RAA230161GSB Evaluation Board

24V Input, USB Voltage Supply for Power Delivery

R19AN0045EJ0101
Rev.1.01
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Introduction

This document is RAA230161GSB (USB Voltage Supply) evaluation board manual. The evaluation board operates by I2C from an external device, or host adapter (RTK0EF0029Z00001BJ) and control tool (Renesas_UVS_Eva_Tool_exe).

By using the board, easy and short time design of the power supply circuit in USB PD provider is possible.

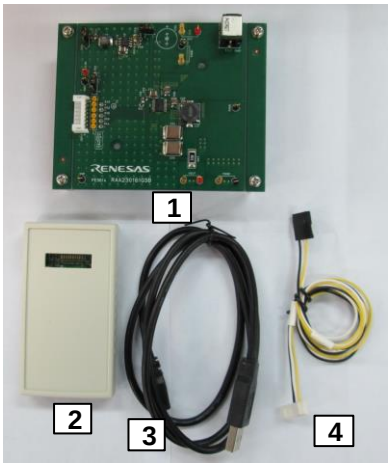
Features

- RAA230161GSB supports the output voltage conforming in USB Power Delivery standard (Power Rule ~ 60 W).
- A safe system is made by the IC which has various protection functions.
- Easy evaluation by the dedicated GUI tool.

  （It can be set the output voltage and the maximum current, and each protection function status is monitored.）

Evaluation Board Contents

No.	Item	Contents
1	Evaluation Board	RAA230161GSB_Evaluation Board
2	Host adaptor	RTK0EF0029Z00001BJ
3	USB cable	USB A - mini B Cable
4	Cable	Host adaptor output cable
5	Control tool	RAA230161GSB Evaluation Tool： Renesas_UVS_Eva_Tool_vxx.zip
6	USB Driver	USBdriver.zip



* The values described in this document are reference values, not guaranteed.

Contents

1. RAA230161GSB Evaluation Board Overview

1.1 Evaluation Board specification

Figure 1.1 shows the outline drawing of the evaluation board. Table 1.1 shows the terminal functions of the evaluation board, Table 1.2 and Table 1.3 show the input / output specifications of the board.

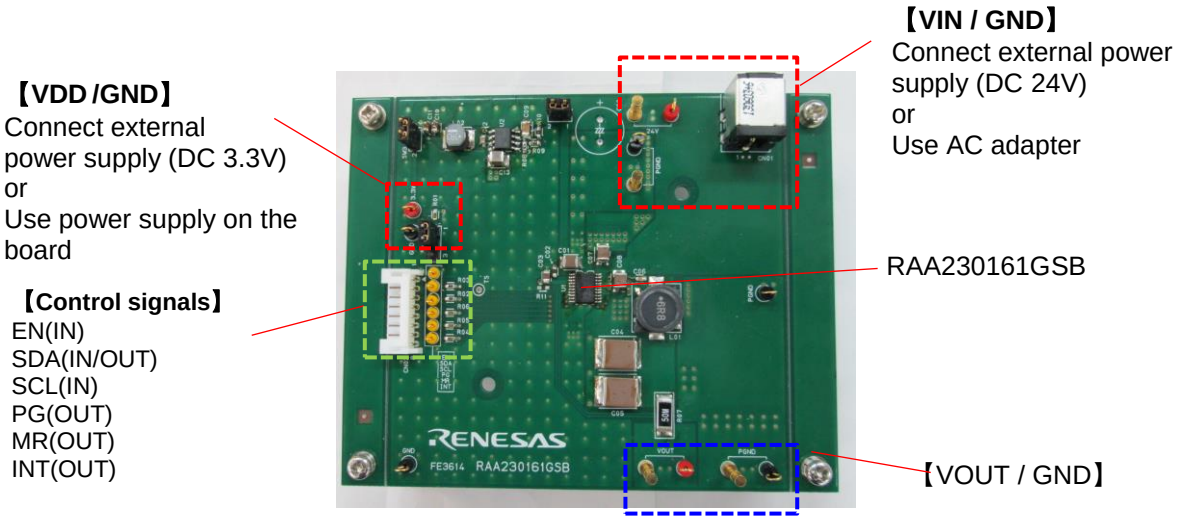


Figure.1.1 RAA230161GSB Evaluation Board outline drawing

Table 1.1 RAA230161GSB Evaluation Board terminal functions

Symbol	I/O	Function
VIN	Power	Power supply for RAA230161GSB and RAA230153GSB (external power input or AC adapter input, selectable)
VDD	Power	Power supply for I2C communication (external power input or on-board power supply, selectable)
EN	IN	Enable control terminal of RAA230161GSB (external input or on-board power supply, selectable)
SDA	IN/OUT	I2C Data input and output terminal
SCL	IN	I2C Clock input terminal
PG	OUT	Power good output terminal
MR	OUT	Reset signal output for microcontroller (Low active)
INT	OUT	Status output terminal (Low active)
VOUT	OUT	Output terminal
GND	GND	GND terminal

Table 1.2 RAA230161GSB Evaluation Board Input specification

Item	Symbol	TYP value	unit	Note
VIN voltage	VIN	24	V	Input current IIN=18mA
VDD voltage (When using external power supply)	VDD	3.3	V	Input current IDD=1uA

Input current IIN is the value when Vout is 5.3V and no load.

Recommending to use a stabilized power supply or an AC adaptor as the evaluation board power supply(VIN).

Table 1.3 RAA230161GSB Evaluation Board output specification

Item	Symbol	TYP value	Unit
Output voltage range	VOUT	5.3(*) / 9.15/ 12.1/ 15.1/ 20	V
Output max current range	IOUT	0.5(*)/ 1.0/ 1.5/ 2.0/ 2.5/ 3.0	A

(*) are default values. These values can be changed by the initial setting screen or register map on the control tool.

1.2 Evaluation board power supply connection

Table 1.4 shows the VDD SW settings, Table 1.5 and Table 1.6 show the power supply connection (1) and (2).

Note: Select either (1) or (2) respectively, do not connect and set (1), (2) at the same time.

Table1.4 VDD SW setting

Item	Symbol	When using an external power supply	When using the on-board power supply
Jumper	SW2	OPEN	SHORT
	SW3	OPEN	SHORT

Table 1.5 VIN(24V) input connection

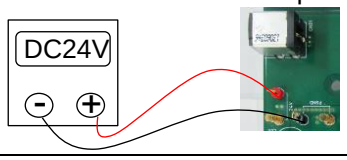
(1) Using an AC adapter	(2) Using an external power supply
Connect the AC adapter plug to the jack (CN01). DC 24V 	Connect the + side of the external DC power supply to "24V" pin and the - side to "PGND" pin. 

Table 1.6 VDD(3.3V) input connection

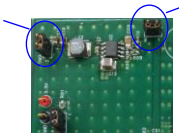
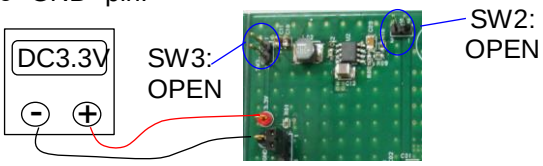
(1) Using the on-board power supply	(2) Using an external power supply
Short SW2 and SW3 respectively. SW3:SHORT SW2:SHORT 	Open SW 2 and SW 3, Connect the + side of the external DC power supply to “3.3V” pin and the - side to “GND” pin. 

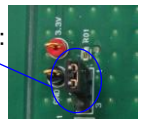
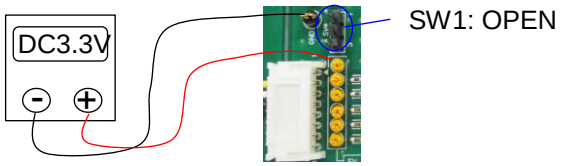
Table 1.7 shows the EN switch setting, Table 1.8 shows the EN input connection (1), (2).

Note : Select either (1) or (2) respectively, do not connect and set (1), (2) at the same time.

Table 1.7 EN input SW setting

Item	Symbol	Using an external input	Using the on-board power supply	
			High	Low
Jumper	SW1	OPEN	1	3

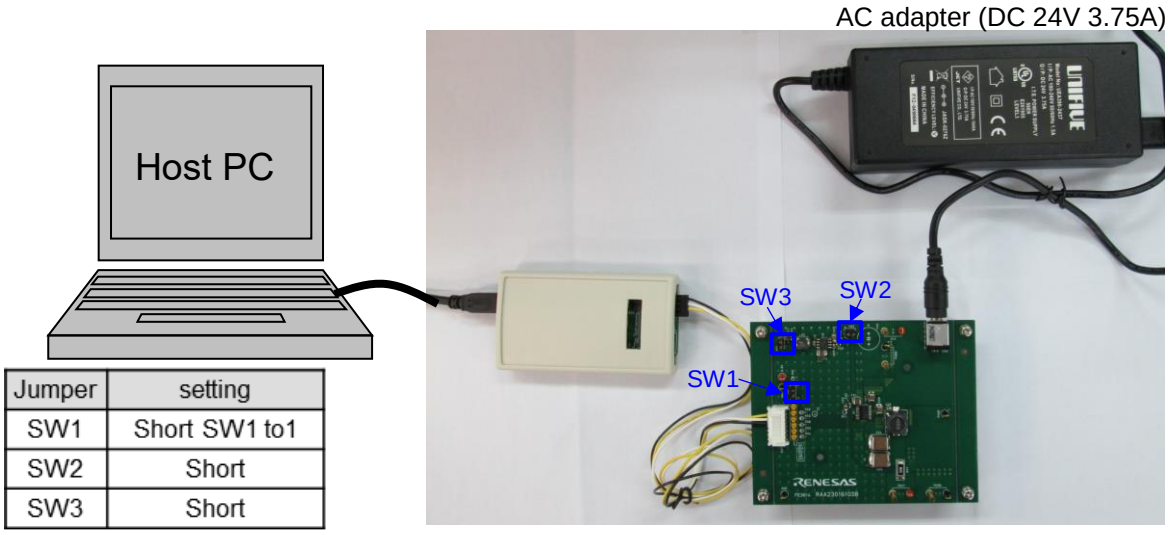
Table 1.8 EN input connection

(1) Using the on-board power supply	(2) Using the external power supply
High input : Short SW1 to 1, Low input : Short SW1 to 3 High input : Short SW1 to 1  Low input : Short SW1 to 3 	Open SW1, Connect the + side of the external DC power supply to “EN” pin and the - side to “GND” pin. 

1.3 Evaluation board connection example

1.3.1 Connection example when using an AC adapter

Figure 1.2 shows an example of the connection when using the AC adapter for VIN(24V) and the on-board power supply for VDD(3.3V). The AC adapter is not attached to the evaluation board. Prepare when using the AC adapter for VIN.

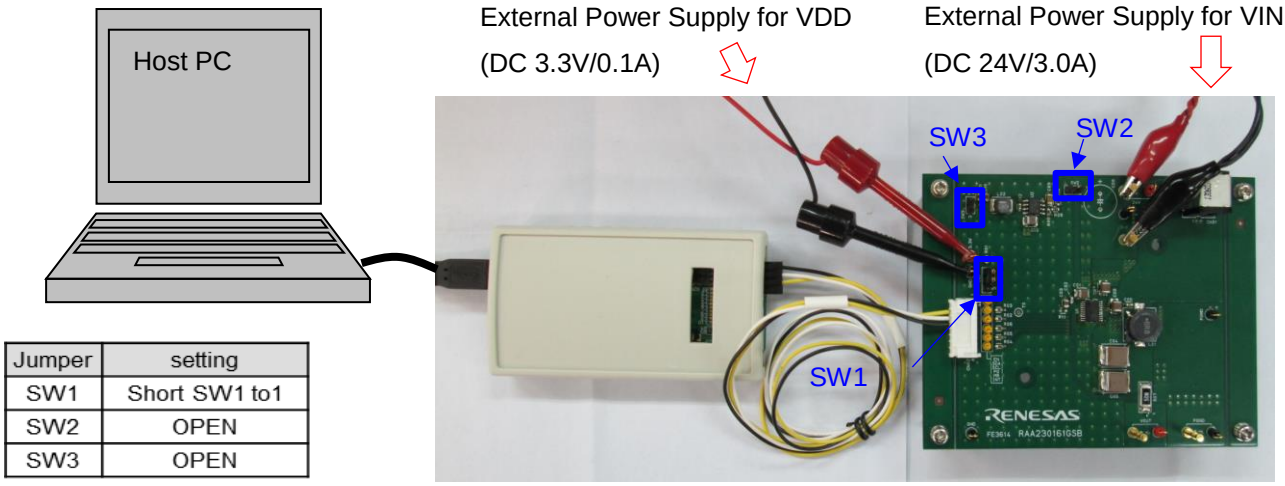


Jumper	setting
SW1	Short SW1 to1
SW2	Short
SW3	Short

Figure 1.2 RAA230161GSB Evaluation Board connection example (using the AC adapter)

1.3.2 Connection example when using an external power supply

Figure 1.3 shows an example of the connection using 2 external power supplies for VIN(24V) and VDD(3.3V).



Jumper	setting
SW1	Short SW1 to1
SW2	OPEN
SW3	OPEN

Figure 1.3 RAA230161GSB Evaluation Board connection example (using the external power supplies)

1.4 Host adaptor：RTK0EF0029Z00001BJ

1.4.1 Connection of the host adaptor

Connect the attached USB A-mini B cable to the "USB mini B" port on the host adaptor, and connect the attached cable to the host adapter output connector (CN1) (Figure 1.4). SDA and SCL of CN02 on the evaluation board are connected to the VDD power supply through a pull-up resistor 2.2kΩ (Figure 1.5).

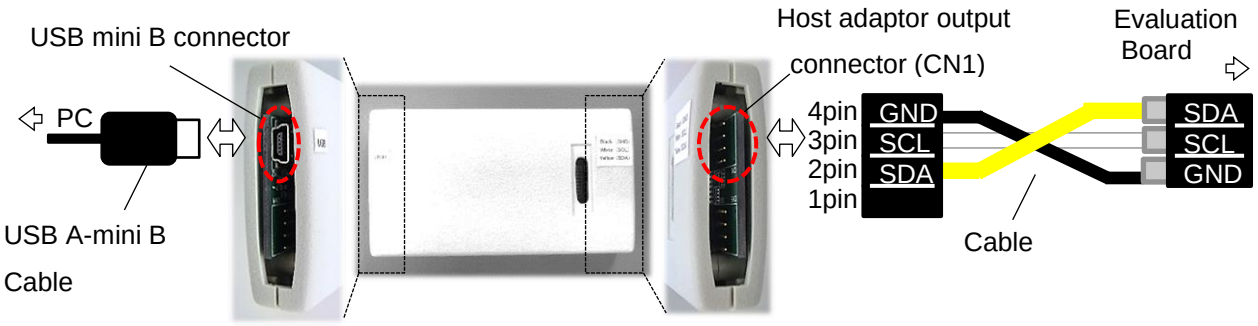


Figure 1.4 RTK0EF0029Z00001BJ description

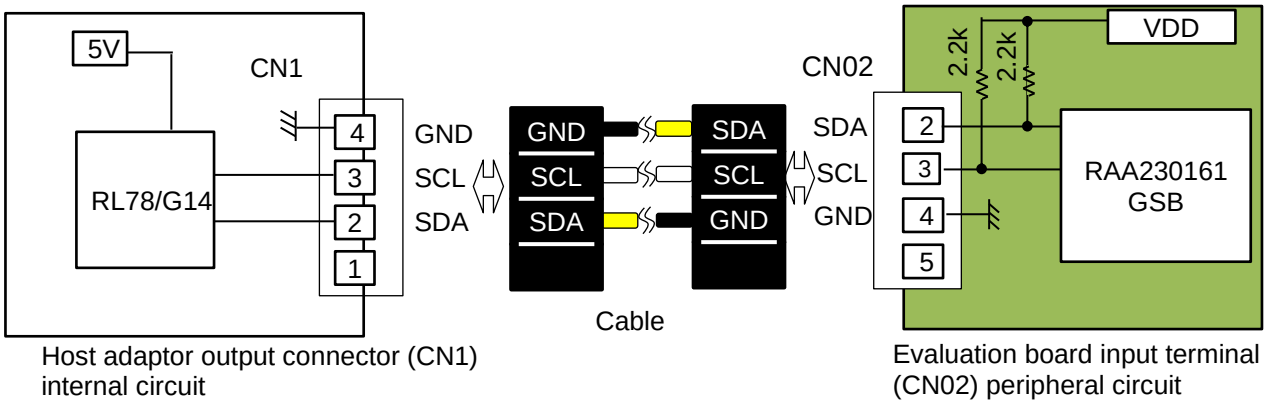


Figure 1.5 RTK0EF0029Z00001BJ CN1 internal circuit

1.4.2 Driver install procedure for the host adaptor

Windows7 needs to install the driver. The driver install procedure is below.

Windows10 does not need to install it.

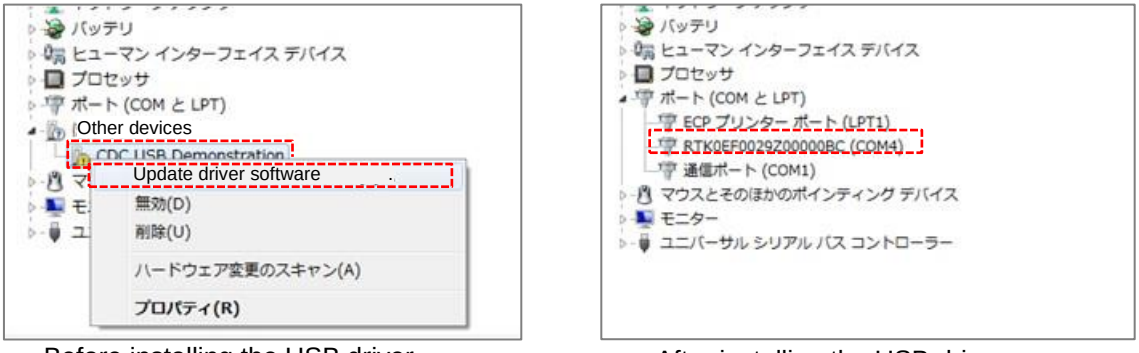
(1) Unzip “USBdriver.zip” on your PC.

(2) Connect host adaptor “RTK0EF0029Z00001BJ” to the PC by USB cable.

(3) When device manager on the PC is opened, unrecognized device is displayed in table. Right click on unrecognized device and select “Update driver software”.

(4) Select “RTK0EF0029Z00000BC_Win7.inf” in “USB driver” folder and install to the PC.

(5) Confirm “RTK0EF0029Z00000BC” was added to the port in device manager.



Before installing the USB driver

After installing the USB driver

Figure 1.6 Device Manager display screen before and after USB driver installation

1.5 Evaluation tool installation

1.5.1 System requirements

PC with Windows 7, 10

1.5.2 Installation guide

- Unzip the .zip file into any folder.
- Run the file “Renesas_UVS_Eva_Tool.exe” in the unzipped folder, then RWCE tool will open.
- When uninstalling this tool, delete the folder.
- Each settings in “Option” are saved. This tool restarts with settings just before closing.
- When initialize the each settings, replace the files to just unzipped file.

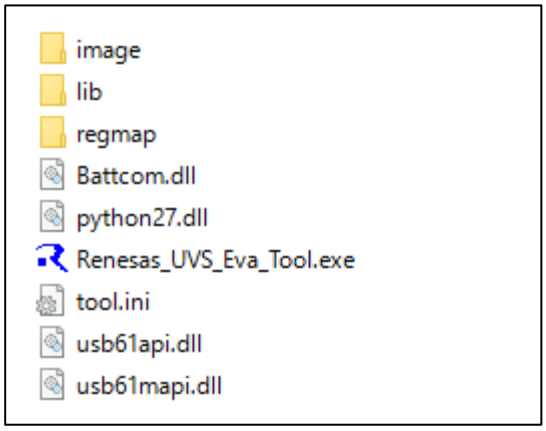


Figure 1.7 Unzipped file

1.5.3 Initial setting

- The tool starts up when executing "Renesas_UVS_Eva_Tool.exe" in the unzipped folder (Figure 1.8).
- Select "Option / I2C emulator setting" in the upper left corner on the main screen and display the I2C Emulator.
- Select "RENESAS Common Board” on the displayed I2C Emulator, and select "Close" to complete the preparation (Figure 1.8).

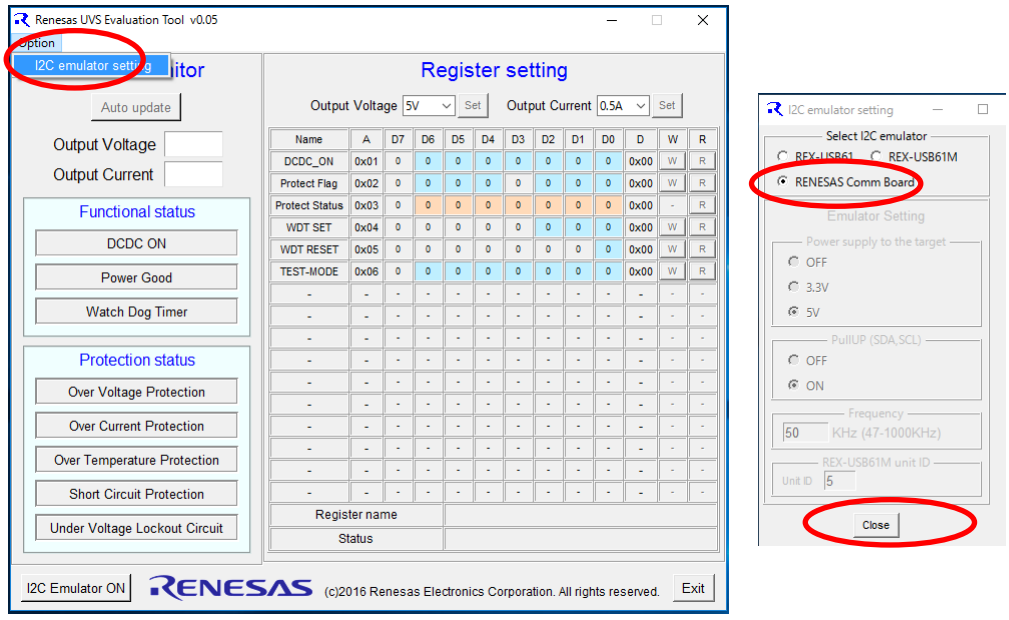


Figure 1.8 Initial setting screen of control tool

1.6 Evaluation tool usage

1.6.1 Tool overview

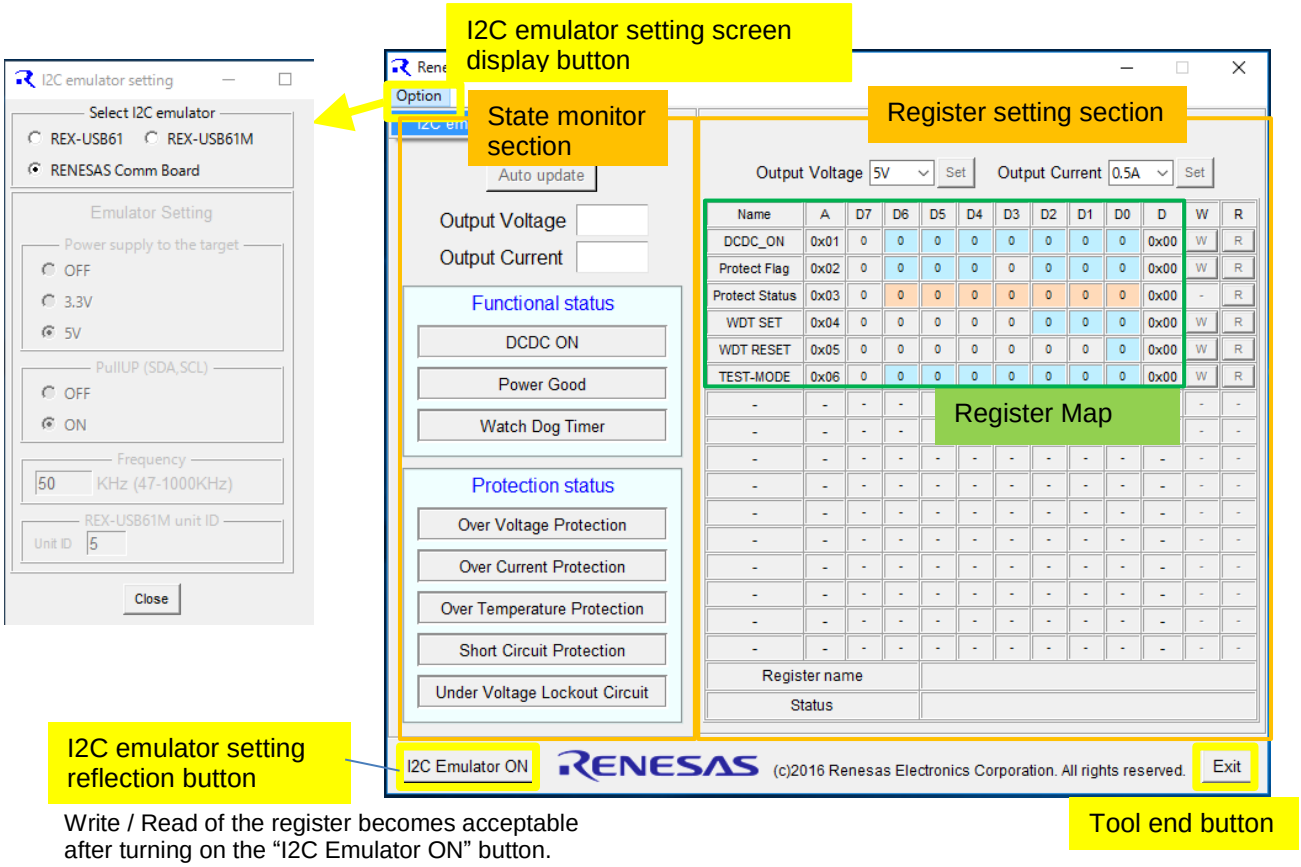


Figure 1.9 Initial setting screen of control tool

1.6.2 Register Map List

Table 1.9 Register Map

Address Name	Address Data [A7:A0]	Data Name								Function (*1)	Reset (*2)
		D7	D6	D5	D4	D3	D2	D1	D0		
DCDC_ ON	0000,0001	0(*3)	ISEL2	ISEL1	ISEL0	VSEL2	VSEL1	VSEL0	DCON	BBBBBBBB	00000000
Protect Flag	0000,0010	-	OVP_F	SCP_F	UVLO_F	-	OCP_F	OTP_F	WDT_F	- BBB- BBB	-000-000
Protect Status	0000,0011	-	-	-	-	-	-	-	PG	-RRRRRRR	-0000000
WDT SET	0000,0100	-	0	0	1	-	WDT1	WDT0	WDT_S	-RRR-BBB	-001-000
WDT RESET	0000,0101	-	-	-	0(*3)	-	-	-	WDT_R	- - - B - - - B	- - - 0 - - - 0
TEST-MODE	0000,0110	-	OVP_M	SCP_M	UVLO_M	0(*3)	OCP_M	OTP_M	0(*3)	-BBBBBBB	-0000000

*0) Slave Address = 1101111

*1) B：Write & Read bit ，R：Read only bit

*2) Initial value of register

*3) Be sure to write "0"

1.6.3 Details of register and bit data

- DCDC_ON(0×01) Register

This register controls VOUT. When "1" is written to the DCON bit (D0) in the register, VOUT starts up, and when "0" is written, VOUT stops. The VOUT voltage is set by the VSEL* bits (D3, D2, D1) and the maximum current of VOUT is set by the ISEL * bit (D6, D5, D4). Details of the setting are shown in Table 1.11 and Table 1.12.

Note : The D7 bit is the dedicated bit for test mode. Be sure to write "0".

Table 1.10 DCDC_ON Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
DCDC_ON	0000,0001	0	ISEL2	ISEL1	ISEL0	VSEL2	VSEL1	VSEL0	DCON	BBBBBBBB	00000000

Table 1.11 VOUT maximum current setting (ISEL *)

ISEL Name	ISEL2 (D6)	ISEL1 (D5)	ISEL0 (D4)	VOUT Current Select
I005	0	0	0	0.5A
I010	0	0	1	1.0A
I015	0	1	0	1.5A
I020	0	1	1	2.0A
I025	1	0	0	2.5A
I030	1	0	1	3.0A

Table 1.12 VOUT voltage setting (VSEL*)

VSEL Name	VSEL2 (D3)	VSEL1 (D2)	VSEL0 (D1)	VOUT Voltage Select
V05	0	0	0	5.3V
V09	0	0	1	9.15V
V012	0	1	0	12.1V
V015	0	1	1	15.1V
V020	1	0	0	20V

- Protect Flag (0×02) Register

When the IC protection function operates, "1" is automatically written to the bits of each protection function, at the same time "0" is written to the DCON bit in the DCDC_ON register. Then VOUT stops. Table 1.14 shows a list of protect functions.

Table 1.13 Protect Flag Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
Protect Flag	0000,0010	-	OVP_F	SCP_F	UVLO_F	-	OCP_F	OTP_F	WDT_F	-BBB- BBB	-000-000

Table 1.14 List of protect function

Data Name	Protect Function / Detection Condition	Operation status at protection			Reset
		Common circuit	DC/DC	Signal output terminal	
OVP_F (D6)	Over voltage protection VOUT > VSEL setting × 110%	Operation	Stop (Latch)	INT=L	By I2C
SCP_F (D5)	Short circuit protection VOUT < VSEL setting × 80%	Operation	Stop (Latch)	INT=L	By I2C
UVLO_F (D4)	Under voltage lockout VIN < 5.7V	Stop	Stop	-	Recover automatically as STBY mode when VIN >6.2V and EN="H"
OCP_F (D2)	Over current protection IOUT > ISEL setting × 120%	Operation	Stop (Latch)	INT=L	By I2C
OTP_F (D1)	Over temperature protection Tj > 165 ˚C	Operation	Stop (Latch)	INT=L	By I2C
WDT_F (D0)	Watch dog timer No reset signal input within WDT setting time	Operation	Stop (Latch)	Output single "L" pulse from MR terminal	By I2C

- Protect Status (0×03) Register

The same state as the PG terminal is written to the PG (D0) bit. PG terminal status can be monitored by reading the bit.

Table 1.15 Protect Status Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
Protect Status	0000,0011	-	-	-	-	-	-	-	PG	-RRRRRRR	-0000000

- WDT SET(0×04) Register

This register controls the start-up of the watchdog timer (WDT). When “1” is written to the WDT_S bit (D0), the WDT counter starts counting. WDT stops when “0” is written to the bit.

The WDT reset time is set by the WDT * bit (D2, D1) in the register. Table 1.17 shows the details of reset setting time.

Table 1.16 WDT SET Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
WDT SET	0000,0100	-	0	0	1	-	WDT1	WDT0	WDT_S	-RRR-BBB	-001-000

D6, D5, D4 bit are the internal management number

Table 1.17 WDT reset setting time (WDT*)

WDT Name	WDT1 (D2)	WDT0 (D1)	WDT Reset Time Select
W008	0	0	8.2ms
W033	0	1	32.8ms
W131	1	0	131ms
W524	1	1	524ms

- WDT RESET (0×05) Register

The WDT is reset by writing "0" to the WDT_R (D0) bit.

Note : The D4 bit is the dedicated bit for test mode. Be sure to write "0".

Table 1.18 WDT RESET Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
WDT RESET	0000,0101	-	-	-	**0**	-	-	-	WDT_R	- - -B - - -B	- - -0 - - -0

- TEST-MODE (0×06) Register

Each protection function is stopped by writing "1" to each bit in this register. Be careful to use the register because the protection circuit doesn’t operate.

Note : The D0 bit and the D3 bit are the dedicated bit for test mode. Be sure to write "0".

Table 1.19 TEST-MODE Register

Address Name	Address Data [A7:A0]	Data Name								Function	Reset
		D7	D6	D5	D4	D3	D2	D1	D0		
TEST-MODE	0000,0110	-	OVP_M	SCP_M	UVLO_M	**0**	OCP_M	OTP_M	**0**	-BBBBBBB	-0000000

1.6.4 Register setting

- The color on the register bit shows below :

  Light blue: R/W possible, Orange: Read only, Gray: Dummy

- The "W" and "R" buttons shows below :

  W: Write to the register

  R: Read the register

- "Register name" shows the bit name when mouse over each bit.

- "Status" shows the status when register is read / written

- Write procedure 1

  1) When clicking a bit on the map, “0" and "1" are inverted. When changed from the previous value, the bit is displayed in red.

  2) Click the "W" button.

- Write procedure 2

  Select the value to set "Output Voltage" / "Output Current" in the pull-down menu and click the "Set" button to write the value to the register. When writing fails, the "Set" button is displayed in red. This write method is not linked with the register map part. When writing by clicking the "W" button of register DCDC_ON (0 x 01) as “Write procedure 1”, the register is overwritten as the state of the map.

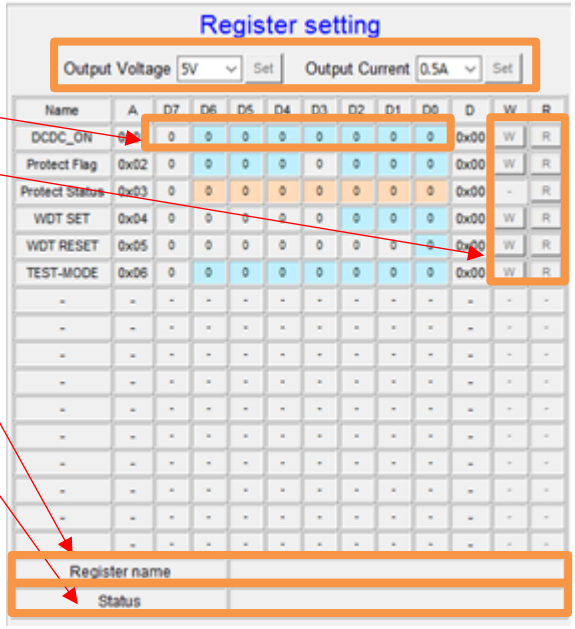


Figure 1.10 Initial setting screen of register setting

- Read procedure

  When clicking the "R" button of the register, the read status is reflected in each bit. At this time, when changed from the previous value, the bit is displayed in red.

1.6.5 Status monitor

- When writing to the DCDC_ON register (0x01) in the register setting part, "Output Voltage", "Output Current", and "Functional status / DCDC_ON" on the status monitor are updated.
- By clicking on the "Auto update" button and turning it ON, the address Protect Flag (0 × 02) and Protect Status (0 × 03) are read every 250ms and the each resister status is displayed.

  Register value = "0": the background is gray
  the character is black

  Register value = "1": the background is white
  the character is red
- When data can not be got due to I2C communication error, the background of each item becomes red. In that case, check the I2C communication situation.
- Click the "Auto update" button again to stop the automatic update.

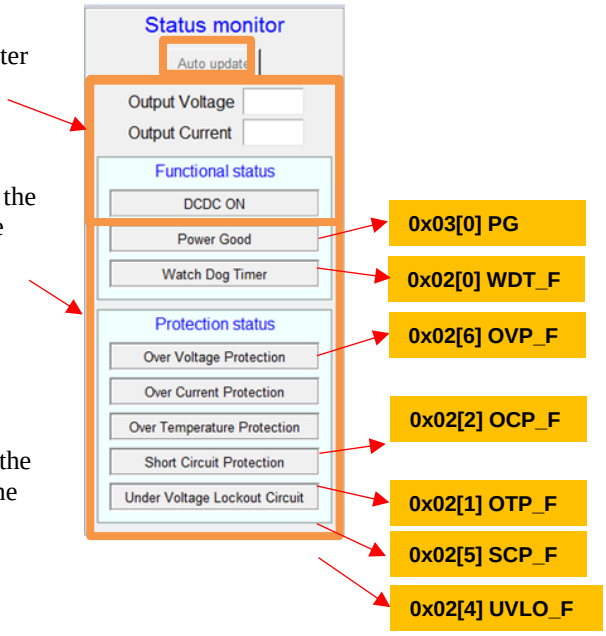


Figure 1.11 Initial setting screen of status monitor

2. RAA230161GSB Evaluation Board operation

2.1 Start-up

1) Apply 24V to VIN from the external DC power supply or AC adapter.

2) Apply 3.3V to VDD.

(When using the power supply on the board (RAA230153GSB) for VDD, it is not necessary to apply by the external DC power supply. Then, when 24V is applied to VIN, RAA230153GSB on the board starts up and applies 3.3V to VDD.)

3) Input “High” to EN.

(When the power supply on the board(RAA230153GSB) is used and SW1 is shorted to “1”, inputting “High” to EN is not necessary. Then, when 24V is applied to VIN, “High” is applied to EN. When SW1 is shorted to “3”, “High” is applied to EN by shorting SW1 to “1”.

4) When the PG output goes low, I2C communication is enabled.

If the PG status can not be monitored, start I2C communication after waiting 50ms from inputting “High” to EN (Figure 2.1).

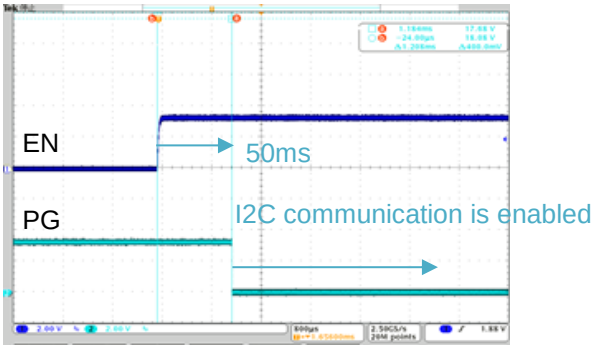


Figure 2.1 I2C communication available timing

5) When the DCON bit in the DCDC_ON register is set to "1" by I2C, DCDC starts up and the set voltage is output at “VOUT” pin (Figure 2.2). At this time, the maximum output current and the output voltage are set, too.

When changing VOUT and the maximum output voltage, set them by I2C in the same way. (Figure 2.3, Figure 2.4)

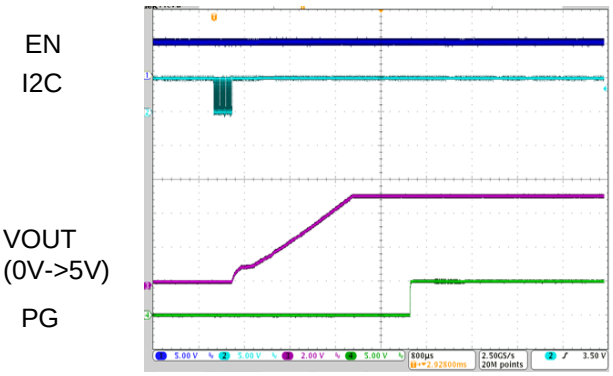


Figure 2.2 VOUT start waveform (start-up)

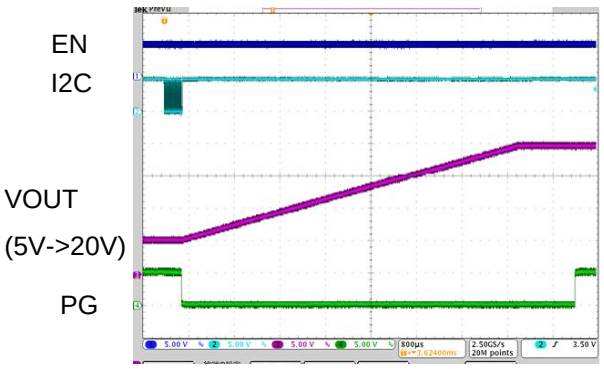


Figure 2.3 VOUT voltage change waveform (Up)

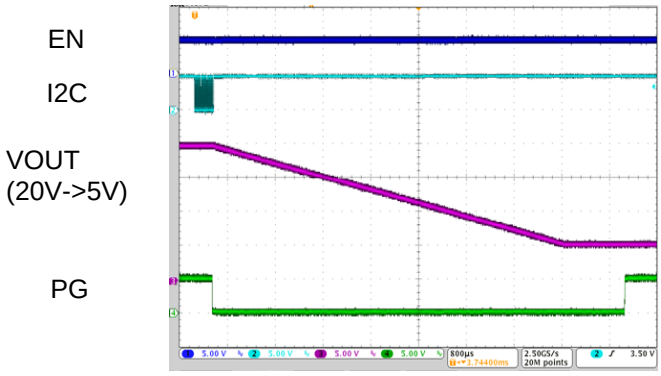


Figure 2.4 VOUT change waveform (Down)

2.2 Stop

1) When the DCON bit is set to "0" by I2C, the DCDC stops and VOUT drops (Figure 2.5).

Likewise, when “Low” is input to EN, the DCDC circuit stops and VOUT drops(Figure 2.6). However, the device registers are also reset, and the setting of the output voltage and maximum output current is initialized.

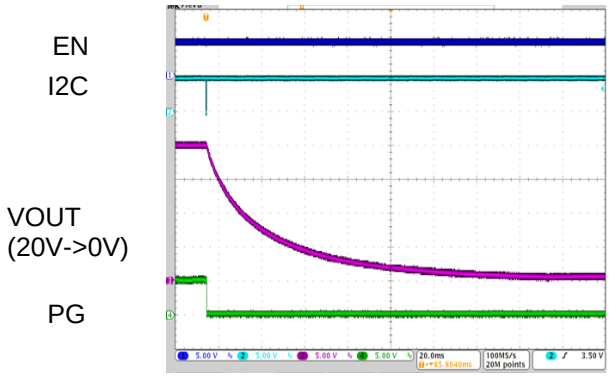


Figure 2.5 VOUT stop waveform (I2C control)

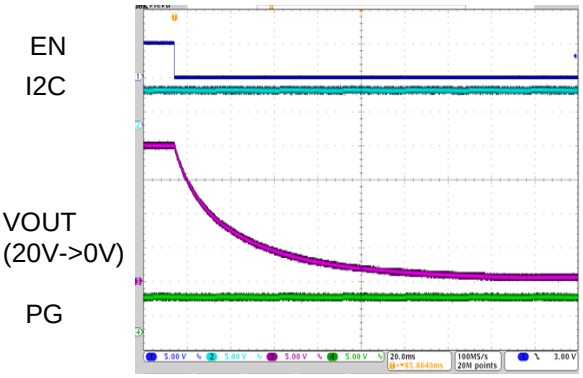


Figure 2.6 VOUT stop waveform (EN control)

2.3 Case of protection function active

1) When the protection function(SCP, OVP, OCP, OTP) operates, the DCON bit automatically becomes "0" and the DCDC circuit stops. At this time, INT outputs “High”, and the FLAG register of the operating protection circuit becomes "1". While "1" is output to the FLAG register, the DCON bit can not be changed and RAA230161GSB can not restart by I2C.

2) Read the FALG register through I2C to check the operating protection circuit.

3) When "0" is written to the FLAG register by I2C and the FLAG is cleared, the DCON bit accepts the writing.

4) When the WDT isn’t reset within the reset time, the DCON bit automatically becomes "0" and the DCDC circuit stops. At this time, MR terminal output 1us low pulse once and the FLAG register of the WDT becomes "1". While the WDT FLAG register is "1", the DCON bit can not be changed and the EN terminal doesn’t accept any signal. To restart, write "0" to the FLAG register of WDT and clear the FLAG, then the DCON bit accepts the writing and the EN terminal accept the signal.

3. Evaluation Board Circuit Diagram and Parts list

3.1 Circuit diagram

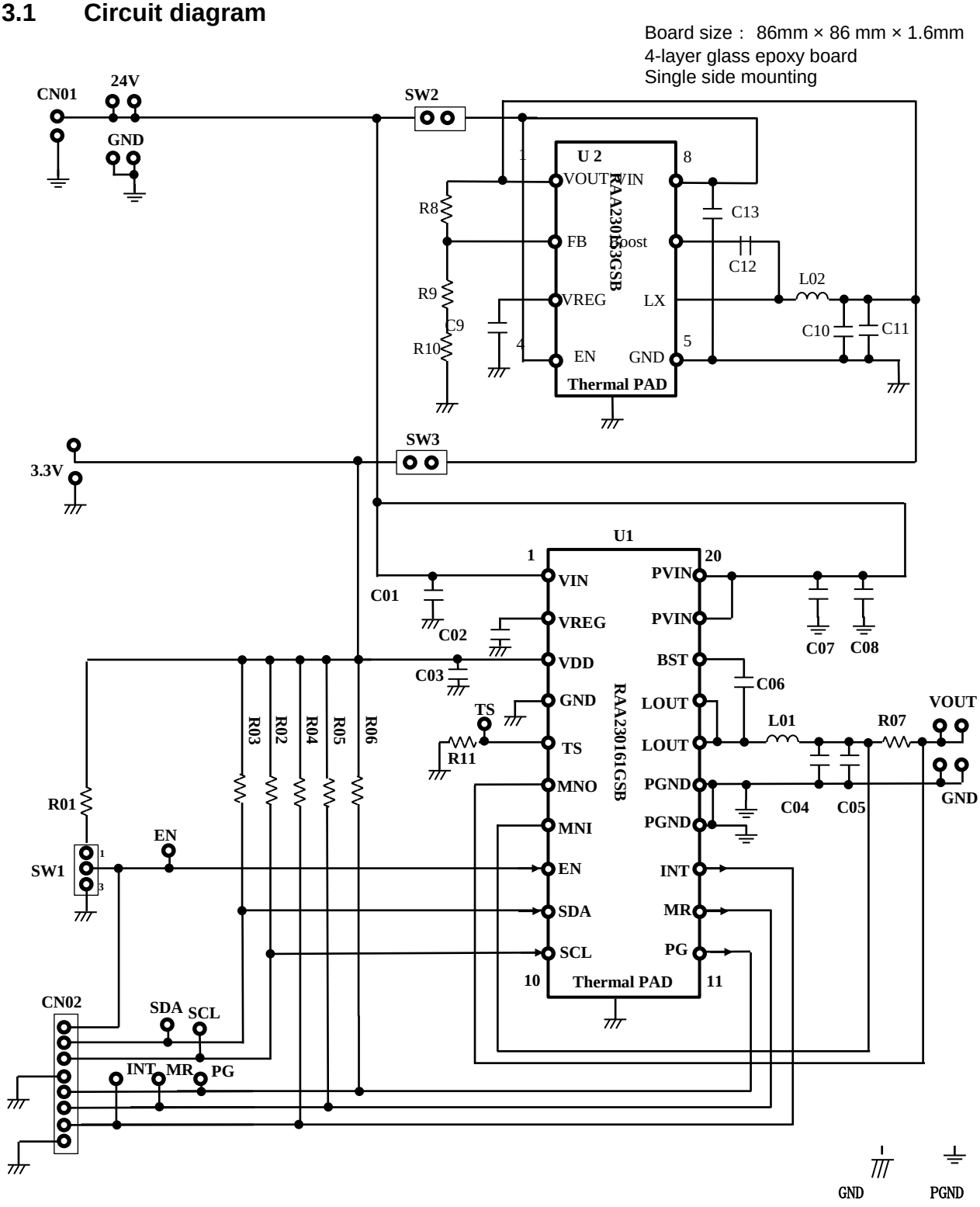


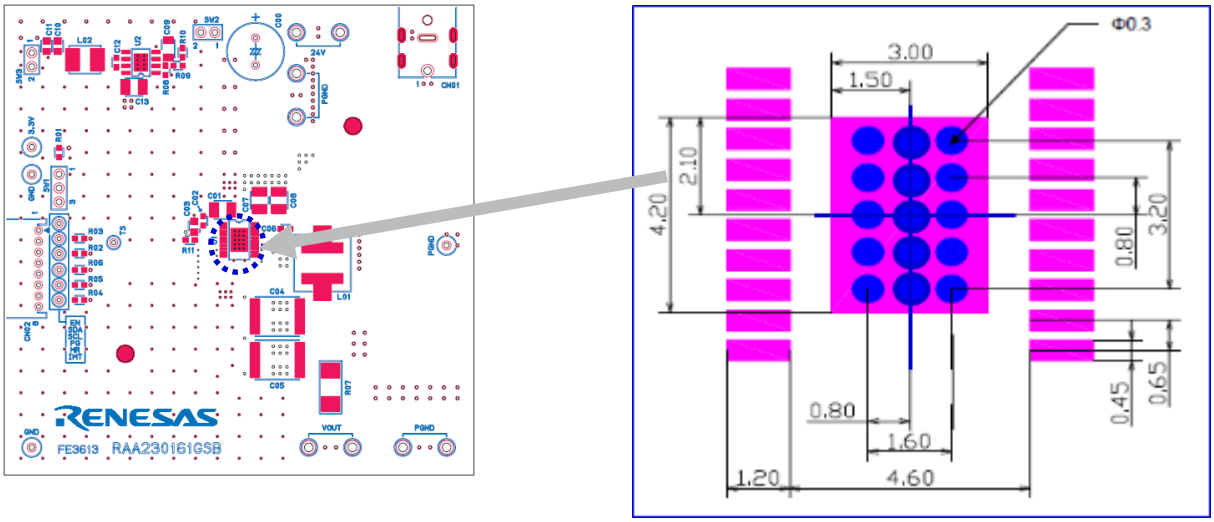
Figure 3.1 RAA230161GSB Evaluation Board circuit diagram

3.2 Parts list

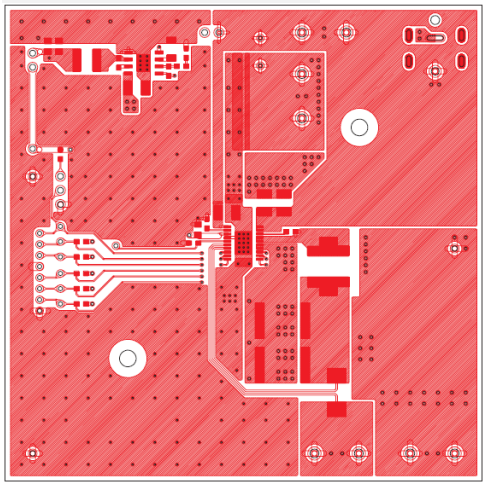
Table 3.1 RAA230161GSB Evaluation Board parts list

Parts	No.	Value	Size	Part number	Note
IC	U1		20pinTSSOP	RAA230161GSB	USB Voltage Supply
	U2	-	8pinHLSOP	RAA230153GSB	VDD power supply IC on board
Inductor	L01	6.8uH	10145	NS10145T6R8NNA	Inductor RAA230161
	L02	3.3uH	5040	NRS5040T3R3NMGJ	Inductor for RAA230153
Capacitor	C01/C07/C08	10uF/35V	3225	GRM32ER71H106KA12L	VIN/PVIN input capacitor for RAA230161
	C02	1uF/25V	1608	GRM188R71E105KA12D	VREG output capacitor for RAA230161
	C03	10uF/20V	20125	GRM21BC71E106KE11L	VDD input capacitor for RAA230161
	C04/C05	22uF/35V	7563	C7563X7S1H226MT	VOUT output capacitor for RAA230161
	C06	0.1uF/ 50V	1608	GRM188B11E104KA01D	BST capacitor for RAA230161
	C09	1uF/10V	3216	GRM319R71A105KA01D	VREG output capacitor for RAA230153
	C10/C11	22uF/25V	2012	GRM21BR61E226ME44L	VOUT output capacitor for RAA230153
	C12	0.1uF/ 25V	1608	GRM188B11E104KA01D	BST capacitor for RAA230153
	C13	10uF/50V	3225	GRM32EB31H106KA12	VIN input capacitor for RAA23015
Resistance	R01/R04/R05/R06	100kΩ	1608	-	EN/PG/INT/MR pull-up resistor for RAA230161
	R02/R03	2.2kΩ	1608	-	I2C pull-up resistor for RAA230161
	R07	50mΩ/1W	6232	ERJL1WKF50MU	OCP current sense resistance for RAA230161
	R08	820kΩ	1608	-	Feedback resistor for RAA230153
	R09	220kΩ	1608	-	Feedback resistor for RAA230153
	R10/R11	0Ω	1608	-	-
Connector	CN01	-	-	2DC-G213-B66	Connector for DC jack
	CN02	-	-	PH Connector	Connector for Host adaptor input
Jumper	SW1	-	-	WLT-8	-
	SW2/SW3	-	-	JS-1	-

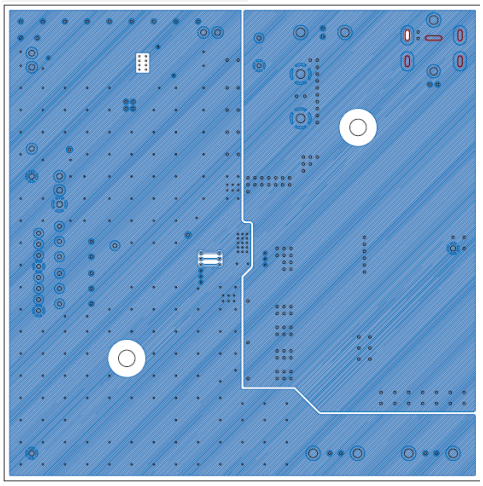
3.3 Pattern diagram



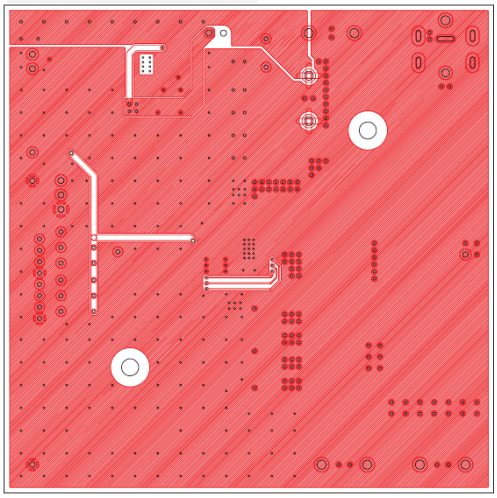
Parts side (L1)



Inner layer (L2)



Inner layer (L3)



Back side (L4)

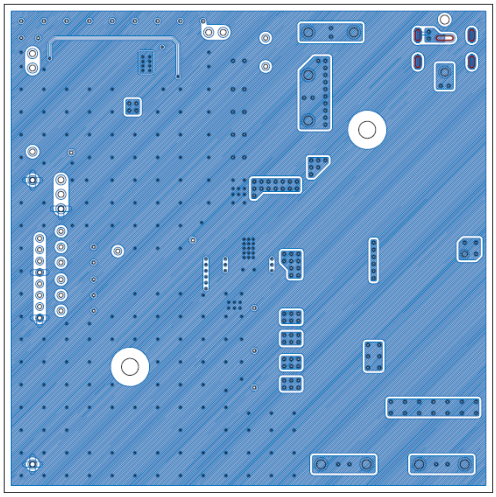


Figure 3.2 RAA230161GSB Evaluation Board pattern diagram

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	May. 8, 2017	-	First Edition issued
1.01	May 15, 2018	15	Explain of WDT protection, updated

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