User's Manual

RA4T1 Group

MCB-RA4T1 User's Manual

Renesas RA Family
RA4 Series

Renesas Electronics
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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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Renesas RA Family

MCB-RA4T1 User's Manual

Contents

Figure of contents

Table of contents

1. Overview

MCB-RA4T1 is a CPU board for motor control evaluation. By using this product in combination with an inverter board, motor control using RA4T1 can be easily performed.

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 e2 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.

2. Product Contents

This kit consists of the following parts.

1. CPU Board (RTK0EMA430C00000BJ) x1
2. USB Cable x1
3. Screw x4
4. Standoff x4

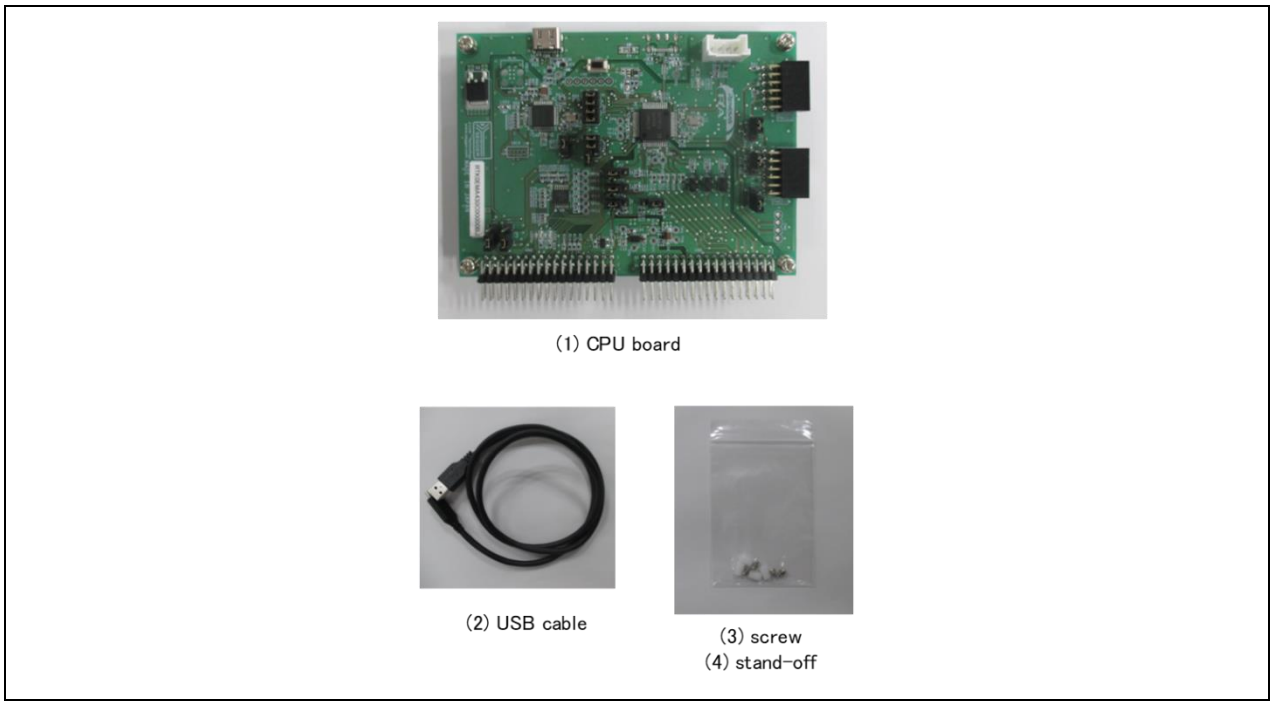

Figure 2-1 Product contents

3. Product Order Information

Product number to order MCB-RA4T1 : RTK0EMA430C00000BJ

4. Hardware Configuration and Default Setting

4.1 Hardware configuration

The specifications of the CPU board are shown below.

Table 4-1 CPU board specification

item		Specification
Product name		CPU Board
Board part No.		RTK0EMA430C00000BJ
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	32 bit
	Package / Pin count	LFQFP / 64 pin
	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-OB (Onboard debugger circuit)
Connector		• Inverter board connector • USB connector for J-Link OB • 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
Board size		85 mm (W) x 109 mm (L)
Operating temperature		Room temperature
Operating humidity		No condensation allowed
EMC Directive		EN61326-1:2021 EMI：Class A EMS：Basic Electromagnetic environment

4.2 Block diagram

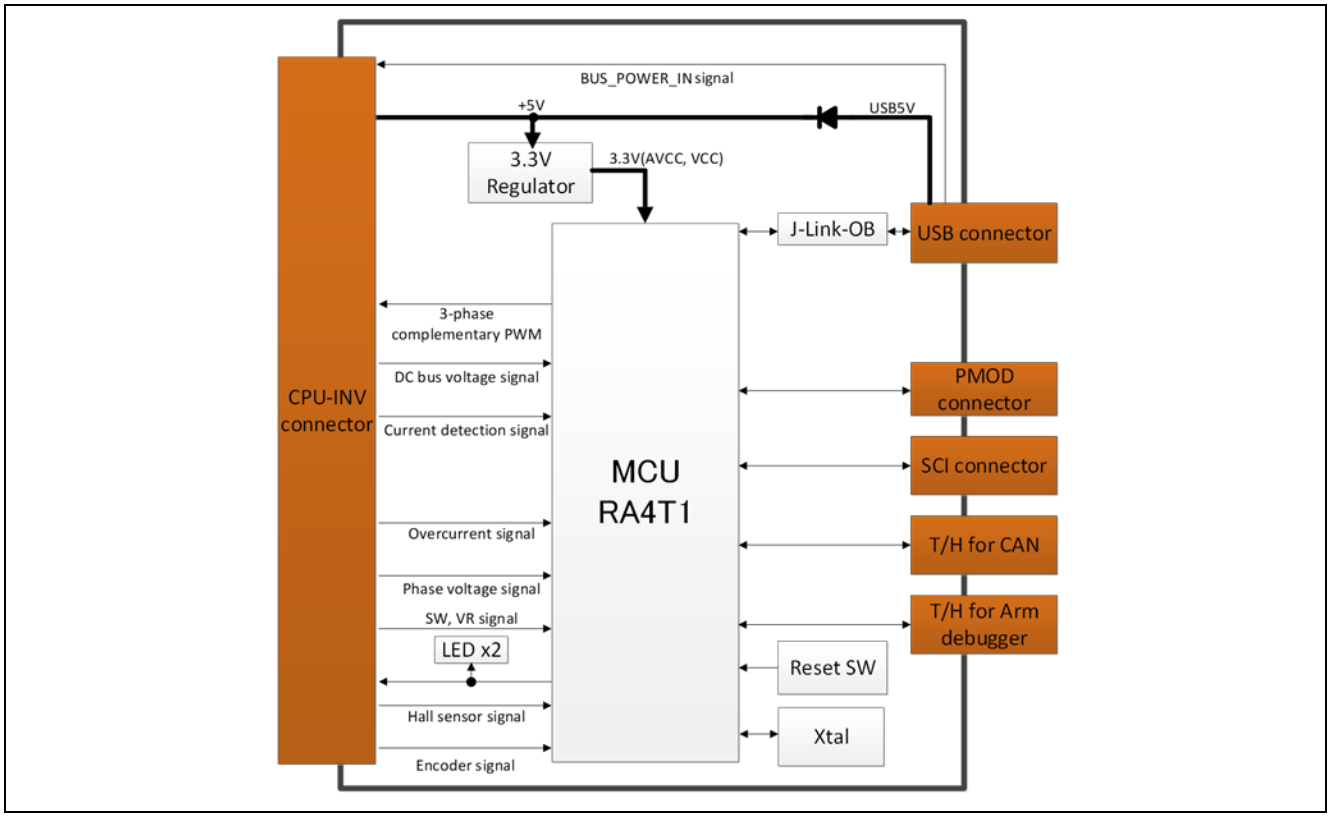

Figure 4-1 CPU board block diagram

4.3 Board Layout

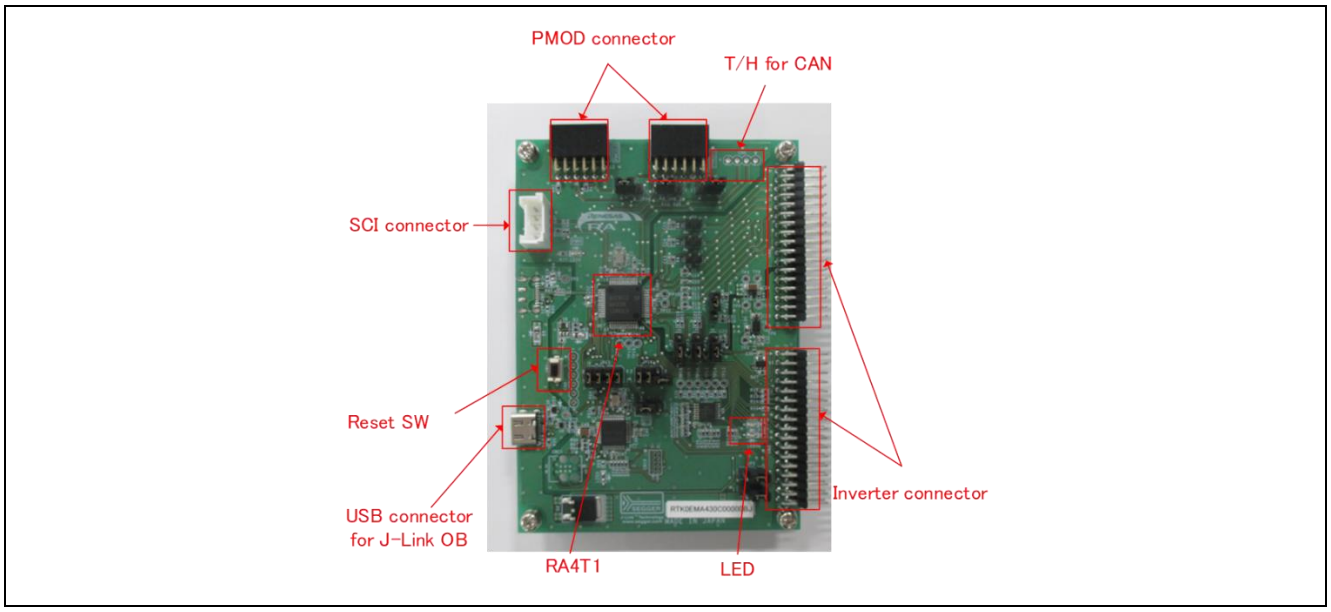

Figure 4-2 CPU Board Layout

4.4 Standoffs and Screws

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

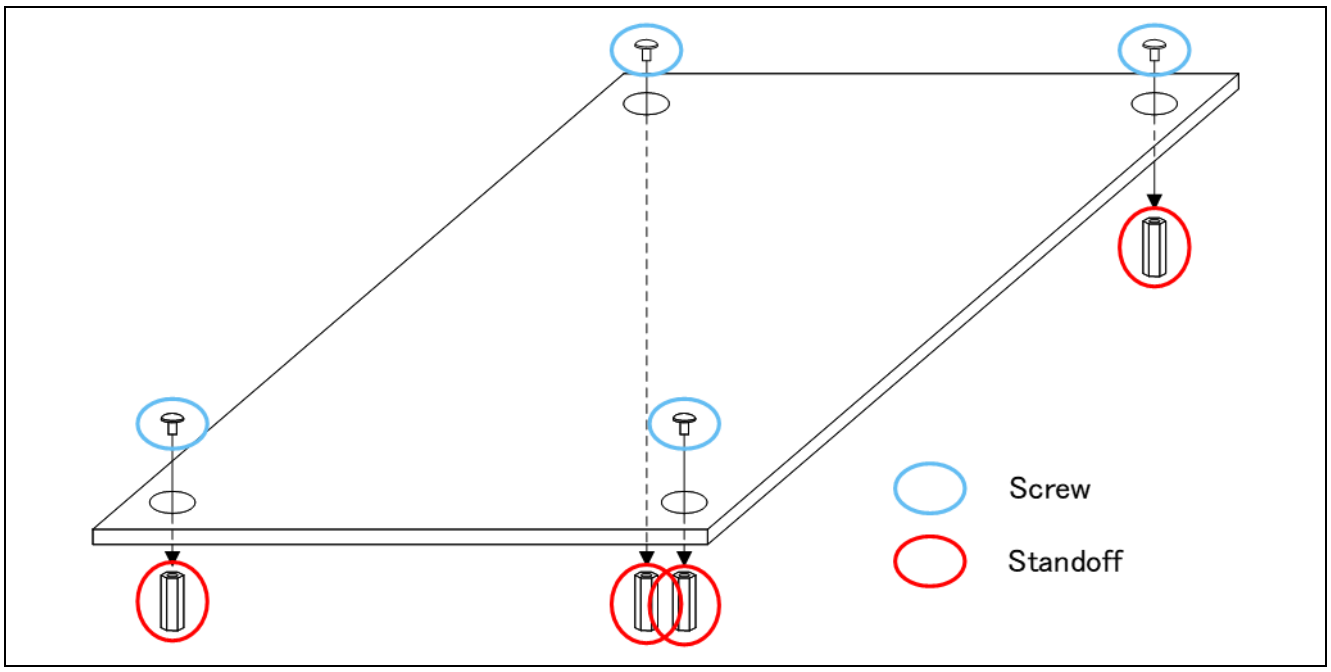

Figure 4-3 Standoffs and Screws assembly

4.5 Jumper pin setting

Default settings and functions of the jumper pins (JP1~JP17) are as follows.

Table 4-2 Jumper pin setting of CPU board

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 JLOB 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 JLOB	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

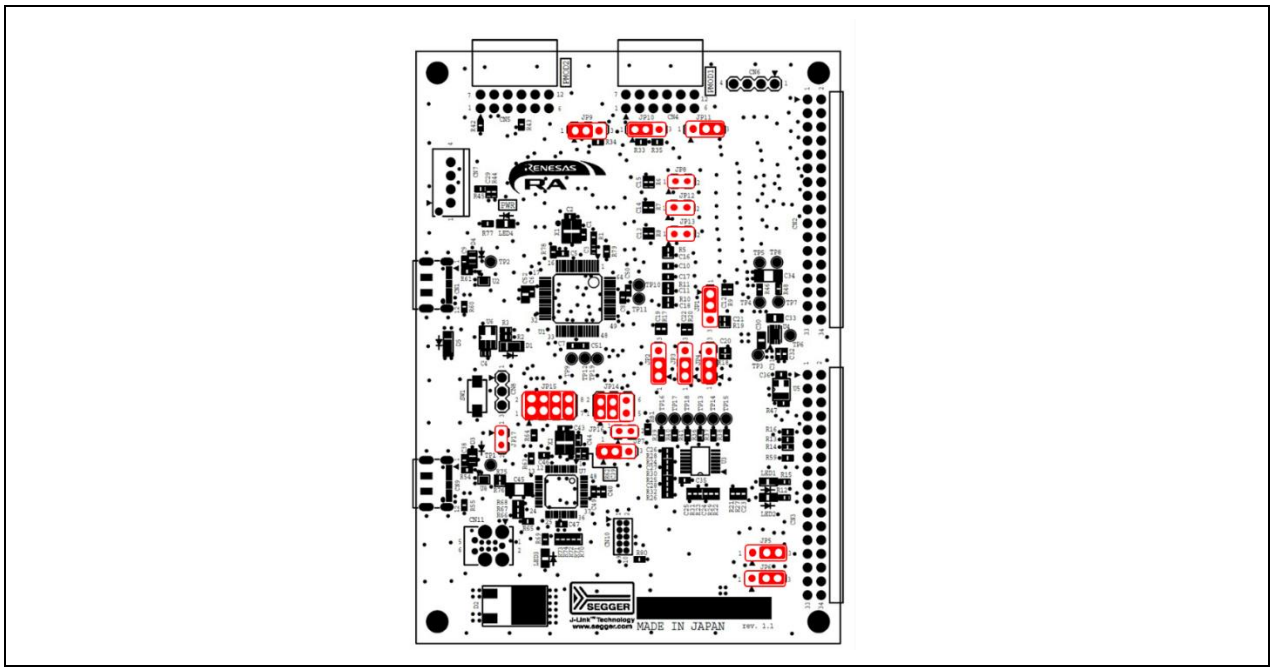

Figure 4-4 Default jumper pin setting of CPU board

4.6 Hardware Setup

4.6.1 Board Connection

Figure 4-5 and Figure 4-6 show connection examples when using this product with the inverter board kit (product name: MCI-LV-1, model name: RTK0EM0000S04020BJ). Note that if the communication board (product name: MC-COM, model name: RTK0EMXC90S00000BJ) is not used, be sure to make an isolated connection between the PC and CPU board via a USB isolator or similar device to prevent PC damage.

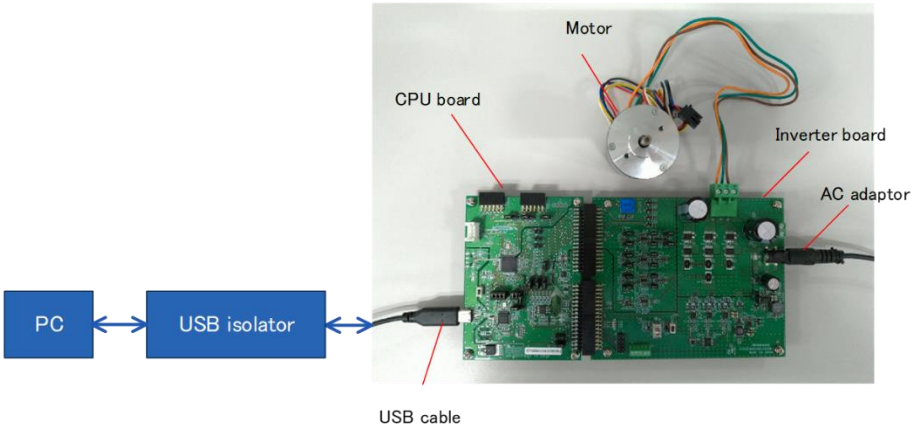

Figure 4-5 Board connection (using VCOM port)

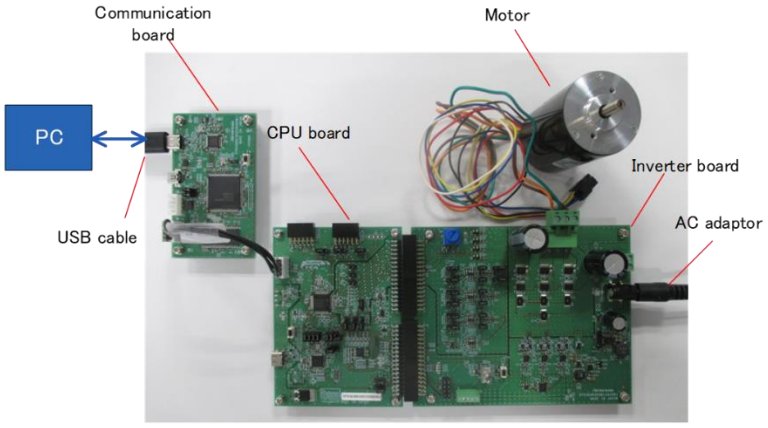

Figure 4-6 Board connection (using communication board)

5. CPU Board Specification

This section describes the specification of the CPU Board.

5.1 Functions

5.1.1 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.

5.1.2 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 programing tool (e.g. J-Flash Lite by SEGGER), set the type of debugger (tool) to “J-Link”.

5.1.3 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.

5.1.4 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 5-1, Table 5-2. Note that these tables show default connection setting for the ports with jumper switches.

Table 5-1 Inverter board connector (CN2) pin assignment

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	- (AGSS)	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 5-2 Inverter board connector (CN3) pin assignment

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	OC#	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	-

5.1.5 Serial communication

For serial communication using Renesas Motor Workbench, the CPU board has SCI connector. Pin assignment for SCI connector is listed in Table 5-3.

Table 5-3 SCI connector (CN7) pin assignment

Pin No.	Pin Function	RA4T1 Connection Pin
1	GND	-
2	MCU RXD	P410/RXD0_B
3	MCU TXD	P411/TXD0_B
4	VCC	-

5.1.6 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.

5.1.7 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 5-4.

Table 5-4 LED pin assignment

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

5.1.8 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 5-5.

Table 5-5 CAN communication pin assignment (CN6)

Pin No.	RA4T1 pin
1	VCC
2	P401/CTX0_B
3	P402/CRX0_B
4	VSS

5.1.9 PMOD

This product has two connectors for PMOD module connection. Pin assignments are shown in Table 5-6 and Table 5-8. CN4 is for both PMOD Type 2A/6A. Type 2A/6A can be switched by JP9,10 and 11. See Table 5-7 for settings.

Table 5-6 PMOD Type 2A/6A connector pin assignment (CN4)

No.	RA4T1 port	No.	RA4T1 port
1	P301_SSLA0/ P110_IRQ3_A	7	P400
2	P207_MOSIA	8	P403
3	P206_MISOA_A/ P205_SCL0	9	P407
4	P302_RSPCKA_A/ P206_SDA0_C	10	P208
5	VSS	11	VSS
6	VCC	12	VCC

Table 5-7 PMOD Type 2A/6A connector jumper setting (CN4)

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	PMOD	VCOM port (1-2, 3-4, 5-6, 7-8 short)	N/A

Table 5-8 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_RTS_D	10	P208
5	VSS	11	VSS
6	VCC	12	VCC

5.2 RA4T1 pin function list

Table 5-9 RA4T1 pin function list

Pin number	RA4T1 pin function	Signal function
1	P400 / (IRQ0_A)	PMOD
2	CTX0_B	CAN
3	CRX0_B	CAN
4	P403 / (IRQ14DS)	PMOD
5	VCL0	Power
6	-	-
7	-	-
8	VSS	GND
9	XTAL	Crystal
10	EXTAL	Crystal
11	VCC	Power
12	TXD0_B	RMW communication
13	RXD0_B	RMW communication
14	GTIOC1A_B	U-phase upper arm
15	GTIOC1B_B	U-phase lower arm
16	P407	PMOD
17	VSS_USB	Power
18	-	-
19	-	-
20	VCC_USB	Power
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)
31	SSLA0_A / (CTS_RTS9_D)	PMOD Type2A(SPI) / (PMOD Type3A(UART))
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	W-phase upper arm
37	GTIOC3B_A	W-phase lower arm
38	P113	LED1
39	VCC	Power
40	VSS	Power
41	P107	-
42	P106	LED2
43	GTETRGA_C / (IRQ0_B)	Encoder Z-phase
44	GTETRGB_B	Over current detection
45	GTIOC2A_A	V-phase upper arm
46	GTIOC2B_A	V-phase lower arm
47	GTIOC5A_D	Encoder A-phase
48	GTIOC5B_D	Encoder B-phase
49	AN016	U-phase voltage sensing / IPS_A
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
54	AN011	W-phase voltage sensing
55	PGAVSS000	PGAGND for current sensing
56	AVCC0	Power

Pin number	RA4T1 pin function	Signal function
57	AVSS0	Power
58	VREFL0	Power
59	VREFH0	Power
60	AN005	VR input
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.

6. Design and Manufacture Information

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

7. 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

Revision History	MCB-RA4T1 User's Manual

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