
Trial series
T2005 / T2005B / T2005C
(T2005C-DC80)
(T2005C-DC80-R005)
Low Voltage Inverter Unit
Users Manual

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1. Introduction

1.1. Introduction

This users' manual is for T2005 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



- 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.



- 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.



- 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 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 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, RL78F14, RL78G1F, RL78G1G, RX23T, RX62T, RX111 CPUs.
(2016/1/1)
- * 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.

2.2. Inverter block diagram

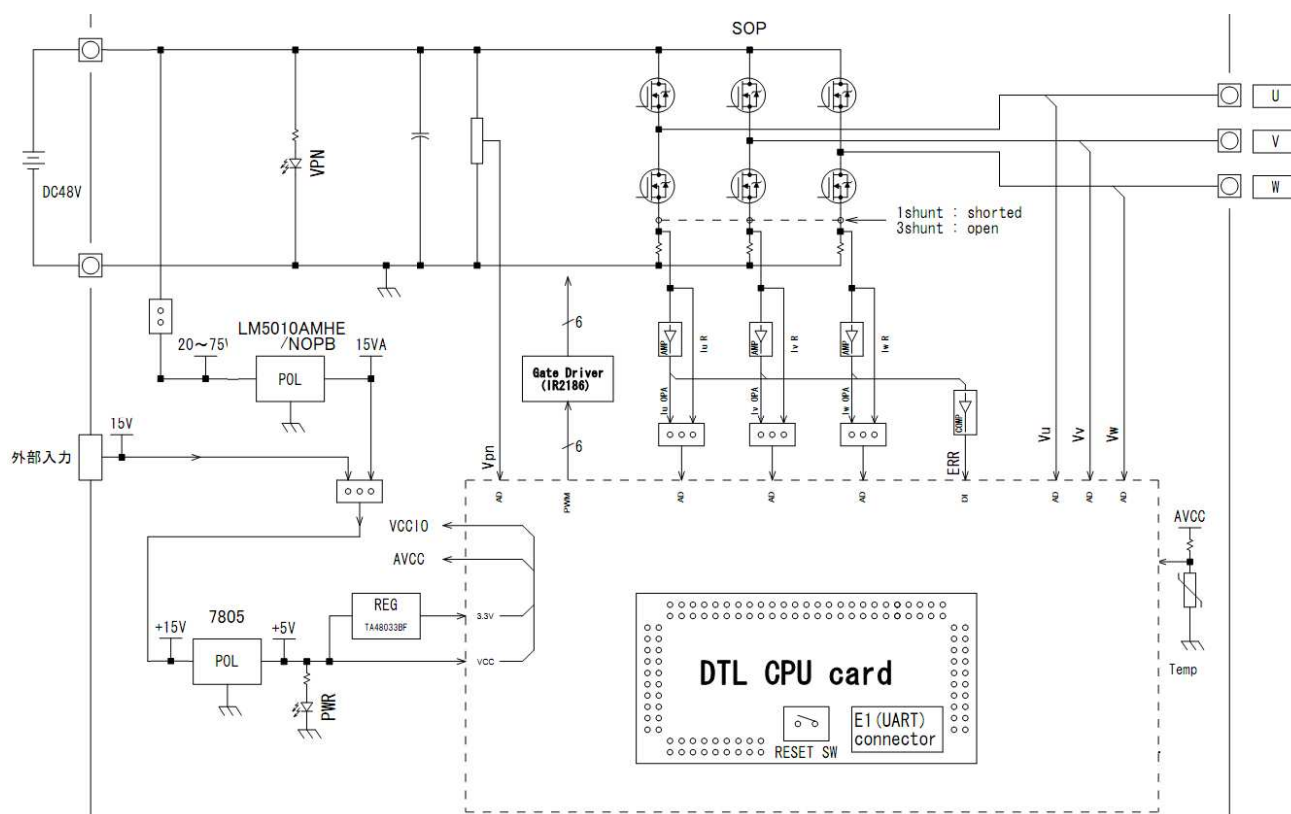


Fig.2.1. Inverter block diagram

2.3. Identify T2005 / T2005B / T2005C inverter

T2005, T2005B or T2005C model name is written on the PCB.

2.4. T2005 / T2005B / T2005C specifications

Item	Specifications	Note
Operation temperature	0°C~35°C	
Operation humidity	Below 90% (No dew condensation)	
Size	280 x350 x 195 mm	
Weight	3.6kg	
Input voltage range	DC12V~DC48V	
Maximum output power	3kW / 3.6kVA @ DC48Vinput	
Rated output current	AC70Arms @ AC30V output	@ switching frequency 15kHz
Switching frequency	2kHz~20kHz	This value is for your information
Deadtime	1.0us	This value is for your information.
Current detection	3 shunt	User can modify for 1 shunt current detection
Shunt register	1mΩ	
Switching device	IRFS7730-7PPBF	Infineon
Control power supply	Generated from DC link	Non-isolated
DC link – control circuit isolation	Non-isolated	
Cooling	Forced air cooling with AC FAN	
PFC controller	No	
Temperature sensor	No	
ICS	No	

*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.

2.5. T2005C-DC80 specifications

Item	Specifications	Note
Operation temperature	0°C~35°C	
Operation humidity	Below 90% (No dew condensation)	
Size	280 x350 x 195 mm	
Weight	3.6kg	
Input voltage range	DC12V~DC48V	
Maximum output power	3kW / 3.6kVA @ DC48Vinput	
Rated output current	AC70Arms @ AC30V output	@ switching frequency 15kHz
Switching frequency	2kHz~20kHz	This value is for your information
Deadtime	1.0us	This value is for you r information.
Current detection	3 shunt	User can modify for 1 shunt current detection
Shunt register	1mΩ	
Switching device	IPB036N12N3	Infineon
Control power supply	External +15V power supply	Non-isolated
DC link – control circuit isolation	Non-isolated	
Cooling	Forced air cooling with AC FAN	
PFC controller	No	
Temperature sensor	No	
ICS	No	

*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.

2.6. T2005C-DC80-R005 specifications

Item	Specifications	Note
Operation temperature	0°C~35°C	
Operation humidity	Below 90% (No dew condensation)	
Size	280 x350 x 195 mm	
Weight	3.6kg	
Input voltage range	DC12V~DC48V	
Maximum output power	3kW / 3.6kVA @ DC48Vinput	
Rated output current	AC70Arms @ AC30V output	@ switching frequency 15kHz Caution Shunt resistor on this inverter is modified. So maximum current sensing level is lower than rated output current. If you use 5V CPU model maximum sensing level is 100A If you use 3.3V CPU model, maximum sensing level is 66A.
Switching frequency	2kHz~20kHz	This value is for your information
Deadtime	1.0us	This value is for your information.
Current detection	3 shunt	User can modify for 1 shunt current detection
Shunt register	5mΩ	
Switching device	IPB036N12N3	Infineon
Control power supply	External +15V power supply	Non-isolated
DC link – control circuit isolation	Non-isolated	
Cooling	Forced air cooling with AC FAN	
PFC controller	No	
Temperature sensor	No	
ICS	No	

*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

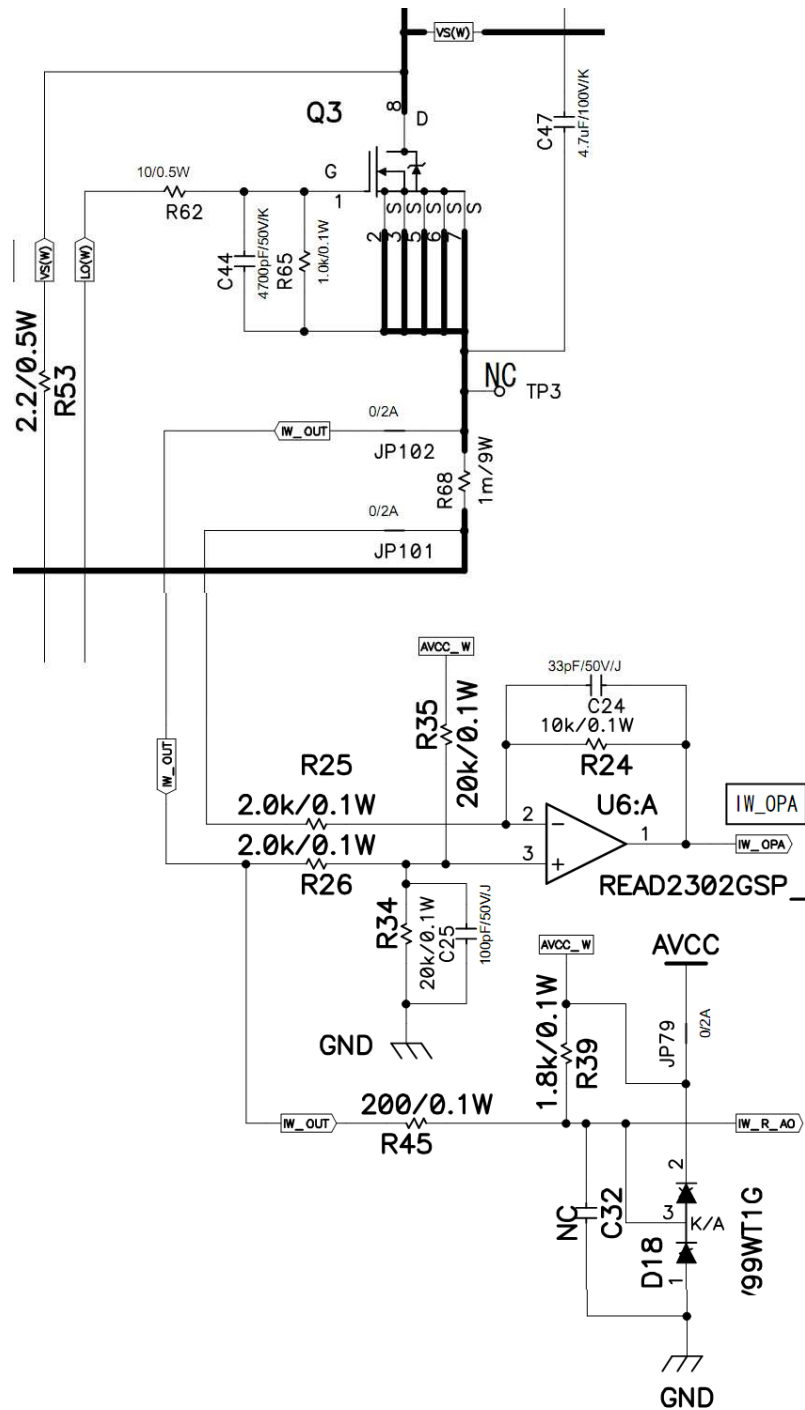
There are two outputs of the current detection circuits of this inverter. Two outputs are selected by JP7, JP8, JP9. Please choose JP setting according to your CPU setting.

T @AV_{cc} = 5V

T2005 T2005B	T2005C	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
		Outputs	Equations	Outputs	Equations
JP3	JP4	I _u OPAMP output	$V_{out} = (10 * R * I_{in} + AV_{cc}) / 2$ R=1mΩ	I _u direct output	$V_{out} = (9 * R * I_{in} + AV_{cc}) / 2$ R=1mΩ
JP11	JP9	I _v OPAMP output	I _{in} =500A -> V _{out} =5V I _{in} =0A -> V _{out} =2.5V	I _v direct output	At internalOPAGain=5 I _{in} =555A->V _{out} =5V
JP12	JP19	I _w OPAMP output	I _{in} =-500A->V _{out} =0V	I _w direct output	I _{in} =0A->V _{out} =2.5 V I _{in} =-555A->V _{out} =0V

@AV_{cc} = 3.3V

T2005 T2005B	T2005C	1-2 Short, 2-3 Open		1-2 Open, 2-3 Short	
		Outputs	Equations	Outputs	Equations
JP3	JP4	I _u OPAMP output	$V_{out} = (10 * R * I_{in} + AV_{cc}) / 2$ R=1mΩ	I _u direct output	$V_{out} = (9 * R * I_{in} + AV_{cc}) / 2$ R=1mΩ
JP11	JP9	I _v OPAMP output	I _{in} =333A -> V _{out} =3.3V I _{in} =0A -> V _{out} =1.65V	I _v direct output	At internalOPAGain=5 I _{in} =366A->V _{out} =3.3V
JP12	JP19	I _w OPAMP output	I _{in} =-333A->V _{out} =0V	I _w direct output	I _{in} =0A->V _{out} =1.65 V I _{in} =-366A->V _{out} =0V

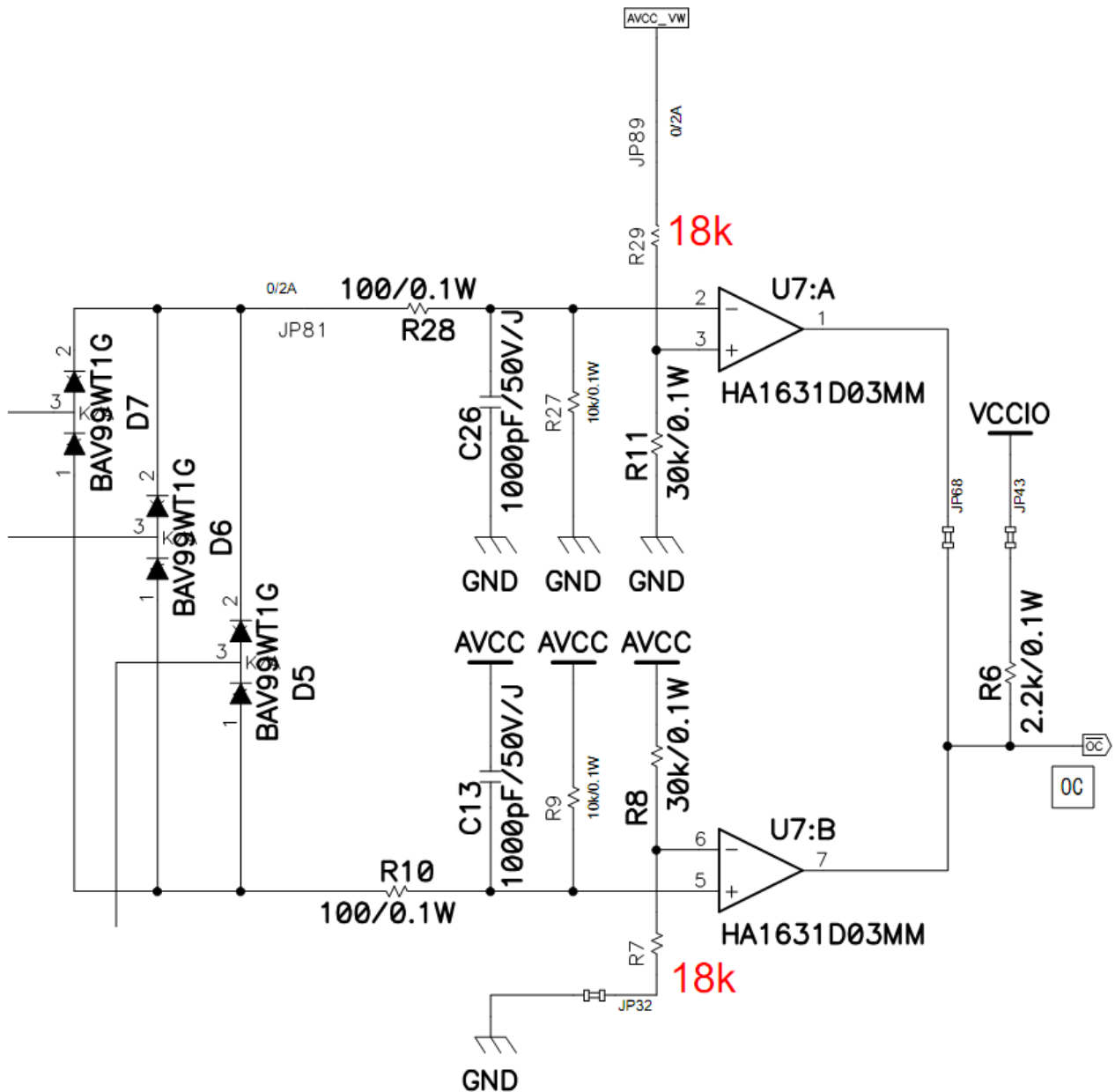


T2005 Current sensing cirtsuics

T2005C has the same circuits, but the parts number is different.

3.3. 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.



T2005 Over current sensing circuits

T2005C has the same circuits, but the parts number is different.

3.4. Voltage detection circuits

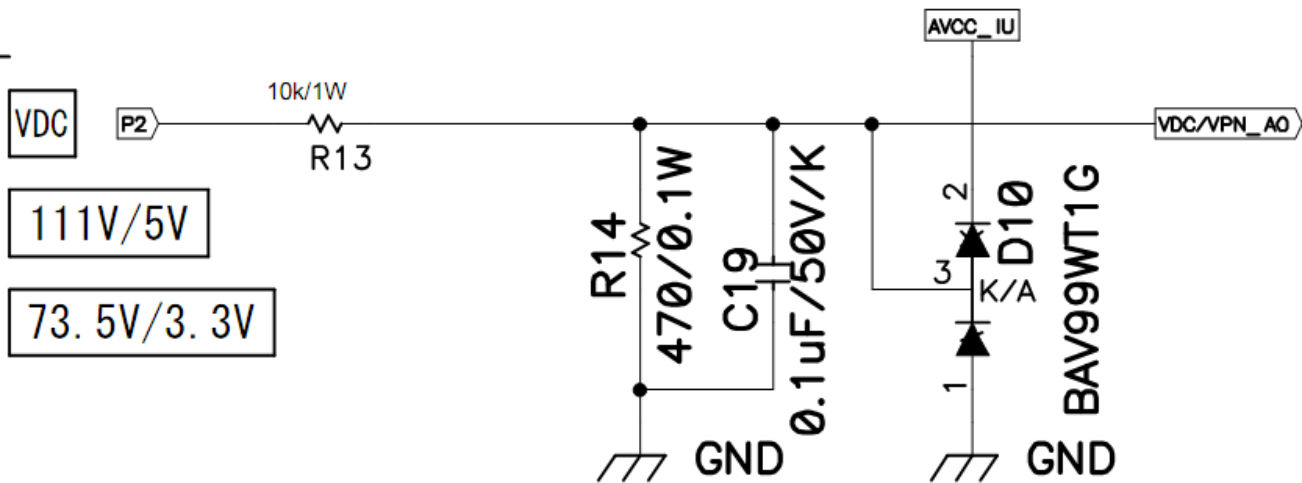
This inverter has four voltage detection circuits.

AVcc = @5V

Voltage	equations
DC link	$V_{out} = \frac{0.47k}{10k + 0.47k} \times V_{in}$
U phase	
V phase	
W phase	Vin=111V -> Vout=5V Vin=0V ->Vout=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	Vin=73.5V -> Vout=3.3V Vin=0V ->Vout=0V



T2005 Voltage sensing circuits
T2005C has the same circuits, but the parts number is different.

3.5. How to choose CPU voltage

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

3.6. Connection information with CPU board

CN-A Digital	Direction	STD Inverter	T5201 RX62T 100pin *1	T5205 RX23T	T5101 RL78/G14 64pin	T5301 RX111 64pin	T5102 RL78/F14 80pin	T5103 RL78/G1F
1	To INV	–	PA2	P00	P52	P32	P44	P141
2	To INV	–	PA3	P01	P53	PB0	P47	P140
3	To INV	PFC_G1	PD0	P31	P54	PA1	P41	P04
4	To INV	VRL	PB3	PB4	P55	PA0	P42	P55
5	To CPU	/FO	P70	P70	P137	PB5	P137	P137
6	To CPU	–						
7	To INV	WN	P76	P76	P10	P55	P30	P10
8	To INV	VN	P75	P75	P11	PB1	P16	P11
9	To INV	UN	P74	P74	P14	PB6	P120	P14
10	To INV	WP	P73	P73	P12	P54	P17	P12
11	To INV	VP	P72	P72	P13	PB3	P15	P13
12	To INV	UP	P71	P71	P15	PB7	P125	P15
13	To CPU		P91	P91	P05	P35	P46	P05
14	To CPU		P92	P92	P06	P31	P45	P06
15	To CPU	5V	5V	5V	5V	5V	5V	5V
16	To CPU	5V	5V	5V	5V	5V	5V	5V
17	To CPU	GND	GND	GND	GND	GND	GND	GND
18	To CPU	GND	GND	GND	GND	GND	GND	GND
19	To CPU	3.3V	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	3.3V

CN-B Analog	Direction	STD Inverter	T5201 RX62T 100pin *1	T5105 RX23T	T5101 RL78/G14 64pin	T5301 RX111 64pin	T5102 RL78/F14 80pin	T5103 RL78/G1F 64pin
1	To INV	AVCC	5V	5V	5V	3.3V	5V	5V
2	To INV	AVCC	5V	5V	5V	3.3V	5V	5V
3	To CPU	–						
4	To CPU	–						
5	To CPU	IU	ANI 000	AN000	ANI 0	ANI 0	ANI 2	ANI2
6	To CPU	IV	ANI 001	AN001		ANI 1	ANI 4	-
7	To CPU	IW	ANI 002	AN002	ANI 1	ANI 2	ANI 3	ANI3
8	To CPU	VPN	ANI 003	AN003	ANI 2	ANI 3	ANI 8	ANI4
9	To CPU	TEMP (Vot)	ANI 0	AN007	ANI 7	ANI 4	ANI 10	ANI7
10	To CPU	VU	ANI 101	AN004	ANI 3	ANI 6	ANI 5	ANI16
11	To CPU	VV	ANI 102	AN005	ANI 4	ANI 8	ANI 6	ANI0
12	To CPU	VW	ANI 103	AN006	ANI 5	ANI 11	ANI 7	ANI1
13	To CPU	(VAC)	ANI 1	AN016	r ANI 16	ANI 12	ANI 9	ANI5
14	To CPU	(IPFC)	ANI 100	(AN017)	r ANI 17	ANI 13	ANI 13	ANI18
15	To CPU	(VR1)	ANI 2	AN017	ANI 6	ANI 14	ANI 11	ANI6
16	To CPU	(RSV)	ANI 3	-	ANI 19	ANI 15	ANI 12	ANI17 (Yin)
17	To INV	VCCIO	5V	5V	5V	3.3V	5V	5V
18	To INV	VCCIO	5V	5V	5V	3.3V	5V	5V
19	To CPU	GND	GND	GND	GND	GND	GND	GND
20	To CPU	GND	GND	GND	GND	GND	GND	GND

3.7. 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 22V, it cannot generate the control voltage. If you want to use below 22V for DC link voltage, you need to separate DC link and the control power source.

Causion ·DC80 model is always external power supply for control power.

A) DC link voltage is below 22V. or to separate DC link and the control power source.

A-1) T2005 / T2005B

1) Remove the short socket on JP85

2) Connect power supply. +15V is for CN1 1pin. And GND is for CN1 3pin.

3) Short 1-2 on JP4

A-2) T2005C

- 1) Remove the short socket on JP84
- 2) Connect power supply. +15V is for CN1 1pin. And GND is for CN1 3pin.
- 3) Short 1-2 on JP2

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

B-1) T2005 / T2005B

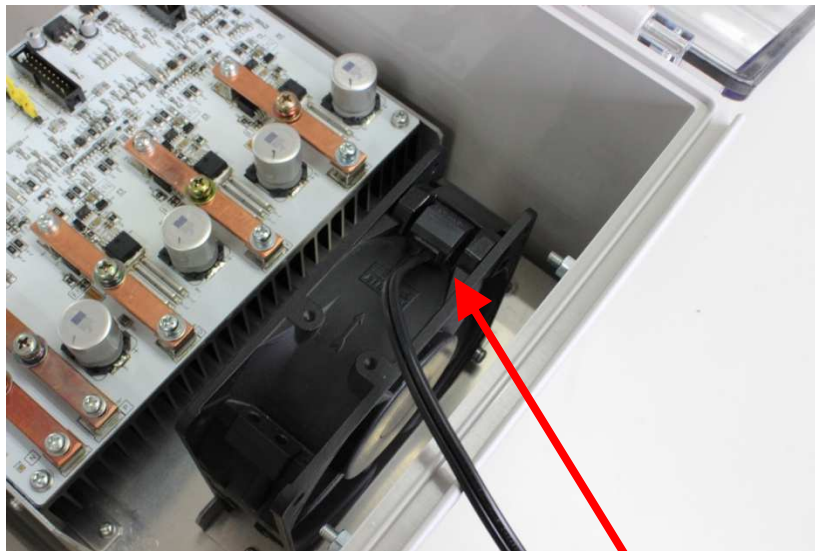
- 1) Install the short socket for JP85. (Default)
- 2) Remove the connection for CN1.
- 3) Short 2-3 on JP4

B-2) T2005C

- 1) Install the short socket for JP83. (Default)
- 2) Remove the connection for CN1.
- 3) Short 2-3 on JP2

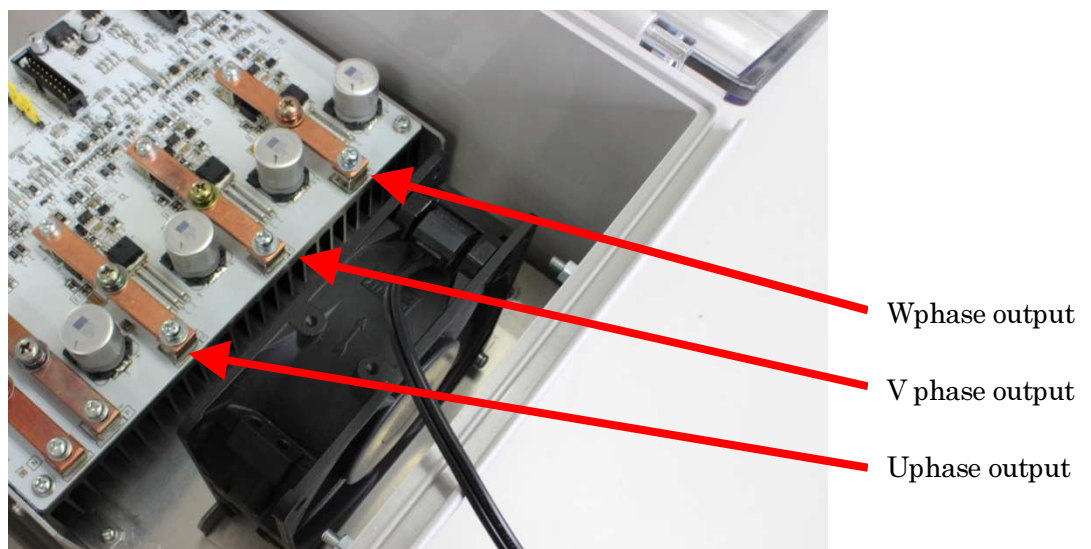
4. External connection for T2005

4.1. FAN power input (AC100V or AC200V)

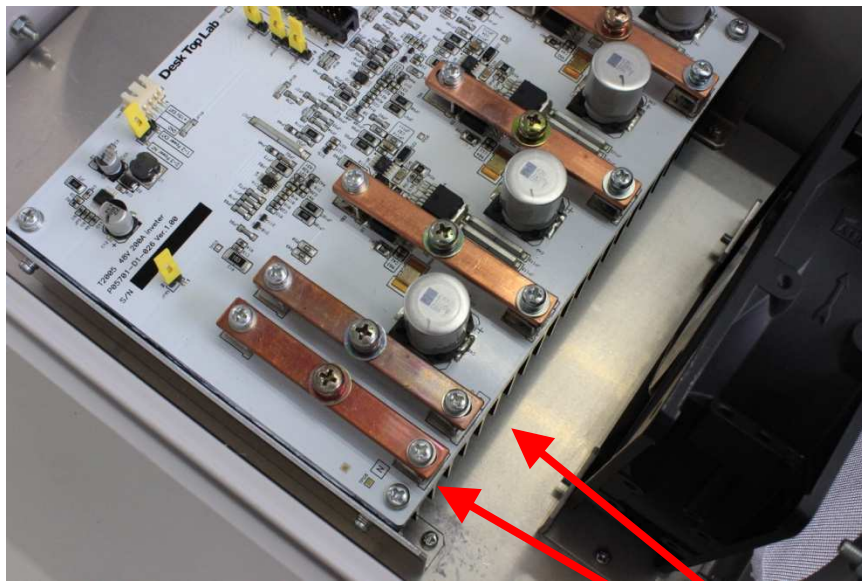


Connect AC100 / AC200V depending on the model

4.2. Inverter AC output



4.3. Inverter DC input



DC inputs — DC input +

5. Temperature raise value data for T2005

5.1. T2005B Temperature raise value data

This is example of the temperature raise value data of this inverter.
If you stop the FAN when you drive the inverter, the inverter may get very high temperature and would be broken. Please make sure to run FAN, when you drive the inverter.

Condition:

T2005B inverter + RX62T 100pin CPU card

Input voltage 48V

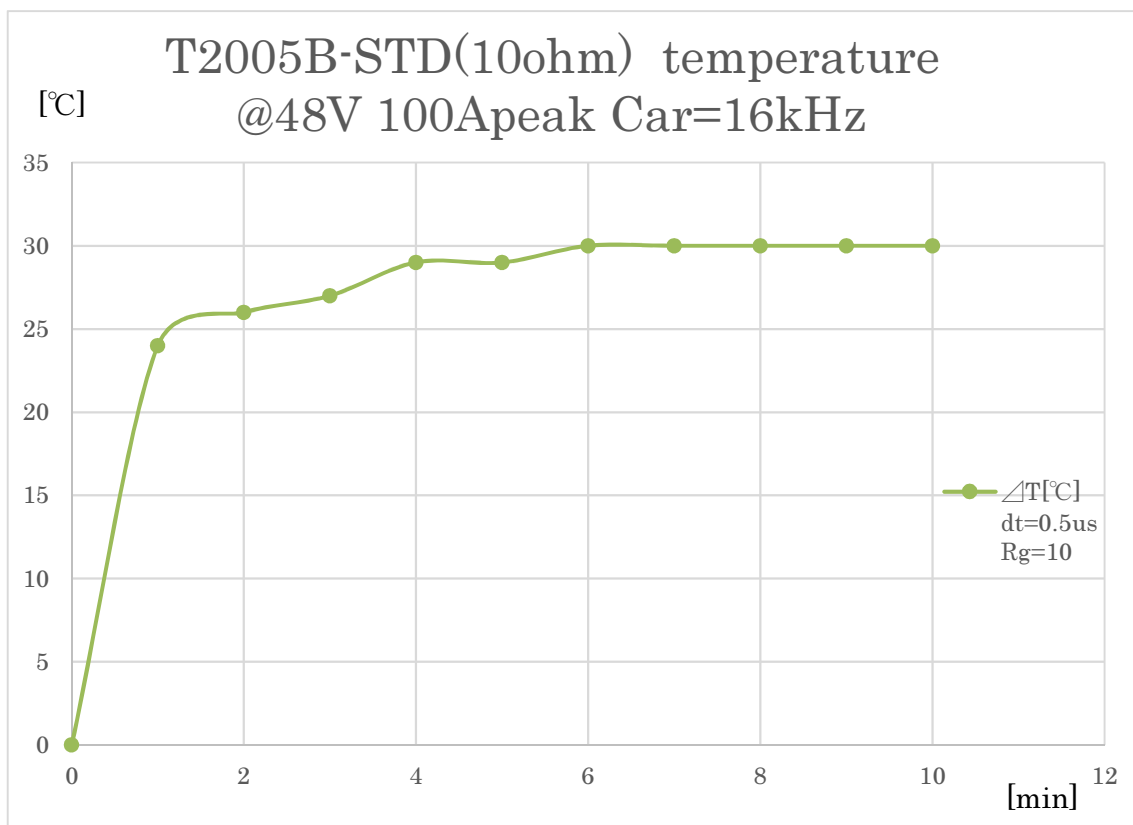
Carrier freq 16kHz

Deadtime 0.5us

FAN ON

3phase current 100A peak

Load 3 phase LR load



5.2. T2005C-DC80 Temperature raise value data

This is example of the temperature raise value data of this inverter.
If you stop the FAN when you drive the inverter, the inverter may get very high temperature and would be broken. Please make sure to run FAN, when you drive the inverter.

Condition:

T2005C0DC80 inverter + RX62T 100pin CPU card

Input voltage 80V

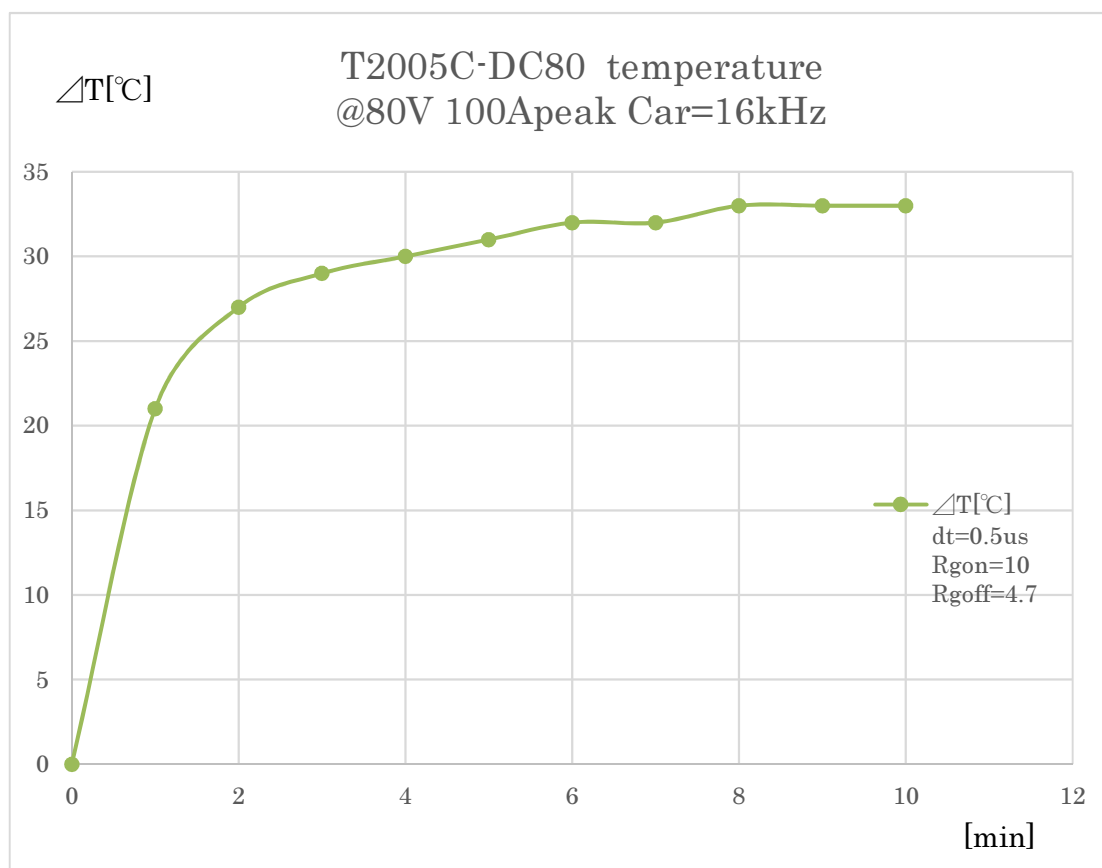
Carrier freq 16kHz

Deadtime 0.5us

FAN ON

3phase current 100A peak

Load 3 phase LR load



5.3. T2005 Temperature raise value data (T2005 old model)

This is example of the temperature raise value data of this inverter.

If you stop the FAN when you drive the inverter, the inverter may get very high temperature and would be broken. Please make sure to run FAN, when you drive the inverter.

Condition:

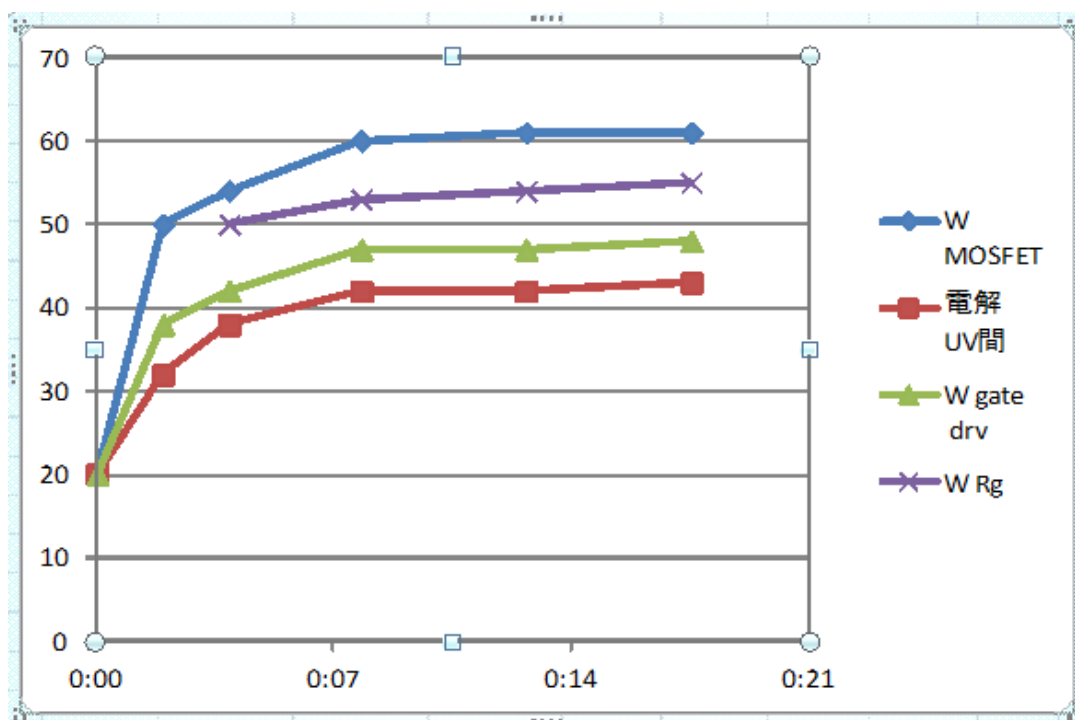
T2005 inverter + RX62T 100pin CPU card

Ambient 20°C

Load 3 phase LR load

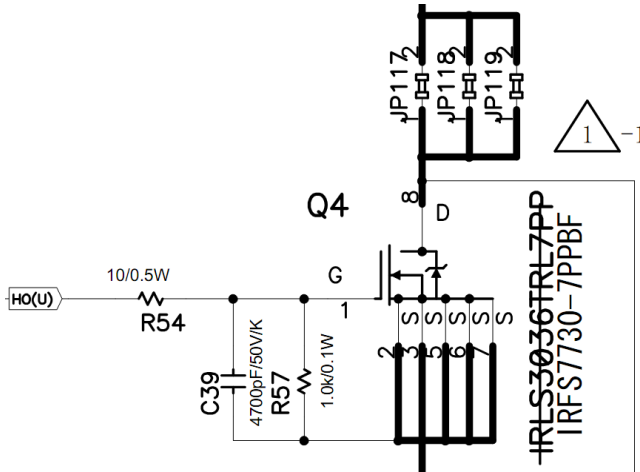
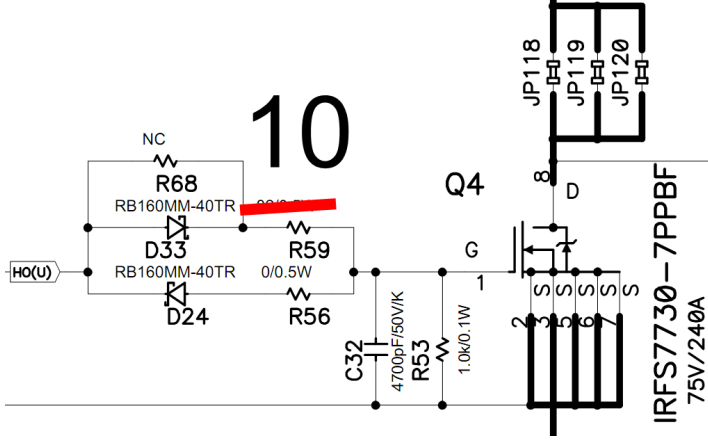
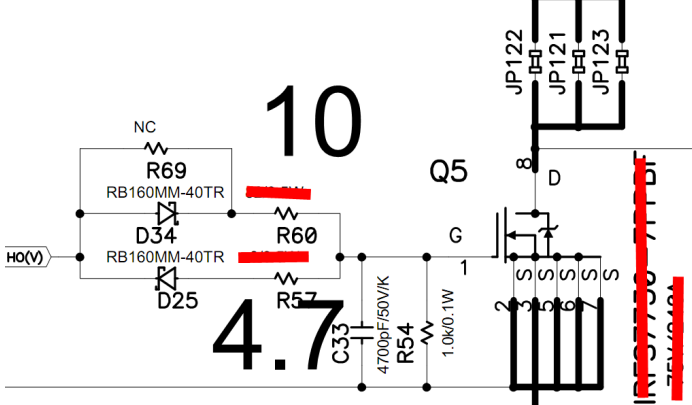
FAN ON

Time [min]	Output Current W phase	W phase MOSFET	Capacitor U-V	W phase Gate Driver	W phase Gate driver
0min	100Apeak	20	20	20	20
2	100Apeak	50	32	38	
4	100Apeak	54	38	42	50
8	100Apeak	57	42	47	53
13	100Apeak	58	42	47	54
18	100Apeak	59	43	48	55



6. Difference between T2005, T2005B, T2005C

6.1. Gate circuits

Model	Gate circuits
T2005	
T2005B	
T2005C T2005C-DC80	

6.2. —DC80 Option

Difference

Parts	T2005C (standard)	T2005C-DC80
MOSFET	IRFS7730-7PPBF 75V / Id=269A @25°C 75V / Id=190A @100°C	IPB036N12N3-G 120V / 180A @25°C 120V / 139A @100°C
Boot strap diode	SS16E-TP 60V / 1A	ES1J-JTP 600V / 1A
Capacitor	MAL214699814E3 1000uF/63V	MAL215099913E3 470uF/100V

6.3. —R005 Option

Difference

Parts	T2005C (Standard)	T2005C-DC80-R005
Current sensing resistor	1m Ω	5m Ω

6.4. Control power supply circuits

Model	Control power supply circuits
T2005	Generated on board from main circuits
T2005B	Generated on board from main circuits
T2005B-DC80	Supply from external connector
T2005C	Generated on board from main circuits
T2005C-DC80	Supply from external connector
T2005C-DC80-R005	Supply from external connector

7. Ordering information

7.1. Order number list

This product has no options

型番	Vdc voltage	
Current model		
T2005C-V100	48V max	
T2005C-V200	48V max	
T2005C-DC80-V100	80V max	Custom model
T2005C-DC80-V200	80V max	Custom model
T2005C-DC80-VD48	80V max	Custom model
T2005C-DC80-VD24	80V max	Custom model
T2005C-DC80-R005-V100	80V max	Custom model
Obsolate model		
T2005-V100	48V max	AC FAN voltage AC85V~AC110V
T2005-V200	48V max	AC FAN voltage AC165V~AC230V
T2005B-V100	48V max	AC FAN voltage AC85V~AC110V
T2005B-V200	48V max	AC FAN voltage AC165V~AC230V
T2005B-VD48	48V max	DC FAN voltage 48V (custom version)
T2005B-VD24	48V max	DC FAN voltage 24V (custom version)

Trial series T2005 Low Voltage Inverter Unit Users Manual

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