
Trial series
T2001C 48V/ 5A peak
Low Voltage Inverter Unit
Users Manual

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1. Introduction

1.1. Introduction

This users' manual is for T2001C 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 user

This inverter is suitable for research or development stage.

1.3. Caution

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1.4. Warning



Danger

- **There is a risk of fire.**

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

- **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 handling 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 checking 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.

2.3. T2001C specifications

Item	Specifications	Note
Operation temperature	0°C~35°C	
Operation humidity	Below 90% (No dew condensation)	
Size	T2001C : 150 x 250 x 85 mm	
Weight	0.5kg	
Input voltage range	DC0V~DC48V	
Maximum output power	100W/ 120VA @DC48Vinput	@ switching frequency 15kHz
Rated output current	AC3A rms	@ switching frequency 15kHz
Switching frequency	2kHz~20kHz	This value is for your information
Deadtime	1us	This value is for your information.
Current detection	3 shunt	User can modify for 1 shunt current detection
Shunt register	50mΩ	
Switching device	RJK1008DPP	RENESAS Vds = 100V, Id = 80A @25°C
Control power supply	Generated from DC link	Non-isolated
DC link – control circuit isolation	Non-isolated	
Cooling	No	
PFC controller	No	
Temperature sensor	No	
ICS	Limited version	Numerical display function 32ch Waveform display function 8ch (Record length 1024pts)
ICS – Main circuits isolation	Yes	

*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. Precautions for each circuits blocks

3.1. Choice of the current detection circuits

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

@AV_{cc} = 5V

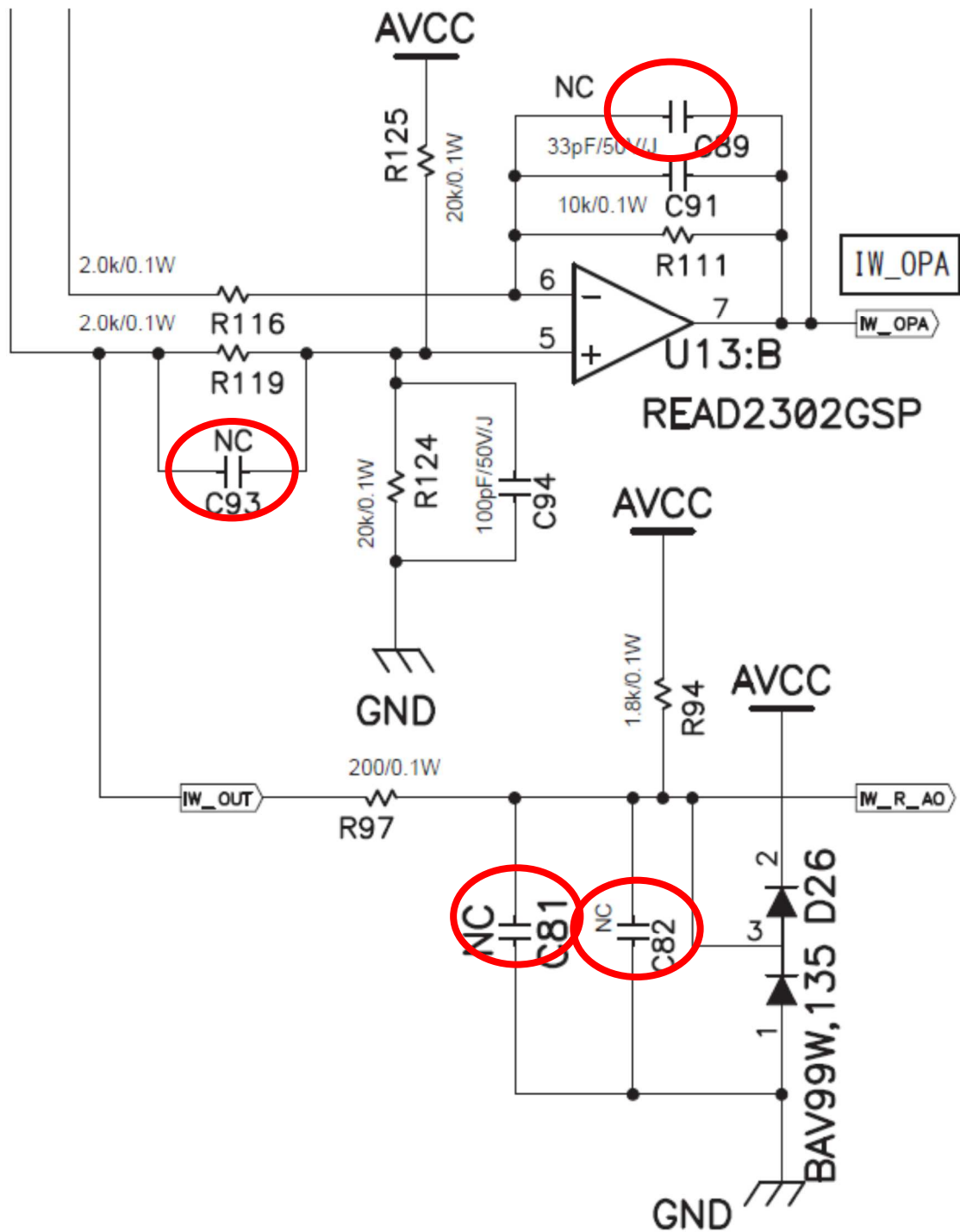
JP	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
	Outputs	Equations	Outputs	Equations
JP3	I _u OPAMP output	$V_{out} = (10 * R * I_{in} + AV_{cc}) / 2$ I _{in} =10A -> V _{out} =5V I _{in} =0A -> V _{out} =2.5V I _{in} =-10A->V _{out} =0V	I _u direct output	$V_{out} = (9 * R * I_{in} + AV_{cc}) / 2$ At internalOPAGain=5 I _{in} =11.1A->V _{out} =5V I _{in} =0A->V _{out} =2.5 V I _{in} =-11.1A->V _{out} =0V
JP4	I _v OPAMP output		I _v direct output	
JP5	I _w OPAMP output		I _w direct output	

@AV_{cc} = 3.3V

JP	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
	Outputs	Equations	Outputs	Equations
JP3	I _u OPAMP output	$V_{out} = (10 * R * I_{in} + AV_{cc}) / 2$ I _{in} =6.6A -> V _{out} =3.3V I _{in} =0A -> V _{out} =1.65V I _{in} =-6.6A->V _{out} =0V	I _u direct output	$V_{out} = (9 * R * I_{in} + AV_{cc}) / 2$ At internalOPAGain=5 I _{in} =7.33A->V _{out} =3.3V I _{in} =0A->V _{out} =1.65 V I _{in} =-7.33A->V _{out} =0V
JP4	I _v OPAMP output		I _v direct output	
JP5	I _w OPAMP output		I _w direct output	

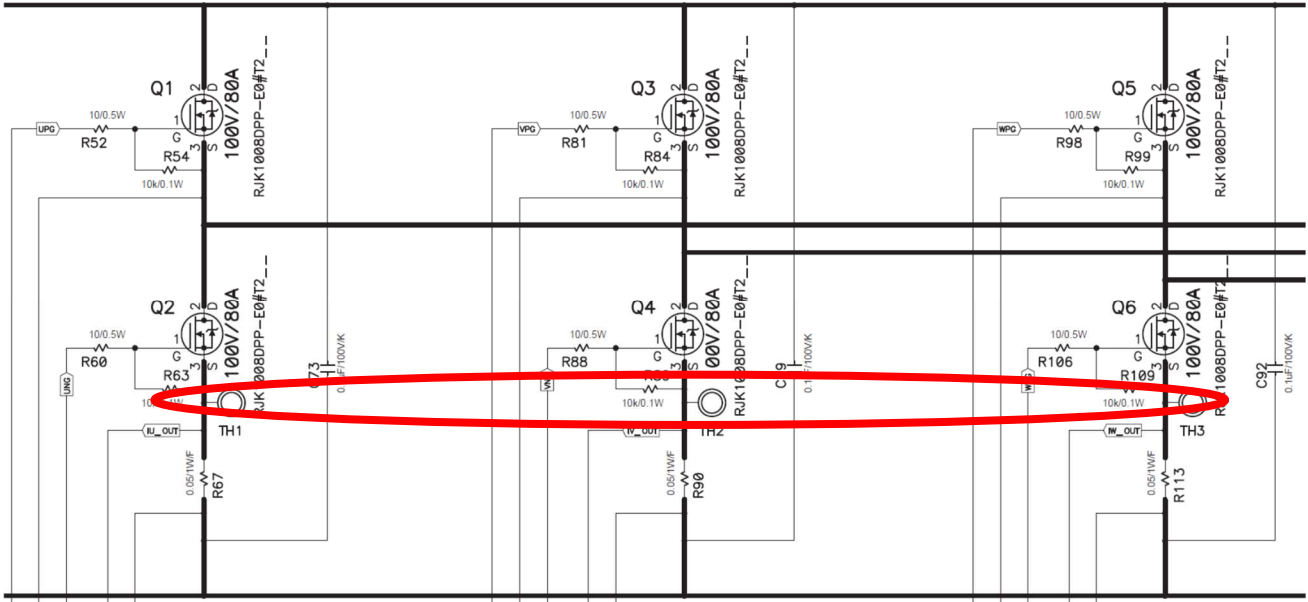
3.2. The filter circuits for the current detection

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.



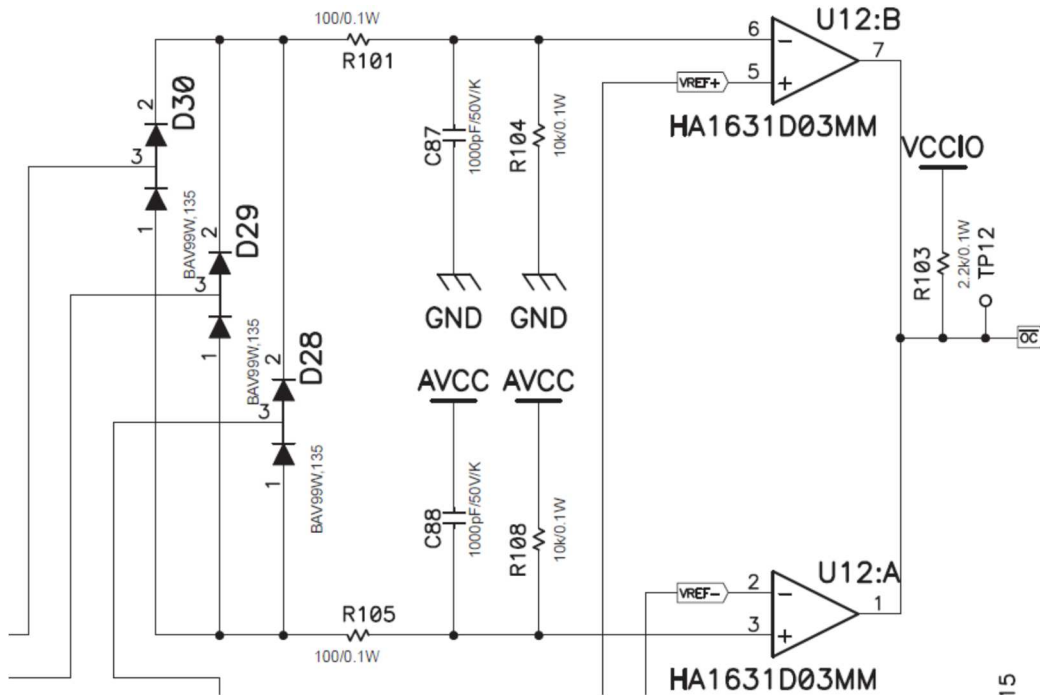
3.3. Alterations for one shunt current detection method

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, resistor value will be 1/3. You need to change the resistor value or remove resistors depending on your requirement.



3.4. 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.



3.5. Voltage detection circuits

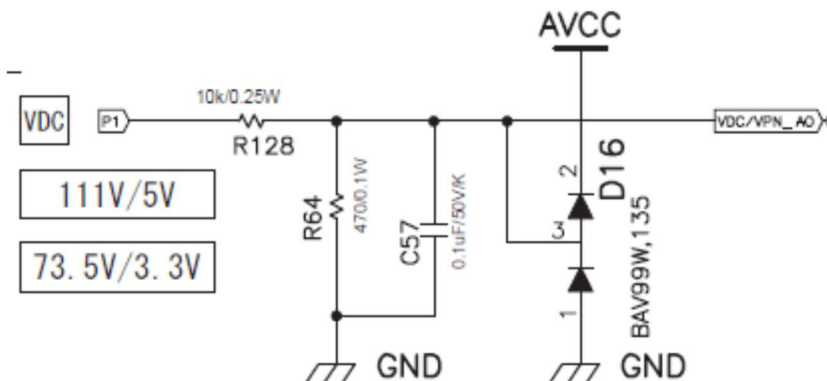
This inverter has four voltage detection circuits.

AVcc = @5V

Voltage	equations
DC link	$V_{out} = \frac{0.47k}{10k + 0.47k} \times V_{in}$
U phase	
V phase	
W phase	$V_{in}=111V \rightarrow V_{out}=5V$ $V_{in}=0V \rightarrow V_{out}=0V$

AVcc = @3.3V

Voltage	equations
DC link	$V_{out} = \frac{0.47k}{10k + 0.47k} \times V_{in}$
U phase	
V phase	
W phase	$V_{in}=73.5V \rightarrow V_{out}=3.3V$ $V_{in}=0V \rightarrow V_{out}=0V$



3.6. How to choose CPU voltage

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

3.7. Connection information with CPU board

CN-A Digital	Direction	STD Inverter	T5101 RL78/G14 64pin	T5102 RL78/F14 80pin	T5201 RX62T 100pin *1	T5205 RX23T	T5206 RX24T
1	To INV	-	P52	P44	PA2	P00	PA2
2	To INV	-	P53	P47	PA3	P01	PA1
3	To INV	PFC_G1	P54	P41	PD0	P31	PD7
4	To INV	VRL	P55	P42	PB3	PB4	PB3
5	To CPU	/FO	P137	P137	P70	P70	P70
6	To CPU	/INV_RES					P55_AN211
7	To INV	WN	P10	P30	P76	P76	P76
8	To INV	VN	P11	P16	P75	P75	P75
9	To INV	UN	P14	P120	P74	P74	P74
10	To INV	WP	P12	P17	P73	P73	P73
11	To INV	VP	P13	P15	P72	P72	P72
12	To INV	UP	P15	P125	P71	P71	P71
13	To CPU	(/SW1)	P05	P46	P91	P91	P80
14	To CPU	(/SW2)	P06	P45	P92	P92	P81
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	T5101 RL78/G14 64pin	T5102 RL78/F14 80pin	T5201 RX62T 100pin *1	T5205 RX23T	T5206 RX24T
1	To INV	AVCC	5V	5V	5V	5V	5V
2	To INV	AVCC	5V	5V	5V	5V	5V
3	To CPU	RSVIN2					
4	To CPU	RSVIN3				P43/AN003	
5	To CPU	IU	ANI 0	ANI 2	ANI 000	AN000	AN100
6	To CPU	IV		ANI 4	ANI 001	AN001	AN101
7	To CPU	IW	ANI 1	ANI 3	ANI 002	AN002	AN102
8	To CPU	VPN	ANI 2	ANI 8	ANI 003	AN003	AN204
9	To CPU	TEMP(Vot)	ANI 7	ANI 10	ANI 0	AN007	AN205
10	To CPU	VU	ANI 3	ANI 5	ANI 101	AN004	AN201
11	To CPU	VV	ANI 4	ANI 6	ANI 102	AN005	AN202
12	To CPU	VW	ANI 5	ANI 7	ANI 103	AN006	AN203
13	To CPU	(VAC)	r ANI 16	ANI 9	ANI 1	AN016	AN207
14	To CPU	(IPFC)	r ANI 17	ANI 13	ANI 100	(AN017)	AN208
15	To CPU	(VR1)	ANI 6	ANI 11	ANI 2	AN017	AN209
16	To CPU	RSVIN1	ANI 19	ANI 12	ANI 3	-	AN210
17	To INV	VCCIO	5V	5V	5V	5V	5V
18	To INV	VCCIO	5V	5V	5V	5V	5V
19	To CPU	GND	GND	GND	GND	GND	GND
20	To CPU	GND	GND	GND	GND	GND	GND

3.8. DC Link voltage below 22V or Using separate power supply between main and control

The control power is generated from the DC link voltage. But if the DC link voltage is below 18V, it cannot generate the control voltage. If you want to use below 18V for DC link voltage, you need to separate DC link and the control power source.

A) DC link voltage is below 18V. or to separate DC link and the control power source.

- 1) Install the short socket for 2-3 on JP2
- 2) Connect power supply. +15V is for CN2 1pin. And GND is for CN2 2pin.

B) The case of to generate control power from the DC link. (Default)

- 1) Install the short socket for 1-2 on JP2 (Default)
- 2) Remove the connection for CN2.

3.9. Selection of power input terminal

These inverter boards have three types of the power input terminals. These inputs are designed for different usage. Please use depending on your usage.

- 1) AC adapter input
- 2) TB1, TB2 inputs
- 3) TB3, TB4 inputs

1) AC adapter input

This is 2.1mm AC adapter input. If you use this input, you can cut off the power supply for the main power circuits by the switch S1 off. If you had written the software that the main circuits are shorted, you can rewrite the software by setting S1 OFF and supplying the power from this input.

When using this input, two point cautions are required. Please do not supply more than 2A to the main circuits. A diode and the switch for main circuits cutting may be damaged.

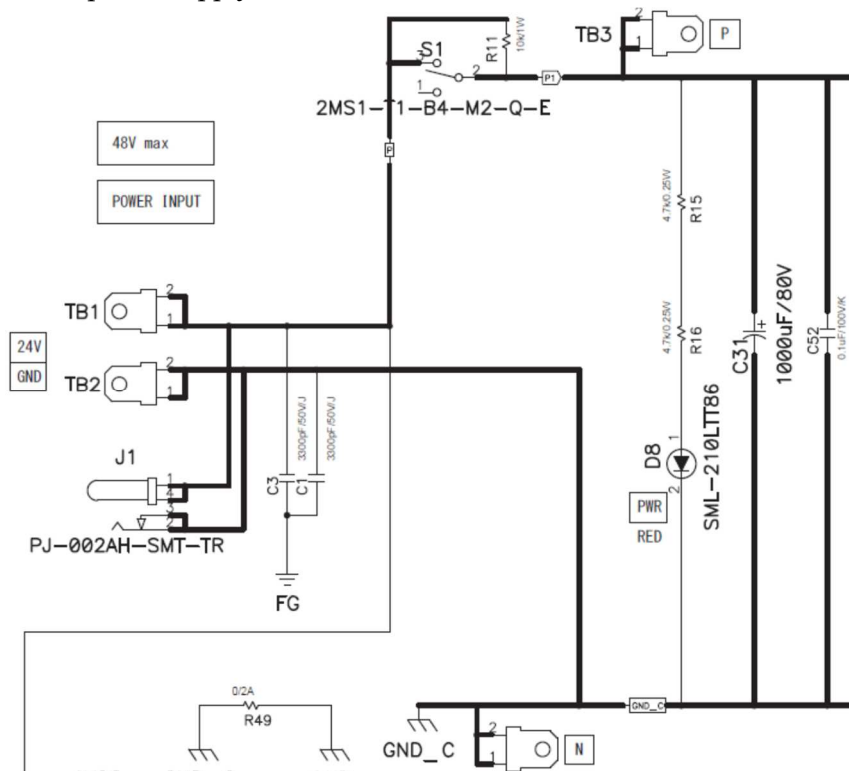
2) TB1, TB2 inputs

These inputs are parallel with the AC adapter input. The feature for this input is the same as 1).

When using this input, do not supply more than 2A to the main circuits. The switch S1 will be damaged.

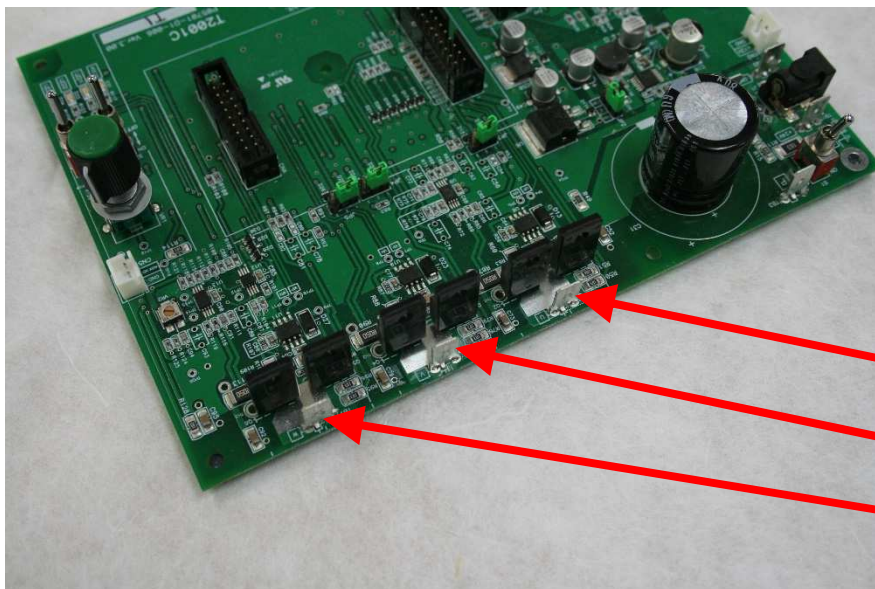
3) TB3, TB4 inputs

Main circuits P and N are connected to TB3 and TB4 respectively. These inputs are used for more than 2A for power supply.



4. External connection for T2001C

4.1. Inverter AC output

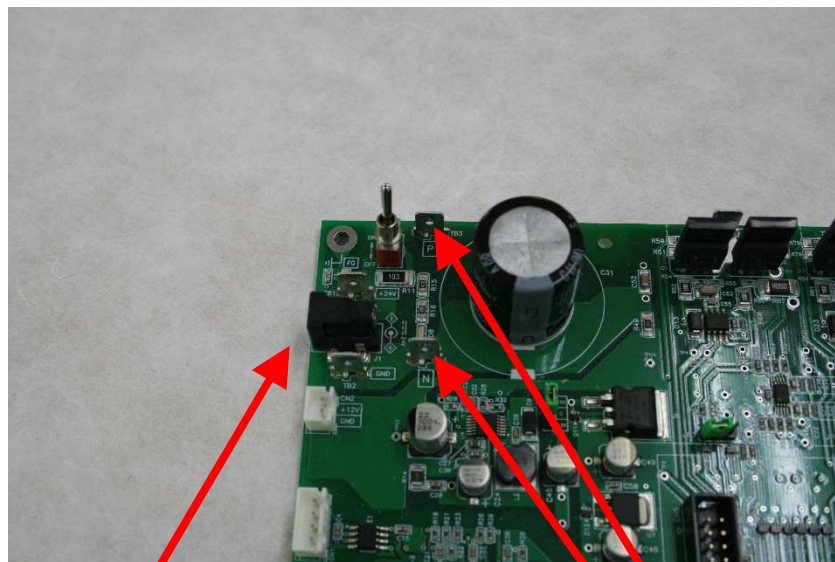


U phase output

V phase output

W phase output

4.2. Inverter DC input

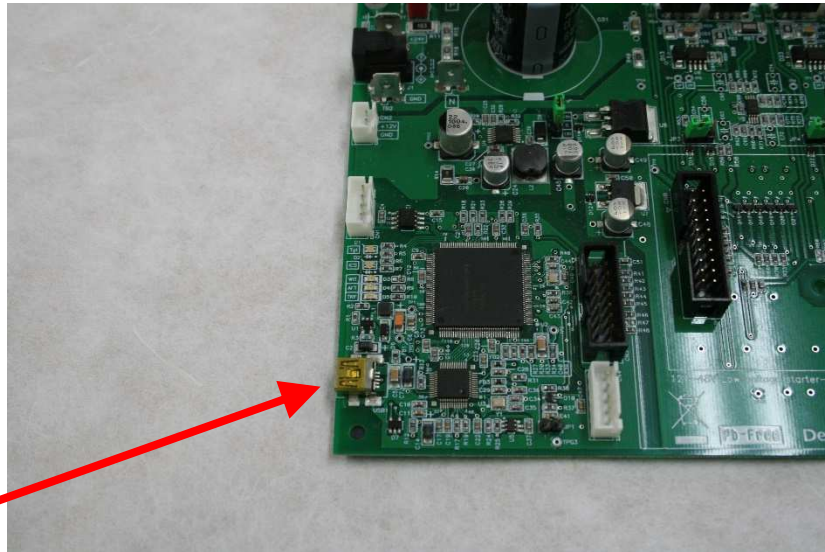


AC adapter input

DC direct inputs TB3 and TB4

4.3. USB connector for ICS (In Circuit Scope)

Mini USB



5. Difference between T2001B and T2001C

5.1. Difference of the basic specification

5.1.1. ICS

Max communication rate for ICS installed on T2001B is 1Mbps, and it can to be changed. But T2001C ICS can modify the communication rate from the PC software “DTLScope.exe”. And T2001C ICS supports from 0.5Mbps to 8Mbps.

5.1.2. Virtual neutral point

T2001C has virtual neutral point at CNB 16pin. This function is fully compatible to RENESAS motor starter kit.

5.1.3. T6X5X conversion card

T2001B doesn't support T6X5X conversion card. But T2001C supports it.

6. Ordering information

6.1. Order number list

型番	Inverter	FAN	CPU	ICS
T2001C	T2001C	NA	NA	Including ICS subset

Trial series T2001C Low Voltage Inverter Unit Users Manual

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