R9A02G011

RTK-251-SinkCharger-ISL9238C Instruction Manual

Introduction

  The RTK-251-SinkCharger-ISL9238C is an evaluation board for Universal Serial Bus Power Delivery (USB PD). The RTK-251-SinkCharger-ISL9238C is designed with USB PD controller R9A02G011 and On-Board Charger ISL9238C. On-Board Charger ISL9238C supports 2 to 4 battery cells in series configuration. This document is the instruction manual for the RTK-251-SinkCharger-ISL9238C.

  The RTK-251-SinkCharger-ISL9238C supports USB PD 2.0, USB PD 3.1, and USB Type-C® Specification. The RTK-251-SinkCharger-ISL9238C works as a USB Type-C® power sink charger or a power bank. The RTK-251-SinkCharger-ISL9238C does not have a battery protection circuit on the board, so, Renesas strongly recommends using a battery module with Renesas' Battery Management System to avoid over-discharging under the power bank mode. The RTK-251-SinkCharger-ISL9238C may be combined with an Evaluation Module of the Battery Fuel Gauging IC (FGIC) RAJ2400100 with Filefish to realize a complete Battery Management System (BMS).

  The configuration switches enable the selection of the number of battery cells, the maximum charge current and the operating mode.

   VIDWriter 1.0.0.0 applies to the RTK-251-SinkCharger-ISL9238C.

Target Devices

100W USB Type-C® Charger or MAX 60W Power Bank: RTK-251-SinkCharger-ISL9238C

     USB Power Delivery Controller: R9A02G011

     On-Board Charger: ISL9238C

Evaluation Module of Battery Fuel Gauging IC (FGIC) with Filefish: RAJ240100 Filefish EVM

     Battery Fuel Gauging IC: RAJ240100

Target VIDWriter: VIDWriter 1.0.0.0 (Version 1.0.0.0)

Part Number

RTK-251-SinkCharger-ISL9238C: RTK0EUG011D09040BJ (Sample Available)

RTK-251-SinkCharger-ISL9238C: RTK0EUG011D09000BJ (EOL)

RAJ240100 Filefish EVM: RTK0EF0136D0000XBX

Related Document

Use this document in combination with the following documents.

The related documents mentioned in this publication may include preliminary versions. However, preliminary versions are not marked as such.

- R9A02G011 Data Sheet: R19DS0088EJ
- R9A02G011 User's Manual: R19UH0102EJ
- E1 Emulator E20 Emulator User's Manual: R20UT0398EJ
- E2 Emulator Lite User's Manual: R20UT3240EJ
- E1/E20 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78): R20UT1994EJ
- Renesas Flash Programmer V3.13 Flash memory programming software User's Manual: R20UT5312EJ
- USB Power Delivery Controller VIDWriter 1.0.0.0 Instruction Manual: R19AN0267EJ

- ISL9238C Short-Form Data Sheet: R16DO0009EU

- RAJ240100 Data Sheet: R01DS0301EJ
- RAJ240100 Filefish User's Manual: R01AN6763EJ

Contents

FIGURES

TABLES

1. Features

RTK-251-SinkCharger-ISL9238C supports the following features.

- USB Power Delivery and USB Type-C®
    - Supports USB Power Delivery Specification Revision 2.0, USB Power Delivery Specification Revision 3.1, USB Type-C® Cable and Connector Specification Revision 2.2.
    - Supported features:
        - Power Role: Sink Only (SNK) or Dual Role Power (DRP)
        - Under Sink Only mode, RTK-251-SinkCharger-ISL9238C requires SPR mode 5, 9, 15, or 20V input from USB Type-C® power sourcing device.
        - Under Power Bank mode, RTK-251-SinkCharger-ISL9238C requires 5, 9, 15, or 20V input from USB Type-C® power sourcing device in sinking mode and supports source PDP ratings of 15W, 27W, 45W, or 60W in sourcing mode.
    - 1 USB Type-C® port
- Interface
    - LED indicators
        - Power Supply Indicator (3 LEDs, green)
    - Switches
        - Battery Configuration control for ISL9238C
        - Charging Current limits control for R9A02G011
    - On-chip debugging emulator interface
        - Renesas on-chip debugging emulator interface to write and debug firmware for R9A02G011
    - Battery Management System interface
        - Renesas BMS evaluation board interface to communicate with Battery module including FGIC

1.1 Block Diagram

Figure 1-1 RTK-251-SinkCharger-ISL9238C block diagram
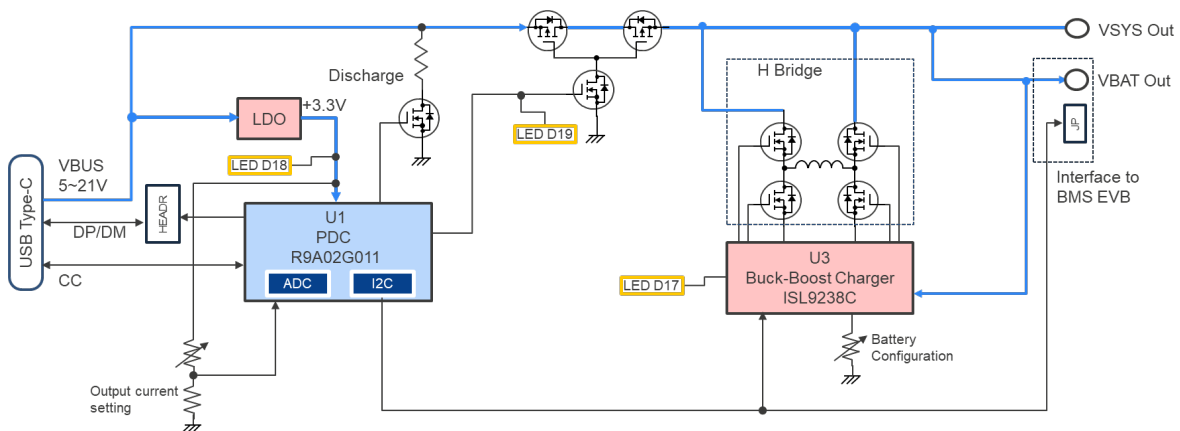
1.2   Component

1.2.1   Component layout

Figure 1-2 Highlighted main parts on the board RTK0EUG011D09040BJ
a. TOP side
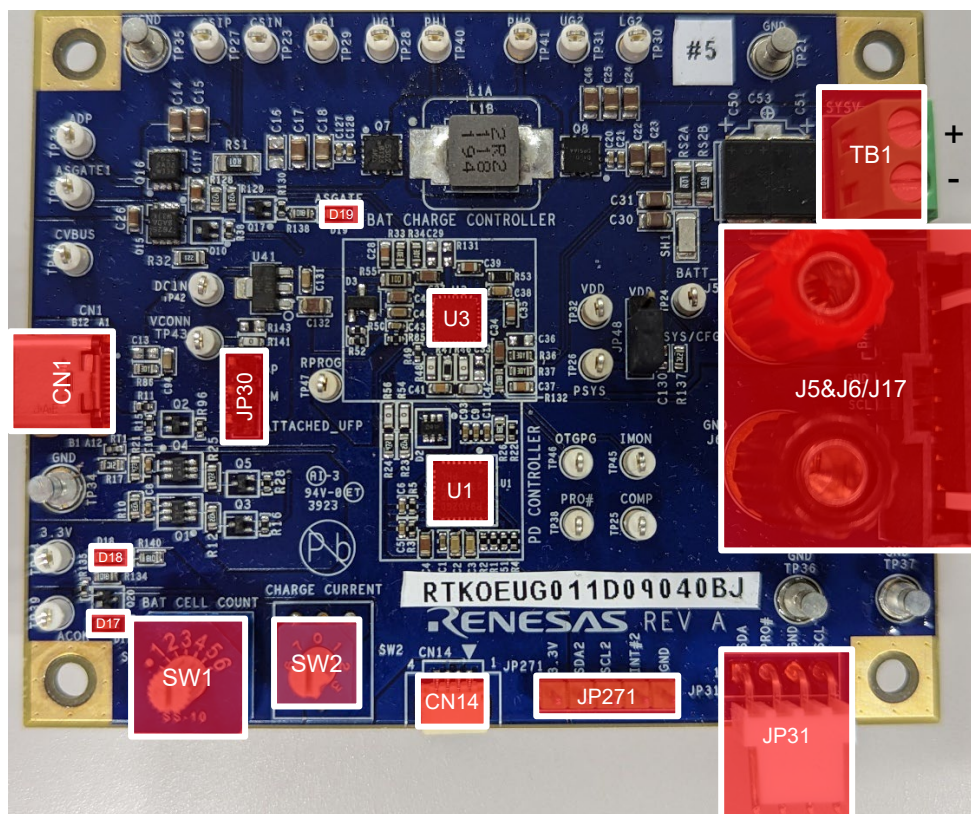
The main changes from RTK0EUG011D09000BJ are the additions of J17 and SW1.

b. Bottom side

Figure 1-3 Highlighted main parts on the board RTK0EUG011D09000BJ(EOL)
a. TOP side
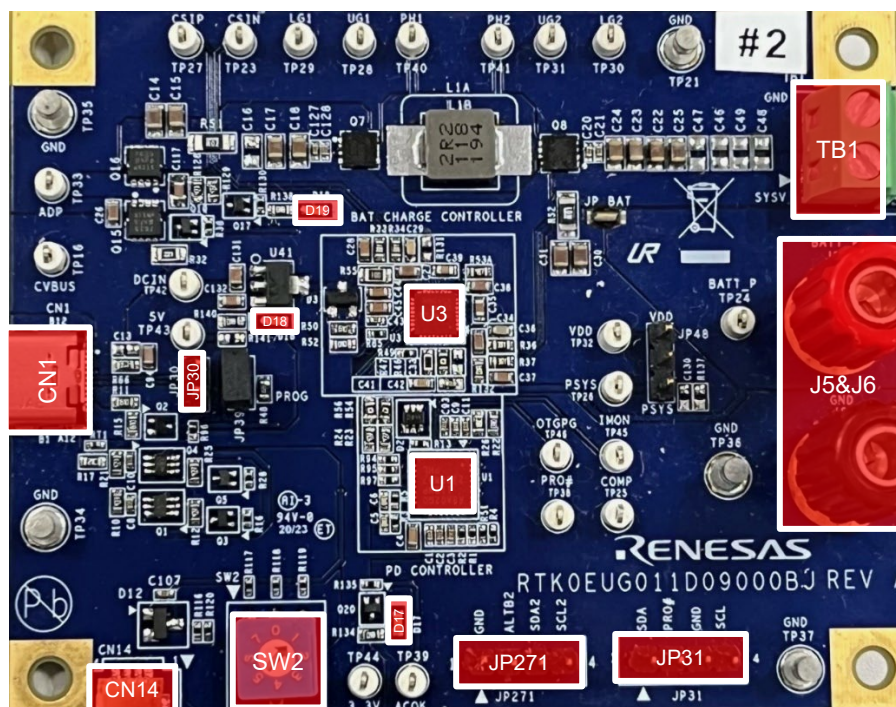
b. Bottom side
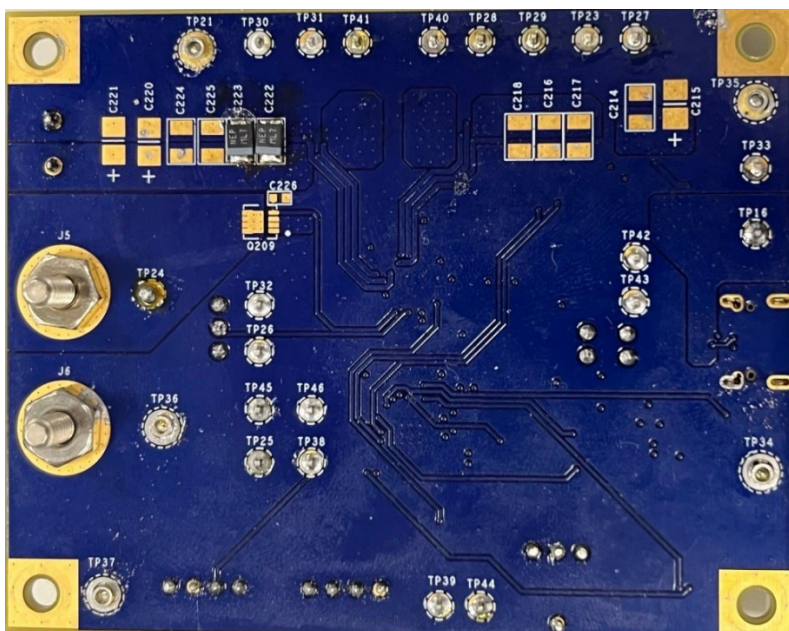
1.2.2 Component information

(1) IC

No.	Description	Remark
U1	R9A02G011 (USB Power Delivery Controller)	-
U3	ISL9238C (On-Board Charger)	-

(2) Connector

No.	Description	Remark
CN1	USB Type-C receptacle	-
CN14	Renesas on-chip debugging emulator interface	-
JP30	USB2.0 Data interface	-
TB1	Connector for VSYS	-
J5&J6	Connector for Battery interface	-
J17	Connector for Battery interface (Not available on RTK0EUG011D09000BJ)	-
JP271	SMBus Slave SCL, SDA, alert on R9A02G011	P60, P61, P62
JP31	SMBus Master SCL, SDA, alert on R9A02G011	P30, P31, P137

(3) Switch

No.	Description	Connects to
SW1	Rotary switch for configuration of number of Battery cells (Not available on RTK0EUG011D09000BJ)	ISL9238C: PROG
SW2	Rotary switch for setting the Charger Current Limit	R9A02G011: P22

(4) LED

No.	Description	Connects to
D17	V_{BUS} presence Indicator	ISL9238C: ACOK
D18	Power Supply Indicator for R9A02G011	+3.3V
D19	Indicator for VBUS gate control	R9A02G011: P73

(5) Test point

No.	Description	Remark
TP16	V_{BUS} (Near USB Type-C receptacle)	-
TP34, TP37	GND	-
TP43	+5V	-
TP44	+3.3V	-
TP33	VADP (Monitor for BB-Charger input)	-

1.3   Function assignment for R9A02G011 on RTK-251-SinkCharger-ISL9238C

Table 1-1 shows the functions assigned to R9A02G011 on RTK-251-SinkCharger-ISL9238C.

Table 1-1 The functions assigned to R9A02G011 pins on RTK-251-SinkCharger-ISL9238C

Pin name	Function	Descriptions
P16	Open	Reserved
P20	VBUSM	V_{BUS} voltage monitor input
P21	OTP	Input for Over Temperature Protection
P22	SW2	Input from Rotary Dip switch for Charging Current Limits control
P31	MSTSDA	SMBus master data input/output (open-drain) connected to ISL9238C
P30	MSTSCL	SMBus master clock output (open-drain) connected to ISL9238C
P40	TOOL0	Connected to on-chip debugging emulator interface for flash programming.
P61	SLVSDA	SMBus slave data input/output (open-drain) connected to JP271
P60	SLVSCL	SMBus slave clock input connected to JP271
P62	SLVALTB	Connected to JP271
P32	Open	-
P80	Attached_UFP	Connects to JP30 to indicate USB-C Attach/Detach (Not available on RTK0EUG011D09000BJ, See Section 4.1 when supports USB peripheral function)
P50	INT1	USB-C Attach/Detach input
P51	Open	-
RD1	RD1	Rd resistor 1, Analog pin from CC-PHY.
CC1	CC1	Configuration Channel 1, Analog pin from CC-PHY
CC2	CC2	Configuration Channel 2, Analog pin from CC-PHY
RD2	RD2	Rd resistor 2, Analog pin from CC-PHY.
REG	REGCTX	Regulator capacitance for CC-PHY. Connecting regulator output stabilization capacitance for internal operation.
VDD	VDD	Power supply (+3.3V)
REGC	REGC	Regulator capacitance. Connecting regulator output stabilization capacitance for internal operation.
P121	Pull-down	-
P122	Pull-down	-
P137	MSTALTB	Connects to JP31
RESETB	RESETB	Chip Reset Input (active low)
P70	Open	-
P71	DISCHG	Discharge control for USB Type-C V_{BUS}
P72	Open	-
P73	Gate	Gate Enable for V_{BUS} line
P81	Open	-
P82	Open	-
P17	Open	Reserved

1.4 Function assignment for ISL9238C on RTK-251-SinkCharger-ISL9238C

Table 1-2 shows the functions assigned to ISL9238C on RTK-251-SinkCharger-ISL9238C.

Table 1-2 The functions assigned to ISL9238C pins on RTK-251-SinkCharger-ISL9238C

Pin name	Function	Descriptions
CSON	CSON	Battery current sense "-" input
CSOP	CSOP	Battery current sense "+" input
VSYS	VSYS	Provides feedback voltage for System Voltage regulation.
BOOT2	BT2	High-side MOSFET Q4 gate driver supply
UGATE2	UG2	High-side MOSFET Q4 gate drive
PHASE2	PH2	Current return path for the high-side MOSFET Q4 gate drive
LGATE2	LG2	Low-side MOSFET Q3 gate drive
VDDP	VDDP	Power supply for the gate drivers.
LGATE1	LG1	Low-side MOSFET Q2 gate drive
PHASE1	PH1b	Current return path for the high-side MOSFET Q1 gate drive
UGATE1	UG1b	High-side MOSFET Q1 gate drive
BOOT1	BT1b	High-side MOSFET Q1 gate driver supply
ASGATE	Open	Unused
CSIN	CSIN	Current sense "-" input from V_{BUS} path
CSIP	CSIP	Current sense "+" input from V_{BUS} path
ADP	ADP	Voltage Sense input from V_{BUS} path
DCIN	DCIN	Internal LDO input that provides power to the IC
VDD	VDD	Internal LDO output that provides the bias power for the internal circuit
ACIN	ACIN	V_{BUS} voltage sense input
OTGEN/CMIN	Pull-up	Unused
SDA	SDA	SMBus slave data input/output (open-drain) connected to R9A02G011
SCL	SCL	SMBus slave clock input connected to R9A02G011
PROCHOT#	PROCHOT#	Unused
ACOK	INDICATOR1	Power Supply Indicator, connected to D17
BATGONE	Pull-down	-
OTGPG/CMOUT	Open	-
PROG	PROG	Input from Rotary Dip switch for Configuration of the number of battery cells. This is for RTK0EUG011D09040BJ. RTK0EUG011D09000BJ has no SW on the board. The PROG pin is directly connected to a resistor that configures a default battery configuration of 3 cells.
COMP	COMP	Error amplifier output
AMON/BMON	AMON/BMON	Unused
PSYS	Pull-down	Unused
VBAT	VBAT	Battery voltage sense input
BGATE	BGATE	Unused

2. Function

2.1 Battery Configuration

Battery Configuration is set by SW1 on RTK0EUG011D09040BJ.

Table 2-1 Rotary switch setting value for Battery Configuration

SW position	RTK0EUG011D09040BJ
1	2 Cells in series
2	3 Cells in series
3	4 Cells in series
4	Reserved
5	Reserved
6	Reserved

Note: RTK0EUG011D09000BJ has no SW1 on the board. So, Battery Configuration is set by resistor on "PROG" pin.

Table 2-2 Resistor values for the configuration of the number of battery cells

Battery Configuration	Resistor value (kΩ) for ISL9238C
2 Cells in series	52.3
3 Cells in series	162 (default)
4 Cells in series	215

Note: Resistor value within a tolerance of +/- 1% must be used.

  If the user wants to use the other number of series cells on RTK0EUG011D09000BJ, please replace the resistor on the RTK-251-SinkCharger-ISL9238C as defined in Table 2-2.

  The standard parameters of charger in firmware (FW) define MaxSysVol/cell as4.048V and MinSysVol/cell as 2.816V, which corresponds to typical voltage for Li-Ion battery chemistries such as $LiCoO_2$ and $LiMn_2O_4$ battery. Table 2-3 shows the default MaxSysVol and MinSysVol for each battery configuration.

Table 2-3 Battery Configuration vs
MaxSysVol/MinSysVol for $LiCoO_2$ and $LiMn_2O_4$ battery in Standard FW

Battery Configuration	MaxSysVol (mV)	MinSysVol (mV)
2 Cells in series	8120	5632
3 Cells in series	12184	8448
4 Cells in series	16240	11264

  For example, the MaxSysVol/cell and MinSysVol/cell for a $LiFePO_4$ based battery are lower than those of other Li-Ion batteries such as $LiCoO_2$ and $LiMn_2O_4$ battery. Therefore, if the user wants to use other MaxSysVol and MinSysVol values, VIDwriter 1.0.0.0 can be used to generate a FW with such parameters. Please refer to Section 2.2 and Section 3.4. The Charger's MaxSysVol range is 8V to 16.8V and the Charger's MinSysVol range is 5.12V to 13.824V, so the user can only set MaxSysVol and MinSysVol with these ranges.

  MaxSysVol represents the maximum battery charging voltage. It is defined as "Full" in this document. If VBAT reaches the "Full" value, the charger operates in Constant Voltage mode. MinSysVol represents the

minimum allowed voltage during discharging mode. It is defined as "Empty" in this document. In charging mode, when VBAT is less than the "Empty" value, the Charger trickle charges the battery at a low current level. When VBAT is between Full and Empty value, the charger operates in Constant Current mode.

For RTK0EUG011D09040BJ, Standard FW includes both MaxSysVol value and MinSysVol value that are matched to the battery cell configuration set by rotary switch SW1. If battery configuration is fixed, the resistor values in Table 2-2 can be used in place of the rotary switch.

2.2   Charging Current Limits

SW2 is used to set Charging Current Limits and operating mode.

There are three operating modes; "Board", "BMS", and "Manual". The default firmware uses "Board" mode, in which the switches on the board configure the EVB parameters. "BMS" sets EVB parameters by battery status information from BMS. "Manual" can set EVB parameters directly.

Note: In order to use "BMS" or "Manual" modes, FW on the board must be rewritten by the VIDwriter 1.0.0.0-generated FW. If operating mode is changed to "Board" from "BMS" or "Manual", FW on the board also must be rewritten by the VIDwriter 1.0.0.0-generated FW.

Table 2-4 Rotary switch setting value for Charging Current Limits

SW position	Charging Current Limits (SW2)
0	The specific values (MaxSysVol, MinSysVol, and Charging Current limit) can be set in FW
1	1A
2	2A
3	3A
4	4A
5	5A
6	6A
7	The values (MaxSysVol, Charging Current limit and so on) are retrieved via BMS interface

When using a battery evaluation module such as "RAJ240100 Filefish EVM", SW2 must be set to SW position 7. In that case, R9A02G011 of RTK-251-SinkCharger-ISL9238C retrieves battery related information from FGIC controller on RAJ240100 Filefish EVM. The R9A02G011 then uses the information obtained from FGIC controller instead of SW2 value to configure the On-Board Charger. At the same time, R9A02G011 gets the number of series cells that the battery module has. Therefore, the SW1 setting is ignored at this case.

If SW2 does not have a suitable charging current value and/or user does not want to set MaxSysVol and MinSysVol as standard values, user needs to set SW2 to SW position 0 and set the expected charging current value, MaxSysVol and MinSysVol. In this case, the SW1 setting is ignored. Install them on FW that is generated by using the VIDwriter 1.0.0.0 as described in Section 3.4.

If the charging current limit is fixed, the substitute circuit as shown in Figure 2-1 can be used in place of the rotary switch.

Figure 2-1 The substitute circuit for output voltage or current
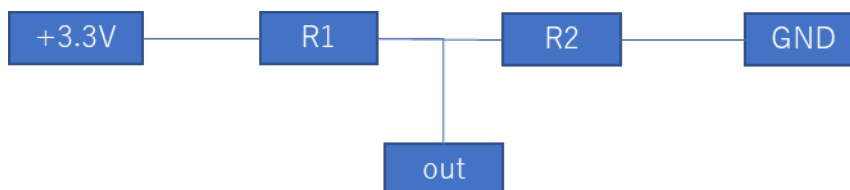
The resistor values in Table 2-5 can be used to define input level of P22.

Table 2-5 Resistors values for substitute circuit

SW Position	Resistor value (Ω)	
	R1	R2
0	Pull up to VDD	
1	3.3k	2.7k
2	2.2k	2.7k
3	1.5k	2.7k
4	1.2k	2.7k
5	1k	2.7k
6	820	2.7k
7	Pull down to GND	

Note: R1 and R2 within a tolerance of +/- 5% must be used.

2.3 Operating Mode Selection

2.3.1 Sinking mode

Under Sink Charger operation and sinking mode for Power Bank operation, R9A02G011 will need the sourcing PDP rating as shown in Table 2-6 to the connected PD sourcing device to realize fast charging when VBAT > MinSysVol. Even if the connected PD sourcing device cannot supply the sourcing PDP rating that is shown in Table 2-6, RTK-251-SinkCharger-ISL9238C will charge battery with the USB-C input power that the PD adapter can supply. For example, when a product may charge at 5V, 9V and 15V, differentiation between 5V, 9V, and 15V charging voltage is charging speed.

The BB-Charger co-works with a battery module. Charging modes for the Battery module are Trickle, Constant Current (CC), and Constant Voltage (CV). As long as VBAT is less than "Empty", the charging current is set to 256 mA. If VBAT is in between "Full" and "Empty", the charger operates in Constant Current mode. If VBAT reaches "Full", the charger works in Constant Voltage mode. If VBAT > MaxSysV, there is no charging/switching.

The current limit during CC and CV modes is defined by the lesser of the charger's current limit and the Type-C input current limit. When the battery is 4 cells (Full = 16.24V and Empty =11.264V for Li-Ion batteries such as $LiCoO_2$ and $LiMn_2O_4$ battery) and Type-C input is 100W, actual charging current will nearly reach the 6A charging current limit at the "Full" voltage. At just over "Empty", it is possible to supply over 9A charging current from Type-C input. However, because the charger's current limitation is 6A, the charger can only supply a maximum of 6A to the battery.

Both the 5A and EPR cables have e-markers to notify the system of 5A capability.

Table 2-6 The expected maximum Type-C sourcing PD Power for Sinking mode

	1A	2A	3A	4A	5A	6A
2 Cells in series	2A@5V	3A@9V	2A@15V	3A@15V	3A@20V	3A@20V
3 Cells in series	2A@9V	2A@15V	3A@15V	3A@20V	4A[1]@20V	5A[1]@20V
4 Cells in series	3A@9V	3A@15V	3A@20V	4A[1]@20V	5A[1]@20V	5A[1]@20V

[1] EPR cable or 5A cable is required.

2.3.2 Sourcing mode

Note: The RTK-251-SinkCharger-ISL9238C does not have a battery protection circuit on the board, so, Renesas strongly recommends using a battery module with Renesas' Battery Management System to avoid over-discharging under the power bank mode. RTK-251-SinkCharger-ISL9238C can support power bank mode as long as the battery module uses protection circuit to avoid over-discharge, over-temperature, etc. However, this should be done at user's own risk.

Under sourcing mode for Power Bank operating, RTK-251-SinkCharger-ISL9238C supports standard max sourcing PD Power as shown in Table 2-7 based on following formula.

Available sourcing power = MinSysVol X Charging Current Limit X 2
The standard PD Power in FW = Max supply current (3A) X Standard supply voltage (5, 9, 15, or 20V)
= 15, 27, 45, or 60W
The Max sourcing PD Power in FW ≤ Available sourcing power

The max sourcing PDP is calculated by the MinSysVol value and Charging Current Limit value. For example, if the MinSysVol is 11.2V and the charging current limit is 1A, the available sourcing power is 22.4W. As a result, the maximum sourcing PDP of the FW is 15W. When the MinSysVol is 11.2V and the charging current limit is 3A, the available sourcing power is 67.2W. Therefore, the user can choose either 15, 27, 45, or 60W as the Max sourcing PDP. The Max sourcing PDP is calculated by the above formula even though MaxSysVol, MinSysVol, and Charging Current Limits are set manually.

When the operating mode is "BMS", the FW cannot recognize the MaxSysVol, MinSysVol, and Charging Current Limits until R9A02G011 retrieves the battery information from BMS. Therefore, the user should set the appropriate Max sourcing PD Power that battery module can support.

The USB-PD PDO list, which is used on PD negotiation, will be generated by this Max sourcing PDP. If the available sourcing power is less than 15W, RTK-251-SinkCharger-ISL9238C will not support sourcing mode for Power Bank operating.

Also, Max sourcing PDP is limited to 60W because there is no V_{CONN} power on RTK-251-SinkCharger-ISL9238C. To support 100W sourcing PDP, V_{CONN} power should be required on system board to check 5A capability of cable. At that case, FW modification is required. Please ask your Renesas' contact person.

Table 2-7 The supported maximum Type-C sourcing PD Power for Sourcing mode

	1A	2A	3A	4A	5A	6A
2 Cells in series	-	15W	27W	45W	45W	60W
3 Cells in series	15W	27W	45W	60W	60W	60W
4 Cells in series	15W	45W	60W	60W	60W	60W

Table 2-8 PDO list

	PDO1	PDO2	PDO3	PDO4
PDP 15W	5V/3A	-	-	-
PDP 27W	5V/3A	9V/3A	-	-
PDP 45W	5V/3A	9V/3A	15V/3A	20V/2.25A
PDP 60W	5V/3A	9V/3A	15V/3A	20V/3A

3. Board setup and how to use

3.1 Required materials to use this board.

- RTK-251-SinkCharger-ISL9238C: 1 unit
- USB Type-C Cable: 1pcs (When the required maximum Type-C sourcing PD Power is 20V@ 5A, 5A cable or EPR cable shall be required.)

Notes:
This board does not require an external power supply except for the batteries.

PLEASE USE THIS BOARD WHEN YOU UNDERSTAND AND AGREE THAT RENESAS DOES NOT HAVE ANY RESPONSIBILITY, INDEMNIFICATION, OR LIABILITY FOR USE OF THIS BOARD.

3.2 How to connect battery module.

RTK-251-SinkCharger-ISL9238C operation will be managed by type of battery module.

3.2.1 How to charge battery module with the standard charger parameters without Renesas BMS interface when connected to a source device.

1. Select the expected Charging Current Limit by setting the rotary switch (SW2) to one of positions 1 to 6. (See Section 2.2)
2. For RTK0EUG011D09040BJ, select the expected battery configuration by rotary switch (SW1). For RTK0EUG011D09000BJ, if need to use something other than the default battery configuration, replace resistor connected to "PROG" pin. (See Section 2.1)
3. Connect Battery module w/o Renesas BMS interface to J5 & J6.
4. Connect USB Type-C® sourcing device to USB Type-C® receptacle (CN1) via USB Type-C® Cable and supply power to the battery module, confirm green LED (D19) lights on.

Figure 3-1 Power Indicator

 LED D19

5. The board supplies power to battery module.

Never change SW2/(SW1) when the Board power is ON.

3.2.2 How to charge battery module with the non-standard charger parameters without Renesas BMS interface when connected to a source device.

1. Must update FW that is generated to have appropriate charger parameters by using the VIDwriter 1.0.0.0, to RTK-251-SinkCharger-ISL9238C.
2. Select the expected Charging Current Limit by setting the rotary switch (SW2) to position 0. (See Section 2.2)
3. Connect Battery module w/o Renesas BMS interface to J5 & J6.
4. Connect USB Type-C® sourcing device to USB Type-C® receptacle (CN1) via USB Type-C® Cable and supply power to the battery module, confirm green LED (D19) lights on as shown in Figure 3-1.

5. The board supplies power to battery module.

Never change SW2/(SW1) when the Board power is ON.

3.2.3   How to charge battery module with Renesas BMS interface when connected to a source device.

1. Must update FW that is generated to have appropriate charger parameters by using the VIDwriter 1.0.0.0, to RTK-251-SinkCharger-ISL9238C.

2. Select the rotary switch (SW2) to 7. (See Section 2.2)

3. For RTK0EUG011D09040BJ, connect Battery module w/ Renesas BMS interface to J17 as described in Section 3.3.1. Or, for RTK0EUG011D09000BJ, connect Battery module to J5 & J6 and JP31(I2C interface for BMS)

Figure 3-2 Interface for battery module for RTK0EUG011D09000BJ

4. FW of RTK-251-SinkCharger-ISL9238C will retrieve the max charging voltage and current limits via Renesas BMS interface and set appropriate value to Battery Charger on RTK-251-SinkCharger-ISL9238C.

5. Connect USB Type-C® sourcing device to USB Type-C® receptacle (CN1) via USB Type-C® Cable and supply power to the battery module, confirm green LED (D19) lights on as shown in Figure 3-1.

6. The board supplies power to battery module.

7. FW of RTK-251-SinkCharger-ISL9238C frequently retrieves the max charging voltage and current limits via Renesas BMS interface and updates setting value of Battery Charger on RTK-251-SinkCharger-ISL9238C.

Never change SW2/(SW1) when the Board power is ON.

3.2.4 Power Bank mode setting

When the user wants to use RTK-251-SinkCharger-ISL9238C in Power Bank mode (DRP) without USB2.0 data communication, install a jumper to short DP and DM of JP30.

Figure 3-3 Connector for Power Bank mode setting

a) For RTK0EUG011D09000BJ   b) For RTK0EUG011D09040BJ
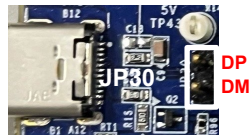
If the user wants to use RTK-251-SinkCharger-ISL9238C in Power Bank mode (DRP) with USB2.0 data communication, please refer to Section 4.1.

3.3   Battery module with Renesas BMS interface.

Battery module with Renesas BMS interface is described in this section. Renesas release Filefish that is FIXED firmware solution for Renesas Battery Fuel Gauging IC (FGIC), which requires no additional firmware development. Using this solution, the battery management system (BMS) can be easily and quickly designed, and the time to market can be significantly reduced.

RAJ240100 Filefish EVM is one of the battery evaluation modules including FGIC with Filefish.

RTK-251-SinkCharger-ISL9238C communicates with RAJ240100 Filefish EVM to realize battery management system.

3.3.1   RAJ240100 Filefish EVM Connection

RAJ240100 Filefish EVM connects to RTK0EUG011D09000BJ via J5, J6, and JP31 connector or RTK0EUG011D09040BJ via J17 connector. RTK0EUG011D09040BJ bundles specific conversion cable to connect to RAJ240100 Filefish EVM as shown in Figure 3-4.

Figure 3-4 Conversion Cable

RTK0EUG011D09040BJ   RAJ240100 EV2Z
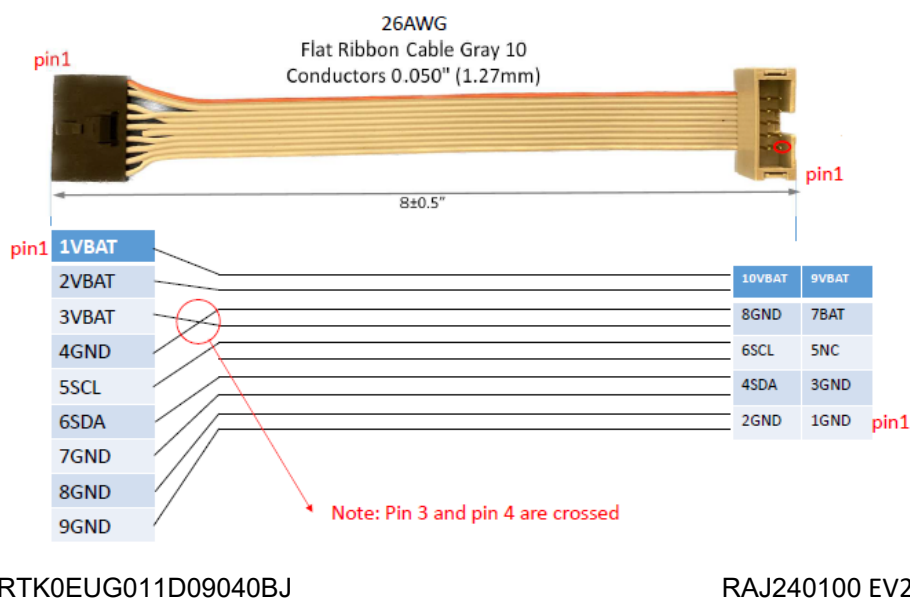
Figure 3-5 RTK0EUG011D09040BJ Connector to BMS EVB and Pin Assign
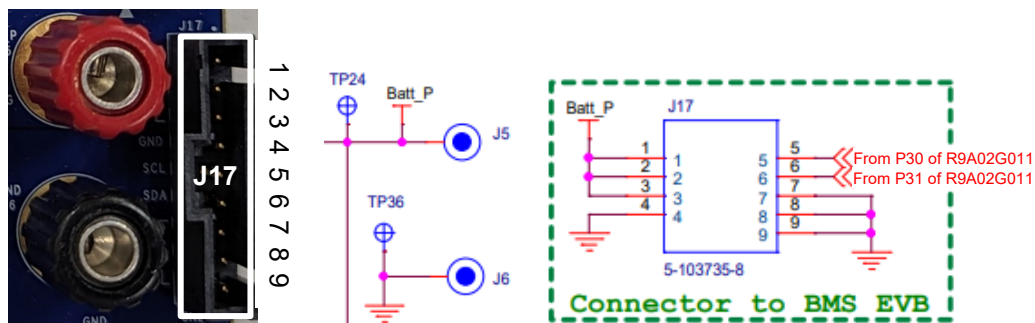
3.3.2   RAJ240100 Filefish EVM

  It is necessary to program battery management configurations to FGIC depending on customer's application conditions. Refer to RAJ240100 Filefish User's Manual R01AN6763EJ for details.

Figure 3-6 RAJ240100 Filefish EVM
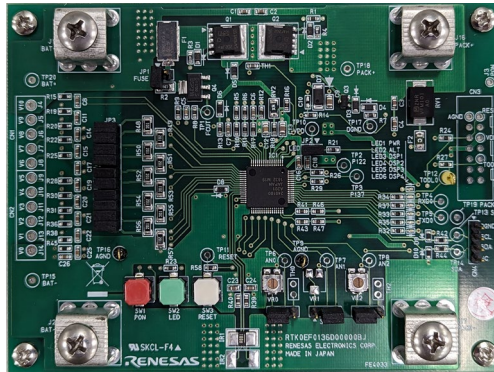
Note:
  Minimum number of cells for Filefish (RAJ240100) is 3 cells in series.

  For more information about Filefish, please contact your Renesas representative.

3.4 Firmware writing to the R9A02G011 on RTK-251-SinkCharger-ISL9238C

This section describes how to generate and write the firmware (e.g. Intel HEX file) to the R9A02G011 in an appropriate method.

3.4.1 FW generation

3.4.1.1 Operating Environment

(1) Host PC

- Processor: 1 GHz or faster

- Main memory: At least 1 Gbyte

- Display: Resolution of 1024 x 768 or higher and 65,536 or more colors

(2) Supported OS

- Windows 10 (32-bit or 64-bit)
- Windows 11 (32-bit or 64-bit)

Remark:
Microsoft.NET Framework 4.6.1 or later has to be installed.

3.4.1.2 Setup the VIDWriter

(1) Install Microsoft .NET Framework 4.6.1 or later.

(2) Uses exe file including in the unzip directory.

This tool can work without installation. DO NOT change directory structure in the unzipped data.

(3) Check Tool version and FW package version in "Help" -> "About".

VIDWriter 1.0.0.0 applies to the RTK-251-SinkCharger-ISL9238C..

3.4.1.3 Run VIDWriter to generate ROM Image File

When you run VIDWriter 1.0.0.0, the window as shown Figure 3-7 will display.

**Figure 3-7 Main window for VIDWriter 1.0.0.0**
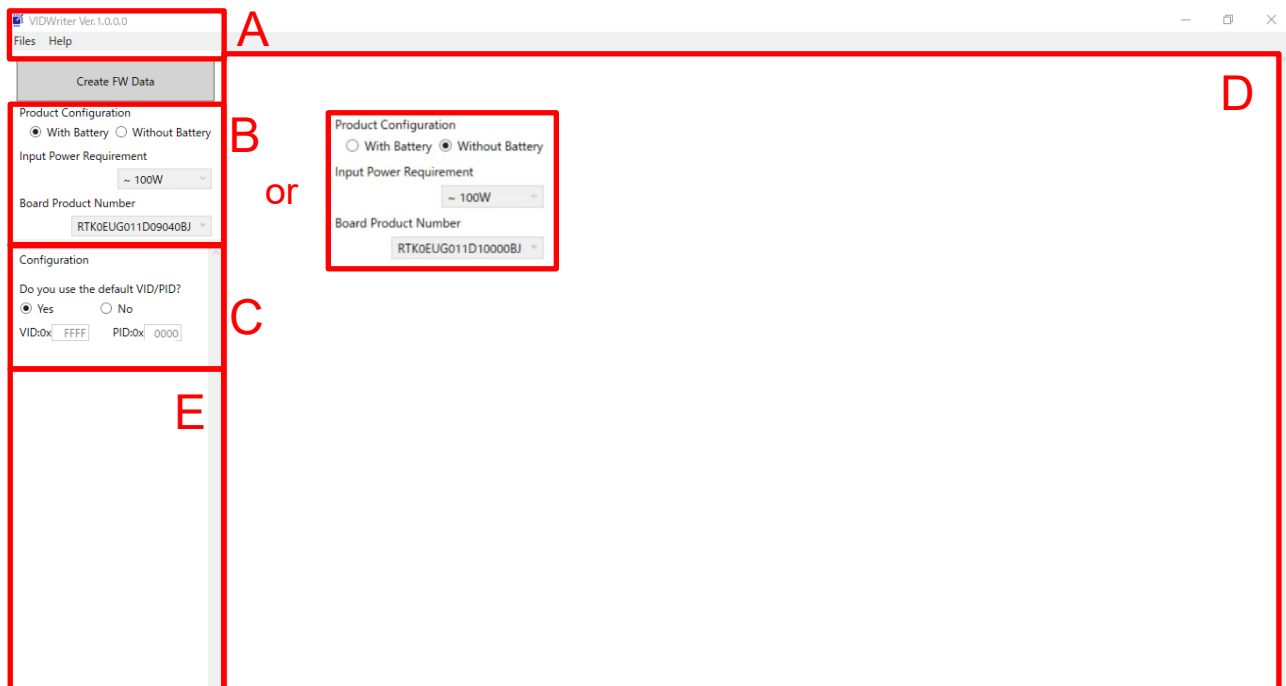
1) Menu Bar
   You can check Tool version and FW package version in "Help" -> "About". VIDWriter 1.0.0.0 applies to the RTK-251-SinkCharger-ISL9238C..

2) Field B to select the required feature
   Choose the features that match your required behavior in this field. Once selected, the recommended turnkey solution will be displayed in Field D and the possible configurations will be shown in Field E.

3) Field C to set VID/PID number.
   If you want to use your own hexadecimal VID and PID numbers instead of the default VID/PID(0xFFFF/0x0000) numbers set in this field, overwrite your own numbers to this field. Otherwise, leave VID: FFFF and PID: 0000.

4) Window for the Renesas recommended turnkey solution
   If user selects "With Battery" in Field B, RTK-251-SinkCharger-ISL9238C will be displayed as Renesas recommended turnkey solution in Field D and RTK0EUG011D09040BJ in Board Product Number field.

Note: In order to use "BMS" or "Manual" modes, FW on the board must be rewritten by this VIDwriter 1.0.0.0-generated FW. If operating mode is changed to "Board" from "BMS" or "Manual", FW on the board also must be rewritten by this VIDwriter 1.0.0.0-generated FW.

Figure 3-8 Main window for VIDWriter 1.0.0.0 after Product Configuration
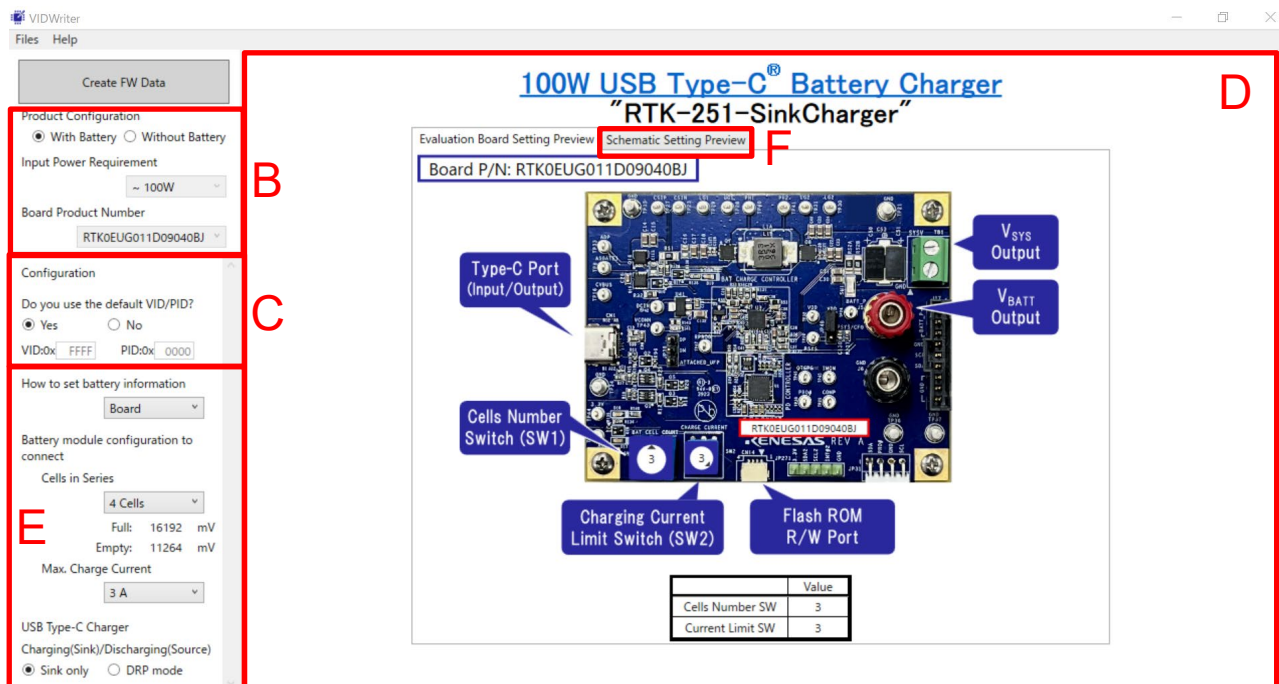
5) Field E configures the turnkey solution recommended by Renesas.
Field E is used to set the Full, Empty, Max Charging Current, and Max sourcing PDP (DRP mode). There are three operating modes; "Board", "BMS", and "Manual". The default firmware uses "Board" mode, in which the switches on the board configure the EVB parameters. "BMS" sets EVB parameters by battery status information from BMS. "Manual" can set EVB parameters directly. After setting in Field E, Field D indicates the appropriate physical settings on the EVB. Next, set the switches on the board according to this picture.

  Note: The RTK-251-SinkCharger-ISL9238C does not have a battery protection circuit on the board, so, Renesas strongly recommends using a battery module with Renesas' Battery Management System to avoid over-discharging under the power bank mode. RTK-251-SinkCharger-ISL9238C can support power bank mode as long as the battery module uses protection circuit to avoid over-discharge, over-temperature, etc. However, this should be done at user's own risk.

Figure 3-9 The Field E and the EVB setting vs "Board" configuration
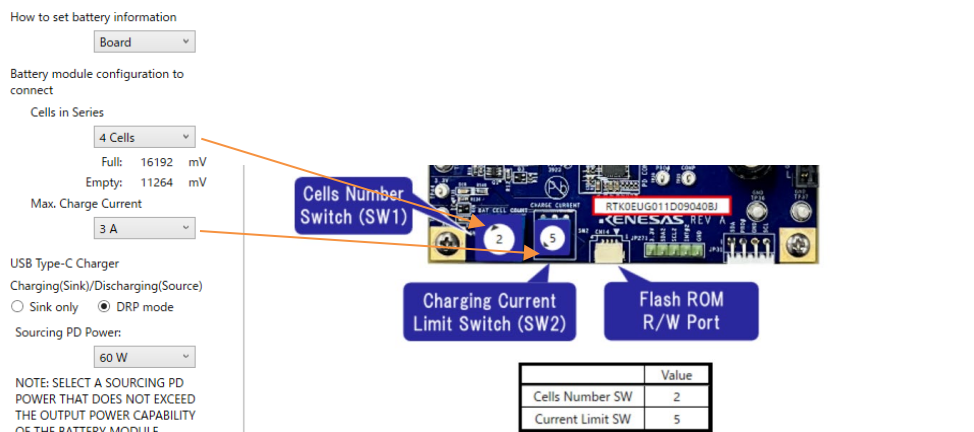
"Full" indicates the maximum battery charging voltage. "Empty" indicates the voltage at which the charger will trickle charge the battery at a low current level if VBAT is below that value.
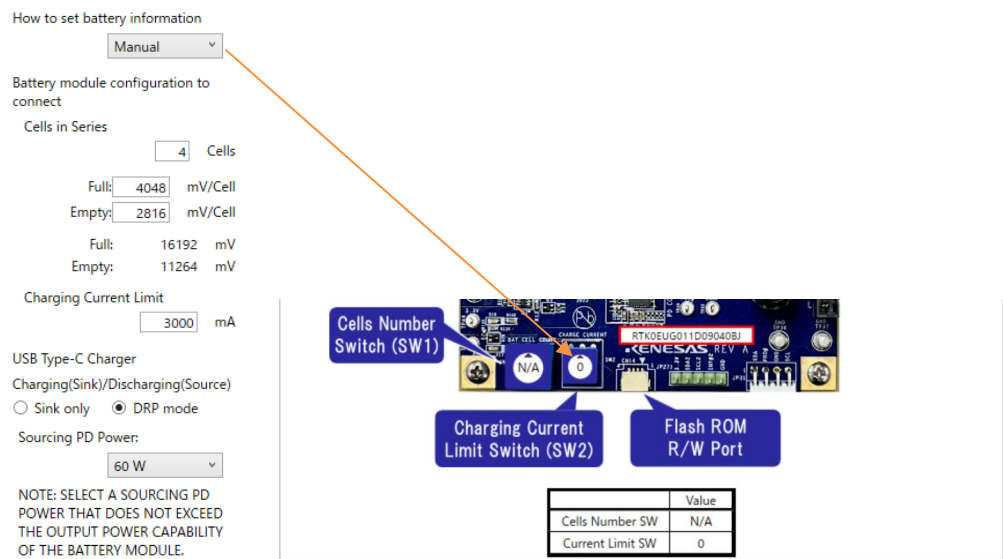
If the user wants to achieve power bank function with RTK-251-SinkCharger-ISL9238C, please select DRP mode. Otherwise, select Sink only. In the sourcing mode of Power Bank operating, the user selects the maximum sourcing PD Power from the drop-down list. See Section 2.3.2 about the maximum sourcing PDP.

Figure 3-10 The Field E and the EVB setting vs "BMS" configuration
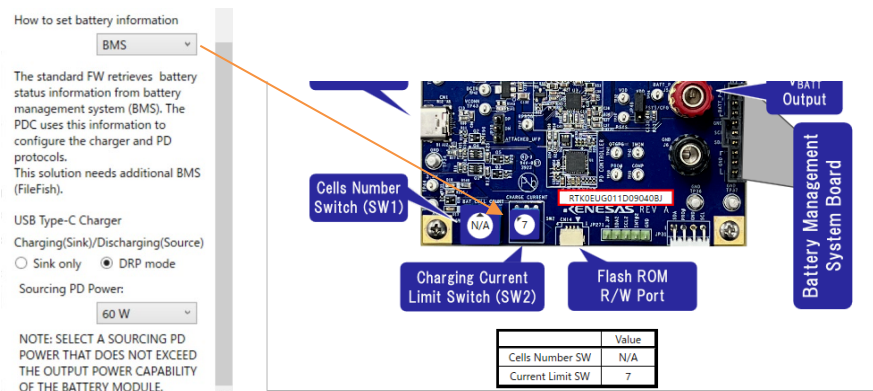
In "BMS" setting, this EVB frequently retrieves battery related information from RAJ240100 Filefish EVM. In this operating mode, this EVB uses the information obtained from RAJ240100 Filefish EVM instead of SW2 value to configure the On-Board Charger.

If the user wants to achieve power bank function with RTK-251-SinkCharger-ISL9238C, please select DRP mode. Otherwise, select Sink only. In this operating mode, the FW cannot recognize the MaxSysVol, MinSysVol, and Charging Current Limits until R9A02G011 retrieves the battery information from BMS. So, VIDwriter 1.0.0.0 cannot define the true max sourcing PD Power under sourcing mode. Therefore, the user should set the appropriate Max sourcing PD Power that battery module can support. See Section 2.3.2 about how to set maximum sourcing PDP.

Figure 3-11 The Field E and the EVB setting vs "Manual" configuration

   If there is no suitable charging current value on SW2 and/or user does not want to set "Full" and "Empty" as standard values, user needs to set SW2 to SW position 0 and set the expected charging current value, "Full" and "Empty". "Full" indicates the maximum battery charging voltage. "Empty" indicates the voltage at which the charger will trickle charge the battery at a low current level if VBAT is below.

   If the user wants to achieve power bank function with RTK-251-SinkCharger-ISL9238C, please select DRP mode. Otherwise, select Sink only. In the sourcing mode of Power Bank operating, the user selects the maximum sourcing PD Power from the drop-down list. See Section 2.3.2 about the maximum sourcing PDP.

6) Press the "Schematic Setting Preview" F tab in field D and you will see the recommended turnkey schematics with appropriated parameters, such as Figure 3-12.

Figure 3-12 Main window for VIDWriter 1.0.0.0 when press Schematic Setting
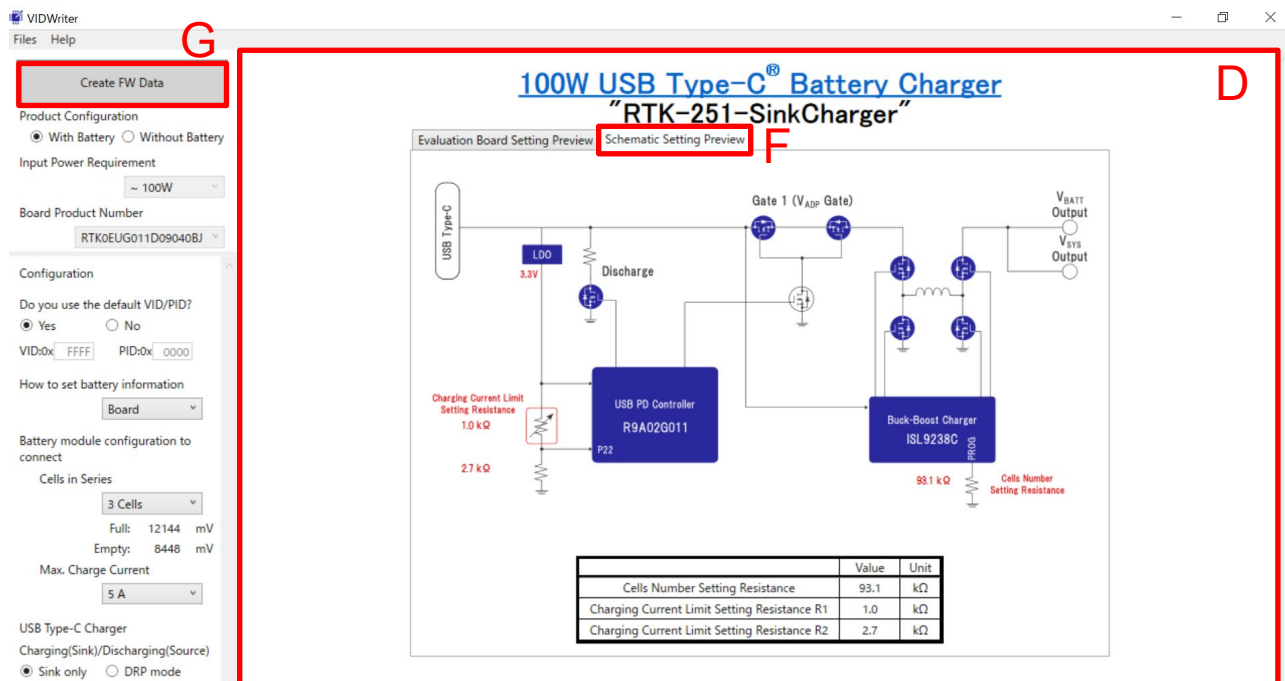
7) Finally, when you press the "Create FW Data" button, a file save dialog will be displayed. The default storage location is the "My Documents" folder. You can change the save location and file name of the ROM image as you like. If you rewrite this ROM image to R9A02G011 on the evaluation board, please use Renesas Flash Programmer V3 as programming software.

3.4.2   Outline of flash memory writing

The R9A02G011 supports Serial programming interface the same as RL78 MCU series.

The code flash memory can be rewritten through serial programming using a flash memory programmer.

The following dedicated flash memory programmers can be used to write data to the flash memory of the R9A02G011. For details, refer to the related documents of the tools.

- PG-FP6

- E1, E2, E2 Lite, E20 on-chip debugging emulator

Data can be written to the flash memory on-board by using a dedicated flash memory programmer. The following table shows the relationship between the situation when writing the firmware and the available writing tool for the writing method using this interface.

Table 3-1 Firmware writing method and available writing tool

Interface	Situations	Available writing tool	Device Configuration	R9A02G011
Serial Programming (TOOL0)	Customer's manufacturing	Example, PG-FP6, SF2000A made by Superfly China	ON board	○
	Design debug, FW update	E1, E2, E2 Lite, E20 on-chip debugging emulator	ON board	○

3.4.2.1   On-board programming

The contents of the flash memory can be rewritten after the R9A02G011 have been mounted on the target system. The connectors that the dedicated flash memory programmer uses must be mounted on the target system.

Please use Renesas Flash Programmer V3 as programming software. Refer to the following documents.

- Renesas Flash Programmer V3.13 Flash memory programming software User's Manual (R20UT5312)
- List of MCUs supported by Renesas Flash Programmer V3 (R20UT3599)
- On the development of flash memory programmer by user, refer to **RL78 microcontrollers (RL78 Protocol A) Programmer Edition Application Note (R01AN0815).**

Flash programing for R9A02G011 is compatible with the RL78 MCU series. Therefore, if user want to use available flash memory programmer that supports RL78 MCU, we may be able to port the library for that programmer. Please ask a contact person.

Table 3-2 Wiring Between R9A02G011GNP and Dedicated Flash Memory Programmer

Pin Configuration of Dedicated Flash Memory Programmer				Pin name	Pin No.
					R9A02G011GNP 32pin
Signal Name		IO	Pin Function		HVQFN
PG-FP6	E1, E2, E2 Lite, E20 on-chip debugging emulator				
SI/RxD	TOOL0	I/O	Transmit/receive signal	P40	7
/RESET	RESET	Output	Reset signal	RESETB	25
VDD	VDD	I/O	VDD voltage	VDD	20
GND	GND	-	Ground	GND Pad	GND PAD
FLMD1	EMVDD	-	Driving power for TOOL0 pin	VDD	20

Table 3-3 Wiring Between R9A02G011GBG and Dedicated Flash Memory Programmer

Pin Configuration of Dedicated Flash Memory Programmer				Pin name	Pin No.
					R9A02G011GBG 42pin
Signal Name		IO	Pin Function		BGA
PG-FP6	E1, E2, E2 Lite, E20 on-chip debugging emulator				
SI/RxD	TOOL0	I/O	Transmit/receive signal	P40	G1
/RESET	RESET	Output	Reset signal	RESETB	A5
VDD	VDD	I/O	VDD voltage	VDD	D4/D5/D6
GND	GND	-	Ground	GND Pad	A1/B1/G6
FLMD1	EMVDD	-	Driving power for TOOL0 pin	VDD	D4/D5/D6

Remark: Pins that are not indicated in the above table can be left open when using the flash memory programmer for flash programming.

3.4.3 FW writing with Renesas on-chip debugging emulator

User can write(load) firmware by Renesas on-chip debugging emulator. Since RTK-251-SinkCharger-ISL9238C does not have full 14 pin connector for the emulator, User shall connect via a converter which is made with the bundled cable when using Renesas on-chip debugging emulator.
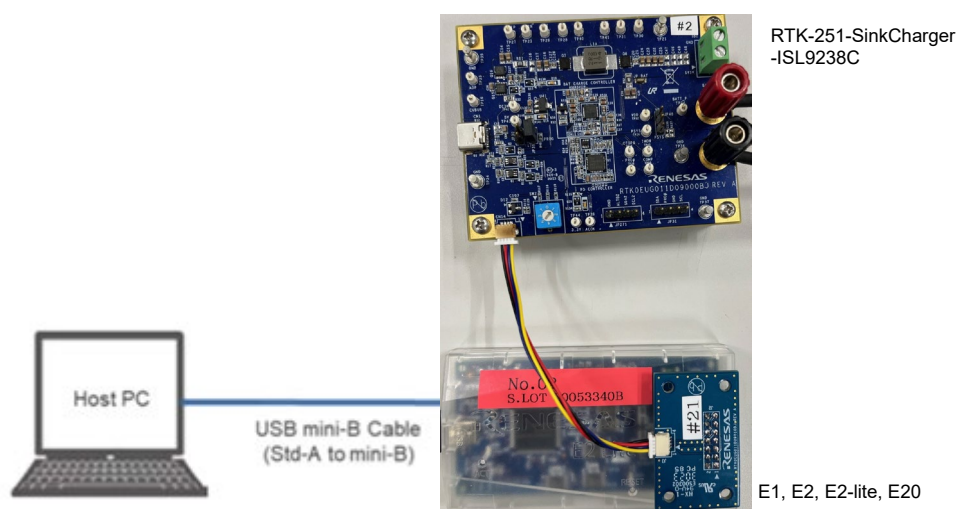
1. Connect conversion connector to CN14 on the board.
2. Connect Renesas on-chip debugging emulator to conversion connector.
3. Connect the emulator to USB port of the PC.

Figure 3-13 Board connection for programming by on-chip debugging emulator
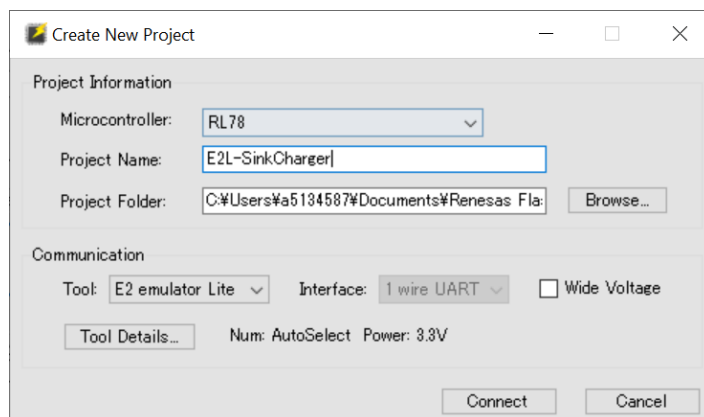
a) RTK0EUG011D09040BJ
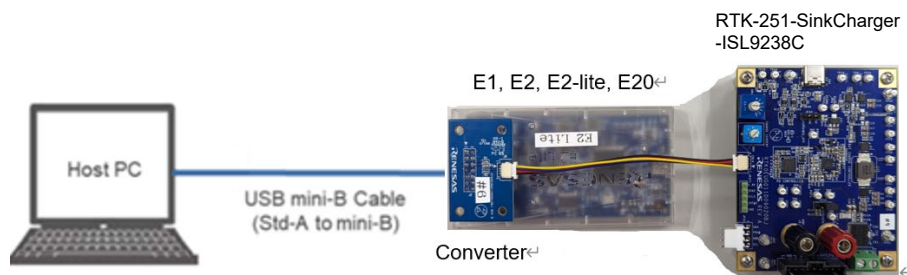
b) RTK0EUG011D09000BJ

4. Execute the "Renesas Flash Programmer V3.xx.

5. Create a "New Project".

6. Select the "RL78" in the "Microcontroller"-list box, input an arbitrary name in the "Project Name"

7. Select your on-chip debugging emulator product in the "Tool"-list box.

8. Click the "Tool detail" and select the "3.3V" in the Power Supply, then click "Connect".
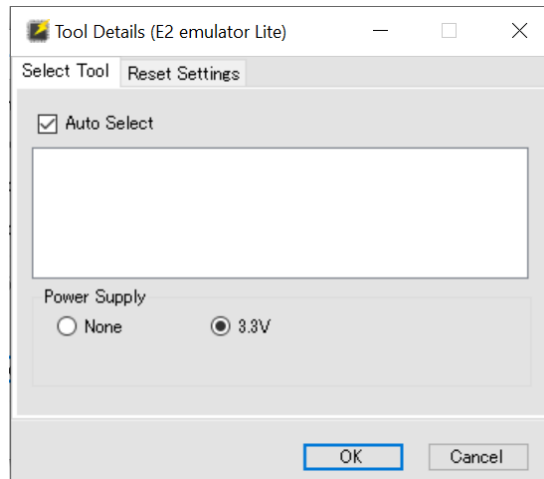
9. Below window appears if new project is created correctly.

    Note: Confirm that the Microcontroller can detect "D720251"

10. Check the "Erase", "Program" and "Verify" in the "Operation Settings"-tab

11. Click the "Start" if you start programming a flash memory data

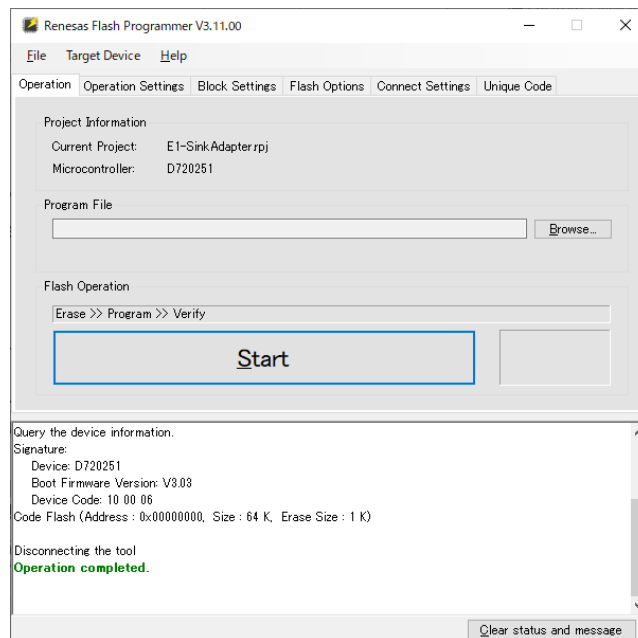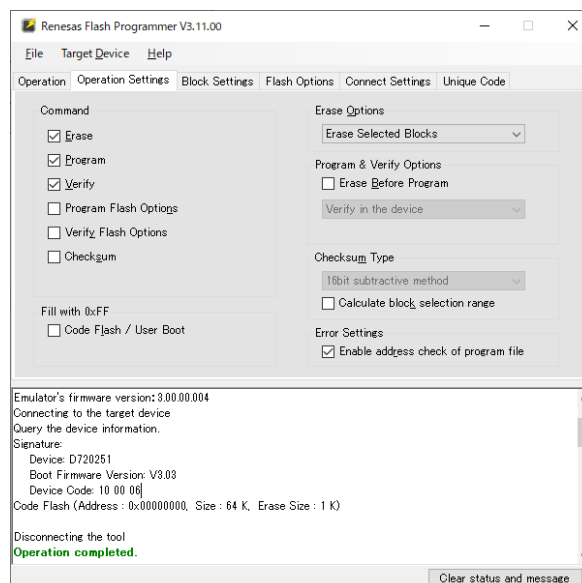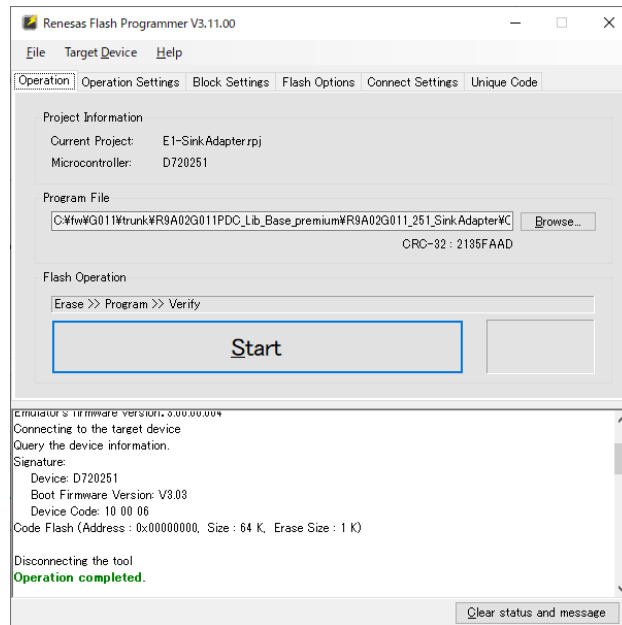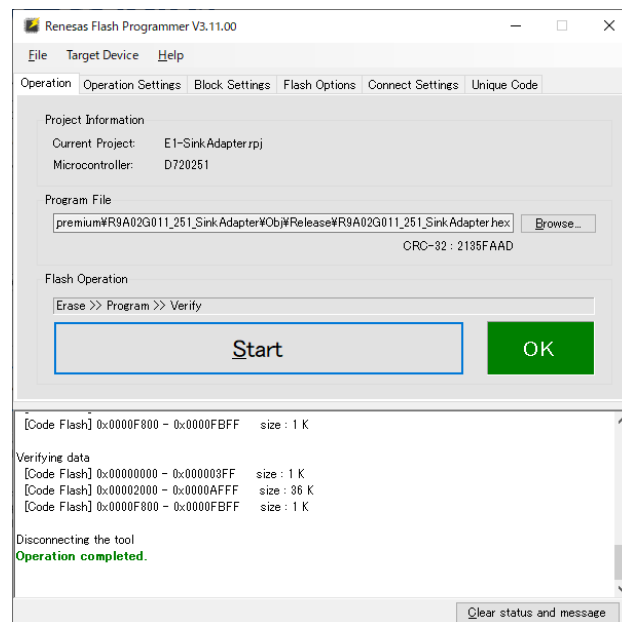12. The "OK" is indicated if program is completed successfully.

4. Optional features

4.1 Supports USB peripheral function

RTK-251-SinkCharger-ISL9238C is designed for Sink only (SNK) Charger / Power bank turnkey solution. There is no USB data communication feature on this board. It has an interface to expand the test/debug of USB2.0 based peripheral function with system.

Figure 4-1 Connector for USB2.0 based peripheral debugging

a) RTK0EUG011D09040BJ

b) RTK0EUG011D09000BJ
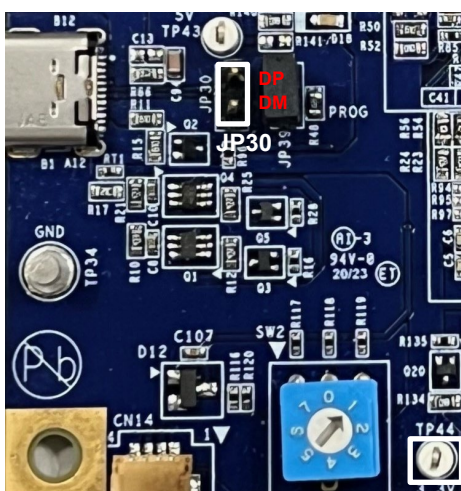
To debug USB2.0 peripheral on RTK-251-SinkCharger-ISL9238C, if there is a jumper between DP and DM of JP30, please remove it and D+/D- signaling of system shall be connected to DP/DM of JP30. Since V_{BUS} appears 0～20V (max), Signal pin "Attached UFP" is allocated on JP30 on RTK0EUG011D09040BJ to detect attach/detach on Type-C®. System can detect Type-C attach/detach by using this signal. On the other hand, becasue there is no this signal on RTK0EUG011D09000BJ, when monitor TP44, system can detect Type-C attach/detach.

4.2 Supports SMBus Slave Interface

RTK-251-SinkCharger-ISL9238C has a SMBus Slave Interface to communicate with other controllers outside of this board. It is an interface to expand the feature with total system.

Figure 4-2 Connector for SMBus Slave Interface

a) For RTK0EUG011D09000BJ   b) For RTK0EUG011D09040BJ

To control RTK-251-SinkCharger-ISL9238C by external controller via SMBus Slave Interface, SMBus Master signaling of system shall be connected to JP271. When system want to control RTK-251-SinkCharger-ISL9238C, please ask Renesas' contact person.

Revision History

Rev.	Date	Description	
		Page	**Summary**
1.00	Mar 14, 2024	-	Initial release

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 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. 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.4.0-1 November 2017)

Corporate Headquarters

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

Trademarks

USB Type-C ® and USB-C ® are trademarks of USB Implementers

Forum. 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/.