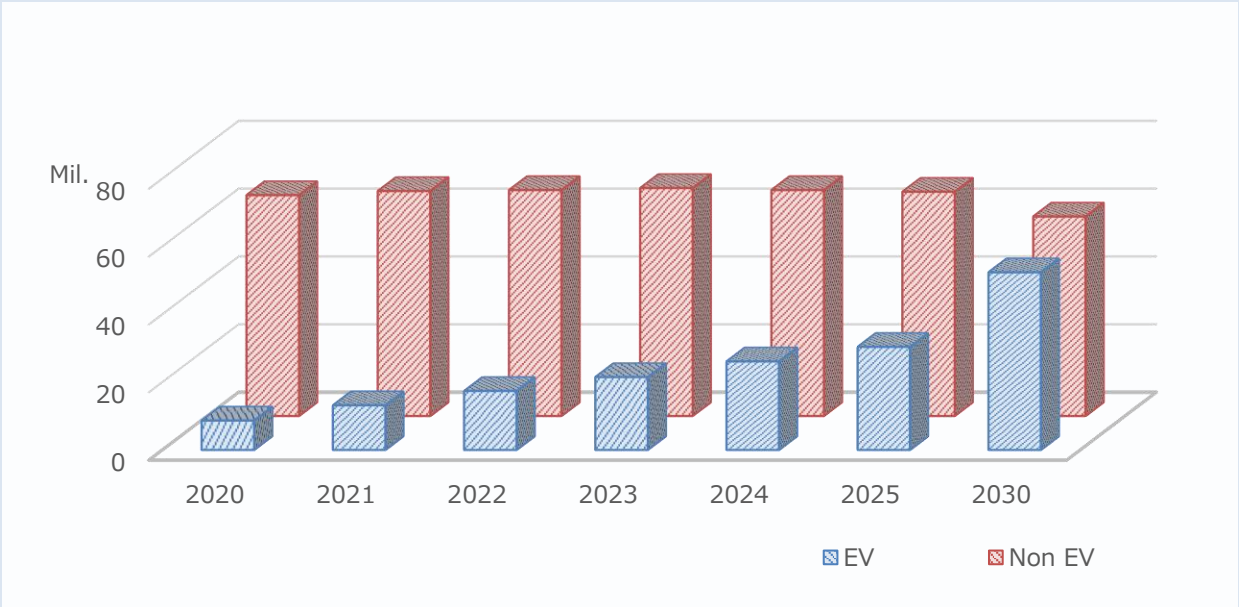

Fig.1 Engine Type Vehicle Market Forecast

Source: Fuji Chimera Research

OUT-21-0323

Lithium-ion batteries have become the mainstream rechargeable batteries used in electric vehicles. While these batteries are highly energy efficient, they are also a fire risk if not properly managed. Therefore, a BMS is required to safety manage the health of the lithium-ion batteries. BMS is a system that monitors and manages the input/output current, voltage, and temperature of lithium-ion batteries. Overcharging or over-discharging the battery, or voltage differences between battery cells, lead to battery failure and reduced life cycle. Even after the engine is turned off, the BMS has to continue to monitor the battery periodically, which is enabled by the RTC function within the BMS.

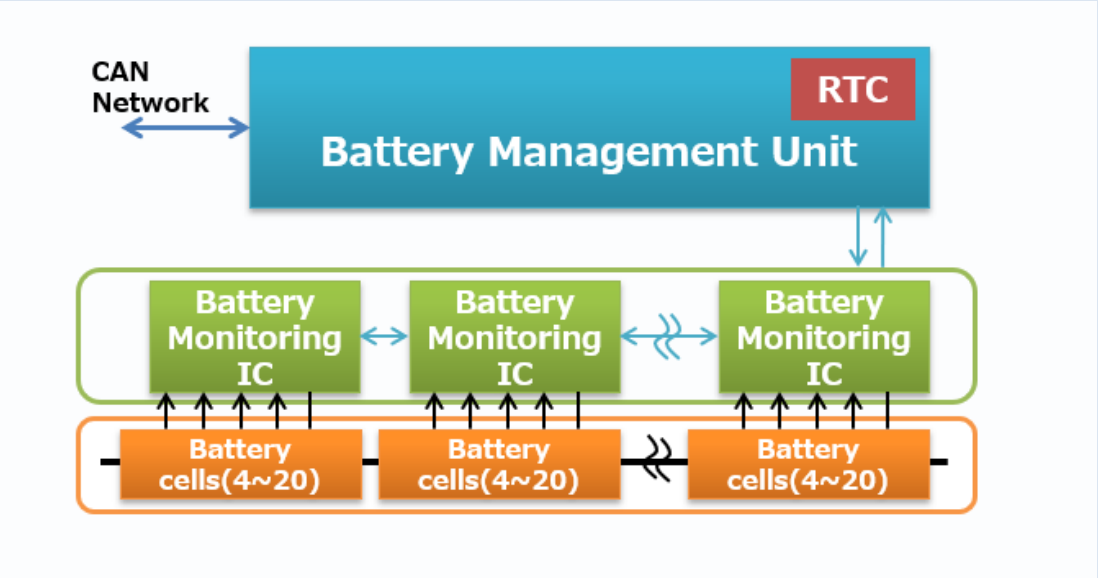

Fig.2 BMS outline drawing

【RTC function configuration】

There are three system configurations to implement the RTC function: (1) using a RTC module (2) using the MCU's built-in RTC function (3) using a RTC IC

Table1　Configuration and function of RTC functions

	Configuration	# of parts	Accuracy	Current consumption	Circuit evaluation*
(1)	(MCU) ＋RTC module	+1	High	Low	Unnecessary
(2)	(MCU's built-in RTC function) ＋Crystal unit ＋External components (capacitors, resistors)	+2	Normal	High	Necessary
(3)	(MCU) ＋RTC IC ＋Crystal unit ＋External components (capacitors, resistors)	+3	Normal	Low	Necessary

※Circuit evaluation : Evaluation that adjusts the oscillation circuit design (oscillator, capacitor, and resistance) in order to optimize the crystal oscillator on each board, also called circuit matching.

The configuration chosen is determined by the specifications required for the application and the customer's design concept.

The RTC module in configuration (1) refers to a product in which a crystal oscillator and RTC IC are combined in one package. The advantages are higher accuracy, lower current consumption, less components to save board space, and ease of design as a circuit evaluation is not required, compared to the other configurations. Epson has an extensive product lineup of RTC modules.

【Advantages of Epson's RTC module】

As mentioned above, BMS is an application that regularly monitors the battery to ensure safety. Therefore, BMS manufacturers require device components to be highly reliable and designed for automotive use with AEC-Q qualification.

By designing, developing, and manufacturing the built-in crystal unit and RTC IC in-house, Epson is able to provide stable supply RTC modules that are highly reliable and traceable. Other advantages of using Epson RTC module are discussed below.

1. High operating temperature

Device components for BMS often require an operating temperature range of -40 °C to +125 °C as the BMS may need to be placed near the battery pack or in the front of the car where the ambient temperature can reach up to 125C. For autonomous driving and ADAS, the amount of image processing and information processing in MCUs has increased, which also drives the car's ambient temperature up. It is more common to observe the operating temperature range for other automotive applications increasing +125°C, as well.

To meet these needs, Epson has a lineup of RTC modules with an operating temperature range of -40°C to +125°C designed specifically for automotive applications.

2. Automotive Quality Support

Automotive semiconductors require tighter environmental and quality conditions than consumer products. In addition, reliability testing is performed at more stringent test conditions for AEC-Q certification. In recent years, the number of components installed in applications has been increasing as electric vehicles become more popular and autonomous driving technology advances. Safety standards for automotive electronic components are set by the Automotive Electronics Council (AEC), a standards development organization. The AEC standard is a reliability test standard for electronic components used in automotive around the world, and the standards are classified according to components such as semiconductors and passive components. Since RTC module is semiconductor, Epson's RTC module are AEC-Q100 compliant and are currently used in variety of automotive applications.

3. Low current consumption

The dark current value (parasitic battery draw) maximum limit requirement for each automotive module has decreased in order to maximize the battery life per charge. If the vehicle draws a higher dark current, the battery will discharge at a faster rate and provide drivers with a shorter driving range

Since the BMS checks the battery status periodically after engine off, the distributed dark current value needs to be a small. Therefore, a low-current-consumption RTC module can be used as a stand-alone timer to reduce the operating time of the MCU and reduce the dark current as a system. Epson RTC module have the following advantages to reduce dark current consumption.

・A combination of a crystal unit designed for low current consumption operation optimized to clock the RTC IC.

・RTC IC designed with Epson low leak process

With these unique technologies, the current consumption during backup mode is only 300nA typ. (Epson automotive RTC module) which contributes to the overall power reduction of the BMS.

Epson utilizes its strengths in in-house crystal and IC design, development, and manufacturing to offer products that contribute to solving customers' problems.

Epson's Automotive RTC modules for BMS application.

Product	**RA8000CE**	**RA4000CE**
Interface	I^2C-Bus	SPI-Bus 3wire / 4wire
Operating temperature	-40 ºC ~ +125 ºC	
Interface voltage range	1.6 V ~ 5.5 V	
Time-keeping (hold) voltage range	1.0 V ~ 5.5 V	
Time-keeping current consumption	300 nA（Typ.）/3 V standard	
Frequency tolerance	± 5.0 x 10^{-6} / -40 ºC to +85 ºC ± 8.0 x 10^{-6} / +85 ºC to +105 ºC ± 50.0 x 10^{-6} / +105 ºC to +125 ºC	
Functions	Time stamp: Records from 1/256 sec. to year digits Max. 2 times	
	Alarm, Auto repeat wakeup timer : 244.14 µs ~ 32years	
	Reset function（optional）	
Dimensions	3.2 × 2.5 × 1.0 t（Max.）mm	
Automotive standard	AEC-Q100	

Detailed information on the above products is available on our website. Please click on the links below.

Product page : RA8000CE RA4000CE