User's Manual

MCI-HV-AC User's Manual

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.

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.
	Note that depending on the connection method of measurement equipment, the product or measurement equipment may be damaged, so please take special care in connecting GND of them.
	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.

Contents

1. Overview

MCI-HV-AC is a total solution evaluation kit for outdoor air conditioner units. By combining this product with a communication board and peripheral devices, air conditioner outdoor unit control can be achieved.

MCI-HV-AC has the following features.

(1) Supports single-phase AC input (AC100V~240V, 50/60Hz)
(2) Supports 2-motor (compressor, fan) control
(3) Equipped with overcurrent detection function, overvoltage protection function, and overheat detection function
(4) Equipped with four-way valve and expansion valve control interface
(5) Equipped with temperature control sensor interface
(6) Equipped with air conditioner indoor unit communication interface

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. 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.

2. Hardware configuration

2.1 Hardware specification

Table 2-1 MCI-HV-AC overview

Item	Specification
Product name	MCI-HV-AC
Board Part No.	RTK0EM0000B17030BJ
External view	 Note: The actual product may differ from this photo.
Product size	287.5 mm(W) x 221 mm(L) x 82 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-AC specification

Item		Specification
Rated input		100~240Vac,2.4kVA,50/60Hz(input from CN1)
Rated output		3 phase,10 Arms(for compressor), 3 phase 1 Arms(for fan)
Switching frequency		PFC : 32 kHz (typical) Inverter : 8kHz (typical), 20kHz (max)
Current sensing		1-/3-shunt sensing
Voltage sensing		AC input voltage, Bus voltage
Protection function	Over current	I_{PFC} : 51.4A IPM1 : 50.5A IPM2 : 5.4A
	Over voltage	445V
	Over-temperature	Inverter, Diode-Bridge :70 °C , PFC:80 °C,
Supporting external temperature sensor		4ch
Supporting peripheral function		Electronic expansion valve(EEV) , 4way valve
Communication		RMW, JTAG, Communication with indoor unit

Table 2-3 MCI-HV-AC performance

Item	Specification
No load standby power	7.2W
PFC Power Factor	0.996 (AC200V input, rated output)
PFC efficiency	97% (AC200V input, rated output)
Inverter efficiency	Inverter 1 : 96% (AC200V input, rated output) Inverter 2 : 96% (AC200V input, rated output)

Table 2-4 MCI-HV-AC MCU details

Item		Specification
Mounted MCU	Product group	RX26T group
	Product No.	R5F526TFCDFP
	Maximum operating frequency	120MHz
	Bit count	32 bit
	Package / Pin count	LFQFP / 100 pin
	ROM	512KB
	System clock	120MHz (Generate with internal PLL)
MCU Power supply		DC5V
Debugger		JTAG compatible

2.2 Function block diagram

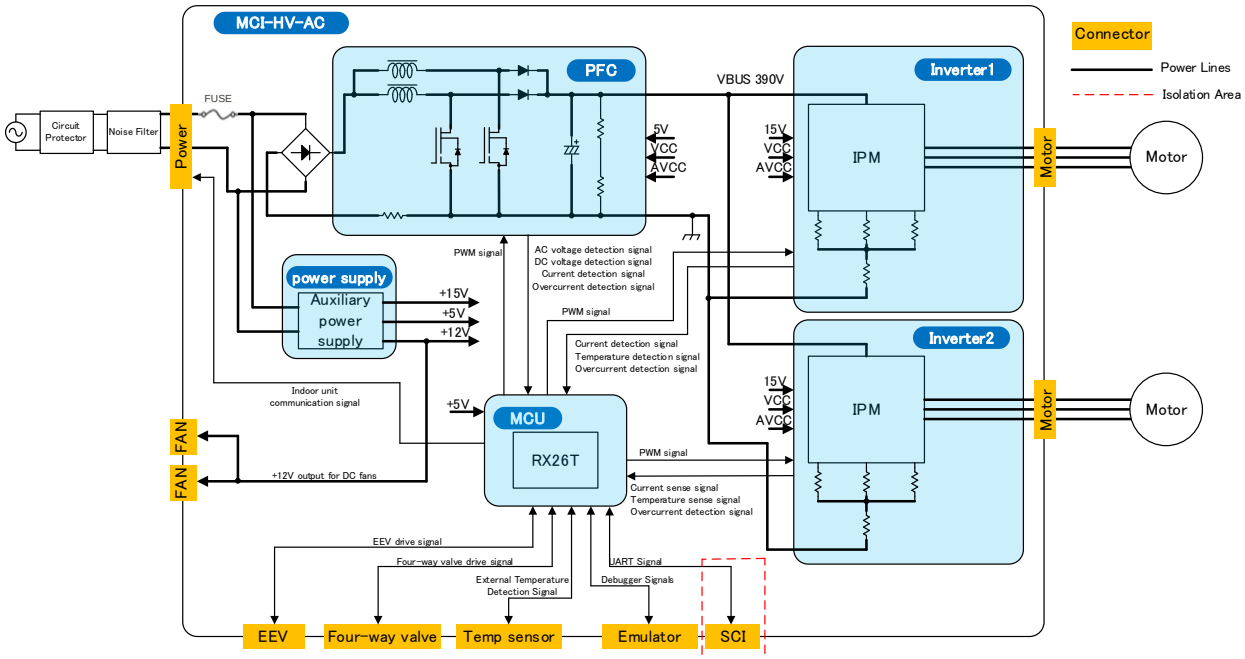


Fig. 2-1 MCI-HV-AC function block diagram

2.3 Board Layout

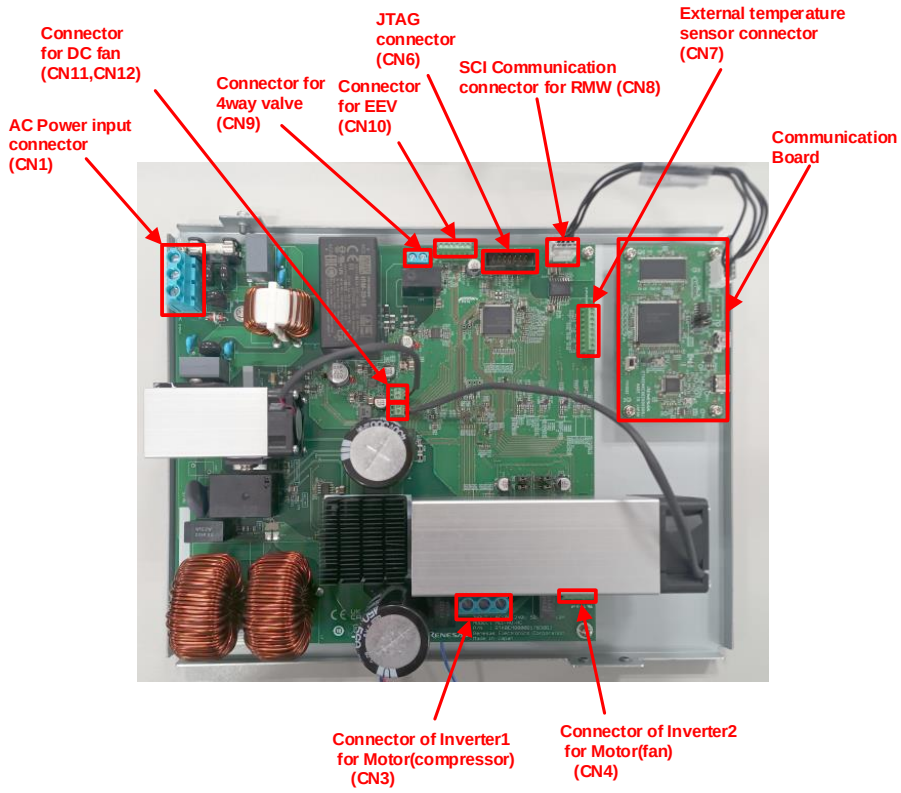


Fig. 2-2 Board layout

2.4 Jumper setting

Default setting and function of the jumpers (JP1~JP4) are as follows.

Table 2-5 Jumper setting of inverter board

Jumper pin	Default setting	Function
JP1, JP2	2-3pin short	1-2pin short: INV1 3-shunt 2-3pin short: INV1 1-shunt
JP3, JP4	1-2pin short	1-2pin short: INV2 3-shunt 2-3pin short: INV2 1-shunt

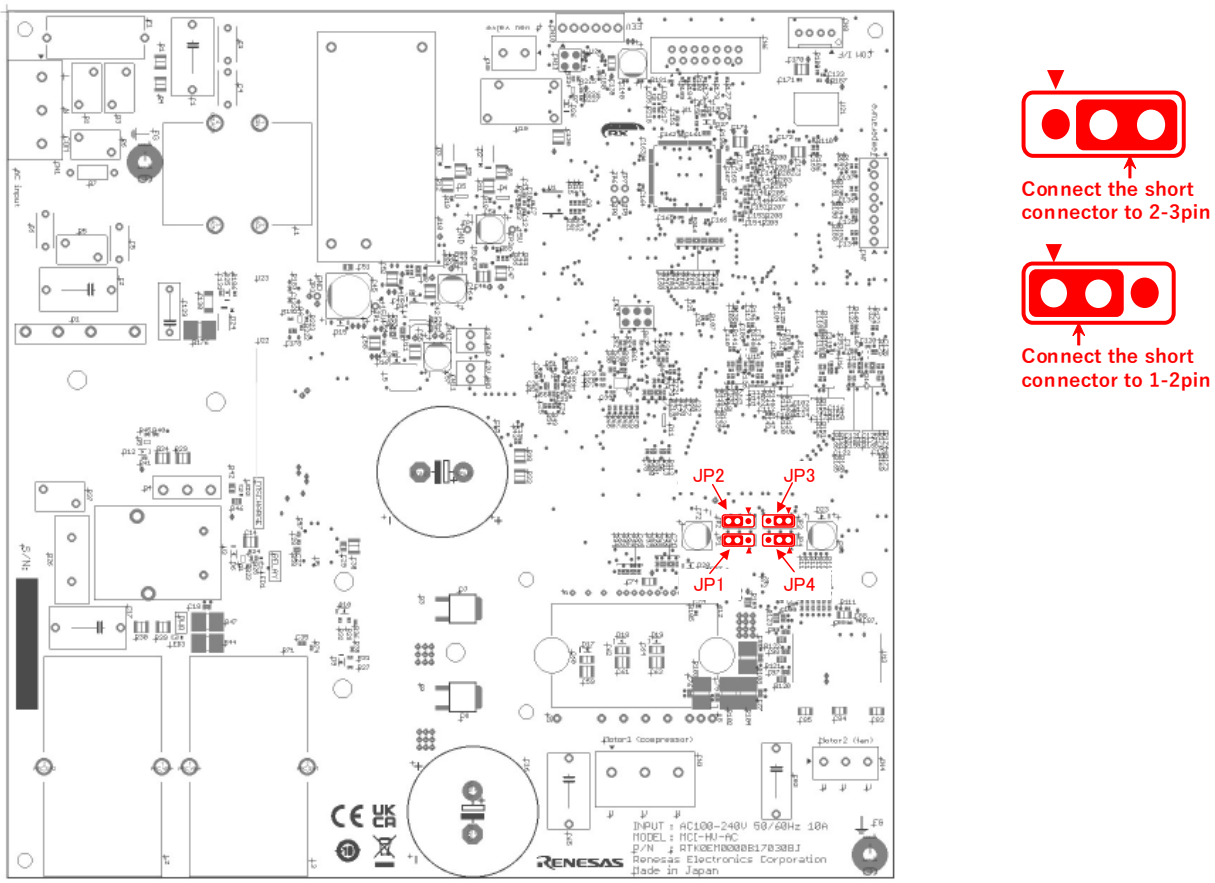


Fig. 2-3 Default jumper pin setting of inverter board

2.5 Connector pin assignment

CN10

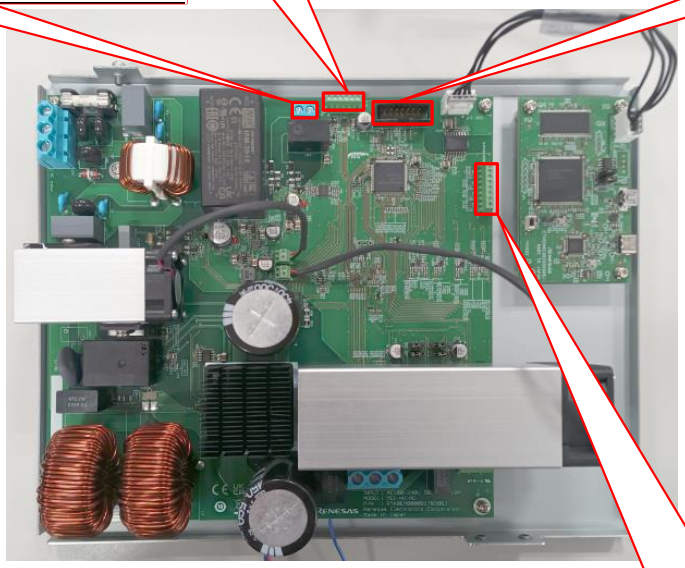
PinNo	Signal Name	function
1	+12V	+12V
2	HV_GPO1_HD2	B +H , B -L
3	HV_GPO1_HD1	B -H , B +L
4	HV_GPO0_HD2	A +H , A -L
5	HV_GPO0_HD1	A -H , A +L
6	GND	GND

CN6

PinNo	Signal Name	function
1	PD4_TCK	TCK
2,12,14	GND	GND
3	PD7_TRST#	TRST
4	PN7_EMLE	EMLE
5	PD3_TDO	TDO
6,10	NC	-
7	PN6_MD/FINED	MD/FINED
8	+5V	+5V
9	PD6_TMS	TMS
11	PD5_TDI	TDI
13	RESET#	RESET

CN9

PinNo	Signal Name	function
1	4WAYVALVE_ACL	4-way valve control
2	ACN	ACN



CN7

PinNo	Signal Name	function
1,3,5,7	+5V	+5V
2	P21_AN217_temp1	Thermistor input terminal 1
4	P20_AN216_temp2	Thermistor input terminal 2
6	P65_AN211_temp3	Thermistor input terminal 3
8	P64_AN210_temp4	Thermistor input terminal 4

Fig. 2-4 Connector pin assignment

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)~(9).
Do not apply main power to the board before you have verified the settings and completed procedures.
Please note that the noise filters and circuit protectors listed are examples only. Please select the appropriate product according to your evaluation environment (power supply, current, etc.).

Table 3-1 Setup items list

Item	Specification, product example
Inverter board	RTK0EM0000B17030BJ (this product)
Communication board	RTK0EMXC90Z00000BJ (Renesas)
Brushless DC Motor1 (compressor)	BXM6200-A (Oriental Motor)
Brushless DC Motor2 (fan)	BXM6200-A (Oriental Motor)
Power supply unit	Output: AC100~240V (1-Phase), 50/60Hz, 15A(100V) / 12A(200V) Isolated stabilized power supply or isolation transformer
Circuit protector	CP30-BA 2P 1-I 20A (Mitsubishi Electric)
Noise filter	NBH-20-432 (COSEL)
PC	Windows10 or later, with USB port
Communication cable	0151370402 (Molex) Included in RTK0EMXC90S00000BJ
USB cable	Type C

For hardware setup, use wiring that meets the following specifications.

For CN1:
- Power wiring diameter: AWG14 (2mm^2) ~ AWG10 (5.5mm^2)
- Strip length: 8mm
- Insulation: 3000Vac/1min to satisfy the insulation requirements

For CN3:
- Power wiring diameter: AWG18 (0.75mm^2) ~ AWG10 (5.5mm^2)
- Strip length: 8mm
- Insulation: 3000Vac/1min to satisfy the insulation requirements

For CN4:
- Power wiring diameter: AWG22 (0.3mm^2) ~ AWG12 (3.5mm^2)
- Strip length: 6mm
- Insulation: 3000Vac/1min to satisfy the double insulation requirements.

For PE:
- Protective earth wire diameter: AWG14 (2mm^2) ~ AWG10 (5.5mm^2)
- Color: Green/Yellow.

(1) Open the main unit cover

Remove the 10 screws securing the main unit cover and open the main unit cover.

Fig. 3-1 Removing the main body cover

(2) Connect the communication board

Connect the communication board to the SCI connector(CN8) on the inverter board with a communication cable, then connect the communication board to the PC with a USB cable.

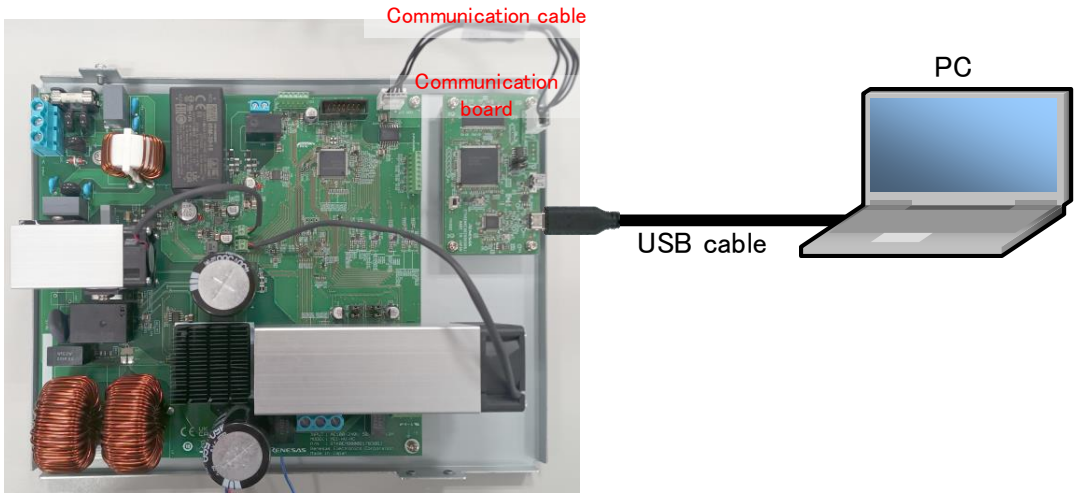


Fig. 3-2 Board Connection (Communication board, PC)

(3) Connect the motor1 to the inverter board

Connect the U, V, W phases of the motor cable to the motor connector (CN3) , and connect the FG cable of the motor to the chassis as shown below.

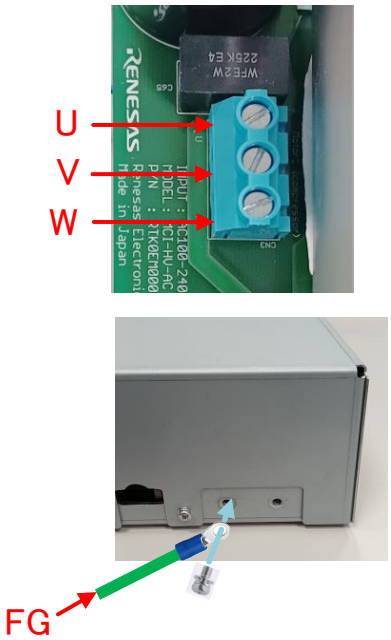


Fig. 3-3 Motor1 Connection

(4) Connect the motor2 to the inverter board

Connect the U, V, W phases of the motor cable to the motor connector (CN4) as shown below, and connect the FG terminal of the board with an FG cable.

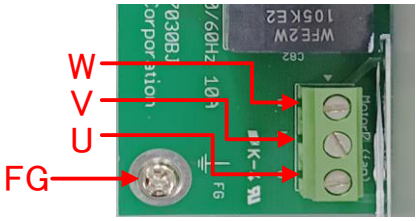


Fig. 3-4 Motor2 Connection

(5) Connection of peripheral devices (option)

This board has a four-way valve connector(CN9), an expansion valve connector(CN10), temperature detection thermistors connector(CN7), and an Emulator connector(CN6) for writing to the MCU. For pin assignments, see Fig. 2-4.

The four-way valve connector can be connected to a solenoid valve, and the expansion valve connector can be connected to a stepping motor, but they must be covered with a cover to prevent users from touching them during operation, and installed at a distance of more than 10cm from the cover.

The temperature detection thermistor must be installed in the housing, with insulation tubes or other insulation of 600V or more.

The Emulator connector must only be used when writing a program to the MCU when the power is off, and must be removed when power is turned on.

(6) Connect the protective earth cable

Connect the protective earth cable with crimp terminal to the PE terminal on the chassis with the round crimp terminal using the M4 screw. The screw is pre-installed on the board.
The protective earth cable should be fixed in place and the insulation distance from the surroundings should be at least 3 mm.

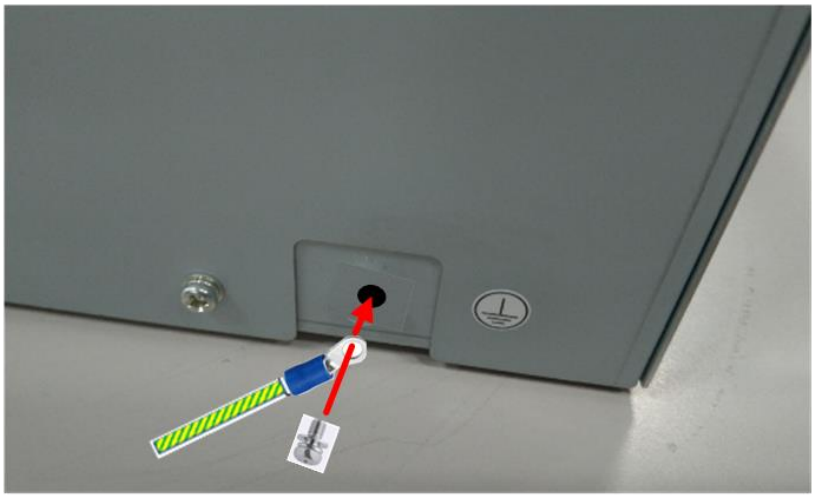


Fig. 3-5 PE connection

(7) Power supply connection

Connect AC power supply to the power connector on the inverter board (CN1) of the inverter board via a circuit protector and noise filter. Connect L to pin 1 of CN1 and N to pin 2. Also, connect the PE terminal of the AC power supply to the PE terminal of the main chassis as shown in Fig. 3-5

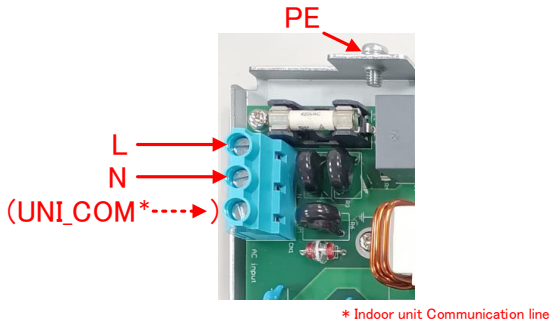


Fig. 3-6 AC power supply connector

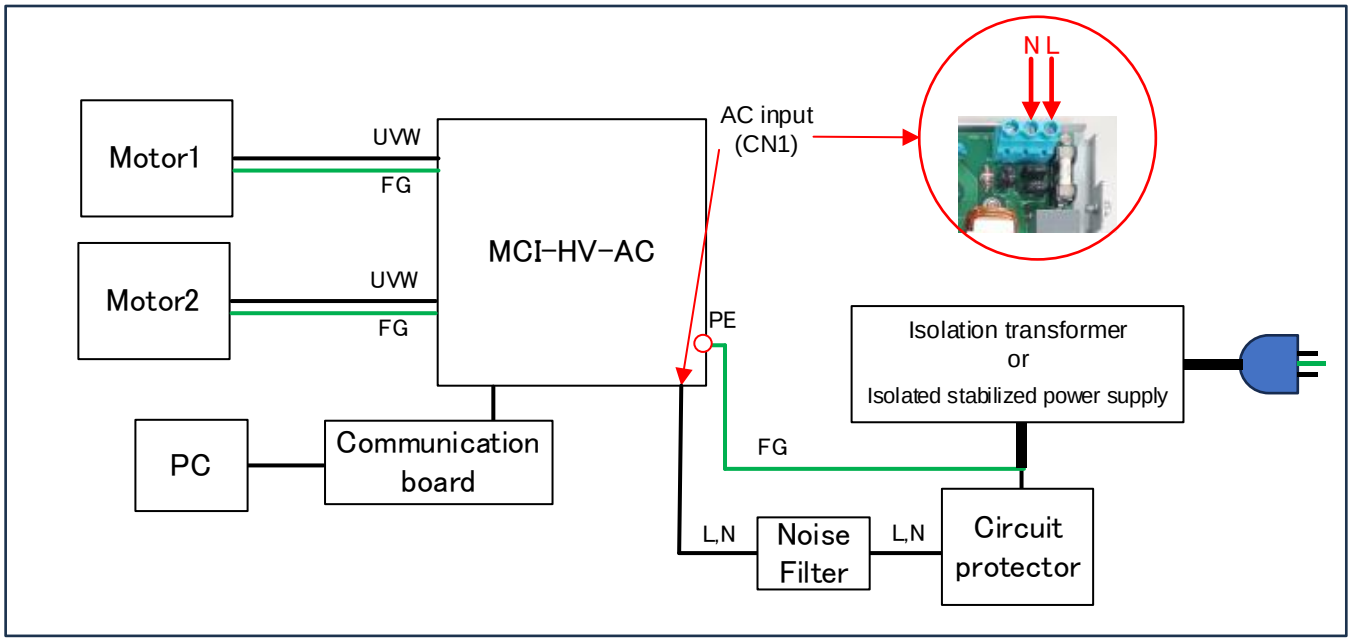


Fig. 3-7 Connection of AC power supply

(8) Close the main unit cover

Close the main unit cover and tighten the screws securely.

Fig. 3-8 Close the main unit cover

(9) Cover the system for safety

To use this product safely, be sure to cover the boards 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. 3-9. 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.
- The heat radiation slit must be designed so that a test pin with a diameter of 4 mm cannot be inserted.
- Fix this product to the metal base plate with screws, cover the entire product with the enclosure, and then fix the base plate and the enclosure with screws.

When connecting optional peripheral devices, cover them to prevent users from touching them, and install them in place at least 10cm away from the cover.

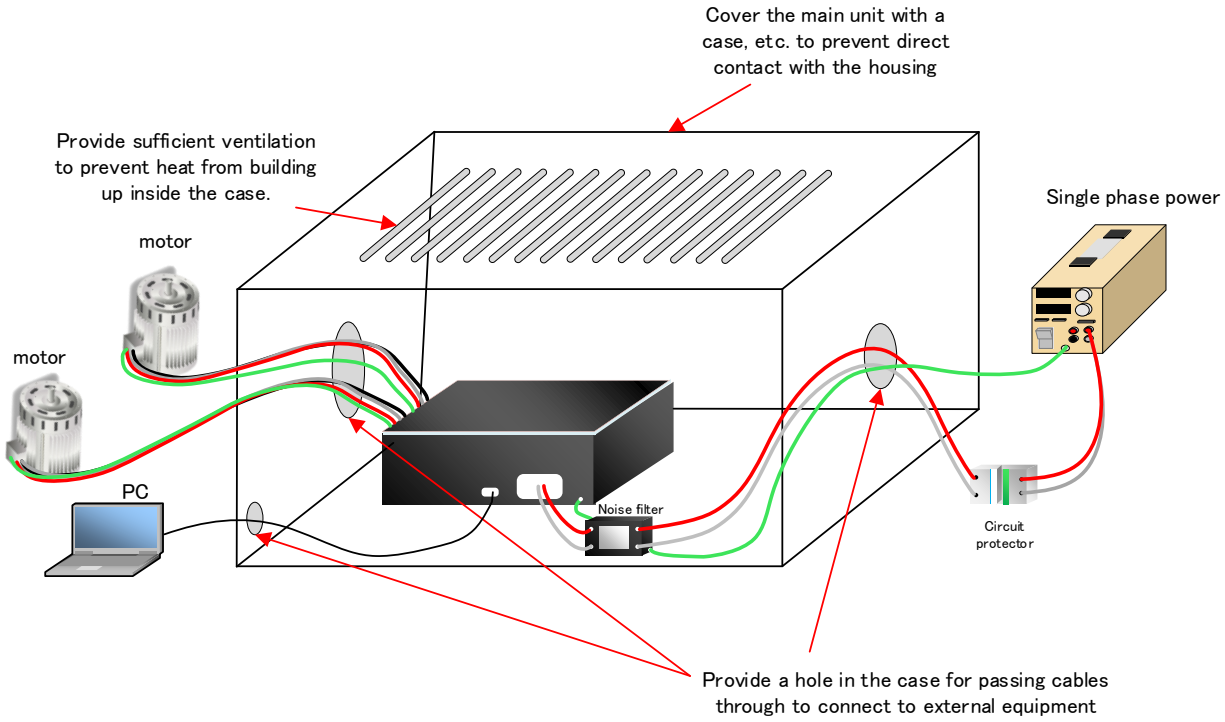


Fig. 3-9 Setup for safe operation

3.2 Motor control operation

The specific method of controlling the motor using this product depends on the specifications of the software written on the MCU with 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

This product internally generates 15V DC, 12V DC, and 5V DC for the primary circuit.
Table 4-1 Regulated voltages shows the details of each power supply.

Table 4-1 Regulated voltages

Voltage	Rated current	Application
DC15V	1.4A	Generates DC5V,DC12V Drives IPM module and relay Drives gate drivers
DC12V	1.0A	Drives DC FAN Drives EEV Drives Four-way valve
DC5V	0.5A	Control circuit, MCU power supply

4.1.2 Voltage sensing

Bus voltage (VBUS) is sensed with the circuit shown in Fig. 4-1 .
The signal (P43_AN003_VBUS) is input to the MCU.

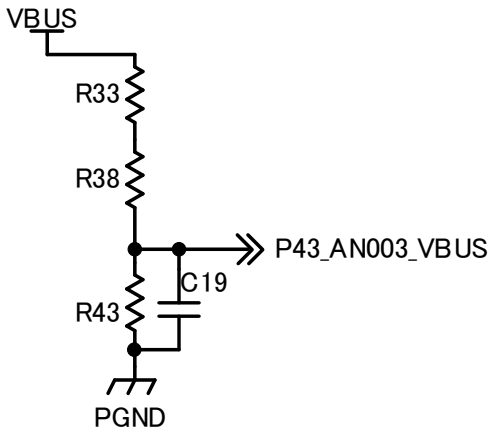


Fig. 4-1 Bus voltage sensing circuit

4.1.3 Discharge control

When main power is shut off, the discharge switch is turned on and the bus voltage is discharged through an IGBT.

LED2 (labeled “DISCHARGE”) turns on during discharging. Do not touch the product until LED2 turns off again after the power is shut off, as voltage is applied internally and there is a risk of electric shock.

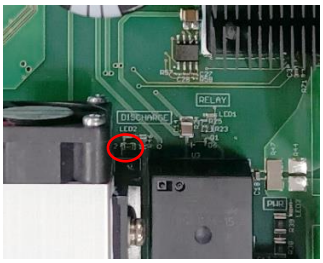


Fig. 4-2 Discharging LED

4.2 PFC

4.2.1 PFC control

Both single PFC and interleaved PFC control are available. For interleaved PFC control, one-shunt current sensing is available. The shunt resistance is 3mΩ.

The PFC current sensing signal is converted to an analog signal in the range of 0 to +5V according to the formula below and input to the MCU as the current detection signal (P62_AN208_IPFC).

$$\mathrm{P62\_AN208\_IPFC} = \mathrm{I_{R47}} \times 0.003 \times \frac{10}{0.75} + \frac{+5\mathrm{V}}{2}$$

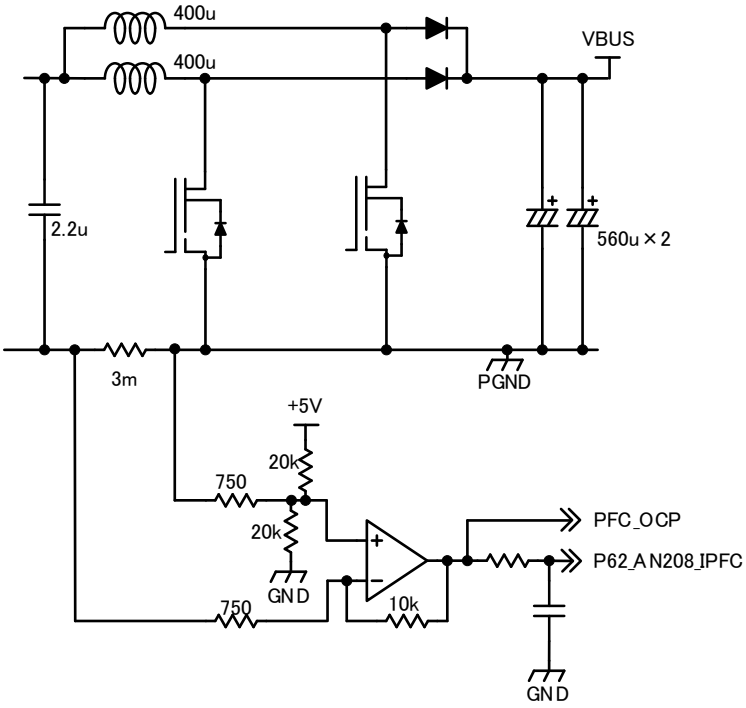


Fig. 4-3 PFC control circuit

4.2.2 PFC over current detection

The PFC overcurrent detection signal is input to the MCU as a signal named (P24_IRQ4_OCPFC) via an operational amplifier and GreenPAK. (P24_IRQ4_OCPFC) is HIGH when the PFC current is less than 51.4A, and is LOW when the PFC current exceeds 51.4A.

In addition, when the PFC current exceeds 51.4A and an overcurrent is detected, the signal named (PFCEN) also switches from HIGH to LOW. Since (PFCEN) is input as the enable signal for U5, no PWM signal is output to the PFC at this time.

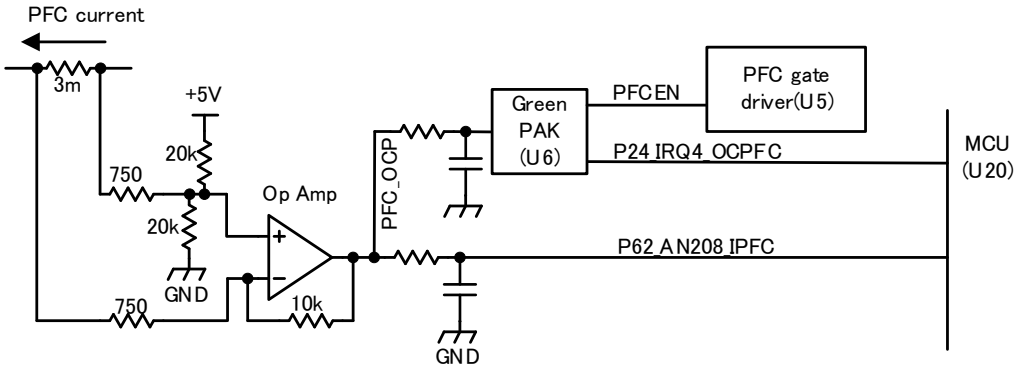


Fig. 4-4 PFC over current detection

4.3 Inverter 1

4.3.1 Current Sensing

In 3-shunt current detection, the U, V, and W phase currents (IU, IV, IW) are detected by shunt resistors (10mΩ) and amplifiers (gain 10/1) and input to the MCU according to the following formula.

$$\mathrm{P40\_AN000\_IU\_1} = \mathrm{IU} \times 0.01 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

$$\mathrm{P41\_AN001\_IV\_1} = \mathrm{IV} \times 0.01 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

$$\mathrm{P42\_AN002\_IW\_1} = \mathrm{IW} \times 0.01 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

1-shunt current detection is also possible by switching JP1 and JP2 according to Table 2-5.
The detected 1-shunt current is output to P40_AN000_IU_1.

$$\mathrm{P40\_AN000\_IU\_1} = \mathrm{I_{total}} \times 0.01 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

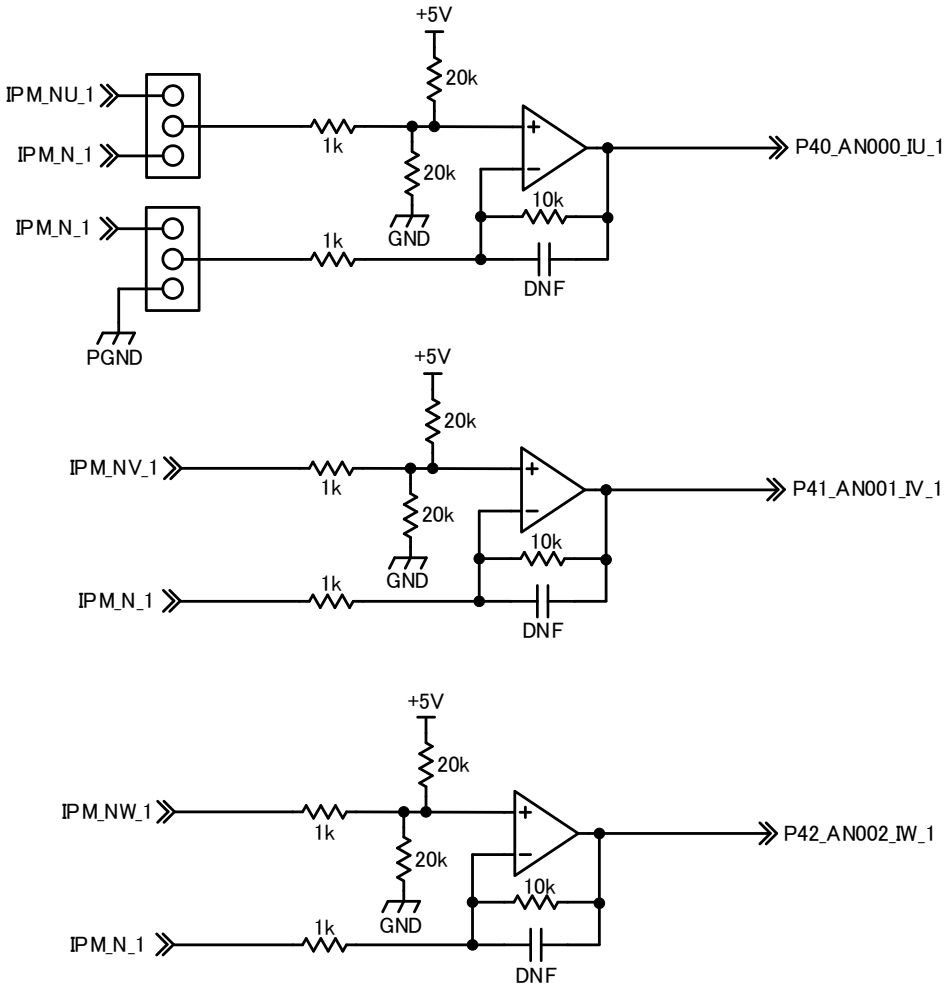


Fig. 4-5 Inverter 1, current detection circuit

4.4 Inverter 2

4.4.1 Current Sensing

In 3-shunt current detection, the U, V, and W phase currents (IU, IV, IW) are detected by shunt resistors (100mΩ) and amplifiers (gain 10/1), and are input to the MCU according to the following formula.

$$\mathrm{P44\_AN100\_IU\_2} = \mathrm{IU} \times 0.1 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

$$\mathrm{P45\_AN101\_IV\_2} = \mathrm{IV} \times 0.1 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

$$\mathrm{P46\_AN102\_IW\_2} = \mathrm{IW} \times 0.1 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

1-shunt current detection is also possible by switching JP3 and JP4 according to Table 2-5.
The detected 1-shunt current is output to P44_AN100_IU_2.

$$\mathrm{P44\_AN100\_IU\_2} = \mathrm{I_{total}} \times 0.1 \times \frac{10}{1} + \frac{+5\mathrm{V}}{2}$$

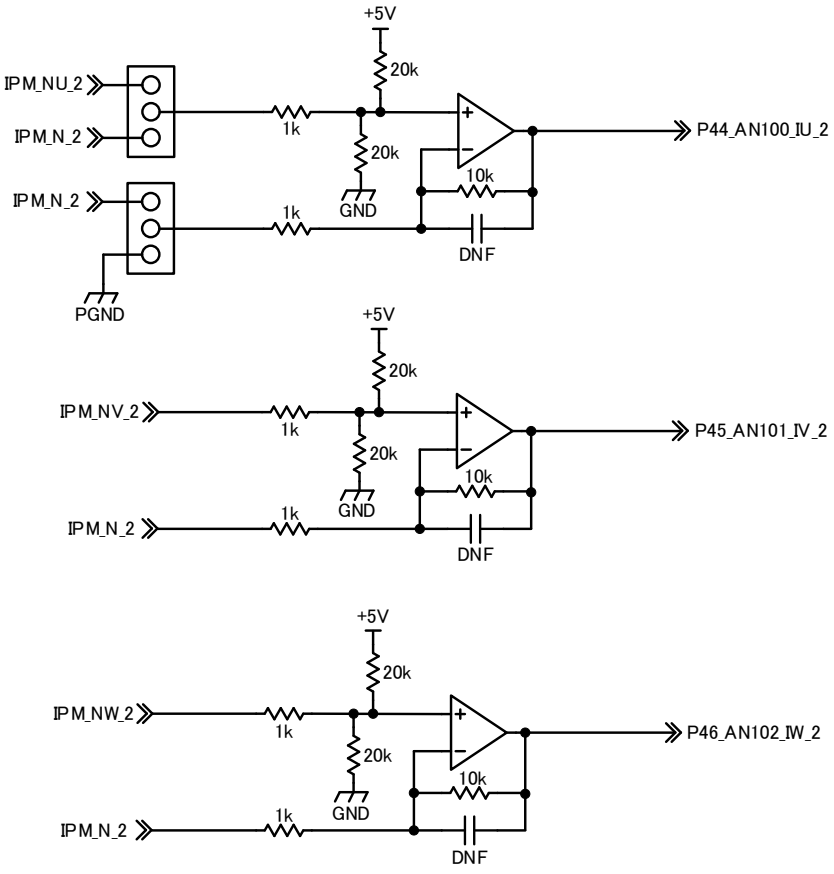


Fig. 4-6 Inverter 2, current detection circuit

4.5 Protection

4.5.1 Inrush current protection

This circuit prevents inrush current when the power is turned on. When the signal (P82_Relay) from the MCU is LOW, the relay (U3) turns off and the bus voltage is charged through the thermistor (R26). When P82_Relay is HIGH, the relay (U3) turns on. The user must control P82_Relay to be LOW at startup and to be HIGH after charging the bus voltage.

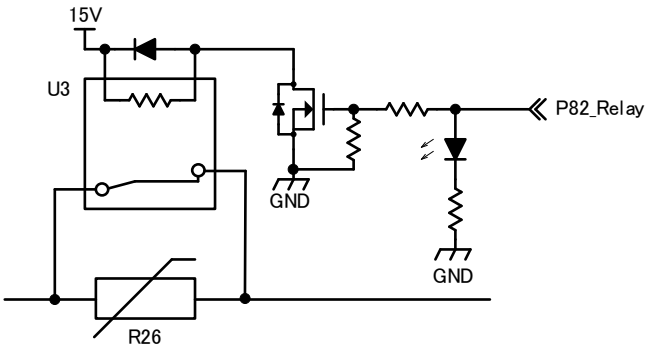


Fig. 4-7 Inrush current protection circuit

4.5.2 Overheat Detection

Thermistors are mounted around the PFC, IPM1, and Diode Bridge. The temperature of each part is detected by inputting analog signals to the MCU. If the PFC temperature exceeds 80°C, or if the IPM1, Diode Bridge temperature exceeds 70°C, overheat detection processing is performed. Details are as shown in the table below.

Detection location	Signal Name	Overheat detection temperature	Post-detection processing		
			PFCPWM	IPM1PWM	IPM2PWM
PFC	P55_AN203_PFC	80℃	Stop	Stop	Stop
IPM1	P61_AN207_IPM1	70℃	Continued operation	Stop	Stop
Diode Bridge	P60_AN206_DB	70℃	Continued operation	Stop	Stop

4.5.3 Overvoltage Detection

When the bus voltage (VBUS) becomes higher than 445V, the control signal P27_IRQ15_OVPFC rises and the MCU performs overvoltage processing. After P27_IRQ15_OVPFC becomes HIGH, P27_IRQ15_OVPFC falls when VBUS becomes lower than 381V.

At this time, a control signal is also output from GreenPAK, and overvoltage processing is also performed on the hardware side for PFC, IPM1, and IPM2. Details are as follows.

Control Point	Signal Name	Actions taken upon detection
PFC	PFCEN	Gate Driver (U5) stops PWM after 125ms
IPM1	IPM1_EN	GreenPAK (U7) stops PWM after 125ms
IPM2	IPM2_EN#	Set the SD pin of U13 to low and stop the PWM after 125ms.

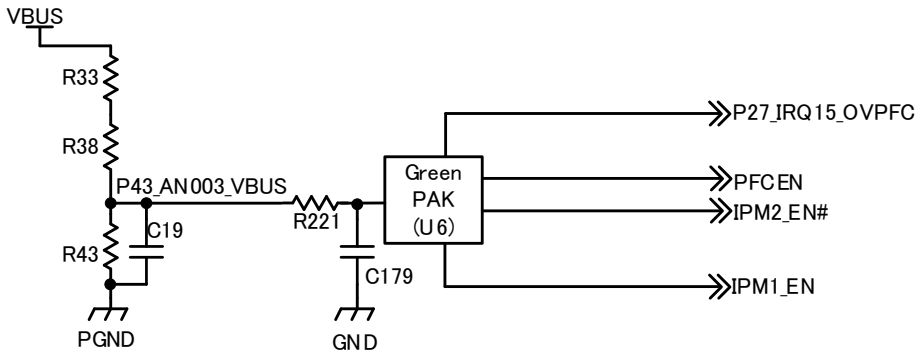


Fig. 4-8 Overvoltage Detection

4.5.4 PWM signal overlap protection

U7 provides overlap protection for the PWM signals to control the IPM1, see 4.12.2 for details.

4.6 Communication Interface

The communication I/F circuit is shown in Fig. 4-9. A digital isolator (U21) enhances the insulation between this product and external devices such as a communication board or PC.

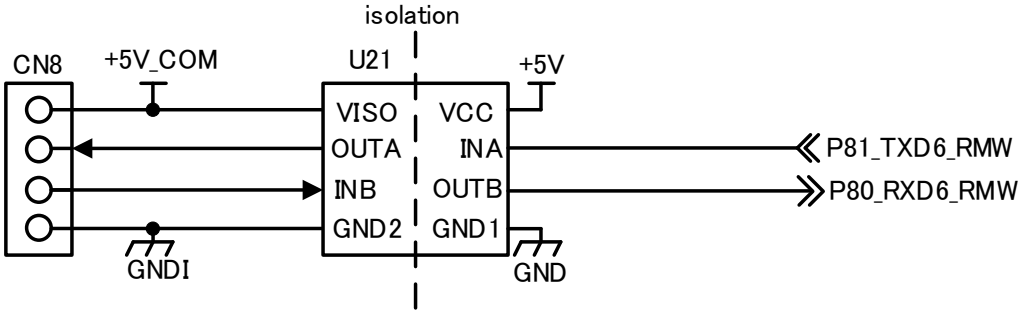


Fig. 4-9 Communication I/F circuit

4.7 Indoor unit communication circuit

The diagram below shows the circuit for communication with the indoor unit. It is a two-way communication circuit, and communication with the indoor unit is performed via CN1.

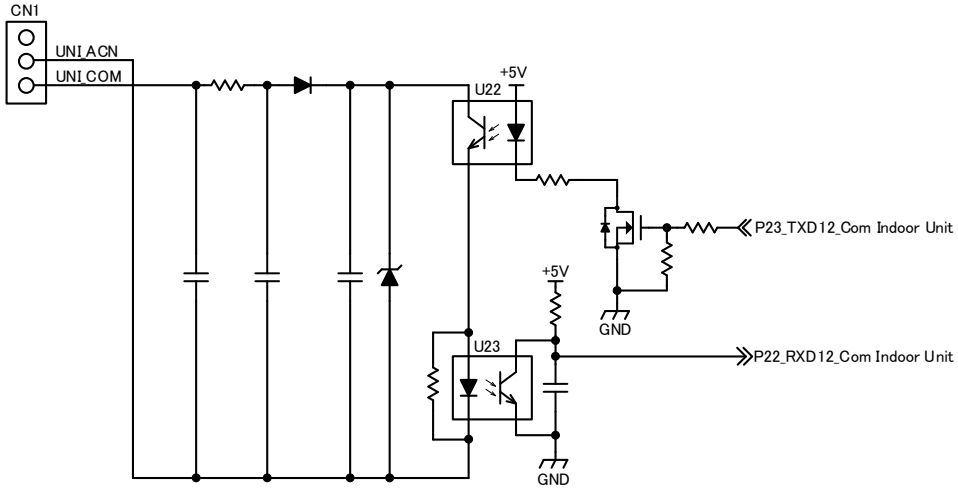


Fig. 4-10 Indoor unit communication circuit

4.8 External temperature detection circuit

It is possible to detect the temperature at any point by connecting a thermistor to pins 1-2, 3-4, 5-6, or 7-8 of CN7 in an external temperature detection circuit. A total of 4 channels are provided, and the temperature detection signal is input to the MCU as an analog signal.

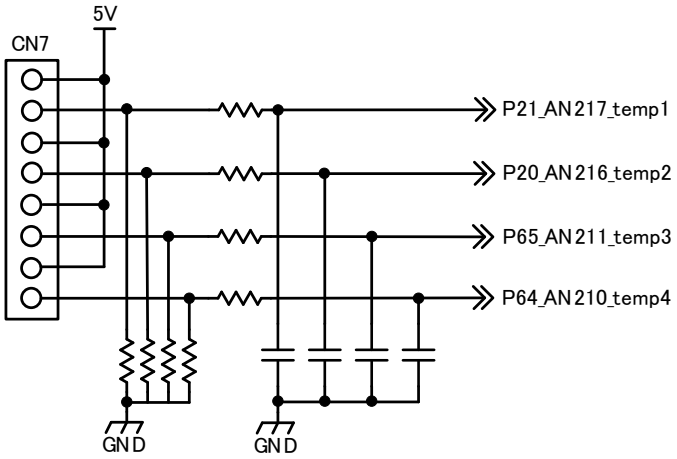


Fig. 4-11 External Temperature Detection Circuit

4.9 EEV drive circuit

This is the circuit for driving the EEV. The MCU outputs PWM signal for driving the EEV, which drives the external EEV through U2.

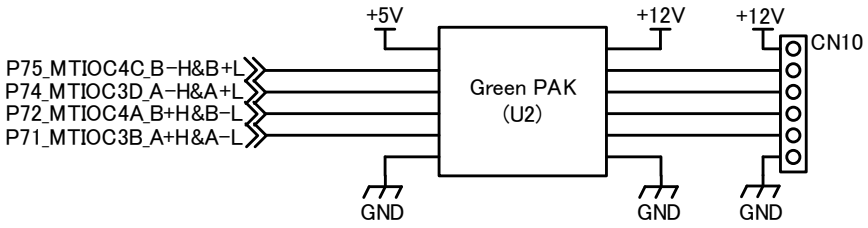


Fig. 4-12 EEV drive circuit

4.10 Four-way valve drive circuit

This is the circuit for driving the four-way valve. The MCU outputs a signal (PB3_4wayValve) for driving the four-way valve, which drives the relay (U19) to operate the four-way valve.

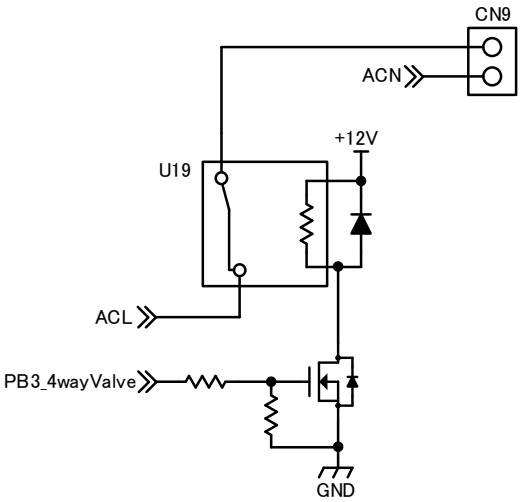


Fig. 4-13 Four-way valve drive circuit

4.11 Debugger connection circuit

This is a circuit for connecting the Renesas debugger E2 emulator. By connecting the E2 emulator to CN6, you can access the MCU.

4.12 GreenPAK

This product is mounted with three different mixed signal programmable device GreenPAKs

4.12.1 Error detection device (U6)

Inputs from OCP (20pin), OV (19pin), FOIPM1 (2pin), and FOIPM2 (3pin)
Output to OVPFC (17pin), OCPFC (18pin), PFCEN (16pin), IPMEN2# (15pin), IPMEN1 (10pin), PWM1 (13pin), and PWM2 (12pin).
The internal circuit configuration is shown in Fig. 4-14.

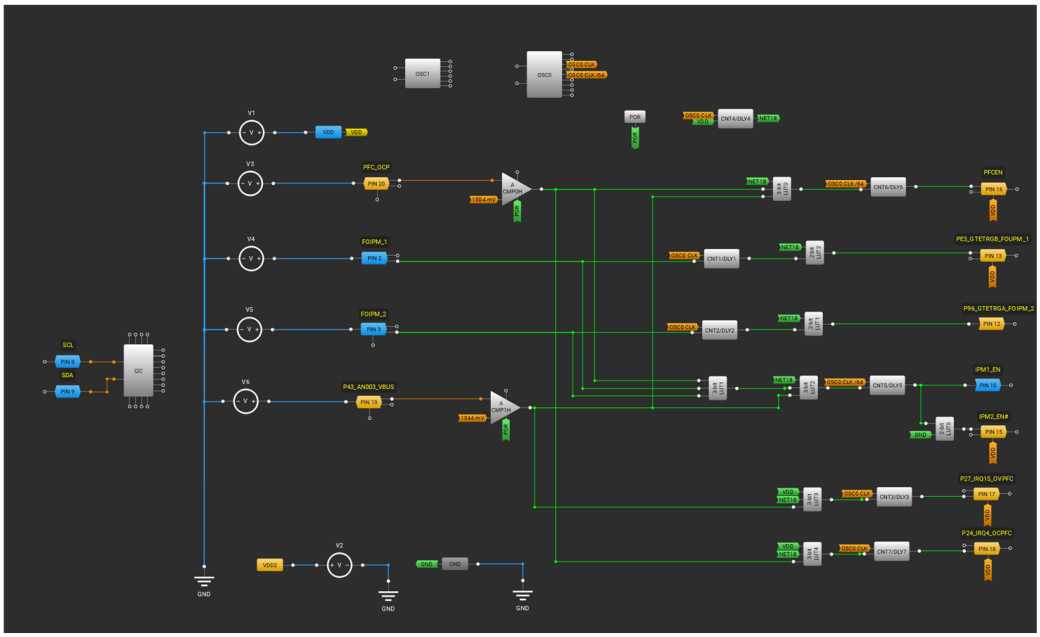


Fig. 4-14 Error detection device (U6) internal circuit

4.12.2 PWM signal overlap protection device (U7)

This circuit protects the high and low sides of the PWM from being turned on simultaneously. If simultaneous-on output waveforms are input, only the low side will be turned on.
The internal circuit configuration is as shown in Fig. 4-15.

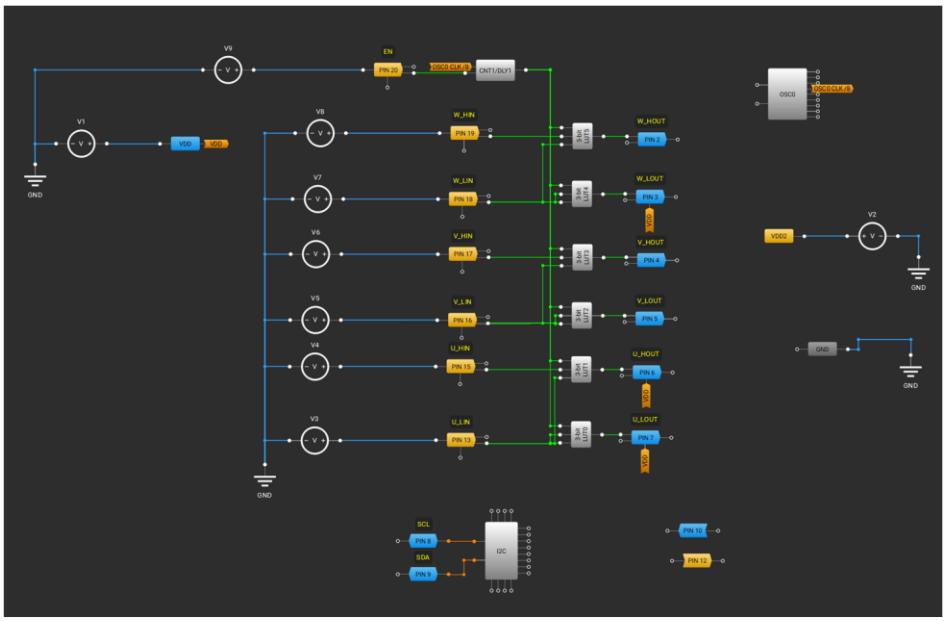


Fig. 4-15 PWM signal overlap protection device (U7) internal circuit

4.12.3 Stepping motor driver device (U2)

When a 5V stepping motor drive waveform is input to GPIO0, GPIO6, GPIO5, and GPIO4, 12V drive waveform is output to HV_GPO0_HD1, HV_GPO0_HD2, HV_GPO1_HD1, and HV_GPO1_HD2.
The internal circuit configuration is shown in Fig. 4-16.

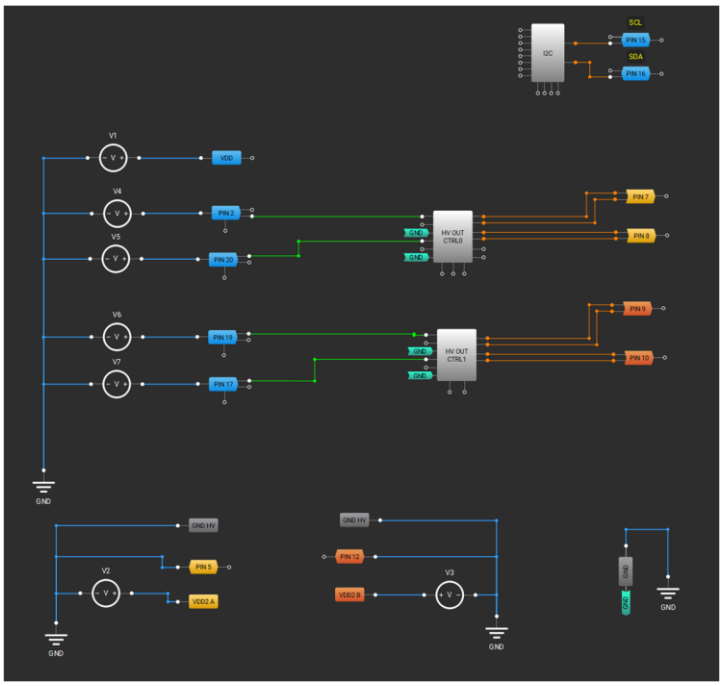


Fig. 4-16 Stepping motor driver device (U2) internal circuit

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(9).
- 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 (CN1), be sure to connect a circuit protector and noise filter.
- The protective earth terminal (PE) must be grounded. See 3.1(6).
- 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.
- When connecting optional peripheral devices, cover them with a cover so that the user does not touch them, and fix them at a distance of at least 10cm from the cover.
- 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: E04SR401938, 3 turns*2) was attached to AC Power Line.
  2. A ferrite core (manufacturer: SEIWA, model: E04SR481938, 3 turns*each2) was attached to U,V,W,FG Line of Motor1 and Motor2.
  3. A ferrite core (manufacturer: TDK, model: ZCAT2035-0930, 1 turns*2) was attached to USB cable.
  4. A ferrite core (manufacturer: TDK, model: ZCAT2035-0930, 1 turns*3) was attached to internal communication cable.

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	March 31, 2025	–	First edition

MCI-HV-AC User's Manual

Renesas Electronics Corporation

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