User's Manual

MCI-HV-1 User's Manual

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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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TOYOSU FORESIA, 3-2-24 Toyosu,
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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	
	High voltage is applied to the terminals during operation and for 30 seconds after power shutdown. Do not touch the terminals or the product during this period.
	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.

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1. Overview

MCI-HV-1 is a motor control evaluation inverter kit. Motor control can be performed easily by using this product with Renesas CPU board and communication board.

Features

(1) Supports over current detection, over voltage protection, over temperature detection.
(2) Equipped with PFC control circuit
(3) Supports worldwide input power supply voltage range (AC100-240V 50/60Hz or DC141- 390V)
(4) Reinforced isolation between high voltage domain and user interface domain
(5) Supports 1-/3-shunt current sensing
(6) Supports HALL sensor and Encoder signal input with reinforced isolation

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. This product is intended for use in the laboratory by engineers with knowledge of motor control and high voltage handling.
5. When using this product, be sure to follow the safety instructions in this manual (see section 5). Use of this product without taking safety measures may result in electric shock or burns.

1.2 Product Contents

This product consists of the following parts.

1. Inverter Board (RTK0EM0000B14030BJ) x1
2. Motor connector x1
3. Power connector x1
4. 35mm standoff x4
5. 15mm standoff x4
6. Screw x4
7. Flat cable x2
8. Communication cable x1

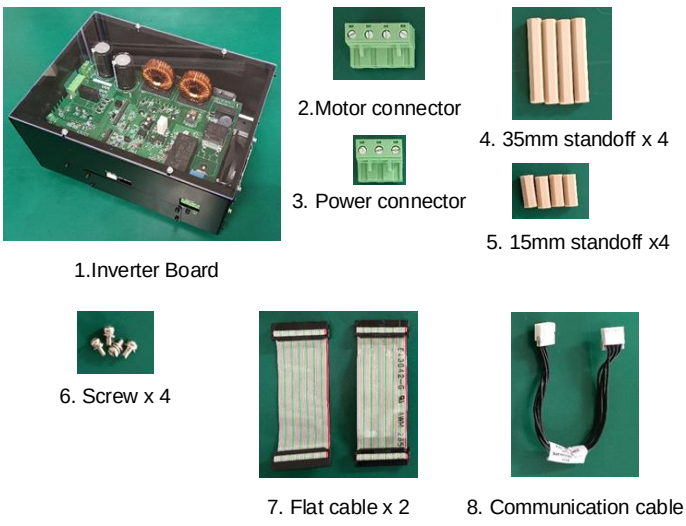


Fig. 1-1 MCI-HV-1 product contents

2. Hardware configuration

2.1 Hardware specification

Table 2-1 MCI-HV-1 overview

Item	Specification
Product name	MCI-HV-1
Board Part No.	RTK0EM0000B14030BJ
External view	 Note: The actual product may differ from this photo.
Product size	265 mm(W) x 200 mm(L) x 135 mm(H)
Environmental conditions	Indoor use only Altitude: up to 2000m Operating temperature range : 0 to 40℃ Operating humidity: 0 to 75% RH Mains supply voltage fluctuations: ±10% Over Voltage Category II Pollution Degree 2
Low Voltage Directive	EN61010-1
EMC Directive	EN61326-1:2021 EMI: Class A EMS: Industrial Electromagnetic environment

Table 2-2 MCI-HV-1 specification

Item		Specification
Rated input	Main power	AC:100-240V 50/60Hz 10A (input from CN2) DC:141-390V 10A (input from CN3)
	Sub power	DC: 15V 1.3A (only required when main power is DC input) DC: 5V (for communication I/F domain, from USB connector)
Rated output *1		1kW for AC200V input 2kW for DC390V input
Switching frequency		PFC : 32 kHz (typical) Inverter : 8kHz (typical), 20kHz (max)
Current sensing	PFC current sensing	1-/2-shunt sensing (default: 1-shunt sensing)
	Inverter current sensing	1-/3-shunt sensing (default: 3-shunt sensing)
PWM logic for PFC and IGBT module		Positive logic
Voltage sensing		Bus voltage, 3phase output voltage
Protection function	PFC overcurrent	49.1A *2
	Inverter overcurrent	48A
	PFC coil over-temperature	76.9 °C *2
	Inverter over-temperature	90 °C *2
Supporting sensor		HALL sensor, Encoder(A/B/Z-phase)

*1 Rated power depends on input voltage.
*2 Detection only

Table 2-3 MCI-HV-1 performance

Item	Specification
No load standby power	7.2W
PFC Power factor	0.982 for 1kW, AC200V
PFC Efficiency	96.8% for 1kW, AC200V
Inverter efficiency	94.1% for 1kW, AC200V 96.5% for 2kW, DC390V

2.2 Function block diagram

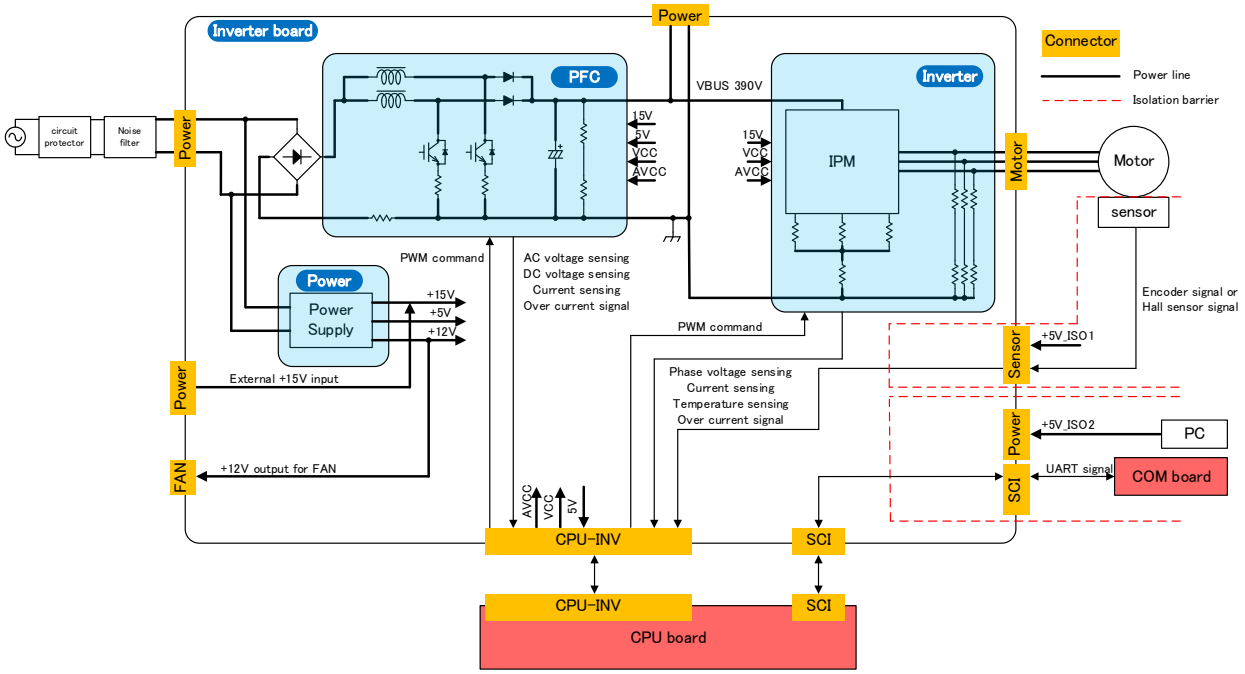


Fig. 2-1 MCI-HV-1 function block diagram

2.3 Board Layout

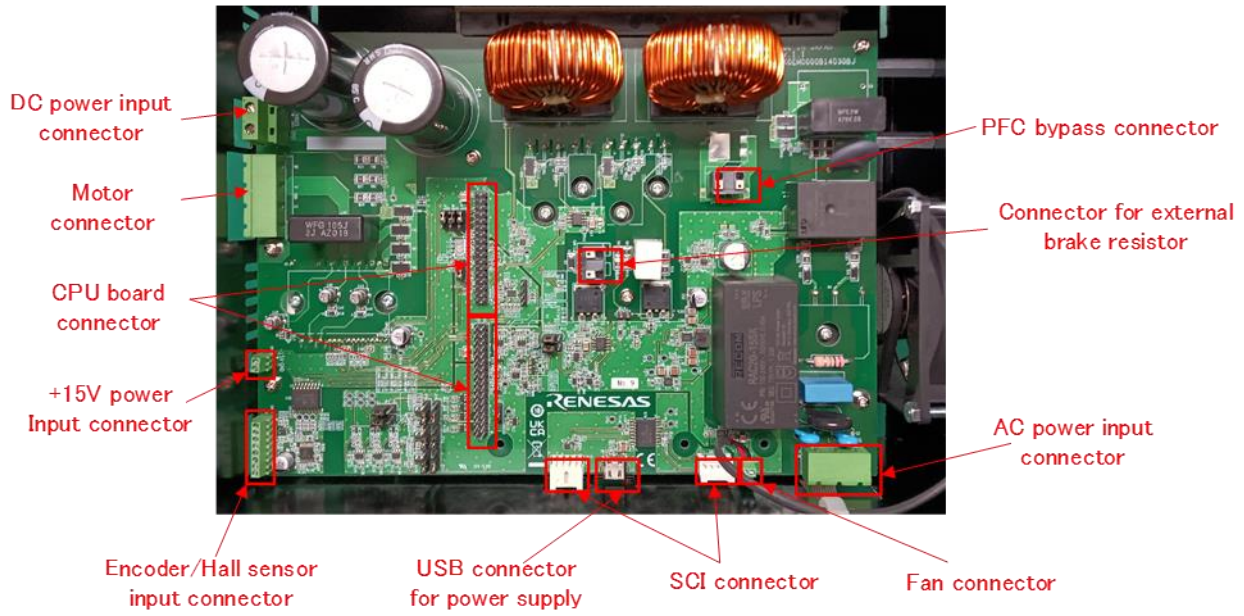


Fig. 2-2 Inverter board layout

2.4 Jumper setting

Default setting and function of the jumpers (JP1~JP16) are as follows.

Table 2-4 Jumper setting of inverter board

Jumper pin	Default setting	Function
JP1, JP2	1-2pin short	1-2pin short: 3-shunt current sensing 2-3pin short: 1-shunt current sensing
JP3	2-3pin short	1-2pin short: select IPM temperature signal 2-3pin short: select PFC phase current signal (ch2)
JP4	2-3pin short	1-2pin short: SW1 level HIGH 2-3pin short: SW1 level LOW
JP5, JP6, JP7	2-3pin short	1-2pin short: HALL signal input 2-3pin short: Encoder signal input
JP8, JP9, JP10, JP11, JP12, JP13	2-3pin short	1-2pin short: use PGA on CPU board for current sensing 2-3pin short: use Amp on inverter board for current sensing
JP14	open	Changing settings is prohibited.
JP15, JP16	1-2pin short	1-2pin short: 1-shunt current sensing for PFC 2-3pin short: 2-shunt current sensing for PFC

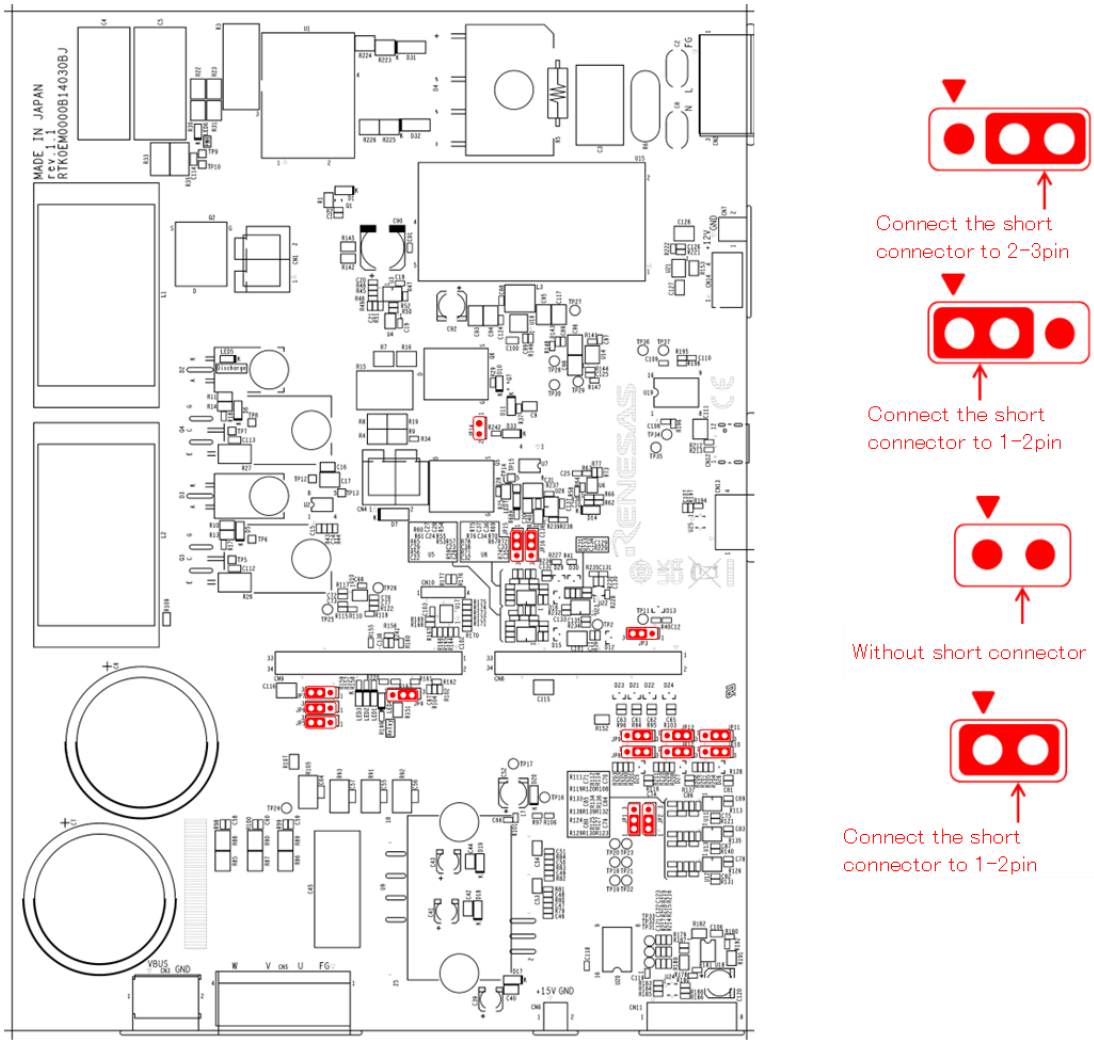
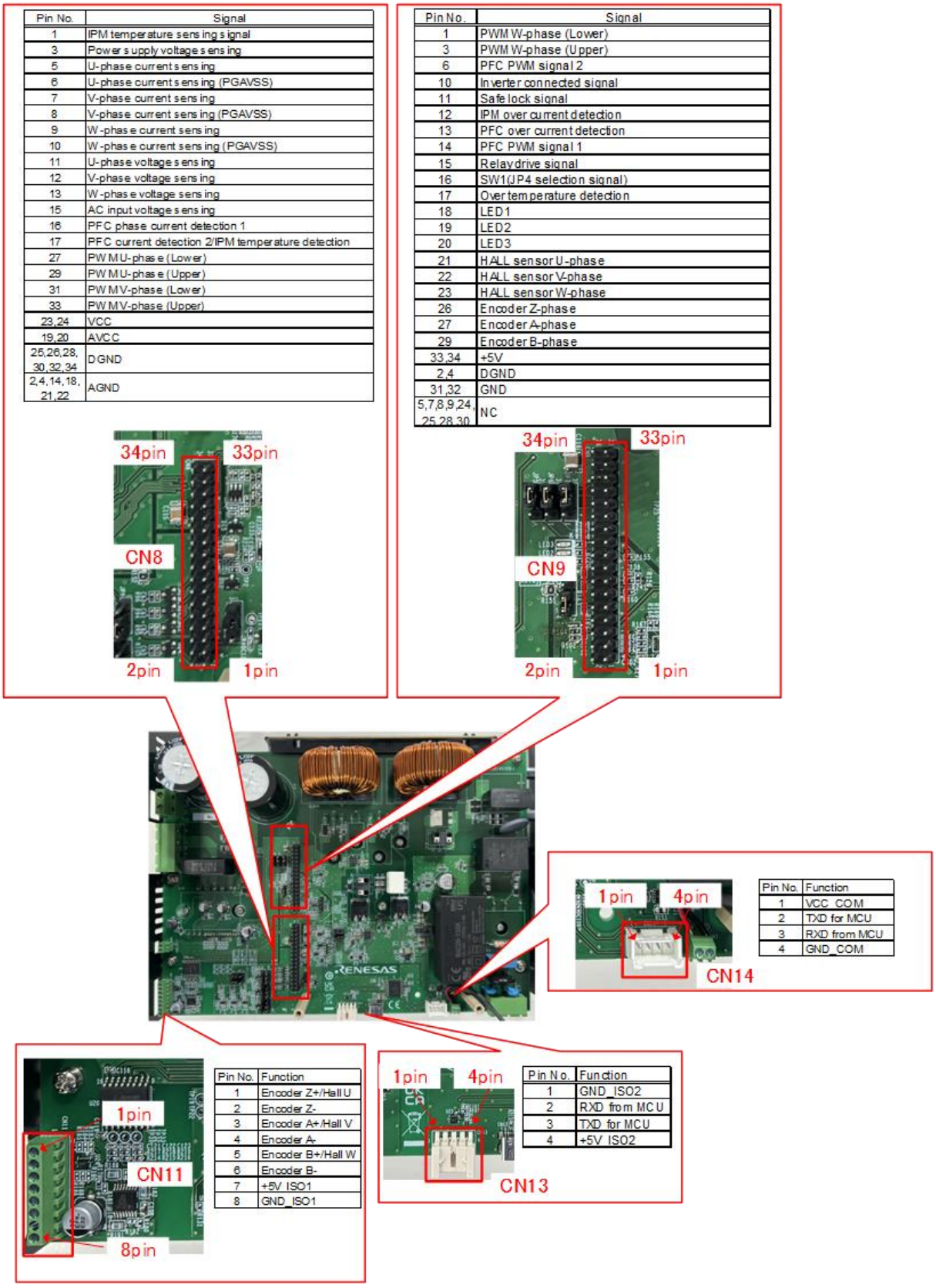


Fig. 2-3 Default jumper pin setting of inverter board

2.5 Pin assignment of connector

Pin No.	Signal
1	IPM temperature sensing signal
3	Power supply voltage sensing
5	U-phase current sensing
6	U-phase current sensing (PGAVSS)
7	V-phase current sensing
8	V-phase current sensing (PGAVSS)
9	W-phase current sensing
10	W-phase current sensing (PGAVSS)
11	U-phase voltage sensing
12	V-phase voltage sensing
13	W-phase voltage sensing
15	AC input voltage sensing
16	PFC phase current detection 1
17	PFC current detection 2/IPM temperature detection
27	PWM U-phase (Lower)
29	PWM U-phase (Upper)
31	PWM V-phase (Lower)
33	PWM V-phase (Upper)
23,24	VCC
19,20	AVCC
25,26,28, 30,32,34	DGND
2,4,14,18, 21,22	AGND

Pin No.	Signal
1	PWM W-phase (Lower)
3	PWM W-phase (Upper)
6	PFC PWM signal 2
10	Inverter connected signal
11	Safe lock signal
12	IPM over current detection
13	PFC over current detection
14	PFC PWM signal 1
15	Relay drive signal
16	SW1(JP4 selection signal)
17	Over temperature detection
18	LED1
19	LED2
20	LED3
21	HALL sensor U-phase
22	HALL sensor V-phase
23	HALL sensor W-phase
26	Encoder Z-phase
27	Encoder A-phase
29	Encoder B-phase
33,34	+5V
2,4	DGND
31,32	GND
5,7,8,9,24, 25,28,30	NC



Pin No.	Function
1	VCC_COM
2	TXD for MCU
3	RXD from MCU
4	GND_COM

Pin No.	Function
1	Encoder Z+/Hall U
2	Encoder Z-
3	Encoder A+/Hall V
4	Encoder A-
5	Encoder B+/Hall W
6	Encoder B-
7	+5V_ISO1
8	GND_ISO1

Pin No.	Function
1	GND_ISO2
2	RXD from MCU
3	TXD for MCU
4	+5V_ISO2

Fig. 2-4 Pin assignment of connector

3. Setup guide

3.1 Hardware setup

When using this product, prepare equipment listed in Table **3-1** and setup according to the procedure (1) ~ (8). Do not apply main power to the board before you have verified the settings and completed procedures.

Note that RTK0EMA270C00000BJ is used as the CPU board in this setup guide, but other CPU boards are also available. Listed noise filter and circuit protector are reference examples. Please select appropriate products according to your evaluation environment (power, current, etc.).

Table 3-1 Setup items list

Item	Specification, product example	
Inverter board	RTK0E0000B14030BJ (this product)	
CPU board (controller board)	RTK0EMA270C00000BJ (Renesas)	
Communication board	RTK0EMXC90Z00000BJ (Renesas)	
Brushless DC motor	BXM6200-A (Oriental Motor)	
Power supply unit	In case of AC	Output: AC100~240V (Single-Phase), 50/60Hz, >10A Isolated stabilized power supply or isolation transformer
	In case of DC	Output: DC141~390V, >10A Output: DC15V, >1.3A Isolated stabilized power supply
Noise filter	NBC-10-472 (COSEL)	
Circuit protector	CP30-BA 2P 1-I 20A (Mitsubishi Electric)	
PC	Windows10 or later, with USB port	
Communication cable	0151370402 (Molex) Included in this product and RTK0EMXC90Z00000BJ	
USB cable	Type C	
Flat cable	34P, 2Rows, 2.54mm pitch. included in this product	
Standoff (35mm)	35mm, included in this product	
Standoff (15mm)	15mm, included in this product	
Motor connector	4P, included in this product	
Power input connector	3P, included in this product	

(1) Connect the CPU board to the inverter board

Attach standoffs (35mm) to the CPU board with M3 screws.

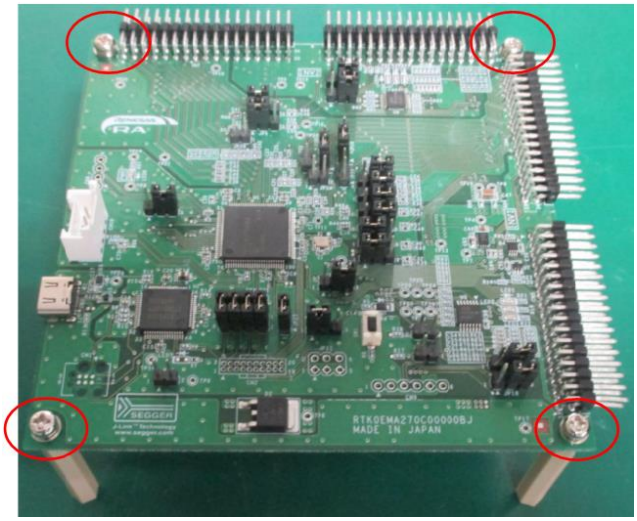


Fig. 3-1 Board Connection (CPU board : standoff)

Open the top panel and connect the CPU board to the inverter board with flat cable and communication cable.



Fig. 3-2 Board Connection (CPU board : Communication cable, Flat cable)

Remove the bottom cover and attach the CPU board with screws from back side. Then attach the bottom cover back on.

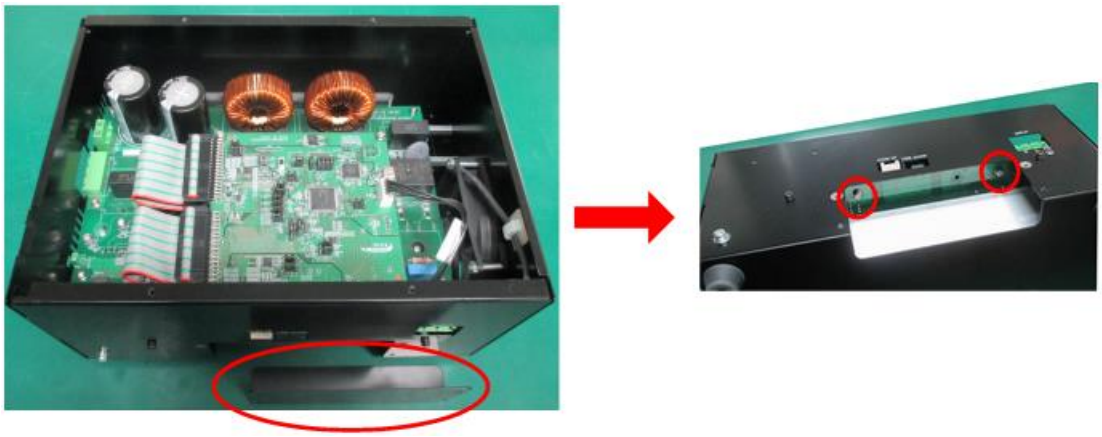


Fig. 3-3 Board Connection (CPU board : inverter board)

(2) Attach the communication board to the inverter board with standoffs (15mm) and a communication cable. Then attach the top panel back on.

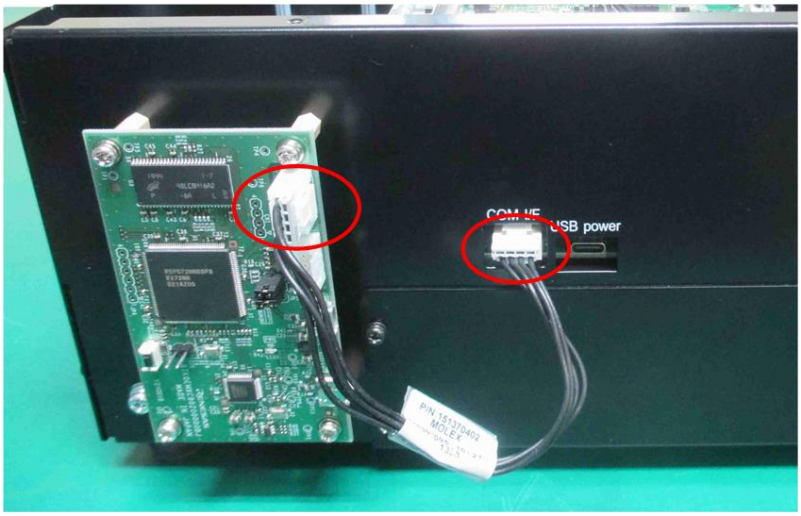


Fig. 3-4 Board Connection (Communication board : standoff, cable)

(3) Connect the inverter board to USB power supply with USB cable. (labeled "USB power" on chassis)

(4) Connect the communication board to PC with USB cable.

(5) Connect the motor to the inverter board

Connect the U, V, W phases and FG of the motor cable to the motor connector as shown below, and connect it to CN5.

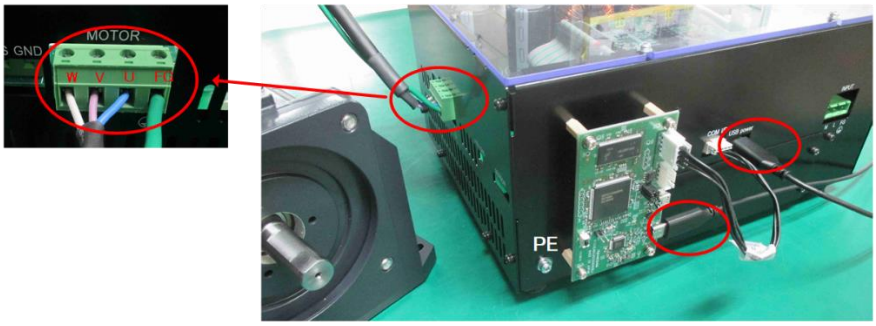


Fig. 3-5 Board Connection (Communication board : PC), Motor Connection

(6) Connect a protective earth cable

Connect a protective earth cable to the PE terminal on the chassis (labeled “PE”) by the conductor with crimped terminal. Screw size is M4.

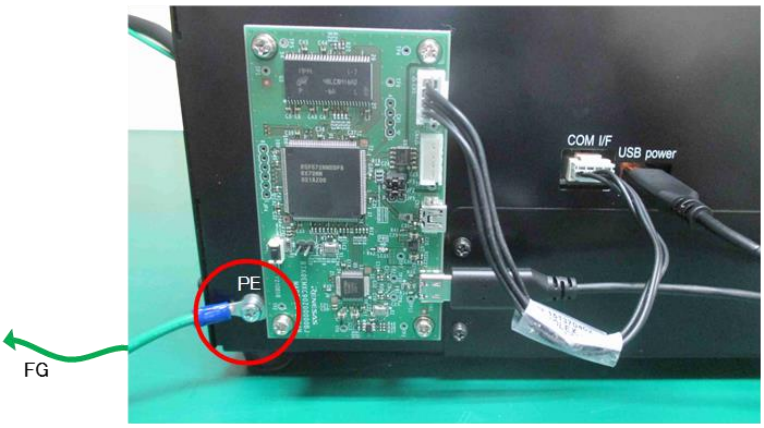


Fig. 3-6 PE connection

(7) Power supply connection

(a) In case of AC input

Connect AC power supply to the power connector on the inverter board (CN2) via a circuit protector and noise filter.

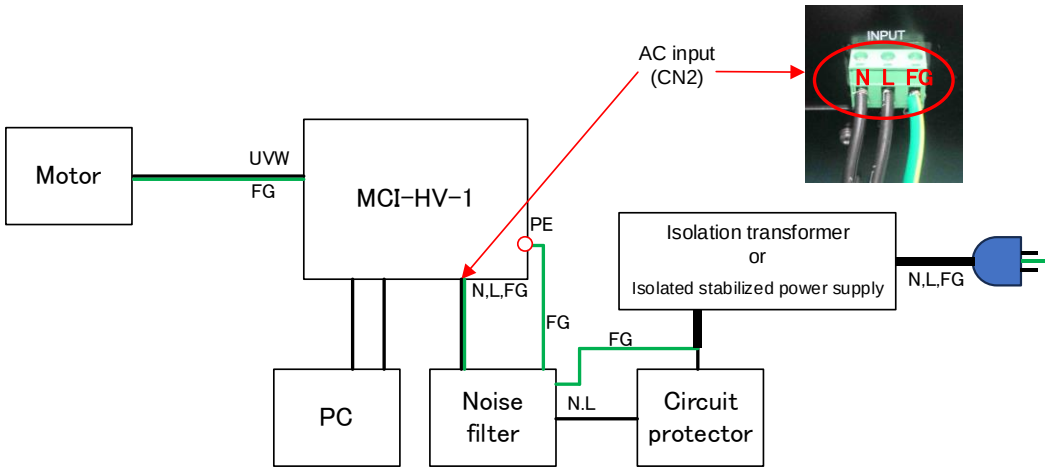


Fig. 3-7 AC power supply connection

(b) In case of DC input

Connect DC power supply to the VBUS connector on the inverter board (CN3) directly, connect a circuit protector and noise filter on the input side of DC power, and connect the 15V to the inverter board +15V connector (CN6).

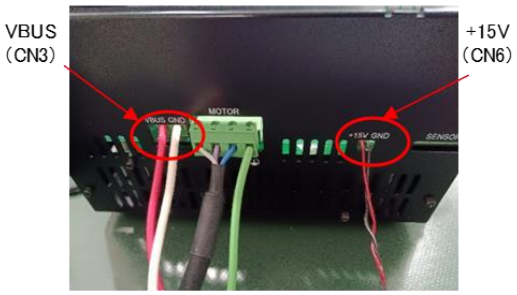


Fig. 3-8 DC power supply connection

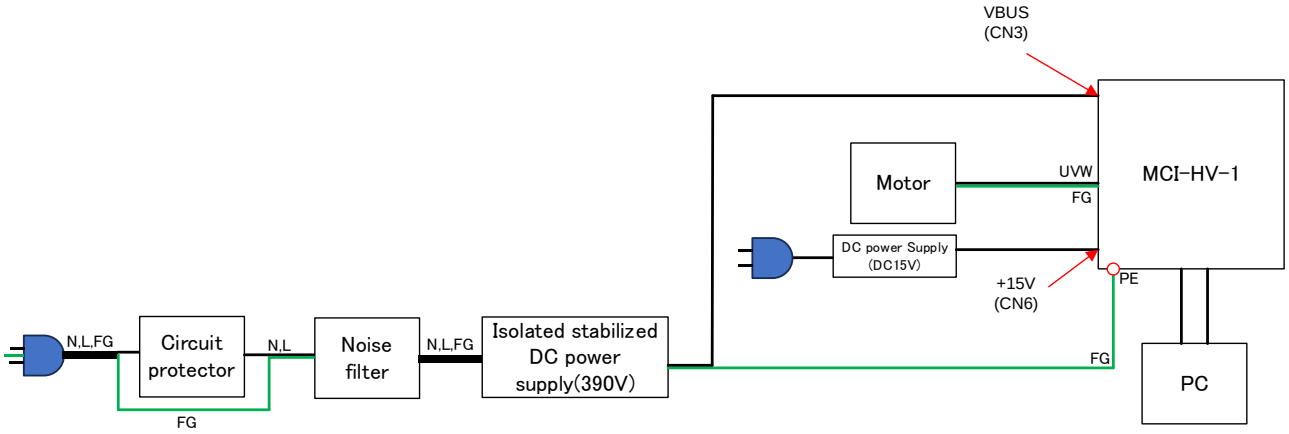


Fig. 3-9 System configuration for DC power supply

(8) Cover the system for safety

To use this product safely, be sure to cover the inverter board and the noise filter with an enclosure made of metal or flame-retardant material with sufficient strength to prevent direct touch as shown in Fig. **3-10**. The enclosure should have slits for heat radiation and holes for cables to pass through.
In addition, regarding the disconnecting device (circuit protector), it should be properly located as follows.

- Do not locate it so that it is difficult to operate the device.
- It must be suitably located and easily reached.
- It must be marked as the disconnecting device for this product.

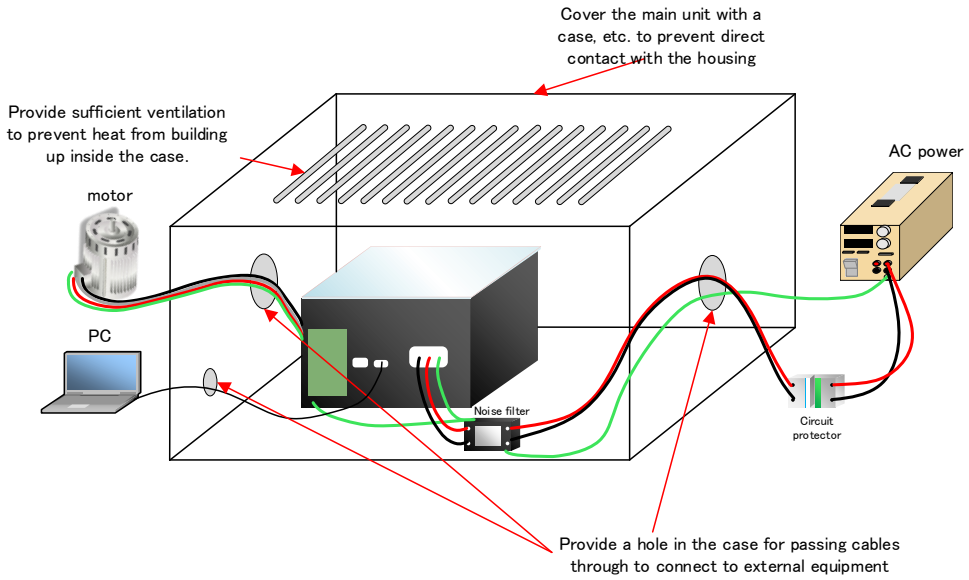


Fig. 3-10 Setup for safe operation

3.2 Power supply

There are two ways to supply main power to the inverter board.

When AC voltage is input as main power, sub power (DC15V) is generated internally. System configuration is shown in Fig. **3-11**.

When DC voltage is input as main power, sub power (DC15V) must be supplied externally. System configuration is shown in Fig. **3-12**.

USB5V power supply for communication I/F is needed for both cases.

When using the DC input, be sure to input a 15 V sub power supply before inputting the main power supply.

Also, when shutting off the power supply, be sure to turn off the 15V sub power supply after turning off the main power supply. Inputting main DC power without a 15V sub power input may damage the board.

The inrush current limitation function does not work with this product when DC power is supplied. Therefore, when using DC power supply, the current limit of about 10 to 30A should be applied on the power supply side, or the power supply voltage should be turned on slowly over about 50 to 100ms.

Similarly, when DC voltage is turned off, it is recommended to disconnect the output or slowly lower the power supply voltage to prevent large current from flowing into the power supply side.

Table 3-2 Power supply for this product

Item	Connector	Use	Voltage
Main power (AC)	CN2	Main power	AC100~240V
Main power (DC)	CN3	Main power	DC141~390V
Sub power (DC15V)	CN6	Control circuit Only needed for “Main power (DC)”	DC15V
USB power	CN12	Communication I/F power	DC5V

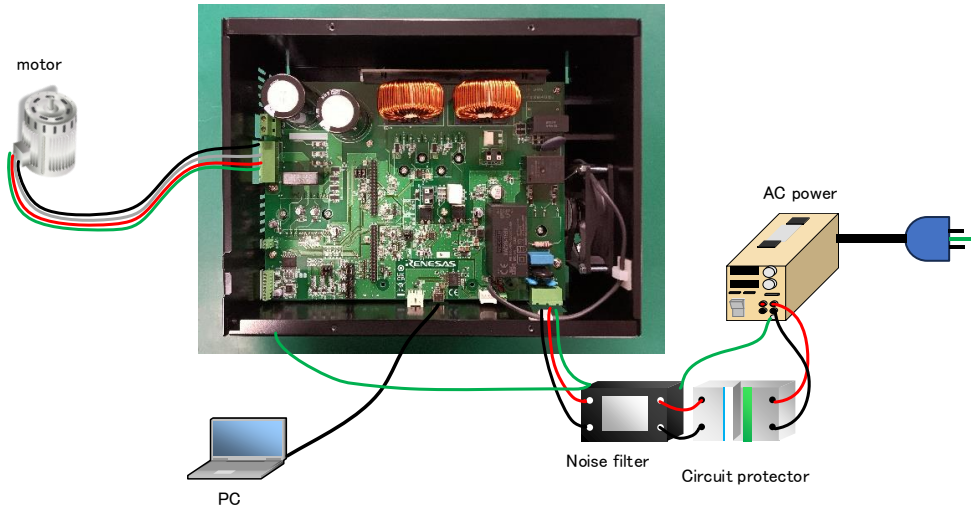


Fig. 3-11 AC power supply

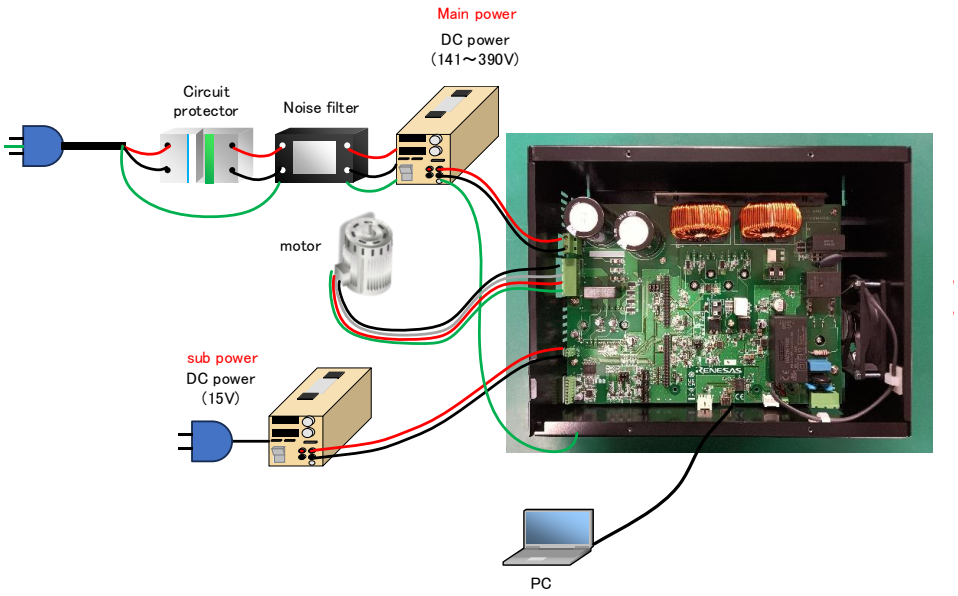


Fig. 3-12 DC power supply

3.3 Motor control operation

The specific method of controlling the motor using this product depends on the specifications of the software written on the CPU board connected to this product. Please refer to the application note of the software for details on the control operation.

4. Hardware detail

This section describes each functional block configuration. Refer to the schematic when necessary.

4.1 Power supply

4.1.1 Voltage regulator

When AC input is used as main power, this product generates DC15V, DC12V and DC5V internally.
When DC input is used as main power, sub power input (DC15V) is required. DC12V and DC5V are generated internally from sub power input.
Table **4-1**shows detail of each power supply.

Table 4-1 Regulated voltages

Voltage	Rated current	Application
DC15V	1.33A	Generates DC12V and DC5V Drives IGBT module and relay Drives gate drivers
DC12V	500mA	Drives FAN
DC5V	2A	Power supply for control circuit and CPU board

4.1.2 Voltage sensing

AC input voltage (ACINL, ACINN) is converted to analog signals ranging 0~AVCC according to the following equation and output to CPU board connector (pin 15 of CN8) as VAC_AD. AVCC is the power for analog circuit, supplied from CPU board.

$$\mathrm{VAC_AD} = (\mathrm{ACINL} - \mathrm{ACINN}) \times \frac{4.7}{2004.7} + \frac{\mathrm{AVCC}}{2}$$

Bus voltage (VBUS) is sensed with the circuit shown in Fig. **4-1** and the sensing signal is output to CPU board connector.

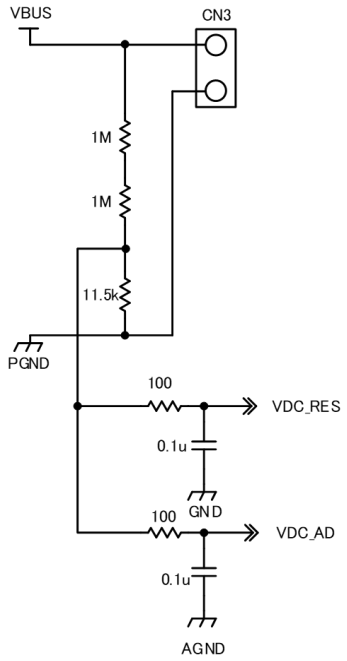


Fig. 4-1 Bus voltage sensing circuit

4.1.3 Discharge control

When main power (AC or DC input) is shut off, the discharge switch is turned on and the bus voltage is discharged through an 8.2 kΩ resistor.

LED5 (labeled “Discharge”) turns on during discharging. Do not touch the product until LED5 turns off again after the power is shut off, as voltage is applied internally and there is a risk of electric shock.

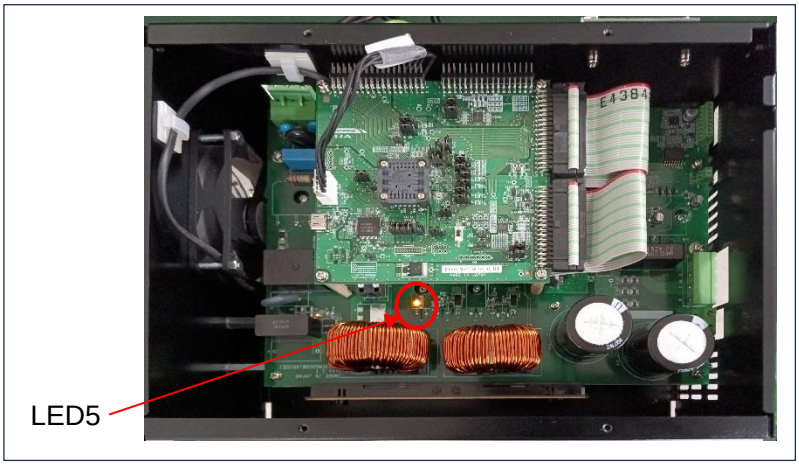


Fig. 4-2 Discharging LED

4.2 PFC

4.2.1 PFC control

Both single PFC and interleaved PFC control are available. For interleaved PFC control, 1-shunt and 2-shunt current sensing are available. Shunt resistance is 5mΩ for 1-shunt sensing and 10mΩ for 2-shunt sensing, respectively.

PFC current sensing signals are converted to analog signals ranging 0~AVCC according to the following equation and output to CPU board connector as IPFC1_AD, IPFC2_AD.

1-shunt sensing:

$$\mathrm{IPFC1_AD} = \mathrm{I_{R33//R35}} \times 0.005 \times \frac{10}{1.2} + \frac{\mathrm{AVCC}}{2}$$

2-shunt sensing:

$$\mathrm{IPFC1_AD} = \mathrm{I_{R26}} \times 0.01 \times \frac{10}{1.2} + \frac{\mathrm{AVCC}}{2}$$

$$\mathrm{IPFC2_AD} = \mathrm{I_{R27}} \times 0.01 \times \frac{10}{1.2} + \frac{\mathrm{AVCC}}{2}$$

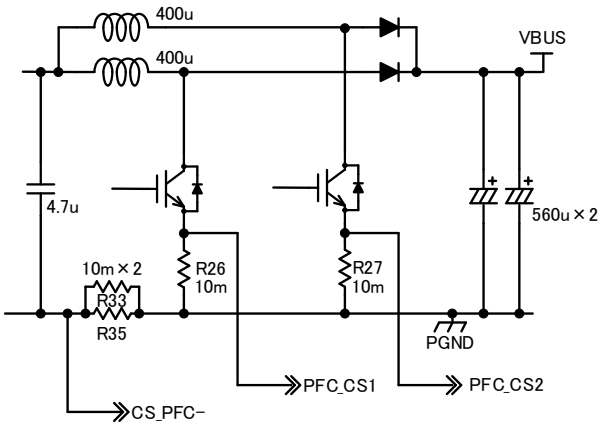


Fig. 4-3 PFC control circuit

4.2.2 PFC over current detection

OC_PFC is HIGH when PFC current is below 49.1 A, and goes LOW when PFC current exceeds 49.1 A. OC_PFC is output to the CPU board connector.

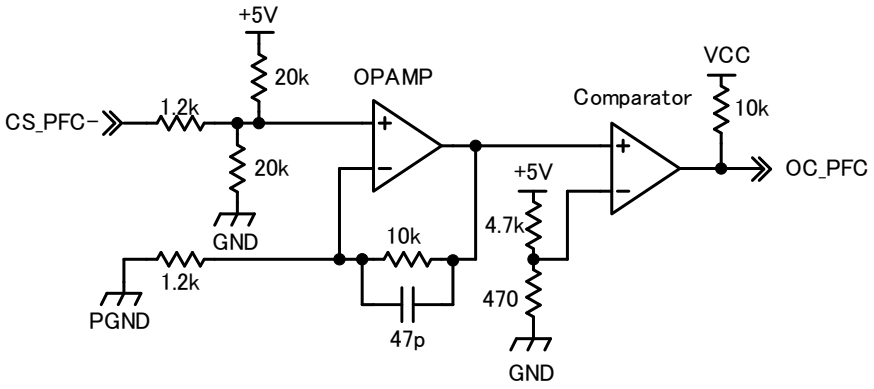


Fig. 4-4 PFC over current detection

4.3 Inverter

4.3.1 Phase voltage sensing

U, V and W-phase voltages (IPM_UOUT, IPM_VOUT, IPM_WIOUT) are converted to analog signals ranging 0~AVCC according to the following equation and output to CPU board connector as UV_AD, VV_AD and WV_AD.

$$\mathrm{VU_AD} = \mathrm{IPM_UOUT} \times \frac{6.8}{2006.8}$$

$$\mathrm{VV_AD} = \mathrm{IPM_VOUT} \times \frac{6.8}{2006.8}$$

$$\mathrm{VW_AD} = \mathrm{IPM_WOUT} \times \frac{6.8}{2006.8}$$

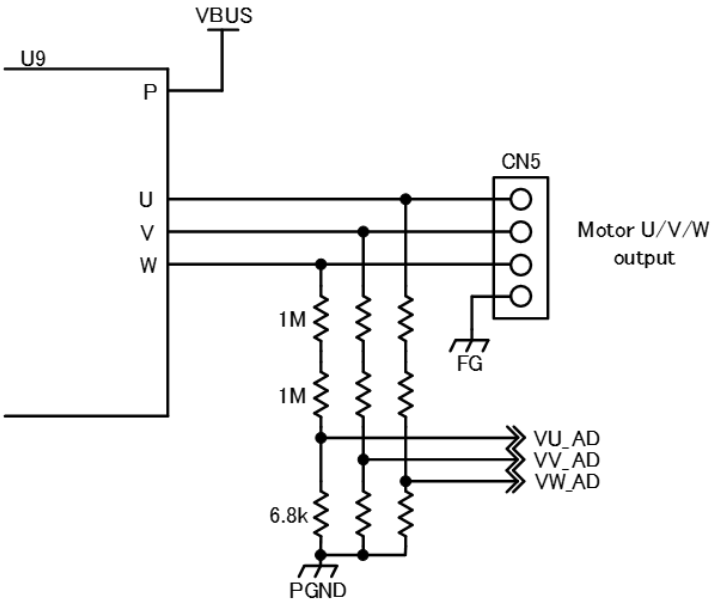


Fig. 4-5 Phase voltage sensing

4.3.2 Phase current sensing

For 3-shunt current sensing, U, V and W-phase currents (IU, IV, IW) are sensed with shunt resistor (10mΩ) and amplifier (gain: 10/2.4), and are output to CPU board connector according to the following equations.

$$\mathrm{IU_AD} = \mathrm{IU} \times 0.01 \times \frac{10}{2.4} + \frac{\mathrm{AVCC}}{2}$$

$$\mathrm{IV_AD} = \mathrm{IV} \times 0.01 \times \frac{10}{2.4} + \frac{\mathrm{AVCC}}{2}$$

$$\mathrm{IW_AD} = \mathrm{IW} \times 0.01 \times \frac{10}{2.4} + \frac{\mathrm{AVCC}}{2}$$

By switching JP1 and JP2 according to Table **2-4**, 1-shunt current sensing is also available. The 1-shunt current is sensed and output to CPU board connector as IU_AD.

$$\mathrm{IU_AD} = \mathrm{I_{total}} \times 0.01 \times \frac{10}{2.4} + \frac{\mathrm{AVCC}}{2}$$

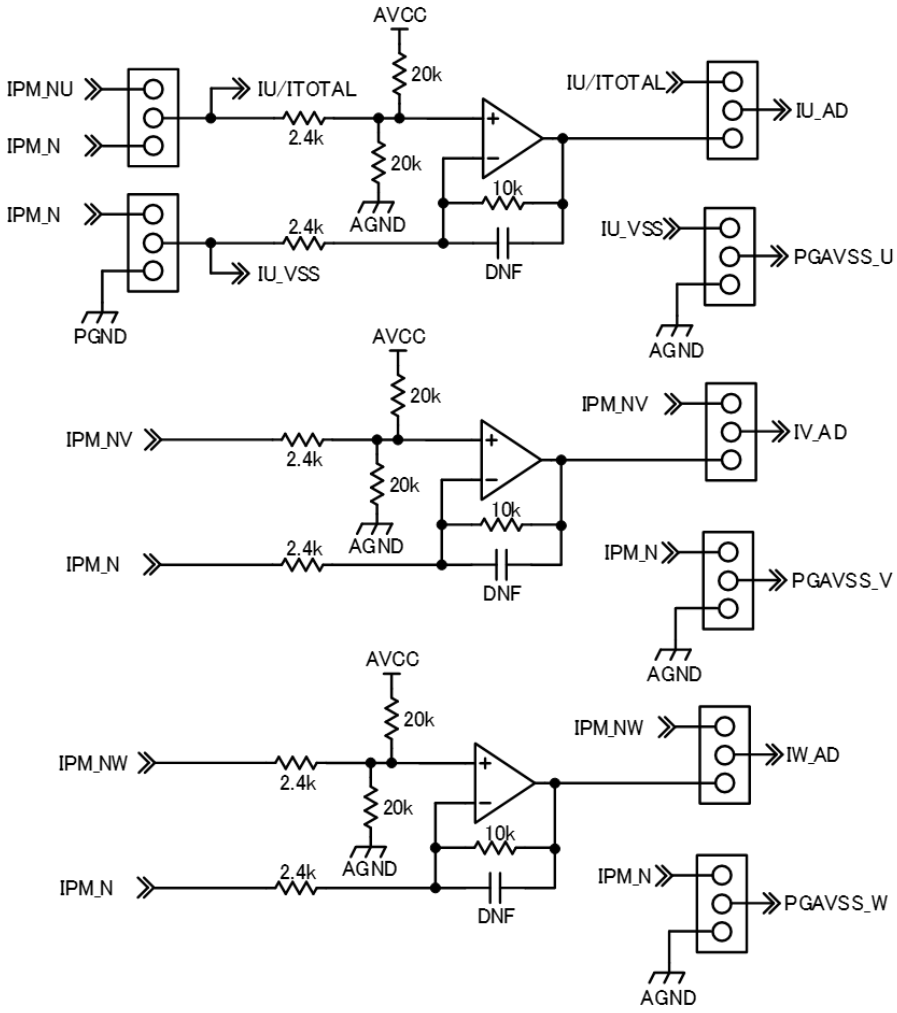


Fig. 4-6 Phase current sensing circuit

4.4 Protection

4.4.1 Inrush current protection

This circuit prevents inrush current at AC power on. Note that the function does not work when DC input is used.

When the signal “RELAY_IN” is LOW, the relay (U1) is turned off and the bus voltage is charged through the thermistor (R3).

When “RELAY_IN” is HIGH, the relay (U1) is turned on.

User should control “RELAY_IN” to be LOW at the startup and to be HIGH after charging up the bus voltage. “RELAY_IN” is input from pin 15 of CN9.

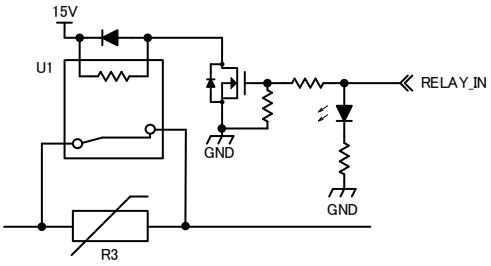


Fig. 4-7 Inrush current protection circuit

4.4.2 Over temperature detection

If the temperature of the IGBT module (U9) exceeds 90°C or the temperature around the PFC coil exceeds 76.9°C, the THERMAL_ERROR signal falls to LOW. Therefore, if you want to protect against overheating, detect the THERMAL_ERROR signal on pin 17 of CN9 with the CPU board and stop the inverter operation, etc.

4.4.3 Overvoltage detection

When the bus voltage (VBUS) becomes higher than 437V, control signal RES_ON_G rises and MOSFET Q5 turns on. Once RES_ON_G rises, it only falls when VBUS becomes lower than 426V.

By installing an external regenerative absorption resistor on CN4, it is possible to suppress the VBUS from rising above 437V.

For example, attach a metal-clad resistor with a resistance value of 100 Ω or more/power rating of 200 W, etc.

Avoid attaching resistors of less than 100Ω. The internal absorption circuit may be damaged.

When decelerating from high speed operation, the regenerative absorption resistor must dissipate heat sufficiently, and it must be confirmed that the heat generated by the resistor is within the allowable range.

Note that a brake resistor is not included in this product and must be installed by the user if overvoltage during motor deceleration and so on is to be prevented.

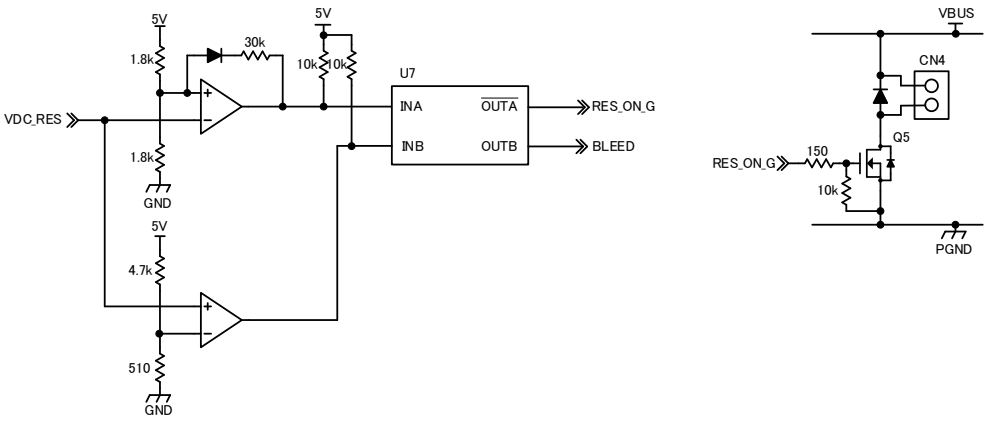


Fig. 4-8 Over voltage detection

4.4.4 PWM signal overwrap protection

U17 provides overwrap protection for PWM signals to control IGBT module. When lower side PWM signal (UN_IPM, VN_IPM and WN_IPM) is HIGH, upper side PWM signal (UP_IPM, VP_IPM and WP_IPM) is always LOW. (lower side signal has priority)

4.5 Communication I/F

Fig. **4-9** shows communication I/F circuit. The digital isolator (U19) provides reinforced isolation between this product and external devices such as communication board and PC. The power for the communication I/F is supplied with USB cable connected to CN12.

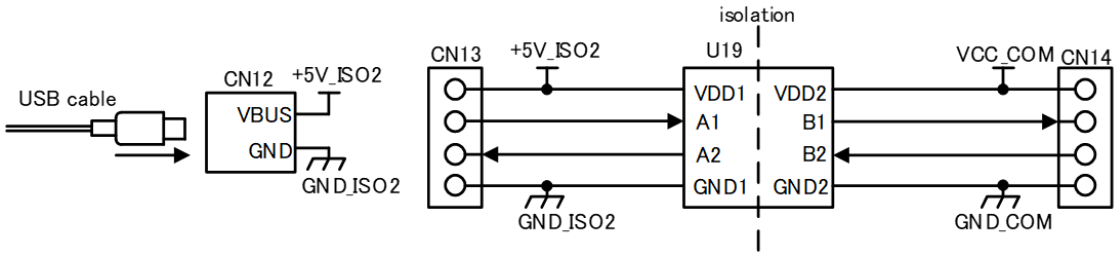


Fig. 4-9 Communication I/F circuit

4.6 Sensor I/F

This sensor I/F supports hall sensor and encoder.

Fig. **4-10** shows sensor I/F circuit. The digital isolator (U20) provides reinforced isolation between this product and external devices such as encoder sensor. The power for the sensor I/F must be externally supplied to pin 7 of CN11.

Regarding encoder signals, it supports single-end input and differential input. However, when using differential inputs, the jumper resistors must be switched.

Hall signal input and encoder signal input share the sensor I/F connector CN11. Pin assignments is shown in Fig. **2-4**. JP5, JP6, and JP7 are used to switch whether the signal is output to the CPU board connector as hall sensor signals or encoder signals. See Table **2-4** for details of the settings.

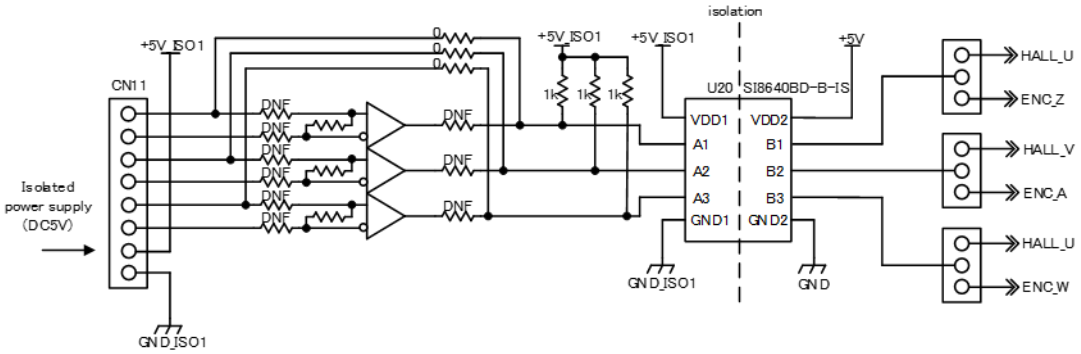


Fig. 4-10 Sensor I/F circuit

5. Safety notice

- Use of this product in a way not specified in this document or the safety manual may result in a loss of safety protection provided by this product. Be sure to use this product in accordance with the ways specified in this document and the safety manual.
- High voltages are applied during operation of this product. Touching this product during operation may cause electric shock, be sure to take safety measures as shown in 3.1(8).
- Do not perform wiring work while the power is on. There is a risk of electric shock or damage to the circuit. Please do so with the power turned off.
- When inputting main power supply from the power connector (CN2 or CN3), be sure to connect a circuit protector and noise filter.
- The protective earth terminal (PE) must be grounded. See3.1(6).
- When connecting a resistor to the connector (CN4) for over voltage protection, please select a power resistor of 100 Ω or more and rated power of 200W or more that matches the evaluation environment.
- Regarding the disconnecting device (circuit protector), it should be properly located as follows.

  - Do not locate it so that it is difficult to operate the device.

  - It must be suitably located and easily reached.

  - It must be marked as the disconnecting device for this product.
- Please read this manual carefully before handling. Incorrect jumper settings may cause damage to the circuit.

6. Regulatory information

This product complies with the following directives.

- Low Voltage Directive : 2014/35/EU (EN61010-1)
- EMC Directive : 2014/30/EU (EN61326-1:2021)

  EMI : Class A
  EMS : Industrial Electromagnetic Environment
  Countermeasures to achieve compliance:

  1. A ferrite core (manufacturer: SEIWA, model: E04SR200935A, 3 turns) was attached to DC Power Line of DC15V power supply.
  2. A ferrite core (manufacturer: SEIWA, model: E04SR482648, 2 turns) was attached to AC Power Line of DC power supply unit.
  3. A ferrite core (manufacturer: SEIWA, model: E04SR401938, 7 turns) was attached to AC Power Line for FG line.
  4. A ferrite core (manufacturer: SEIWA, model: E04SR401938, 3 turns) was attached to power line (to motor) for U,V and W line (without FG line)
  5. A ferrite core (manufacturer: KITAGAWA, model: RFC-20, 3 turns) was attached to power line (to motor) for U,V,W and FG line
  6. A ferrite core (manufacturer: KITAGAWA, model: RFC-H13, 1 turn) was attached to power line (to motor) for U,V,W and FG line

7. Website and Support

You can obtain information on the design and manufacture of this product from renesas.com.
In order to learn, download tools and documents, apply technical support for the kit, visit the below Web site.
• Renesas Support renesas.com/support

Revision History

Rev.	Date	Description	
		page	Summary
1.00	February 28, 2024	–	First edition

MCI-HV-1 User's Manual

Renesas Electronics Corporation