# RAJ240090/100

## R-BMS F Quick Start Guide

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## Introduction

The RAJ240090/100 R-BMS F evaluation kit consists of an evaluation module (EVM), a USB System Management Bus (SMBus) and an interface adaptor which allows users to evaluate their battery management system using Renesas RAJ240090/100 Li-ion battery Fuel Gauge IC (FGIC).

Additionally, the kit comes with the R-BMS F firmware, which is a fixed and easy to use software requiring no additional development with user configurable settings for determining different thresholds of the device.

This User's Manual provides detailed information of the evaluation kit and how to set it up to construct 3 - 8 (RAJ240090) or 3 – 10 (RAJ240100) Li-ion battery cell series to start operation and performance evaluation.

## Target Device

RAJ240090

RAJ240100

**Note:**
RAJ240100 R-BMS F evaluation module can be used for RAJ240090.

Default cell count setting of each EVM is as follows. To amend the cell count, full package is needed.

- RAJ240090 R-BMS F: 8 cell
- RAJ240100 R-BMS F: 10 cell

Windows Decimal Symbol setting must be a period "." in order for the GUI to launch.

Refer to the URL below and download the package for more details.
https://www.renesas.com/en/products/power-management/battery-management/battery-fuel-gauges/rtk0ef0136dk0002bu-raj240090100-fixed-firmware-evaluation-kit-battery-management?srsltid=AfmBOoosCZkj9rzQs4-SWU6cEFGQyDvZ6t1va625EB77caIJB0NhPJMg#overview

## Contents

# 1. Evaluation Kit Features & Contents

This chapter overviews the EVM features and hardware contents.

## 1.1 Features

- Complete evaluation system for the RAJ240090/100 with 3-8 cell (RAJ240090) or 3 – 10 cell (RAJ240100) Li-ion battery.
- Optimized circuit module for 3-cell to 8-cell (RAJ240090) or 10-cell (RAJ240100) configuration for quick setup.
- SMBus I/F communication.
- Built in resistor cell simulator for quick setup with minimum wire connections.
- GUI based PC software for configuration.

## 1.2 Hardware Contents

The R-BMS F evaluation kit comes with the hardware items shown in Table 1-1 below.

**Table 1-1 R-BMS F Evaluation Kit Contents**

| Item | Description |
|---|---|
| R-BMS F EVM | EVM for evaluating R-BMS F with RAJ240090/100 FGIC. |
| USB SMBus Converter (I/F) | USB SMBus interface adapter. |
| Cables | A USB cable for connecting the SMBus I/F to the PC.<br>A serial cable to connect the SMBus I/F to the EVM. |

## 1.3 Performance Specification Summary

The R-BMS F evaluation kit specifications are shown in Table 1-2 below.

**Table 1-2 Performance Specification Summary**

| Specification | Min | TYP | Max | Unit |
|---|---|---|---|---|
| Input voltage Pack+ to Pack- | | | 45 | V |
| Battery voltage V1/V2/V3/…../V10 | 2.5 | | 4.2 | V |
| Charge and discharge current | 0 | | 30 | A |

**Note:** Board cooling may be required for continuous operation at or below the maximum current.

## 1.4 Required Equipment

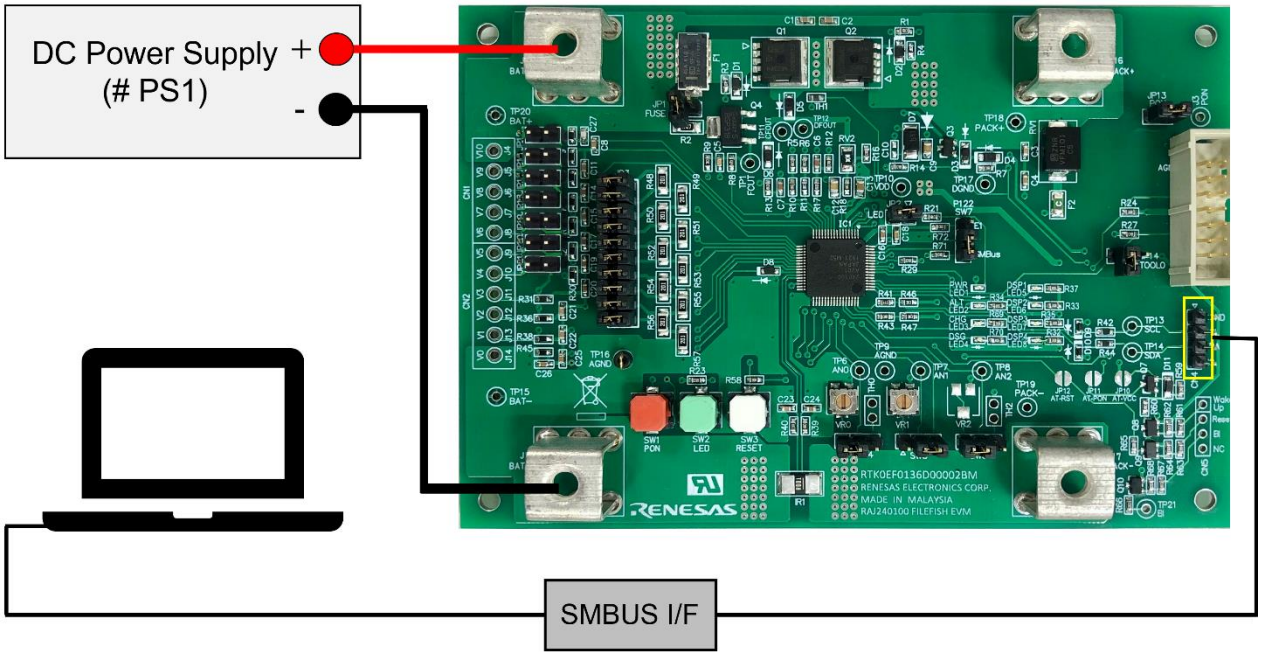
The equipment in Table 1-3 is required to operate the EVM.

**Table 1-3 Required Equipment list**

| Item | Symbol | Description |
|---|---|---|
| DC power supply 1 | PS#1 | For Battery simulation.<br>Bipolar DC power supply will be needed for charger test. |
| DC power supply 2 | PS#2 | Optional and may be needed to simulate the charger. |
| DC load<br>or assorted resistors | DCL | Optional and may be needed to simulate the system load.<br>A bipolar DC power supply can be used instead. |
| Computer with a USB port | - | Windows operating system is required. |

**Note:** Additional equipment may be needed to operate the EVM with a more extensive test.

## 1.5 EVM Connection with Minimum Configuration (10 cells)



# 2. Function Outline

## 2.1 Features

- High accuracy Voltage, Current, and Temperature detection and safety protection.
- Safety and outperformed charging controlling.
- Accurate capacity calculation
- Make less power consumption by power saving control.
- Supports the Smart Battery Data specification V1.1
- Supports various system by parameter of FlashROM (Fixed data / Own data / Flexible data)
- Supports on-board firmware updating via SMBus
- Current Range: -32768 mA to 32767 mA

## 2.2 Function outline

- Voltage, Current, Temperature measurement
- Remaining Capacity (RC) Calculation
- Relative State Of Charge (RSOC) Calculation
- Full Charge Capacity (FCC) update
- Initial Calibration mode for accurate measurement
- Capacity correction by Lookup table
- Mode transition: Normal, Sleep, Shutdown, Fail
- Over Current, Over / Under Voltage, and Over Temperature protection
- Fuse Blow
- RMA Data & Fault Logging
- LED Display Module (optional)
- JEITA Charging (optional)
- Master Communication (optional)

# 3. SMBus Commands

Some commands are not listed. Refer to firmware specification for more details.

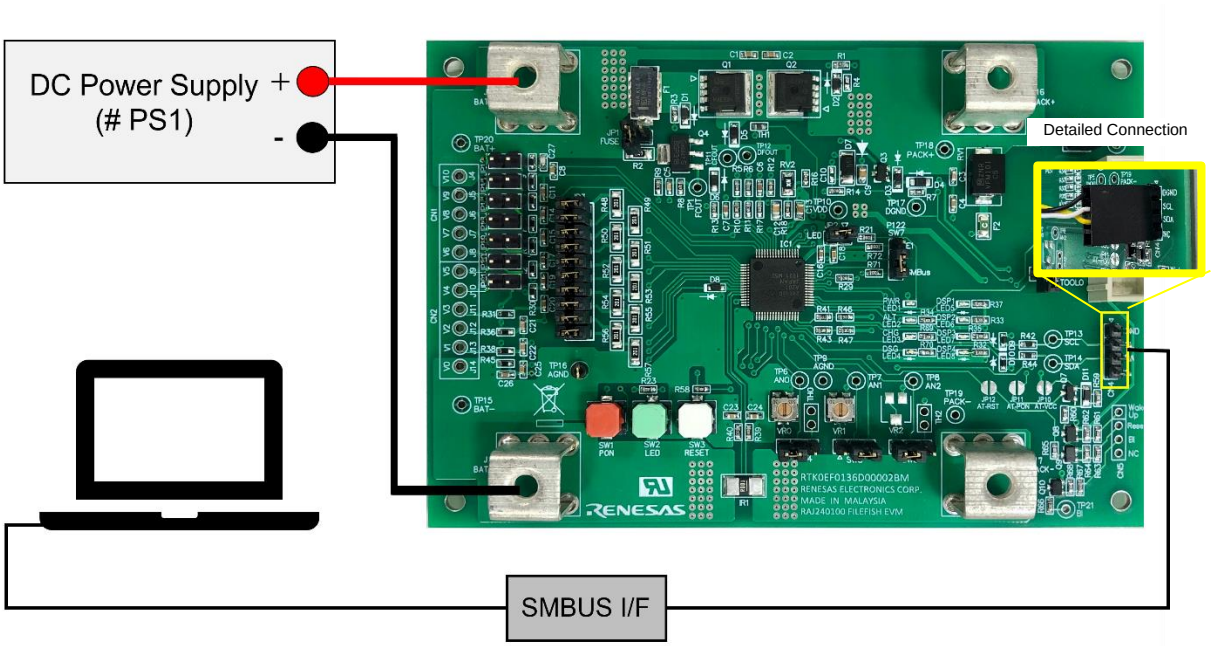
<table>
<tr><th>Function</th><th>Code</th><th>Access</th><th>Unit</th><th>Description</th></tr>
<tr><td>Temperature()</td><td>0x08</td><td>RW</td><td>0.1K</td><td>The cell-pack's internal temperature</td></tr>
<tr><td>Voltage()</td><td>0x09</td><td>RW</td><td>mV</td><td>The cell-pack voltage</td></tr>
<tr><td>Current()</td><td>0x0A</td><td>RW</td><td>mA</td><td>The current being supplied through the battery's terminals</td></tr>
<tr><td>RelativeStateOfCharge()</td><td>0x0D</td><td>RW</td><td>%</td><td>The predicted remaining battery capacity expressed as a percentage</td></tr>
<tr><td>RemainingCapacity()</td><td>0x0F</td><td>RW</td><td>mAh</td><td>The predicted remaining battery capacity</td></tr>
<tr><td>FullChargeCapacity()</td><td>0x10</td><td>RW</td><td>mAh</td><td>The predicted pack capacity when it is fully charged</td></tr>
<tr><td>ChargingCurrent()</td><td>0x14</td><td>RW</td><td>mA</td><td>Desired charging rate to the Smart Battery Charger</td></tr>
<tr><td>ChargingVoltage()</td><td>0x15</td><td>RW</td><td>mV</td><td>Desired charging voltage to the Smart Battery Charger</td></tr>
<tr><td>BatteryStatus()</td><td>0x16</td><td>RW</td><td>Bit flags</td><td>The Smart Battery's status with Alarm and Status
<table>
<tr><th>Bit</th><th>Field</th></tr>
<tr><td>15</td><td>OVER_CHARGED_ALARM</td></tr>
<tr><td>14</td><td>TERMINATE_CHARGE_ALARM</td></tr>
<tr><td>13</td><td>Reserved</td></tr>
<tr><td>12</td><td>OVER_TEMP_ALARM</td></tr>
<tr><td>11</td><td>TERMINATE_DISCHARGE_ALARM</td></tr>
<tr><td>10-8</td><td>Reserved</td></tr>
<tr><td>7</td><td>INITIALIZED</td></tr>
<tr><td>6</td><td>DISCHARGING</td></tr>
<tr><td>5</td><td>FULLY_CHARGED</td></tr>
<tr><td>4</td><td>FULLY_DISCHARGED</td></tr>
<tr><td>3-0</td><td>Reserved</td></tr>
</table></td></tr>
<tr><td>CycleCount()</td><td>0x17</td><td>RW</td><td>cycle</td><td>The number of cycles the battery has experienced</td></tr>
<tr><td>DesignCapacity()</td><td>0x18</td><td>RW</td><td>mAh</td><td>The theoretical capacity of a new pack</td></tr>
<tr><td>ManufactureDate()</td><td>0x1B</td><td>RW/WW</td><td>-</td><td>The date the cell pack was manufactured in a packed</td></tr>
<tr><td>SerialNumber()</td><td>0x1C</td><td>RW/WW</td><td>-</td><td>The serial number</td></tr>
<tr><td>ManufacturerName()</td><td>0x20</td><td>BR</td><td>String</td><td>The character array containing the battery's manufacturer's name</td></tr>
<tr><td>DeviceName()</td><td>0x21</td><td>BR</td><td>String</td><td>The character string that contains the battery's name</td></tr>
<tr><td>DeviceChemistry()</td><td>0x22</td><td>BR</td><td>String</td><td>The partial list of chemistries and their expected abbreviations</td></tr>
<tr><td>ManufacturerData()</td><td>0x23</td><td>BR</td><td>String</td><td>The manufacturer data contained in the battery</td></tr>
<tr><td>OperationStatus()</td><td>0x41</td><td>RW</td><td>-</td><td>The cell-pack's operation status
<table>
<tr><th>Mode number</th><th>Mode name</th></tr>
<tr><td>0x00</td><td>INIT</td></tr>
<tr><td>0x01</td><td>WAKEUP</td></tr>
<tr><td>0x02</td><td>DISCHARGE</td></tr>
<tr><td>0x03</td><td>CHARGE</td></tr>
<tr><td>0x05</td><td>CHG TERM</td></tr>
<tr><td>0x06</td><td>CHG WAIT</td></tr>
<tr><td>0x07</td><td>PRE CHG</td></tr>
<tr><td>0x09</td><td>SLEEP</td></tr>
<tr><td>0x17</td><td>TEMPORARY FAIL</td></tr>
<tr><td>0x1E</td><td>POWER DOWN</td></tr>
<tr><td>0x1F</td><td>PERM FAIL</td></tr>
<tr><td>0x20</td><td>INIT CALIB</td></tr>
<tr><td>0x99</td><td>FIXED DATA ERROR</td></tr>
<tr><td>0xFF</td><td>(Reset)</td></tr>
</table></td></tr>
<tr><td>FETTemp()</td><td>0x44</td><td>RW</td><td>0.1K</td><td>The FET temperature</td></tr>
<tr><td>PACKVoltage()</td><td>0x47</td><td>RW</td><td>mV</td><td>The cell-pack output voltage</td></tr>
<tr><td>StateOfHealth()</td><td>0x48</td><td>RW</td><td>%</td><td>The predicted percentage of cell aging</td></tr>
<tr><td>VoltageOfCellx()</td><td>0x60-0x69</td><td>RW</td><td>mV</td><td>Each cell voltage (0x60 is the bottom, 0x69 is the top)</td></tr>
<tr><td>FirmwareVersion()</td><td>0xF1</td><td>RW</td><td>-</td><td>The firmware version</td></tr>
<tr><td>FirmwareSubVersion()</td><td>0xF2</td><td>RW</td><td>-</td><td>The firmware subversion</td></tr>
</table>

# 4. Quick Bootup/Start

Refer to user's manual in the package for more details. To use SMBus I/F, package would be needed.

1. Configure the cell count. For more details, refer to in section 4.1.
2. Connect the power supply (PS#1) between BAT+ and BAT- terminals.
3. Adjust the DC power supply (PS#1) setting to a value between 3V to 4.2V per cell.
4. Default series number of cell setting is 10 cell.
5. Apply voltage between BAT+ and BAT- terminals using the DC power supply (PS#1).
6. Press the "**PON**" switch (SW1) to boot-up the system from power down mode.
7. Confirm the LED status. LED1 (PWR) will turn on (green) when it succeeds in booting up.

   **Note:** if JP2 is not connected, LED1 will not turn ON.
8. The battery pack status can be monitored via SMBus connector (CN4).




## 4.1 Reducing the Cell Count

The R-BMS F solution supports 3 to 10 cells. The EVM utilizes the Jumpers JP15 – JP21 to specify the number of cells to be used when applying voltage to the battery terminals. see Table 4-1 below.

**Table 4-1 Reducing the Cell Count**

| Cell Count | JP15 | JP16 | JP17 | JP18 | JP19 | JP20 | JP21 |
|---|---|---|---|---|---|---|---|
| 3 Cells | closed | closed | closed | closed | closed | closed | closed |
| 4 Cells | closed | closed | closed | closed | closed | closed | open |
| 5 Cells | closed | closed | closed | closed | closed | open | open |
| 6 Cells | closed | closed | closed | closed | open | open | open |
| 7 Cells | closed | closed | closed | open | open | open | open |
| 8 Cells | closed | closed | open | open | open | open | open |
| 9 Cells | closed | open | open | open | open | open | open |
| 10 Cells | open | open | open | open | open | open | open |

# 5. R-BMS_F_Tool

The R-BMS_F_Tool is a GUI software used for monitoring and evaluating the R-BMS F EVM. It provides the features shown in Table 5-1.

**Table 5-1 Function Overview**

| Menu Name | Function/Description |
|---|---|
| HOME | Home Screen. |
| SYSTEM MONITOR | Read/Log the SMBus register data. |
| FIXED DATA | Battery Parameter read/write. |
| FLEXIBLE DATA | Latest system data read/write. |
| CALIBRATION DATA | Board level calibration read/write. |
| CALIBRATION | Perform board level calibration. |
| FLASH UPDATE | Firmware flash memory (Fixed/Calibration, Flexible) data update |
| FACTORY DEFAULT | EVM roll back function |
| FUNCTION CONFIG | Easy battery parameter setting function |

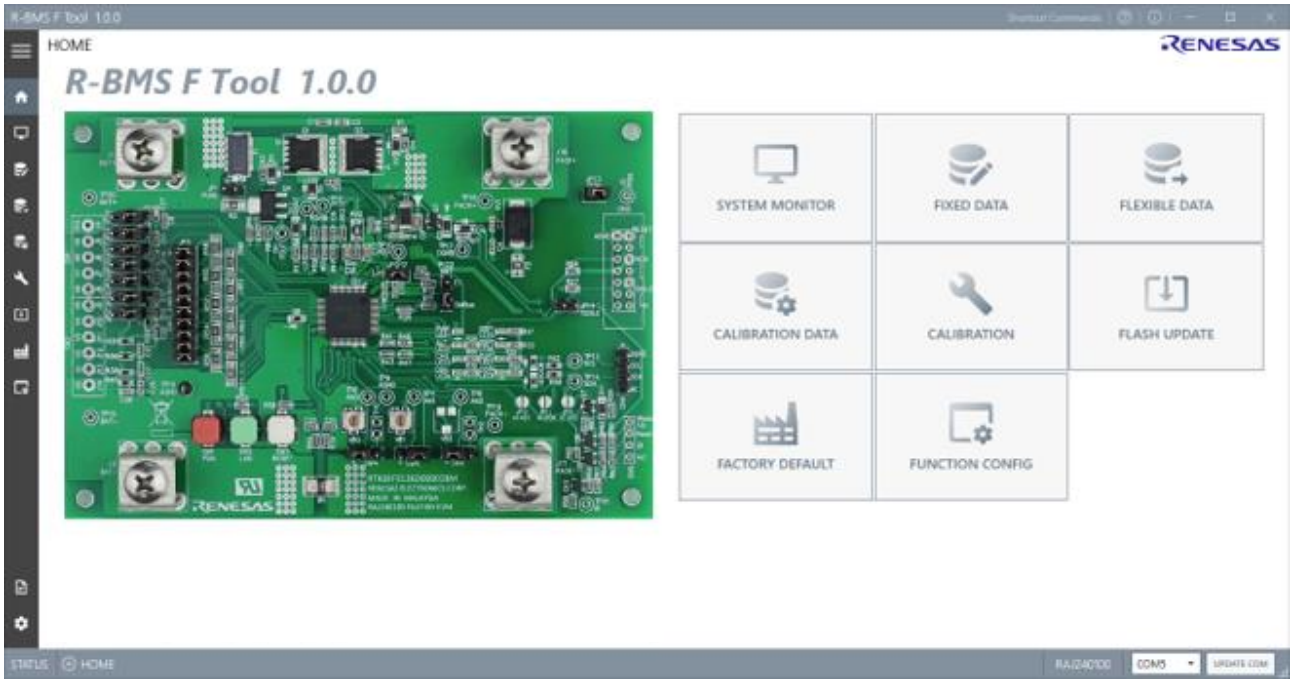



**Figure 5-1 R-BMS_F_TOOL Overview**

## 5.1 Software Requirements

The R-BMS_F_Tool requires a Windows 10 or later system.

## Revision History

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Mar. 3, 2025 | | First release |
| 1.01 | May 12, 2025 | | Add SMBus Commands<br>Add Quick Bootup/start |

# General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between $V_{IL}$ (Max.) and $V_{IH}$ (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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