Trial series “T1102”
3kW 4kVA Inverter Unit
Users Manual

Index

1. Introduction

1.1. Introduction

This users' manual is for T2001B and T2002B low voltage inverter training kit. These inverters are designed for PMSM motor and induction motor. When you use this inverter, please check your motor specifications like sensor, power, voltage range, current range and so on.

1.2. Suitable use

This inverter is suitable for research or development stage.

1.3. Precaution

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1.4. Warning

Danger

・There is a risk of file.

If you find inverter firing, Fuming, abnormal sounding, or other abnormal conditions, stop the inverter immediately. After you stop the inverter, you should disconnect all wiring connected to the inverter.

Danger

・There is a risk of electrical shock.

There is a high voltage parts inside the inverter. Do not touch directly on working or after you stopped the inverter, while there is a charge in the capacitor. If you don't keep this warning, by electric shock, there is a risk of serious injury or death.

Danger

・There is a risk of blindness.

This inverter has an enclosure. If the inverter ruptured while opening the lid of the enclosure, there is a possibility the liquid contained in the internal capacitor, such as

damaged parts enters the eyes, and it would make you blindness. Please do not open the lid of the enclosure after stopped the inverter immediately, even during the operation. If you open the lid, please be sure to wear goggles for protection such as in the photo below.

Caution

・There is a risk of burns

While driving or after stopped, this inverter gets hot such as more than 100 degree. If you touch the inverter, please pay attention to the temperature.

Caution

・Please do not block the air vents of the enclosure. (only for T2000B)

In this inverter there is a vent for cooling the inside. If you block the air vent, cooling capacity is reduced. And it may cause the inverter damage or fire.

Caution

・Please drive the FAN while driving the inverter. (only for T2000B)

In this inverter there is a FAN to cooling the inverter. If you do not drive the FAN while driving the inverter, the temperature of the inverter will rise, it may cause the inverter damage or fire.

Caution

・If you want to create a software, please create the protection routine first, such as over-current protection, over-heat protection and so on.

In this inverter, there is no mechanism to protect the inverter hardware alone. Please make the protection software first, or you may break the inverter.

Caution

・Do not drive the inverter when the ambient is very high or very high humidity.

This inverter is designed for experimental use. So this inverter won't work under below conditions. Do not use under the environment that is out of the operation environment of this manual.

- Environment where there is vibration and shock.
- Environment where there is saprophagous gas, combustible gas, humidity over 90%
- Very High or very low temperature environment

Caution

· This product handing high voltage. Please use a person who is aware of the danger of high voltage.

The wiring materials are enclosed in this inverter for reference. But they do not necessarily mean that they are appropriate for your application. Please use it before check the applications.

Caution

· Rating of this product is measured under certain conditions.

Maximum power capacity would be affected by input voltage output voltage, output current, load conditions, operations conditions and ambient temperature. To prevent the inverter broken, please watch the temperature, current, voltage, and external sensors for to protect inverter.

2. Inverter overview

2.1. Feature

This inverter unit is designed for a research or development of consumer use.

* Non-isolated structure inverter based on an inexpensive circuit for a mass-production.
* This inverter is driven by RL78G14, RX111, RX62T CPUs. (2013/11/22)
* Unused CPU pin can be used freely by the user.
* DC link voltage, three phase output current, three phase output voltage sensor is included.
* Convenient to experiment, top transparent case, with cooling FAN
* Inrush current circuits

2.2. Inverter block diagram

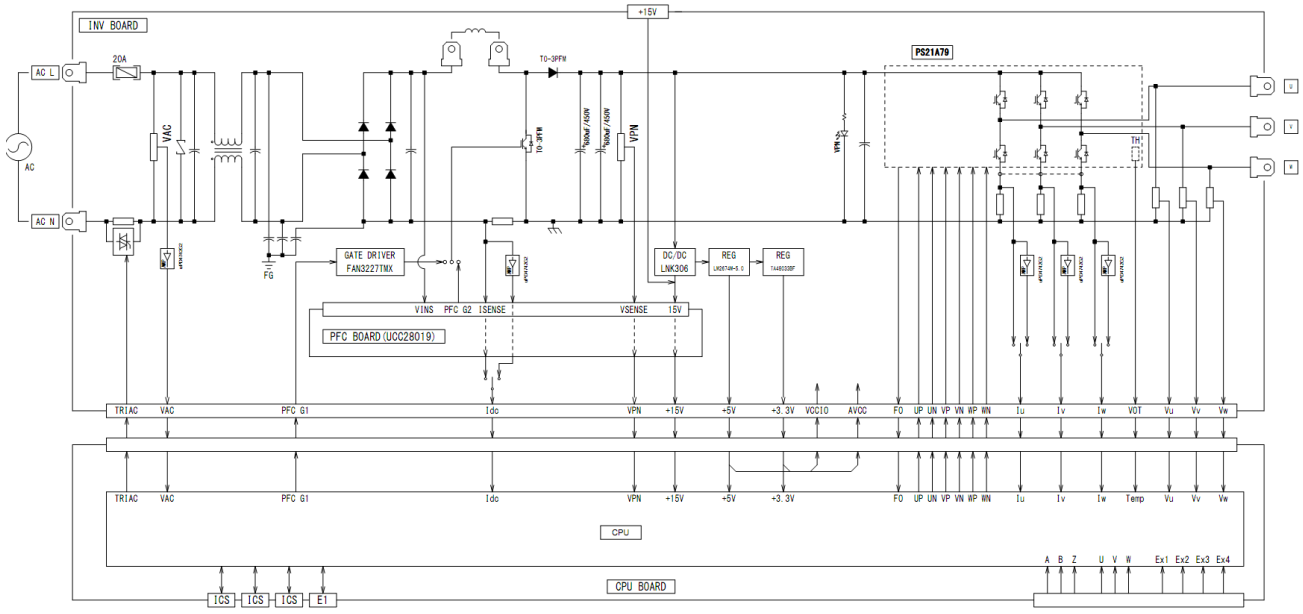


図 2.1. Inverter block diagram

2.3. Specification

Item	Specification	Remark
Operation temperature	0℃～35℃	
Operation humidity	Below 90% (No dew condensation)	
Size	250 x 350 x 180 mm	
Weight	4.0kg	
Input voltage range	AC85V～AC265Vrms	
Maximum input power	3kW at AC200Vrms input	1.5kW at AC100Vrms input
Rated output power	4kVA at AC200Vrms output	At switching frequency 15kHz
Rated output current	AC11.6A rms at AC200V output	At switching frequency 15kHz
Switching frequency	2kHz～20kHz	This data is example
Deadtime	2.5us	This data is example
Current detection	3 shunt	3 shunt is default. Can be changed to 1 shunt type
Shunt register	10mΩ	
Control power supply	PS21A79	MITSUBISHI ELECTRONICS
Control power supply	Generated from DC link	Non-isolated
DC link – control circuit isolation	Non-isolated	
Cooling	Force air cooling	
PFC controller	UCC28019A	
Main circuit devices	FCH041N60F APT60DQ60BCTG	MOSFET FairChild Vds=600V, Id=48.1A @100deg Fast recovery diode APT Vr=600V, If=60A @110deg
Grid voltage sensor		
DC-BUS current sensor		
DC-BUS voltage sensor		
3phase current sensor		
3phase voltage sensor		
IPM temp sensor		

*Caution: Each maximum value, the rated value, may be changed by the type of load, input voltage, ambient environment, such as by air cooling conditions. Desk top laboratories Inc does not guarantee the condition of all the rated and maximum values of these specifications. Please install the protection way by the customer, depending experimental environment and the load environment.

3. Precaution for each circuits blocks

3.1. In-rush current protection circuits

<IMPORTANT>

This inverter has in-rush current protection circuits. In-rush current protection circuit is to prevent the destruction of the inverter main circuits and capacitor. If you power on the inverter when the capacitor does not have the electro charge, very large current flows into the DC link capacitor, because the capacitor voltage is almost 0. Once this situation happens, the inverter is sometimes destroyed. So to prevent large current flows, we add the in-rush current protection circuits. In the system the usage is fixed, there is a type so that it is activated automatically by the hardware. As the usage of this inverter is not fixed, the in-rush current control circuit of this inverter is controlled by the software.

This circuit has current limit resister, relay or Triac. In rush protection function works following. When the power on, relay or Triac is open. After DC-link voltage goes enough high, CPU turns on the relay or Triac.

This protection circuit is to prevent the destruction of the inverter. But if you mistake how to use this circuit, it may break the inverter. Please keep following cautions.

* Procedure example:

A) Keep off the Triac until DC link voltage reaches 80% of the rated PFC voltage.

B) DC link voltage reaches 80% of the rated DC link voltage, then turn on the Triac gate signal.

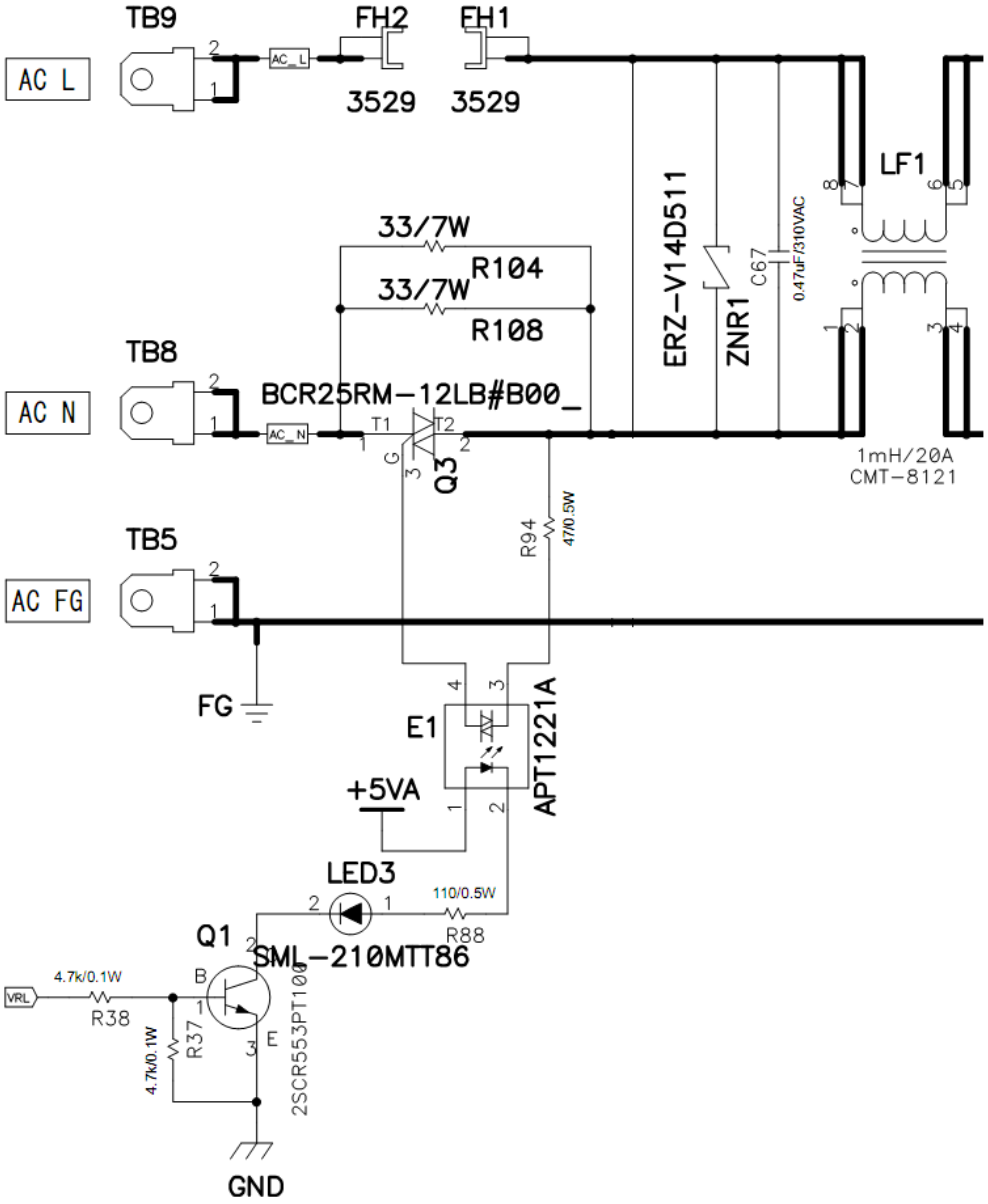
C) Do not off the gate signal forever.

*** Caution**

1) Do not start to work the inverter, before Triac gate signal goes ON state. Or in rush protection resister will burn.

2) Once turn on the Triac gate signal, do not gate off.

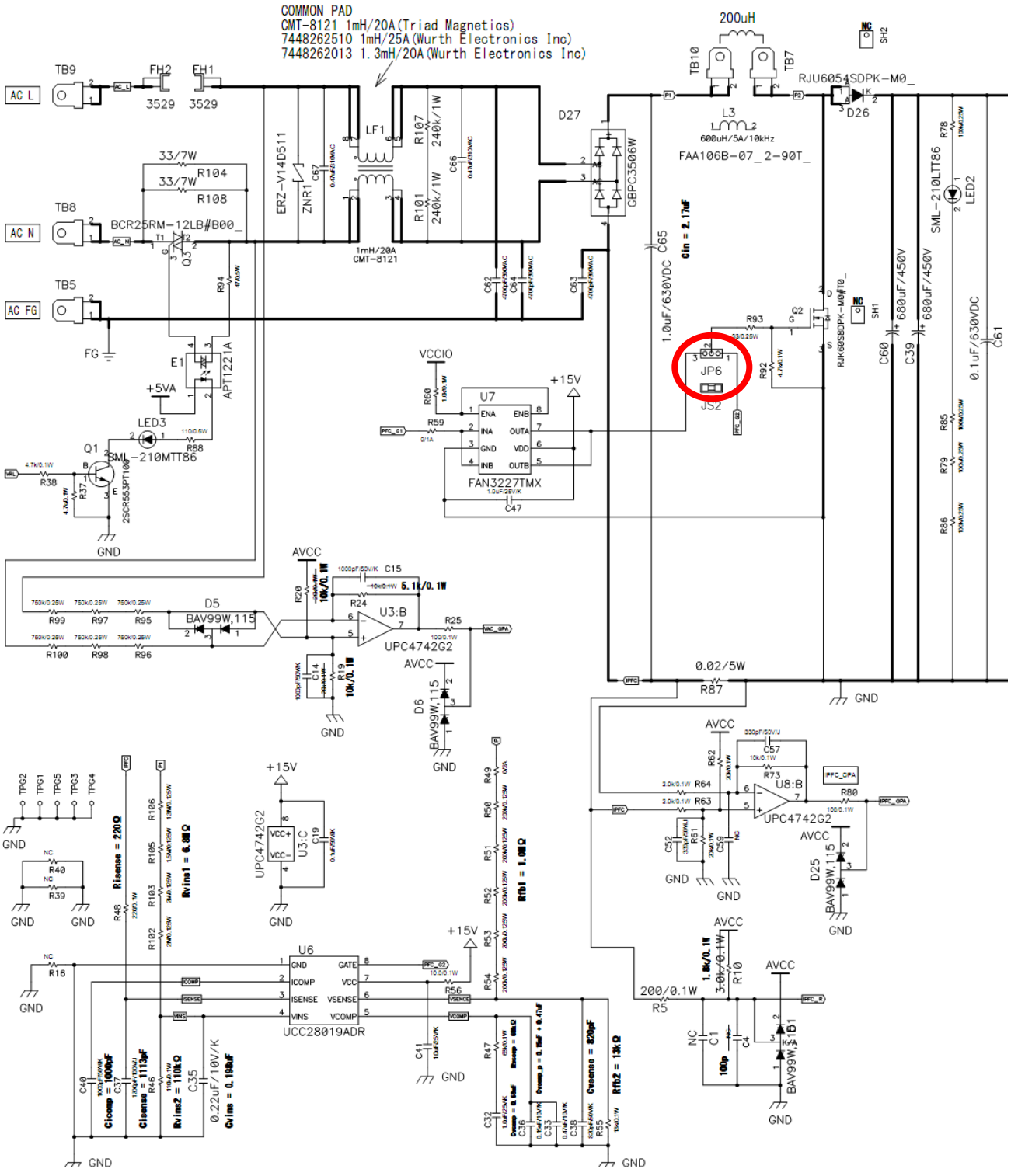
3) Do not power on and off frequently. In rush current protection resister will burn.


TB9
AC L
FH2
FH1
3529
3529
LF1
33/7W
R104
33/7W
R108
ERZ-V14D511
ZNR1
C67
0.47uF/310VAC
TB8
AC N
BCR25RM-12LB#B00_
T1
T2
G
Q3
1mH/20A
CMT-8121
R94
47/0.5W
TB5
AC FG
FG
E1
APT1221A
+5VA
LED3
110/0.5W
R88
Q1
SML-210MTT86
4.7k/0.1W
VRL
R38
B
R37
4.7k/0.1W
E
2SCR553PT100
GND

3.2. PFC circuit

This inverter has both analog PFC IC circuits and the software PFC circuits controlled by CPU. This function can be changed by jumper pin.

If you short below figure JP6 1-2, analog PFC circuits works. If you short JP6 2-3, the software PFC circuits can be used. If you open JP6, PFC circuits do not work.



3.3. Choice of the current detection circuits

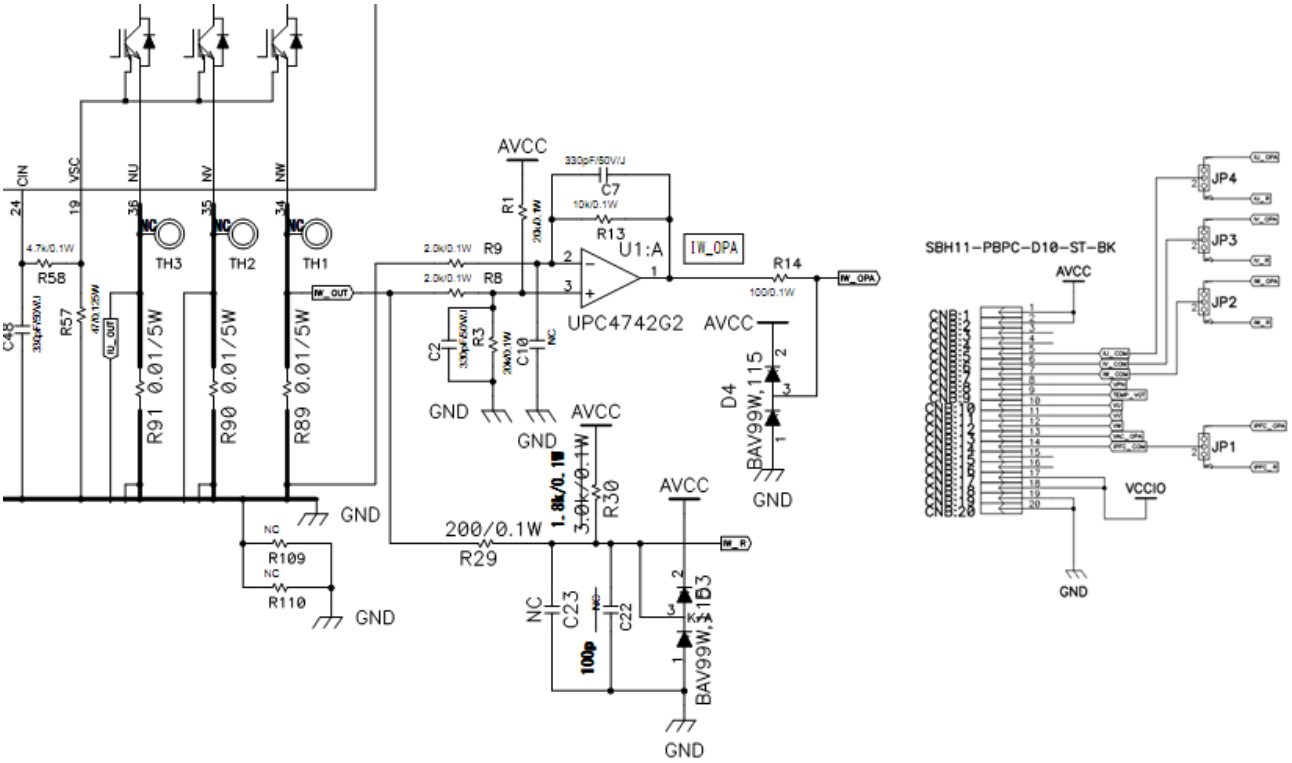
There are two outputs of the current detection circuits of this inverter. Two outputs are selected by JP1, JP2, JP3, JP4. Please choose JP setting according to your CPU setting.

At AVcc = 5V

JP	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
	Outputs	Equations	Outputs	Equations
JP1	Iu OPAMP output	$Vout = (10 * R * Iin + AVcc) / 2$ Iin=50A -> Vout=5V Iin=0A -> Vout=2.5V Iin=-50A->Vout=0V	Iu OPAMP output	$Vout = (9 * R * Iin + AVcc) / 2$ At 内蔵 OPAGain=5 Iin=55.56A->Vout=5V Iin=0A->Vout=2.5 V Iin=-55.56A->Vout=0V
JP2	Iv OPAMP output		Iv OPAMP output	
JP3	Iw OPAMP output		Iw OPAMP output	
JP4	Ipfc OPAMP output		Ipfc OPAMP output	

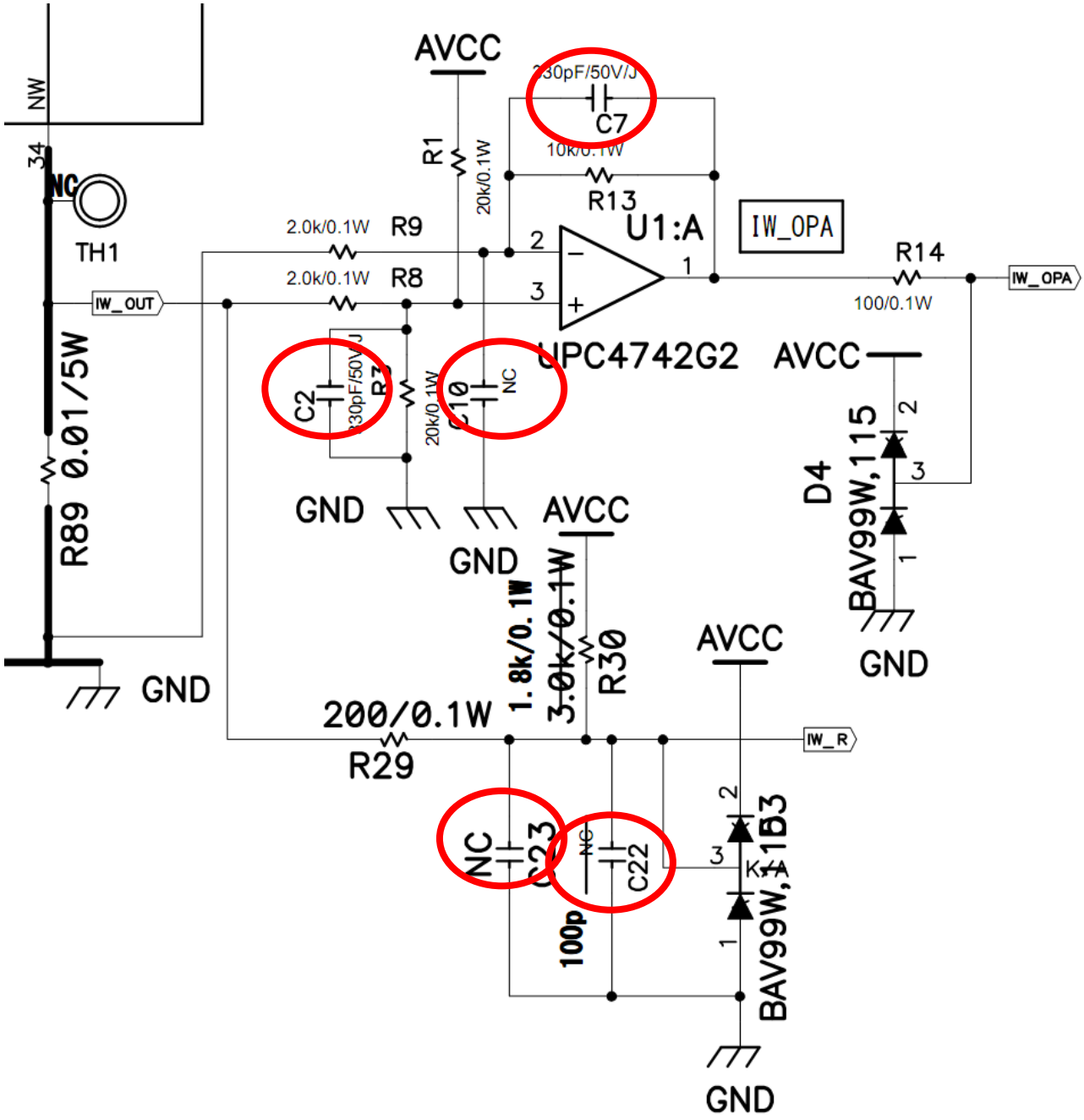
At AVcc = 3.3V

JP	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
	Outputs	Equations	Outputs	Equations
JP1	Iu OPAMP output	$Vout = (10 * R * Iin + AVcc) / 2$ Iin=33A -> Vout=3.3V Iin=0A -> Vout=1.65V Iin=-33A->Vout=0V	Iu OPAMP output	$Vout = (9 * R * Iin + AVcc) / 2$ At 内蔵 OPAGain=5 Iin=36.67A->Vout=3.3V Iin=0A->Vout=1.65 V Iin=-36.67A->Vout=0V
JP2	Iv OPAMP output		Iv OPAMP output	
JP3	Iw OPAMP output		Iw OPAMP output	
JP4	Ipfc OPAMP output		Ipfc OPAMP output	



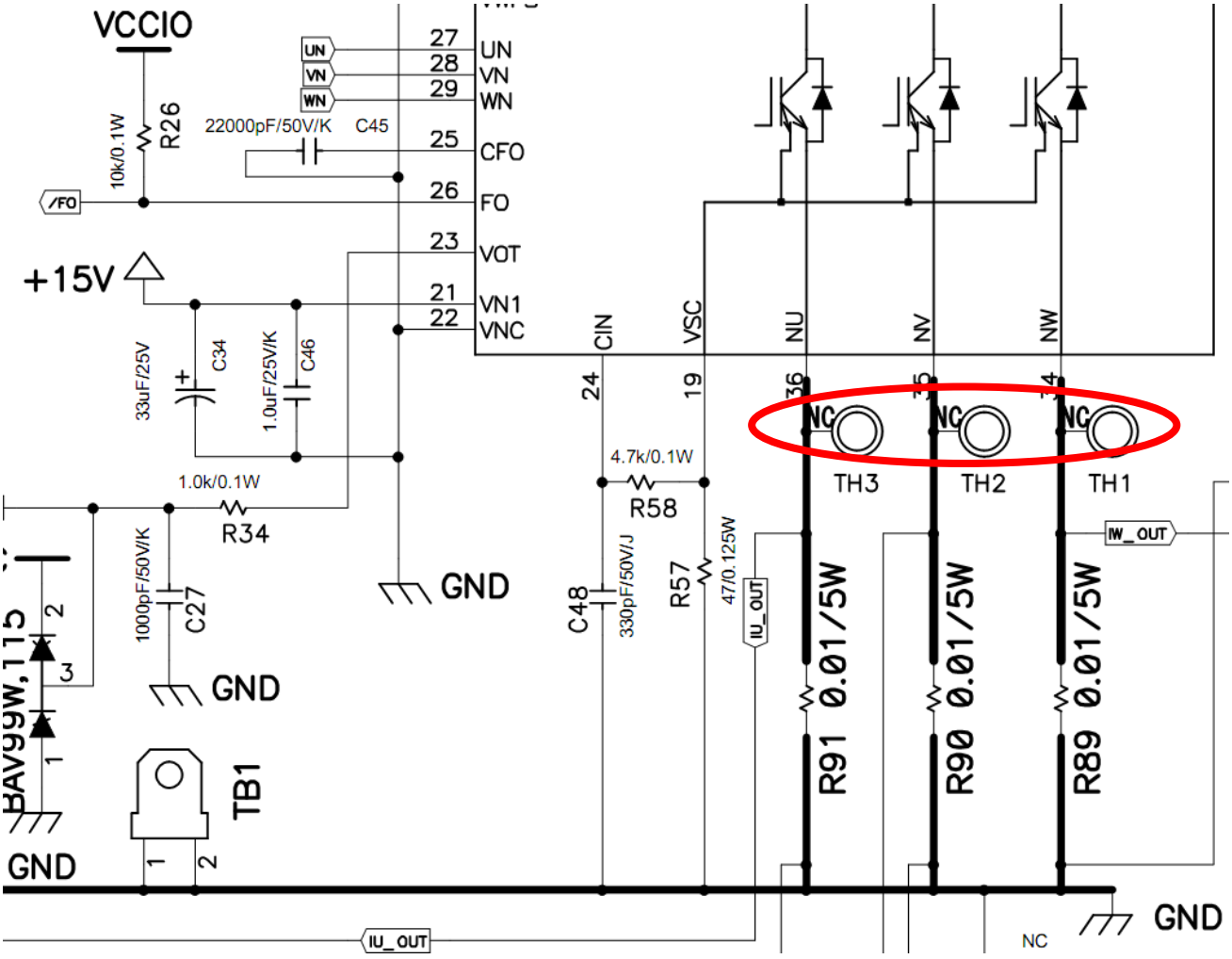
3.4. The filter circuits for the current detection

The filter parameters for the current detection circuits need be changed by the application, noise environment, switching frequency, control algorithm and so on. As shown below, this inverter provides the pattern of the filter capacitor.



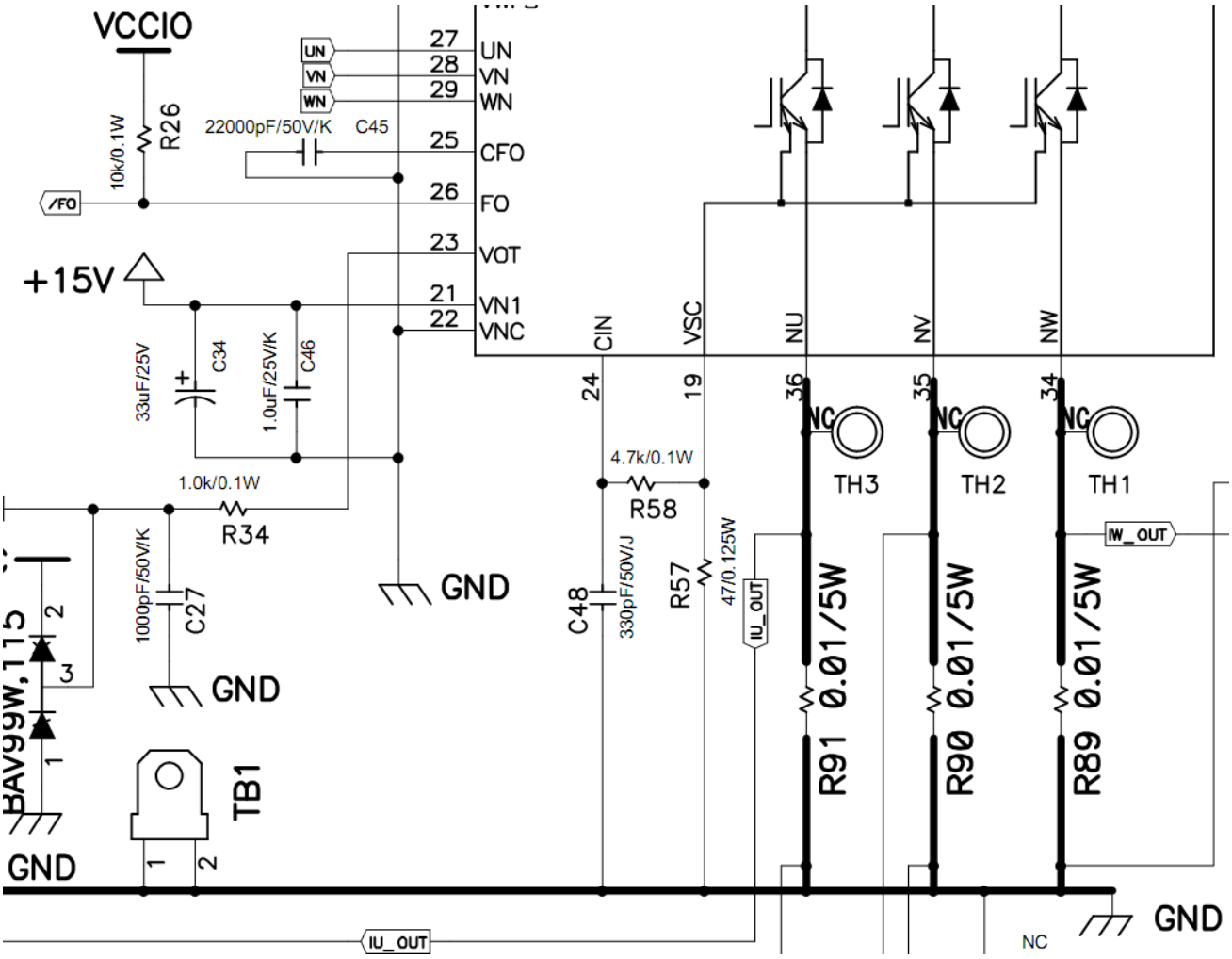
3.5. Alterations for one shunt current detection method

This inverter is based on three shunt current detection. But this inverter can be converted to the one shunt current detection. If you want to use one shunt current detection method, please connect TH1, TH2 and TH3 hole. In case of this alteration, resister value will be 1/3. You need to change the resister value or remove resisters depending on your requirement.



3.6. Over current detection circuits

The over current detection circuits of this inverter use the comparators. The outputs of the comparators are connected to the /INT pin of CPU. So user need to install the gate-block routine to your application.



3.7. Voltage detection circuits

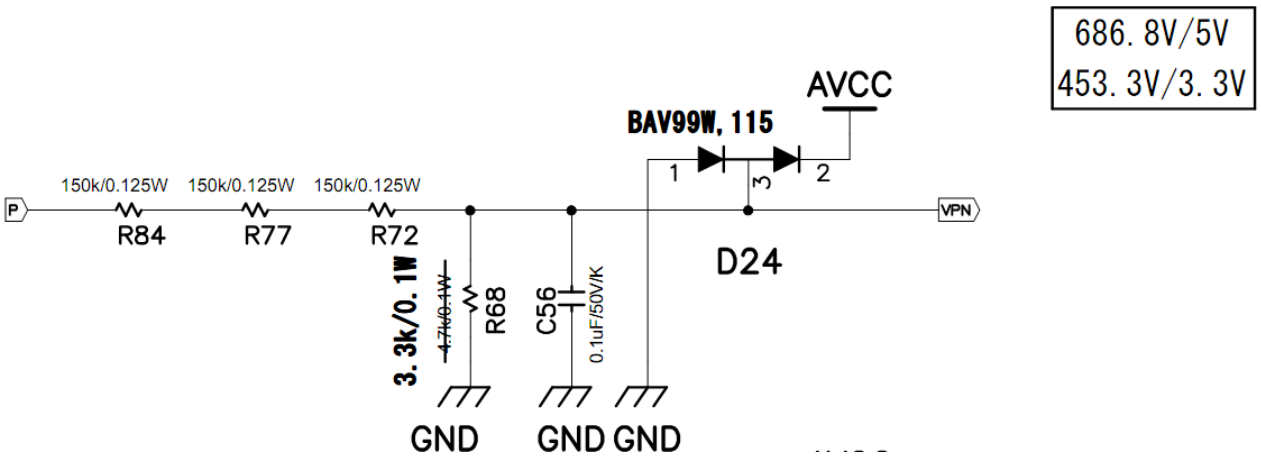
This inverter has four voltage detection circuits.

At AVcc = 5V

Voltage	Equation
DC link U phase V phase W phase	$Vout = \frac{5.0}{686.8} \times Vin$ Vin=686.8V -> Vout=5V Vin=0V ->Vout=0V

At AVcc = 3.3V

Voltage	Equation
DC link	$Vout = \frac{3.3}{453.3} \times Vin$ Vin=453.3V -> Vout=3.3V Vin=0V ->Vout=0V



3.8. How to choose CPU voltage

This inverter board automatically supplies the proper CPU voltage. You don't worry about how to choose CPU voltage.

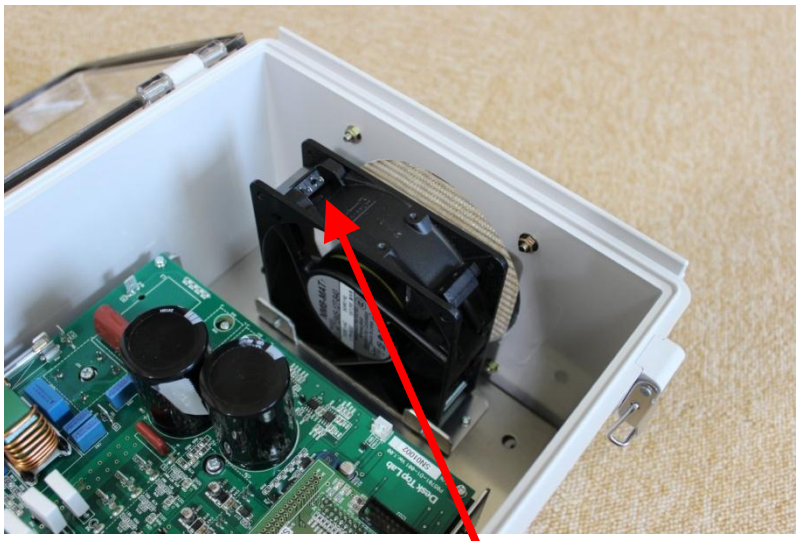
3.9. Connection information with CPU board

CN-A **Digital**	Direction	STD Inverter	T5201 RX62T 100pin *1	T5202 RX62T 64pin *1	T5101 RL78/G14 64pin	T5301 RX111 64pin	T5102 RL78/F14 80pin	---- RX63U 100pin
1	To INV	-	PA2	PA2	P52	P32	P44	
2	To INV	-	PA3	PA3	P53	PB0	P47	
3	To INV	PFC_G1	PD0	PB0	P54	PA1	P41	
4	To INV	VRL	PB3	PB3	P55	PA0	P42	
5	To CPU	/FO	P70	P70	P137	PB5	P137	
6	To CPU	-						
7	To INV	WN	P76	P76	P10	P55	P30	
8	To INV	VN	P75	P75	P11	PB1	P16	
9	To INV	UN	P74	P74	P14	PB6	P120	
10	To INV	WP	P73	P73	P12	P54	P17	
11	To INV	VP	P72	P72	P13	PB3	P15	
12	To INV	UP	P71	P71	P15	PB7	P125	
13	To CPU		P91	P91	P05	P35	P46	
14	To CPU		P92	P92	P06	P31	P45	
15	To CPU	5V	5V	5V	5V	5V	5V	
16	To CPU	5V	5V	5V	5V	5V	5V	
17	To CPU	GND	GND	GND	GND	GND	GND	
18	To CPU	GND	GND	GND	GND	GND	GND	
19	To CPU	3.3V	3.3V	3.3V	3.3V	3.3V	3.3V	
20	To CPU	3.3V	3.3V	3.3V	3.3V	3.3V	3.3V	

CN-B **Analog**	Direction	STD Inverter	T5201 RX62T 100pin *1	T5202 RX62T 64pin *1	T5101 RL78/G14 64pin	T5301 RX111 64pin	T5102 RL78/F14 80pin	---- RX63U 100pin
1	To INV	AVCC	5V	5V	5V	3.3V	5V	
2	To INV	AVCC	5V	5V	5V	3.3V	5V	
3	To CPU	-						
4	To CPU	-						
5	To CPU	IU	ANI 000	ANI 000	ANI 0	ANI 0	ANI 2	
6	To CPU	IV	ANI 001			ANI 1	ANI 4	
7	To CPU	IW	ANI 002	ANI 001	ANI 1	ANI 2	ANI 3	
8	To CPU	VPN	ANI 003	ANI 002	ANI 2	ANI 3	ANI 8	
9	To CPU	TEMP(Vot)	ANI 0	ANI 103	ANI 7	ANI 4	ANI 10	
10	To CPU	VU	ANI 101	ANI 003	ANI 3	ANI 6	ANI 5	
11	To CPU	VV	ANI 102	ANI 100	ANI 4	ANI 8	ANI 6	
12	To CPU	VW	ANI 103	ANI 101	ANI 5	ANI 11	ANI 7	
13	To CPU	(VAC)	ANI 1		r ANI 16	ANI 12	ANI 9	
14	To CPU	(IPFC)	ANI 100		r ANI 17	ANI 13	ANI 13	
15	To CPU	(VR1)	ANI 2	ANI 102	ANI 6	ANI 14	ANI 11	
16	To CPU	(RSV)	ANI 3		ANI 19	ANI 15	ANI 12	
17	To INV	VCCIO	5V	5V	5V	3.3V	5V	
18	To INV	VCCIO	5V	5V	5V	3.3V	5V	
19	To CPU	GND	GND	GND	GND	GND	GND	
20	To CPU	GND	GND	GND	GND	GND	GND	

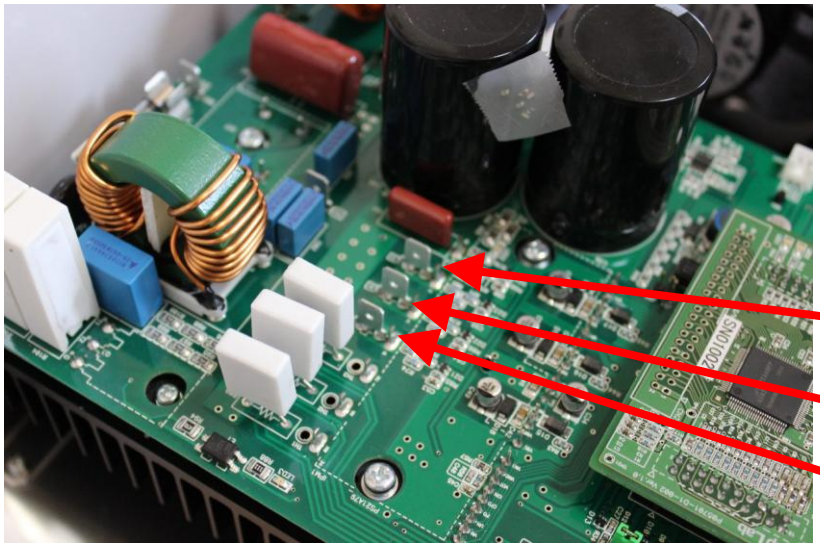
4. External connection

4.1. FAN power input



Connect FAN power input connector

4.2. Inverter AC output



U phase output

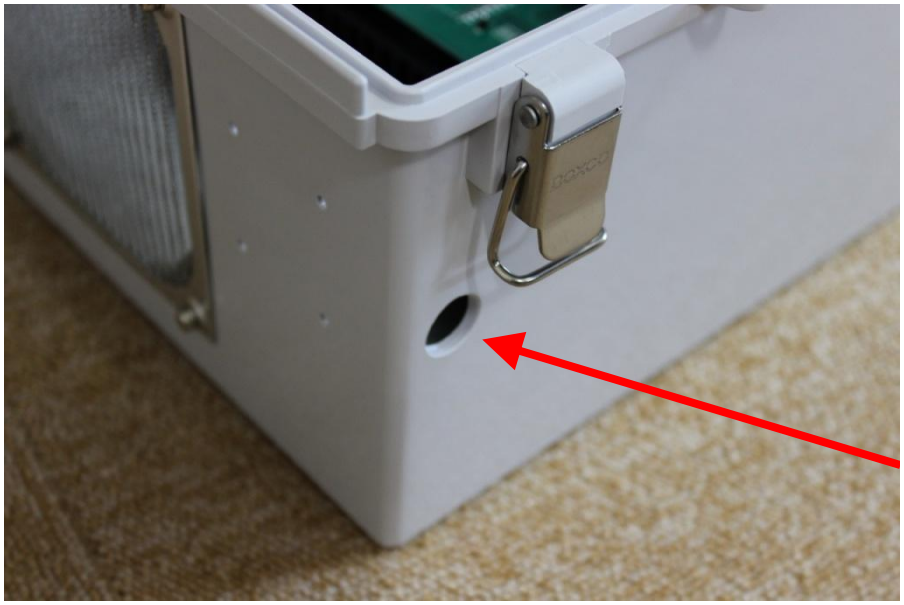
V phase output

W phase output

4.3. Inverter AC input

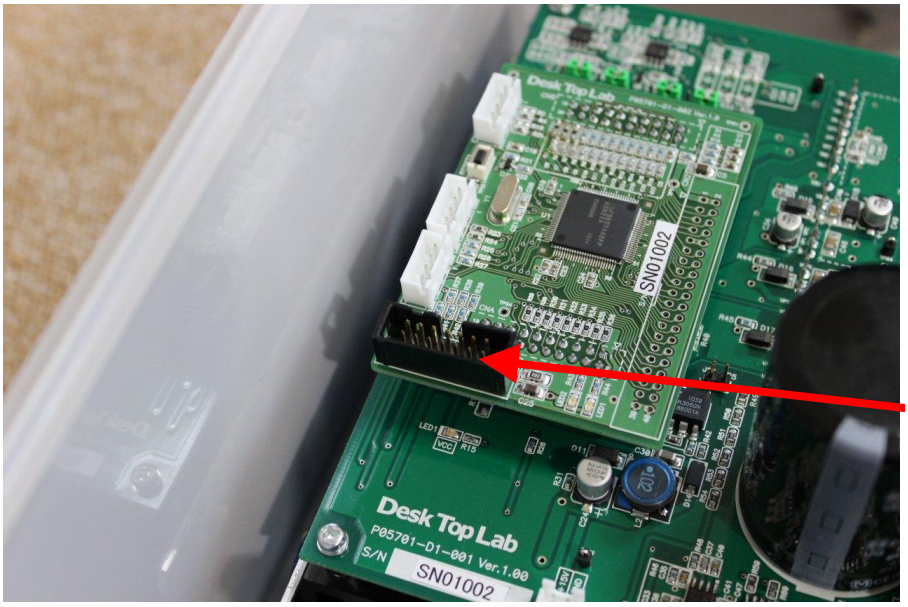
4.4. USB connector for ICS (In Circuit Scope)

This is option.



4.5. E1 connector (RX62T 100pin)

This connector is option.
This picture shows that the combination with RX62T CPU card and T1102 inverter board.



Connector for E1

5. Temperature raise value data for T1102

5.1. Temperature raise value data

Condition :

T1102 inverter + RX62T 100pin CPU card
Internal FAN 100V rms
Input voltage AC 200Vrms
Ambient 25℃
Load 3 phase LR load

Input power	PFC Diode	PFC MOSFET	PFC Inductor	Bridge Diode	In-rush current protection TRIAC	IPM
1.0kW	31℃	34℃	33℃	31℃	38℃	40℃
1.5kW	36℃	42℃	38℃	35℃	44℃	43℃
2.0kW	41℃	48℃	43℃	42℃	55℃	45℃
2.4kW	45℃	60℃	50℃	44℃	65℃	48℃
2.85kW	52℃	71℃	63℃	52℃	76℃	56℃
3.0kW	56℃	83℃	69℃	54℃	82℃	58℃
3.2kW	65℃	89℃	75℃	62℃	84℃	60℃

6. Ordering information

6.1. Order number list

Order number	Inverter	FAN
T1102-V100	T1102	AC110V
T1102-V200	T1102	AC230V

Trial series T1102 3kW 4kVA High Voltage Inverter Unit Users Manual

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