Evaluation Kit Manual

RA4T1 Group

MCK-RA4T1 Evaluation Kit Manual

Renesas RA Family
RA4 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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For Your Safety

Be sure to read the precautions and instructions in this manual before using this product.

Meaning of Notations

In this manual, items related to the safe use of the product are indicated as described below.

The degree of injury to persons or damage to property that could result if the designated content in this manual is not followed is indicated as follows.

⚠ Danger	Indicates content that, if not followed, could result in death or serious injury to the user, and which is highly urgent.
⚠ Warning	Indicates content that, if not followed, could result in death or serious injury to the user.
⚠ Caution	Indicates content that, if not followed, could result in injury to persons or physical damage.

Warnings Regarding Use of the Product

■ Danger Items

⚠ Danger	
  	• The product should be used only by persons (users) having a thorough knowledge of electrical and mechanical components and systems, a full knowledge of the risks associated with handling them, and training in inverter motor control and handling motors, or equivalent skills. Users should be limited to persons who have carefully read the Caution Items contained in this manual. • The product contains high-temperature components that could be dangerous. Do not touch the product or cables while power is being supplied. • Carefully check to make sure that there are no pieces of conductive materials or dust adhering to the board, connectors, and cables. • Do not touch the motor while power is being supplied. • Ensure that the motor is insulated and placed in a stable location before supplying power.

■ Warning Items

Warning	
	Always insert plugs, connectors, and cables securely, and confirm that they are fully inserted. Incomplete connections could cause fire, burns, electric shock, or injury.
	Use the power supply apparatus specified in the manual. Failure to do so could cause fire, burns, electric shock, injury, or malfunction.
	Disconnect the power supply and unplug all cables when the system will not be used for a period of time or when moving the system. Failure to do so could cause fire, burns, electric shock, or malfunction. This will protect the system against damage due to lightning.
	Use a mechanism (switch, outlet, etc.) located within reach to turn off (disconnect) the power supply. In case of emergency, it may be necessary to cut off the power supply quickly.
	In this product, the ground of the main power supply circuit is connected to the ground of the CPU board. When the user evaluates the product, be aware that the product and the measuring instruments may be damaged depending on the connection method of the measuring instruments.
	Turn off the power supply immediately if you notice abnormal odor, smoke, abnormal sound, or overheating. Continuing to use the system in an abnormal condition could cause fire, burns, or electric shock.
	Do Not Disassemble, Modify, or Repair! Doing so could cause fire, burns, electric shock, injury, or malfunction.
	Do not use the product for any purpose other than initial evaluation of motor control in a testing room or lab. Do not integrate the product or any part of it into other equipment. Do not insert or remove cables or connectors when the product is powered on. The product has no safety case. The user must cover the product for safety protection. Failure to observe the above could cause fire, electric shock, burns, or malfunction. The product may not perform as expected if used for other than its intended purpose.

■ Caution Items

Caution	
	Caution – Hot! The motor gets hot. Touching it could cause high-temperature burns.
	Follow the procedure specified in the manual when powering the system on or off. Failure to do so could cause overheating or malfunction.
	Caution – Static Electricity Use the antistatic band. Failure to do so could cause malfunction or unstable motion.

Renesas RA Family

MCK-RA4T1 Evaluation Kit Manual

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1. Overview

MCK-RA4T1 is a motor control evaluation kit. By using this product, motor control with RA4T1 can be performed easily.

MCK-RA4T1 has characteristics shown below.

（1） Supports Brushless DC motor.

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

（3） Supports Motor Control Development Support Tool (Renesas Motor Workbench).

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

There are two versions of the MCK-RA4T1 (Version 1 and Version 2), each with a different circuit diagram and terminal configuration. The model names for each are as follows:

Version 1 Model : RTK0EMA430S00020BJ
Version 2 Model : RTK0EMA430S00021BJ

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 e^2 studio 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.
5. The onboard debugger circuit on this product is not isolated. *1 For evaluations of motor drive operation, please use the communication board (MC-COM) or USB isolator to connect to the PC and use the Renesas Motor Workbench development support tool. Because the communication board is equipped with an isolator, isolation between the PC and this product is ensured. Furthermore, Renesas Motor Workbench allows variables to be read and written without stopping the MCU, enabling safe evaluation and debugging of motor drive operation. *2

   *1 When using the onboard debugger or an external emulator, this product and the PC share a common GND. In that case, supplying external power to the inverter board or driving the motor may damage the board or the PC.
   *2 If the MCU is stopped by the debugger while the motor is running, the MOSFETs on the inverter board may remain ON(conducting state), which may result in damage to the motor or the inverter board.

2. Product Contents

This kit consists of the following parts.

1. Inverter Board (RTK0EM0000B12020BJ) x1
2. CPU Board (Version 1 : RTK0EMA430C00000BJ)
   (Version 2 : RTK0EMA430C00001BJ) x1
3. Brushless DC Motor (R42BLD30L3) x1
4. USB Cable x1
5. Screw x8
6. Standoff x8

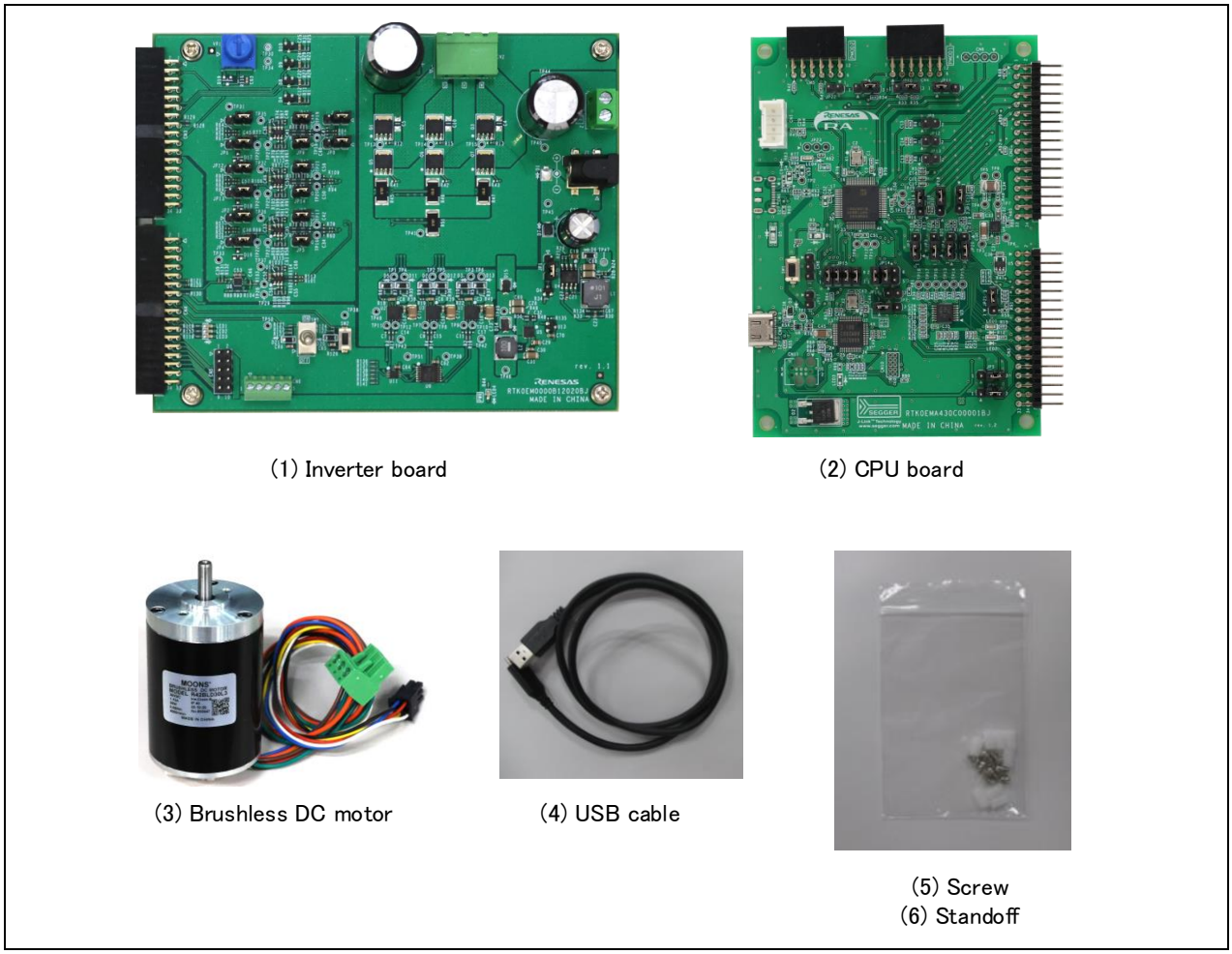


Figure 2-1 Product contents

3. Product Order Information

Product number to ordering this product	Included item
RTK0EMA430S00020BJ (MCK-RA4T1 Version 1)	CPU Board (RTK0EMA430C00000BJ) Inverter Board (RTK0EM0000B12020BJ) Brushless DC Motor (R42BLD30L3) USB cable
RTK0EMA430S00021BJ (MCK-RA4T1 Version 2)	CPU Board (RTK0EMA330C00001BJ) Inverter Board (RTK0EM0000B12020BJ) Brushless DC Motor (R42BLD30L3) USB cable

Product number for ordering item	Included item
RTK0EMA430C00000BJ (MCB-RA4T1 Version 1)	CPU Board (RTK0EMA430C00000BJ)
RTK0EMA430C00001BJ (MCB-RA4T1 Version 2)	CPU Board (RTK0EMA430C00001BJ)
RTK0EM0000S04020BJ (MCI-LV-1)	Inverter Board (RTK0EM0000B12020BJ) Brushless DC Motor (R42BLD30L3)
RTK0EMXC90S00000BJ (MC-COM)	Communication board (RTK0EMXC90Z00000BJ) Communication cable USB cable

4. Hardware Configuration and Default Setting

4.1 Hardware configuration

MCK-RA4T1 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-RA4T1 specification (1/3)

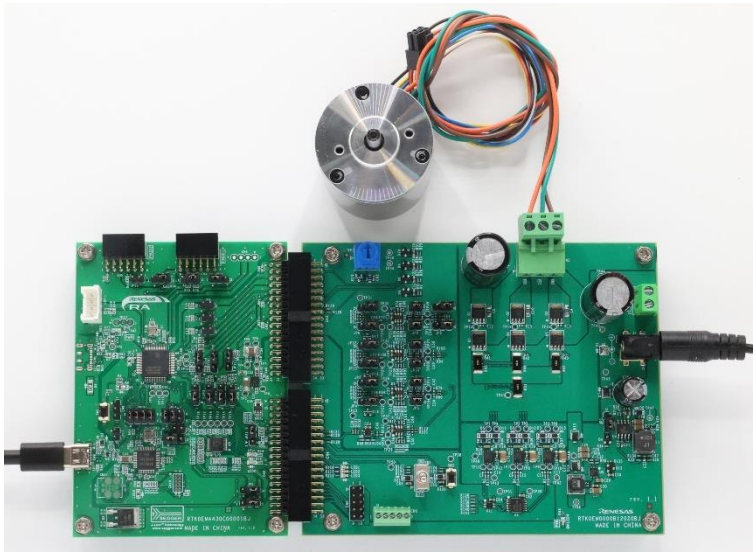
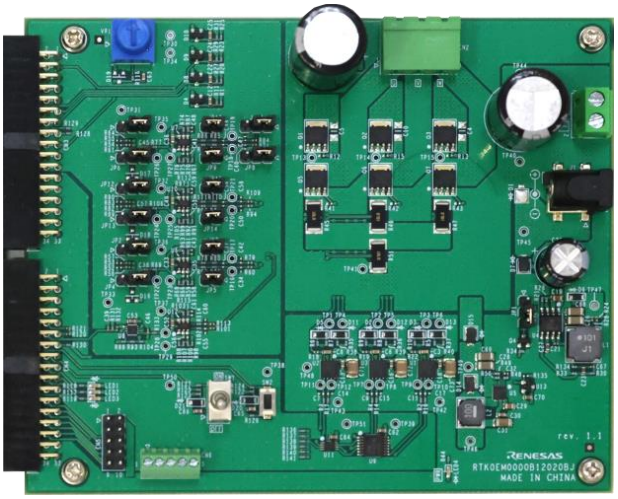
Item	Specification	
Kit product name	MCK-RA4T1	
Kit product No.	Version 1 : RTK0EMA430S00020BJ Version 2 : RTK0EMA430S00021BJ	
Kit configuration	Inverter Board	RTK0EM0000B12020BJ
	CPU Board	Version 1 : RTK0EMA430C00000BJ Version 2 : RTK0EMA430C00001BJ
	Brushless DC Motor	R42BLD30L3 (MOONS') Rated voltage : 36V Rated current : 1.13A
Isolation	Inverter board - CPU board : Non-isolated	
External view	 Note: The actual product may differ from this photo.	
Board size	Inverter board : 133mm (W) x 109mm (L) CPU board : 85mm (W) x 109mm (L)	
Operating temperature	Room temperature	
Operating humidity	No condensation allowed	
EMC Directive	EN61326-1:2021 EMI:Class A EMS:Basic Electromagnetic environment	

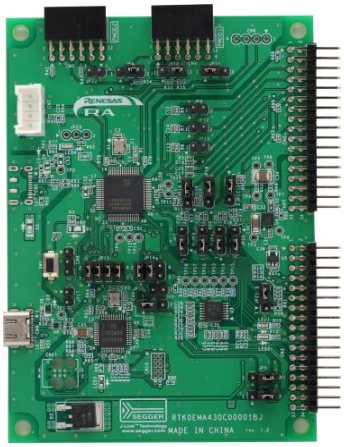
Table 4-2 MCK-RA4T1 specification (2/3)

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 10A (RMS value) *2
Switching frequency	20kHz (typical)
Current sensing method	1- / 2- / 3-shunt sensing
Shunt resistor	10mΩ
PWM logic	Low side, High side : Positive logic
DC bus voltage detection (bus voltage detection)	Detection by resistance division (0V ~ 48V)
3-phase output voltage detection	Detection by resistance division (0V ~ 48V)
3-phase output current sensing	With shunt resistor (-16.5A ~ +16.5A)
Overcurrent detection function	21.4A (AVCC=3.3V)
Supporting sensor	HALL sensor, Encoder, Inductive position sensor
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-RA4T1 specification (3/3)

item		Specification
Product name		CPU Board
Board part No.		Version 1 : RTK0EMA430C00000BJ Version 2 : RTK0EMA430C00001BJ
Compatible inverter board		RTK0EM0000B12020BJ
External view		 Note: The actual product may differ from this photo.
Mounted MCU	Product group	RA4T1 group
	Product No.	R7FA4T1BB3CFM
	CPU maximum operating frequency	100MHz
	Bit count	32bit
	Package / Pin count	LFQFP / 64pin
	ROM	256KB
MCU input clock		10MHz (Generate with external crystal 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 On-Board (Onboard debugger circuit)
Connector		• Inverter board connector • USB connector for J-Link On-Board • SCI connector for Renesas Motor Workbench communication • Through hole for CAN communication • 10 pin through hole for Arm debugger • Pmod connectors
Switch		MCU reset switch
LED		User-controllable LED x2, Power LED x1

4.2 Block diagram

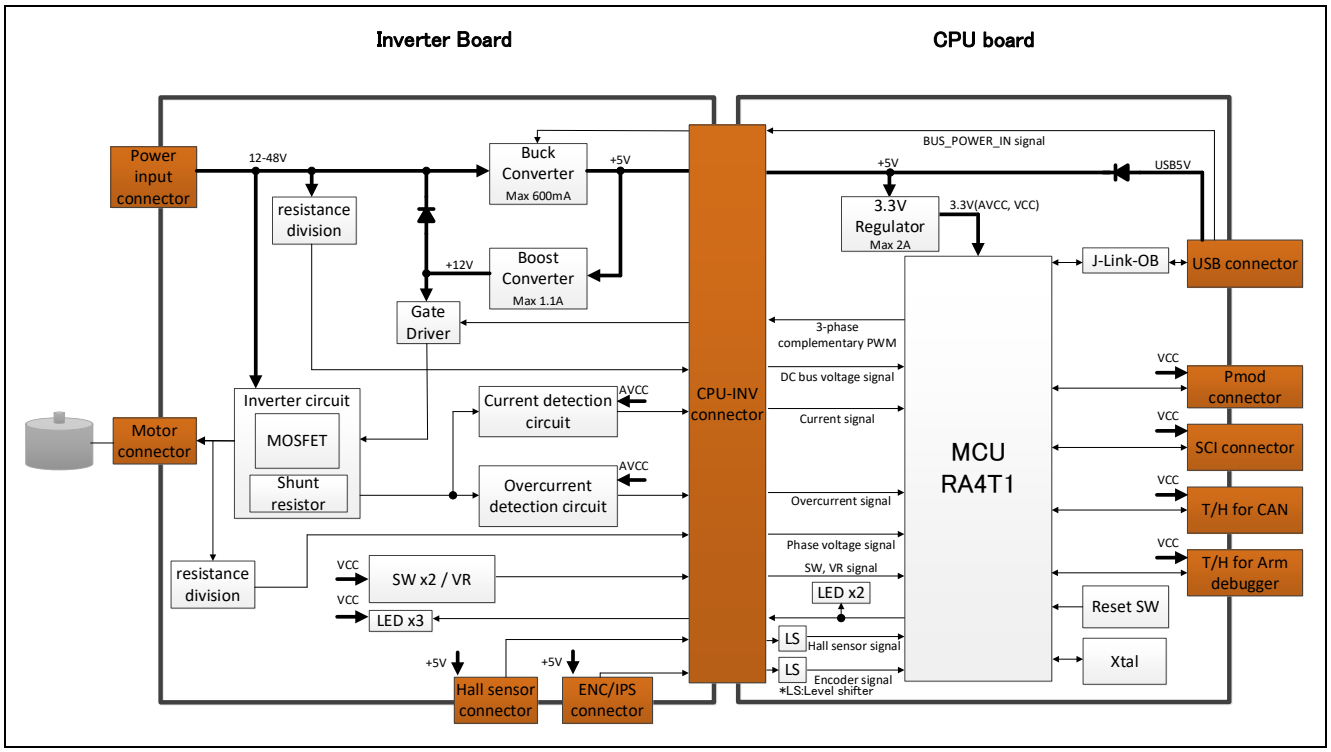


Figure 4-1 MCK-RA4T1 block diagram

4.3 Board Layout

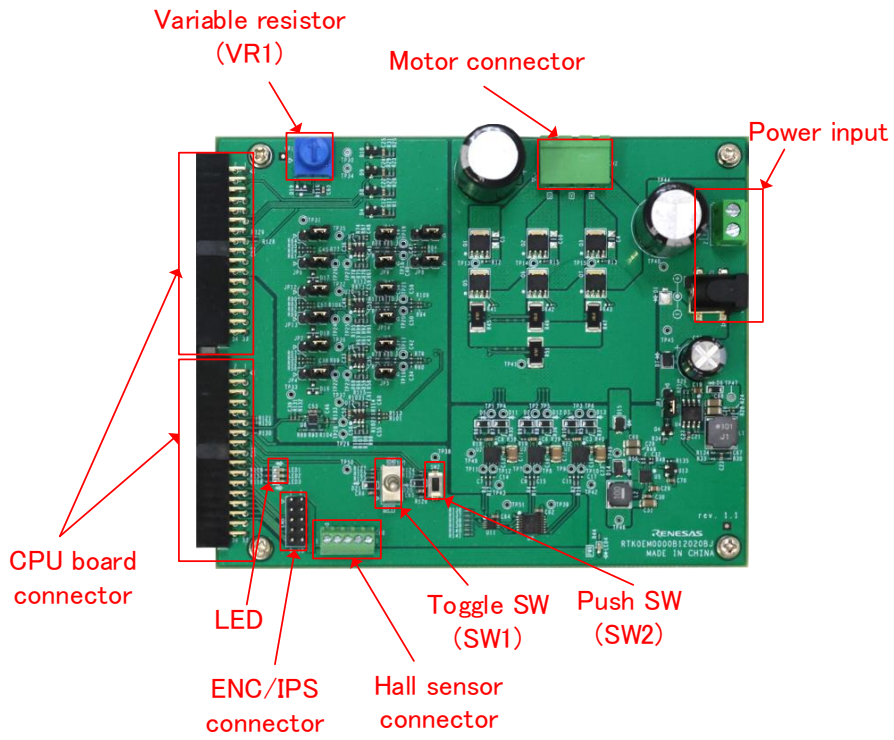


Figure 4-2 Inverter Board

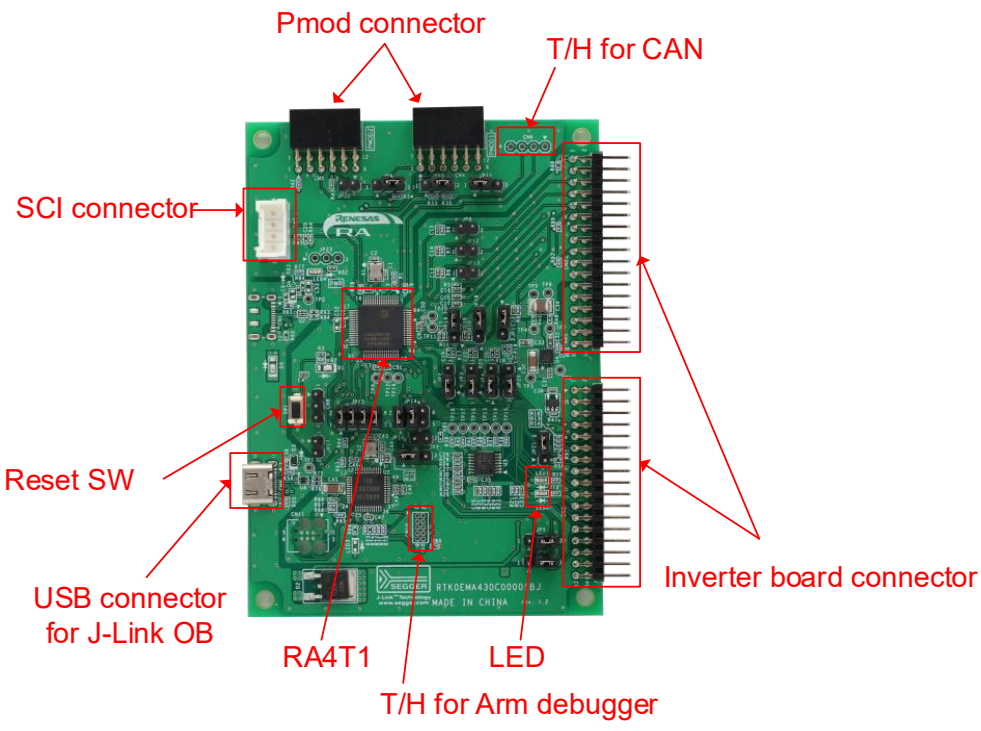


Figure 4-3 CPU Board

4.4 Standoffs and Screws

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

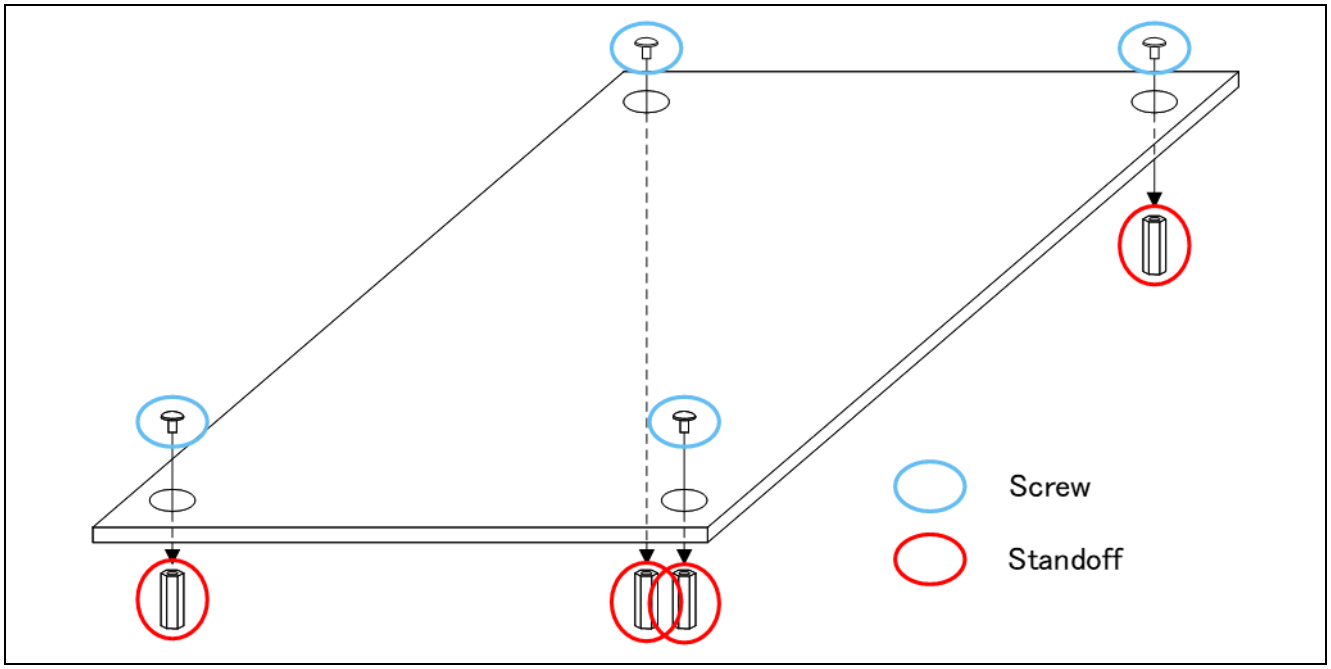


Figure 4-4 Standoffs and Screws assembly

4.5 Jumper pin setting

4.5.1 Inverter Board

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

Table 4-4 Jumper pin setting of inverter board

Jumper pin	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 sensing amplifiers 2-3pin short : Enable current sensing amplifiers
JP5, JP7, JP9, JP10, JP14, JP15	1-2pin short	1-2pin short : Current sensing amplifier gain = 20 1-2pin open : Current sensing amplifier gain = 10
JP8, JP11	1-2pin short	1-2pin short : 2-/3-shunt current sensing 2-3pin short : 1-shunt current sensing

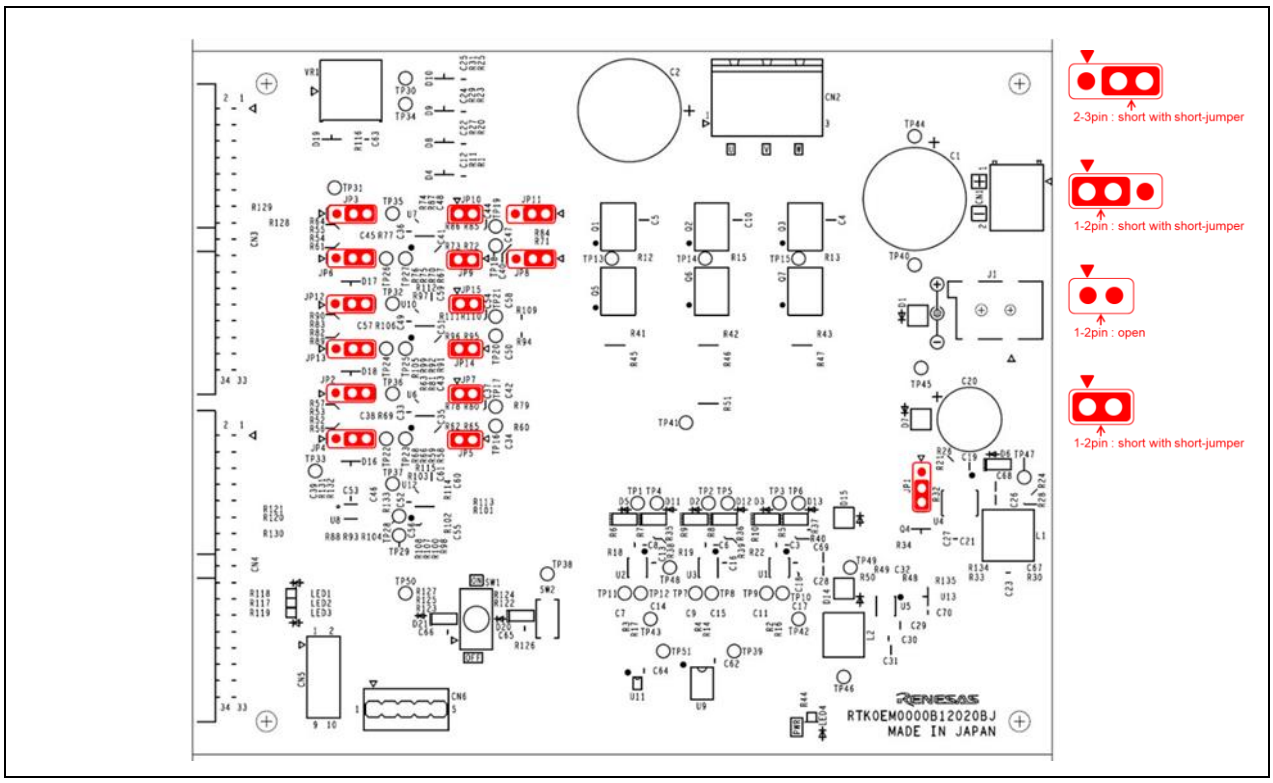


Figure 4-5 Default jumper pin setting

4.5.2 CPU Board

(1) Version 1(RTK0EMA430C00000BJ)'s default settings and functions of the jumper pins (JP1~JP17) are as follows.

Table 4-5 Jumper pin setting of CPU board (Version 1)

JP No.	Function	Setting (function in use)			Default setting
		open	1-2 short	2-3 short	
1	IPS/VU select	N/A	VU	IPS	1-2 short
2	IPS/HALL select	N/A	HALL	IPS	1-2 short
3	IPS/HALL select	N/A	HALL	IPS	1-2 short
4	IPS/HALL select	N/A	HALL	IPS	1-2 short
5	IPS/ENC select	N/A	IPS	ENC	2-3 short
6	IPS/ENC select	N/A	IPS	ENC	2-3 short
7	Reset control for RA4T1	by SW1	by J-Link-OB or SW1	Reset	1-2 short
8	IU sensing	CSA	PGA	N/A	open
9	Pmod Type2A/6A select	N/A	Type 2A	Type 6A	1-2 short
10	Pmod Type2A/6A select	N/A	Type 2A	Type 6A	1-2 short
11	Pmod Type2A/6A select	N/A	Type 6A	Type 2A	2-3 short
12	IV sensing	CSA	PGA	N/A	open
13	IW sensing	CSA	PGA	N/A	open
14	Debugger connection	Not connected	Connected (1-2, 3-4 short)	N/A	1-2, 3-4 short
15	UART connection	Pmod	VCOM port (1-2, 3-4, 5-6, 7-8 short)	N/A	1-2, 3-4, 5-6, 7-8 short
16	MD port pull-down	open	Pull-down	N/A	open
17	Enable/disable J-Link-OB	Enabled	Disabled	N/A	open

CSA : with current sensing amplifier on inverter board
PGA : with programmable gain amplifier in MCU
IPS : Inductive Position Sensor
ENC : Encoder
HALL : HALL sensor

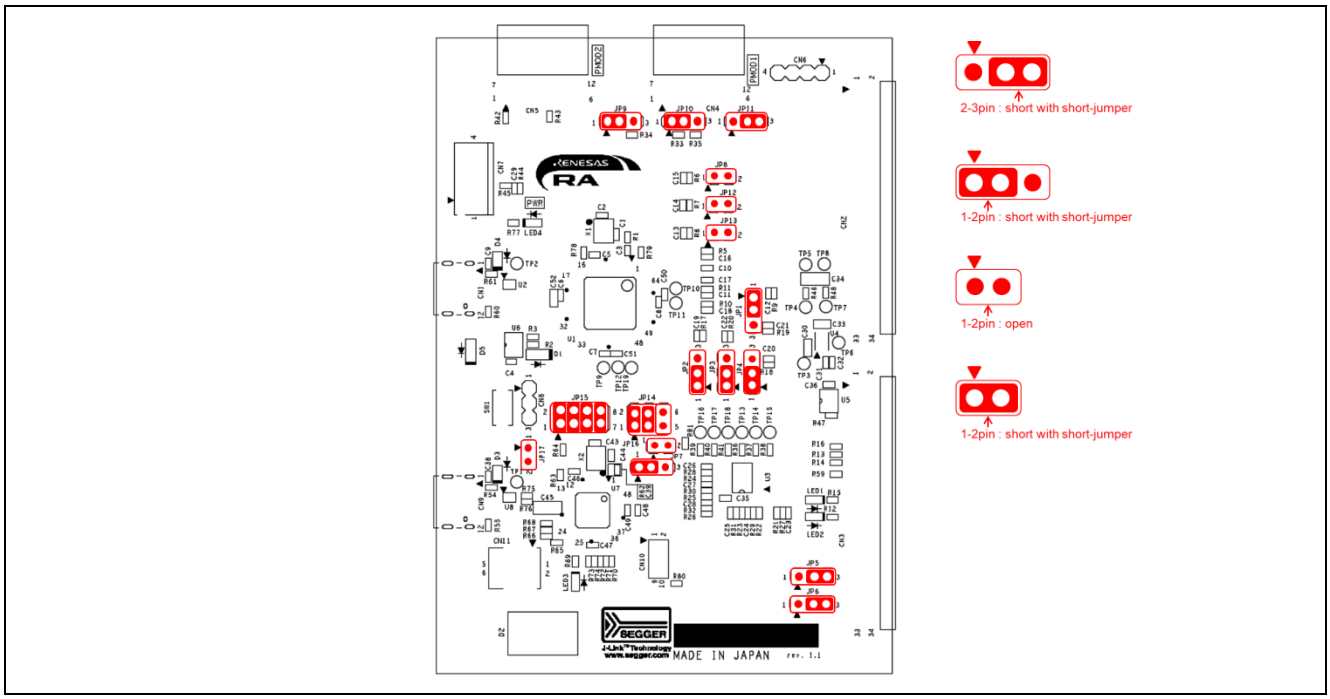


Figure 4-6 Default jumper pin setting of CPU board (Version 1)

(2) Version 2(RTK0EMA430C00001BJ)'s default settings and functions of the jumper pins (JP1~JP22) are as follows.

Table 4-6 Jumper pin setting of CPU board (Version 2)

JP No.	Function	Setting (function in use)			Default setting
		open	1-2 short	2-3 short	
1	IPS/VU select	N/A	VU	IPS	1-2 short
2	IPS/HALL select	N/A	HALL	IPS	1-2 short
3	IPS/HALL select	N/A	HALL	IPS	1-2 short
4	IPS/HALL select	N/A	HALL	IPS	1-2 short
5	IPS/ENC select	N/A	IPS	ENC	2-3 short
6	IPS/ENC select	N/A	IPS	ENC	2-3 short
7	Reset control for RA4T1	by SW1	by J-Link-OB or SW1	Reset	1-2 short
8	IU sensing	CSA	PGA	N/A	open
9	Pmod Type2A/6A select	N/A	Type 2A	Type 6A	2-3 short
10	Pmod Type2A/6A select	N/A	Type 2A	Type 6A	2-3 short
11	Pmod Type2A/6A select	N/A	Type 6A	Type 2A	1-2 short
12	IV sensing	CSA	PGA	N/A	open
13	IW sensing	CSA	PGA	N/A	open
14	Not connected	Not connected	Connected (1-2, 3-4short)	N/A	1-2, 3-4 short
15	UART connection	Pmod	VCOM port (1-2, 3-4, 5-6, 7-8 short)	N/A	1-2, 3-4, 5-6, 7-8 short
16	MD port pull-down	open	Pull-down	N/A	open
17	Enable/disable J-Link-OB	Enable	Disable	N/A	open
18	IPFC1/VV select	N/A	VV	IPFC1	2-3 short
19	VAC/VW select	N/A	VW	VAC	2-3 short
20	PFCPWM2/MOSIA_A select	N/A	MOSIA_A	PFCPWM2	2-3 short
21	PFCPWM1/Pmod select	N/A	Pmod	PFCPWM1	2-3 short
22	PFCPWM2/ I2C Pull-up select	PFCPWM2	I2C Pull-up	-	open

CSA : with current sensing amplifier on inverter board
PGA : with programmable gain amplifier in MCU
IPS : Inductive Position Sensor
ENC : Encoder
HALL : HALL sensor

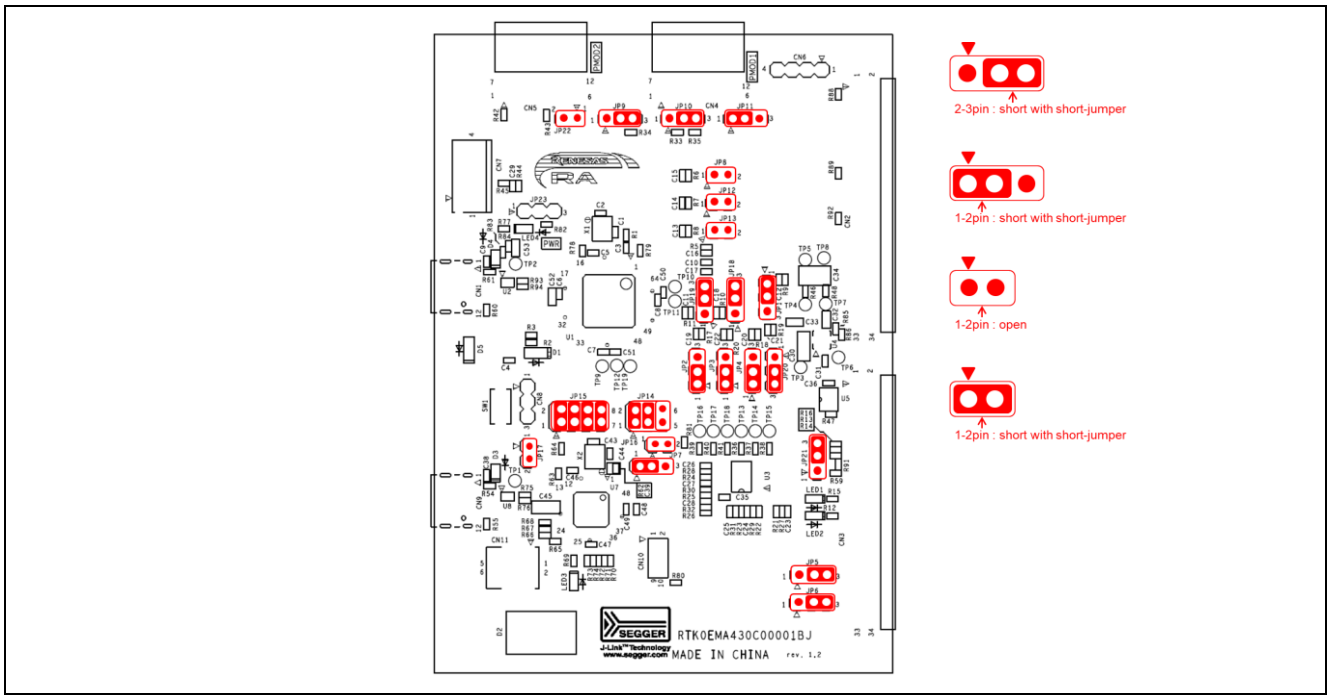


Figure 4-7 Default jumper pin setting of CPU board (Version 2)

4.6 Hardware Setup

4.6.1 Board Connection

Figure 4-8 and Figure 4-9 show connection examples when using this product with the inverter board kit (product name : MCI-LV-1, model name : RTK0EM0000S04020BJ). To prevent damage to the PC, isolate the PC and CPU board either by using a USB isolator as shown inFigure 4-8 , or by using a communication board kit (Product Name: MC-COM, Model Name: RTK0EMXC90S00000BJ) as shown in Figure 4-9. Also, when writing programs to the CPU board, connect as shown in Figure 4-10. 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 4-8 and Figure 4-9, the power is supplied from the AC adapter.

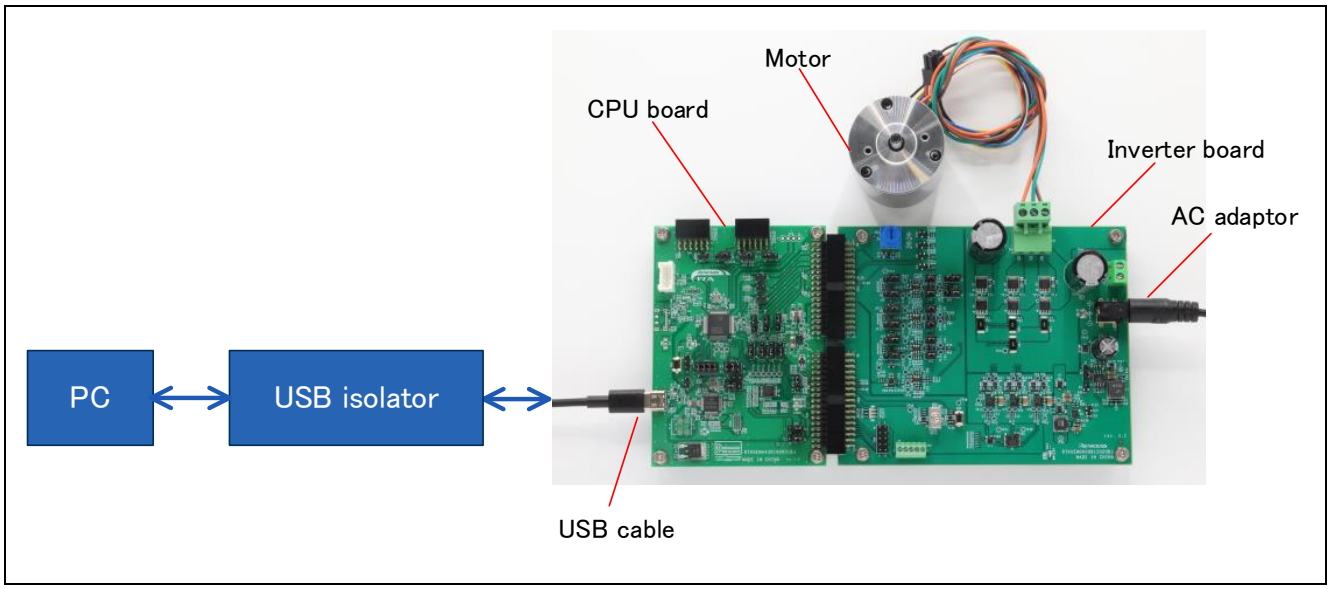


Figure 4-8 Board connection (using VCOM port)

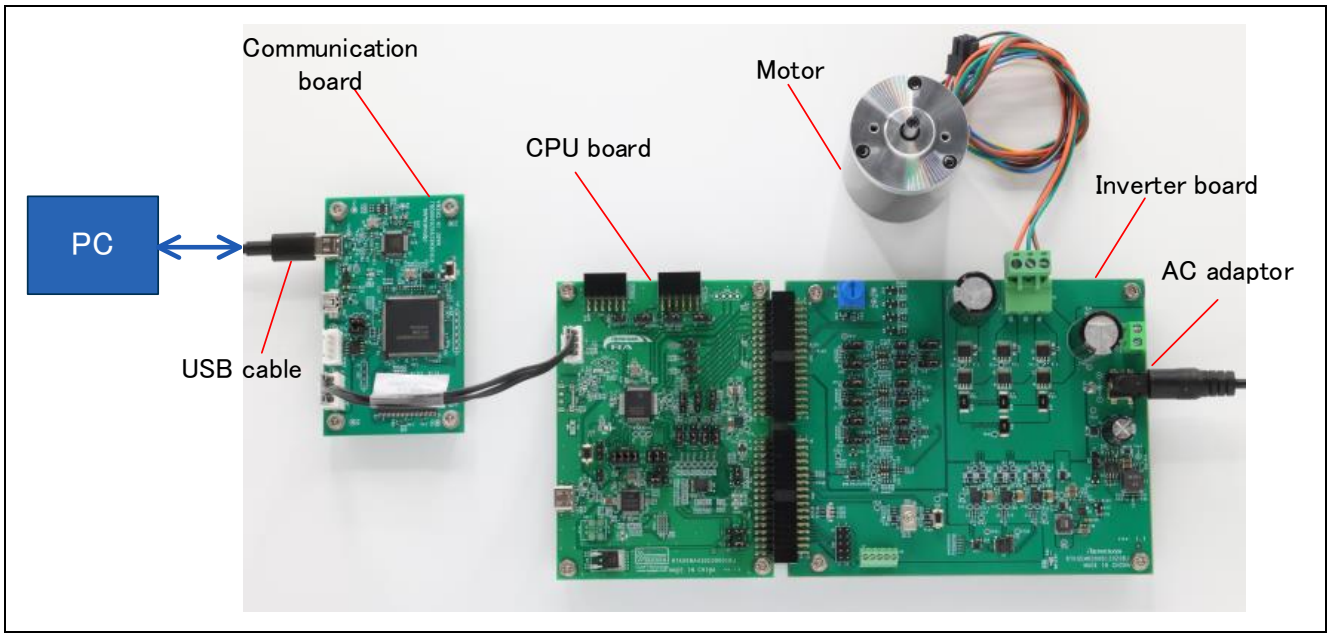


Figure 4-9 Board connection (using communication board)

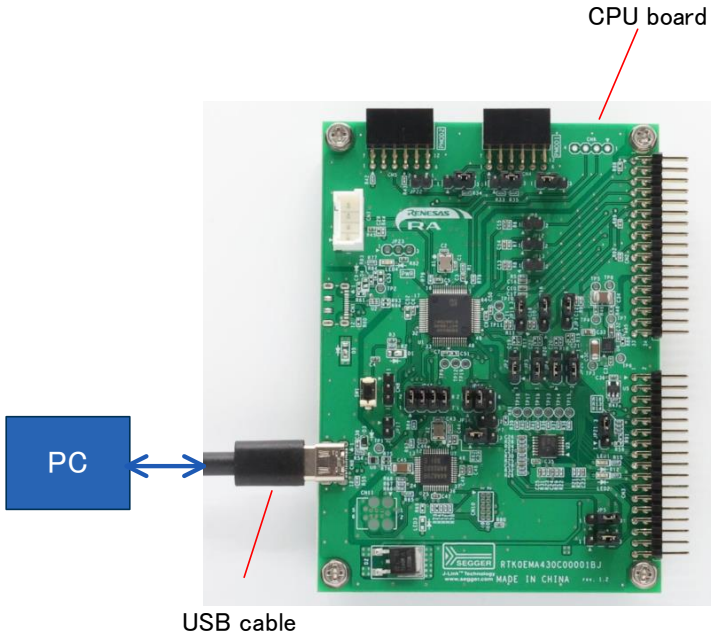


Figure 4-10 Board connection (CPU board only)

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.

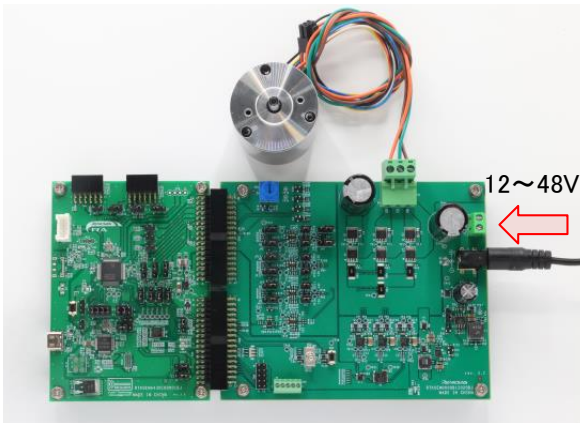


Figure 4-11 Power supply from DC jack

(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.

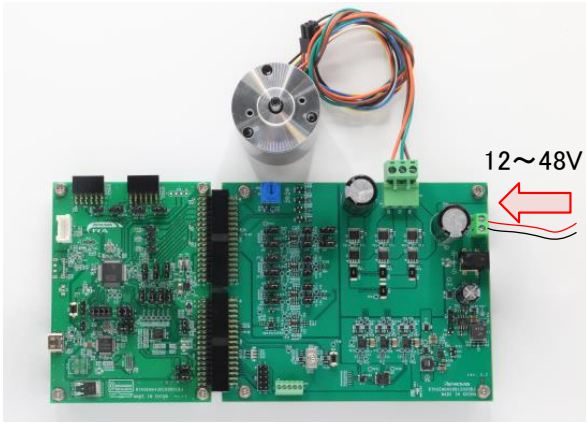


Figure 4-12 Power supply from terminal block

(3) From USB connector

5V power is supplied from the USB connector on the CPU board. To provide sufficient power for motor operation, use a USB isolator and USB adapter capable of supplying at least 1A, as shown in Figure 4-13, Figure 4-14. For the connection shown in Figure 4-10, the board can be connected directly to a PC.

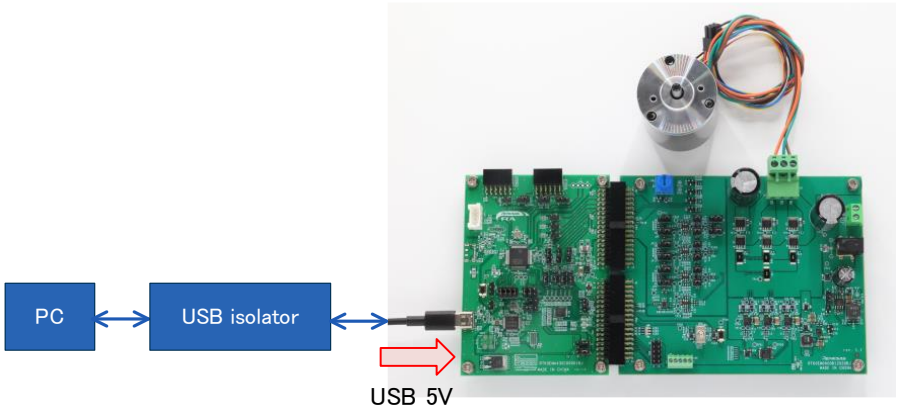


Figure 4-13 Power supply from USB connector (when using VCOM port)

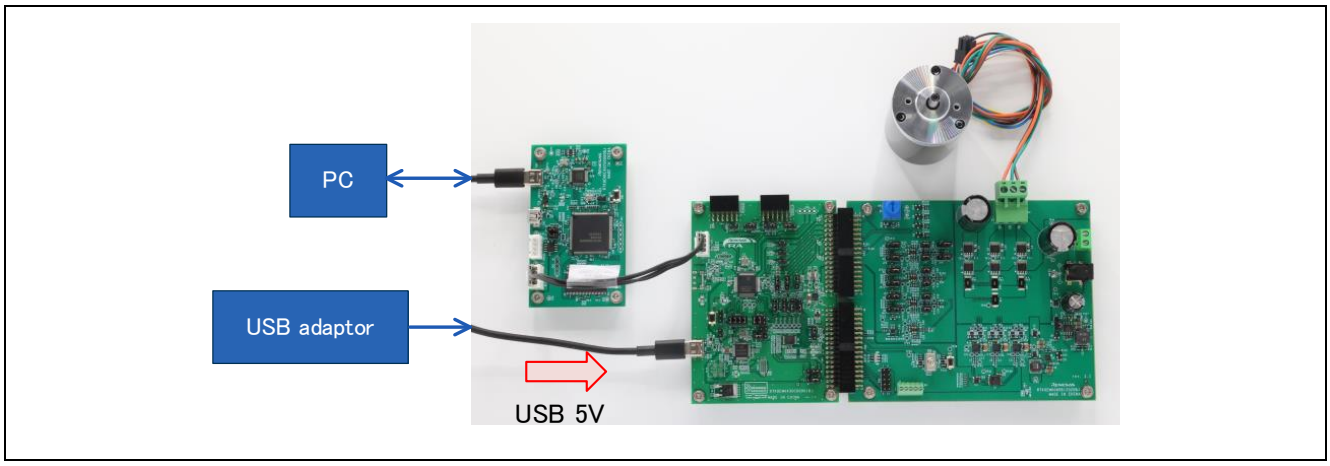


Figure 4-14 Power supply from USB connector (when using communication board)

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 4-7 for the power supply conditions and each voltage generation.

Table 4-7 Power supply and driving voltage generation

			Case 1	Case 2	Case 3
Power supply condition	CPU board	USB 5V	✓	-	✓
	Inverter board	External power (12~48V)	-	✓	✓
Power source for	CPU board	I/O (VCC, AVCC, 3.3V)	[A]	[B]	[A]
		BUS (5V)	[A]	[B]	[A]
	Inverter board	I/O (VCC, AVCC, 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

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 and 5.1.4 for the current sensing and 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.
If the gate drive PWM signals output from the MCU enter a high-impedance (Hi-Z) state, such as during reset or low-voltage conditions, all gate driver outputs become LOW, and all MOSFETs remain in the OFF state.

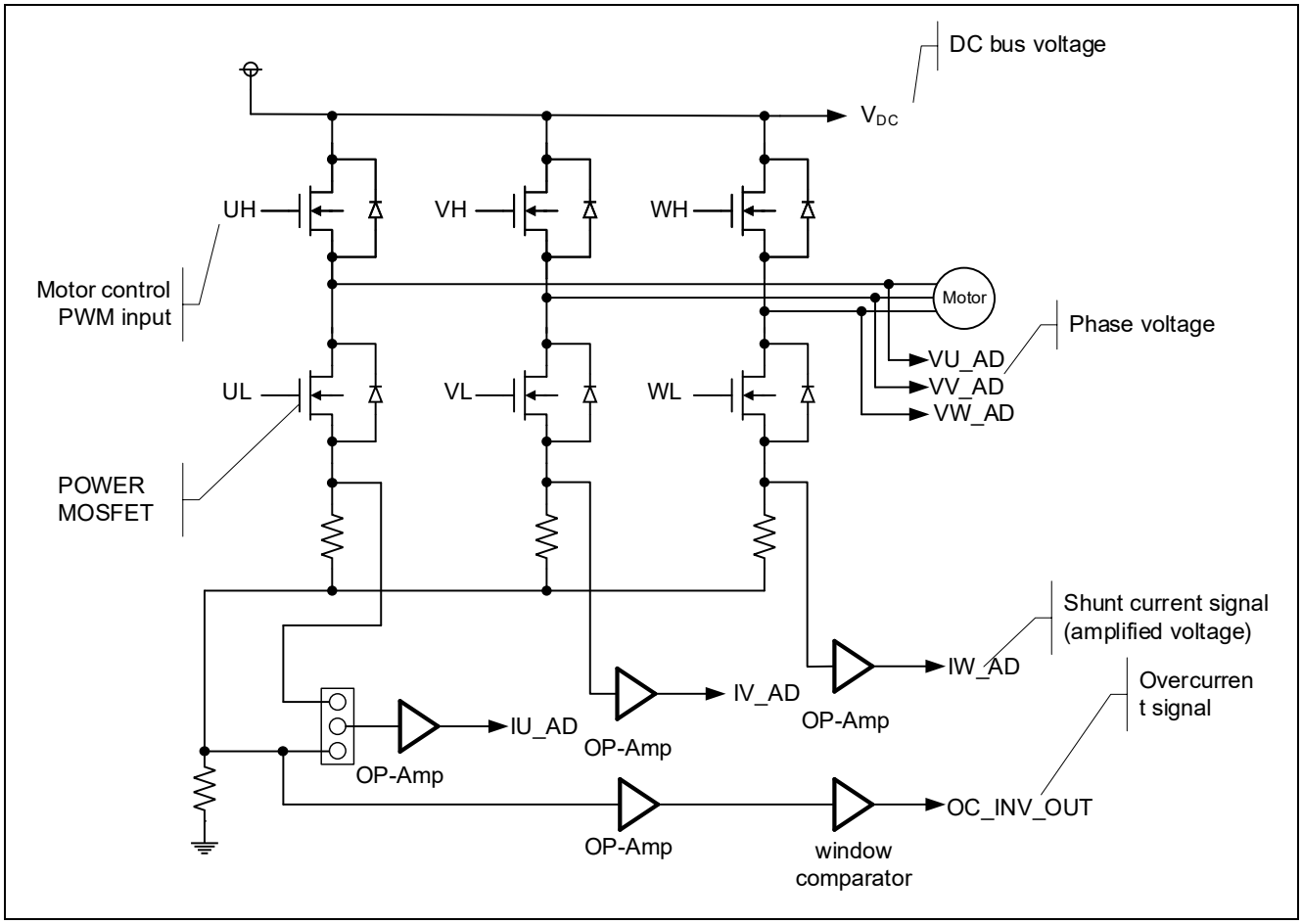


Figure 5-1 Illustration of inverter control circuit block

5.1.2 Current detection circuit

The inverter board has the current sensing circuit to measure the current at the U, V and W phase. The current sensing circuit uses shunt resistor at each phase. Voltage drop caused by the current flowing through the shunt resistor is amplified by the current sensing amplifier to output. The default gain of the current sensing 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 sensing circuit is shown in equations (1) and (2). In addition, by switching JP8 and JP11 to 2-3 pin short circuit, 1 shunt current sensing can be supported.

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

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

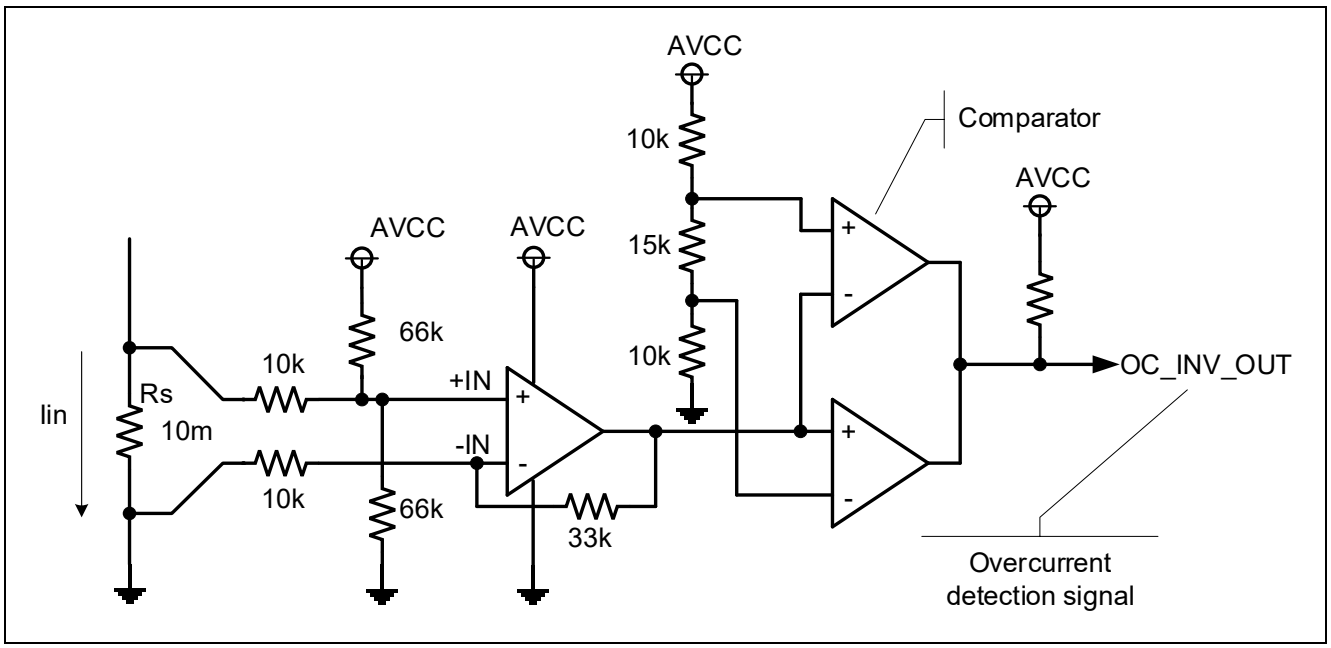


Figure 5-2 Current sensing circuit

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 10mΩ, the threshold current for over current detection is 21.4A for AVCC=3.3V

This circuit detects overcurrent and outputs a detection signal; however, it does not provide any protection function. Appropriate protection must be implemented by the MCU software.

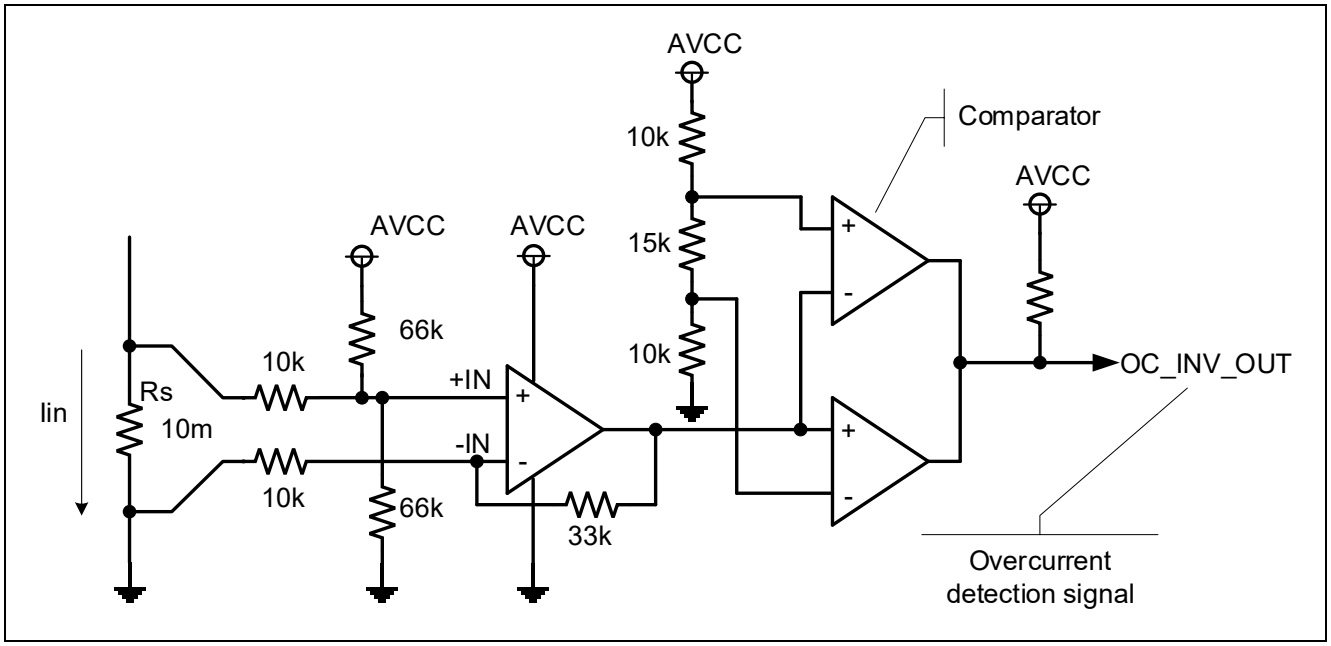


Figure 5-3 Overcurrent detection circuit

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 MCU 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).

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

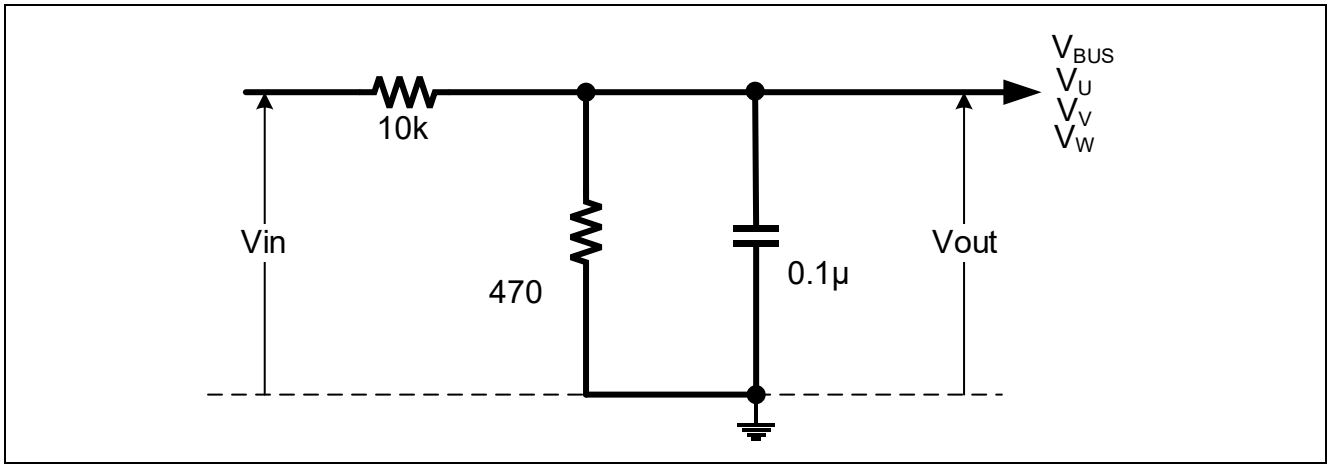


Figure 5-4 Output voltage detection circuit

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

5.1.9 Test points

The inverter board has several test points to monitor various signals. They are marked in Figure 5-5 and summarized in Table 5-5.

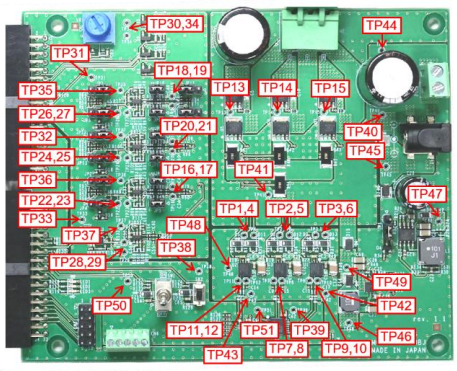


Figure 5-5 Test points

Table 5-5 Test points

No.	Signal name	Description
TP1	-	Gate of U-phase high-side MOSFET
TP2	-	Gate of V-phase high-side MOSFET
TP3	-	Gate of W-phase high-side MOSFET
TP4	-	Gate of U-phase low-side MOSFET
TP5	-	Gate of V-phase low-side MOSFET
TP6	-	Gate of W-phase low-side MOSFET
TP7	-	Gate driver input, V-phase, high-side
TP8	-	Gate driver input, V-phase, low-side
TP9	-	Gate driver input, W-phase, high-side
TP10	-	Gate driver input, W-phase, low-side
TP11	-	Gate driver input, U-phase, high-side
TP12	-	Gate driver input, U-phase, low-side
TP13	-	Motor output, U-phase
TP14	-	Motor output, V-phase
TP15	-	Motor output, W-phase
TP16	IWP	Current sensing, W-phase
TP17	IWN	Current sensing, W-phase
TP18	IUP	Current sensing, U-phase
TP19	IUN	Current sensing, U-phase
TP20	IVP	Current sensing, V-phase
TP21	IVN	Current sensing, V-phase
TP22	-	Current sensing amplifier output, W-phase
TP23	AGND	Analog Ground
TP24	-	Current sensing amplifier output, V-phase
TP25	AGND	Analog Ground
TP26	-	Current sensing amplifier output, U-phase
TP27	AGND	Analog Ground
TP28	-	Overcurrent detection amplifier output
TP29	AGND	Analog Ground
TP30~33	AVCC	Analog Power
TP34~37	AGND	Analog Ground
TP38,39	DGND	Digital Ground
TP40~43	GND	Power Ground
TP44,45	VDC	External power supply / bus voltage
TP46,47	+5V	+5V power supply
TP48,49	+12V	+12V power supply / gate driver operation voltage
TP50,51	VCC	Digital Power

5.2 Pin assignment

5.2.1 CPU board connector

Table 5-6 CPU board connector (CN3)

Pin No.	Output direction	Signal
1	-	SPARE1
2	-	AGND
3	To CPU	DC bus voltage detection
4	-	AGND
5	To CPU	U-phase current sensing
6	To CPU	U-phase current sensing (PGAVSS)
7	To CPU	V-phase current sensing
8	To CPU	V-phase current sensing (PGAVSS)
9	To CPU	W-phase current sensing
10	To CPU	W-phase current sensing (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 UL
28	-	DGND
29	To INV	PWM UH
30	-	DGND
31	To INV	PWM VL
32	-	DGND
33	To INV	PWM VH
34	-	DGND

Table 5-7 CPU board connector (CN4)

Pin No.	Output direction	Signal
1	To INV	PWM WL
2	-	DGND
3	To INV	PWM WH
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	Overcurrent 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	-	GND
32	-	GND
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 5-8.

Table 5-8 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 connector for encoder/inductive position sensor signal input. Pin assignment for them is listed in Table 5-9.

Table 5-9 Connector 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 (CN9). 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 RA4T1 with it. When you write a program, connect the CPU board to PC with USB cable. J-Link-OB operates as debugger equivalent to J-Link. If connecting from Integrated Development Environment or flash programming tool (e.g. J-Flash Lite by SEGGER), set the type of debugger (tool) to “J-Link”.

6.1.3 J-Link Virtual COM Port

This product supports J-Link Virtual COM Port. To enable this function, short 1-2, 3-4, 5-6, and 7-8 pins of JP15. By connecting to a PC with USB connector (CN9), a virtual COM port via USB is available.

6.1.4 Inverter board connector

An inverter board can be connected to this board with CN2 and CN3. The pin assignments of the connectors are shown in Table 6-1~Table 6-4. Note that these tables show default connection setting for the ports with jumper switches.

(1) The pin assignments (CN2 to CN3) for Version 1 (RTK0EMA430C00000BJ) are shown below

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

Pin No.	Pin Function	RA4T1 Pin	Pin No.	Pin Function	RA4T1 Pin
1	NC	-	2	AGND	- (AVSS)
3	VPN	P004/AN004	4	AGND	- (AVSS)
5	IU	P000/AN000	6	PGAVSS	P003/PGAVSS000
7	IV	P001/AN001	8	NC	-
9	IW	P002/AN002	10	NC	-
11	VU	P500/AN016	12	VV	P014/AN012
13	VW	P013/AN011	14	AGND	- (AVSS)
15	NC	-	16	NC	-
17	VR	P005/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	P408/GTIOC1B_B	28	GND	- (VSS)
29	UP	P409/GTIOC1A_B	30	GND	- (VSS)
31	VN	P102/GTIOC2B_A	32	GND	- (VSS)
33	VP	P103/GTIOC2A_A	34	GND	- (VSS)

Table 6-2 Inverter board connector (CN3) pin assignment (Version 1)

Pin No.	Pin Function	RA4T1 Pin	Pin No.	Pin Function	RA4T1 Pin
1	WN	P112/GTIOC3B_A	2	GND	- (VSS)
3	WP	P111/GTIOC3A_A	4	GND	- (VSS)
5	DRV_SCK	P302/RSPCKA_A	6	DRV_RXD	P207/MOSIA_A
7	DRV_TXD	P206/MISOA_A	8	DRV_CS	P301/SSLA0_A
9	BUS_POWER_IN	-	10	INV_CONNECTED	-
11	SAFE_LOCK	-	12	OCINV	P104/GTETRGB_B
13	DRV_nFault	P400	14	DRV_EN	P403
15	CON_MOT_SEL	P407	16	SW1	P304
17	SW2	P200	18	LED1	P113
19	LED2	P106	20	NC	-
21	HALL_U	P008/IRQ12DS	22	HALL_V	P006/IRQ11_DS
23	HALL_W	P015/IRQ13_A	24	SIO_SDA	P206/SDA0_C
25	SCK_SCL	P205/SCL0_C	26	CSN_IRQN/ENC_Z	P105/GTETRGA_C
27	IPS_A ENC_A	P500/AN016 P101/GTIOC5A_D	28	IPS_A#	P008/AN008
29	IPS_B ENC_B	P006/AN006 P100/GTIOC5B_D	30	IPS_B#	P015/AN013
31	GND	- (VSS)	32	GND	- (VSS)
33	+5V	-	34	+5V	-

(2) The pin assignments (CN2 to CN3) for Version 2 (RTK0EMA430C00001BJ) are shown below

Table 6-3 Inverter board connector (CN2) pin assignment (Version 2)

Pin No.	Pin Function	RA4T1 Pin	Pin No.	Pin Function	RA4T1 Pin
1	Temperature	P500/AN016(*)	2	AGND	- (AVSS)
3	VPN	P004/AN004	4	AGND	- (AVSS)
5	IU	P000/AN000	6	PGAVSS	P003/PGAVSS000
7	IV	P001/AN001	8	NC	-
9	IW	P002/AN002	10	NC	-
11	VU	P500/AN016	12	VV	P014/AN012(*)
13	VW	P013/AN011(*)	14	AGND	- (AVSS)
15	VAC	P013/AN011	16	IPFC1	P014/AN012
17	VR/IPFC2	P005/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	P408/GTIOC1B	28	GND	- (VSS)
29	UP	P409/GTIOC1A	30	GND	- (VSS)
31	VN	P102/GTIOC2B	32	GND	- (VSS)
33	VP	P103/GTIOC2A	34	GND	- (VSS)

(*) Exclusively assigned by jumper pin and jumper register setting

Table 6-4 Inverter board connector (CN3) pin assignment (Version 2)

Pin No.	Pin Function	RA4T1 Pin	Pin No.	Pin Function	RA4T1 Pin
1	WN	P112/GTIOC3B	2	GND	- (VSS)
3	WP	P111/GTIOC3A	4	GND	- (VSS)
5	DRV_SCK	P302/RSPCKA_A	6	PFCPWM2/ DRV_RXD	P301/GTIOC4B P207/MOSIA_A(*)
7	DRV_TXD	P206/MISOA_A	8	DRV_CS	P301/SSLA0_A
9	BUS_POWER_IN	-	10	INV_CONNECTED	-
11	SAFE_LOCK	-	12	OCINV	P104/GTETRGB
13	OCPFC/ DRV_nFault	P400/IRQ0	14	PFCPWM1/ DRV_EN	P302/GTIOC4A P403/IRQ14-DS(*)
15	CON_MOT_SEL	P407	16	SW1	P304
17	SW2	P200	18	LED1	P113
19	LED2	P106	20	NC	-
21	HALL_U	P008/IRQ12-DS	22	HALL_V	P006/IRQ11-DS
23	HALL_W	P015/IRQ13	24	SIO_SDA	P206/SDA0_C
25	SCK_SCL	P205/SCL0_C	26	CSN_IRQN/ENC_Z	P105/GTETRGA
27	IPS_A ENC_A	P500/AN016 P101/GTIOC5A	28	IPS_A#	P008/AN008
29	IPS_B ENC_B	P006/AN006 P100/GTIOC5B	30	IPS_B#	P015/AN013
31	GND	- (VSS)	32	GND	- (VSS)
33	+5V	-	34	+5V	-

(*) Exclusively assigned by jumper pin and 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 6-5.

Table 6-5 SCI connector pin assignment (CN7)

Pin No.	Pin Function	RA4T1 Connection Pin
1	GND	-
2	MCU RXD	P410/RXD0
3	MCU TXD	P411/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 reset 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 6-6.

Table 6-6 LED pin assignment

RA4T1 port		LED1	LED2
P113	Output HIGH	OFF	-
	Output LOW	ON	-
P106	Output HIGH	-	OFF
	Output LOW	-	ON

6.1.8 CAN Communication

This product has through holes for CAN communication. Note that CAN driver is not equipped. Pin assignment for CAN communication connector is listed in Table 6-7.

Table 6-7 CAN communication pin assignment (CN6)

Pin No.	RA4T1 Connection Pin
1	VCC
2	P401/CTX0
3	P402/CRX0
4	VSS

6.1.9 Pmod

This product has two connectors for Pmod module connection. Pin assignments are shown in Table 6-8 and Table 6-10. CN4 is for both Pmod Type 2A/6A. Type 2A/6A can be switched by JP9,10 and 11. The signals connected to terminals 1 to 4 of CN5 are shared between Pmod Type 3A and VCOM. Type 3A/VCOM can be switched by JP15. See Table 6-9 for settings.

Table 6-8 Pmod Type 2A/6A connector pin assignment (CN4)

No.	RA4T1 port	No.	RA4T1 port
1	P301_SSLA0_A/ P110_IRQ3	7	P400
2	P207_MOSIA_A	8	P403
3	P206_MISOA_A/ P205_SCL0_C	9	P407
4	P302_RSPCKA_A/ P206_SDA0_C	10	P208
5	VSS	11	VSS
6	VCC	12	VCC

Table 6-9 Pmod Type 2A/6A/3A connector jumper setting (JP9,JP10,JP11,JP15)

JP No	RA4T1 port		
	Open	1-2 short	2-3 short
9	N/A	Type2A	Type6A
10	N/A	Type2A	Type6A
11	N/A	Type6A	Type2A
15	Type3A	VCOM port (1-2, 3-4, 5-6, 7-8 short)	N/A

Table 6-10 Pmod Type 3A connector pin assignment (CN5)

No.	RA4T1 port	No.	RA4T1 port
1	P303_CTS9	7	P400
2	P109_TXD9	8	P403
3	P110_RXD9	9	P407
4	P301_CTS_RTS9	10	P208
5	VSS	11	VSS
6	VCC	12	VCC

6.1.10 Arm debugger

This product has through holes for Arm debugger. Pin assignment for Arm debugger connector is listed in Table 6-11.

Table 6-11 Arm debugger connector pin assignment (CN10)

Pin No.	RA4T1 port	Pin No.	RA4T1 port
1	VCC	2	P108/SWDIO
3	VSS	4	P300/SWCLK, P201/MD
5	VSS	6	-
7	-	8	-
9	VSS	10	RES

6.1.11 Test points

The CPU board has several test points to monitor various signals. They are marked in Figure 6-1 and summarized in Table 6-12.

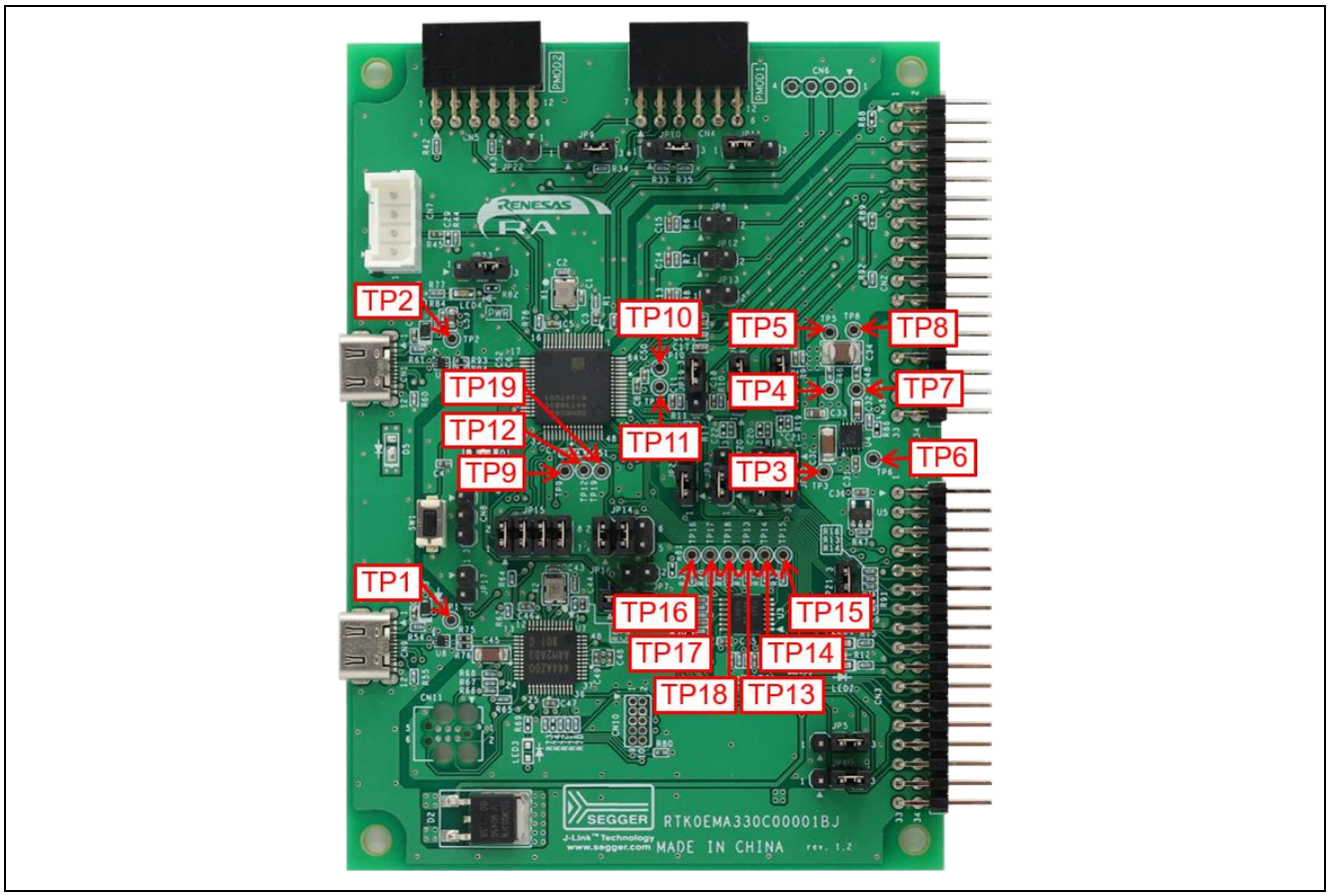


Figure 6-1 Test points

Table 6-12 Test points

No.	Signal name	Description
TP1	+5V_USB2	USB Power (J-Link-OB)
TP2	+5V_USB1	USB Power (MCU)
TP3	+5V	+5V Power
TP4	VCC	Digital Power
TP5	AVCC	Analog Power
TP6	GND	+5VGND
TP7	GND	Digital GND
TP8	AGND	Analog GND
TP9	VCC	Digital Power
TP10	AVCC	Analog Power
TP11	AGND	Analog GND
TP12	VSS	Digital GND
TP13	P008/IRQ12/HU	P008/IRQ12/HU
TP14	P006/IRQ11/HV	P006/IRQ11/HV
TP15	P015/IRQ13/HW	P015/IRQ13/HW
TP16	P101/GTIOC5A/ENCA	P101/GTIOC5A/ENCA
TP17	P100/GTIOC5B/ENCB	P100/GTIOC5B/ENCB
TP18	P105/GTETRGA/ENCZ	P105/GTETRGA/ENCZ
TP19	P107/GPIO	P107/GPIO

6.1.12 Pin function list

Table 6-13 RA4T1 pin function list

Pin number	Pin function	Board function
1	P400 / (IRQ0_A)	Pmod / OCPFC
2	CTX0_B	CAN
3	CRX0_B	CAN
4	P403 / (IRQ14DS)	Pmod
5	VCL	VCL
6	XCIN	-
7	XCOUT	-
8	VSS	VSS
9	XTAL	Crystal
10	EXTAL	Crystal
11	VCC	VCC
12	TXD0_B	RMW communication
13	RXD0_B	RMW communication
14	GTIOC1A_B	PWM_UP
15	GTIOC1B_B	PWM_UN
16	P407	Pmod
17	VSS_USB	VSS_USB
18	USB_DM	USB
19	USB_DP	USB
20	VCC_USB	VCC_USB
21	MOSIA_A	Pmod Type2A(SPI)
22	MISOA_A / (SDA0_C)	Pmod Type2A(SPI) / (Pmod Type6A(I2C))
23	SCL0_C	Pmod Type6A(I2C)
24	P208	Pmod
25	RES#	ARM debugger
26	MD	ARM debugger
27	P200	SW2
28	P304	SW1
29	CTS9_D	Pmod Type3A(UART)
30	RSPCKA_A	Pmod Type2A(SPI) / (PFCPWM1)
31	SSLA0_A / (CTS_RTS9_D)	Pmod Type2A(SPI) / (Pmod Type3A(UART)) / (PFCPWM2)
32	SWCLK	ARM debugger
33	SWDIO	ARM debugger
34	TXD9_B	Pmod Type3A(UART)
35	RXD9_B / (IRQ3_A)	Pmod Type3A(UART) / (Pmod Type6A(I2C))
36	GTIOC3A_A	PWM_WP
37	GTIOC3B_A	PWM_WN
38	P113	LED1
39	VCC	VCC
40	VSS	VSS
41	P107	TP19
42	P106	LED2
43	GTETRGA_C / (IRQ0_B)	Encoder Z-phase
44	GTETRGB_B	OCINV / OCPFC
45	GTIOC2A_A	PWM_VP
46	GTIOC2B_A	PWM_VN
47	GTIOC5A_D	Encoder A-phase
48	GTIOC5B_D	Encoder B-phase
49	AN016	U-phase voltage sensing / IPS_A / (Temperature)
50	IRQ12DS / (AN008)	HALL sensor U-phase / (IPS_A#)
51	IRQ11DS / (AN006)	HALL sensor V-phase / (IPS_B)
52	IRQ13_A / (AN013)	HALL sensor W-phase / (IPS_B#)
53	AN012	V-phase voltage sensing / (IPFC1)
54	AN011	W-phase voltage sensing / (VAC)
55	PGAVSS000	PGAGND for current sensing
56	AVCC0	AVCC0
57	AVSS0	AVSS0

Pin number	Pin function	Board function
58	VREFL0	VREFL0
59	VREFH0	VREFH0
60	AN005	VR input / IPFC2
61	AN004	Bus voltage sensing
62	AN002	W phase current sensing
63	AN001	V phase current sensing
64	AN000	U phase current sensing

Note: Jumper switching is required to use the functions in parentheses.

7. Regulatory information

This product meets the following standards. See “General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products” of this Evaluation Kit Manual for the precautions.

7.1 EMC Directive

This product is herewith confirmed to comply with the requirements set out in the Council Directives on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility Directive 2014/30/EU.

This product is in conformity with the following relevant UK Statutory Instrument(s) (and its amendments): 2016 No. 1091 Electromagnetic Compatibility Regulations 2016.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct this interference.

7.2 Material Selection, Waste, Recycling and Disposal Standards

- China SJ/T 11364-2014, 10-year environmental protection use period.
- WEEE Directive (2012/19/EU) & The Waste Electrical and Electronic Equipment Regulations 2013



The WEEE (Waste Electrical and Electronic Equipment) regulations put responsibilities on producers for the collection and recycling or disposal of electrical and electronic waste. Return of WEEE under these regulations is applicable in the UK and European Union.

This product (including all accessories) is not intended for household use. After use the product cannot be disposed of as household waste, and the WEEE must be treated, recycled and disposed of in an environmentally sound manner.

Renesas Electronics Europe GmbH can take back end of life product. Register for this service at; https://www.renesas.com/form/weee-questionnaire

8. Design and Manufacture Information

The design resources for the MCK-RA4T1 (schematics, PCB layout data, BOM, etc.) and software development tools (Renesas Motor Workbench, QE for Motor, sample code, application note, etc.) are available for download from the following website: renesas.com/mck-ra4t1

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

・RA Product Support Forum renesas.com/ra/forum

・Renesas Support renesas.com/support

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	May 23, 2023	-	First edition
1.10	December 23, 2023	7, 20	Corrected overcurrent threshold (21.4A for AVCC=3.3V, 32.4A for AVCC=5.0V)
1.20	March 1, 2026	-	Support MCK-RA4T1 Version 2

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