User's Manual

RA2T1 Group

MCK-RA2T1 User's Manual

Renesas RA Family
RA2 Series

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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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1. Overview

MCK-RA2T1 is a motor control evaluation kit. By using this product, motor control with MCK-RA2T1 can be performed easily.
MCK-RA2T1 has characteristics shown below.

（1） Supports Brushless DC motor.

（2） Supports 1-/2-/3-shunt current detection.

（3） Supports Motor Control Development Support Tool.

（4） Provides overcurrent protection function using overcurrent detection circuit.

1.1 Presupposition and precautions of this document

1. Experience of using tools: This document assumes that the user has used terminal emulation program of Integrated Development Environment (IDE) such as e2studio before.
2. Knowledge about the development subject: This document assumes that the user has a basic knowledge to modify the sample project regarding MCU and embedded system.
3. Before using this product, wear an antistatic wrist strap. If you touch this product with static charge on your body, a device failure may occur, or operation may become unstable.
4. All screen shots provided in this document is for reference. Actual screen displays may differ depending on the software and development tool version which you use.

2. Product Contents

This kit consists of the following parts.

1. Inverter Board (RTK0EM0000B12020BJ) x1
2. CPU Board (RTK0EMA810C00000BJ) x1
3. Communication board (RTK0EMXC90Z00000BJ) x1
4. Brushless DC Motor (R42BLD30L3) x1
5. Communication cable x1
6. Screw x12
7. Standoff x12

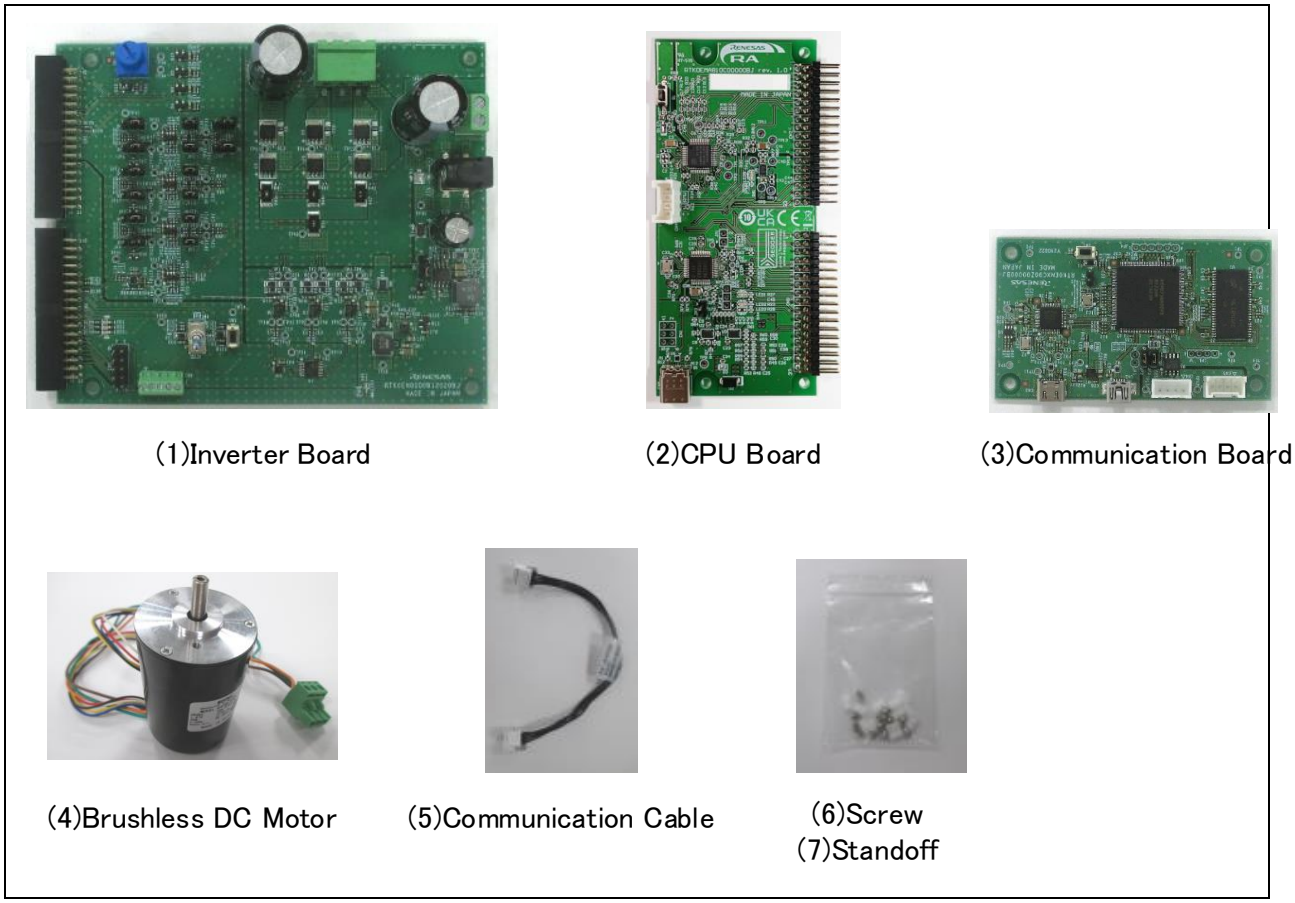


Figure 2-1 Product contents

3. Product Order Information

Product number to order MCK-RA2T1:RTK0EMA810S00020BJ

4. Hardware Configuration and Default Setting

4.1 Hardware configuration

MCK-RA2T1 consists of the inverter board, the CPU board and the communication board. Specifications as a kit and for the relevant boards are listed below.

Table 4-1 MCK-RA2T1 specification (1/4)

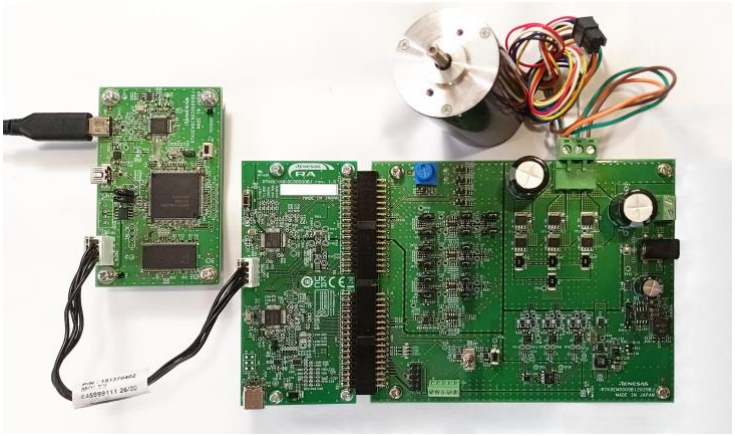
Item	Specification	
Kit product name	MCK-RA2T1	
Kit product No.	RTK0EMA810S00020BJ	
Kit configuration	Inverter Board	RTK0EM0000B12020BJ
	CPU Board	RTK0EMA810C00000BJ
	Communication board	RTK0EMXC90Z00000BJ
	Brushless DC Motor	R42BLD30L3 (MOONS') Rated voltage：36[V] Rated current：1.67[A]
Isolation	Inverter board - CPU board : Non-isolated Communication board – CPU board : isolated (up to $1kV_{RMS}$)	
External view	 Note: The actual product may differ from this photo.	
Board size	Inverter board : 133 mm (W) x 109 mm (L) CPU board : 50 mm (W) x 109 mm (L) Comunication board : 89mm(W) × 52mm(L)	
Operating temperature	Room temperature	
Operating humidity	No condensation allowed	
EMC Directive	EN61326-1:2021 EMI：Class A EMS：Industrial electromagnetic environment	

Table 4-2 MCK-RA2T1 specification (2/4)

Item	Specification
Product name	Inverter board
Board part No.	RTK0EM0000B12020BJ
External view	 Note: The actual product may differ from this photo.
Power supply	2 ways • From DC jack or Power supply connector (DC 12~48V) *1 • From CPU board (DC 5V)
Rated output current	AC 10 A (RMS value) *2
Switching frequency	20 kHz (typical)
Current detection method	1- / 2- / 3-shunt detection
Shunt resistor	10 mohm
PWM logic	Lower arm, Upper arm : Positive logic
DC bus voltage detection （bus voltage detection）	Detection by resistance division
3-phase output voltage detection	Detection by resistance division
3-phase output current detection	With shunt resistor
Overcurrent detection function	21.4 A
Supporting sensor	HALL sensor, Encoder
Connector	• CPU card connector • Motor connector • Power input connector • HALL sensor connector • Encoder/Inductive position sensor connector
Switch	• Toggle switch x1 • Push switch x1
LED	• LED x3 • Power LED

*1 The polarity of the DC jack (J1) is center positive. The compatible plug has an inner diameter of 2.1 mm and an outer diameter of 5.5 mm.
*2 It is strongly recommended to attach a heat sink to the MOSFET when using over 5A.

Table 4-3 MCK-RA2T1 specification (3/4)

item		Specification
Product name		CPU Board
Board part No.		RTK0EMA810C00000BJ
Compatible inverter board		RTK0EM0000B12020BJ
External view		 Note: The actual product may differ from this photo.
Mounted MCU	Product group	RA2T1 group
	Product No.	R7FA2T1074CFL
	CPU maximum operating frequency	64MHz
	Bit count	32 bit
	Package / Pin count	LQFP / 48 pin
	ROM / RAM	64KB / 8KB
MCU input clock		8MHz (Generate with on-chip oscillator)
Power supply		DC 5V Select one way automatically from the below • Power is supplied from compatible inverter board • Power is supplied from USB connector
Debugger		J-Link-OB (Onboard debugger circuit)
Connector		• Inverter board connector (1 pair) • USB connector for J-Link OB • SCI connector for Renesas Motor Workbench communication
Switch		MCU reset switch
LED		User-controllable LED x2, Power LED x1

Table 4-4 MCK-RA2T1 specification (4/4)

item		Specification
Product name		Communication Board
Board part No.		RTK0EMXC90Z00000BJ
External view		 Note: The actual product may differ from this photo.
Mounted MCU	Product group	RX72N group
	Product No.	R5F572NNDDFB
	CPU maximum operating frequency	240MHz
	Bit count	32 bit
	Package / Pin count	LFQFP / 144 pin
	RAM	1M byte
MCU input clock		20MHz (Generate with external crystal oscillator)
Power supply		DC 5V • Power is supplied from USB connector
Connector		• USB Type-C connector for PC • SCI connector for CPU board • USB miniB connector (not available for users)
Isolation		• Between SCI connector and MCU • Up to 1kV$_{RMS}$
Switch		MCU external reset switch

4.2 Block diagram

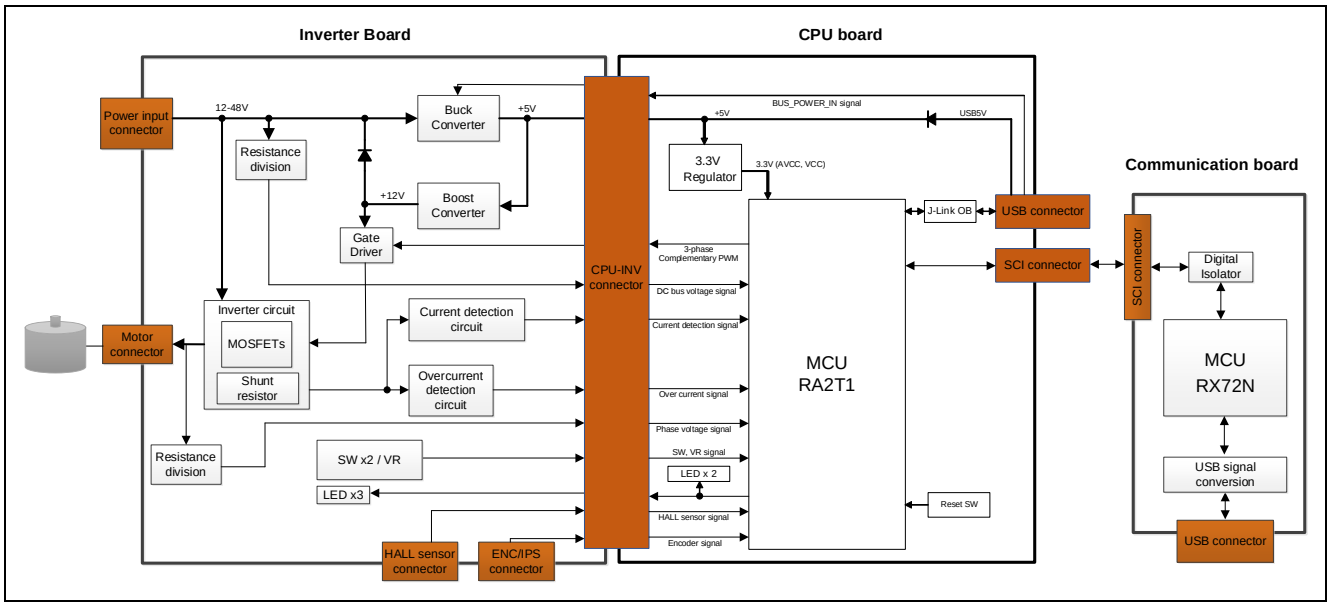


Figure 4-1 MCK-RA2T1 block diagram

4.3 Board Layout

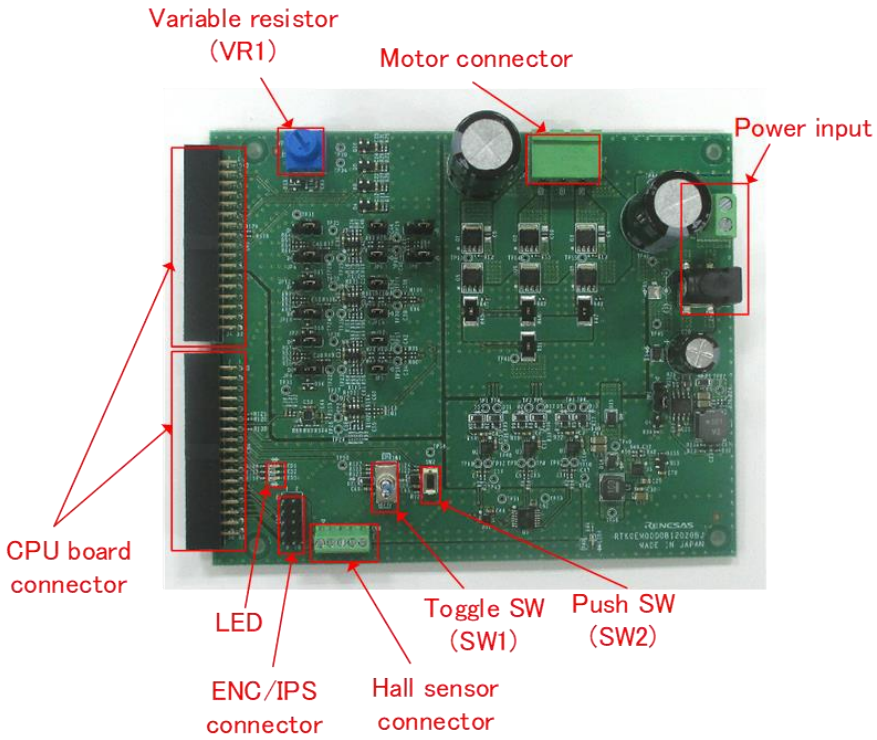


Figure 4-2 Inverter board Layout

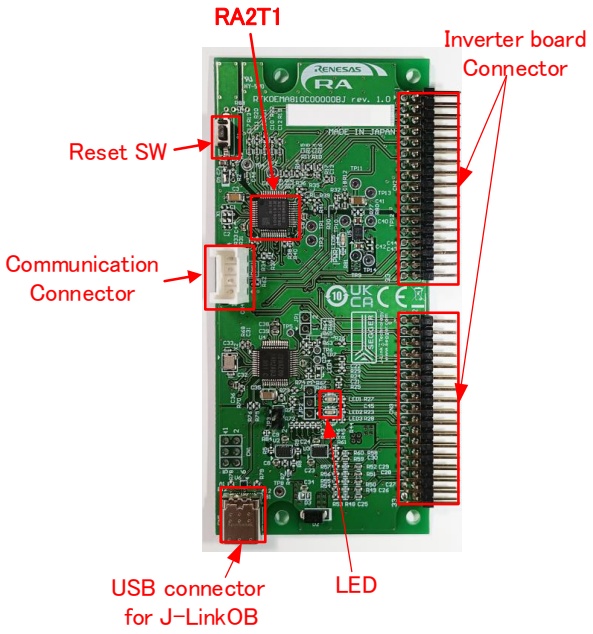


Figure 4-3 CPU Board Layout

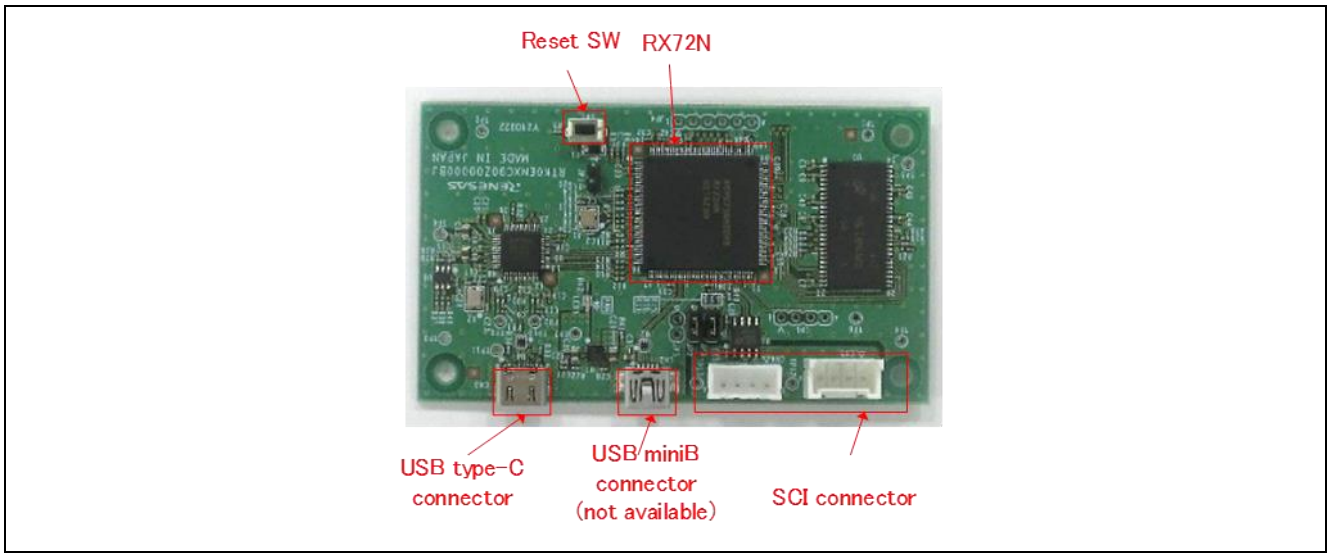


Figure 4-4 Communication board Layout

4.4 Standoffs and Screws

Before using this product, assemble the included standoffs and screws as shown below.

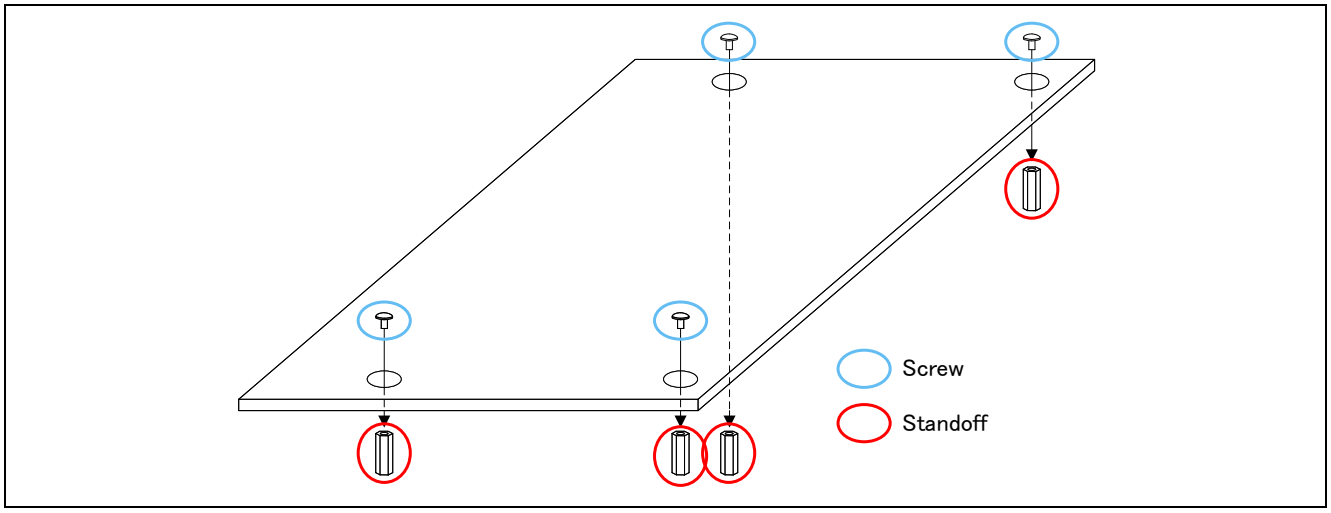


Figure 4-5 Standoffs and Screws assembly

4.5 Jumper pin setting

4.5.1 Inverter board

Default settings and functions of the jumper pins (JP1~JP15) are as follows.

Table 4-5 Jumper pin setting of Invertor board

JP No.	Default setting	Function
JP1	2-3pin short	1-2pin short : Disable 5V regulator 2-3pin short : Enable 5V regulator
JP2, JP3, JP4, JP6, JP12, JP13	2-3pin short	1-2pin short : Disable current detection amplifiers 2-3pin short : Enable current detection amplifiers
JP5, JP7, JP9, JP10, JP14, JP15	1-2pin short	1-2pin short : Current detection amplifier gain = 20 1-2pin open : Current detection amplifier gain = 10
JP8, JP11	2-3pin short	1-2pin short : 2-/3-shunt current detection 2-3pin short : 1-shunt current detection

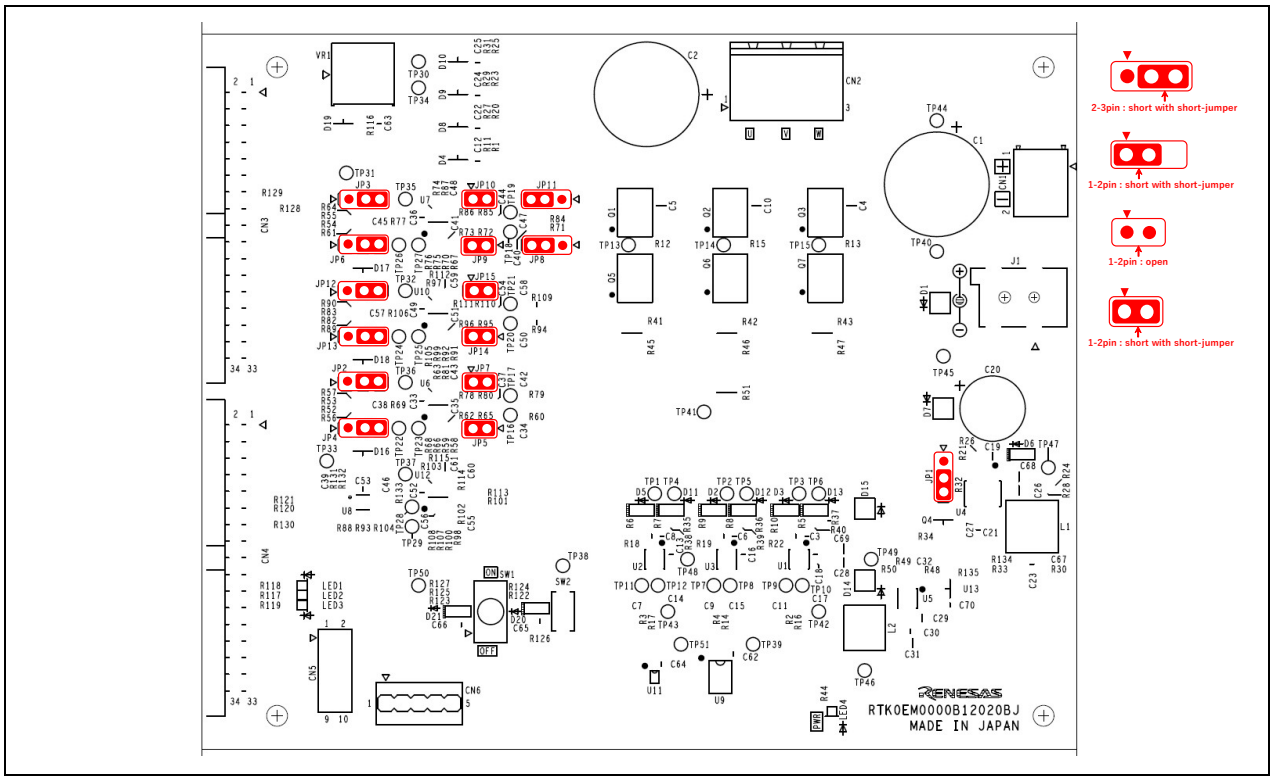


Figure 4-6 Default jumper pin setting of Inverter board

4.5.2 CPU board

Default settings and functions of the jumper pins are as follows.

Table 4-6 Jumper pins setting of CPU board

Jumper pin	Default setting	Function
JP3	1-2pin open	1-2pin short : On board debugger invalid 1-2pin open : On board debugger valid

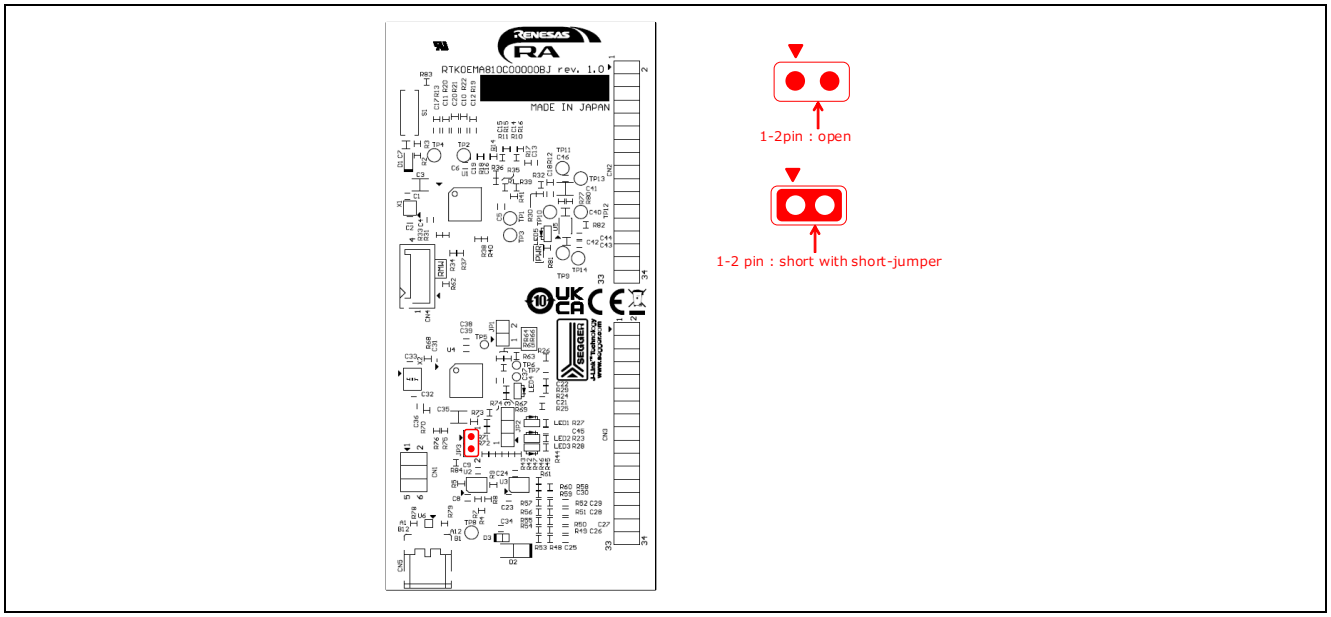


Figure 4-7 Default jumper pin setting of CPU board

4.5.3 Communication board

Default settings and functions of the jumper pins (JP1~JP3) are as follows.

Table 4-7 Jumper pin setting of Communication board

Jumper pin	Default setting	Function
JP1	1-2pin open	1-2pin short : Enable pull-up for MD port (Not available) 1-2pin open : Enable pull-up for MD port
JP2	1-2pin short	1-2pin short : Disable pull-up for GPIO(PC6) 1-2pin open : Enable pull-up for GPIO(PC6)
JP3	1-2pin short	1-2pin short : Disable pull-up for GPIO(PC5) 1-2pin open : Enable pull-up for GPIO(PC5)

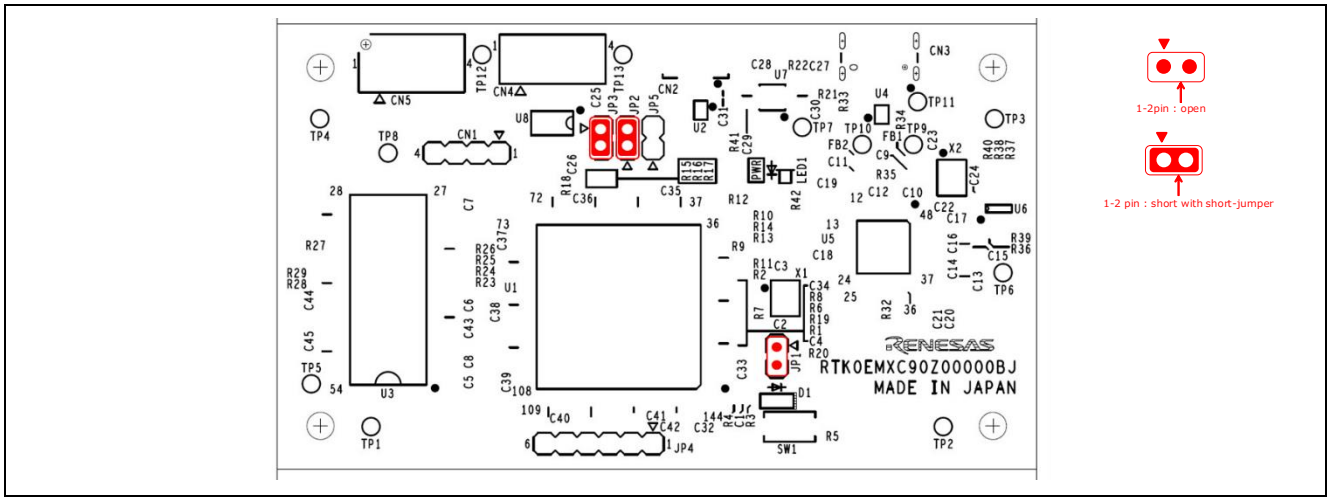


Figure 4-8 Default jumper pin setting of Communication board

4.6 Hardware Setup

4.6.1 Board Connection

When using this product for motor control evaluation, connect the boards as shown in Figure 4-9. Note that the connector between the CPU board and the inverter board is a tight fit, so be careful not to bend the pins when connecting or disconnecting.
Please refer to 4.6.2 for the power supply method. In Figure 4-9 the power is supplied from the AC adapter.

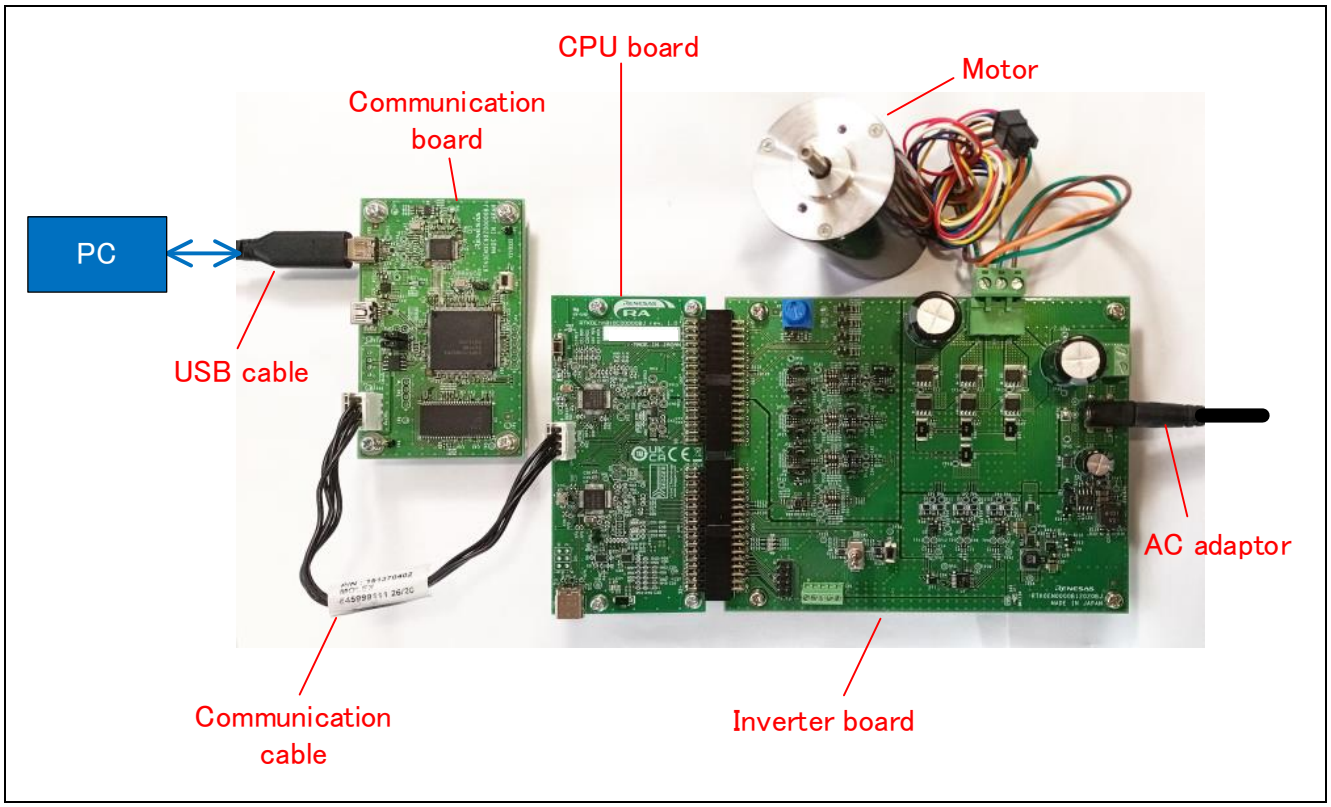


Figure 4-9 Board connection

4.6.2 Power Supply

There are three ways to supply power to the CPU board and inverter board, and the power supply for the communication board is independent of the CPU board and inverter board and is supplied at 5V from the USB connector.

(1) From DC jack

Use an AC adapter or something similar to supply power from the DC jack (J1) on the inverter board. The compatible plug has an outer diameter of 5.5 mm, an inner diameter of 2.1 mm, and a polarity of center positive. The input voltage range is 12 to 48V.

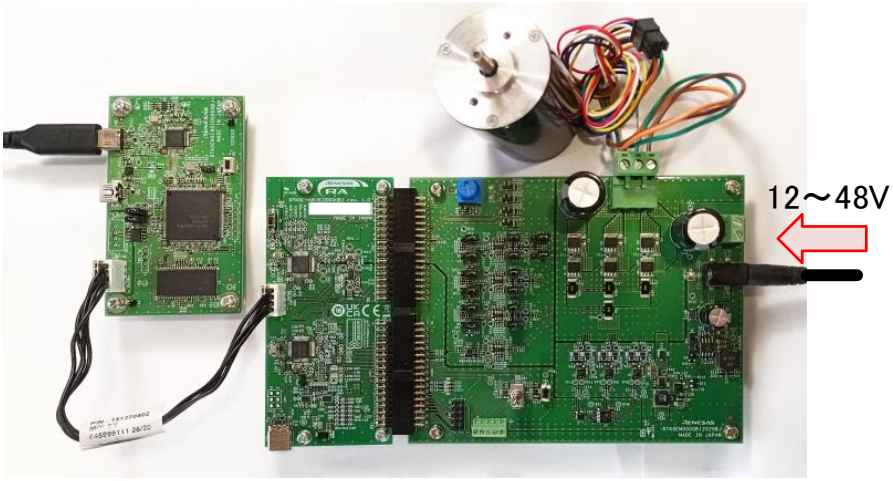


Figure 4-10 Power supply from DC jack

(2) From terminal block

Supply power from the terminal block (CN1) of the inverter board using a DC stabilized power supply or the like. The polarity should follow the silk indication (“+”, “-“) on the board. The input voltage range is 12 to 48V.

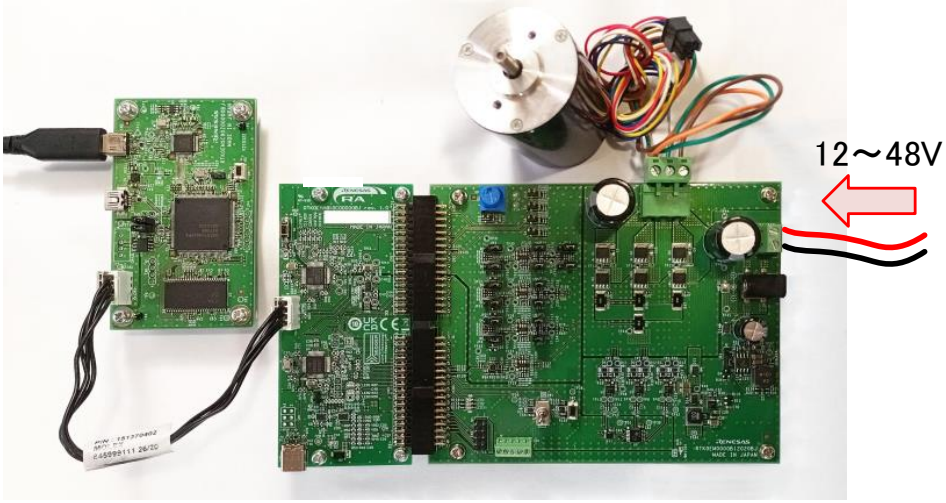


Figure 4-11 Power supply from terminal block

(3) From USB connector

5V power is supplied from the USB connector (Type-C) on the CPU board. Use a USB adapter capable of outputting 1A or more so that the motor can be driven sufficiently.

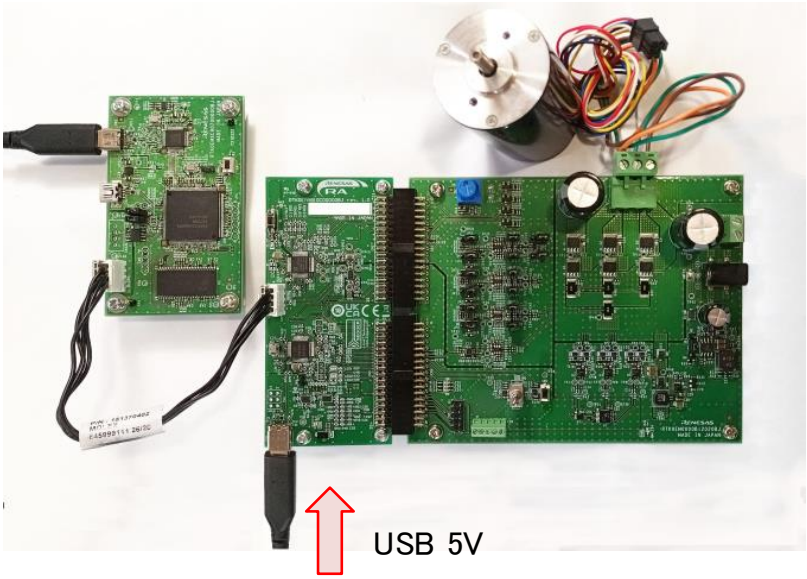


Figure 4-12 Power supply from USB connector

It is also possible to supply power from the USB connector on the CPU board and the DC jack or terminal block on the inverter board at the same time. In this case, the MCU drive voltage of 3.3V and the gate driver drive voltage are generated from the USB supply of 5V, while the motor drive voltage is supplied from the DC jack or terminal block. Please refer to Table 4-8 for the power supply conditions and each voltage generation.

Table 4-8 Power supply and driving voltage generation

			Case 1	Case 2	Case 3
Power supply condition	CPU board	USB 5V *1	✓	–	✓
	Inverter board	External power (12~48V) *2	–	✓	✓
Power source for	CPU board	I/O (VCC, 3.3V)	[A]	[B]	[A]
		BUS (5V)	[A]	[B]	[A]
	Inverter board	I/O (VCC, 3.3V)	[A]	[B]	[A]
		BUS (5V)	[A]	[B]	[A]
		Gate driver (11.4V)	[A]	[B]	[A]
		Motor drive (11.4V or 12~48V)	[A]	[B]	[B]

Power supply condition:

✓ : supplied

- : not supplied

Driving voltage generation

[A]: generated from USB 5V on CPU board

[B]: generated from external power on inverter board

1 Motor drive current of 1 A or more may be required for each inverter board.

*2 When connecting two inverter boards to the CPU board and also inputting an external power supply to INV2, it is necessary to supply an external power supply (which can be different from INV2) to INV1 as well, or to supply USB 5V to the CPU board.

5. Inverter Board Specification

This section describes inverter board specification.

5.1 Functions

5.1.1 Inverter control circuit block

The inverter board has the inverter control circuit block which controls the motor with 6 POWER MOSFETs. POWER MOSFET is controlled with 6-phase timer output of MCU.
The inverter control circuit block outputs DC bus voltage, U, V and W phase voltage and shunt current to the connectors (CN3, CN4). By inputting these output voltages to A/D of MCU on the CPU card, analog values of the voltage and the shunt current of each phase can be measured. Refer to
5.1.2 for the current detection and refer to 5.1.4 for the voltage detection, respectively. Also function to detect overcurrent from the input current is available. Refer to 5.1.3 for details.
An illustration of the inverter control circuit block is shown in Figure 5-1 . In the actual circuit, some inputs on the A/D pins are via voltage dividers and offsets and so on. Refer to the circuit diagram for details.

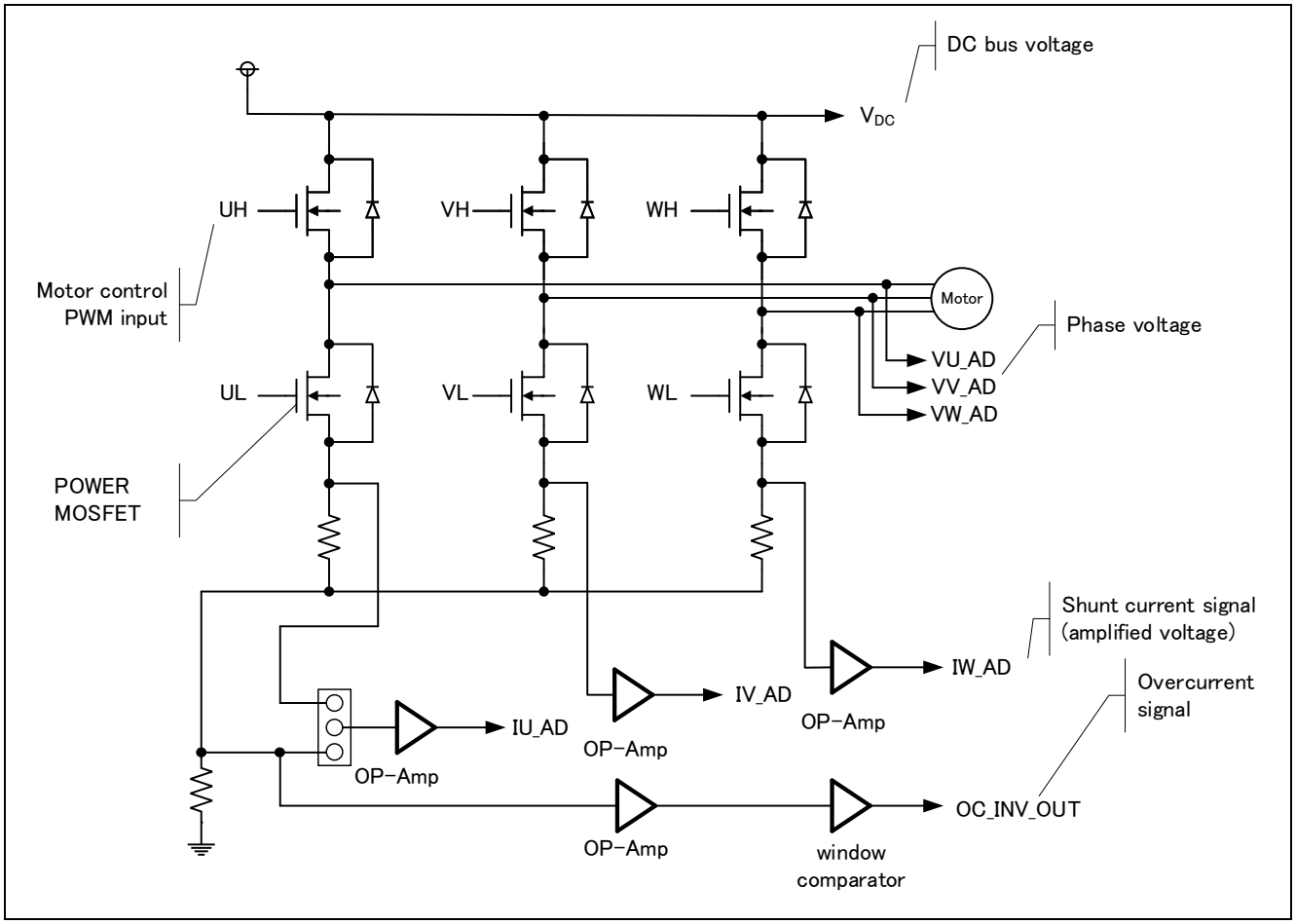


Figure 5-1 Illustration of inverter control circuit block

5.1.2 Current detection circuit

The inverter board has the current detection circuit to measure the current at the U, V and W phase. The current detection circuit uses shunt resistor at each phase. Voltage drop caused by the current flowing through the shunt resistor is amplified by the current detection amplifier to output. The default gain of the current detection amplifier is set to 20x, but the gain can be changed to 10x by setting JP5, JP7, JP9, JP10, JP14, and JP15 to open. The relationship between the current Iin flowing through the shunt resistor and the voltage Vout output from the current detection circuit is shown in equations (1) and (2). In addition, by switching JP8 and JP11 to 2-3 pin short circuit, one shunt current detection can be supported.

$$\text{Amplifier gain 10x} : \mathrm{Vout[V]} = \mathrm{Iin[A]} \times \mathrm{Rs[\Omega]} \times 10 + \mathrm{AVCC}/2 \quad (1)$$

$$\text{Amplifier gain 20x} : \mathrm{Vout[V]} = \mathrm{Iin[A]} \times \mathrm{Rs[\Omega]} \times 20 + \mathrm{AVCC}/2 \quad (2)$$

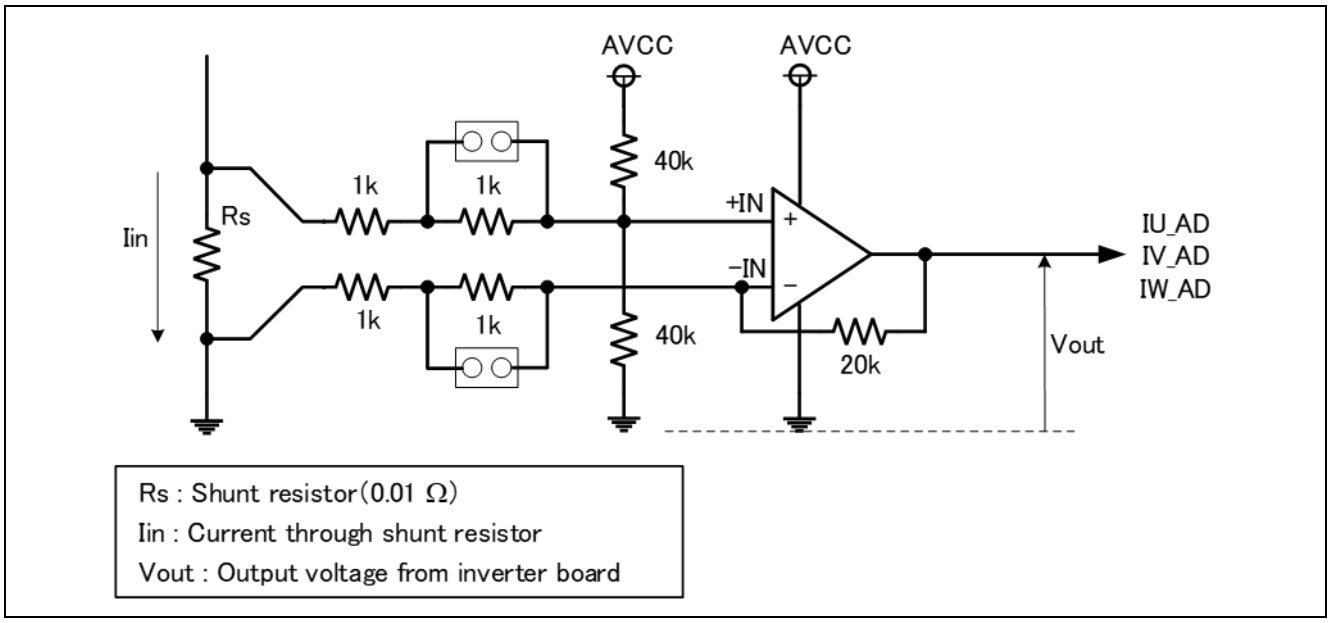


Figure 5-2 Current detection circuit

5.1.3 Overcurrent detection circuit

Detect the overcurrent from the input current, using the overcurrent detection circuit illustrated in Figure 5-3 If the current value is within the range of threshold, OC_INV_OUT is HIGH, and this changes to LOW if overcurrent is detected. Therefore, you can protect the board and motor by monitoring the over current detection signal and setting PWM signals for gate driver to LOW or Hi-Z if the over current detection signal changes to LOW. As the value of the shunt resistor Rs is 10 mohm, the threshold current for over current detection is 21.4A for AVCC=3.3V and 32.4A for AVCC=5.0V, respectively.

The overcurrent detection circuit does not directly protect the board and motor. Protect them by performing appropriate processing with equipment such as microcontroller.

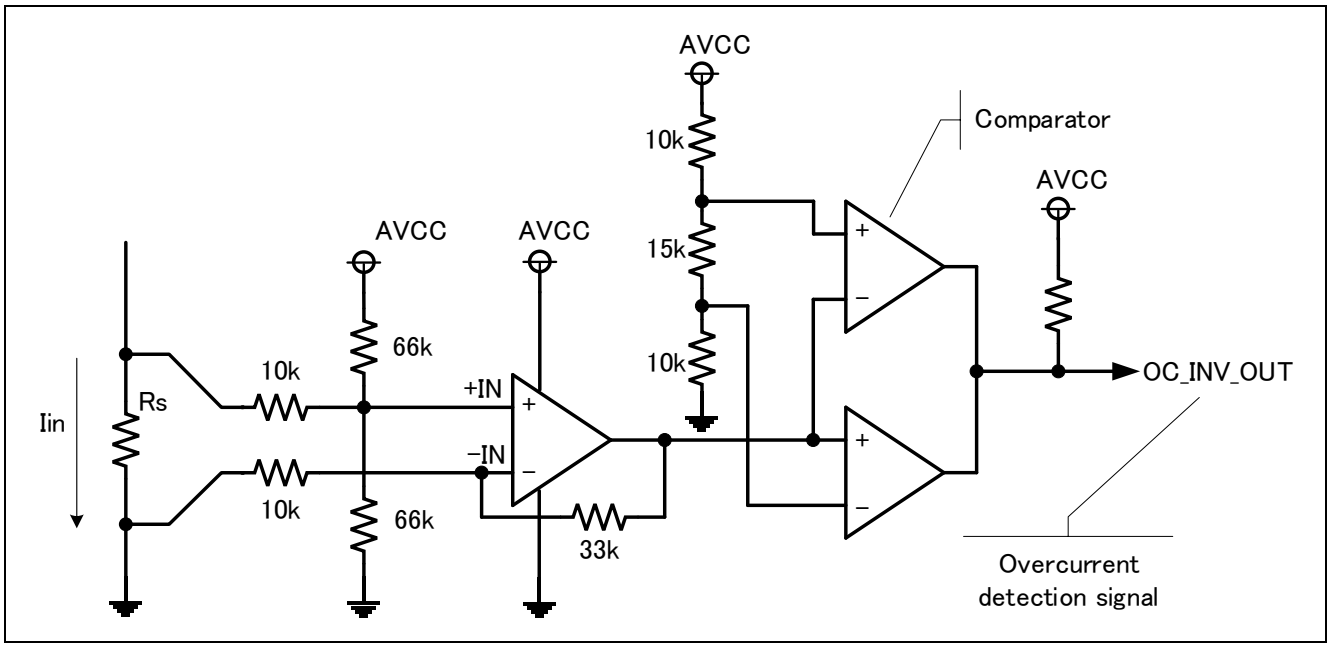


Figure 5-3 Overcurrent detection circuit

5.1.4 Output voltage detection circuit

The inverter board has the circuit that inputs bus voltage and three-phase output voltage (U, V and W phase) into the AD pin of the microcontroller through resistive voltage divider. Relation between the three-phase output voltage, the bus voltage and the detection voltage is described by the below equation (3).

$$\mathrm{Vout}[V] = \frac{470}{10 \times 10^3 + 470} \times Vin[V] \qquad (3)$$

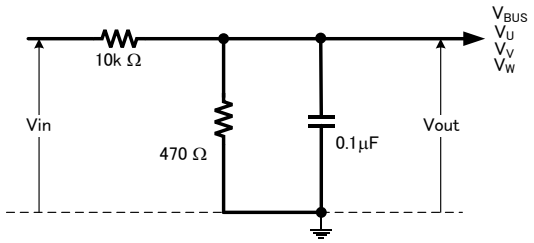


Figure 5-4 Output voltage detection circuit

5.1.5 Voltage generation circuit

On the inverter board, the gate driver voltage ("+12V" in the schematic) is generated from the 5V power supply ("+5V" in the schematic) with the boost converter. If 5V is not supplied from the CPU board, the buck converter on the inverter board generates 5V from the voltage input (12 to 48V) from the DC jack or terminal block.

Table 5-1 Voltage generation

Item	Input voltage [V]	Output voltage (TYP.) [V]	Output current (Max) [A]
5V generation	12～48	5	0.6
Gate driver voltage generation	5	11.4	-

5.1.6 LED

The inverter board has three LEDs which the user can control. The LED ON/OFF is controlled by the pin state.

Table 5-2 LED

Connector pin		LED1	LED2	LED3
CN4-18	HIGH	OFF	-	-
	LOW	ON	-	-
CN4-19	HIGH	-	OFF	-
	LOW	-	ON	-
CN4-20	HIGH	-	-	OFF
	LOW	-	-	ON

5.1.7 Toggle switch and push switch

The inverter board has toggle switch (SW1) and push switch (SW2). The pin voltage is controlled by the state of them.

Table 5-3 Toggle switch and push switch

Connector pin		SW1	SW2
CN4-16	HIGH	ON	-
	LOW	OFF	-
CN4-17	HIGH	-	RELEASE
	LOW	-	PUSH

5.1.8 Variable resistor

The inverter board has a variable resistor (VR1). If turning the variable resistor clockwise, terminal voltage of the variable resistor (CN3-17) becomes low. If turning it counterclockwise, the voltage becomes high.

Table 5-4 Variable resistance specification

Item	Specification
Input voltage range	0~AVCC
Variable resistor range	0~10kΩ

5.2 Pin assignment

5.2.1 CPU board connector

Table 5-5 CPU board connector (CN2)

Pin No.	Output direction	Signal
1	-	SPARE1
2	-	AGND
3	To CPU	DC bus voltage detection
4	-	AGND
5	To CPU	U-phase current detection
6	To CPU	U-phase current detection (PGAVSS)
7	To CPU	V-phase current detection
8	To CPU	V-phase current detection (PGAVSS)
9	To CPU	W-phase current detection
10	To CPU	W-phase current detection (PGAVSS)
11	To CPU	U-phase voltage detection
12	To CPU	V-phase voltage detection
13	To CPU	W-phase voltage detection
14	-	AGND
15	To CPU	VPFC_AD
16	To CPU	IPFC_AD
17	To CPU	VR1
18	-	AGND
19	-	AVCC
20	-	AVCC
21	-	AGND
22	-	AGND
23	-	VCC
24	-	VCC
25	-	DGND
26	-	DGND
27	To INV	PWM U-phase (Lower)
28	-	DGND
29	To INV	PWM U-phase (Upper)
30	-	DGND
31	To INV	PWM V-phase (Lower)
32	-	DGND
33	To INV	PWM V-phase (Upper)
34	-	DGND

Table 5-6 CPU board connector (CN3)

Pin No.	Output direction	Signal
1	To INV	PWM W-phase (Lower)
2	-	DGND
3	To INV	PWM W-phase (Upper)
4	-	DGND
5	-	SPARE2
6	-	SPARE3
7	-	SPARE4
8	-	SPARE5
9	To INV	Bus power signal from CPU board
10	To CPU	Inverter connected signal
11	To CPU	Save interlock signal
12	To CPU	Over current detection
13	To CPU	OC_PFC_OUT
14	To INV	PWM_IN
15	To INV	RELAY_IN
16	To CPU	SW1
17	To CPU	SW2
18	To INV	LED1
19	To INV	LED2
20	To INV	LED3
21	To CPU	HALL U
22	To CPU	HALL V
23	To CPU	HALL W
24	To CPU	IPS_SIO_SDA
25	To CPU	IPS_SCK_SCL
26	To CPU	IPS_CSN_IRQN/Encoder Z
27	To CPU	IPS_A/ Encoder A
28	To CPU	IPS_A#/ Encoder A#
29	To CPU	IPS_B/ Encoder B#
30	To CPU	IPS_B#/ Encoder B#
31	-	DGND
32	-	DGND
33	-	+5V
34	-	+5V

5.2.2 Hall sensor signal input

This product has connector for hall sensor signal input. Pin assignment of it is listed in Table 5-7.

Table 5-7 Connector for hall sensor signal input (CN6) pin assignment

Pin No.	Pin Function
1	DGND
2	+5V
3	HALL_W
4	HALL_V
5	HALL_U

5.2.3 Encoder/Inductive position sensor signal input

This product has pins for encoder/inductive position sensor signal input. Pin assignment for them is listed in Table 5-8.

Table 5-8 Pins for encoder/inductive position sensor signal input (CN5) pin assignment

Pin No.	Pin function
1	VCC
2	+5V
3	CSN_IRQN/ENC_Z
4	SIO_SDA
5	SCK_SCL
6	IPS_A/ENC_A
7	IPS_A#/ENC_A#
8	IPS_B/ENC_B
9	IPS_B#/ENC_B#
10	DGND

6. CPU Board Specification

This section describes the specification of the CPU Board.

6.1 Functions

6.1.1 Power supply

When not connected to the inverter board, power should be supplied from the USB connector (CN5). When connecting to the inverter board, power supply from the USB connector or from the inverter board will be automatically selected. USB power supply has priority.

6.1.2 Onboard debugger

This product has the onboard debugger circuit, J-Link On-Board (hereinafter called “J-Link-OB”). You can write a program (firmware) of RA2T1 with it. When you write a program, open the jumper of JP3 and connect the USB connector (CN5) on the CPU board to PC with USB cable. J-Link-OB operates as a debugger equivalent to J-Link. If connecting from Integrated Development Environment (e.g. e2studio) or flash programing tool (e.g. Renesas Flash Programmer), set the type of debugger (tool) to “J-Link”.

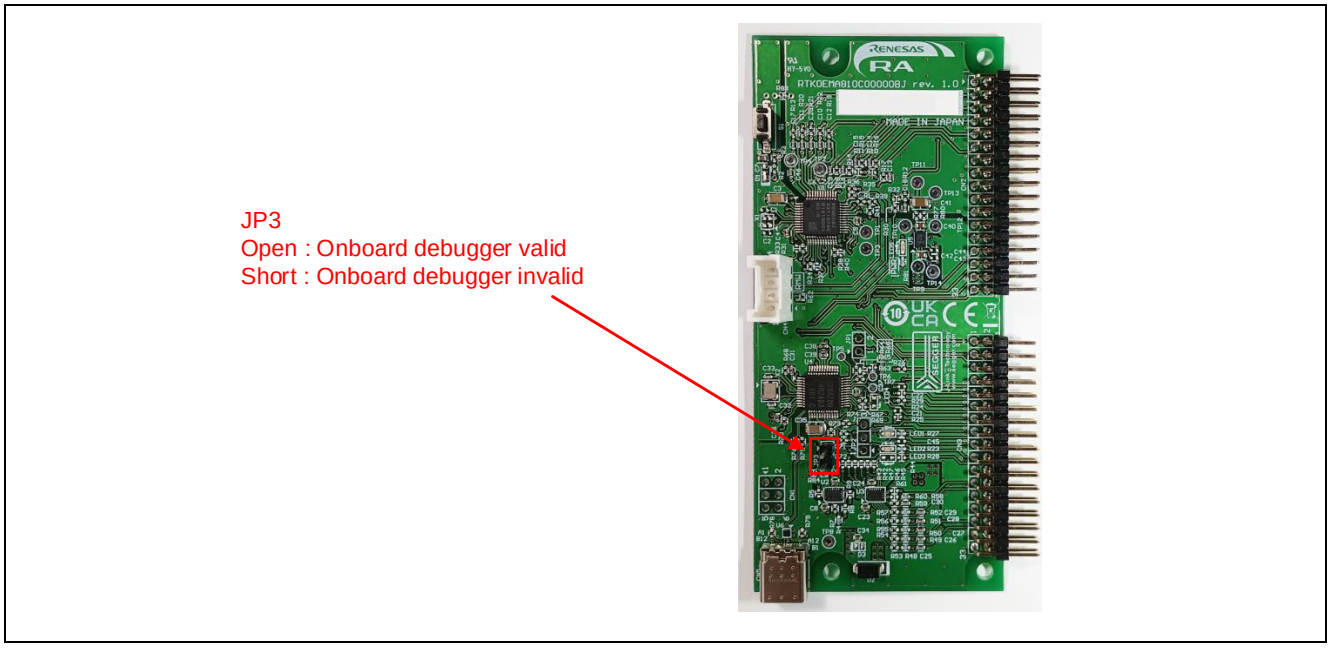


Figure 6-1 Jumper setting of JP3

6.1.3 J-Link Virtual COM Port

This product supports J-Link Virtual COM Port. By connecting to a PC with USB connector (CN5), a virtual COM port via USB is available.

6.1.4 Inverter board connector

This board can connect to the inverter board with CN2 and CN3. The pin assignments of the connectors are shown in Table 6-1, Table 6-2.

Table 6-1 Inverter board connector (CN2) pin assignment

Pin No.	Pin Function	RA2T1Pin	Pin No.	Pin Function	RA2T1 Pin
1	HVtemp	P103/AN019 (*)	2	AGND	- (AVSS)
3	VPN	P000/AN008	4	AGND	- (AVSS)
5	IU	P013/AN000	6	NC	-
7	IV	P014/AN001	8	NC	-
9	IW	P015/AN002	10	NC	-
11	VU	P102/AN020	12	VV	P012/AN007
13	VW	P011/AN006	14	AGND	- (AVSS)
15	VPFC	P001/AN009	16	IPFC	P002/AN010
17	VR	P010/AN005	18	AGND	- (AVSS)
19	AVCC	- (AVCC)	20	AVCC	- (AVCC)
21	AGND	- (AVSS)	22	AGND	- (AVSS)
23	VCC	- (VCC)	24	VCC	- (VCC)
25	GND	- (VSS)	26	GND	- (VSS)
27	UN	P407/GTIOC0B	28	GND	- (VSS)
29	UP	P208/GTIOC0A	30	GND	- (VSS)
31	VN	P110/GTIOC2B	32	GND	- (VSS)
33	VP	P109/GTIOC2A	34	GND	- (VSS)

(*) Exclusively assigned by jumper register setting

Table 6-2 Inverter board connector (CN3) pin assignment

Pin No.	Pin Function	RA2T1Pin	Pin No.	Pin Function	RA2T1 Pin
1	WN	P112/GTIOC1B	2	GND	- (VSS)
3	WP	P111/GTIOC1A	4	GND	- (VSS)
5	NC	-	6	PWMPFC2	P401/GTIOC3B (*)
7	NC	-	8	NC	-
9	BUS_POWER_IN	-	10	INV_CONNECTED	P403
11	SAFE_LOCK	P200	12	OCINV	P302/GTETRGA
13	OCPFC	P301/GTETRGB (*)	14	PWMPFC1	P400/GTIOC3A (*)
15	Relay	P207	16	SW1	P402
17	SW2	P104	18	LED1	P913
19	LED2	P914	20	LED3	P915
21	HALL_U	P206/IRQ0	22	HALL_V	P409/IRQ6
23	HALL_W	P408/IRQ7	24	NC	-
25	NC	-	26	ENC_Z	P301/GTETRGB (*)
27	ENC_A	P400/GTIOC3A (*)	28	NC	-
29	ENC_B	P401/GTIOC3B (*)	30	NC	-
31	GND	- (VSS)	32	GND	- (VSS)
33	+5V	-	34	+5V	-

(*) Exclusively assigned by jumper register setting

6.1.5 Serial communication

For serial communication using Renesas Motor Workbench, the CPU board has SCI connector. Pin assignment for SCI connector is listed in Table 6-3.

Table 6-3 SCI connector (CN4) pin assignment

Pin No.	Pin Function	RA2T1 Connection Pin
1	GND	-
2	MCU RXD	P100/RXD0
3	MCU TXD	P101/TXD0
4	VCC	-

6.1.6 Reset circuit

This product has a reset circuit to enable power-on reset or external reset on MCU. Push the tact switch (SW1) to externally reset MCU.

6.1.7 LED

This product has 2 controllable LEDs, so that they can be used for program debug and the system. LED switches “ON” when output from the corresponding port is “LOW” and switches “OFF” when output is “HIGH”. Pin assignment for corresponding LEDs is listed in Table 6-4.

Table 6-4 LED pin assignment

RA2T1 port		LED1	LED2	LED3(DNF)
P913	Output HIGH	OFF	-	-
	Output LOW	ON	-	-
P914	Output HIGH	-	OFF	-
	Output LOW	-	ON	-
P915	Output HIGH	-	-	(OFF)
	Output LOW	-	-	(ON)

6.2 RA2T1 pin function list

Table 6-5 RA2T1 pin function list

Pin No.	RA2T1 pin function	Signal function
1	P400/GTIOC3A	PFCPWM1/ENCA
2	P401/GTIOC3B	PFCPWM2/ENCB
3	VCL1	System
4	P402	SW1
5	P403	INV CONNECTED
6	VSS1	GND
7	P213/XTAL	External clock
8	P212/EXTAL	External clock
9	VCC1	VCC
10	P409/IRQ6	HALL_V
11	P408/IRQ7	HALL_W
12	P407/GTIOC0B	UN
13	P915	LED3
14	P914	LED2
15	P913	LED1
16	P208/GTIOC0A	UP
17	P207	Relay
18	P206/IRQ0	HALL_U
19	RES#	Reset
20	P201/MD	ARM debugger
21	P200	SAFE LOCK
22	P302/GTETRGA	OC INV
23	P301/GTETRGB	OCPFC/ENCZ
24	P300/SWCLK	ARM debugger
25	P108/SWDIO	ARM debugger
26	P109/GTIOC2A	VP
27	P110/GTIOC2B	VN
28	P111/GTIOC1A	WP
29	P112/GTIOC1B	WN
30	VCC2	VCC
31	VSS2	GND
32	P104/IRQ1	SW2/Overtemp
33	P103/CTS0/AN019	VCOM/HVtemp
34	P102/AN020	VU
35	P101/TXD0	SCI
36	P100/RXD0	SCI
37	P500	VCOM
38	P015/AN002	IW
39	P014/AN001	IV
40	P013/AN000	IU
41	P012/AN007	VV
42	AVCC0	AVCC
43	AVSS0	AGND
44	P011/AN006	VW
45	P010/AN005	IPFC2/VR
46	P002/AN010	IPFC1
47	P001/AN009	VPFC
48	P000/AN008	VPN

7. Communication Board Specification

This section describes the specification of the communication board.

7.1 Functions

7.1.1 Power supply

Power of this product is supplied at 5V from USB connector.

7.1.2 USB communication

This product is equipped with a USB type-C connector for communication with a PC when using Renesas Motor Workbench, etc.

7.1.3 Serial communication

This board has two SCI connectors for serial communication with the target MCU when using Renesas Motor Workbench, etc. The pin assignments are shown in Table 7-1 and Table 7-2. When using the communication cable bundled with this product, use CN5.
The serial communication connector and the MCU (RX72N) are connected via a digital isolator, so the communication board and the CPU board with the target MCU are isolated.

Table 7-1 SCI connector (CN5) pin assignment

Pin No.	Function	Note
1	VCC	
2	RXD	Connect to TXD of target MCU
3	TXD	Connect to RXD of target MCU
4	GND	

Table 7-2 SCI connector (CN4) pin assignment

Pin No.	Function	Note
1	VCC	
2	RXD	Connect to TXD of target MCU
3	TXD	Connect to RXD of target MCU
4	GND	

8. Design and Manufacture Information

You can obtain information on the design and manufacture of this product from renesas.com .

9. Website and Support

In order to learn, download tools and documents, apply technical support for RA family MCU and its kit, visit the below Web site.
• RA Product Information renesas.com/ra
• Renesas Support renesas.com/support

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