

DY3E Series Three-Phase Compound Stepper Motor Drive Unit

User Manual

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The user manual describes all items concerning the operation of this drive unit in detail as much as possible. However, it's impractical to give particular descriptions for all unnecessary and/or unavailable operations on the motor due to the limit of the manual, specific operations of the product and other causes. Therefore, the operations not specified in this manual may be considered impossible or unallowable.

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Warning and precautions



Installation

The drive unit should be installed in well ventilated and safe perfect electric cabinet. It is suggested that the recommended interval is employed in Fig 1 to get the excellent heat dissipation.

Wiring

The wiring must be stable and terminal must be tightened when the motor line and power line have big current. The drive unit and stepper motor must be earthed stably.

Power-on

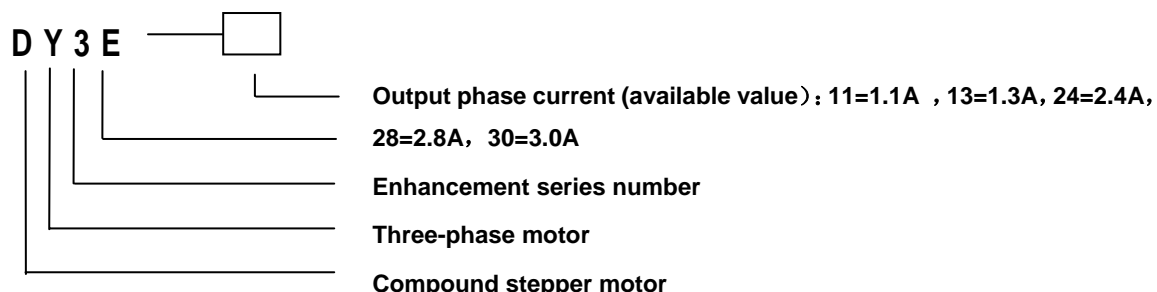
Do not plug out/plug in the plug with the electricity, otherwise, the unexpected result maybe occur.

The overcurrent protector should be installed to protect the power line from being cut off when the overcurrent occurs.

The power switch should be employed with the air switch instead of the general knife-break switch.

The drive unit is turned on when there is no conductive abnormal thing in the drive unit, and the wiring is correct and stable.

1 Type specification



2 Performance introduction

The three-phase compound stepper motor is adopted with the rare earth material, with little exhaustion of electromagnetism, high conversion efficiency and excellent dynamism compared to other reaction stepper motor. The three-phase compound stepper can stably run with low noise, big output and without stepping out. The three-phase stepper motor greatly improves the vibration and noise driven by the sine wave current, and is the top grade motor.

DY3E series three-phase compound stepper drive unit developed by GSK CNC Equipment has characteristics as follows:

Latest innovative technology

It is employed with the micro-electronic technology to embed the new generation high speed monolithic processor into the drive unit to improve the control performance and simplify the circuit; employed with AC servo control method to get AC servo run characteristics, and the three-phase sine current drive output; the low voltage DC power supply in the drive unit use the switch power supply to reduce the volume of power circuit and to get the reliable stability.

Micro stepping angle

It is employed with the vector division technology to control the min. angle of the motor rotating to be $1/20$ (0.03°) of the stepping angle of motor. The micro step control can ensure the stepper motor can stably run with low speed, and its run effect approaches that of AC servo. The micro step drive unit is matched with μm (0.001mm) grade CNC control device to realize μm grade min. movement, used for machining the cambered surface, conical surface, thread and other workpiece, which can obviously improve the fine effect of workpiece's surface.

High torque

The output torque of stepper motor is in direct proportion, the input current capacity is in direct proportion of voltage used by the amplifier of drive unit when it runs with the high speed. Presently, the used voltage of most stepper motor is below DC150V, but that of DY3E reaches DC310V, so, it still has the high torque output when it runs with the high speed.

High reliability

The control parts are high integrated, the amplifier is employed with Mitsubishi new intellectual module with tight structure, terse circuit, few connectors, external wind cooling heat dissipation to protect the dust from the machine inner, and with the over-temperature, overvoltage, low-voltage, protection and alarm signal output.

3 Technical parameters

Input power supply	AC220V -15%~+10% 50 Hz /60Hz 3A (Max)
Output phase current	The phase current valid value is less than or equal to 4.5A.
Adapted motor	Three-phase compound stepper motor(stepping angle 0.6°)
Working environment	$0^{\circ}\text{C}\sim+40^{\circ}\text{C}$ 30%~95%RH, no dewing. No erosive, inflammableness, explosive, conductive gas, liquid and dust.
Storage environment	$-40^{\circ}\text{C}\sim+55^{\circ}\text{C}$ $\leq 95\%$ RH, no dewing.
Drive mode	SPWM(sine pulse width regulation)constant-current chopping, three-phase sine current output.
Stepping angle	User can set the following: 0.030° , 0.036° , 0.045° , 0.060° , 0.072° , 0.075° , 0.090° , 0.120° , 0.144° , 0.900° , 0.300° , 0.360° , 0.450° , 0.600° , 0.720° , 0.750°
Pulse/minute corresponded to motor	12000, 10000, 8000, 6000, 5000, 4800, 4000, 3000, 2500, 400, 1200, 1000, 800, 600, 500, 480
Stepping angel setting mode	DIP switch (SW1, SW2, SW3, SW5);
Input signal	$\overline{\text{CP}}/\overline{\text{CP}}$ (pulse); $\overline{\text{DIR}}/\overline{\text{DIR}}$ (direction); $\overline{\text{EN}}/\overline{\text{EN}}$ (enabling);
Input level	5V, 5 mA ~10mA, 12V to 1K resistance, 24V to 2.2K. The input is valid when the input circuit has the current.
Position pulse input mode	Single pulse mode: CP (pulse) +DIR (direction) Pulse width $\geq 2\mu\text{s}$; Pulse frequency : (stepping angle $<0.300^{\circ}$) $\leq 200\text{kHz}$; (stepping angle $\geq 0.300^{\circ}$) $\leq 20\text{kHz}$; When the direction is changed, DIR(direction) signal leading CP(pulse) singal $\geq 10\mu\text{s}$.
Output signal	RDY1/RDY2 (ready): ON without alarm and with enabling, the load: 30V, 0.5A (Max) .
Power-down phase memory	The drive unit automatically memories the current phase after the drive unit is turned off.
Automatic reducing the current lock	After the input pulse stops 3 seconds, the locked current will automatically reduce by one half.

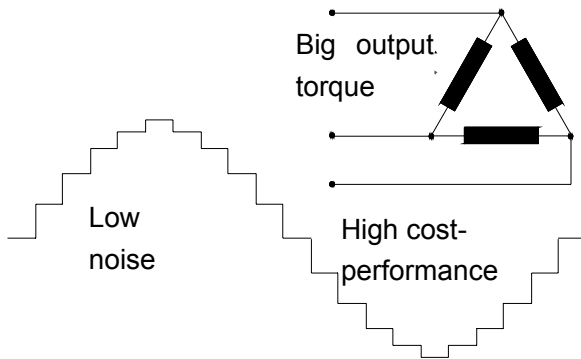
Protection function	Overtemperature, abnormal brake, overvoltage, normal IPM module.
Stauts indicator	Green LED RDY: normal indicator is ON when there is no fault with the enabling; A, B, C: pulse indicator Yellow LED ALM: brake abnormal, low-voltage, overvoltage, over-temperature, it flashes when IPM is abnormal.
Contour dimesion	244 mm×163 mm×92mm (see Fig. 1)
Weight	2.7kg

4 Advanced stepper motor control method

The AC servo control method is applied the drive unit of three-phase compound stepper motor, its input AC220V becomes to DC 310V after commutating, and then becomes three-circuit 310V stepping sine wave current after pulse width modulation, and their fixed time sequence separately flows through three-circuit wind, and each step corresponds to one step of motor rotating. Change the motor's speed by changing the frequency of sine current output by drive unit, and step amount output by per rev confirms the angle of every step rotating.

According to the present electronic technology, the step amount of sine current is divided into many. According to the theory, the step amount per rev is many, which is the subdivided technology. The theory analysis and much experiment verify: when the subdivision amount exceeds 10, the skip and the step-out appear after the motor has the load. So it is no actual meaning when the subdivision amount exceeds 10. Presently, only three-phase sine current subdivision technology can ensure that the motor output torque does not drop after subdivision, and each step can be precisely positioned.

When the three-phase wind is connected with the sine current(three-phase current phase shift is 120°) , the current in the air gap of motor creates constant rotary magnetic potential of one space maximum value, the space magnetic potential power and direction are related to the current 's sequence and power of each phase, the current of drive unit in the motor wind is bidirectional grade step wave(the current wave forms the sine wave when the grade amount increases infinitely), and the phase difference of each current is 120° . The magnetic rotor tracks the rotor space magnetic potential face to move to form the motor rotating, and when the space magnetic potential positions to some point, the rotor also positions to the point to realize the precise positioning. The relationship between phase current waveform and the stepping angle is as follows:



When some phase current changes one full period (other phase current also separately changes one full period, only their stepping angle is different), the rotor of stepping motor rotates one pitch, and its corresponding mechanical angle is $360^\circ/Z_2$ (Z_2 is the teeth number of rotor). When the phase current is divided into N step current value in one period, the rotor is located at the different positioning point when it is in each step current, so the stepping angle of stepper motor is $\alpha = 360^\circ/(N \times Z_2)$, or the step number per rev of motor is $S = N \times Z_2$. When each sine period is composed of 20 current step N , and the teeth number Z_2 of rotor is 50, the stepping angle of motor is $\alpha = 360^\circ/(N \times Z_2) = 360^\circ / (20 \times 50) = 0.36^\circ$, the needed pulse number per rev is $S = N \times Z_2 = 20 \times 50 = 1000$.

5 Installation specifications

The contour and installation dimension is as Fig. 1.

Installation steps:

a) Unpack check

DY3E drive unit is packed solely. Please check the drive unit type, serial number, User Manual, accessories and so on after unpacking, and contact with us if they are be inconsistent with those in the packing box.

Check whether the drive unit distorts, its parts are abnormal, and if they are so, install them after they are safety or contact with us.

b) Installation

DY3E drive unit should be installed in the excellent ventilated and perfect guard electric cabinet, and please install it according to recommended interval as Fig. 1 to get the excellent heat dissipation of drive unit.

c) Wiring

Connect the signal wire, motor wire and power wiring according to the following interface specifications. The wiring must be connected stably and the motor wiring and power wiring should be more than 1 mm².

Because the drive unit works in the high frequency chopping mode, the stepper motor will have the induced voltage and leak the current. It is suggested that the power supply of drive unit should be provided by the insulated transformer, and the drive unit and the stepper motor must be stably earthed to get the safety. The power switch should select the air switch, leakage protection switch or contactor to get the rapid and reliable power-on or power-off.

6 Drive unit contour

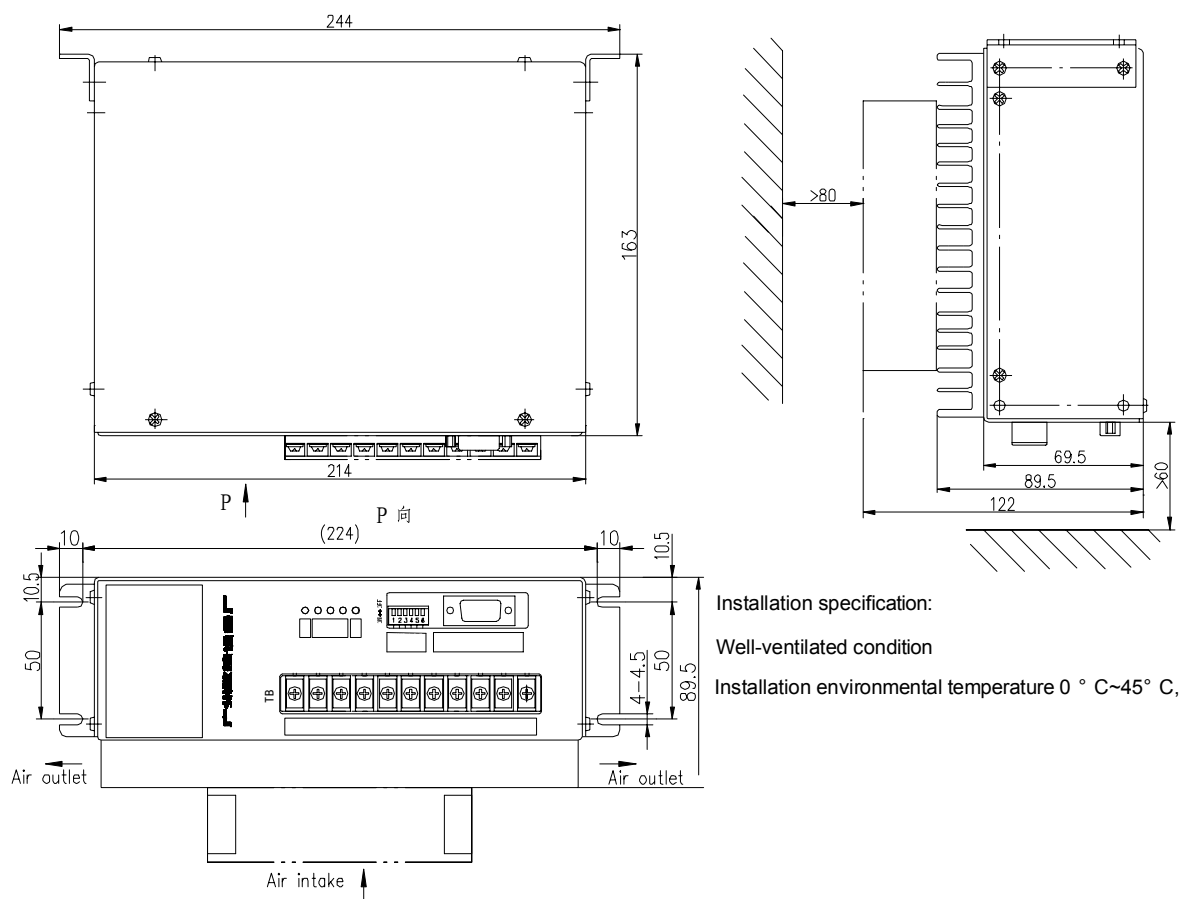


Fig. 1

7 Interface and dial switch explanation

1) Signal interface

Signal wiring table

Pin	Terminal name	Signal explanation
1	CP+	Pulse signal (+) input
9	CP-	Pulse signal (-) input
2	DIR+	Direction level signal(+) input
10	DIR-	Direction level signal(-) input
3	EN+	Enabling signal(+) input
11	EN-	Enabling signal(-) input
6	RDY1	Ready signal
14	RDY2	Ready signal

Note: Pin6 is connected with P14 in the electric cabinet when DY3E runs normally; they are not connected each other when it alarms.

2) Motor interface and power interface

When the power input is AC 220V, the power supply is connected to r, t from L, N. The internal coil of stepper motor likes a star, and its outgoing line can be connected to U, V, W arbitrarily. We should turn off the power supply when the motor rotates in the mistake direction, and then change the connector position of 2 lines arbitrarily.

3) Status indicator

The drive unit alarms when the yellow alarm indicator ALM is ON. 4 green indicators: RDY is ready indicator, and it runs normally when it is ON; A, B, C six indicators are for pulse input status, their initial status are that of two axes before power-down. A, B, C have 8 kinds of status, we can judge whether the machining process is step-out based on that their statuses are same in the machine zero before machining or in the machine zero return after machining.

4) Dial switch

There are 6 dial switches SW1~SW6. SW1, SW2, SW3, SW5 are for setting the stepping angle and there are 16 kind of different stepping angle. The cross tabulation between the dial switch position and the stepping angle is as Table 1, SW4 and SW6 are for coarse switch to control the current output of drive unit. The cross tabulation between the dial switch position and output current is as Table 2.

Table 1

Switch position	SW ₁	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF
	SW ₂	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON	ON	OFF
	SW ₃	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF
	SW ₅	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON	ON	ON	OFF
Stepping angle (°)		0.036	0.072	0.06	0.144	0.09	0.12	0.9	0.30	0.36	0.45	0.6	0.72	0.045	0.75	0.075	0.03

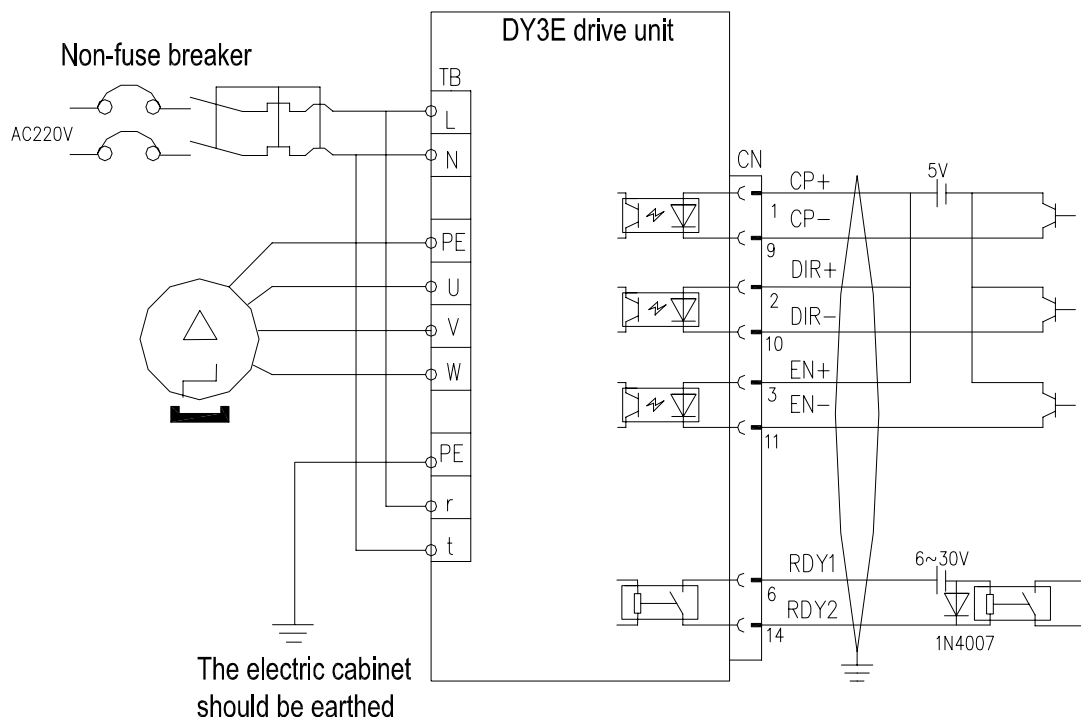
Table 2

Switch position	SW 4	ON	OFF	ON	OFF
	SW 6	ON	ON	OFF	OFF
Current value		Full current	Full current×0.8	Full current×0.6	Full current×0.4


Note 1: The dial switch position: it is OFF when it is to the right, and it is ON when it is to the left.

Note 2: The full current is the current value marked by the drive unit.

8 Interface method of DY3E drive unit



Note 1: The above is the input signal level 5V. When the signal level is more than 5V, the limiting-current resistance should be connected in series and the input current should be 4~10mA.

Note 2: The protection earthing  of the drive unit should be connected with the electric cabinet of machine tool.

Note 3: We should select the proper non-fuse breaker to match with the drive unit.

9 Parameter list of three-phase compound stepper motor

Type	Phases	Hold torque	Stepping angle	Static phase current	Unload run frequency	Unload start frequency	Phase inductance	Rotation inertia Kgcm ²	Voltage range VKC	Weight Kg
90BYG350A	3	2Nm	0.6	1.0A	30000Hz	1600Hz	28mH	1.5	80~325V	3
90BYG350B	3	4Nm	0.6	1.1A	30000Hz	1600Hz	38mH	3.0	80~325V	4
90BYG350C	3	6Nm	0.6	1.3A	30000Hz	1600Hz	43mH	4.5	80~325V	5
110BYG350A	3	8Nm	0.6	2.4A	30000Hz	1600Hz	20mH	8.4	80~325V	7
110BYG350B	3	12Nm	0.6	2.8A	30000Hz	1600Hz	30mH	12.6	80~325V	10
110BYG350C	3	16Nm	0.6	3.0A	30000Hz	1600Hz	35mH	16.8	80~325V	12

Note: the run stepping angel between the unloaded frequency and unloaded start frequency is 0.6°.

Type	Stepping angle	Run torque frequency features (Nm/Hz)								
90BYG350A	0.6	<u>2.0</u> 300	<u>1.9</u> 500	<u>1.8</u> 1000	<u>1.8</u> 2000	<u>1.7</u> 4000	<u>1.7</u> 6000	<u>1.6</u> 8000	<u>1.2</u> 10000	<u>1.1</u> 12000
90BYG350B	0.6	<u>4.0</u> 300	<u>3.7</u> 500	<u>3.7</u> 1000	<u>3.6</u> 2000	<u>3.5</u> 4000	<u>2.7</u> 6000	<u>1.9</u> 8000	<u>1.6</u> 10000	<u>1.4</u> 12000
90BYG350C	0.6	<u>6.0</u> 300	<u>5.5</u> 500	<u>5.4</u> 1000	<u>5.4</u> 2000	<u>4.3</u> 4000	<u>2.7</u> 6000	<u>2.2</u> 8000	<u>1.6</u> 10000	<u>1.5</u> 12000
110BYG350A	0.6	<u>8.4</u> 300	<u>8.4</u> 500	<u>8.4</u> 1000	<u>8.3</u> 2000	<u>8.1</u> 4000	<u>7.0</u> 6000	<u>5.1</u> 8000	<u>4.5</u> 10000	<u>4.0</u> 12000
110BYG350B	0.6	<u>11.7</u> 300	<u>11.7</u> 500	<u>11.7</u> 1000	<u>11.6</u> 2000	<u>10.6</u> 4000	<u>7.6</u> 6000	<u>5.7</u> 8000	<u>5.1</u> 10000	<u>4.2</u> 12000
110BYG350C	0.6	<u>15.9</u> 300	<u>15.9</u> 500	<u>15.9</u> 1000	<u>15.8</u> 2000	<u>13.0</u> 4000	<u>8.5</u> 6000	<u>6.5</u> 8000	<u>5.6</u> 10000	<u>5.1</u> 12000

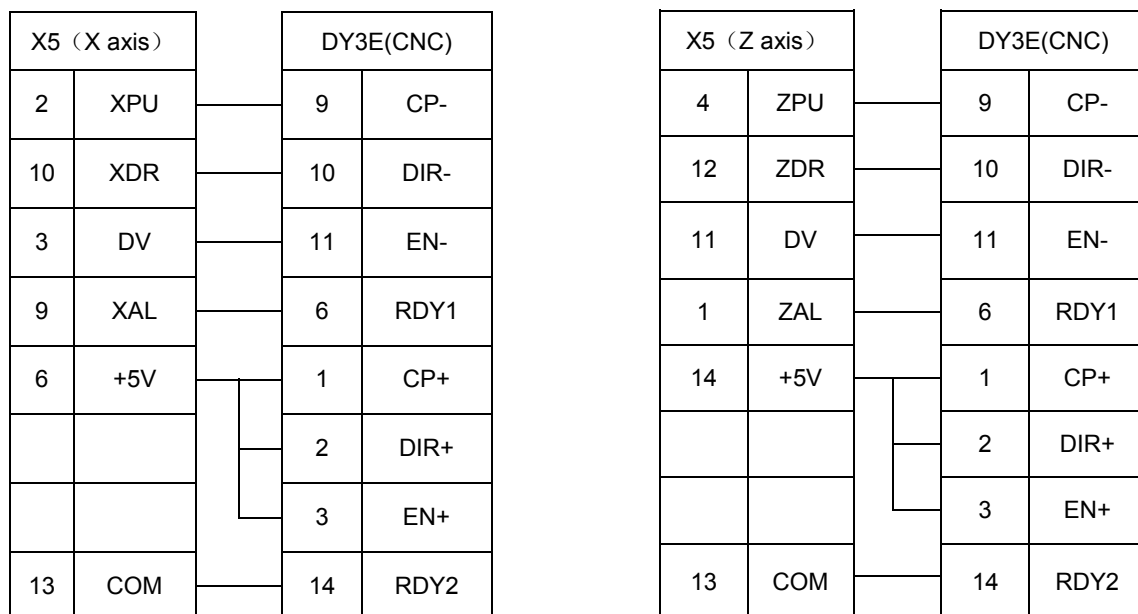
10 DY3E being connected with CNC system

1) DY3E being connected with GSK980TA

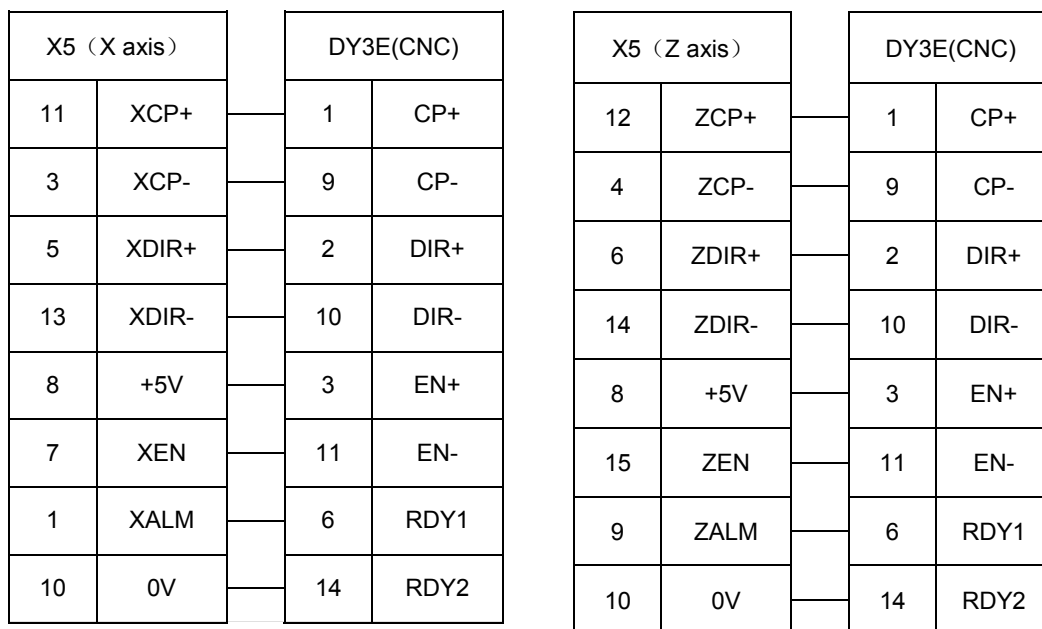
Socket XS30 (X axis)		DY3E(CNC)	
Signal name	Pin	Pin	Signal name
XCP+	1	1	CP+
XCP-	9	9	CP-
XDIR+	2	2	DIR+
XDIR-	10	10	DIR-
OV	11	14	RDY2
XDALM	5	6	RDY1
+5V	12	3	EN+
0V	14	11	EN-

Socket XS31 (Z axis)		DY3E(CNC)	
Signal name	Pin	Pin	Signal name
ZCP+	1	1	CP+
ZCP-	9	9	CP-
ZDIR+	2	2	DIR+
ZDIR-	10	10	DIR-
OV	11	14	RDY2
ZDALM	5	6	RDY1
+5V	12	3	EN+
0V	14	11	EN-

2) DY3E being connected with GSK928TA



3) DY3E being connected with GSK928TC\TC-1\TC-2



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