Evaluation System for BLDC Motor

User's Manual

For your safety

Be sure to read this manual before using the Evaluation System for BLDC Motor（RTK0EMX270S00020BJ）(hereafter, referred to as the Product)

- Follow the instructions in this manual when using the Product.
- Keep this manual near the Product so that you can refer to it whenever necessary.
- Transfer or resale of the Product to third parties is prohibited without written approval.
- The purchaser or importer of the Product shall ensure compliance with local regulations. In addition, the customer is responsible for ensuring that the Product is handled correctly and safely in accordance with the laws of the customer's country (region).
- The manual for the Product and specification (hereafter, referred to as the Documents) are the tool which was developed to evaluate function and performance of Renesas Electronics semiconductor device (hereafter, referred to as the Renesas Electronics device) which is mounted on the Product, and not guarantee the same quality, function and performance as our devices.
- By purchasing the Product or downloading the Documents from Renesas Electronics website, the support services provided from Renesas Electronics are not guaranteed.
- All information contained in this manual represents information on products at the time of publication of this manual. Please note that the product data, specification, sales offices, contents of website, address, etc., are subject to change by Renesas Electronics Corporation without notice due to product improvements or other reasons. Please confirm the latest information on Renesas Electronics website.

Meaning of Notations

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

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

⚠ Danger	Indicates content that, if not followed, could result in death or serious injury(*1) 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*2 to persons or physical damage.*3

Note 1. Serious injury refers to conditions resulting in persistent after-effects and for which treatment would necessitate hospitalization or regular hospital visits, due to injuries, such as loss of eyesight, burns (high- or low-temperature), electric shock, bone fracture, poisoning.

Note 2. Injury refers to conditions for which treatment would necessitate hospitalization or regular hospital visits.

Note 3. Physical damage refers to damage affecting the wider surroundings, such as the user's house or property.

■Requirements related to the handling of the Product are classified into the following categories.

・Marks indicating that an action is prohibited.

	General prohibition The indicated action is prohibited		（Example）Do not touch. Touching the specified part could result in injury.

・Marks indicating that an action requires caution.

	General caution Indicates general caution that is not specified.		（Example）High temperature Indicates the possibility of injury due to high temperature.

・Marks indicating that the specified action is required.

	General instruction The specified action is required.		（ Example ） Turn off (disconnect) power supply. Instructs the user to turn off (disconnect) the power supply to the product.

Warnings Regarding Use of the Product

■Danger Items

Danger	
  	・The Product should be used only by persons 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 (hereafter, referred to as Users). Limit users by carefully reading the Caution items described in this manual. ・Unlike typical equipment, the Product has no protective case to ensure safety, and it contains moving parts and high-temperature components that could be dangerous. Do not touch the evaluation board or cables while power is being supplied. ・Carefully check that there are no pieces of conductive materials or dust adhering to the board, connectors, and cables. ・There are moving parts, driven by a motor. 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.
	Do not connect load to motor. ・This could cause fire, burns, or injury.

■Warning Items

⚠ Warning	
	Caution-Rotating parts ・The system includes a motor. Touching the rotating shaft could cause high-temperature burns or injury.
	Insert plugs, connectors, and cables securely, and confirm that they are fully inserted. ・Incomplete connections could cause fire, burns, electric shock, or failures.
	Use the power supply apparatus specified in the manual. ・Failure to do so could cause fire, burns, electric shock, injury, or failures.
	Stop supplying power and unplug all cables when the Product is not used for a long period of time or moved. ・Failure to do so could cause heat, fire, burns, electric shock or failures. ・This will protect the system against damage due to lightning.
	Use the Product where a mechanism (switch, outlet, etc.) is within reach so that power supply is turned off (disconnected) immediately. ・If an abnormality occurs, it is necessary to cut off the power supply quickly.
	Stop supplying power immediately if you notice abnormal odor, smoke, abnormal sound, or overheating. ・Continuing to use the Product in an abnormal condition could cause fire, burns, or electric shock.
	Do not disassemble, modify, or repair the Product. ・Doing so could cause fire, burns, electric shock, injury, or fialures.
	Do not use the Product for any purpose other than initial evaluation of motor control in a testing room or laboratory. 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. ・Failure to observe the above could cause fire, electric shock, burns, or failures. ・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 turning on/off power to each system. ・Failure to do so could cause overheating or failures in devices.
	Caution – Static Electricity! Before using this product, wear an antistatic wrist strap. If you touch this product with a static charge on your body, it could cause device failures or unstable operation.
	Before using the Product, mount the ferrite core on each cable connecting inverter board and motor. Make sure to mount the ferrite core near the inverter board. ・Failure to do so could interfere with operation of other devices or cause failures.

Overview

The Evaluation System for BLDC Motor（RTK0EMX270S00020BJ）is a motor control evaluation kit.

This user's manual describes the proper handling of the Product.

Mounted devices

Gate driver:	HIP4086ABZT
MOSFET:	RJK1054DPB
Regulator:	ISL9001AIRNZ

Related documents

- INV-BRD
  - Circuit diagram: R12TU0072
  - Parts list：R12TU0073
  - PCB pattern Drawing：R12TU0074
- Related to Motor Control Development Support Tool "Renesas Motor Workbench"
  - User's manual：R21UZ0004

Package contents

Refer to the sheet "Included Items" which is included in the package.

Abbreviations

Abbreviations	Full Name	Remarks
Motor RSSK	Evaluation System for BLDC Motor	The Product Product No.： RTK0EMX270S00020BJ
INV-BRD	Inverter Board （Inverter Board）	Inverter board included in the Product Product No.： RTK0EM0000B10020BJ
Support Tool	Motor Control Development Support Tool "Renesas Motor Workbench V.x.xx "	Manufactured by Renesas Electronics ※ V.x.xx means release version.

Contents

1. Features

(1) Supports permanent magnet synchronous motors

(2) Supports 3-shunt current detection

(3) Equipped with USB mini B for Support Tool communication

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

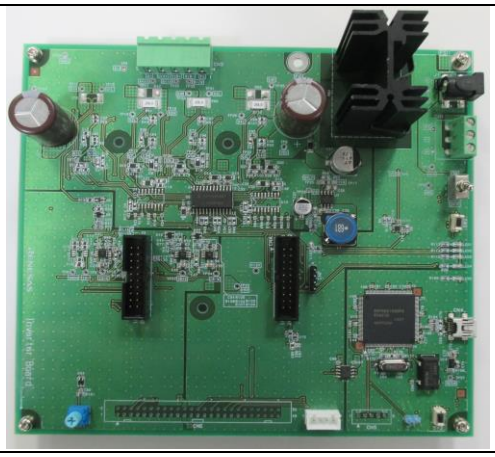
2. Specifications

2.1 Specification

Table 2-1 Evaluation System for BLDC Motor Specification Table（1/2）

Item	Specification	
Kit specification		
Series	Evaluation System for BLDC Motor	
Kit product No.	RTK0EMX270S00020BJ	
Kit configuration	Inverter board	RTK0EM0000B10020BJ
	Permanent magnet synchronous motor	TG-55L-KA（Manufactured by Tsukasa Electric Co., Ltd.） Rated voltage：24[V] Rated current：0.42[A]
Inverter circuit and CPU card	Non-insulated	
External view	 Note : CPU Card is not included in this product.	
Operating temperature	Room temperature	
Operating Humidity	No condensation	
EMC standard	Europe：EN61326-1：2013 Class A	

Table 2-2 Evaluation System for BLDC Motor Specification Table（2/2）

Item	Specification
Inverter board specification	
Product name	Inverter Board
Board product No.	RTK0EM0000B10020BJ
Exterior view	
Operating input voltage	DC 24～48 V （±5%） Select one from the below. ・ Power connector ・ Center-positive DC jack
Maximum input power	250 W
Rated output capacity	250 VA
Rated output current	AC 5 A （RMS value）
Switching frequency	2 kHz ~ 20 kHz（Reference value）
Current detection method	3-shunt method
Shunt resistor	10mΩ
PWM logic	Lower arm: Positive logic Upper arm: Negative logic
DC bus voltage detection （bus voltage detection）	Detection by resistance division（5 V ~ 48 V）
3-phase output voltage detection	Detection by resistance division（0 V ~ 48 V）
3-phase output current detection	MOSFET Detection using shunt resistor under the source（-10 A ~ +10 A）
Overcurrent detection function	10 A
Communication interface	USB mini B ※Communicating with PC requires "Support Tool" by Renesas Electronics.
Connector	・ CPU card connector x2 ・ USB mini B connector ・ Power input connector ・ Motor connector
Switch	・ Toggle switch x1 ・ Push switch x1
LED	・ LED x3 ・ LED for power source for inverter control circuit block

2.2 Information regarding regulation

2.2.1 European Union regulatory notices

This product complies with the following EU Directives. (These directives are only valid in the European Union.)

CE Certifications:

・Electromagnetic Compatibility (EMC) Directive 2014/30/EU

EN61326-1 : 2013 Class A

WARNING: This is a Class A product. This equipment can cause radio frequency noise when used in the residential area. In such cases, the user/operator of the equipment may be required to take appropriate countermeasures under his responsibility.

・Information for traceability

・Authorised representative

Name: Renesas Electronics Corporation

Address: Toyosu Foresia, 3-2-24, Toyosu, Koto-ku, Tokyo 135-0061, Japan

・Manufacturer

Name: Renesas Electronics Corporation

Address: Toyosu Foresia, 3-2-24, Toyosu, Koto-ku, Tokyo 135-0061, Japan

・Person responsible for placing on the market

Name: Renesas Electronics Europe GmbH

Address: Arcadiastrasse 10, 40472 Dusseldorf, Germany

・Trademark and Type name

Trademark: Renesas

Product name: Evaluation System for BLDC Motor

Type name: RTK0EMX270S00020BJ

Environmental Compliance and Certifications:

・Waste Electrical and Electronic Equipment (WEEE) Directive 2012/19/EU

3. Block Diagram

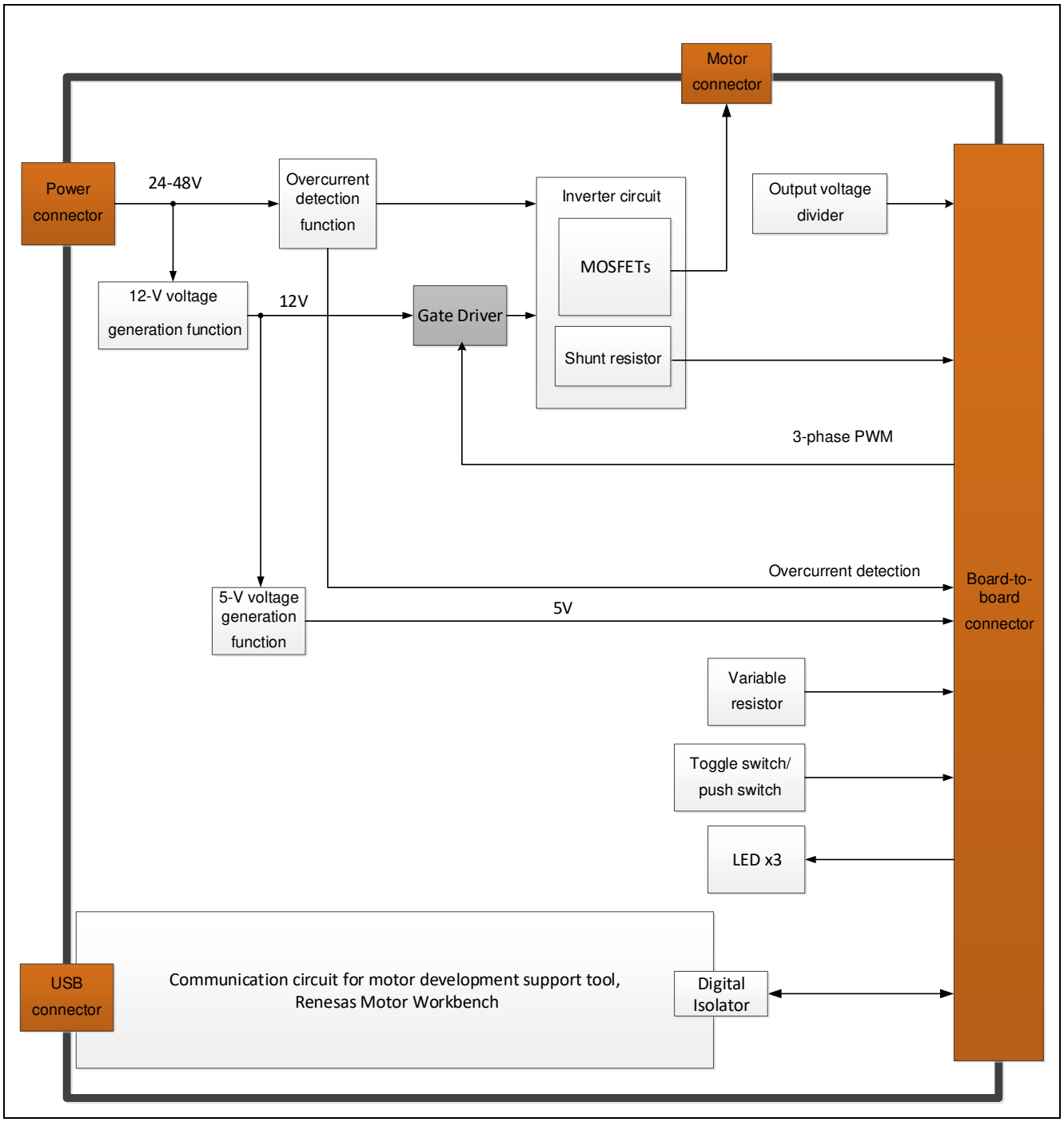


Figure 3-1 Evaluation System for BLDC Motor

4. Layout

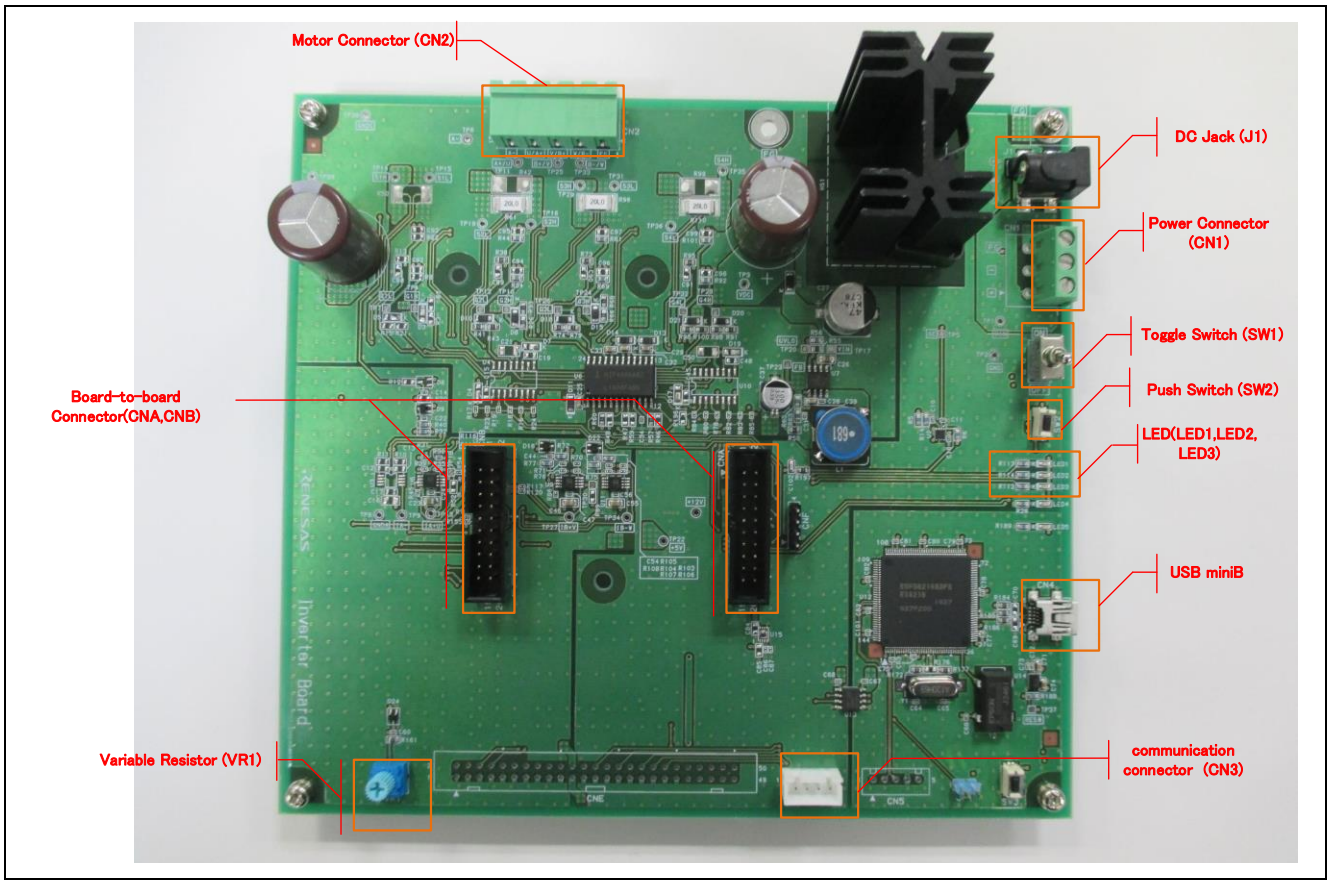


Figure 4-1 Layout

5. Usage

5.1 Set up hardware

This chapter describes how to set up hardware when combining the Product with the CPU card which is the option board. As the operation procedure is different according to the CPU card and the software written onto the CPU card, please refer to the user's manual and application note for specific operation procedure.

The Product includes permanent magnet synchronous motor, "TG-55L-KA" (hereafter, referred to as the Motor), manufactured by Tsukasa Electric Co., Ltd. This chapter describes the procedure to set up hardware using this motor.

In addition, the Product can be connected with the motor conforming to the inverter specifications listed in the second chapter. If you use motors other than the one included in the Product, make sure to check the specification of the motor thoroughly before using it.

Use antistatic band when using the Product. Because touching the Product while being charged with static electricity could cause failure or unstable operation.

Advance Preparation

Prepare the following items.

- Stabilized power supply : Output voltage of DC24V or more, the upper limit of the output current can be set at 1A
- Power supply cable (x2) : Cables which enable to apply the current of 1A or more. (to connect the stabilized power supply with the INV-BRD)
- CPU card : CPU card compatible with the Product

  e.g.) RX23T CPU card (product No. : RTK0EM0003C01202BJ)

5.1.1 Connect the Motor and the CPU Card with the Board

Following Figure 5-1, mount the CPU card on the INV-BRD and then connect the motor and the cables included in the Product.

Figure 5-1 illustrates how to connect the bundled motor, “TG-55L-KA”

Although hole sensor signal connector is included for the cable, you do not need to connect it if you don’t use the hole sensor signal (if sensorless vector control is performed).

Attach the ferrite core included in the Product to the motor connection cables by referring to Figure 5-1. Make sure to attach the ferrite core to close position to the Product.

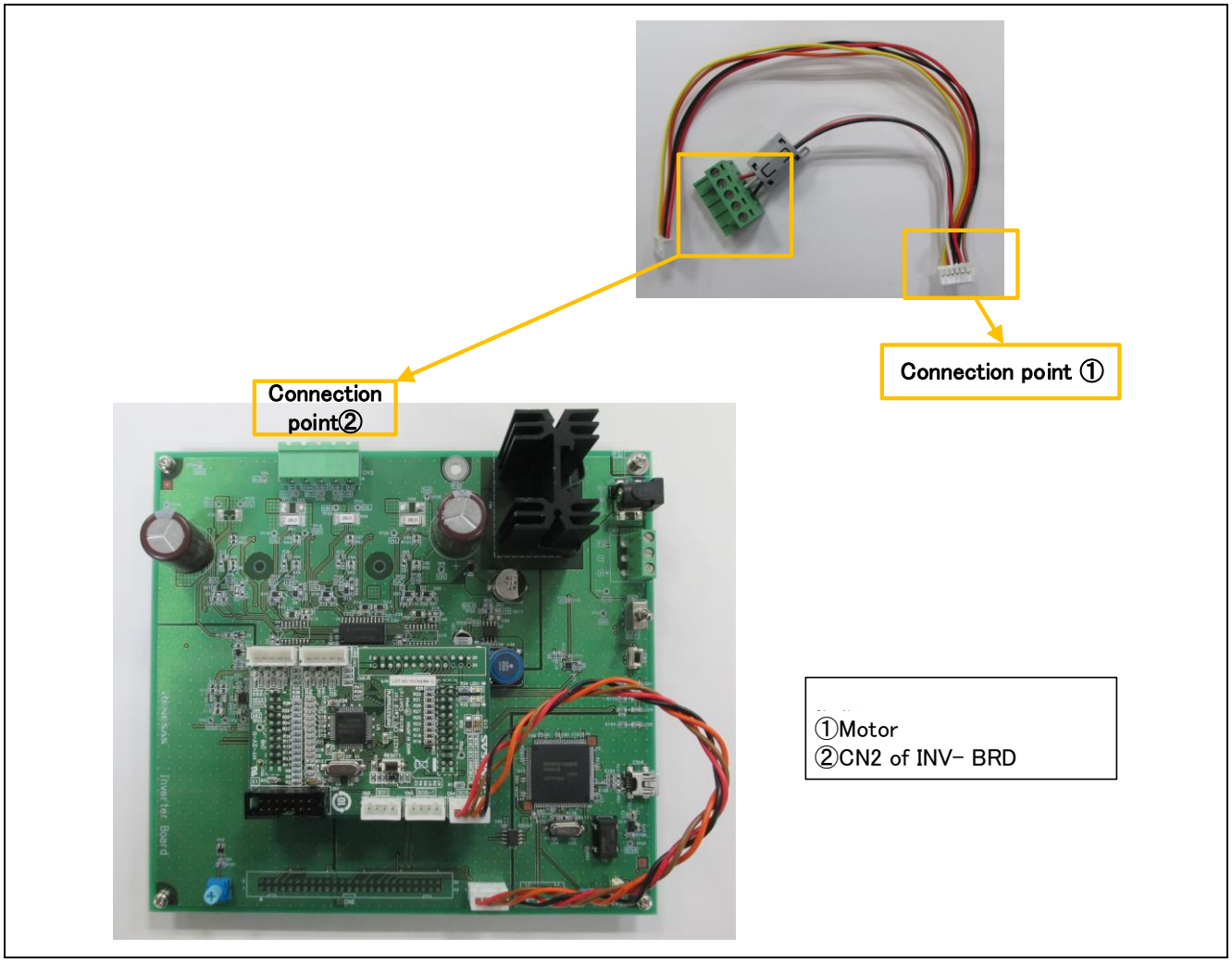


Figure 5-1 Connect Cables

5.1.2 Connect the Stabilized Power Supply and the Cables

The Product has the terminal block (CN1) as connector to supply power for the board. Connect positive output of the stabilized power supply with 1 pin of CN1 (“+” silk) and negative output with 2 pin (“-” silk).

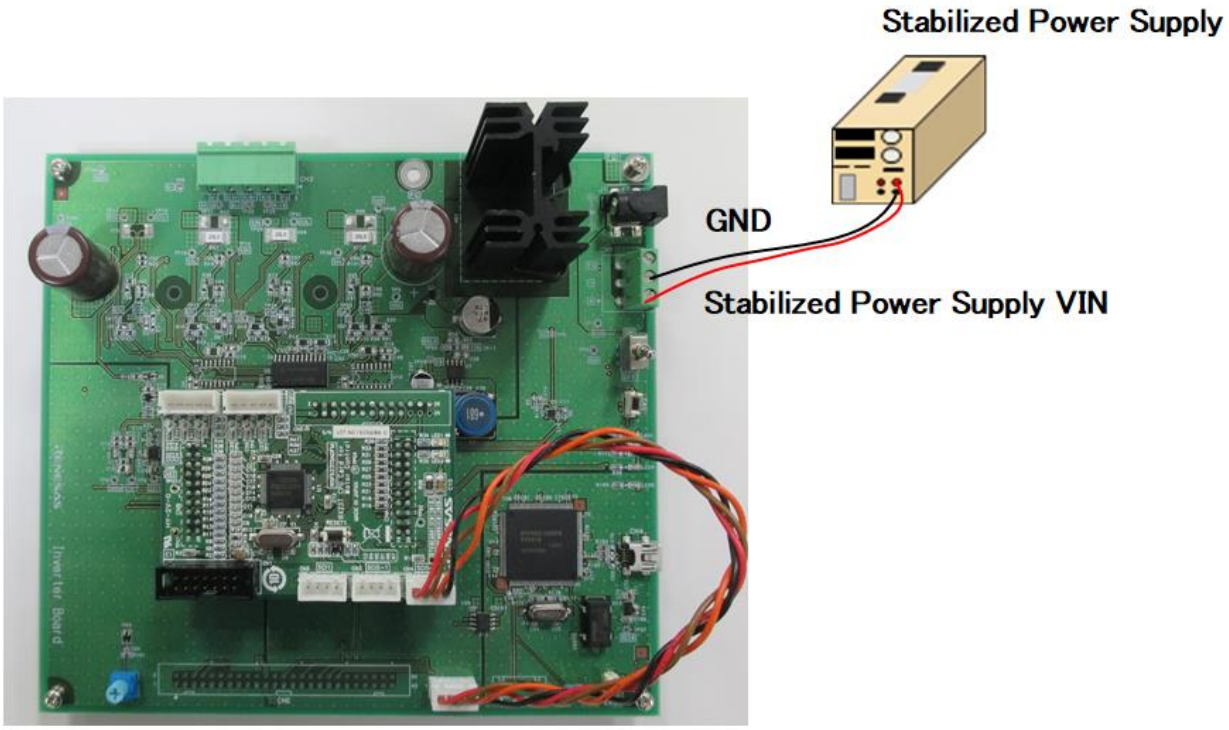


Figure 5-2 Connect Stabilized Power Supply

5.1.3 Supply Power

Use the stabilized power supply and set the output voltage to 24V and the limit current to 1A. Then, turn on the device. If the voltage drops even for a second, the power supplied for the CPU card is also reduced, which causes reset, as a result the program is halted.

5.1.4 Check the Motor Operation

As for the procedure to rotate and stop the motor, follow the application note of the software written in the CPU card.

5.1.5 Finish the Operation Check

When completing the operation check procedure, make sure that the motor shaft is not rotating before turning off the output from the stabilized power supply.

5.2 Preparation to use the Support tool

The Product supports the “Support Tool” manufactured by Renesas Electronics. It is equipped with the USB mini B connector as the communication interface. In order to use "Support Tool" you need to connect the INV-BRD to the PC with USB cable. (Connector number of the RX23T-CPU card is shown as an example. As for other CPU card numbers, refer to the CPU card manual.)

（1） Connect the communication cable

Connect CN4 which is the SCI connector on the CPU card and CN3 which is the connector on the INV-BRD with the communication cables included in the Product.

（2） Connect the USB cable

Connect CN4 which is the USB mini B connector on the inverter board and your PC with the USB cable included in the Product.

For instructions on using the tool, refer to the user’s manual of the Motor Control Development Support Tool, “Renesas Motor Workbench V.x.xx”.

※ V.x.xx means the release version of the applicable tool.

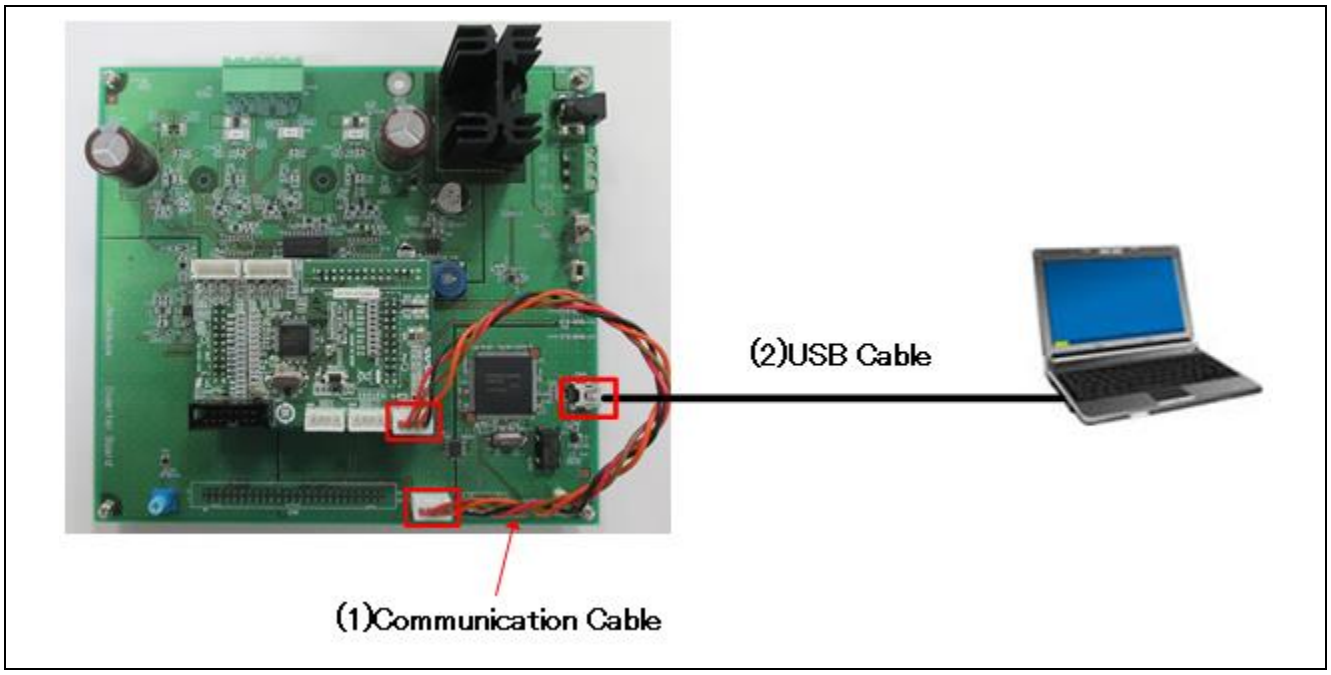


Figure 5-3 Connect Cables

5.3 Deal with Abnormalities

5.3.1 Deal with Abnormal Odor, Smoke, Unusual Sound, Overheating, etc.

If any abnormality (abnormal odor, smoke, unusual sound and overheating) occurs, immediately turn off the stabilized power supply and cut off the current flowing into the inverter.

6. Inverter Board specifications

This chapter describes the specification of the INV-BRD.

6.1 Outline

The INV- BRD is the inverter board which enables to operate the motor by connecting it with the CPU card manufactured by Renesas Electronics.

6.2 Functions

6.2.1 Inverter Control Circuit Block

The INV-BRD is equipped with the inverter control circuit block which controls the motor with six Power MOS-FETs. The POWER MOS-FETs control the motor with six-phase timer output from the microcontroller.

The inverter control circuit block outputs DC bus voltage, U, V and W phase voltage and shunt current to the connectors (CNA, CNB). By entering these output values in A/D of the microcomputer of the CPU card, analog values of the voltage and the shunt current of each phase can be measured. Refer to 6.2.2 and 6.2.4 for the current detection and the voltage detection, respectively. Also function to detect overcurrent from the input current is available. Refer to 6.2.3 for details.

An illustration of the inverter control circuit block is shown in Figure 6-1. 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.

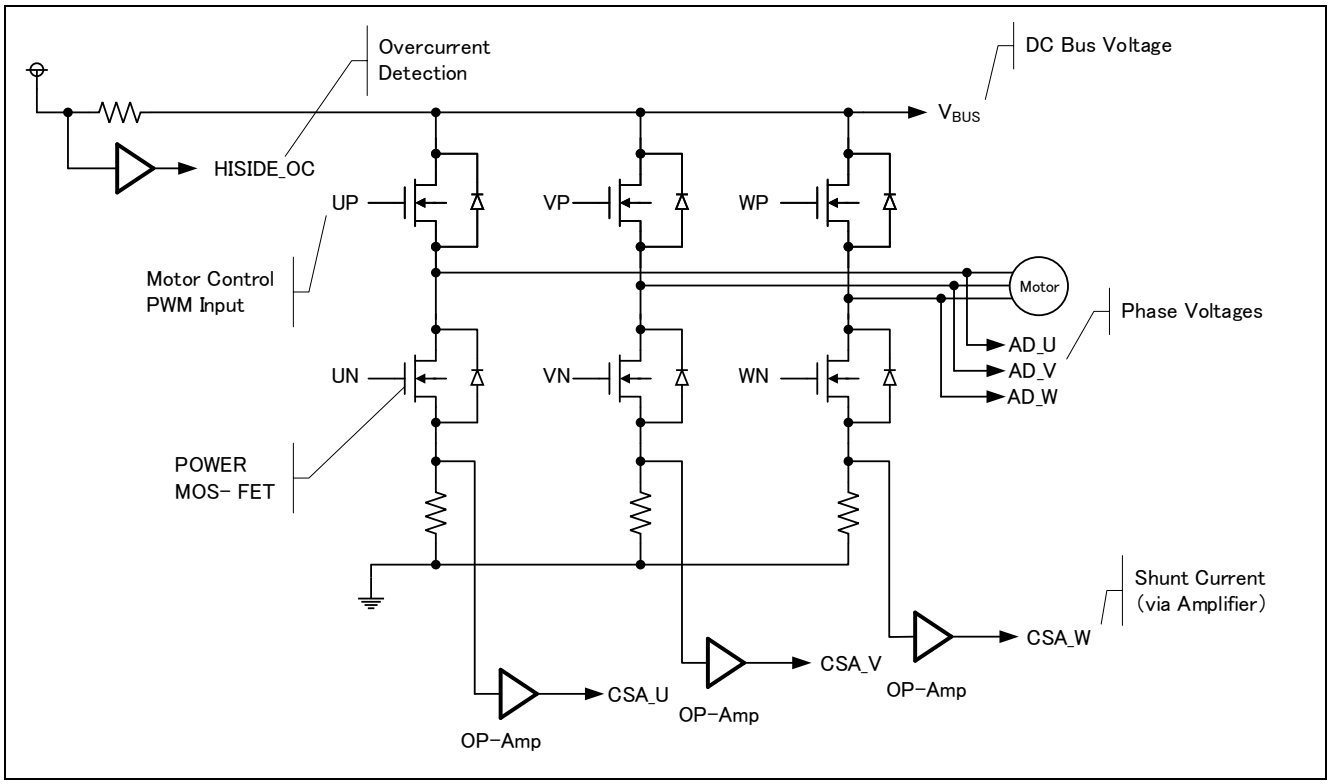


Figure 6-1 Illustration of Inverter Control Circuit Block

6.2.2 Current Detection Circuit

The INV-BRD is equipped with the current detection circuit to measure the current at the U, V and W phase. The current detection circuit uses shunt resistance at each phase. Voltage drop caused by the current flowing through the shunt resistor is amplified by the current detection amplifier to output. The relation between Iin which is the current flowing through the shunt resistor and Vout which is the voltage output from the current detection circuit is described by the below equation(1).

$$\mathrm{Vout[V]} = \mathrm{Iin[A]} \times \mathrm{Rs[\Omega]} \times 20 + 2.5 \qquad (1)$$

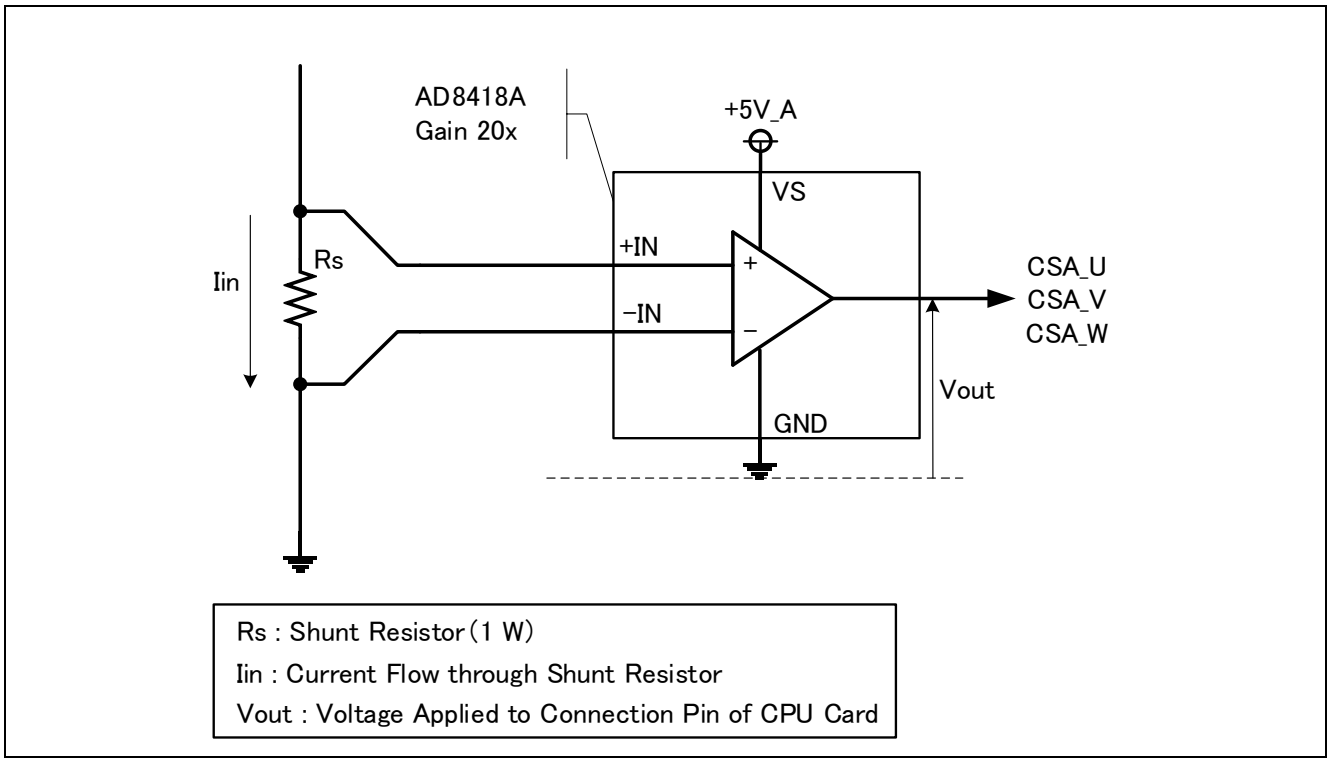


Figure 6-2 Current Detection Circuit

Table 6-1 Relation between the Current Flow thorough Shunt Resistor and the Voltage Output from Current Detection Circuit

Iin [A]	Vout[V]
10	4.5
2	2.9
0	2.5
-2	2.1
-10	0.5

6.2.3 Overcurrent Detection Circuit

Detect the overcurrent from the input current, using the overcurrent detection circuit illustrated in Figure 6-3. If the current value is within the range of threshold, HISIDE_OC is HIGH, but if an overcurrent is detected, HISIDE_OC goes LOW. Therefore, by monitoring the OC pin and forcing Motor control PWM signal into the inactive state (High side signals UP, VP, WP are HIGH, Low side signals UN, VN, WN are LOW) when OC is low, you can protect the board and motor.

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

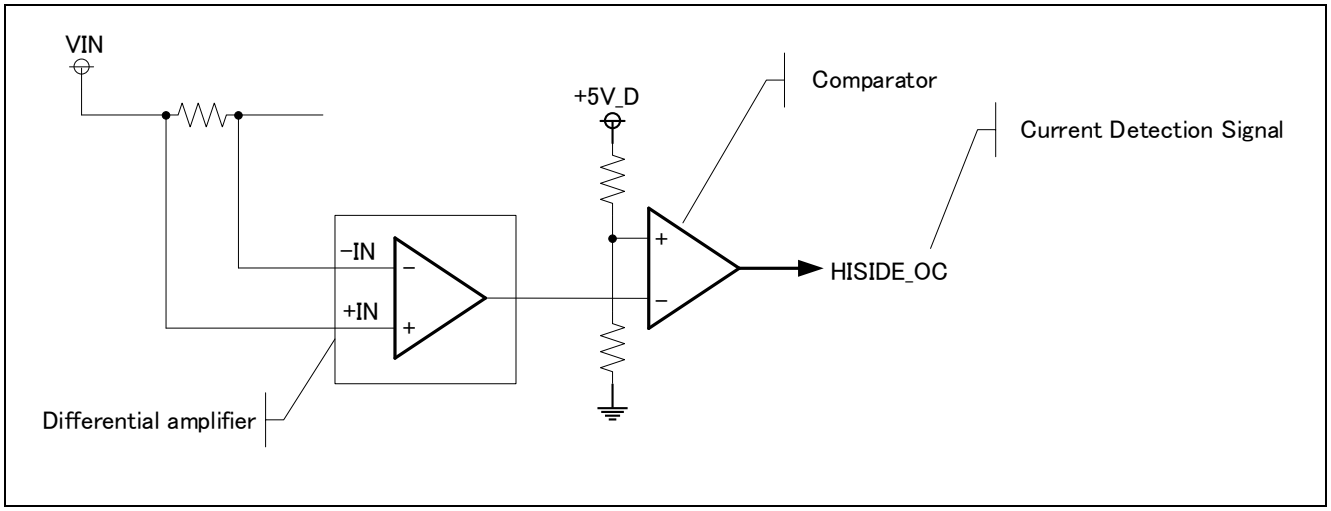


Figure 6-3 Overcurrent Detection Circuit

6.2.4 Output Voltage Detection Circuit

The INV-BRD 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 (2).

$$\mathrm{Vout}[V] = \frac{470}{10 \times 10^3 + 470} \times Vin[V] \quad (2)$$

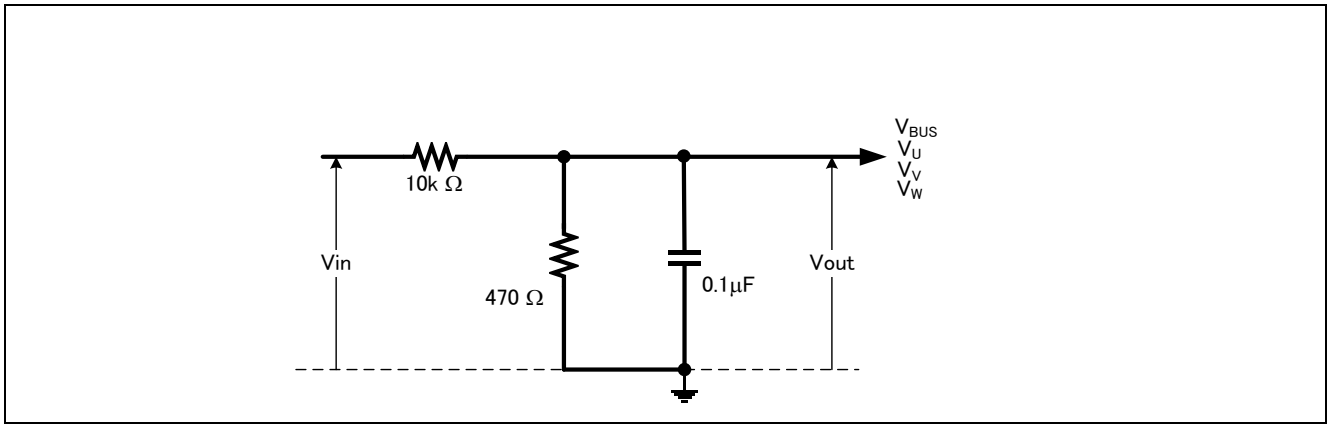


Figure 6-4 Output Voltage Detection Circuit

6.2.5 Voltage Generation Circuit

The INV- BRD generates voltage of 12V and 5V from the main power supply (24~48V).

Table 6-2 Voltage Generation Circuit

Item	Input Voltage [V]	Output Voltage (TYP.) [V]	Output Current (Max) [A]	Application
12VGeneration	24～48	12	0.6	● 5Vgeneration ● Gate Driver IC
5VGeneration	12	5	0.5	● MCU Power Supply

6.2.6 LED

The INV-BRD has three LEDs which the user can control. The user can control them from the CPU card connected with the INV-BRD.

Table 6-3 LED

Pins Compatible with CPU Card Connector		LED1	LED2	LED3
CNA-1	Hi	Off	-	-
	Low	On	-	-
CNA-2	Hi	-	Off	-
	Low	-	On	-
CNA-3	Hi	-	-	Off
	Low	-	-	On

6.2.7 Toggle Switch and Push Switch

The INV-BRD has toggle switch (SW1) and push switch (SW2). The user can use them at his or her discretion.

Table 6-4 Toggle Switch and Push Switch

Pins Compatible with CPU Card Connector		SW1	SW2
CNA-13	Hi	OFF	-
	Low	ON	-
CNA-14	Hi	-	RELEASE
	Low	-	PUSH

6.2.8 Variable Resistor

The INV-BRD has a variable resistor (VR1). The user can use the resistor at his or her discretion. If turning the variable resistor clockwise, terminal voltage of the variable resistor (CNB-15) becomes low. If turning it counterclockwise, the voltage becomes high.

Table 6-5 Variable Resistor Specification

Item	Specification
Input Voltage Range	0～+5V_A
Variable Resistor Range	0～10k Ω

6.3 Pin assignment

6.3.1 Connector Pin Function Assignment

Table 6-6 Board-to Board Connector CNA Connection

#	Output	Signal	Connection destination (inverter board)
1	To INV	LED1#	LED1
2	To INV	LED2#	LED2
3	To INV	LED3#	LED3
4	To INV	VRL	-
5	To CPU	Overcurrent detection	Comparator output U2.1
6	-		
7	To INV	PWM phase WN	Gate driver U6.11 CLI
8	To INV	PWM phase VN	Gate driver U6.4 ALI
9	To INV	PWM phase UN	Gate driver U6.3 BLI
10	To INV	PWM phase WP	Gate driver U6 12 CHI
11	To INV	PWM phase VP	Gate driver U6.5 AHI
12	To INV	PWM phase UP	Gate driver U6.2 BHI
13	To CPU	SW1	SW1
14	To CPU	SW2	SW2
15	To CPU	Digital 5V	+5V_D
16	To CPU	Digital 5V	+5V_D
17	To CPU	Digital GND	GND_D
18	To CPU	Digital GND	GND_D
19	-	-	-
20	-	-	-

Table 6-7 Board-to-Board Connector CNB Connection

#	Output	Signal	Connection destination (inverter board)
1	To CPU	Analog 5V	+5V_A
2	To CPU	Analog 5V	+5V_A
3	To CPU	-	GND_A
4	To CPU	Differential input current detection	R97,R76,C52
5	To CPU	Phase U current detection	Current detection amplifier U5.5
6	To CPU	Phase V current detection	Current detection amplifier U9.5
7	To CPU	Phase W current detection	Current detection amplifier U11.5
8	To CPU	Supply voltage divider	R2, R4
9	-	-	-
10	To CPU	Phase U voltage divider	R32, R40
11	To CPU	Phase V voltage divider	R72, R77
12	To CPU	Phase W voltage divider	R105, R108
13	-	-	-
14	-	-	-
15	To CPU	Volume	VR1
16	-	-	-
17	To CPU	Digital 5V	+5V_D
18	To CPU	Digital 5V	+5V_D
19	To CPU	Analog ground	GND_A
20	To CPU	Analog ground	GND_A

Table 6-8 Board-to-Board Connector CN10 connection

#	Output	Signal	Connection destination (inverter board)	Connection destination (CPU card)
1	To INV	RMW Communication: Transmission	U13.3 A2	U2.22 PD3/TXD1
2	-	Digital ground	GND_D	GND_D
3	To CPU	RMW Communication: Reception	U13.2 A1	U2.20 PD5/RXD1
4	-	Digital ground	GND_D	GND_D

7. Usage Notes

Important points to observe when using the Product are described below.

- When enabling FG (frame ground) of the Product, make sure to mount metal feet on the four corners of the INV-BRD. If connecting to FG, use 3 pin of CN1 and the foot by the side of J1. (Either case has silk for FG.)

Website and Support

Renesas Electronics Website
http://japan.renesas.com/

Inquiries
http://japan.renesas.com/contact/

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2019.11.11	—	First edition
1.10	2023.6.8	20	6.2.3 Overcurrent Detection Circuit Correction of description about overcurrent detection

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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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
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