✵ This user manual describes all proceedings concerning the operations of this Drive Unit in detail as much as possible. However, it is impractical to give particular descriptions for all unnecessary or unallowable Drive Unit due to the manual text limit, product specific applications and other causes. Therefore, the proceedings not indicated herein should be considered impractical or unallowable.

Preface

Your Excellency,

It's our pleasure for your patronage and purchase of this GSK DY3F Series Three-phase Compound Step Drive Unit made by GSK CNC Equipment Co., Ltd.

> This manual offers the corresponding contents and cautions using this drive unit. And it is suitable for the DY3F (V3.0) version. It is better to install and connect after carefully read this manual.

Technological Spot Service

You can ask for spot service if you have the problems that can't be solved by telephone. We will send the authorized engineers to your place to resolve the technological problems for you.

All specifications and designs herein are subject to change without further notice.

Chinese version of all technical documents in Chinese and English languages is regarded as final.

Content

Precaution and Explanation

Installation

The drive unit should be installed in well ventilated and safe and perfect electric cabinet. It is better to install the space interval recommended by Fig. 1 to guard against the cooling of the drive unit!

Wring

The wring should be connected stably, and then tighten the terminal, because the excessive current may occur both in the motor and power lines.

The drive unit and step motor should be grounded reliably!

Power On

Never attempt to plug out/in the motor plug when the power is turned on, and therefore, the unexpected result may occur.

The overcurrent protector should be installed to guard against the power line; the circuit can be cut off when the overcurrent occurs.

The power switch should be used the on-off and reliable air switch instead of using the common disconnecting-link one.
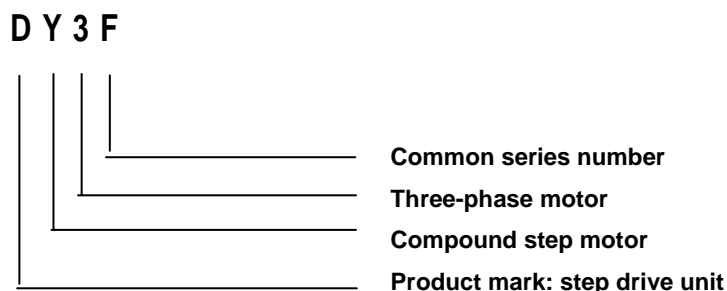
The drive unit only can be operated after confirming that there is no conductive foreign material in it and the connection is correct and reliable!

Order

The output current of the drive unit that is more than 5.2A should be customized to the company.

Do not use the common product with more than 5.2A; otherwise, the consequences should be undertaken.

1. Type Explanation

D Y 3 F

Common series number
Three-phase motor
Compound step motor
Product mark: step drive unit

2. Performace Brief

The three-phase compound step motor is manufactured by the rare earth permanent-magnet material, of which it has some advantages, such as the less loss of electromagnetism, high conversion efficiency and excellent dynamic character, compared to the reaction stop motor. This motor can be operated with stable, low noise, wide output torque and without step-out. It greatly improves its vibration and noise driven by the sine wave current, of which it is a high grade product.

DY3F Series Three-phase Step Drive Unit developed by the GSK has characters as follows:

Latest technology

It is used the micro-electronic technology to embed the new generation high-speed singlechip into the drive unit improving the control performance and simplifying the circuit; it is also employed the AC servo control schematics; it owns the AC servo operation character and three-phase sine current drive output; the low voltage DC power inside the drive unit is used the switch power technology to shorten the volume of the power circuit and get reliably

Micro step

It is used the vector subdivision technology to control the least angle rotated of the step motor, which is 1/20(0.03°) of the motor step angle. The step motor is operated stably with low speed based upon the micro step control; its operation effect approaches that of the AC servo. The micro step drive unit is matched with the μm (0.001mm) CNC controller to realize its least movement, which is

used for workpieces, such as the arc machining, cone surface and the thread etc.; it also can be obviously improve the meticulous effect of the workpiece surface.

High torque

The step motor output torque is proportional against the input current. The input current capacity is proportional with the voltage used by the power amplifier of the drive unit r when it is operated with high speed. At present, the most step motor drive unit is power amplifier grade, which is used the less than DC150V due to the limitation technology, however, the one of that of the DY3F step motor drive unit reaches to DC310V, and therefore, the drive step motor still outputs high torque during the high speed.

High reliability

The control parts are high integrated, the power amplifier is employed with Mitsubishi the new intellective module with tight structure, concise circuit, few connectors, and external wind cooling to protect the dust from entering the machine, as well the overtemperature, overvoltage, undervoltage, protection and alarm signal output.

3. Technical Parameters

|	
Input power	AC220V -15%~+10% 50 Hz /60Hz 10A（Max）
Output phase current	Phase current enabled value is less than or equal to 6.8A
Adapted motor	Three-phase compound step motor (Step angle 0.6°)
Working environment	0℃~45℃ 10%~85%RH, no condensing. No corrosion, inflammable, explosive, conductive gas, liquid and dust.
Storage environment	-20℃~80℃ 10%~85%RH, no condensing
Drive mode	SPWM (Sine pulse width regulation) constant-current chopping, three-phase sine wave current output.
Step angle	User set: 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° and 0.750°

Pulse/rev. of the corresponding motor	12000, 10000, 8000, 6000, 5000, 4800, 4000, 3000, 2500, 400, 1200, 1000, 800, 600, 500 and 480
Step angle setting mode	DIP switch (SW7, SW8, SW9 and SW10) setting
Input signal	CP/$\overline{\text{CP}}$ (pulse); DIR/$\overline{\text{DIR}}$ (direction); EN/$\overline{\text{EN}}$ (enabling);
Input LEVEL	1KΩ resistance series-in when 5V, 5 mA ~10mA and 12V; 2.2 KΩ series-in when 24V. The input is enabled when its circuit has the current.
The input mode of the position pulse	Single pulse mode: CP (pulse) + DIR (direction) Pulse width ≥2μs; Pulse frequency: (step angle <0.300°) ≤200kHz; (step angle ≥0.300°) ≤15kHz; The DIR (direction) signal leading the CP (pulse) signal ≥10μs.
Output signal	RDY1/RDY2 (Ready); loading 30V, 0.5A (Max), it is ON without alarm.
Power-down phase memory	Automatically memory the current phase after the drive is power off.
Motor current automatic half function	The drive that is ON within 100μs is without pulse input, the locking current is automatically reduced half, and vice versa.
Protective function	Abnormal brake, underpressure, overpressure, IPM module abnormality
State instruction	Green LED RDY: Normal indicator is ON without fault; A, B, C: The pulse indicates with enabling Yellow LED ALM: abnormal brake, underpressre, overpressure, IPM module flashes when it is abnormal
Figure dimension	244 mm×163 mm×92mm (Refer to the Fig.)
Weight	2.7kg

4. Advanced Step Motor Control Schema

The AC servo control schema manufactured by GSK is applied to the three-phase compound step drive unit, its input AC 220V becomes DC 310V after commutating, and then turns into three-circuit 310V stage wave current by the pulse width debugging, which are separately flew to the three-circuit winding based upon the fixed time sequence, and each stage corresponds to one step of motor rotation. The motor speed can be changed by the sine current frequency from the drive unit; the output stage number of each revolution confirms the angle of each step rotation.

The stage number of the sine current can be divided into many kinds based upon the present electric technology. Theoretically, the step number per revolution of the motor is high, which is the subdivided technology. The theory analysis and a large number of experiments shown: if the subdivided number exceeds 10, the skip and the step-out appears after the motor is loaded. And therefore, there is no meaning when the subdivided number is more than 10. Presently, only the three-phase sine current subdivided technology can ensure that the motor's torque does not reduce after subdividing, and each step can be accurately positioned.

When the three-phase winding is connected with the sine wave current (The phase differential of the three-phase current is 120°), this current in the air gap of the motor is generated a constant rotation magnetic potential with the space maximum value. Both the dimension and direction of this space magnetic potential is related with the sequence and dimension of the current of each phase; the current in the motor winding of the drive unit is bidirectional grade stage wave (The current wave becomes the sine wave when the grade number is increased infinitely), and the phase differential of each current is 120°. The motor rotation is performed by which the motor magnetic rotor traces the stator magnetic potential surface movement. When the space magnetic potential is positioned to one point, the rotor is also on this point to realize the accurate positioning. The relationship between the motor phase current wave and the motor step angle is shown below:

Strong torque output

Low noise

High cost-performance
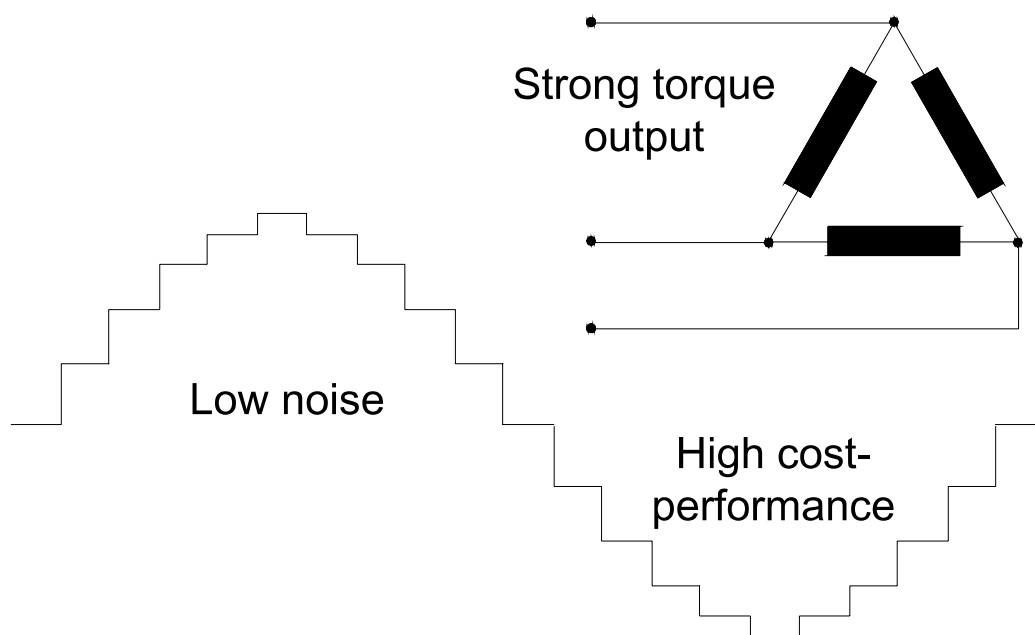
When one phase current changes into a completed period (Other phase current is also changed its completed period, only the different of the phase angle), the step motor rotor will perform one pitch, the corresponding mechanical angle is 360°/Z2 (Z2 is the rotor gear number of the motor). If the phase current is divided into N stage current values within one period, the rotor at each stage is on the different positioning point. And therefore, the step angle of the step motor is: a=360°/(NZ2), or the motor steps per revolution is: S=N×Z2. If each sine period is composed of 20 current stages N and the rotor gears Z2 of the motor is 50, the step angle of the motor is =360°/(NZ2)=360°/（20×50）=0.36°. The required pulse number of each revolution of the motor is S=N×Z2=20×50=1000.

5. Installation Explanation

The figure and installation dimension of the drive unit is as the Fig.1.

Installation steps:

a) Unpack checking

DY3F drive unit is single (axis) packing. It is important to check the accessories, such as the drive unit type, series number, user manual and certificate, after unpacking. Immediately contact with our company if they are inconsistent with the packing list

Check whether the abnormal occurs, such as the distortion of the machine of the drive unit and the damage of the components, if does, it is better to install without any effect in usage, or contact

with our company.

b) Installation

DY3F drive unit should be installed into the electric cabinet with well-ventilated and perfect protection to ensure the cooling of the drive unit. It is better to install the drive unit based upon the recommended space interval in the Fig. 1.

c) Wiring

Some wires, such as the signal, motor and power, should be completely connected based upon the following explanation. The current that flows through the motor wire and power wire is strong, so it is necessary to connect stably, and both the motor wire and power cable should be more than $1mm^2$.

The inductive voltage and leakage current may be generated in the step motor, due to the drive unit is operated at the high frequency chopping method. It is recommended that the power of the drive unit should be offered by the isolation transformer, and the drive unit and step motor should be stably grounded to ensure the safety use. The power supply should be used the air switch, leakage protection switch or contactor to ensure that the ON/OFF can be rapidly and reliably performed.
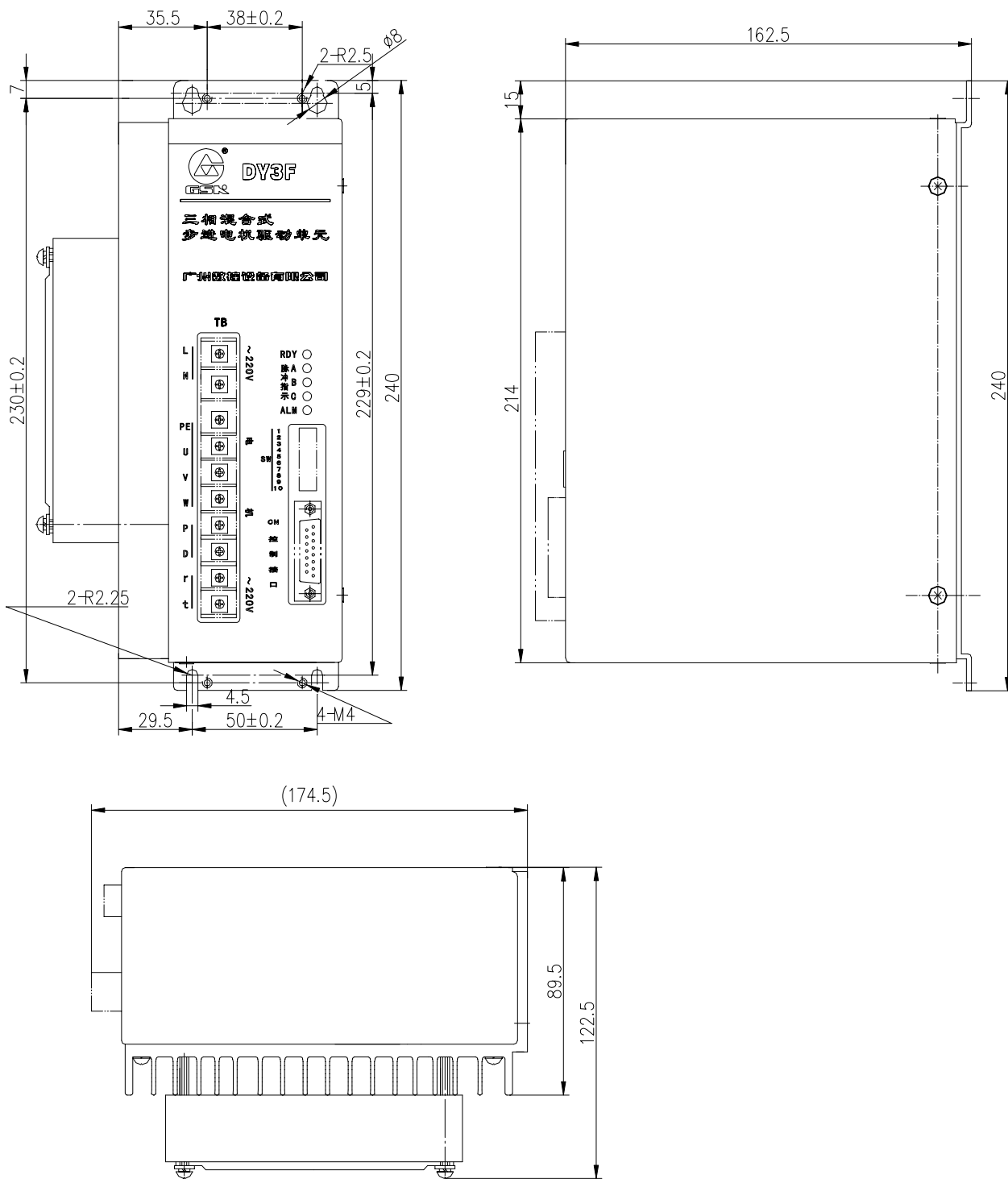
6. The Configuration of the Drive Unit

Fig. 1

7. The Explanations both the Interface and the Dial Switch

1) Signal interface and wiring are shown below:

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: Pin 6 and pin 14 are switched on in the electric cabinet when DY3F operation is normal; they are switched off when alarm occurs.

2) Motor interface and power interface

The power inputs AC 220V, which is parallelly connected to the r, t port from the L, N port.

The inner coil of the step motor is connected as triangle (or as "Y", but the output phase current of the drive unit should be adjusted), the leading wire of the motor can be randomly connected to the U, V and W. Turn off the power and then exchange 2 joints of the motor line arbitrarily when the motor rotates in a mistake direction.

3) State indicator

The drive unit alarm occurs when the yellow indicator ALM is ON. Four green indicators: the RDY drive unit is the ready one, which means the operation is normal when this indicator is ON; A, B and C indicators are the pulse input state; the power-on initial state is the previous one before power-down in case of the enabling. A, B and C have 8 kinds of state indications, so that we can estimate whether the machine is step-out to confirm their states are identical based upon the program zero before machining and the one after machining.

4) Dial switch

There are 10 dial switches in the state indicator SW1～SW10. Therein, SW1, SW2, SW3 and SW4 are the one of the drive unit output current, and then there are 16 kinds motor phase current can be set. SW7, SW8, SW9 and SW10 are the step angle setting switch, which can be set 16 kinds different motor phase current. SW5 and SW6 are separately regarded as the drive unit SPWM and the semi-current mode function selection switch. Refer to the Table 1 for details.

Table 1 The function setting table of the dial switch

Current setting of the motor line						The setting of the motor step angle					
SW1	SW2	SW3	SW4	Line current (A)	Compatible product	SW7	SW8	SW9	SW10	Step angle (°)	Step No./rev.
OFF	OFF	OFF	OFF	1．0		OFF	OFF	OFF	OFF	0．03	12000
ON	OFF	OFF	OFF	1．4		ON	OFF	OFF	OFF	0．036	10000
OFF	ON	OFF	OFF	1．8		OFF	ON	OFF	OFF	0．045	8000
ON	ON	OFF	OFF	2．2	DY3E-13	ON	ON	OFF	OFF	0．06	6000
OFF	OFF	ON	OFF	2．5		OFF	OFF	ON	OFF	0．072	5000
ON	OFF	ON	OFF	2．9		ON	OFF	ON	OFF	0．075	4800
OFF	ON	ON	OFF	3．3		OFF	ON	ON	OFF	0．09	4000
ON	ON	ON	OFF	3．7		ON	ON	ON	OFF	0．12	3000
OFF	OFF	OFF	ON	4．1	DY3E-24	OFF	OFF	OFF	ON	0．144	2500
ON	OFF	OFF	ON	4．5		ON	OFF	OFF	ON	0．3	1200
OFF	ON	OFF	ON	4．8	DY3E-28	OFF	ON	OFF	ON	0．36	1000
ON	ON	OFF	ON	5．2	DY3E-30	ON	ON	OFF	ON	0．45	800
OFF	OFF	ON	ON	5．6		OFF	OFF	ON	ON	0．6	600
ON	OFF	ON	ON	6．0		ON	OFF	ON	ON	0．72	500
OFF	ON	ON	ON	6．4		OFF	ON	ON	ON	0．75	480
ON	ON	ON	ON	6．8	DY3E-40	ON	ON	ON	ON	0．9	400
The SPWM chopping frequency setting of the drive unit						The setting of the motor semi-current mode					
SW5	OFF		ON			SW6	OFF			ON	
	Reserved						Pulse stops 100ms semi-current mode			Upconversion and upflow mode	

**Note 1: That the dial switch towards right is OFF, left is ON.**

Note 2: The function of the upconversion and upflow mode is when the drive unit is without the input pulse within 100us, it will be automatically reduced the output phase current 60% of the rated value; this function can save the energy, effectively cool the motor and extend the life span of the drive unit. Generally, it should be set as the upversion and upflow mode; as well, it can be set as the pulse stop 100ms semi-current mode if the low-speed torque of the motor is inadequate.

Note 3: If the internal coil of the step motor is connected as the triangle (because of $I_{line} = \sqrt{3} \times I_{phase}$), the dial switch SW1, SW2, SW3 and SW4 should be set, and the set line current should be $\leq$ the $\sqrt{3}$ times of the rated value of the motor's nameplate (It is phase current on the nameplate)

Note 4: If the internal coil of the stop motor is connected as the "Y" type (because $I_{line} = I_{phase}$), the dial switch SW1, SW2, SW3 and SW4 should be set, and the set line current $\leq$ the rated value marked on the motor's nameplate (It is current phase on the nameplate).

Note 5: The compatible product is that the DY3F drive unit sets the corresponding phase current can be directly replaced the DY3E drive unit. Both the installation and controllable interface are shared with the compatibility.

8. DY3F Drive Unit Interface Schematic
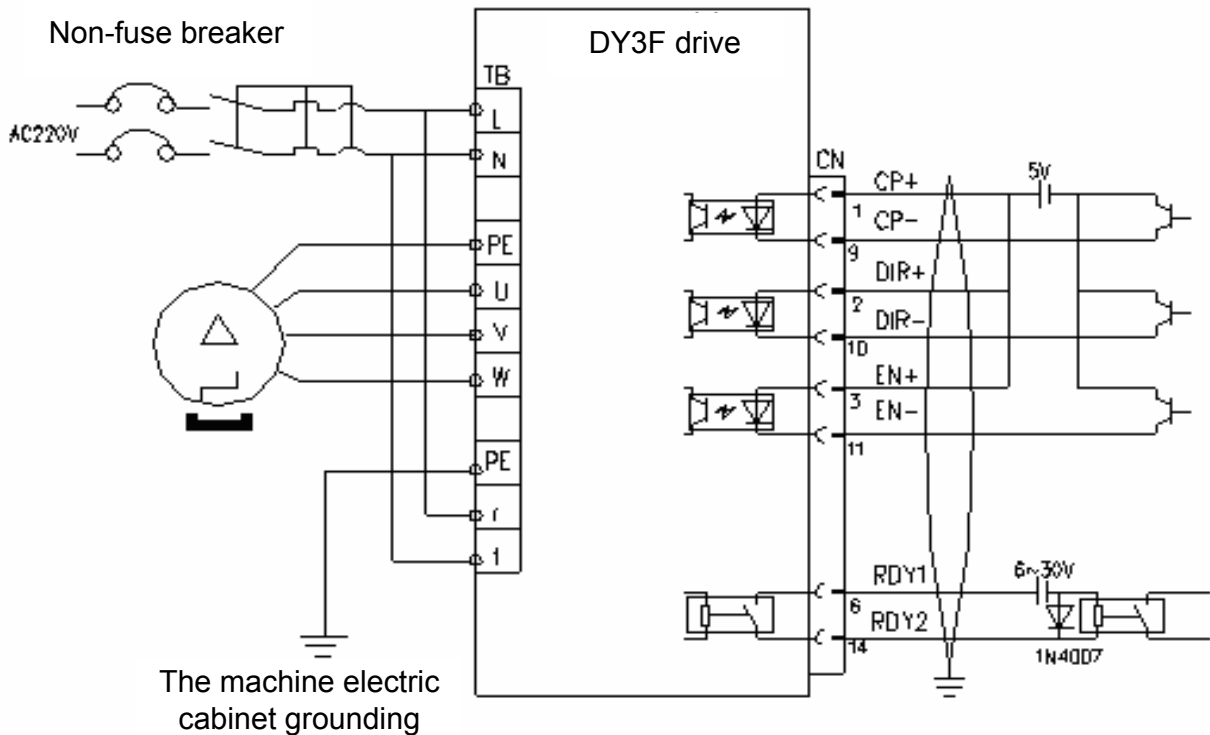
Note 1: The connection when the input signal LEVEL is 5V. When the LEVEL is more than 5V, the

limitation current resistance should be connected with in-series, so that the input current is

4mA～10mA.

Note 2: The ⏚ port of the drive unit should be connected with grounding with the machine electric

cabinet.

Note 3: The suitable non-fuse breaker should be selected to match the drive unit.

9. Three-phase Compound Step Motor Parameter Table

Type	Phase No.	Hold torque	Step angle	Phase current	Unload operation frequency	Unload start frequency	Phase inductance	Moment of Inertial Kgcm^2	Used voltage range VKC	Weight
90BYG350A	3	2Nm	0.6°	1.7A	30000Hz	1600Hz	28mH	1.5	80V～325V	3Kg
90BYG350B	3	4Nm	0.6°	1.9A	30000Hz	1600Hz	38mH	3.0	80V～325V	4Kg
90BYG350C	3	6Nm	0.6°	2.3A	30000Hz	1600Hz	43mH	4.5	80V～325V	5Kg
110BYG350A	3	8Nm	0.6°	4.2A	30000Hz	1600Hz	20mH	8.4	80V～325V	7Kg
110BYG350B	3	12Nm	0.6°	4.8A	30000Hz	1600Hz	30mH	12.6	80V～325V	10Kg
110BYG350C	3	16Nm	0.6°	5.2A	30000Hz	1600Hz	35mH	16.8	80V～325V	12Kg

Note: The operation step angle between the unload operation frequency and start frequency is 0.6°.

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

10. The Connection Between the DY3F and the System

1) The connection between the DY3F and the GSK980TD series\GSK980TB

Socket Xs30 (X axis)		DY3F(CN)		Socket Xs30 (Z axis)		DY3F(CN)	
Signal name	Pin	Pin	Signal name	Signal name	Pin	Pin	Signal name
XCP+	1	1	CP+	ZCP+	1	1	CP+
XCP-	9	9	CP-	ZCP-	9	9	CP-
XDIR+	2	2	DIR+	ZDIR+	2	2	DIR+
XDIR-	10	10	DIR-	ZDIR-	10	10	DIR-
OV	11	14	RDY2	OV	11	14	RDY2
XDALM	5	6	RDY1	ZDALM	5	6	RDY1
+5V	12	3	EN+	+5V	12	3	EN+
0V	14	11	EN-	0V	14	11	EN-

2) The connection between the DY3F and GSK928TA\GSK928MA

X5 (X axis)		DY3F(CN)		X5 (Z axis)		DY3F(CN)	
2	XPU	9	CP-	4	ZPU	9	CP-
10	XDR	10	DIR-	12	ZDR	10	DIR-
3	DV	11	EN-	11	DV	11	EN-
9	XAL	6	RDY1	1	ZAL	6	RDY1
6	+5V	1	CP+	14	+5V	1	CP+
		2	DIR+			2	DIR+
		3	EN+			3	EN+
13	COM	14	RDY2	13	COM	14	RDY2

3) The connection between the DY3F and GSK928TC\ GSK928TC-1\ GSK928TC-2\ GSK928TE series

X5 (X axis)		DY3F(CN)		X5 (Z axis)		DY3F(CN)	
11	XCP+	1	CP+	12	ZCP+	1	CP+
3	XCP-	9	CP-	4	ZCP-	9	CP-
5	XDIR+	2	DIR+	6	ZDIR+	2	DIR+
13	XDIR-	10	DIR-	14	ZDIR-	10	DIR-
8	+5V	3	EN+	8	+5V	3	EN+
7	XEN	11	EN-	15	ZEN	11	EN-
1	XALM	6	RDY1	9	ZALM	6	RDY1
10	0V	14	RDY2	10	0V	14	RDY2