

R9A02G011

JP214/RTK-251-SinkAdapter Instruction Manual

Introduction

The JP214 / RTK-251-SinkAdapter is an evaluation board for Universal Serial Bus Power Delivery (USB PD). The RTK-251-SinkAdapter is designed with USB PD controller R9A02G011 and Buck-Boost Voltage Regulator (BB-VR) ISL95338 (substitute product: RAA489800). This document is the instruction manual for RTK-251-SinkAdapter.

The RTK-251-SinkAdapter supports USB PD 2.0, USB PD 3.1, USB Type-C[®] Specification. The RTK-251-SinkAdapter works as USB Type-C[®] power sink, it converts USB-C input power supplied by Type-C sourcing device to DC output. Because there are several losses on the cable, BB-VR, and board, USB PD controller compensates the USB-C input level to achieve the expected DC output. For example, When Type-C sourcing device supplies up to 20V@5A, RTK-251-SinkAdapter can provide up to 20V@4A to DC output with these losses. The board also has an operating mode that feed USB-C input directly to the DC output. Switches connected to the USB PD controller R9A02G011 allows selection of DC output voltage/current and operating mode.

Target Devices

100W USB Type-C[®] Input Power Converter: JP214 / RTK-251-SinkAdapter

USB Power Delivery Controller: R9A02G011

Buck-Boost Voltage Regulator: ISL95338 (substitute product: RAA489800)

Target VIDWriter: VIDWriter 1.0.0.0 (Version 1.0.0.0)

Part Number

RTK0EUG011D10000BJ

Related Document

Use this document in combination with the following documents.

The related documents indicated 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
- ISL95338 Data Sheet: FN8896
- RAA489800 Short-Form Data Sheet: R16DO0003EU
- ISL85415 Data Sheet: FN8373

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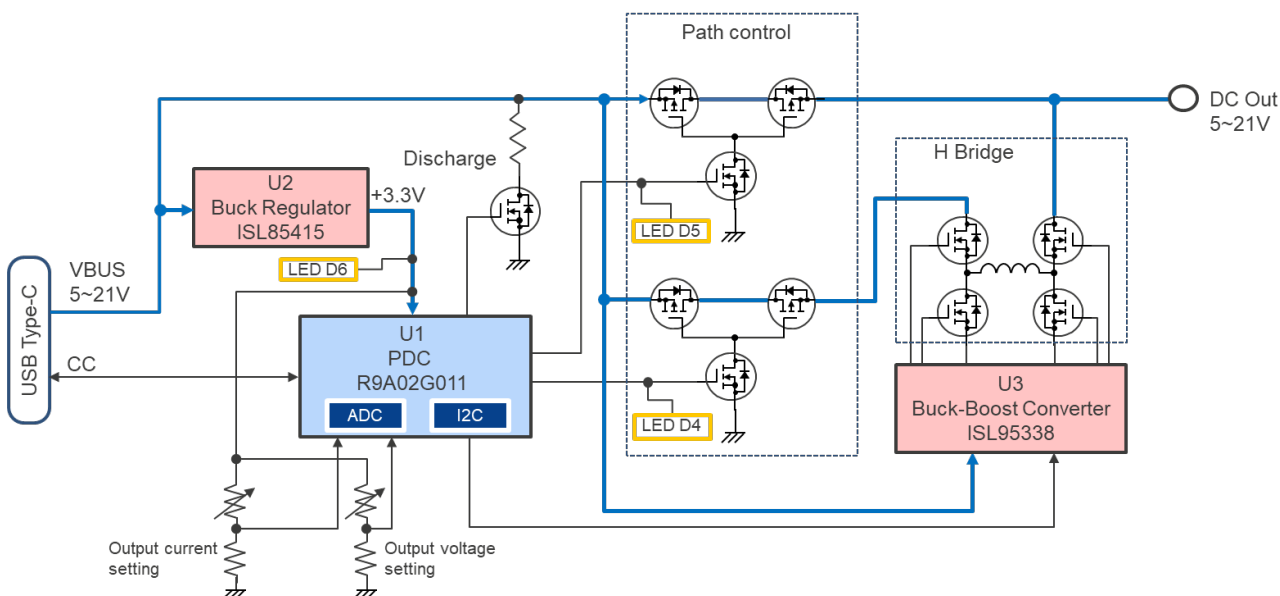
1. Features

RTK-251-SinkAdapter supports the following features.

- USB Power Delivery and USB Type-C®
 - Supports compliant with USB Power Delivery Specification Revision 2.0, USB Power Delivery Specification Revision 3.1, USB Type-C® Cable and Connector Specification Revision 2.1.
 - Certified by USB Implementers Forum TID=8528(PSD: Single Port Power Sinking Device)
 - Power Role: Sink only(SNK)
 - 100W Power Sink (5, 9, 12, 15, 18, 20V)
 - 1 USB Type-C® port
- Power Sink voltage: 5 to 20V
- Interface
 - LED indicators
 - Power Supply Indicator for R9A02G011 (1 LED, green)
 - Bypass path indicator (1 LED, green)
 - Normal path indicator (1 LED, green)
 - Switch
 - A DC output voltage control to R9A02G011
 - A DC output current control to R9A02G011
 - An operation mode selection to R9A02G011
 - On-chip debugging emulator interface
 - Renesas on-chip debugging emulator interface to write and debug firmware for R9A02G011
 - Mode Options
 - Normal mode: DC output is generated by BB-VR input voltage from Type-C sourcing device negotiated with the R9A02G011.
 - ByPass mode: DC output appears directly input voltage from Type-C sourcing device negotiated with the R9A02G011.

1.1 Block Diagram

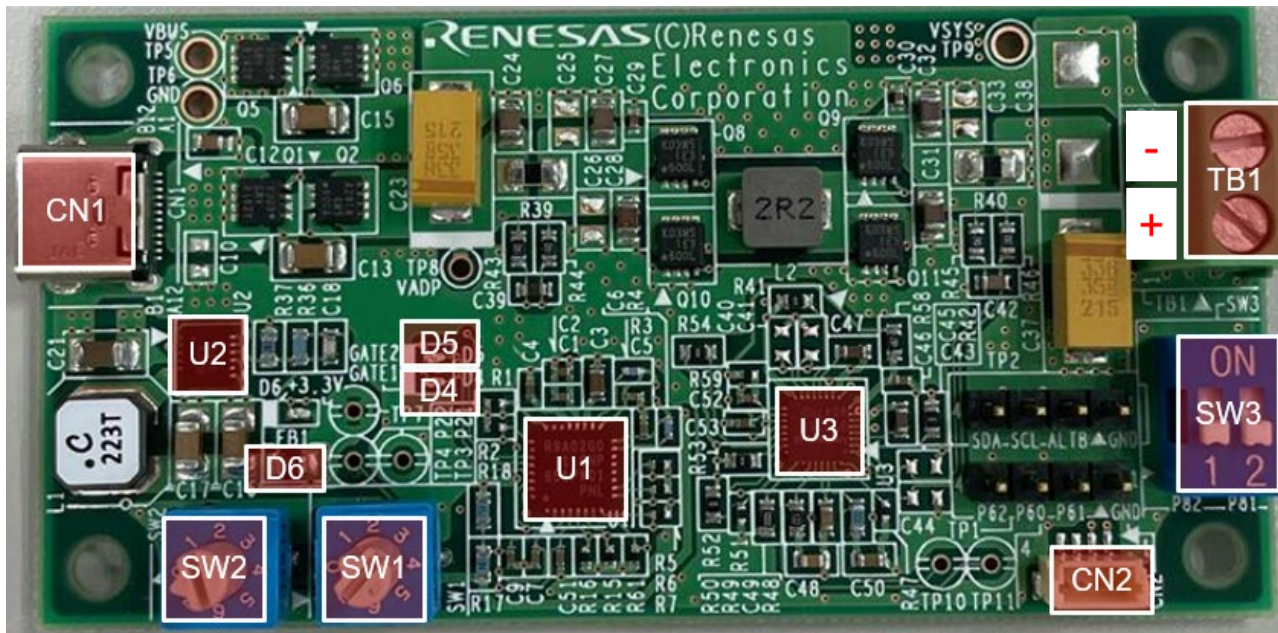
Figure 1-1 RTK-251-SinkAdapter block diagram



1.2 Component

1.2.1 Component layout

Figure 1-2 Highlighted mainly parts on the board



1.2.2 Component information

(1) IC

No.	Description	Remark
U1	R9A02G011 (USB Power Delivery Controller)	-
U2	ISL85415 (Wide VIN Synchronous Buck Regulator)	-
U3	ISL95338 (Buck-Boost Voltage Regulator)	-

(2) Connector

No.	Description	Remark
CN1	USB Type-C receptacle	-
CN2	Renesas on-chip debugging emulator interface	-
TB1	DC Jack for power output	-

(3) Switch

No.	Description	Connects to R9A02G011
SW1	Rotary Dip switch for output voltage control	P21
SW2	Rotary Dip switch for output current control	P22
SW3	Dip switch for mode selection	P81, P82

(4) LED

No.	Description	Connects to R9A02G011
D4	Normal path indicator (green)	P73
D5	Bypass path indicator (green)	P72
D6	Power Supply Indicator for R9A02G011, same meaning as VBUS Indicator (green)	

(5) Test point

No.	Description	Connects to R9A02G011
TP1	SMBus Slave SCL, SDA, alert on R9A02G011	P60, P61, P62
TP2	SMBus Master SCL, SDA, alert on R9A02G011 (SMBus Slave SCL on ISL95338)	P30, P31, P137
TP3	SW1 analog input on R9A02G011	P21
TP4	SW2 analog input on R9A02G011	P22
TP5	V _{BUS} (Near USB Type-C receptacle)	-
TP6	GND	-
TP7	+3.3V	-
TP8	VADP (Monitor for BB-VR input)	-
TP9	VSYS (DC output)	-
TP10	Renesas use only	-
TP11	Renesas use only	-

1.3 Function assignment for R9A02G011 on JP214 / RTK-251-SinkAdapter

Table 1-1 shows the functions assigned to R9A02G011 of JP214 / RTK-251-SinkAdapter.

Table 1-1 The function assigned to R9A02G011 of JP214 / RTK-251-SinkAdapter

Pin name	Function	Descriptions
P16	Open	-
P20	VBUSM	V _{BUS} voltage monitor input
P21	SW1	Input from Rotary Dip switch for DC output voltage control
P22	SW2	Input from Rotary Dip switch for DC output current control
P31	MSTSDA	SMBus master data input/output (open-drain) connected to ISL95338
P30	MSTSCS	SMBus master clock output (open-drain) connected to ISL95338
P40	TOOL0	Connected to on-chip debugging emulator interface for flash programming.
P61	Pull-up	Pull-up to +3.3V
P60	Pull-up	Pull-up to +3.3V
P62	Pull-up	Pull-up to +3.3V
P32	Open	-
P80	Open	-
P50	Open	-
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	Pull-down
P122	Pull-down	Pull-down
P137	MSTALTB	PROCHOT# signal from ISL95338
RESETB	RESETB	Chip Reset Input (active low)
P70	Open	-
P71	DISCHG	Discharge control for USB Type-C V _{BUS}
P72	Gate2	Bypass path gate (Gate2/D5) control
P73	Gate1	Normal path gate (Gate1/D4) control
P81	sw_in	Mode switch (SW3) input
P82	sw_in	Mode switch (SW3) input
P17	Open	-

2. Function

2.1 DC Output Voltage & maximum Current setting

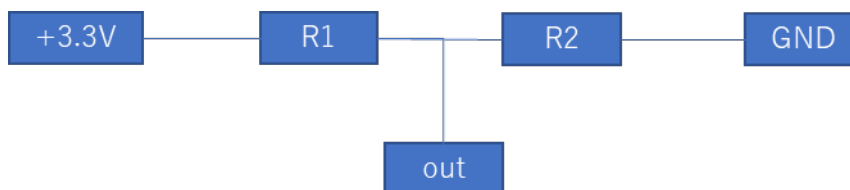
DC Output voltage and maximum current is set by SW1 and SW2.

Table 2-1 Rotary switch setting value

SW position	Maximum Current (SW2)	Voltage (SW1)
0	0A	5V
1	1A	9V
2	2A	12V
3	3A	15V
4	4A	18V
5	5A	20V
6	Prohibited (future use)	Prohibited (future use)
7	Prohibited (future use)	Prohibited (future use)

If output voltage and maximum current are fixed, the substitute circuit as shown in Figure 2-1 can be used instead of the rotary switch.

Figure 2-1 The substitute circuit for output voltage or current



The resistor values in Table 2-2 can be used to define input level of P20 and P21.

Table 2-2 Resistors values for substitute circuit

Position	Resister value (kΩ)	
	R1	R2
0	4.7	2.7
1	3.3	2.7
2	2.2	2.7
3	1.5	2.7
4	1.2	2.7
5	1	2.7
6	-	-

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

If user expects to use other DC output and maximum current level, please ask a contact window.

2.2 Mode selection

RTK-251-SinkAdapter have 2 modes. User can select either of them by setting SW3.

Table 2-3 Mode switch description

SW3		Mode name	Behavior
1	2		
OFF	OFF	Prohibited	NA
OFF	ON	ByPass mode	If the voltage and current set by SW1 and SW2 can be negotiated with Type-C sourcing device, open Gate2 (LED D5) provide power to DC output from Type-C V_{BUS} directly.
ON	OFF	Normal mode	Because there are losses on cable, BB-VR and also path on board, if 1.2 times of power (voltage x current that set by SW1 and SW2) can be negotiated with Type-C sourcing device, open Gate1 (LED D4) and BB-VR generated the voltage and maximum current to expected value that set by SW1/SW2 and supply it on DC output.
ON	ON	Prohibited	NA

Figure 2-2 ByPass / Normal mode enable

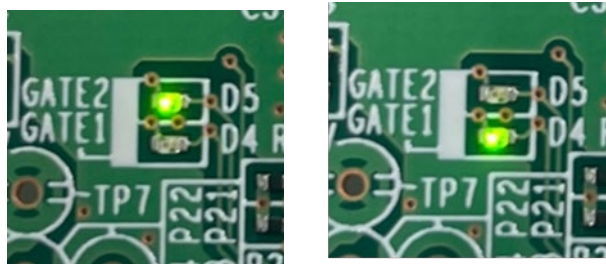


Table 2-4 The required Type-C sourcing PD Power(min) on Normal Mode

	1A	2A	3A	4A	5A
5V	1.2A@5V	2.4A@5V	2A@9V	2.6A@9V	2A@15V
9V	1.2A@9V	2.4A@9V	2.2A@15V	2.9A@15V	2.7A@20V
12V	1.6A@9V	2A@15V	2.9A@15V	2.9A@20V	3.6A ¹ @20V
15V	1.2A@15V	2.4A@15V	2.7A@20V	3.6A ¹ @20V	4.5A ¹ @20V
18V	1.5A@15V	2.9A@15V	3.3A ¹ @20V	4.4A ¹ @20V	
20V	1.2A@20V	2.4A@20V	3.6A ¹ @20V	4.8A ¹ @20V	

¹5A cable is required.

DC output power should be limited within USB Type-C sourcing device power budget. For example, if USB Type-C sourcing device power budget is 60W(3A@20V), Maximum DC output power on this board under normal mode becomes 4A@12V.

3. Board setup and how to use

3.1 Required materials to use this board

- RTK-251-SinkAdapter: 1 unit
- USB Type-C Cable: 1pcs (When the expected DC output power is over 54W, 5A cable shall be required.)

Notes:

This board is BUS-powered Sink and does not require an external power connection.

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 use when connected to a source device

1. Connect DC load to DC terminal block (TB1).
2. Selecting the operating mode by mode switch (SW3) if it uses as bypass mode. If it uses as normal mode, User can use it as default.
3. Selecting the expected output voltage by rotary DIP switch (SW1)
4. Selecting the expected maximum current by rotary DIP switch (SW2)
5. Connect USB Type-C sourcing device to USB Type-C receptacle (CN1) via USB Type-C Cable and supply power to the board, confirm green LED (D6) lights on.
6. The board supplies power to DC load as selected output voltage and maximum current.

Never change SW1/SW2/SW3 when the Board power is ON.

3.3 Firmware writing to the R9A02G011 on JP214 / RTK-251-SinkAdapter

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

3.3.1 FW generation

3.3.1.1 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.

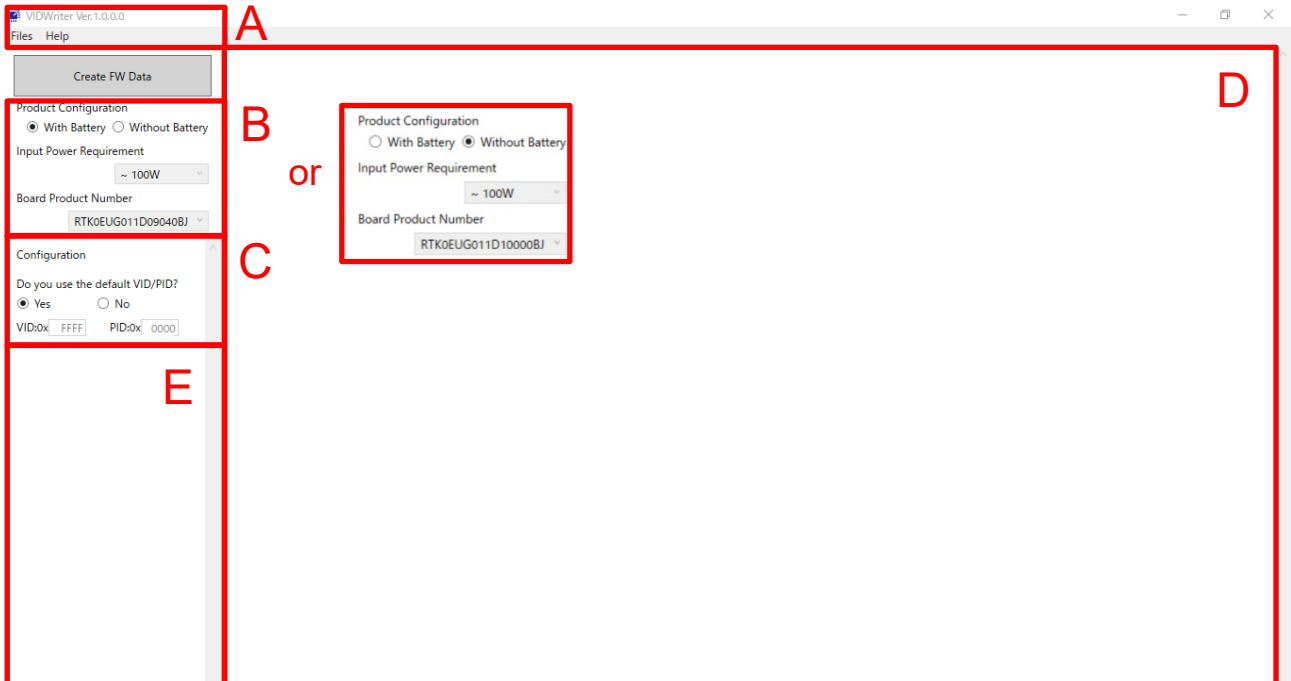
3.3.1.2 Setup the VIDWriter

- (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 JP214 / RTK-251-SinkAdapter.

3.3.1.3 View Description for VIDWriter 1.0.0.0

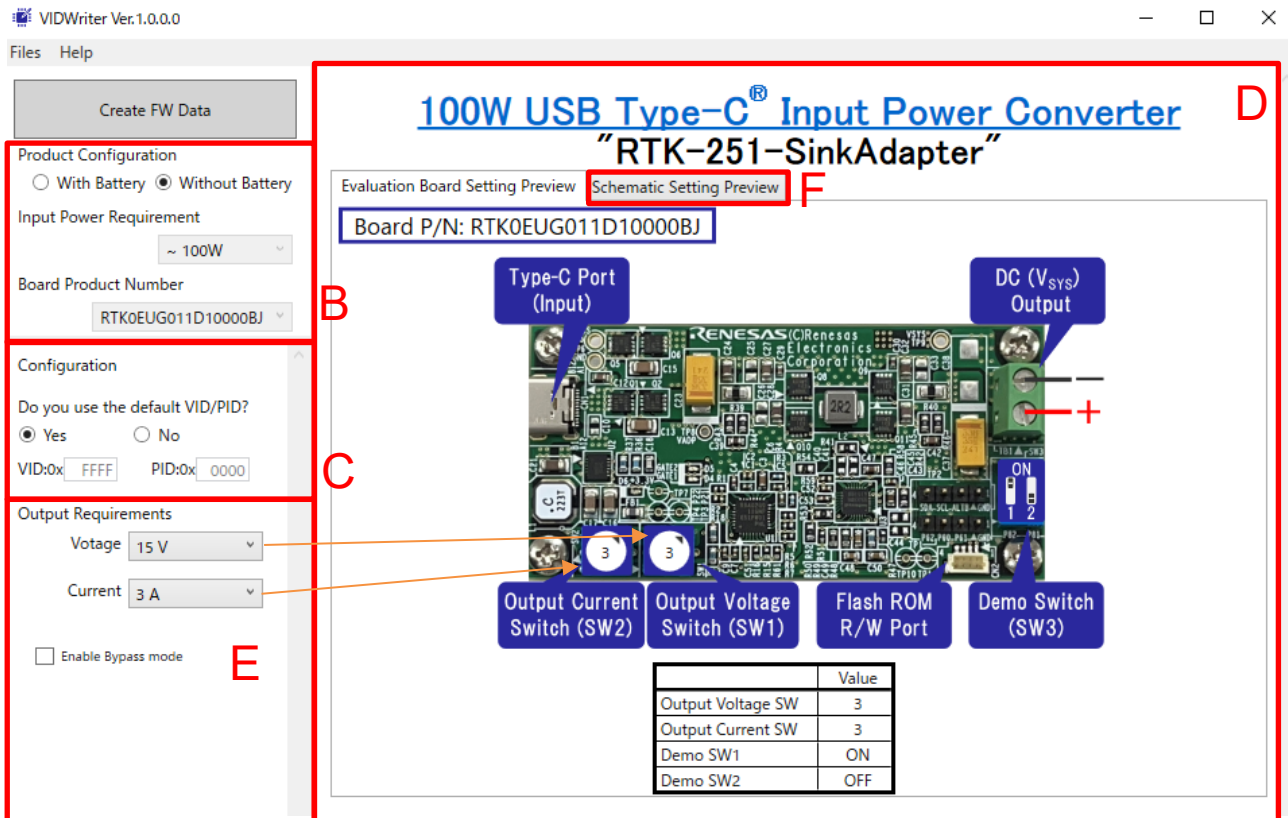
When you run VIDWriter 1.0.0.0, the window as shown Figure 3-1 will display.

Figure 3-1 Main window for VIDWriter 1.0.0.0



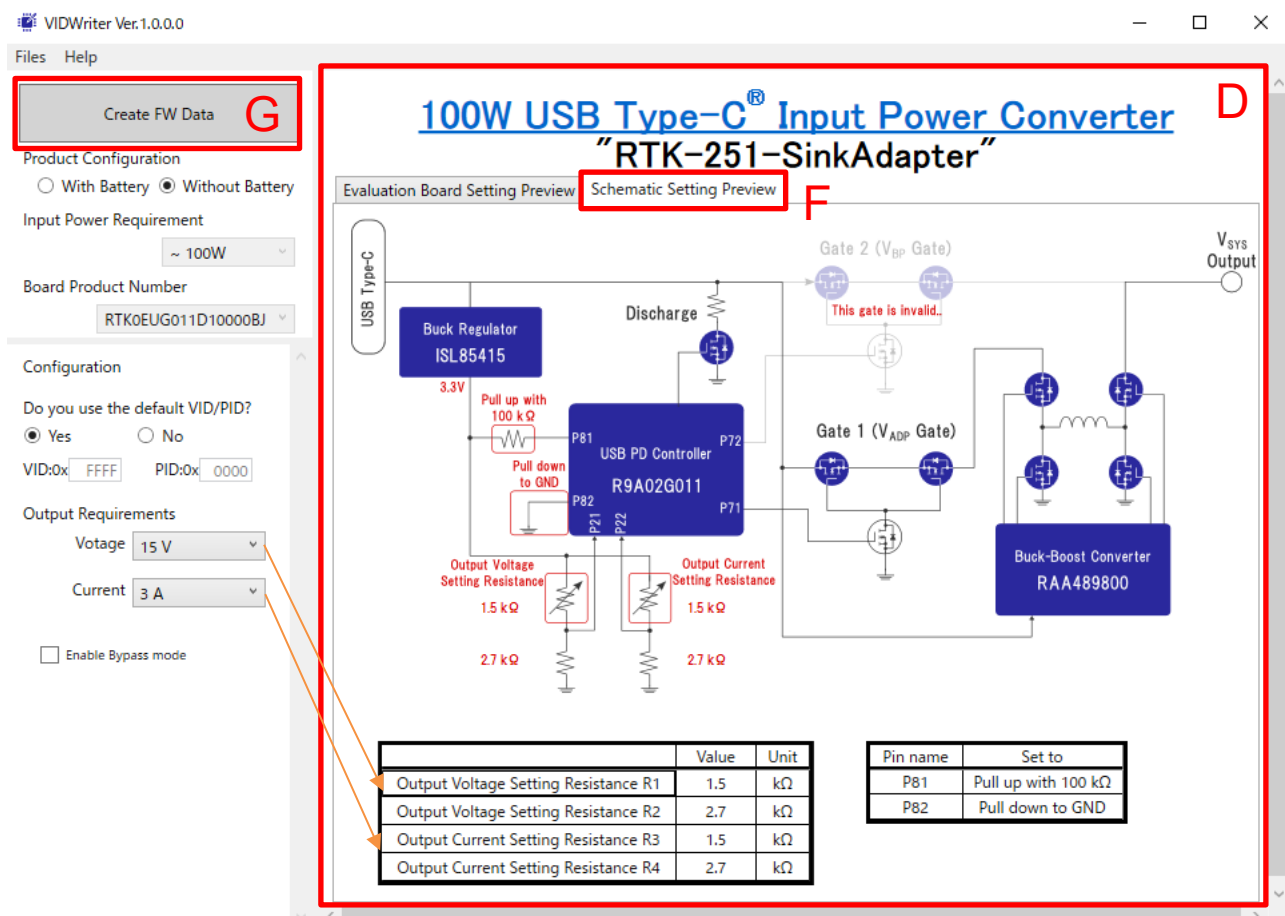
1. **Menu Bar**
You can check Tool version and FW package version in “Help” -> “About”. VIDWriter 1.0.0.0 applies to the JP214 / RTK-251-SinkAdapter.
2. **Field B to select the required feature**
Choose the features that match your required behavior in this field. Once selected, the recommended turnkey 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 in this field. Otherwise, leave it as VID: FFFF and PID: 0000.
4. **Window for the Renesas recommended turnkey solution**
If user selects “Without Battery” in Field B, JP214 / RTK-251-SinkAdapter will be displayed as Renesas recommended turnkey solution in Field D and RTK0EUG011D10000BJ in Board Product Number field.

Figure 3-2 Main window for VIDWriter 1.0.0.0 after feature selection



- Field E configures the turnkey solution recommended by Renesas. When select the setting for both DC output voltage and maximum output current of this EVB, from the drop-down list in this field, Field D indicates the appropriate physical settings on the EVB. Next, set the switches on the board according to this picture.
- Also, if you require to feed USB-C input directly to the DC output on the board, check "Enable Bypass Mode".
- Press the "Schematic Setting Preview" F tab in field D and you will see the recommended turnkey schematics with appropriated parameters, such as Figure 3-3.

Figure 3-3 Main window for VIDWriter 1.0.0.0 when press Schematic Setting Preview



- 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 EVB, please use Renesas Flash Programmer V3 as programming software. See the documents below.

3.3.2 Outline of flash memory writing

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

The code flash memory can be rewritten to 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	○

3.3.2.1 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 (R20UT5312EJ)
- List of MCUs supported by Renesas Flash Programmer V3 (R20UT3599EJ)
- On the development of flash memory programmer by user, refer to **RL78 microcontrollers (RL78 Protocol A) Programmer Edition Application Note (R01AN0815EJ)**.

Flash programming 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 window.

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

Pin Configuration of Dedicated Flash Memory Programmer				Pin name	Pin No.
Signal Name		IO	Pin Function		R9A02G011GNP 32pin
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.
Signal Name		IO	Pin Function		R9A02G011GBG 42pin
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

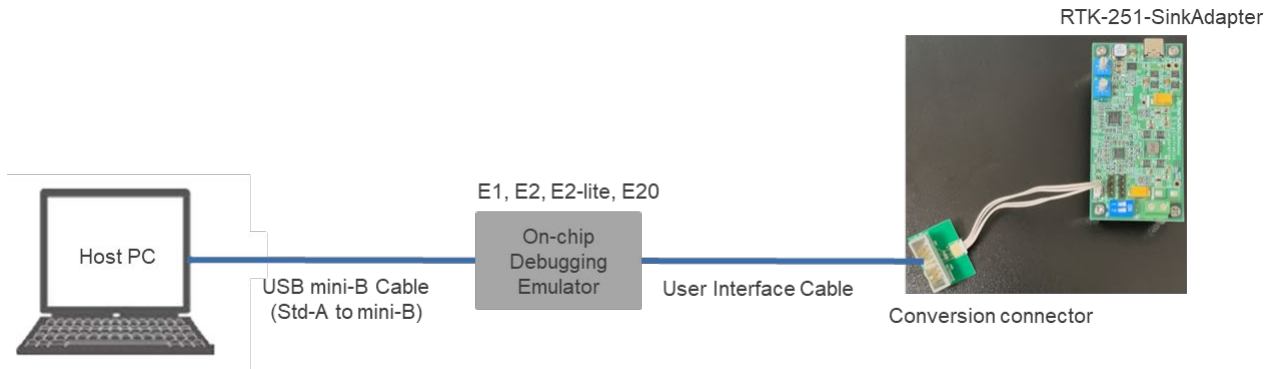
Remark: Pins that are not indicated in the above table can be left open when using the flash memory programmer for flash programming.

3.3.3 FW writing with Renesas on-chip debugging emulator

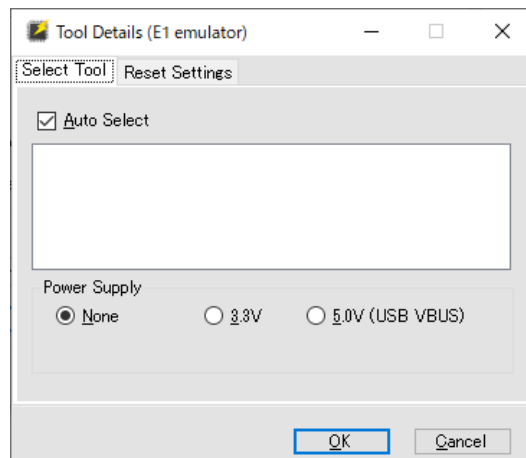
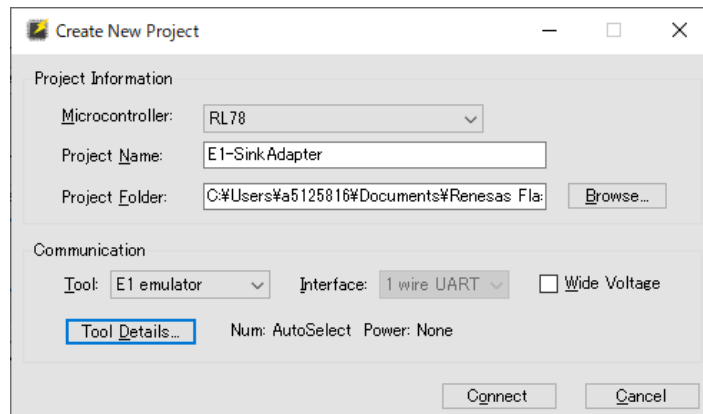
User can write(load) firmware by Renesas on-chip debugging emulator. Since RTK-251-SinkAdapter does not have full 14 pin connector for the emulator, User shall connect via a converter which is made with the bundled cable when using Renesas on-chip debugging emulator.

1. Connect conversion connector to CN2 on the board.
2. Connect Renesas on-chip debugging emulator to conversion connector.
3. Connect the emulator to USB port of the PC.

Figure 3-4 Board connection for programming by on-chip debugging emulator

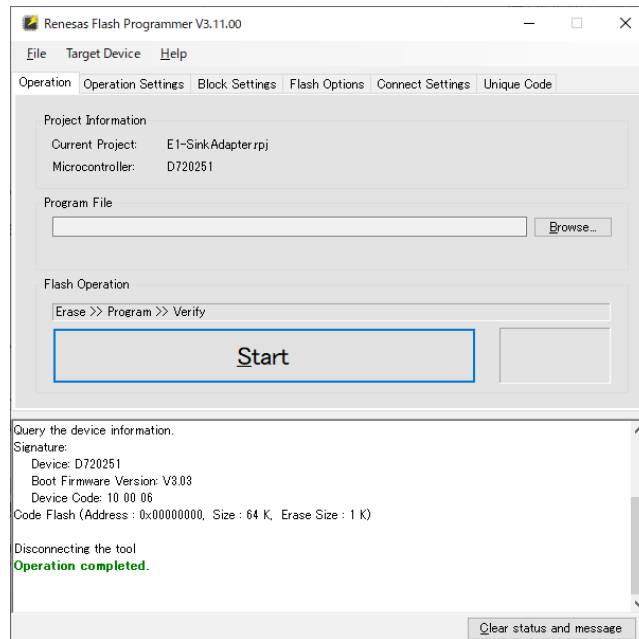


4. Connect USB-C AC adapter to CN1 on the board.
5. Execute the "Renesas Flash Programmer V3.xx."
6. Create a "New Project".
7. Select the "RL78" in the "Microcontroller"-list box, input an arbitrary name in the "Project Name"
8. Select your on-chip debugging emulator product in the "Tool"-list box.
9. Click the "Tool detail" and select the "None" in the Power Supply, then click "Connect".

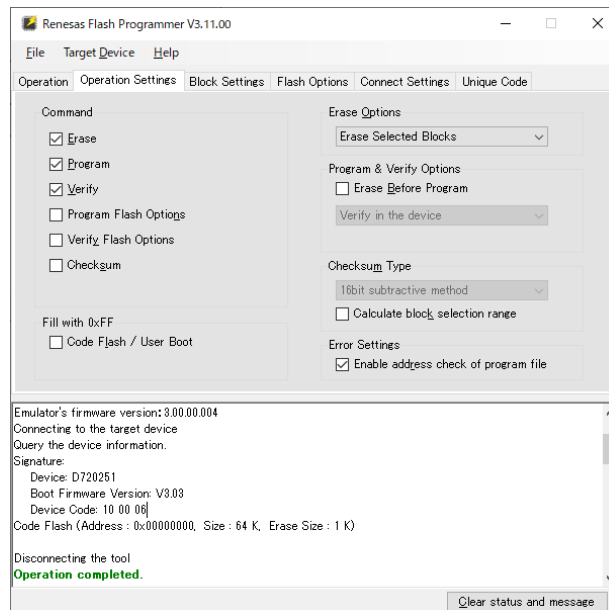


10. Below window appears if new project is created correctly.

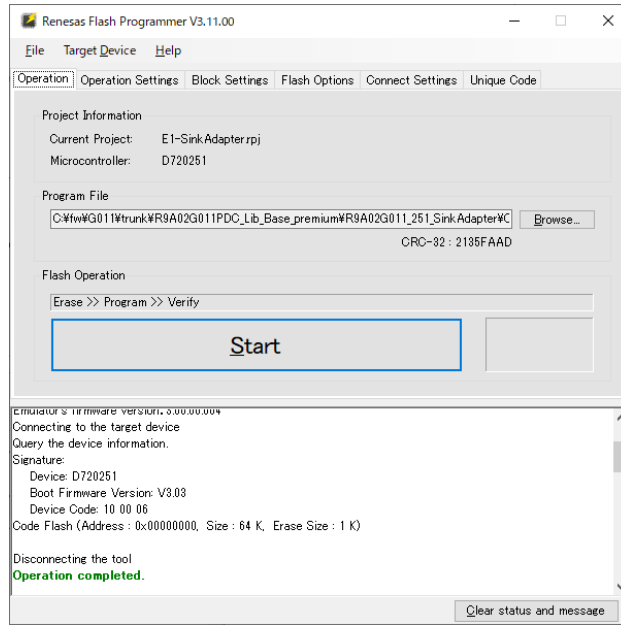
Note: Confirm that the Microcontroller can detect “D720251”



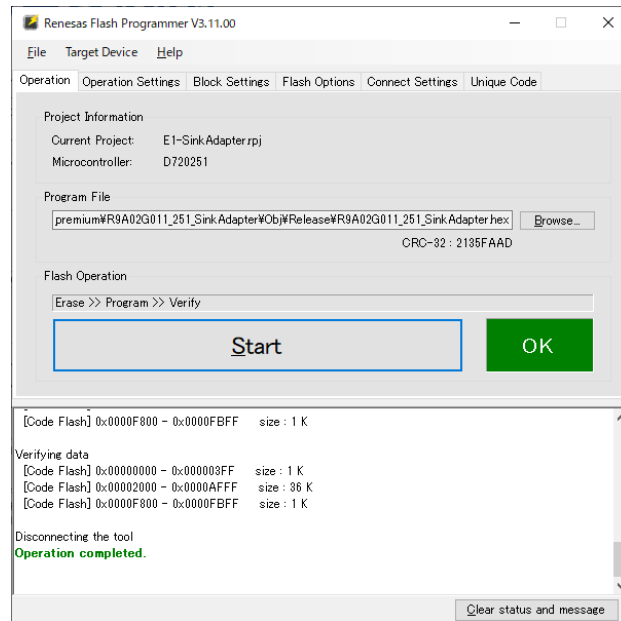
11. Check the “Erase”, “Program” and “Verify” in the “Operation Settings”-tab



12. Click the “Start” if you start programming a flash memory data



13. The “OK” is indicated if program is completed successfully.



Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Sep 11, 2023	-	Initial release
1.01	Mar 14, 2024	2	Updated Related Document (changed the version from v3.12 to v3.13 for Renesas Flash Programmer Flash memory programming software User's Manual)
		16	Changed the version from v3.12 to v3.13 for Renesas Flash Programmer Flash memory programming software User's Manual in section 3.3.2.1
		13	Modify Section 3.3.1.3 View Description for VIDWriter

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

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

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity.

Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

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

3. Input of signal during power-off state

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

4. Handling of unused pins

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

5. Clock signals

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

6. Voltage application waveform at input pin

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

7. Prohibition of access to reserved addresses

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

8. Differences between products

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

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