RAJ240090 / RAJ240100 Starter Kit

User's manual of Sample code

R01AN4062EJ0219
Rev.2.19
Nov 30, 2022

Introduction

RAJ240090 / RAJ240100 starter kit consists of an evaluation module (EVM), USB System Management Bus (SMBus) interface adapter and etc. which allows users to evaluate Renesas RAJ240090 / RAJ240100 Li-Ion battery Fuel Gauge IC (FGIC) features and performance. This User's Manual provides detail information of starter kit to construct a 3 to 10 series cells Li-ion battery evaluation environment, and the necessary basics to start performing discharge/charge test using the EVM.

Following is the content outline of this manual:

- Chapter 1: "**Kit features and contents**" – Kit features, item list.
- Chapter 2: "**System Overview**" – EVM overview, EVM setup.
- Chapter 3: "**Basic Operation**" – EVM boot up. Basic Charge and Discharge operation.
- Chapter 4: "**Advanced Operation**" – Firmware update, Initial calibration, Data backup and restore.
- Chapter 5: "**Appendix**"

Target Device

RAJ240090 (3 to 8 series cells)
RAJ240100 (3 to 10 series cells)

Contents

1. Kit features and contents

This chapter explains the kit features and kit contents.

1.1 Features

- Complete evaluation system of the RAJ240090 / RAJ240100 FGIC for 3-10 series cells
- Sample source code and default parameters for 10 series cells are pre-programmed in the EVM.
- GUI based software with USB SMBus I/F for easy evaluation and allows data logging for trial and evaluation
- Adjustable parameter based on user battery characteristics

1.2 Item List

Table 1 RAJ240090 / RAJ240100 Starter Kit Equipment list

Item	Description
RAJ240090 / RAJ240100 EVM RTK0EF0014D00005BM	This EVM is used for evaluating RAJ240090 / RAJ240100. EVM is composed of two distinct parts that are mother board (Part No. RTK0EF0014D00005BM) and socket board (RTK0EF0015Z00000BM or RTK0EF0016Z01000BJ). These boards are described to one parts as “EVM” in this document.
USB SMBus Converter (I/F) RTK0EF0029Z00001BJ or RTK0EF0029Z00001BM	USB SMBus interface adapter.
Cable	USB cable for USB SMBus I/F and a wire.

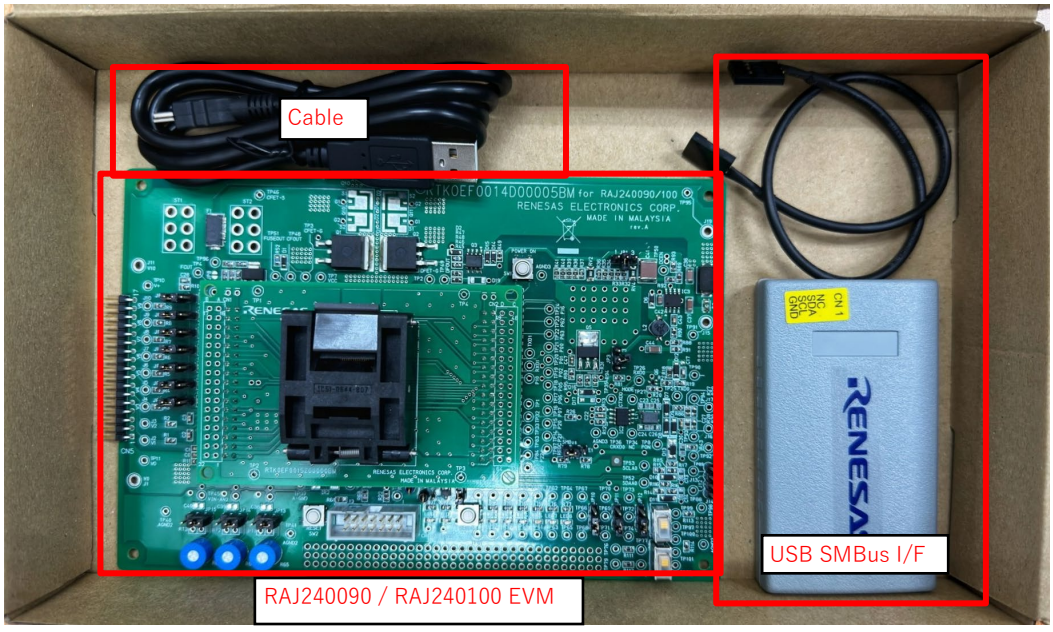


Figure 1 RAJ240090 / RAJ240100 Starter Kit overview

2. System Setup

This chapter explains outline of the sample source code, EVM overview, and the configuration to start evaluation.

2.1 EVM Specification

Table 2 EVM Specification

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

Caution Please take care about wire connection and polarity of each power supply. Incorrect connection might cause serious problem for FGIC and EVM

Caution For normal operation, keep battery cell voltage within 3 to 4.2V range.
If battery cells are used for your evaluation, pay attention to limit current not exceed the charge and discharge specification to avoid damaging the cell.

2.2 Sample source code outline

The sample source code is pre-programmed in this EVM. The EVM supports SMBus (System Management Bus) I/F protocol with the following features.

- Voltage / current / temperature monitoring
- FCC / RC / RSOC calculation
- Simple safety functions and internal battery mode control
- MOSFET / Operation Status
- Data transfer via SMBus I/F

For more details, please refer to Sample code specification “R01AN3919EJxxxx-raj240xxx”.

The Sample code is pre-programmed with basic safety functions based on the EVM hardware configuration. However, additional safety features can be added to the firmware based on necessity.

2.3 RAJ240090 / RAJ240100 EVM

2.3.1 EVM overview

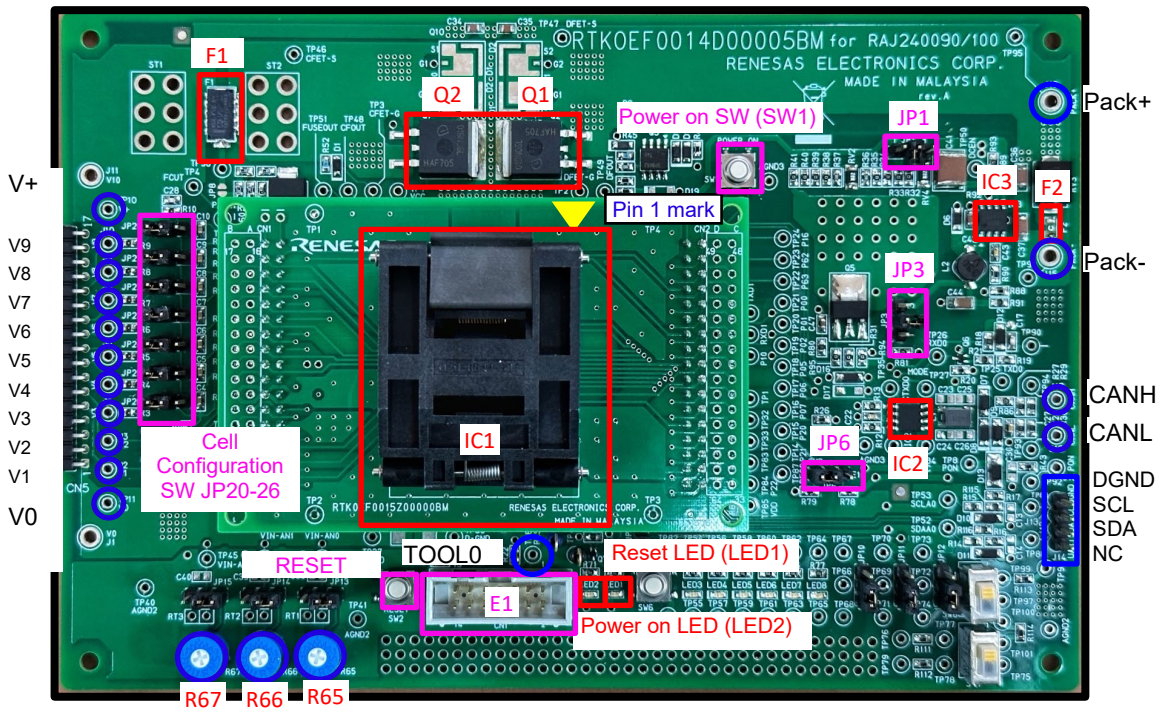


Figure 2 RAJ240090 / RAJ240100 EVM overview

2.3.2 Device description

Table 3 EVM Device description

Device	Description
IC1	FGIC RAJ240090 or RAJ240100
IC2	CAN transceiver
IC3	DCDC-converter (for CAN transceiver)
F1	Protection Fuse, will be cut if Permanent Failure is detected
F2	Secondary protection fuse
Q1 / Q2	Charge / Discharge MOSFET
IR1	Shunt Resistor (Located under the socket board)
R65	Alternative potentiometer for thermistor RT1
R66	Alternative potentiometer for thermistor RT2
R67	Alternative potentiometer for thermistor RT3
LED1	Reset LED (On: Reset=High, OFF: Reset=Low)
LED2	ON: RAJ240090 / RAJ240100 EVM(CREG2) is active OFF: RAJ240090 / RAJ240100 EVM(CREG2) is not active

2.3.3 Switch and connector description

Table 4 EVM Switch and connector description

Switch / Connector	Description
SW1 (POWER ON)	Boot-up from Power down mode when No charger and No Load
SW2 (RESET)	Reset button for FGIC MCU (AFE cannot be reset)
JP1	CAN transceiver power source selector Short pin 1 and pin 2: Based on CREG2 via drop down MOSFET Short pin 2 and pin 3: Top of cell voltage (V+)
JP3	DCDC-converter: Short-circuit 2pin and 3pin
JP6	E1 / SMBus Selector for updating firmware
JP20-26	Number of series cell configuration switch
E1	E1/E2 socket

2.3.4 Pin description

Table 5 EVM Pin description

Pin Name	Description
Pack+	Pack positive terminal
Pack -	Pack negative terminal
SCL	SMBus SCL header (Clock)
SDA	SMBus SDA header (Data)
DGND	SMBus ground terminal
CANH	CAN HIGH-level bus terminal
CANL	CAN LOW-level bus terminal
V+	Positive connection to cell #10 (Top cell)
V9	Positive connection to cell #9
V8	Positive connection to cell #8
V7	Positive connection to cell #7
V6	Positive connection to cell #6
V5	Positive connection to cell #5
V4	Positive connection to cell #4
V3	Positive connection to cell #3
V2	Positive connection to cell #2
V1	Positive connection to cell #1 (bottom cell)
V0	Battery negative terminal
TOOL0 (TP31)	For factory default setup

2.3.5 Cell configuration

RAJ240090 / RAJ240100 EVM supports 3 to 10 cells. The EVM configuration can be modified based on the application conditions. By default, EVM configuration is set for 10 series cells application. When the configuration is changed, the FGIC parameters need to be updated accordingly. For more detail, please refer to Section 4.5.

Table 6 Cell configuration

No.of series cells	JP20	JP21	JP22	JP23	JP24	JP25	JP26
10S (Default)	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short
9S	2-3pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short
8S	2-3pin short	2-3pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short
7S	2-3pin short	2-3pin short	2-3pin short	1-2pin short	1-2pin short	1-2pin short	1-2pin short
6S	2-3pin short	2-3pin short	2-3pin short	2-3pin short	1-2pin short	1-2pin short	1-2pin short
5S	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short	1-2pin short	1-2pin short
4S	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short	1-2pin short
3S	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short	2-3pin short

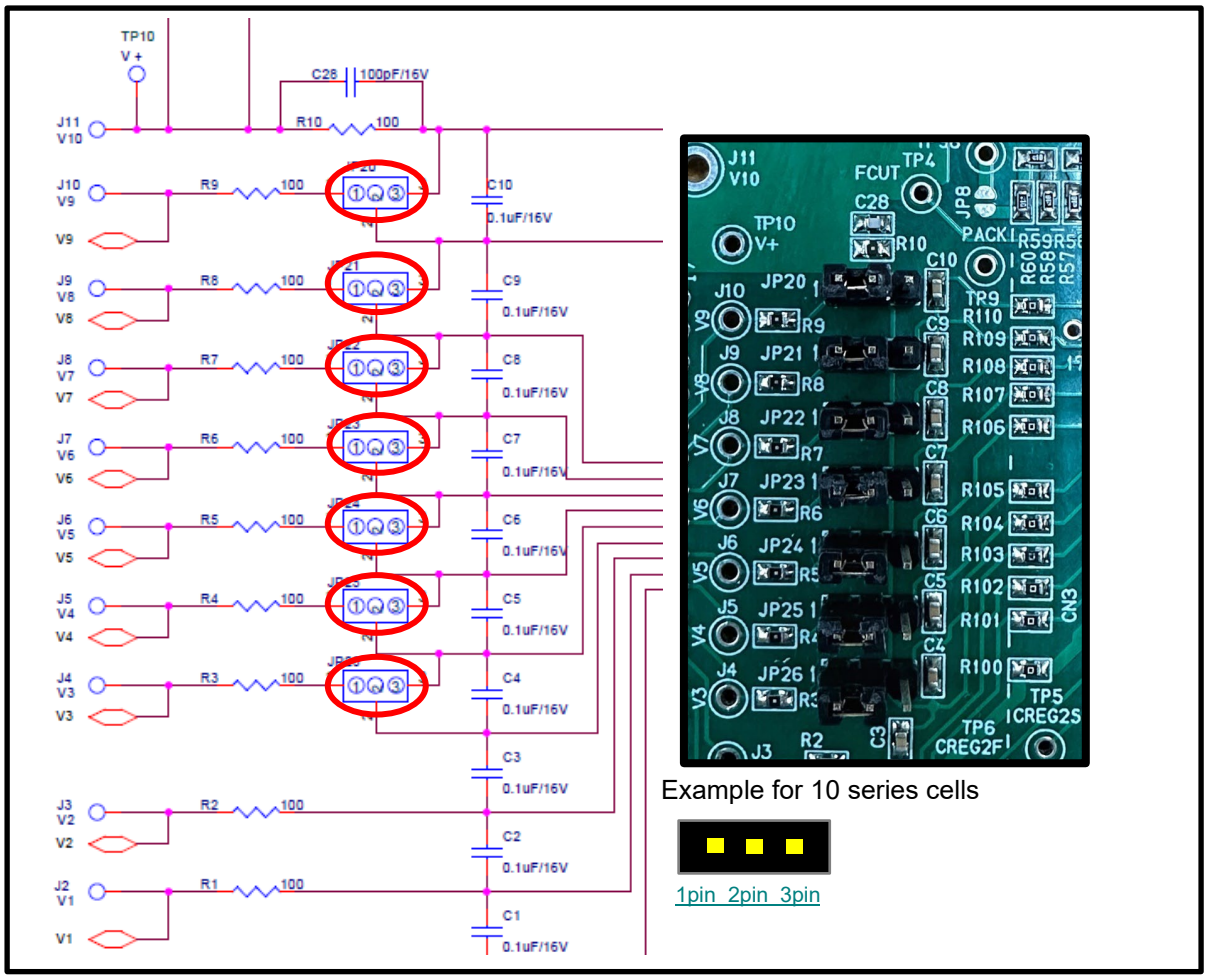


Figure 3 Jumper setting of series cell configuration

2.3.6 Order of cell connection

Table 7 shows the cell connection configuration. Cell 1 is lowest cell and Cell 10 is highest.
When you use real battery cells, please pay attention to battery cell connection order as follows.

1. Connect the bottom of cell (Cell minus) to V0.
2. Connect the top of cell (Cell plus) to V+.
3. Connect the other cells from bottom.

Table 7 Cell connection

Number of cells	Cell3	Cell4	Cell5	Cell6	Cell7	Cell8	Cell9	Cell10
10	V2 to V3	V3 to V4	V4 to V5	V5 to V6	V6 to V7	V7 to V8	V8 to V9	V9 to **V+**
9	V2 to V3	V3 to V4	V4 to V5	V5 to V6	V6 to V7	V7 to V8	V8 to **V+**	
8	V2 to V3	V3 to V4	V4 to V5	V5 to V6	V6 to V7	V7 to **V+**		
7	V2 to V3	V3 to V4	V4 to V5	V5 to V6	V6 to **V+**			
6	V2 to V3	V3 to V4	V4 to V5	V5 to **V+**				
5	V2 to V3	V3 to V4	V4 to **V+**					
4	V2 to V3	V3 to **V+**						
3	V2 to **V+**							

2.3.7 AN0-AN2 (Thermistor input)

EVM has three thermistor inputs to AN0-2 by variable resistor (See Figure 4 and Figure 5). If you want to use a thermistor, please short 1-2pin of JP13-15 and use RT1-3 pattern in Figure 4 and Figure 5.

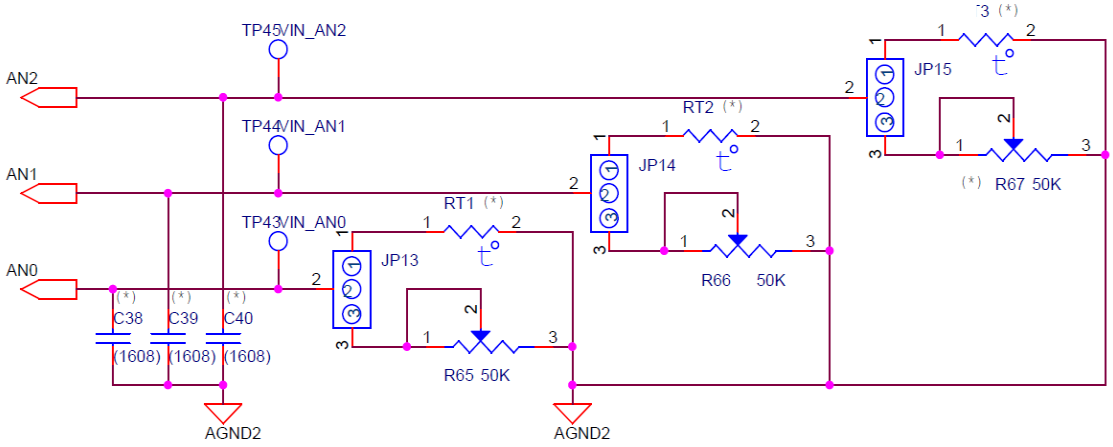


Figure 4 Thermistor Logic

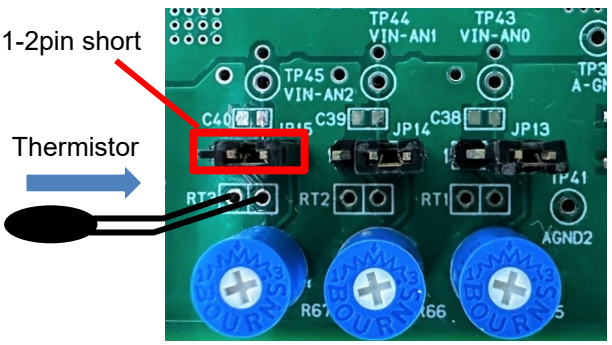


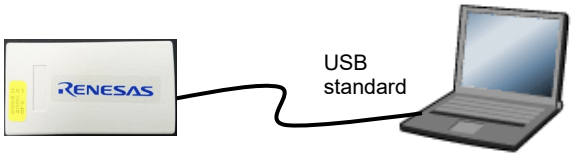
Figure 5 Thermistor connection example

2.4 Driver install for USB SMBus I/F

In order to use the USB SMBus I/F, the USB SMBus I/F driver needs to be installed. Please refer to the following steps for installation.

The device driver is included in the installation package.

1. Connect USB SMBus I/F to the PC with the USB cable.



2. Select the following steps depending on your PC OS version

A. **Windows 10**
Driver is automatically installed to the PC.

B. **Windows 7**
   a. Click on the Start Menu, right click on "Computer", and select "Manage".
   b. Select "Device Manager" from the left, look for “Unknown Device” or “CDC USB Demonstration” under “Other devices” (Refer to Figure 6). Some OS detects “RTK0EF0029Z0000xBx” from the beginning.
   c. Right click on the "CDC USB Demonstration” and choose the "Update Driver Software" option.
   d. Choose the "Browse my computer for Driver software" option.
   e. Move to the extracted file folder and look for USB SMBus I/F driver and select the driver file. (RTK0EF0029Z0000xBx_Win7.inf).
   f. When the installation is successful, it should be in Ports (COM & LPT) category and device name should be “RTK0EF0029Z0000xBx”.

C. **Windows 8**: Steps are the same as Windows 7.
Instead of selecting RTK0EF0029Z0000xBx_Win7.inf, select RTK0EF0029Z0000xBx_Win8.inf in Win8 folder.

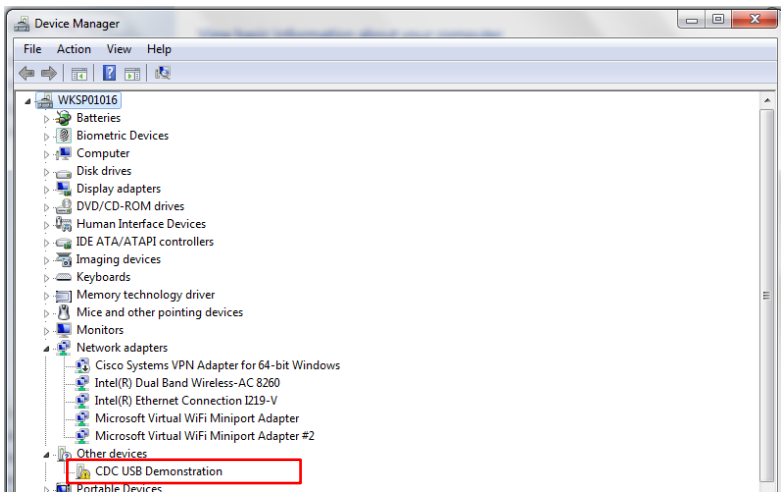


Figure 6 **Target device in Device manager (Windows 7, 8)**

2.5 Renesas SMBus monitoring tool (RSB TOOL2)

Renesas provides development assist tool with the EVM to accelerate customer evaluation. This tool assists evaluation, battery pack development, testing, and utilizing parameters.

Followings are the key features of the RSB TOOL2.

- [SBDC]: Smart Battery Data Communication (SBDC)
- [Mem]: Battery Parameter modification
- [Calib]: Initial Calibration setting
- [FlashUp]: Flash Update
- [SMBCOM]: SMBus single command Read / Write
- [Demo]: Battery status monitor by simple view
- [FD]: Factory default

Users can check sample code status and configure battery pack parameters (such as protection threshold, number of series cells and etc.) in the GUI application window by selecting the corresponding button as shown in Table 7 and Table 8

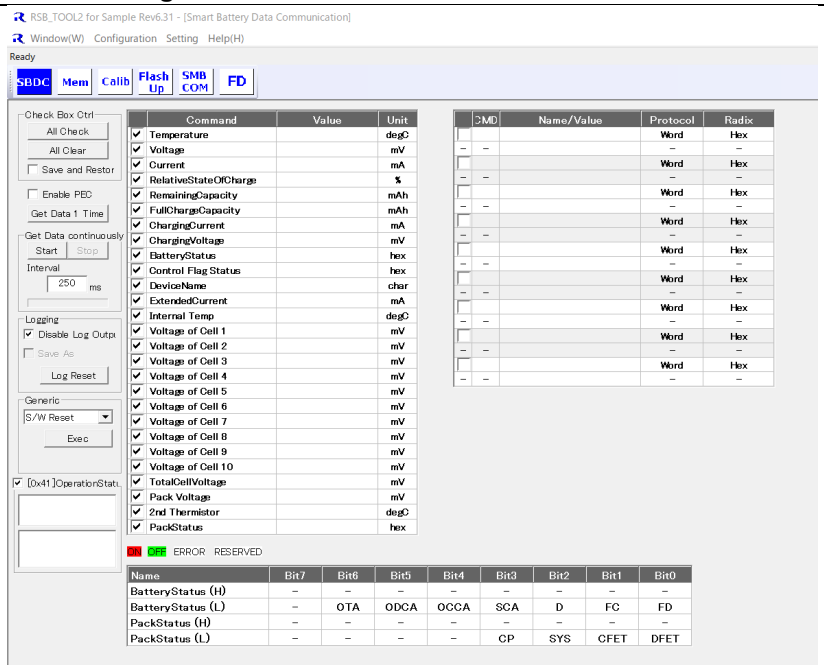
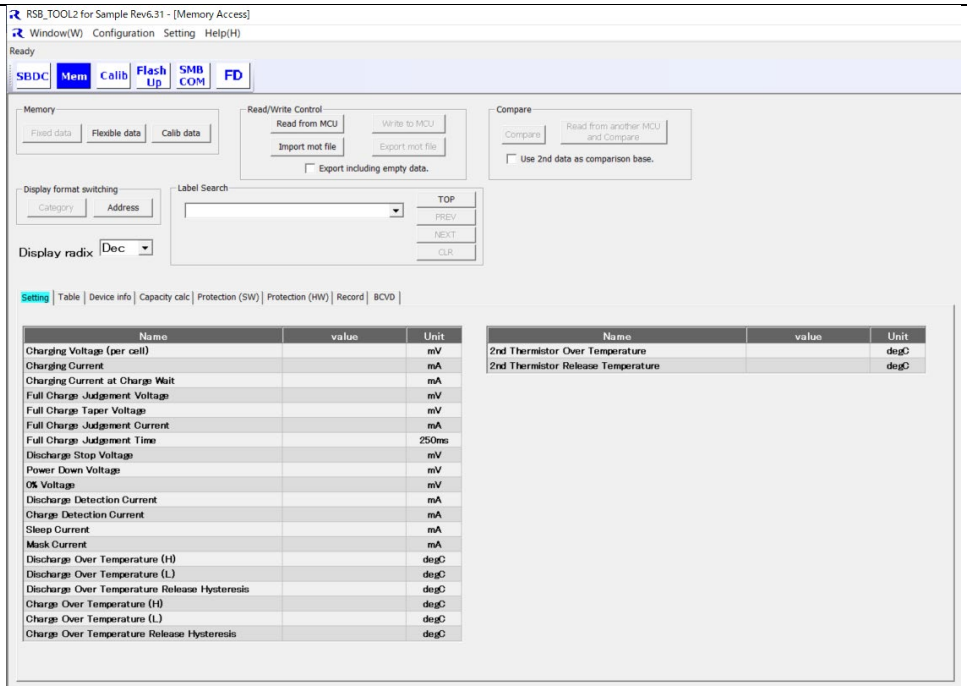
Caution The correct parameter setting is important to achieve best performance.
The settings can be configured using the [Mem] window

For more details, please refer to the following documents of latest version.

RSB TOOL2 specification: “R01AN3920EJxxxx-raj240xxx.pdf”.

Sample code specification: “R01AN3919EJxxxx-raj240xxx.pdf”

Table 8 Setting and Monitor window of RSB TOOL2

Button	Function	Window image and Feature
SBDC	Detail Status Monitor	
Mem	Detail Parameter Setting	

Note Detail parameter setting is included the following function

a. Parameter comparison between Import value and flash data
b. Parameter search
c. Parameter address display
d. Set / Edit Calibration value

Table 9 Setting and Monitor window of RSB TOOL2

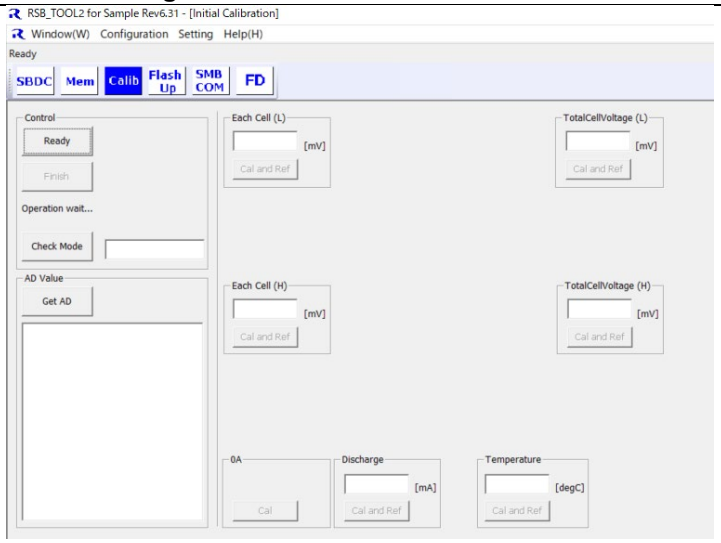
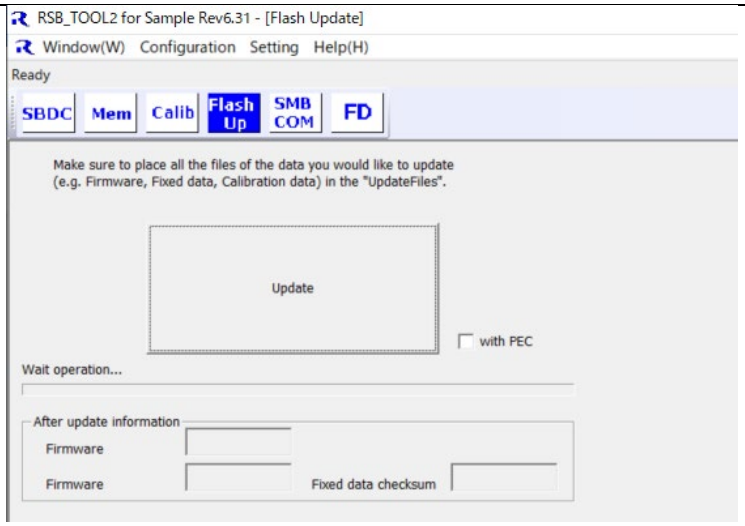
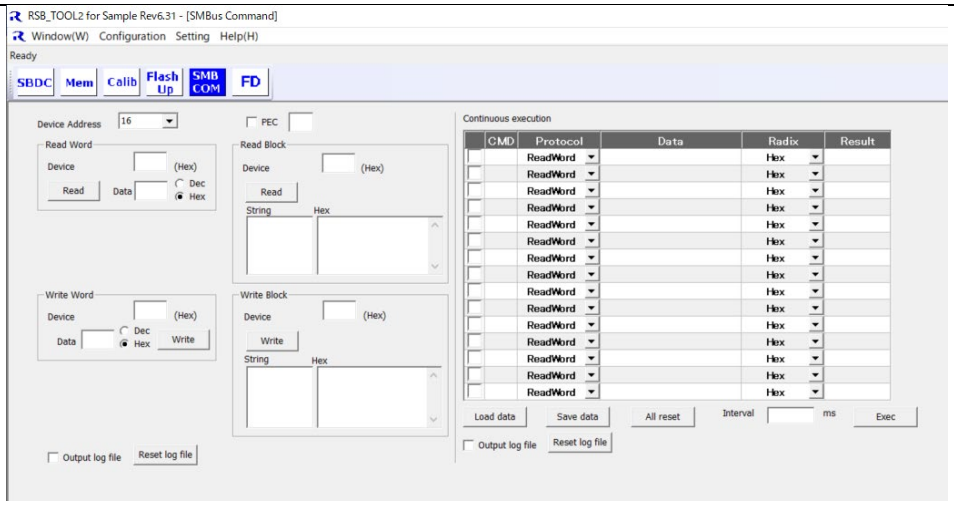
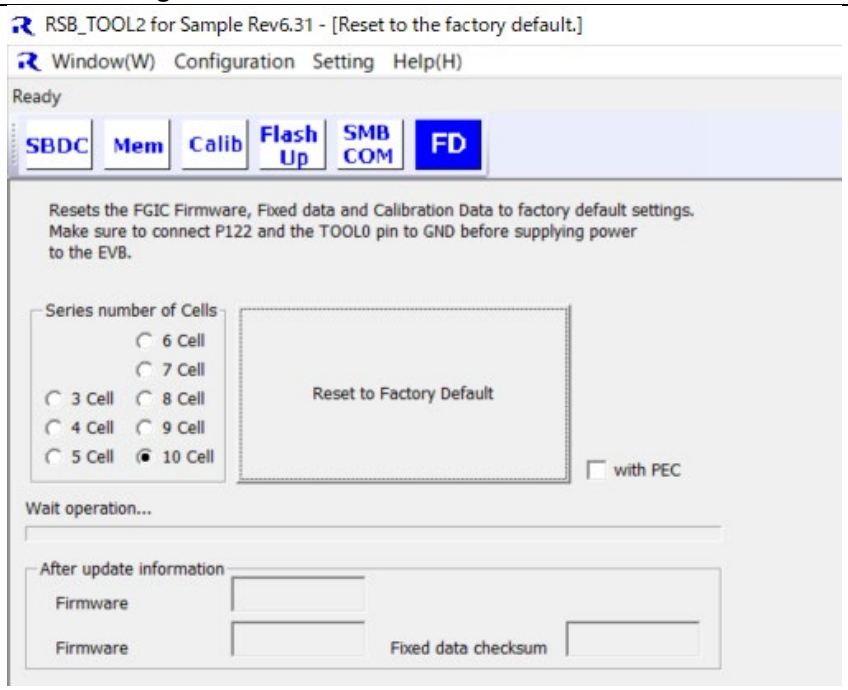
Button	Function	Window image and Feature
Calib	Initial Calibration	 **Note** For detail setting on calibration, refer to the specification of RSB TOOL2.
Flash Up	Flash Update	 **Note** When updating, the minimum cell voltage must be set to **Power Down Voltage** or more. (default parameter setting is 2.5V at the sample code)
SMB COM	SMBus Single Command R/W	

Table 10 Setting and Monitor window of RSB TOOL2

Button	Function	Window image and Feature
FD	Factory Default	

Note Detail information is descrived in Section 4.10

Note When updating, the minimum cell voltage must be set to **Power Down Voltage** or more. (default parameter setting is 2.5V at the sample code)

3. Basic Operation

This chapter explains the EVM setup, boot up procedure, and status monitor by using RSB TOOL2

3.1 Items for EVM Setup and Evaluation

The following items are required for EVM setup and evaluation

- RAJ240090 / RAJ240100 EVM
- USB SMBus I/F
- USB cable
- Computer setup with Operating System Windows 7 or higher
- Battery cells or dummy cells using series resistor and bipolar power supply (PS #1) which can supply 42V and 5A
- DC power supply (PS #2) which can supply 42V and 2A (Constant current [CC mode] and constant voltage [CV mode] capability is desirable.) or DC electronic load

3.2 EVM Connection

Figure 7 shows the example of EVM connection. In this example, the board is configured for 10 series cells by dummy cell with bipolar power supply.

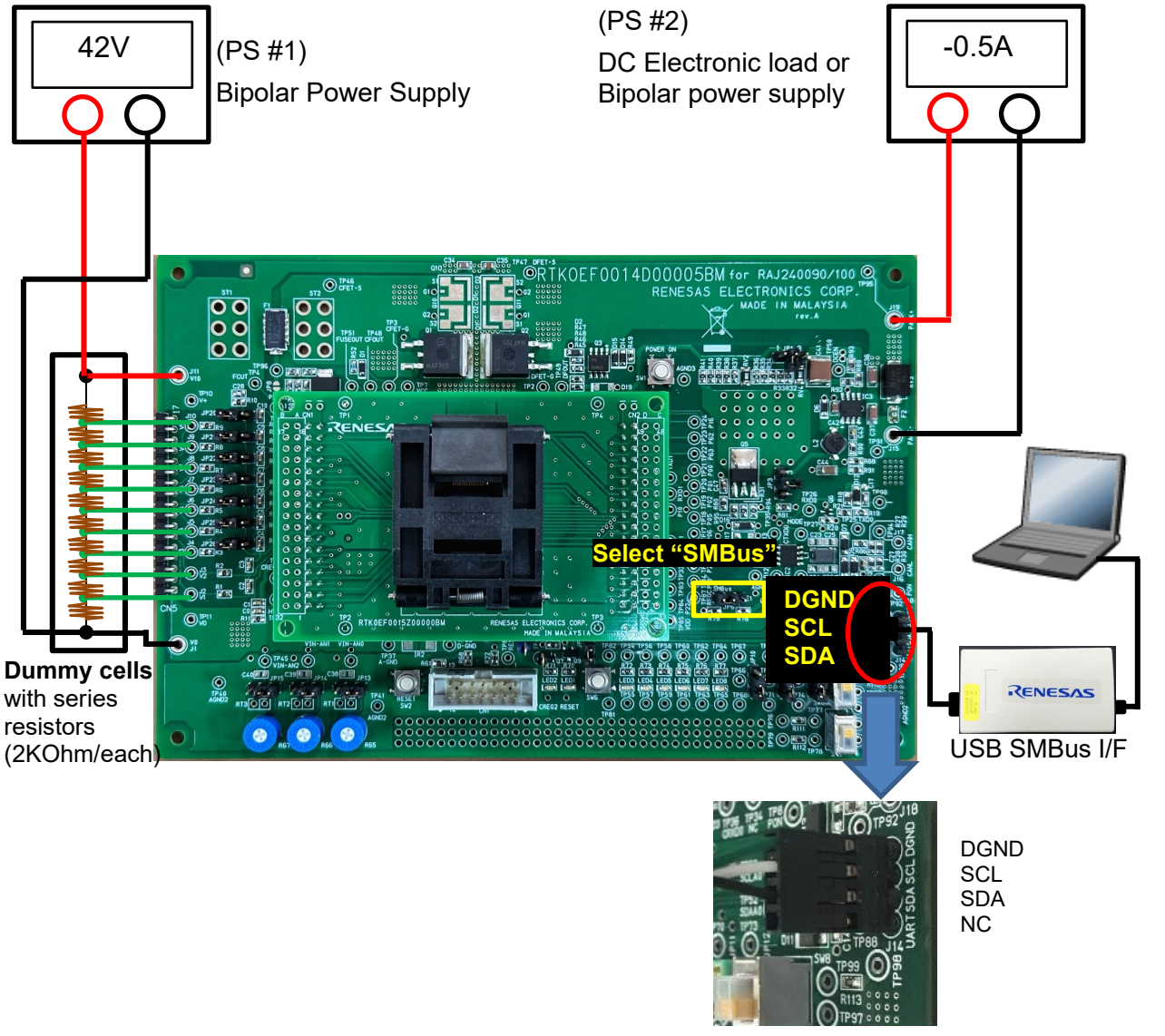


Figure 7 RAJ240090 / RAJ240100 EVM connection by dummy cells

Figure 8 shows another example of EVM connection. In this example, the board is configured using 10 series real battery cells.

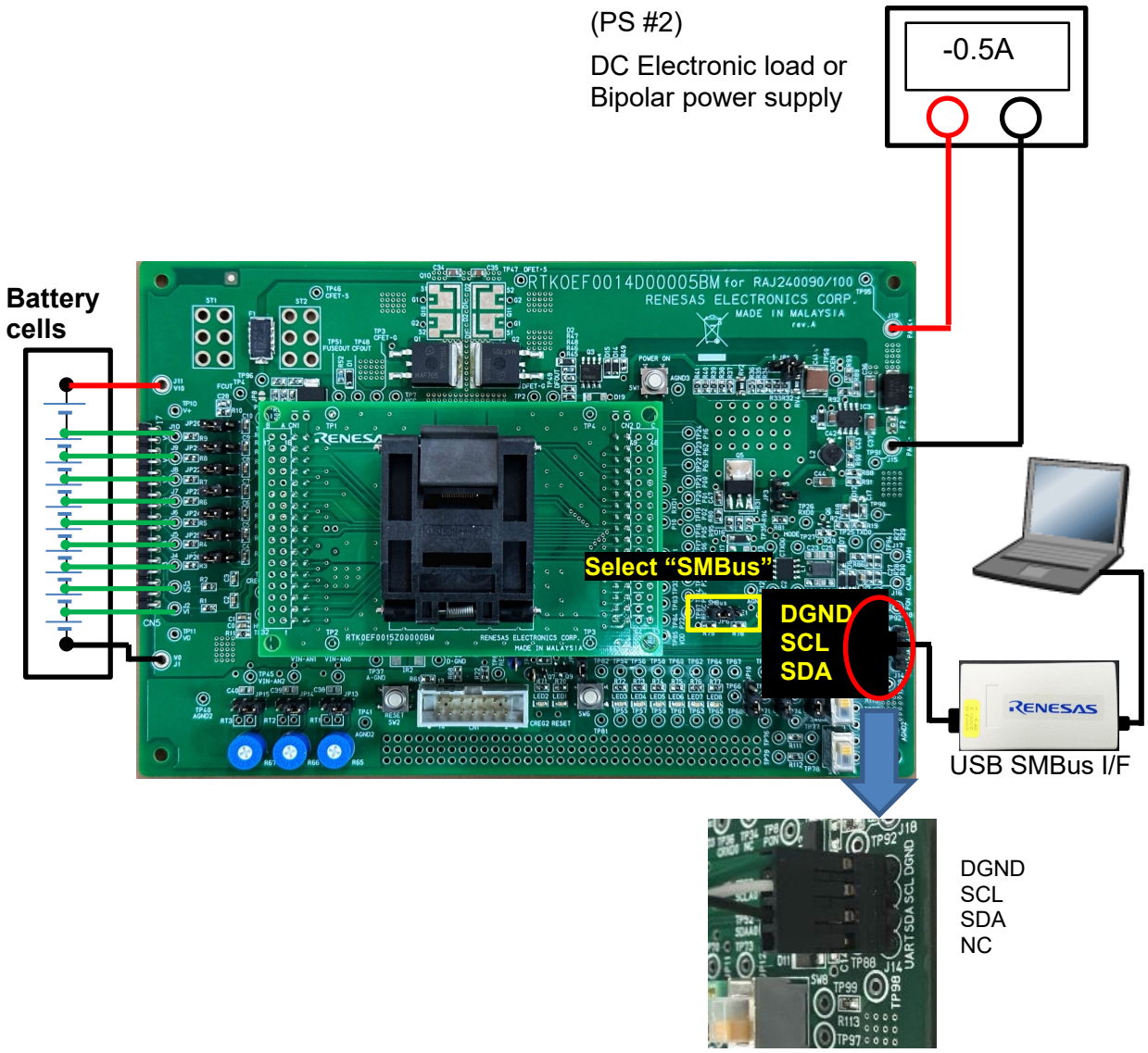


Figure 8 RAJ240090 / RAJ240100 EVM connection by real battery cells.

When using real battery cells, please pay attention to the connection orientation to the power supply of FGIC.

Also, please pay attention to the procedure while connecting the battery cell.

Connection procedure as shown below. (Example using 10 series cells)

1. Connect the bottom part of cell (Cell minus) to V0.
2. Connect the top part of the cell (Cell plus) to V+.
3. Connect the other cells from bottom part before top part (as indicate in step 1 and 2 above).

3.2.1 Battery simulator (PS#1 in Figure 7)

Real battery cells or bipolar power supply (four-quadrant power supply) with dummy battery cells can be used to emulate the battery operation. When a bipolar power supply is used, please divide the voltage by using a series of resistors connected to each intermediate pin (depends on the targeted number of cells in series).

3.2.2 Load or charger simulator (PS#2 in Figure 7)

To perform a discharge test, an electronic load or bipolar power supply can be used. To perform a charge test, a power supply is needed. For each condition, please connect the positive wire to Pack+ and the ground wire to Pack-.

3.2.3 Cable connection

When using the provided Renesas USB/SMBus interface, the cable connection for SMBus communication are as shown below.

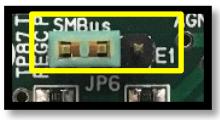
Table 11 Cable connection between USB SMBus I/F and EVM

Items	USB SMBus I/F	EVM
Clock line of SMBus	SCL	SCL (J13)
Data line of SMBus	SDA	SDA (J12)

3.3 RAJ240090 / RAJ240100 boot up

Follow the below steps to boot-up RAJ240090 / RAJ240100 EVM with connection described in Section 3.2

1. Connect all equipment as shown in Figure 7 (Section 3.2).
   Detail location for power switch, led, and label, can also be found in Figure 9 below.
2. Confirm that JP6 connector is selecting “SMBus”. (Two pins on left are shorted.)



3. Adjust bipolar power supply (PS #1) to apply voltage 3V to 4.2V per cell between V+ and V0 terminals.
4. Apply voltage between V+ and V0 by using PS #1.

   Note When booting up the device with this procedure, Pack (+) terminal must be in OPEN circuit.

5. Press the Power on switch (SW1) to boot-up the system from power down mode.
   (This is a basic procedure for RAJ240090 / RAJ240100 to boot up from Power Down mode).
6. Confirm the LED2 is turned on.
   - When the LED2 is turned ON: RAJ240090 / RAJ240100 has completed boot-up sequence.
   - When the LED2 is turned OFF: RAJ240090 / RAJ240100 has not completed boot-up sequence.

   Note If the LED stays OFF, check connection of equipment and try pressing SW1 again.

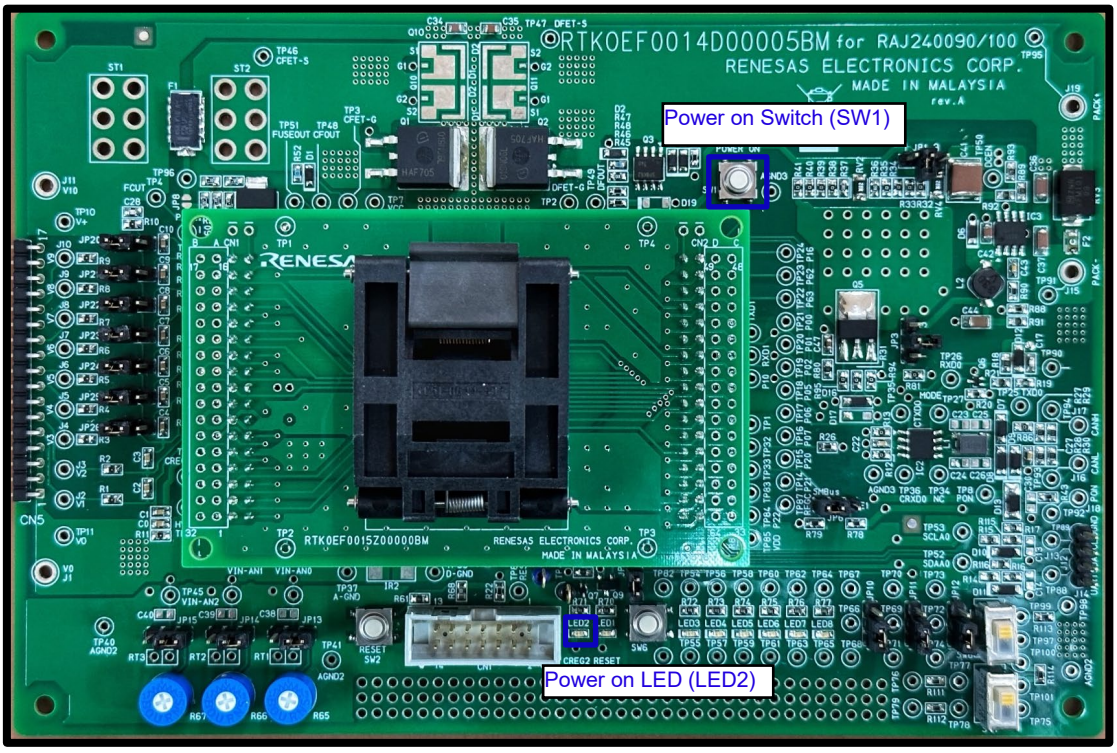


Figure 9 Position of “power on SW” and “power on LED”

3.4 Battery Status monitoring

3.4.1 Monitor each Smart Battery Data

Follow the below steps to start RAJ240090 / RAJ240100 EVM evaluation.

Precaution The sample code is compatible with 'System Management Bus Specification Revision 1.1' and 'Smart Battery Data Specification Revision 1.1a'. For more details, please refer to "r01an3920ejxxxx-raj240xxx.pdf" and "r01an3919ejxxxx-raj240xxx.pdf".

Note GUI based application software (RSB TOOL2.exe) is provided to monitor command values, configure FGIC parameters and etc.

1. Ensure the RAJ240090 / RAJ240100 EVM is ready (Refer to Section 3.3).
2. Run RSB TOOL2.exe from the installed directory.
   If RSB TOOL2 is not installed in the PC, follow instructions in Appendix 5.9.
3. Choose the items that need to monitor by enabling the check box (Highlighted by **RED** frame in Figure 10)
4. Click [Start] button (for continuous data logging) or [Get Data 1 time] button (for single measurement) to update the data on the RSB_TOOL2. (Highlighted by **BLUE** frame in Figure 10)

To ensure the EVB is operating normally, check for the following three conditions. (Refer to Figure 11)

a. Mode is "Discharging"

b. Recorded Current is "0"

c. Recorded voltage is same as the voltage applied by "PS#1"

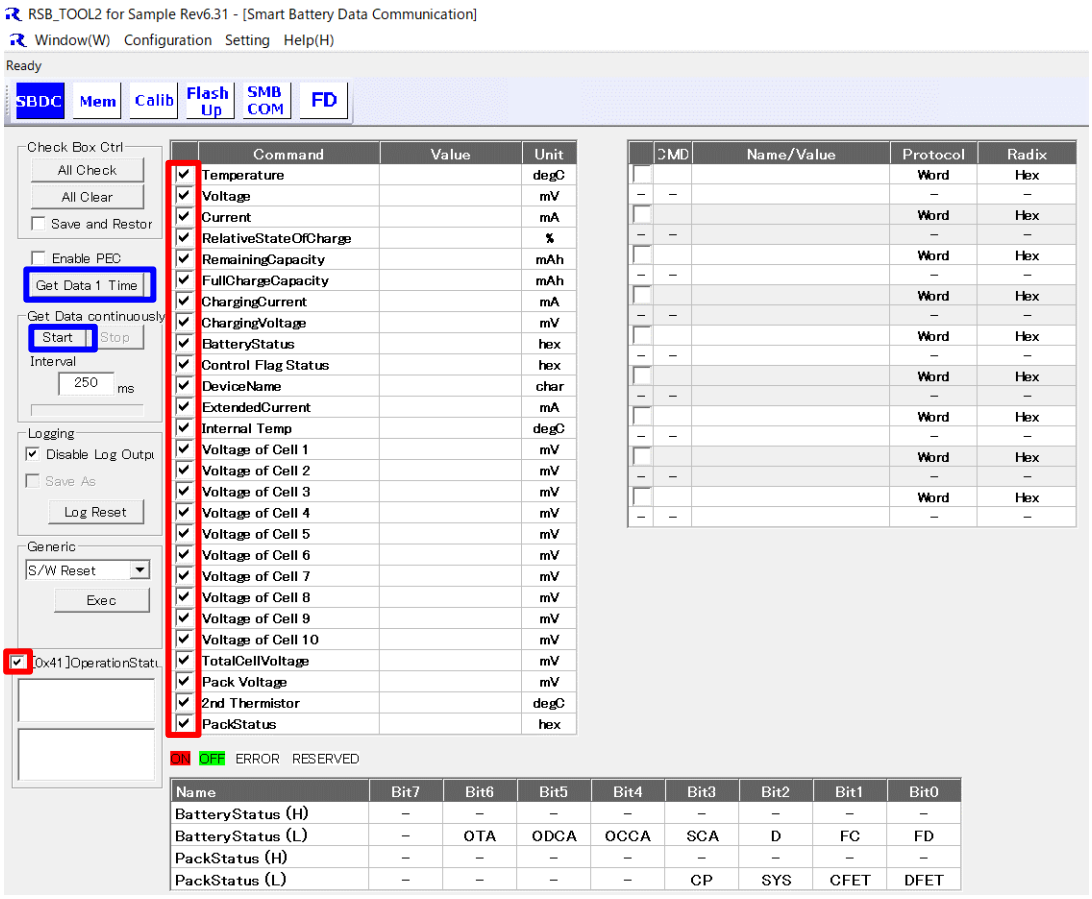


Figure 10 SBDC Screen Example

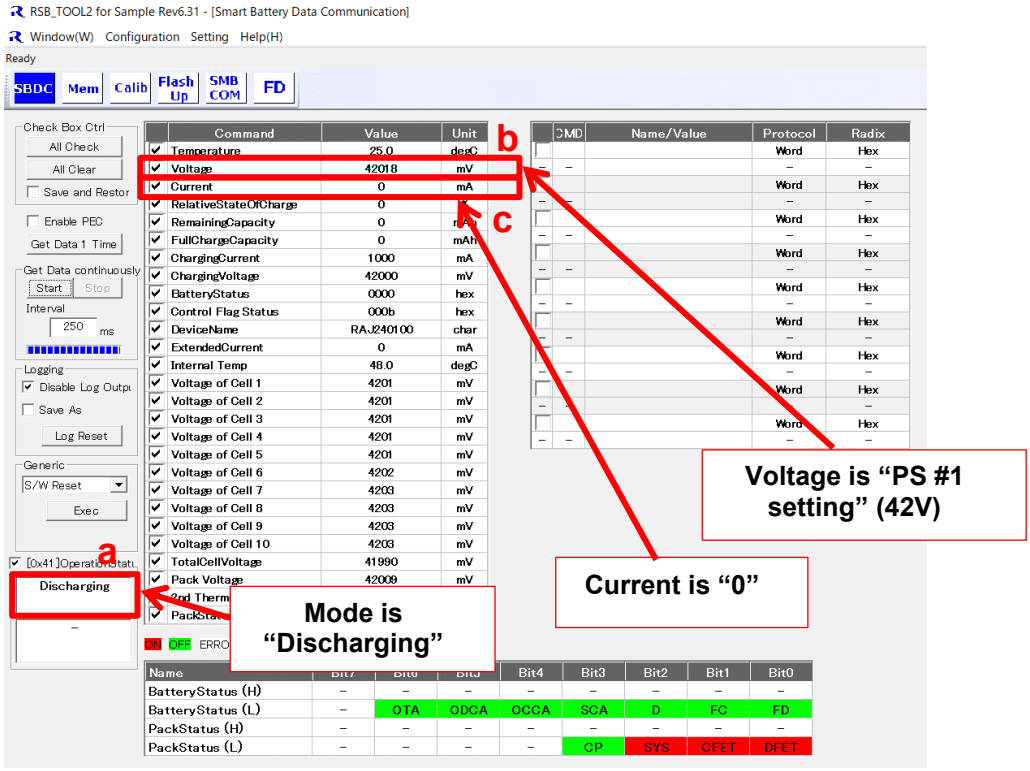


Figure 11 Boot-up Status

3.4.2 Change Configuration of Smart Battery Data

The RSB_TOOL2 has external sbs command file and uses this file to make configuration of Smart Battery Data on the SBDC screen. By creating new sbs command file in csv format, you can change the configuration of Smart Battery Data on the SBDC screen. It is necessary to place this sbs command file in the following directory.

Location : \tool\RSB_TOOL2\configuration\sbs\

The configuration file has two formats and you can create a csv format file.

1. Binary format
   This format file is placed in the above directory by default.
   This format can not be changed/modified/created by User as it is encrypted.

2. Csv format
   This format can be created by User using specific Excel file that is implemented Macro. This Excel file is placed on “configuration/generate” folder. For how to create, please refer to the specified Excel file.

Note: When csv format configuration file is used, only the following functions are valid.
I. Smart Battery Data Communication
II. Memory Access
III. Flash Update
IV. SMBus Command

3.5 Operation Example

3.5.1 Battery Discharge Test

Follow the steps below to perform battery discharge test.

Note A bipolar power supply (4 quadrant power supply) is recommended to emulate battery cells (cell side) as this type of power supply can sink and source current while maintaining the preset voltage. A DC electronic load is often used to emulate the system load (pack terminal side) conditions.

1. Ensure the DC Bipolar power supply setting is correct before starting the test. (Refer following examples)
   PS #1
   - Voltage Supply mode
   - Supply voltage = 42V (30V to 42V range)
   - Clamping current >1.0A

   PS #2
   - Current Sink mode
   - Current Sink = -0.5A

2. First, turn on Bipolar Power Supply of cell side(PS#1).
3. Next, turn on Bipolar Power Supply of pack side(PS#2).
4. Confirm Operation status (0x41) is in Discharge mode and current (0x09) turns into negative value.

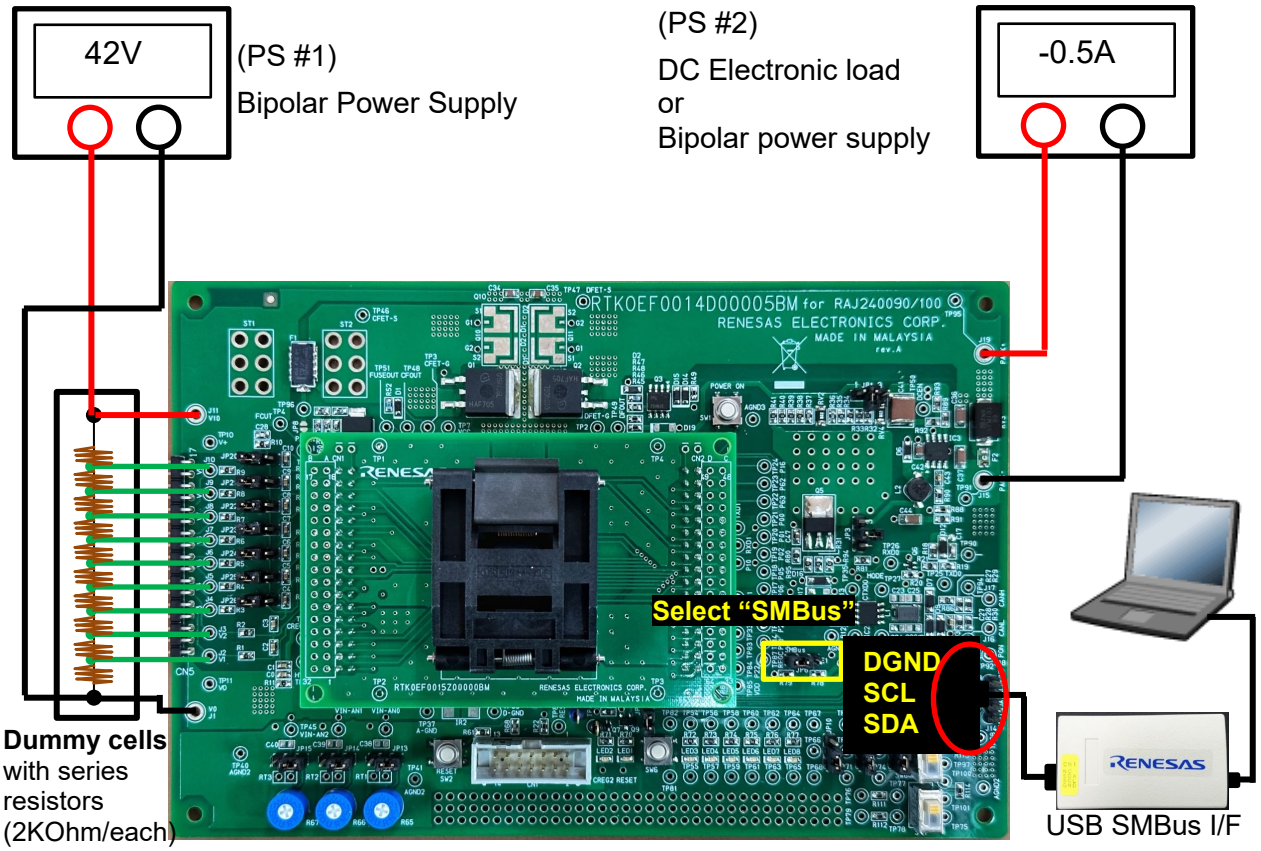


Figure 12 Battery Discharge Test (10 series cells configuration)

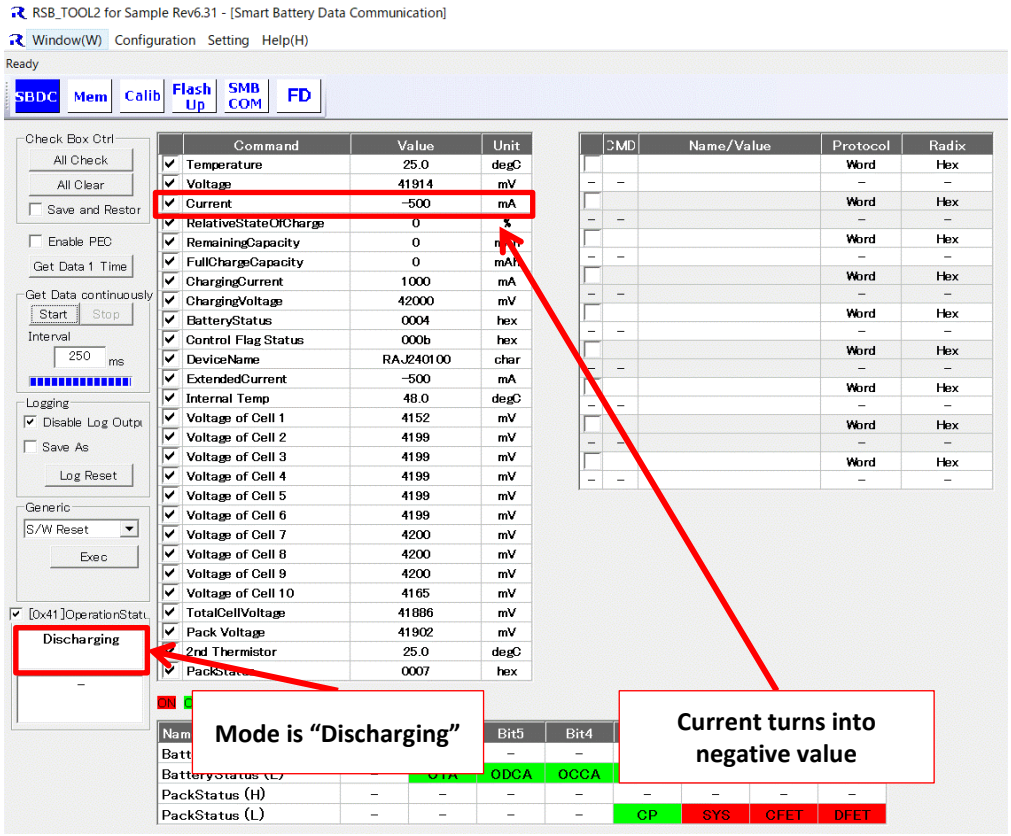


Figure 13 Battery Discharge Test Screen

3.5.2 Battery Charge test

Follow the steps below to perform battery charge test.

Note A bipolar power supply (4 quadrant power supply) is recommended to emulate battery cells (cell side) as this type of power supply can sink and source current while maintaining the preset voltage. A DC electronic load is often used to emulate the system load (pack terminal side) conditions

1. Ensure DC Bipolar power supply setting is correct before start. (Refer following examples)
   PS #1
   - Voltage Supply mode
   - Supply voltage = 40V (36V to 42V range)
   - Clamping current >0.5A

   PS #2
   - Current Source mode
   - Current Source = 0.5A
   - Clamping voltage > 42V (Max:50V)

2. First, turn on Power supply of cell side (PS#1).
3. Next, turn on Power supply of pack side (PS#2)
4. Confirm Operation status (0x41) is in Charging mode and current (0x09) turns into positive value.

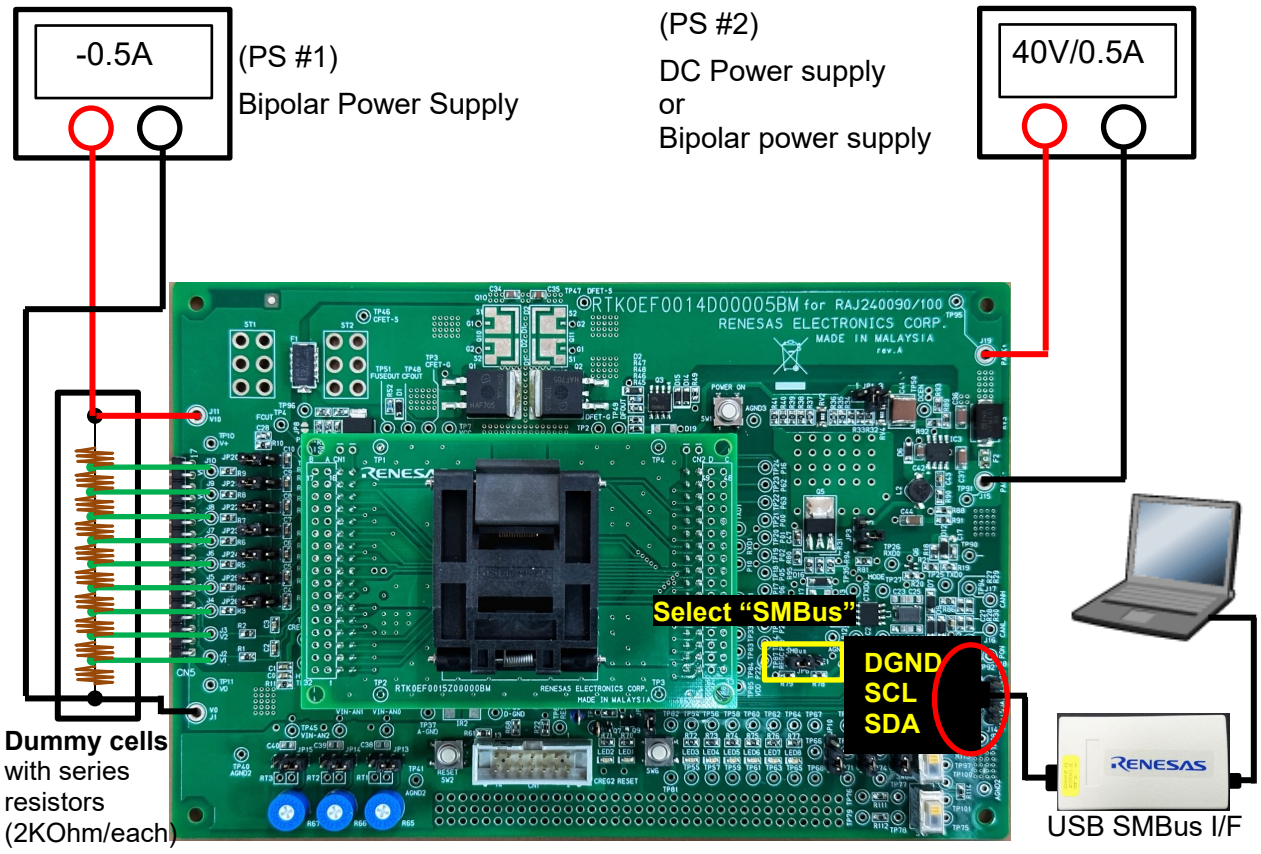


Figure 14 Battery Charge Test (10 series cells configuration)

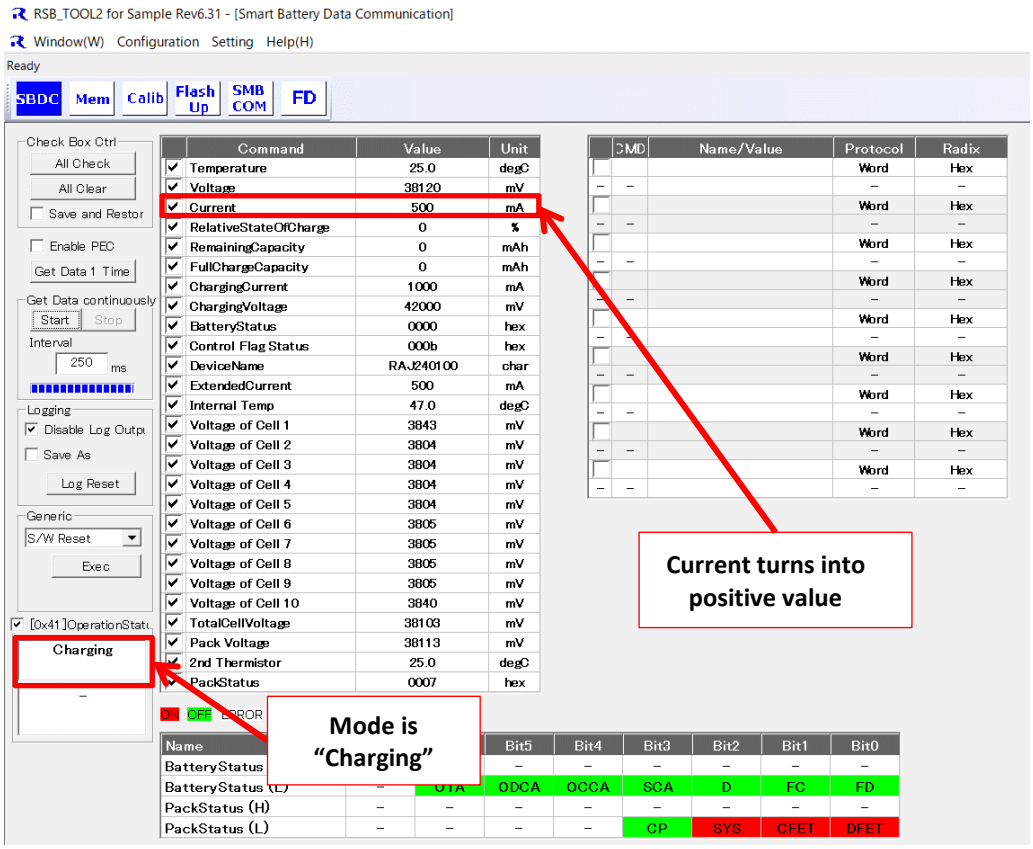


Figure 15 Battery Charge Test Screen

4. Advanced Operation

This chapter explains advanced development procedure using EVM setup. However, depends on the setting , erase prohibition area of FGIC flash memory is erased when using E1/E2 emulator. Therefore, we strongly recommended the backup the erase prohibition area of flash memory before the evaluation. Please refer to section 4.6.2 and 4.8.

4.1 EVM Connection with Renesas E1/E2 emulator

Figure 16 shows an example of the EVM connection. In this example, the board is configured for 10 series cells configuration, JP6 is set to E1 pin, and the board is using Renesas E1/E2 emulator.

The configuration is same as Figure 7, with exception JP6 configuration and E1/E2 emulator connection.

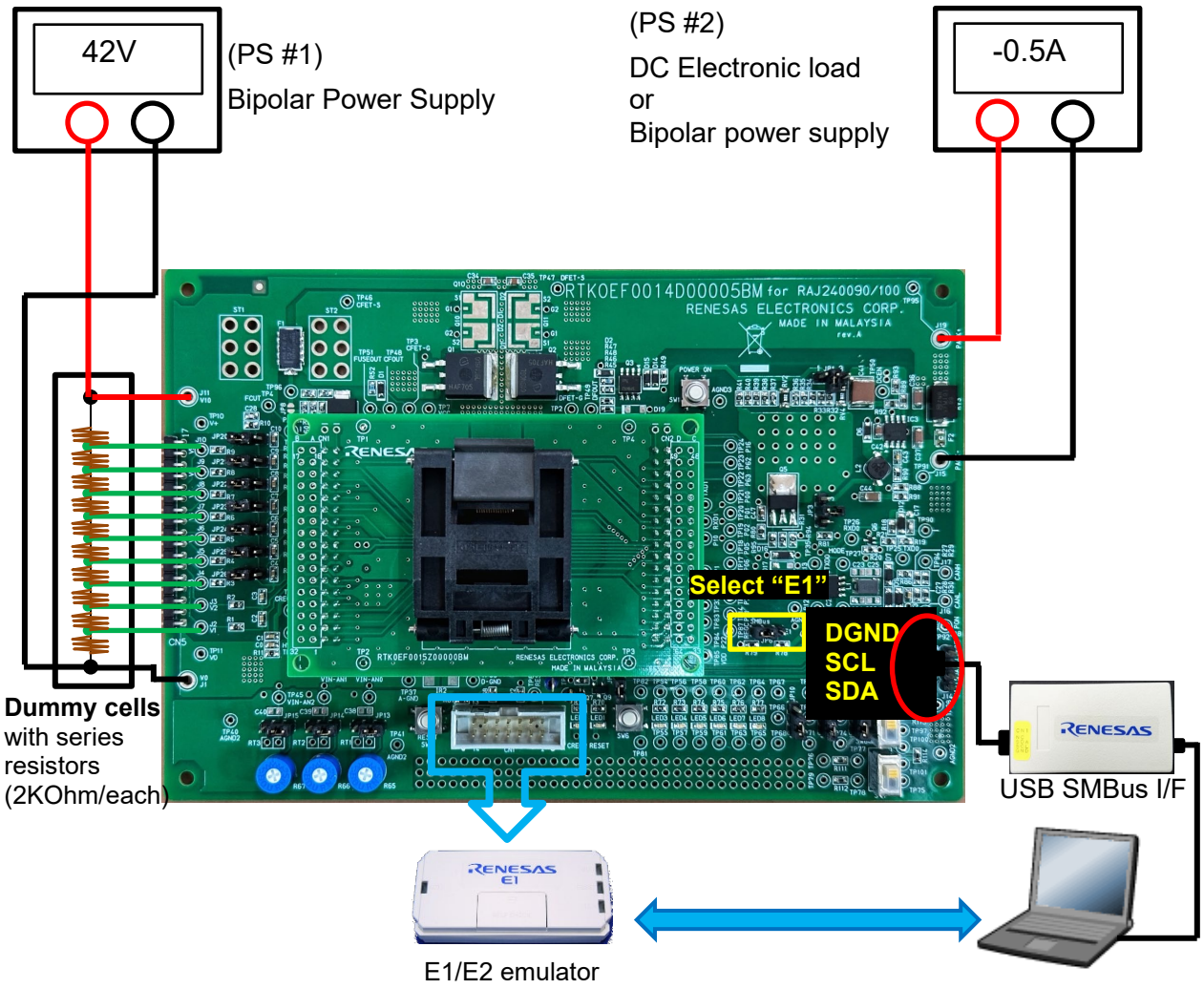


Figure 16 RAJ240090 / RAJ240100 EVM connection with E1/E2 emulator

4.2 E1/E2 Emulator operation: Important notice for CS+ user

Renesas provides RAJ240090 / RAJ240100 CS+ project sample source code as a part of the starter kit. This section explains essential information to use CS+, an integrated development environment (IDE) for Renesas MCU products.

If Incorrect ID code error occurred as shown in Figure 17 and cannot connect with E1/E2 emulator, please refer to appendix Section 5.3 for further details.

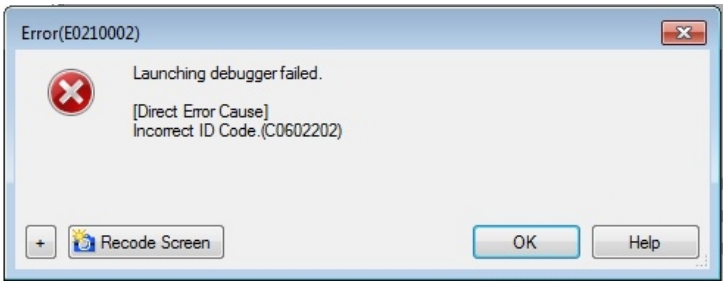


Figure 17 Incorrect ID Code Error

4.2.1 Download mode

Before connecting to the E1/E2 emulator, please ensure that the Download mode is set to “Data priority”.

Precaution If the E1/E2 emulator is connected when CS+ download mode is set to “Speed priority”, RAJ240xxx will lose essential information (trimming data and SMBus boot program). If the data need to be backed up, please refer to Section 4.6.2 and Section 4.9 for more details.

1. Click "**RL78 E1/E2(Serial) (Debug Tool)** " in Project tree.
2. Select "**Download File Settings**" tab.
3. Chage "**Download Mode**" from "**Speed priority**" to "**Data priority**".

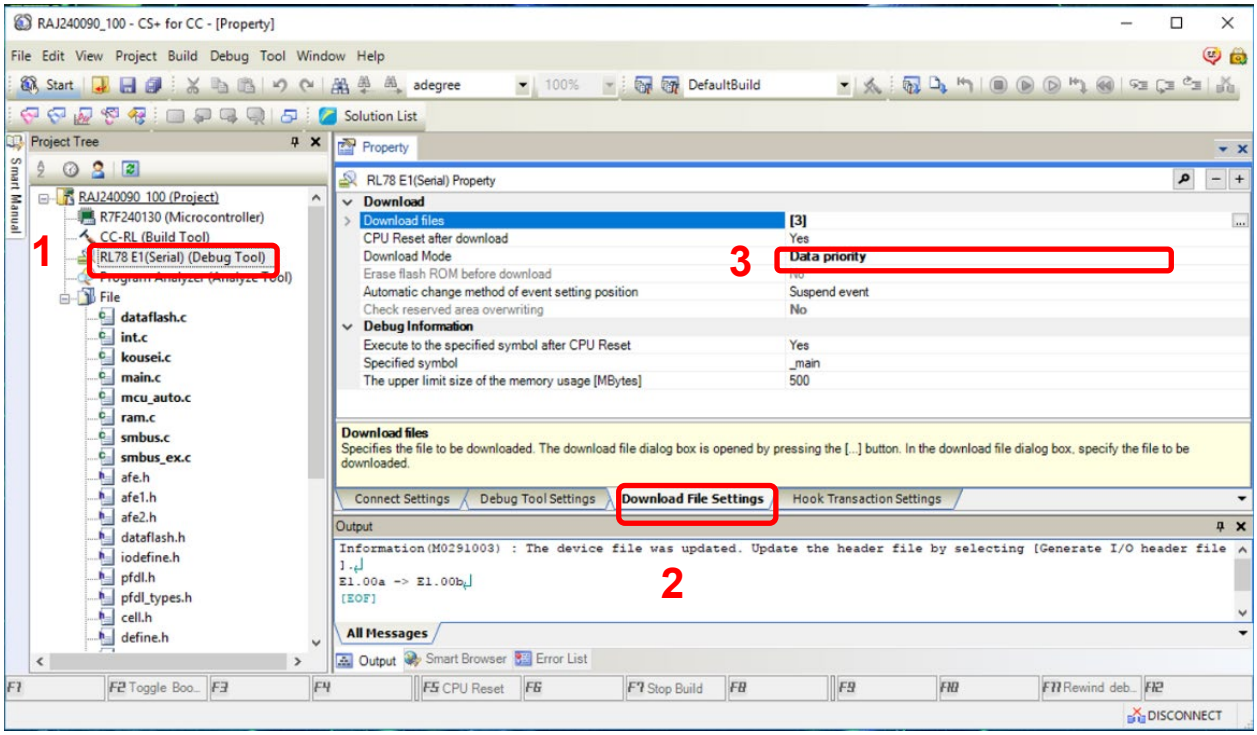


Figure 18 setting screen of CS+

4.2.2 Option byte setting (00C3H)

RAJ240090 / RAJ240100 has on chip debug option byte. (Address: 00C3H). With the following specification.

If E1/E2 emulator is used, the recommend setting is “85H”. The sample source code has preset it to “85H”.

Caution **Setting it to “84H” will fail security ID authentication, and RAJ240090/RAJ240100 will erase all flash memory.**

Bit 7	Bit 6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
OCDENSET	0	0	0	0	1	0	OCDERSD

Table 12 Option byte (00C3H/010C3H) specification

OCDENSET	OCDERSD	Operation
0	0	Disables on-chip debug operation.
0	1	Setting prohibited.
1	0	Enables on-chip debug operation. **Erases data of flash memory in case on-chip debug security ID authentication failure**.
1	1	Enables on-chip debug operation. Does not erase data of flash memory in case of on-chip debug security ID authentication failure.

4.2.3 Limitation of the RSB TOOL2 function

While debugging with E1/E2 emulator, the RSB TOOL2 menu as below are only available.

[SBDC]
[SMBCOM]

Note: For the debugger connection conditions, refer to the manual of E1/E2 emulator.

4.3 RAJ240090 / RAJ240100 boot up with E1/E2 emulator

Please confirm the settings of Section 4.1 before using E1/E2 debugging.

1. Connect each equipment based on Figure 16.
2. Confirm JP6 selects E1.
3. Apply voltage (3V to 4V per cell) between V+ and V- using PS#1 or connect Li-ion battery from the bottom to top.
4. Apply voltage (4.2V per cell) between Pack+ and Pack- using PS#2. This procedure is needed for RAJ240090/RAJ240100 to boot up. The boot up can be done by pressing switch S1 instead of applying voltage using PS#2 when there is no load and no power supply connected between Pack+ and Pack-.
5. Confirm LED2 is turned on. If LED2 is still off, please try to press SW1 or check the connection.
6. Open RAJ240090 / RAJ240100.mtpj to start CS+.
7. Select "**Connect to Debug Tool**" in Debug
8. Select "**Download**" to write firmware into PC
9. Push "**start**" button or click "**Go**" to run the firmware.

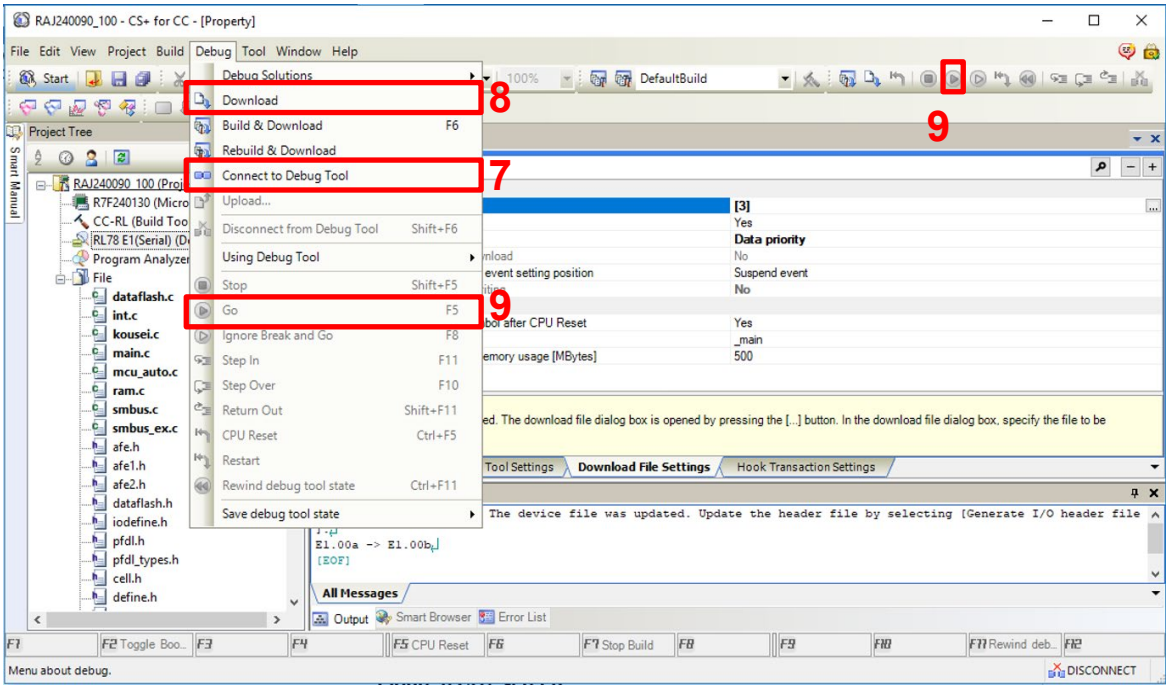


Figure 19 CS+ screen

4.4 Update / Download firmware

There are three options to update/download firmware into the device.

To perform firmware update/download, Renesas recommends using CS+ or RSB TOOL2.

Table 13 Comparison table for firmware update/download

Procedure (Tool)	Pros	Cons	Section
CS+	When using E1/E2 emulator, do not need to change configuration.	Need to use E1/E2 emulator Need to be caution about Download mode setting	4.4.1
RSB TOOL2	No need to use E1/E2 emulator	Need to use USB SMBus I/F	4.4.2
RFP	-	If block setting is not appropriate, RFP erase essential data.	5.4

4.4.1 Download procedure using CS+

1. Perform EVM boot up (Refer to Section 4.3)
2. Click "**Connect to Debug Tool**" in the Debug menu
3. Click "**Download**" to update firmware.

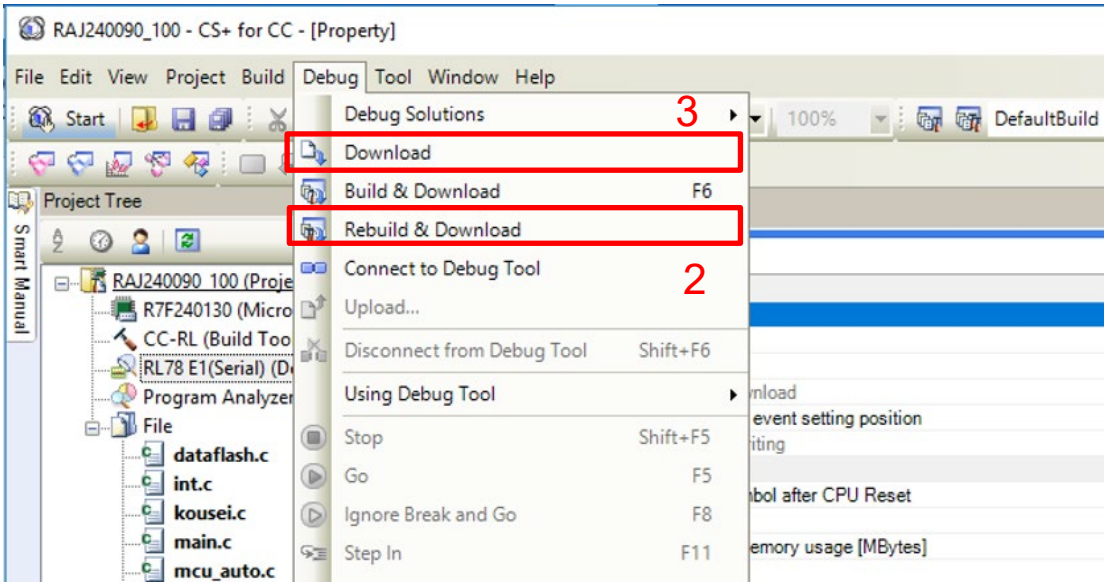


Figure 20 Firmware download by using CS+

4.4.2 Download procedure using RSB TOOL2

There are two ways to update firmware. One is using E1/E2 emulator and another is using RSB_TOOL2.

This section explains how to update firmware using RSB_TOOL2 when EVM is active.

1. Store the target file of update to UpdateFiles folder, before update.
2. Click [**Flash Up**] button on RSB TOOL2
3. Click "**Update**" button
4. Check the status on the After update information window.

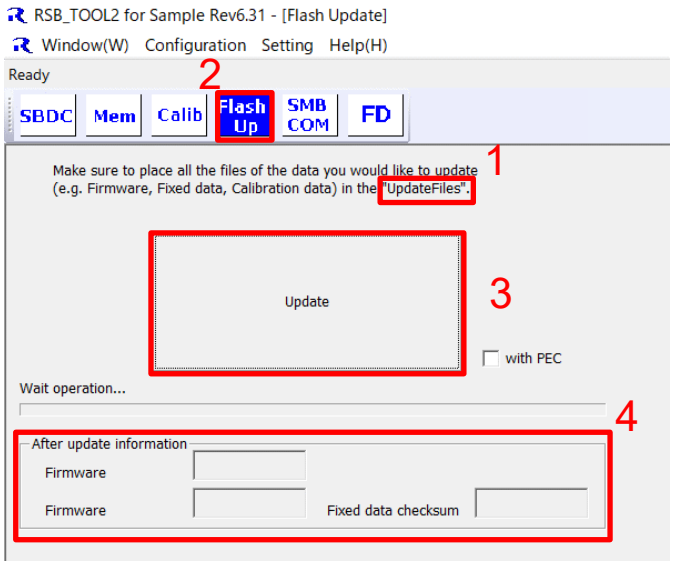


Figure 21 download by using RSB TOOL2

You can select files at each update by changing options. Please refer to specification of the RSB TOOL2 (r01an3920ej0xxx-raj240xxx).

4.5 Parameter modification with RSB TOOL2

It is strongly recommended to update FGIC parameters such as protection threshold, number of series cells and etc. based on battery pack characteristics to ensure proper operations and accurate measurements.

There are two options to modify the parameters as described in Section 4.5.1 (simplified parameter modification assist) and Section 4.5.1 (detailed parameter modification, which is more complicated). To use these functions, the EVM needs to boot-up as described in Section 3.3 and 3.4.

4.5.1 Parameter modification by Mem button

1. Click **[Mem]** button on RSB TOOL2.
2. Click "**Read from MCU**" or "**Import mot file**" button and select target file.
3. Select target parameter category.
4. Click target parameter edit box and modify the value.
5. Click "**Write to MCU**" to write back parameters to RAJ240090 / RAJ240100

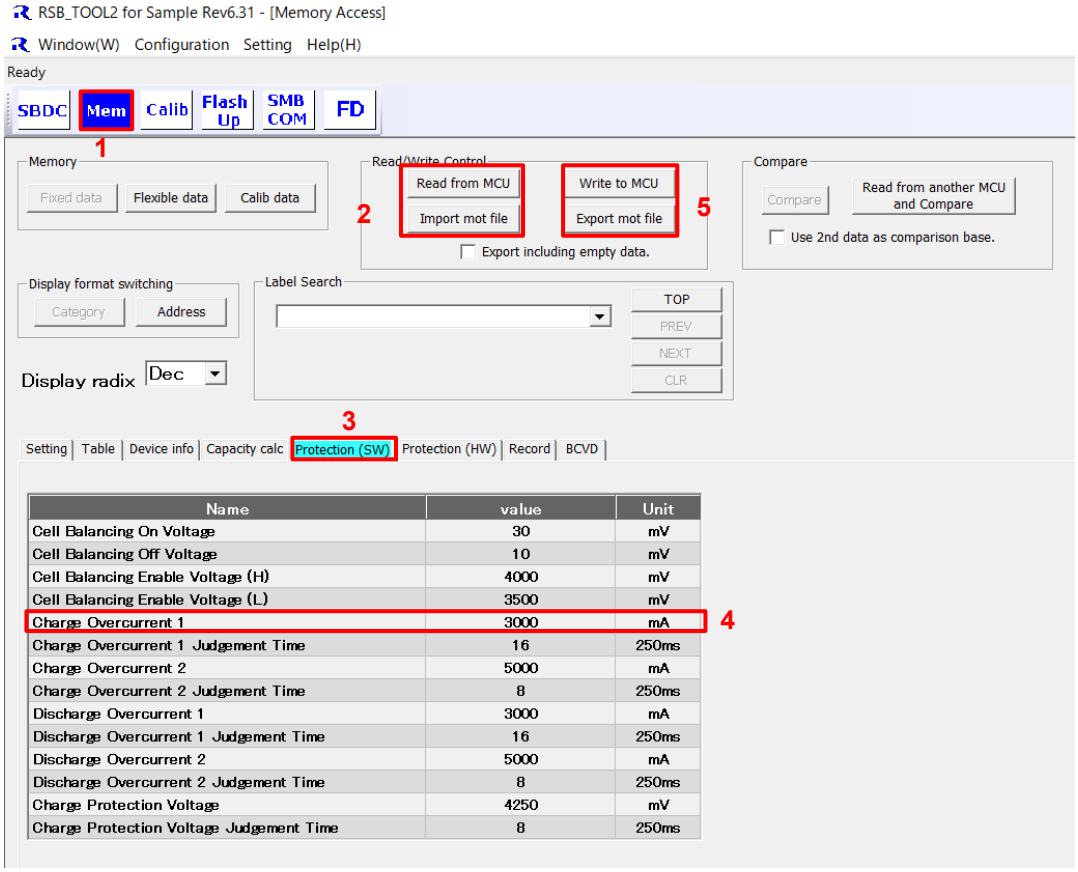


Figure 22 Charge overcurrent 1 setting by [Mem] button

4.5.2 Parameter of cell configuration

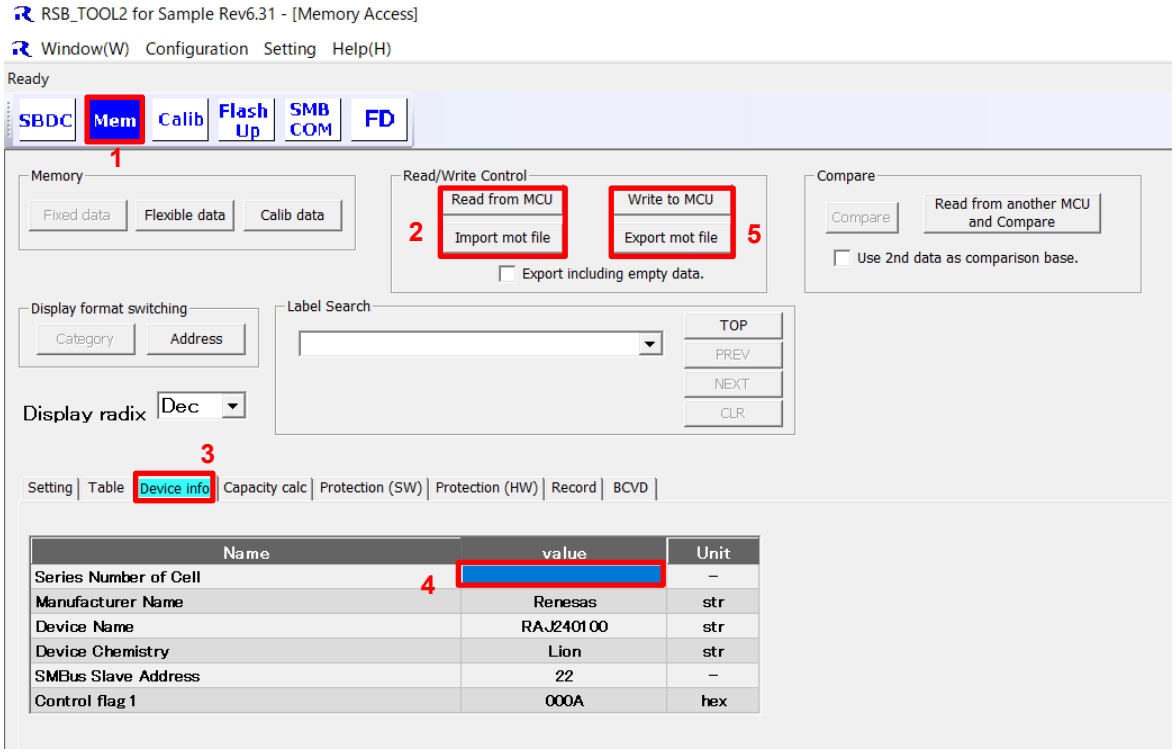
When the configuration of the cell changes depending on the system requirement, the series number of cell must be changed at least. This section explains how to change it as an example of parameter modification.

(Refer to Section 2.3.5 for board setting)

(1) Series of Cells

FGIC measures each cell voltage based on a series number of cell information. It can be configured in the memory access window. Click [Mem] button to display intuitive design screen for users to configure major parameters easily. Followings are procedures to update FGIC parameters.

1. Click **[Mem]** button
2. Click "**Read from MCU"** or "**Import mot file"** button to activate parameter edit
3. Select **"Device info"** tab.
4. Click **"Series Number of Cell"** to modify the parameter.
5. Click **"Write to MCU"** or **"Export mot file"** button to apply modification



(2) Parallel of cells

The sample code does not have any setting for number of parallel cell information. Battery cells in parallel can be handled as one battery cell, but several parameters must be updated to accommodate changes. When changing the parallel number of cells, the following parameters are affected.

- Initial Full Charge Capacity
- Over Current parameters
- Full Charge Judgement parameters

4.5.3 Change Configuration of Battery Parameter

The RSB_TOOL2 has external memory map file and uses this file to make configuration of battery parameter on the MEM screen. By creating new memory map file in csv format, you can change the configuration of battery parameter on the MEM screen. It is necessary to place this memory map file in the following directory.

Location : \tool\RSB_TOOL2\configuration\memory\

The configuration file has two formats and you can create a csv format file.

3. Binary format
   This format file is placed in the above directory by default.
   This format can not be changed/modified/created by User as it is encrypted.

4. Csv format
   This format can be created by User using specific Excel file that is implemented Macro. This Excel file is placed on “configuration/generate” folder. For how to create, please refer to the specified Excel file.

Note: When csv format configuration file is used, only the following functions are valid.
I. Smart Battery Data Communication
II. Memory Access
III. Flash Update
IV. SMBus Command

4.6 Initial calibration

To ensure system accuracy, it is recommended to perform initial calibration.

Basically, the starter kit is shipped with typical calibration values stored. However, it is recommended to perform calibration for voltage, current, and temperature during initial run.

Renesas solution comes with two options for calibration, “One-point” calibration and “Two-point” calibration.

Two-point calibration provides better performance as compare to One-point, but involves more complicated procedure.

The calibration method can be selected based on application, and this can be configured by selecting the Control Flag bits in the parameter setting. In this section both are explained.

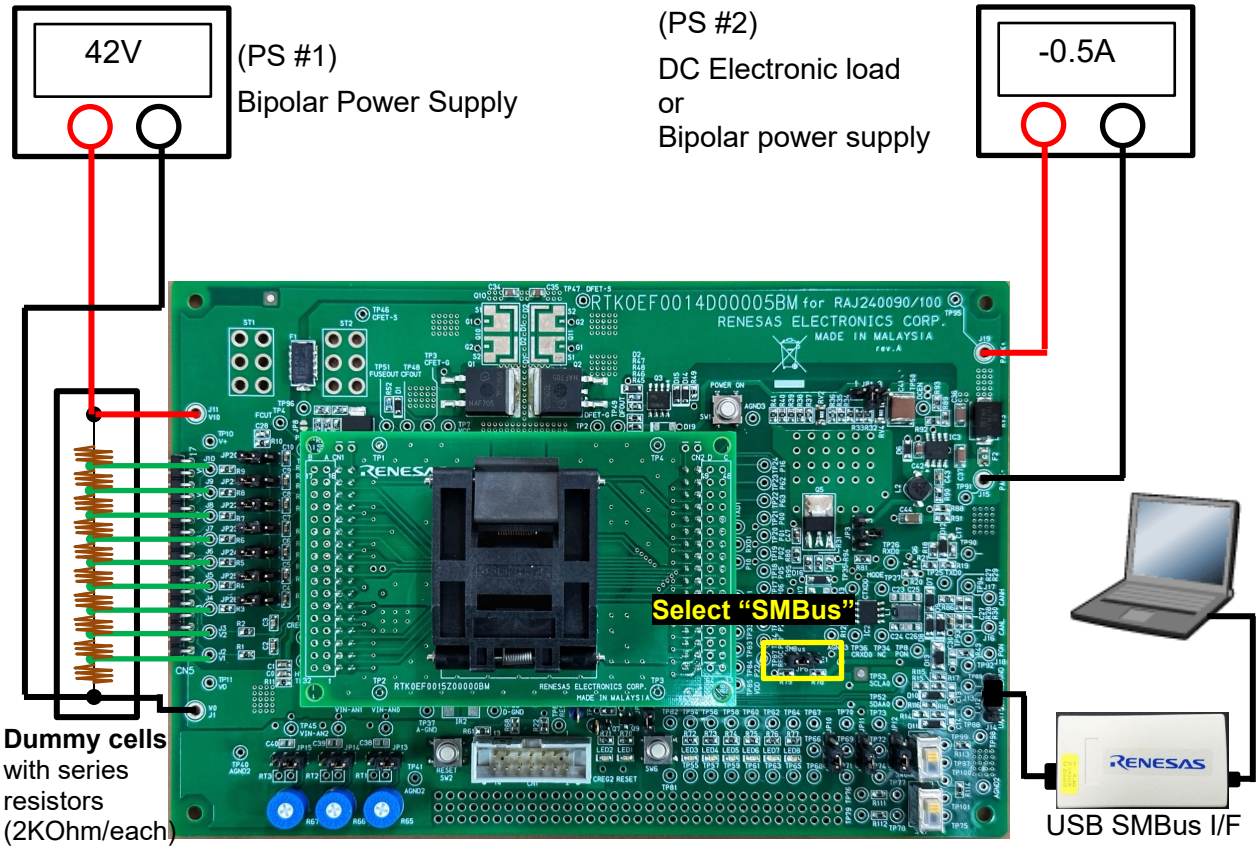


Figure 23 Setup configuration of Initial calibration

Note1 Initial calibration can be carried out repeatedly if necessary.
Note2 Do not connect E1/E2 emulator when operating initial calibration.
Note3 Fixed data must to be stored the device before the initial calibration.
Note4 Protection functions are enabling even during the calibration mode, therefore calibration values should be set below protection detection value.

4.6.1 Two-point calibration

1. Click [**Calib**] button on RSB TOOL2. (Figure 24)
2. Click "**Ready**" button to start calibration
3. Input each input boxes as follows. (Value is example)
   a. Cell all (L) : 2000 [mV]
   b. PackCellVoltage (L) : 20000 [mV]
   c. Cell all (H): 4000 [mV]
   d. PackCellVoltage (H) : 40000 [mV]
   e. Discharge: 500 [mA]
   f. Temperature: 25 [°C]
4. Apply 20V between V+ and V- using PS #1. After that, click **Cal and Ref** button in green-highlighted area as seen in Figure 25.
5. Push "**Cal and Ref"** button in 0A and Temperature *Note1.
6. Apply **40V** between V+ and V- using PS #1. Then, click "**Cal and Ref"** button in blue-highlighted area as seen in Figure 25.
7. Turn on EQ#2 and load 0.5**A***Note2 between Pack + and Pack-, and click "**Cal and Ref"** button in Discharge. Then, turn off PS #2.
8. Click "**Finish"** button to finish calibration

Note1 Ideally, temperature is calibrated by using a thermostatic chamber. To make it simple and easy, users can set the data of room temperature into the Temperature box for rough evaluation.

Note2 It is recommended to use the most used current or higher for the discharge current calibration value.

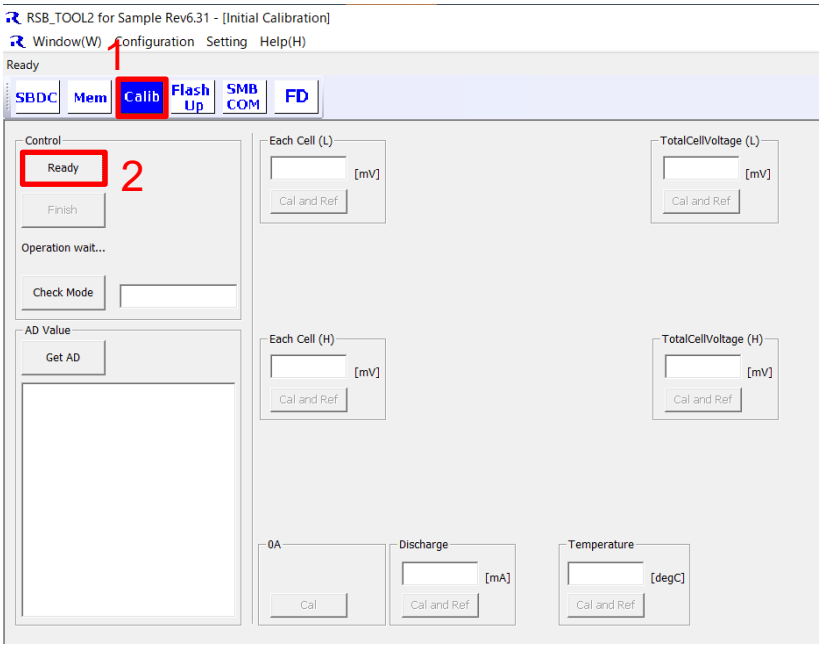


Figure 24 Initial calibration window

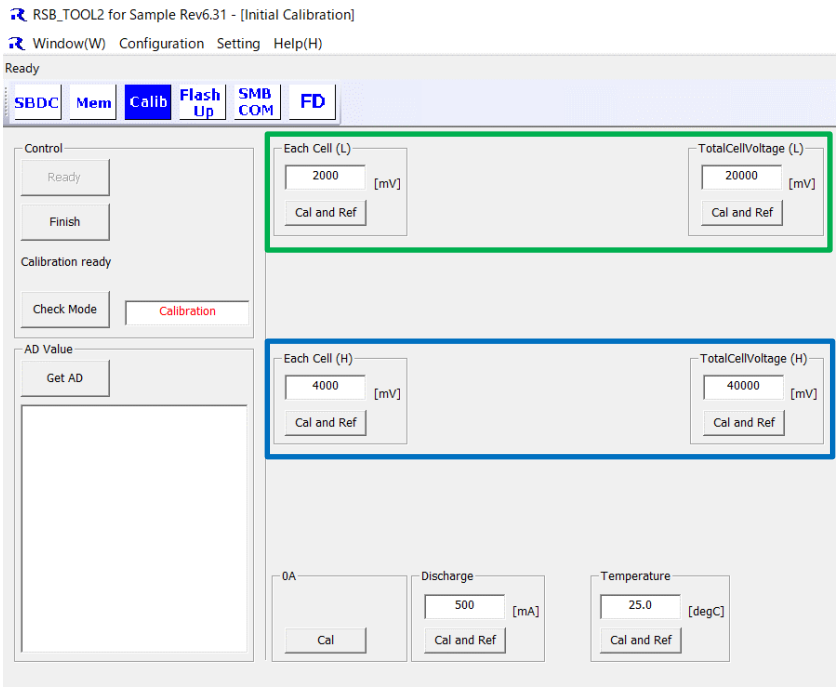


Figure 25 Two-point calibration ready

4.6.2 One-point calibration

1. Click [**Calib**] button on RSB TOOL2
2. Click "**Ready**" button to start calibration
3. Input each input boxes as follows. (Value is example)
   a. Cell all (H): 4000 [mV]
   b. PackCellVoltage (H) : 40000 [mV]
   c. Discharge: 500 [mA]
   d. Temperature: 25 [°C]
4. Apply **40V** between V+ and V- using PS #1.Then, click "**Cal and Ref"** button in blue-highlighted area of Figure 26.
5. Push "**Cal and Ref"** button in Temperature *Note1.
6. Turn on EQ#2 and load **0.5A***Note2 between Pack + and Pack-, and click "**Cal and Ref"** button in Discharge. Then, turn off PS #2.
7. Click "**Finish"** button to finish calibration

Note1 Ideally, temperature is calibrated by using a thermostatic chamber. To make it simple and easy, users can set the data of room temperature into the Temperature box for rough evaluation.

Note2 It is recommended to use the most used current or higher for the discharge current calibration value.

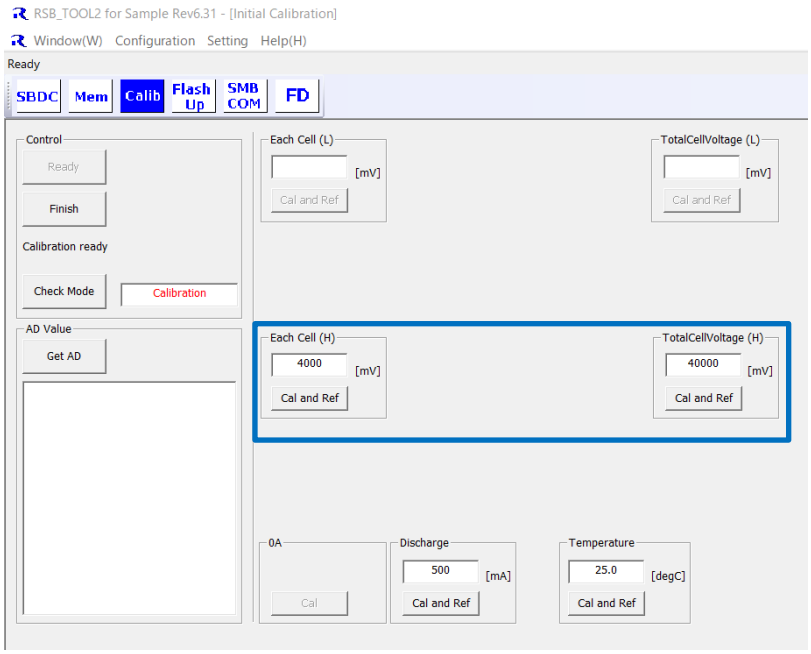


Figure 26 One-point calibration

4.7 Memory Map and Erase Prohibition Area

The RAJ240090 / RAJ240100 memory map has an erase prohibited area which is not physically protected. (refer to Figure 27)

The user needs to operate consciously so that the erase prohibited area will not disappear.

The detail of erase prohibition area is described at the following sections.

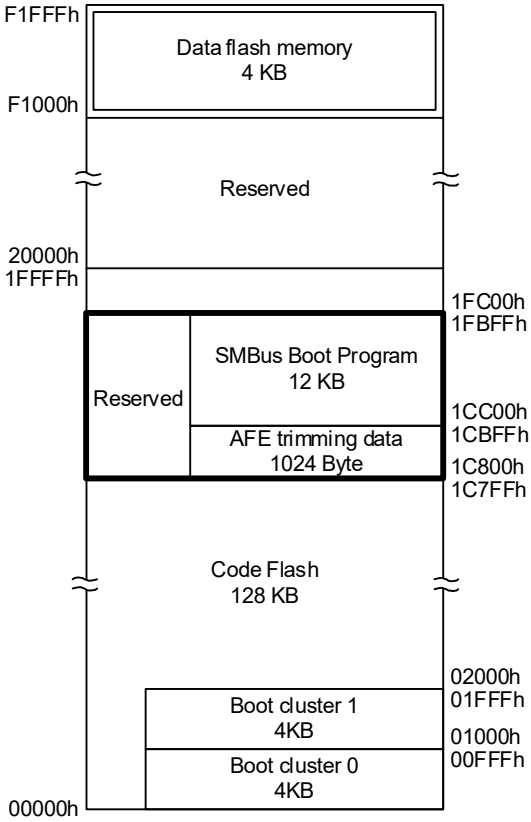


Figure 27 Erase prohibition area

4.7.1 AFE trimming data

AFE trimming data is the device specific value needed for the device to operate correctly. Therefore, when the trimming data is erased, the device will not operate normally. Each trimming data and its address are shown Table 14.
This AFE trimming data can be back-up when E1/E2 emulator started. Please refer to Section 4.8.

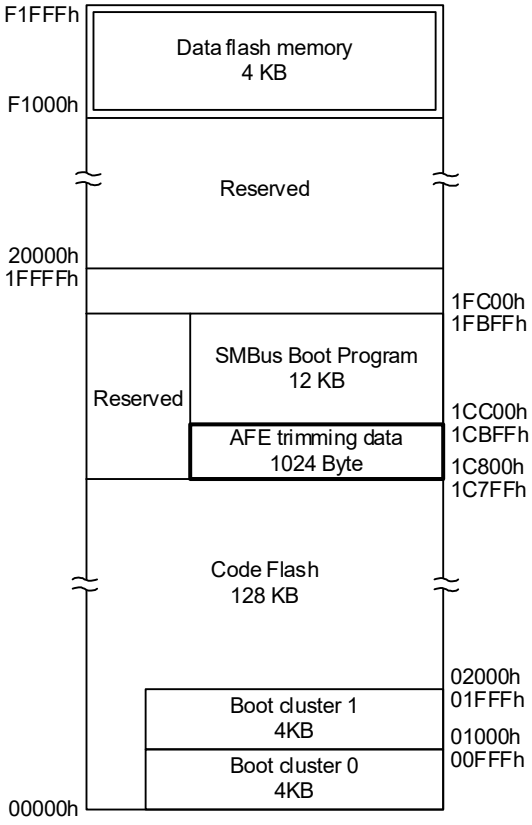


Figure 28 Memory Map

Table 14 Trimming data address

Trimming	Trimming data stored address (CPU)	Trimming register			Setting order *
		Symbol(AFE)	Symbol(MCU)	AFE address Window (trim)	
AFE Reference Voltage	1C865H	BT0	AFEREG0A	F050AH	1
AFE Reference Voltage	1C866H	BT1	AFEREG0B	F050BH	2
VREG2 Voltage (3.3V)	1C86BH	REG2T	AFEREG10	F0510H	3
VREG2 Voltage (5.0V)	1C86CH	REG2T	AFEREG10	F0510H	3
AFE internal buffer Voltage	1C869H	BUFT0	AFEREG0E	F050EH	4
AFE internal buffer Voltage	1C86AH	BUFT1	AFEREG0F	F050FH	5
AFE On-chip Oscillator	1C860H	AOCOT0	AFEREG04	F0504H	6
AFE On-chip Oscillator	1C861H	AOCOT1	AFEREG05	F0505H	7
AFE On-chip Oscillator	1C862H	AOCOT2	AFEREG06	F0506H	8
AFE Low-speed On-chip Oscillator	1C863H	ALOCOT0	AFEREG07	F0507H	9
AFE Low-speed On-chip Oscillator	1C864H	ALOCOT1	AFEREG08	F0508H	10
ADC Reference Voltage	1C867H	RT0	AFEREG0C	F050CH	11
Current integration Reference Voltage	1C868H	RT1	AFEREG0D	F050DH	12
MOSFET Voltage Boost	1C86DH	FCPT0	AFEREG11	F0511H	13

* Note Register setting order is recommended value.

4.8 Back up procedure of trimming data

After changing Download mode to “Data priority” (refer to Section 4.2.1), essential data can be backup by using below steps.

1. Select “**Connect to Debug tool**” in Debug.
2. Select “**Upload**” in tab.
3. Specify File name, File type, and Save range (address) as follows
   File Name: Any name
   File Type: Intel Hex format
   Start Address: 0x1C800H
   End Address: 0x1FBFFH
4. Push “**Save**” button to save. File is backed up in the folder where there is “.mtpj”.
5. Click “**Disconnect from Debug tool**” in Debug

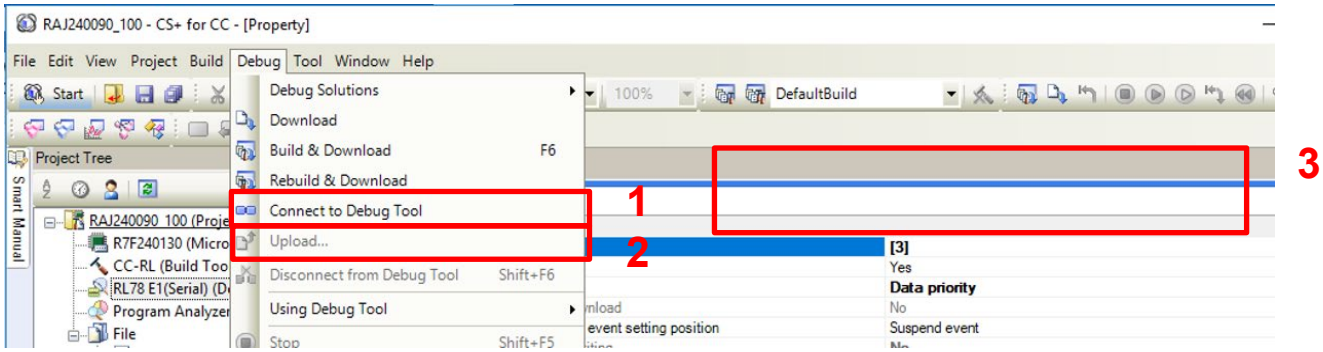


Figure 29 Backup procedure

4.9 Procedure to restore trimming data

Essential information can be written back by following methods.

Note If the trimming data is erased accidentally due to misconfiguration of the emulator during startup mode, in order for the device to operate normally, it is necessary to recover the erased trimming data.

In addition to backup data, other data can be downloaded and restore other files by using this procedure.

1. Click "**RL78 (Serial) (Debug tool)**" and select "**Download File setting**" tab.
2. Click "**…**" button to modify download settings
3. Click "**Add**" button to add target file.
4. Add information and Push "**OK**"
5. When downloading files, CS+ downloads the additional file into target IC via E1/E2 emulator as well.

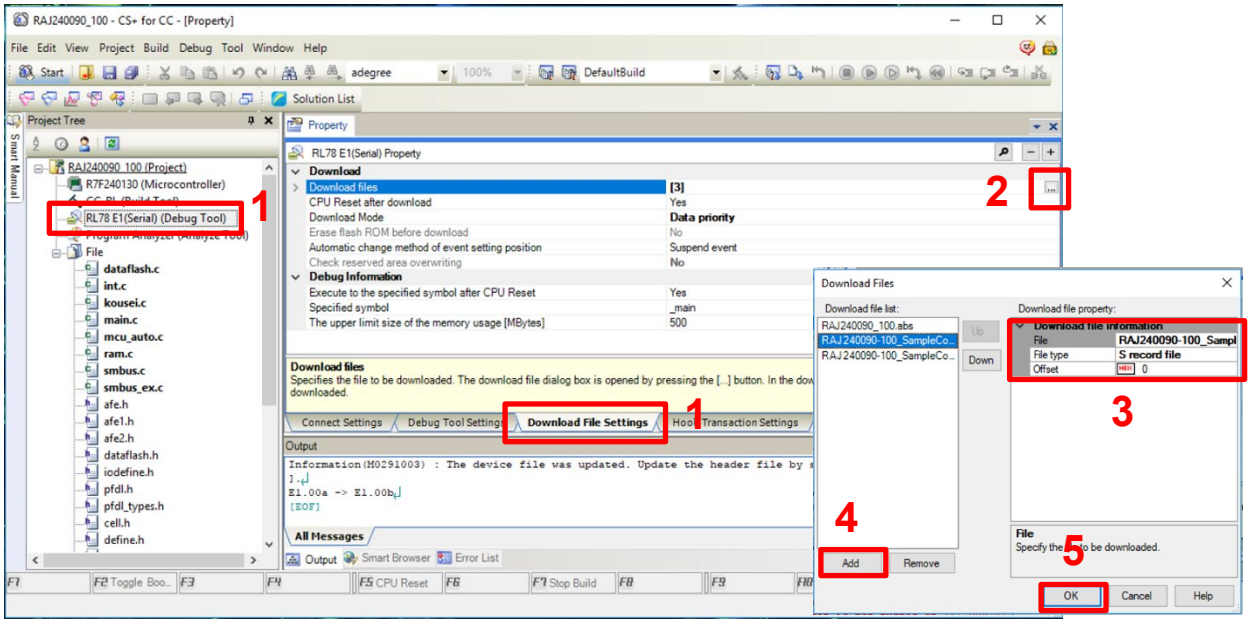


Figure 30 Restore setting

4.10 Factory default

4.10.1 Factory default overview

This function resets the IC's status such as firmware, Fixed data, and Calibration data to the factory default. If you change firmware, fixed data, and calibration data by accident and FGIC does not work properly, this function helps to return to the initial state easily if IC does not have hardware damage.
It is also applicable to blank chip. The factory default function helps a lot to setup IC to ready to use.

RSB_TOOL2 does not read/write trimming area. If you want to back up/write back trimming data, please perform section 4.8 and section 4.9 in advance.

4.10.2 Factory default procedure

Procedure is as follows. Also, a jumper wire is required for entry in update mode in the step 2.

1. Connect each equipment according to Figure 7 without (PS#2).
2. Connect the TOOL0 (TP31) terminal to V0 (cell minus) by jumper wire for enter the flash ROM update mode
3. Apply 36V between V+ and V- using PS #1
4. Push SW1 to boot up EVB
5. Confirm LED 1 and 2 in EVB turned on.
6. Open RSB_TOOL2_for_Sample_RevX.XX.exe
7. Click "**FD**" button
8. Select the same number of series cells as the board setting. (10cell is default)
9. Click "**Reset to the factory default**" and confirm followings.
   If you fail to reset to the factory default, please check system configuration then push the SW2. Then, try it from procedure 8
10. Firmware version/checksum/Fixed data checksum will be displayed in update information area.
11. Turn off PS#1. Put out the IC and put into next target IC. Repeat from procedure 3.

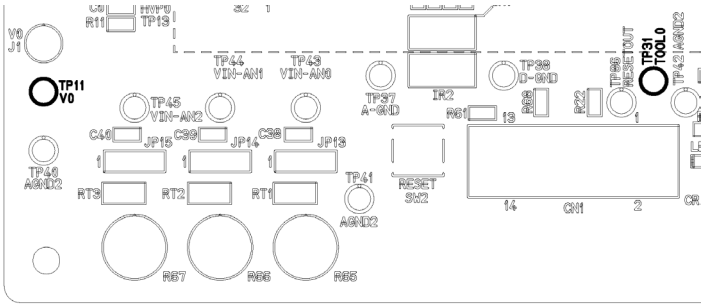


Figure 31 Terminal of update mode entry

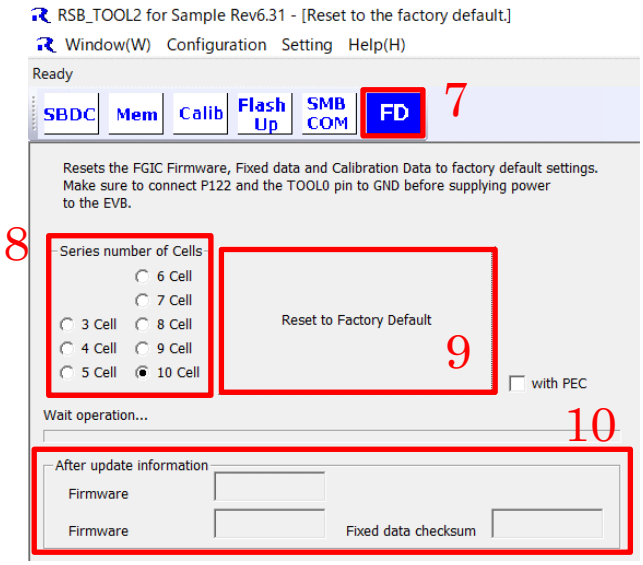


Figure 32 Factory default

5. Appendix

5.1 CS+

CS+ is an integrated development environment for Renesas MCU products. This section explains the setup procedure before starting development of CS+ project.

Since FGIC products are supported at the CS+ for CC version 8.01 or later already. User can find the target FGIC in the device list of Using microcontroller window as following Figure. In this case, do not need device file installation. Please skip section 0.

If there is no particular reason, Renesas recommends to use CS+ for CC version 8.01 or later.

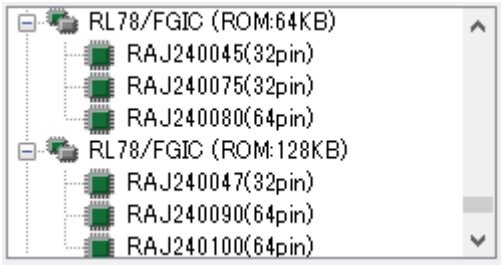


Figure 33 Device list in the Using microcontroller window.

Device file installation

Before creating a new CS+ project, it is necessary to have the microcontroller configuration files installed when using older version before CS+ for CC version 8.01. If you load the previous project file with the CS+ V8.01 or more, you also need to install the device file.

Note The device file package is compatible with CS+ CC-RL 6.00 or later.
The evaluation version of CS+ can be downloaded from the following website.

https://www.renesas.com/en-us/products/software-tools/tools/ide/csplus.html#downloads

For installation, copy "Device_Custom" folder in the “Device_Custom_FGC128K-S_E101c.zip” file, to the CS+ installation location.

By default, CS + is installed in drive C

"C:\Program Files\Renesas Electronics\CS+\CC"
"C:\Program Files\Renesas Electronics\CS+\CACX"

For using in CS + for CC V 3.01 and earlier, under Device_Custom, replace PG_before_CS + _ V 301 with the existing PG. (applicable only if it the file name is different)

Note In the latest release, PG data for "CS + V 3.01 or earlier" is added to the PG folder. Please pay attention and use the appropriate files.

5.1.1 Create new project

When creating a new CS+ project for RAJ240090 / RAJ240100, the microcontroller setting needs to be changed in CS+ base to the device used. Please select the “R7F240130” from device lists as follows when using older version before CS+ for CC version 8.01. If you are using the latest version of the CS+ please select the FGIC product name directly in the device list as Figure 33.

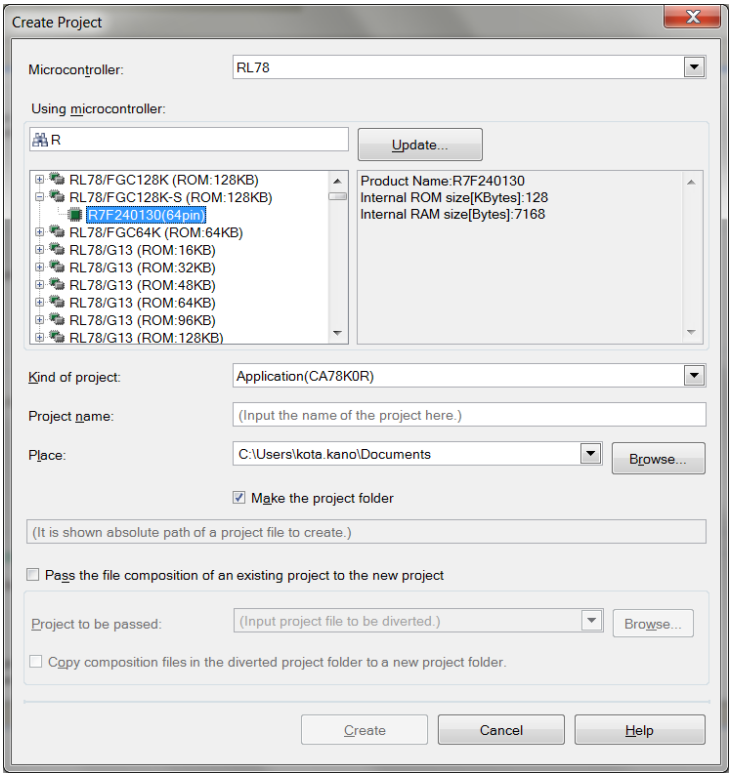


Figure 34 Create Project by CS+

5.1.2 Changing device file

When changing to another CS+ project, there might be a need to change the microcontroller configuration.

1. Right click "**R7F240130 (Microcontroller)**" and select "**Change Microcontroller**". Microcontroller name might different from **R7F240130** depends on the environment.
2. Click OK and ignore the popup message (Question (Q0232002)).
3. Select Target Microcontoroller from the list and select "OK".

When a new project is created using CS+ for Renesas FGIC, please modified using Renesas sample code project.

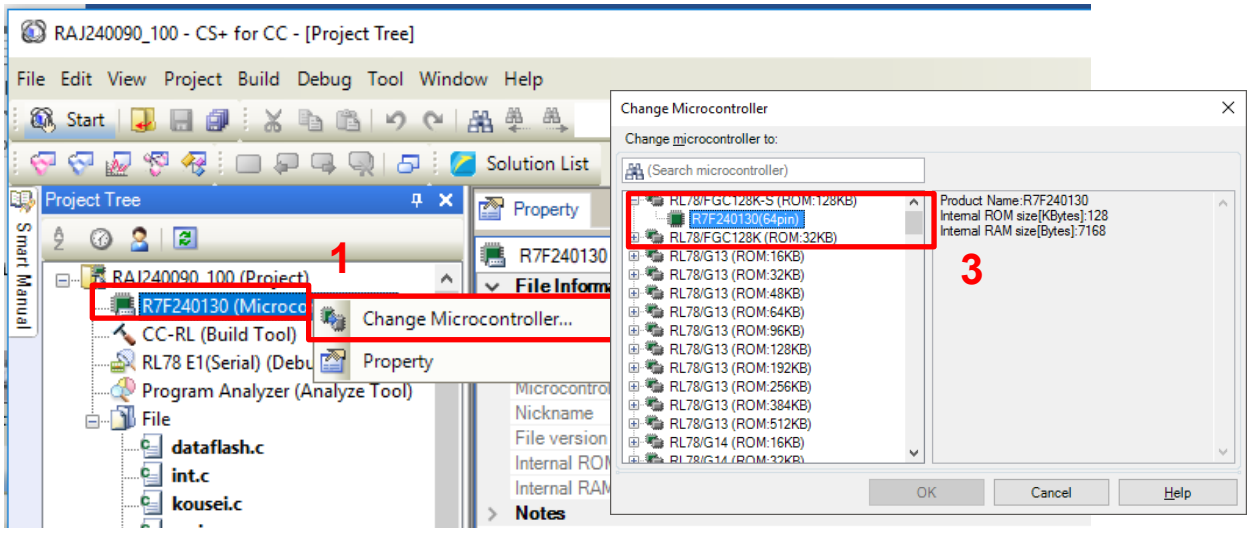


Figure 35 Device file configuration

5.2 IAR

5.2.1 Device file install

RAJ240090/100 device file should be installed as follows.
To install all parts of the device file package please copy the content of the subfolder 'update' to the subfolder 'rl78' of your Embedded Workbench installation. Existing files shall be replaced.

5.2.2 Create new project

When a new project is created by IAR, please set the microcontroller as follows on target tab in option of Project.

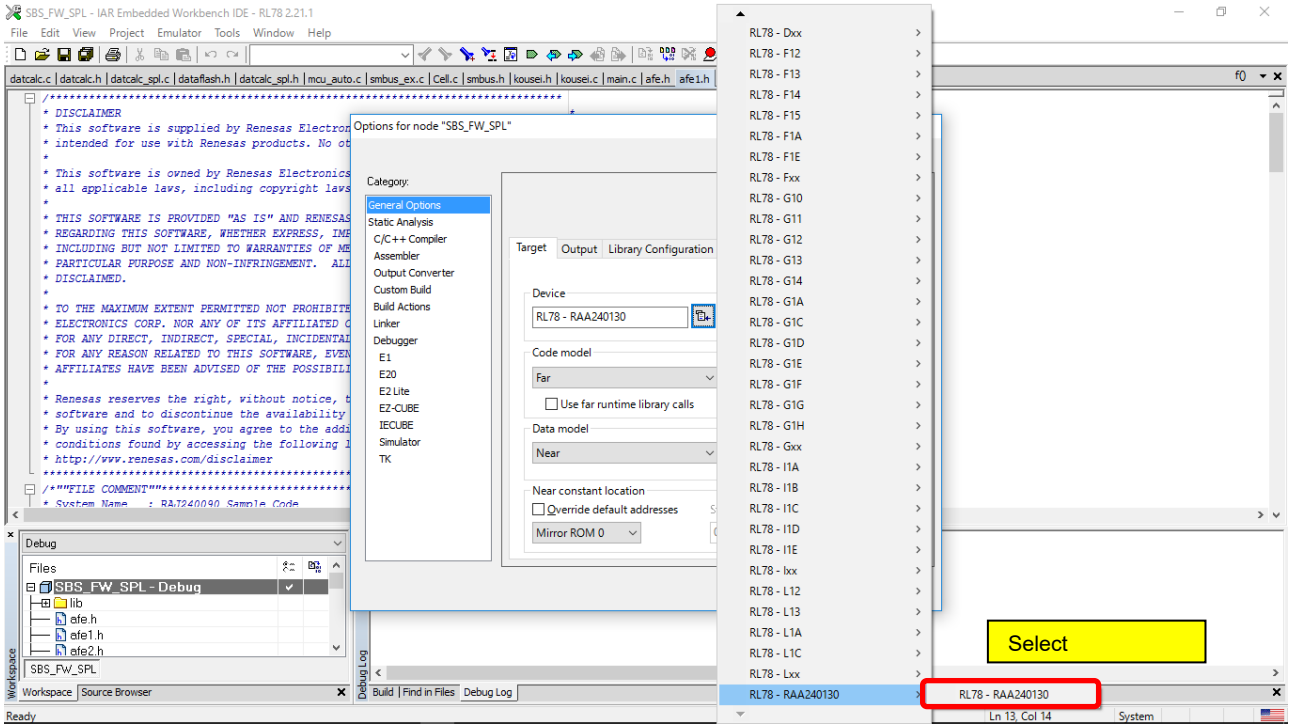


Figure 36 Create new project

5.2.3 Download and debug

When E1/E2 emulator (IAR) is connected, and then "Download and Debug"(Figure 37) is done on IAR.

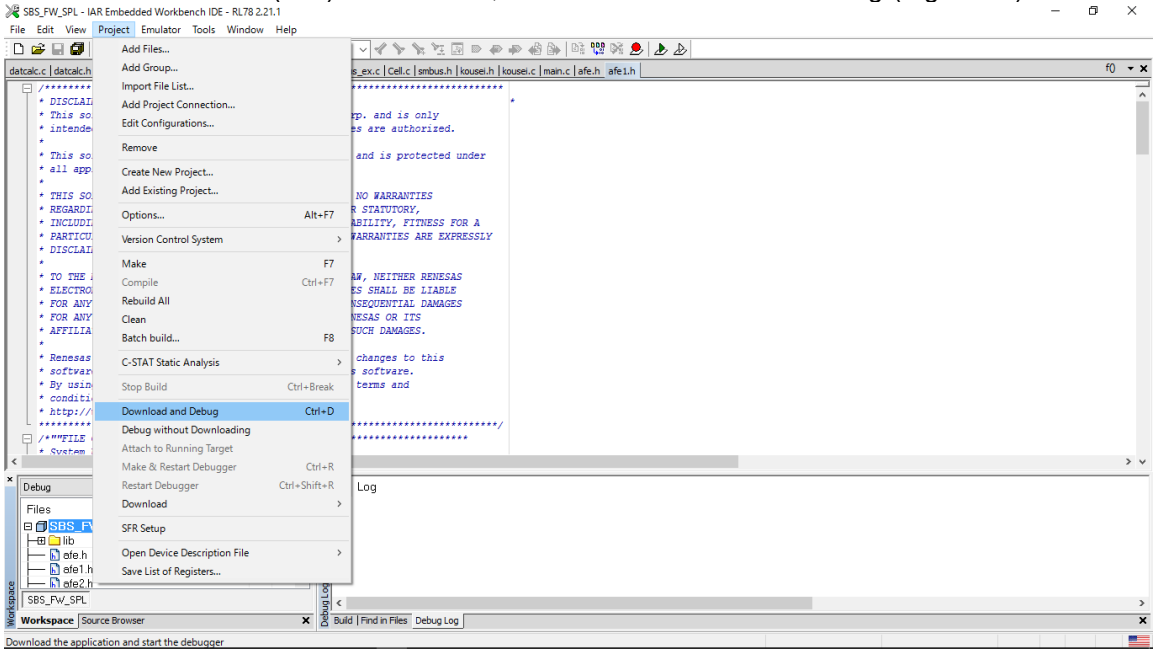


Figure 37 IAR main screen

5.3 On chip debug prohibited

When E1/E2 emulator is connected, In a FGIC which 04H (On chip debug operation is prohibited) is written in on chip Debug Option Byte (00C3H).
The peculiar data in this IC will be erased, when E1/E2 emulator is connected.
Please erase flash ROM block 0 then write an ID in ID code area before connecting E1/E2 emulator.
Regarding the method of writing ID, please refer to section 5.4.

5.4 Renesas Flash Programmer

Renesas provides the flash writing environment that is Renesas Flash Programmer (hereafter referred to as RFP) using E1/E2 emulator. User can write the object code at the on-board state when prepared the connection terminal for E1.

5.4.1 Important notice for RFP user

Table 15 shows the Flash ROM area where user need to care when using RFP.
If RFP is used without any precaution, essential information may be lost. This section explains the procedure to protect / consider essential information.

Table 15 Areas to be considered when flash writing

	AFE Trimming data and SMBus boot program	**Initial calibration data**	**Fixed Data**
Description	Must not be modified (Refer to Section 4.6.2)	Recommend not to modify	Take care: Overwriting these addresses alters the fixed data
Block	Block 114 to Block 126 (1C800H to 1FBFFH)	DataFlash 1 (F1800H to F1BFFH)	Block 54 (0D800H to 0DBFFH)

5.4.2 RFP setting

(1) MCU registration

Following steps are the procedures for performing MCU registration.

1. Perform EVM boot up (Refer to Section 4.3)
2. Open RFP (Rev 3.00 or later).
3. Click the File menu and select the "**Create a new project**".
4. Select Microcontroller to **RL78** and click "**Connect**" button.
5. The Microcontroller name of the Project can be seen.

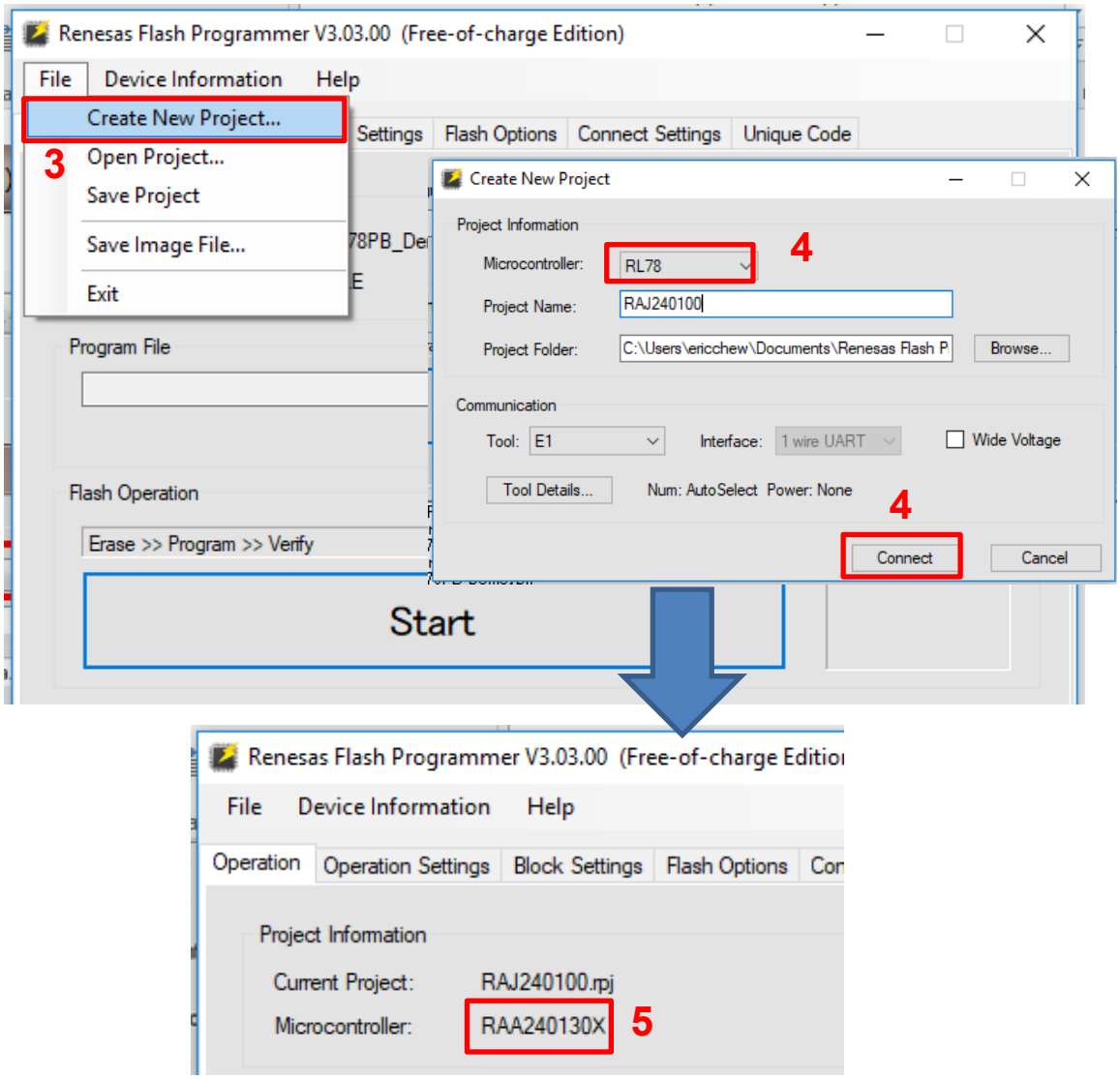


Figure 38 RFP MCU registration

(2) Block setting

1. Continue from previous MCU registration
2. Select **"Block Setting"** tab on RFP.
3. Disable Erase / P.V check from Block 114 to 126 and Data Flash 1
4. Disable Erase / P.V check Block 54 if you want to keep Fixed Data of sample code.

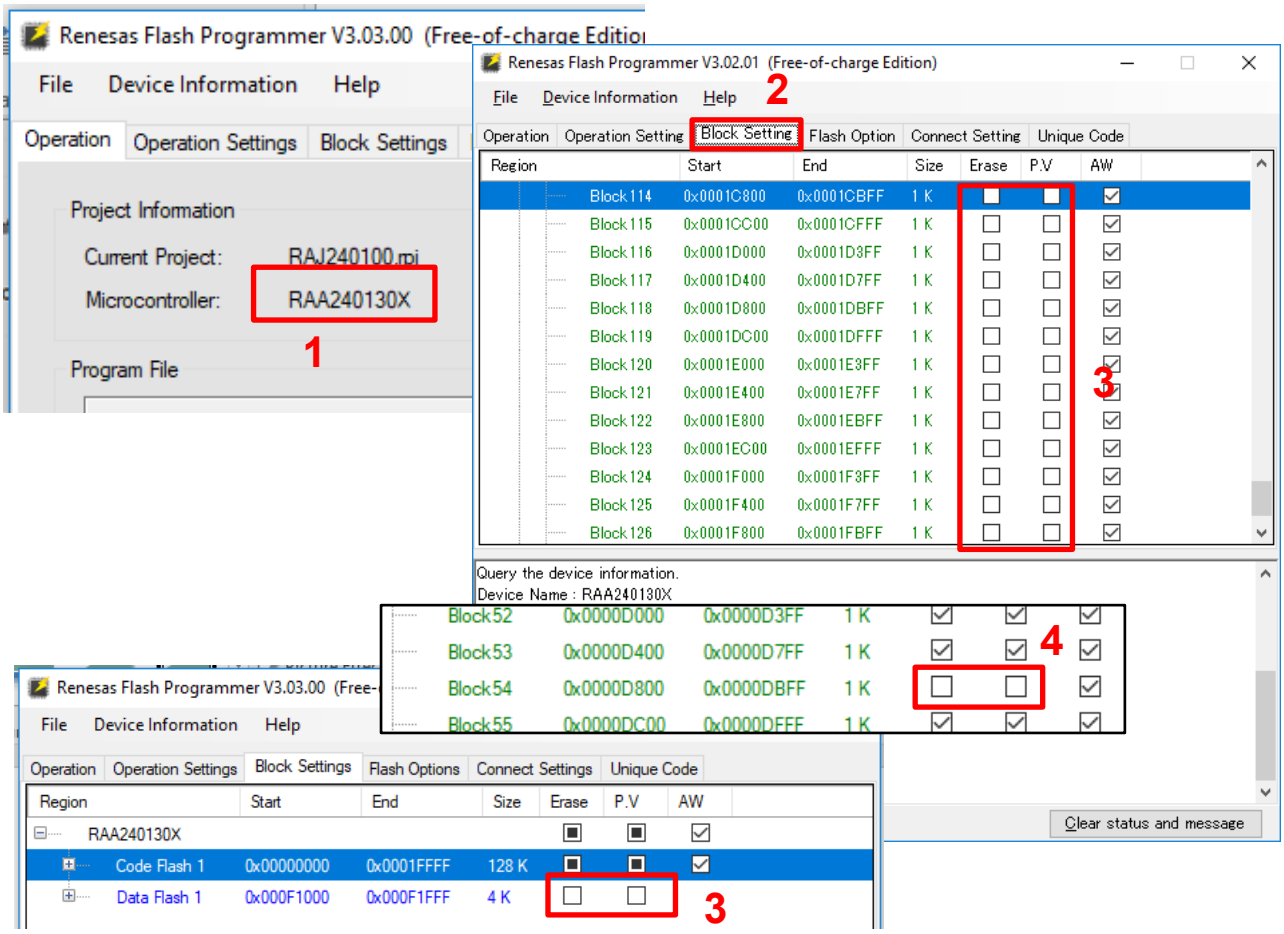


Figure 39 RFP Block setting

5.4.3 Update Firmware

1. Continue from previous Block setting
2. Click “**Browse**” button and select target file.
3. Click “**Start**” to Write firmware

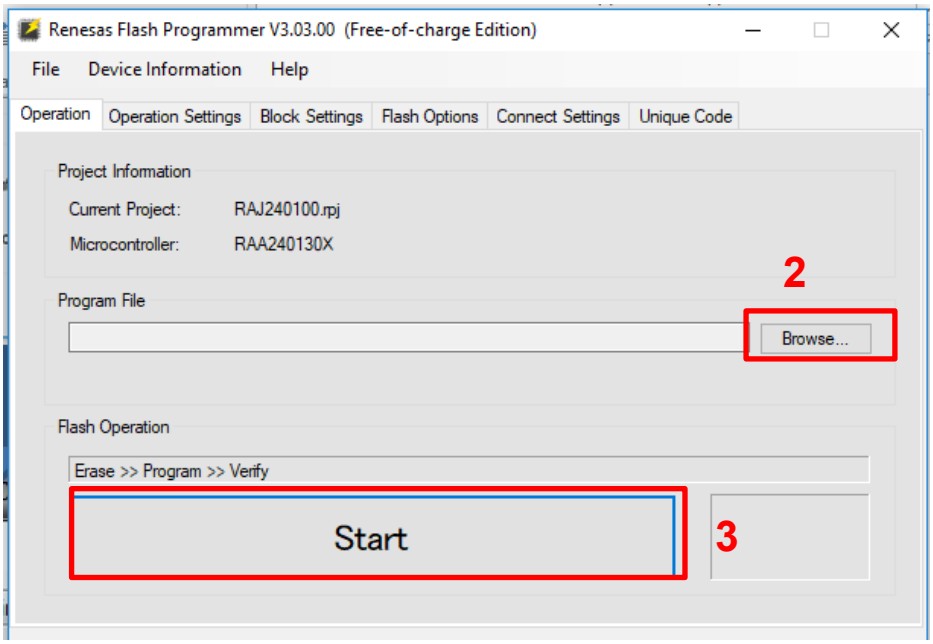


Figure 40 Flash Operation

5.5 ID code setting of NEW device for debugging

It is necessary to set ID code in FGIC before connecting E1/E2 emulator.

The ID code is not set prior to shipment. Users must set ID code in order to use E1/E2 emulator with the specific FGIC for the first time.

5.5.1 Connect Error by ID code

When E1/E2 emulator (CS+) is connected for the first time, the error (Figure 42) may occur. This happens if the evaluation board with new FGIC is connected to E1/E2 emulator, and "Connect to Debug tool" (Figure 41) is selected on CS +.

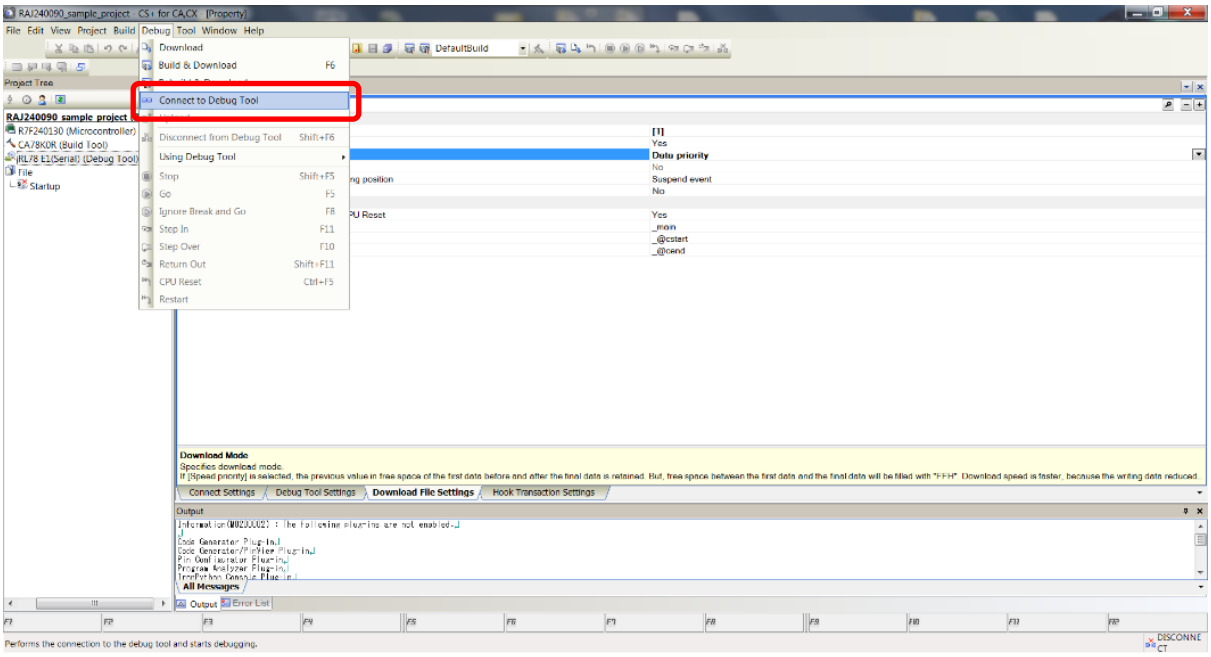


Figure 41 Screen of CS +

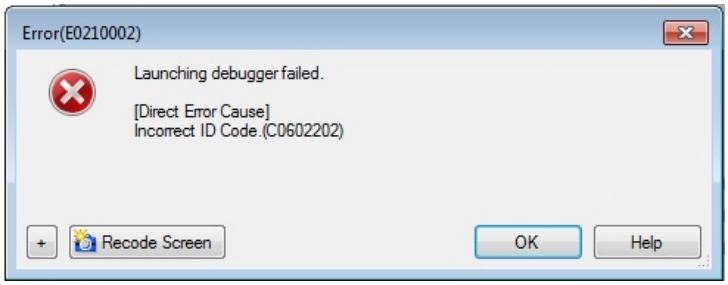


Figure 42 **Incorrect ID error**

This error can be cleared by writing ID in the ID code area of battery management IC by using RenesasFlashProgrammer(RFP). Figure **43** shows the example of the reference ID written.

```
S0030000FC
S2140000C400000000000000000000FFFFFFFFFFFF2D
S804000000FB
```

Figure 43 **File example of adjusting ID to all 0 (Motorola S-Record Format)**

5.6 SMBus command list

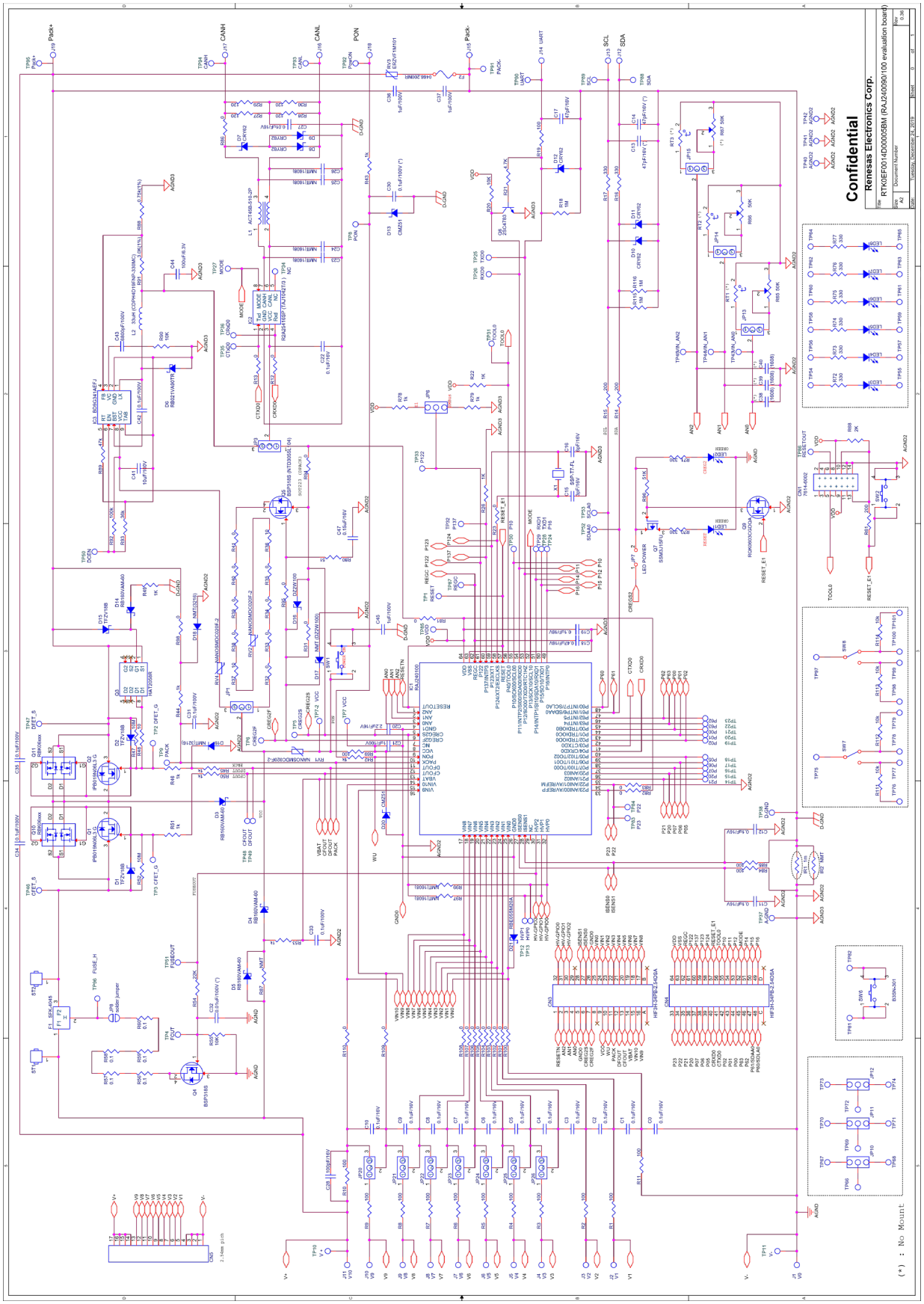
This sample source code has the following SMBus commands implemented. These command protocol are Read/WriteWord or BlockRead.

For more details, please refer to “r01an3919ej0302-raj24090(SampleCode)_r3.02.pdf”

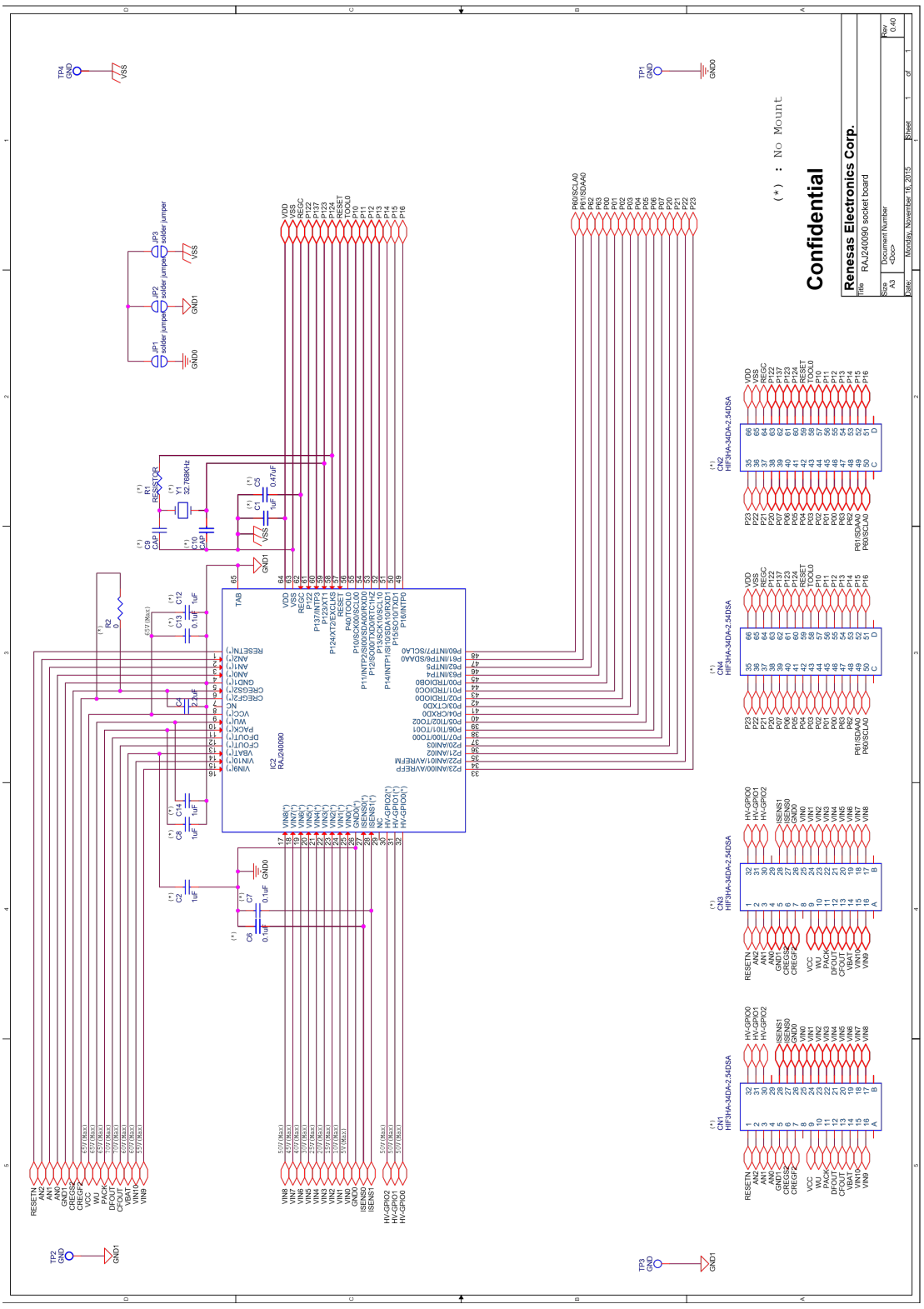
Table 16 SMBus command list

Command	Protocol	Data	Unit
0x00	Read/WriteWord	ExtraFunction	
0x08	ReadWord	Temperature(AN0)	0.1K
0x09	ReadWord	Voltage (Total voltage)	mV
0x0a	ReadWord	Current	mA
0x0d	ReadWord	RelativeStateOfCharge	%
0x0f	ReadWord	RemainingCapacity	mwah
0x10	ReadWord	FullChargeCapacity	mAh
0x14	ReadWord	ChargingCurrent	mA
0x15	ReadWord	ChargingVoltage	mV
0x16	ReadWord	BatteryStatus	
0x1f	ReadWord	Control Flag Status	
0x30	ReadWord	Voltage of Cell 1	mV
0x31	ReadWord	Voltage of Cell 2	mV
0x32	ReadWord	Voltage of Cell 3	mV
0x33	ReadWord	Voltage of Cell 4	mV
0x34	ReadWord	Voltage of Cell 5	mV
0x35	ReadWord	Voltage of Cell 6	mV
0x36	ReadWord	Voltage of Cell 7	mV
0x37	ReadWord	Voltage of Cell 8	mV
0x38	ReadWord	Voltage of Cell 9	mV
0x39	ReadWord	Voltage of Cell 10	mV
0x41	ReadWord	OperationStatus	
0x42	ReadWord	Total Cell Voltage	mV
0x43	ReadWord	PACK voltage	mV
0x44	ReadWord	2nd Thermistor	0.1K
0x45	ReadWord	PackStatus	
0x46	ReadWord	CellBalancingStatus	
0x50	Read/WriteWord	AFE register Write	
0x51	Read/WriteWord	AFE register Read (Address set)	
0x52	ReadWord	AFE register Read (Data)	
0x57	Read/WriteWord	InitialCalibrationReference	
0x58	Read/WriteWord	InitialCalibration	
0x5a	WriteWord	SMBus boot jump	
0x5c	ReadWord	Number of series cells	Number
0x5d	WriteWord	Software Reset	
0x5e	WriteWord	Flashers	
0x5f	ReadWord	FirmwareVersion	
0x60	ReadWord	AD value of Cell 1	
0x61	ReadWord	AD value of Cell 2	
0x62	ReadWord	AD value of Cell 3	
0x63	ReadWord	AD value of Cell 4	
0x64	ReadWord	AD value of Cell 5	
0x65	ReadWord	AD value of Cell 6	
0x66	ReadWord	AD value of Cell 7	
0x67	ReadWord	AD value of Cell 8	
0x68	ReadWord	AD value of Cell 9	
0x69	ReadWord	AD value of Cell 10	
0x71	ReadWord	AD value of AN0	
0x72	ReadWord	AD value of AN1	
0x73	ReadWord	AD value of PACK voltage	
0x74	ReadWord	AD value of MCU BG	
0x75	ReadWord	AD value of CREG2	
0x76	BlockRead	AD value of Current	

5.7 EVM circuit diagram



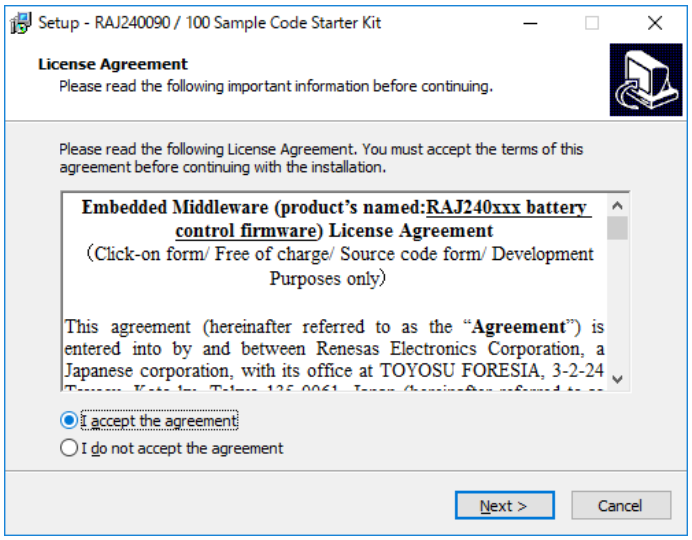
5.8 Socket Board circuit diagram



5.9 RSB TOOL installation

If RSB TOOL2 is not installed on the PC, it is necessary to install the application as shown in following steps.

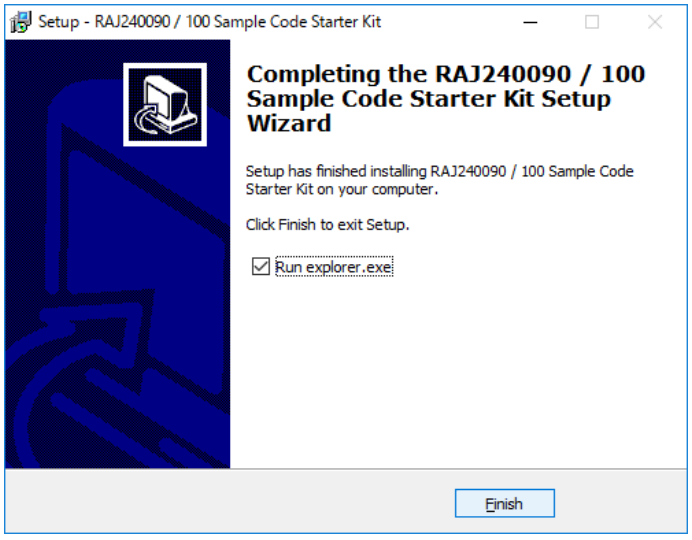
1. Execute the installation file of starter kit. (RAJ240090-100_StarterKit_SampleCode_RevX.XX")
2. Select the "RUN" button when a security warning message is informed.
3. Select the language English or Japanese.
4. Click "I accept the agreement" after reading the license agreement disclosed.



5. Key in the password.

   Regarding the password, please contact Renesas sales companies or agent where the starter kit is obtained

6. Click "Next" after reading the important notice of middleware.
7. Select the location path to save the program and documents. To continue setup, click "Next".
8. Click "Install" to install the Starter Kit program.
9. Upon completion, the application software and documents will be extracted and installed in the specified folder.



10. To uninstall, execute the "uninst.exe" in the installed folder.

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/contact/

All trademarks and registered trademarks are the property of their respective owners.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Nov.17, 2017		First version
2.00	Nov.17, 2017		New EVB support
2.18	Apr 14, 2022	36,49,50	Deleted the information of QE for Battery Management.
2.19	Nov.30, 2022		Update EVM pictures and circuit

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.

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION (“Vulnerability Issues”). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.
(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.