DA98D Digital AC Servo Drive Unit

User Manual

(V5.00)

广州数控设备有限公司

GSK CNC EQUIPMENT CO., LTD.

In this User manual, we will exert ourselves to describe each item related to operation of this drive unit. But due to reasons like limit in space and specific product uses, detailed description of unnecessary or impossible operation of this drive unit will be not included. Therefore, items that are not specially indicated in this manual will all be regarded as “impossible” or “disallowed” operations.

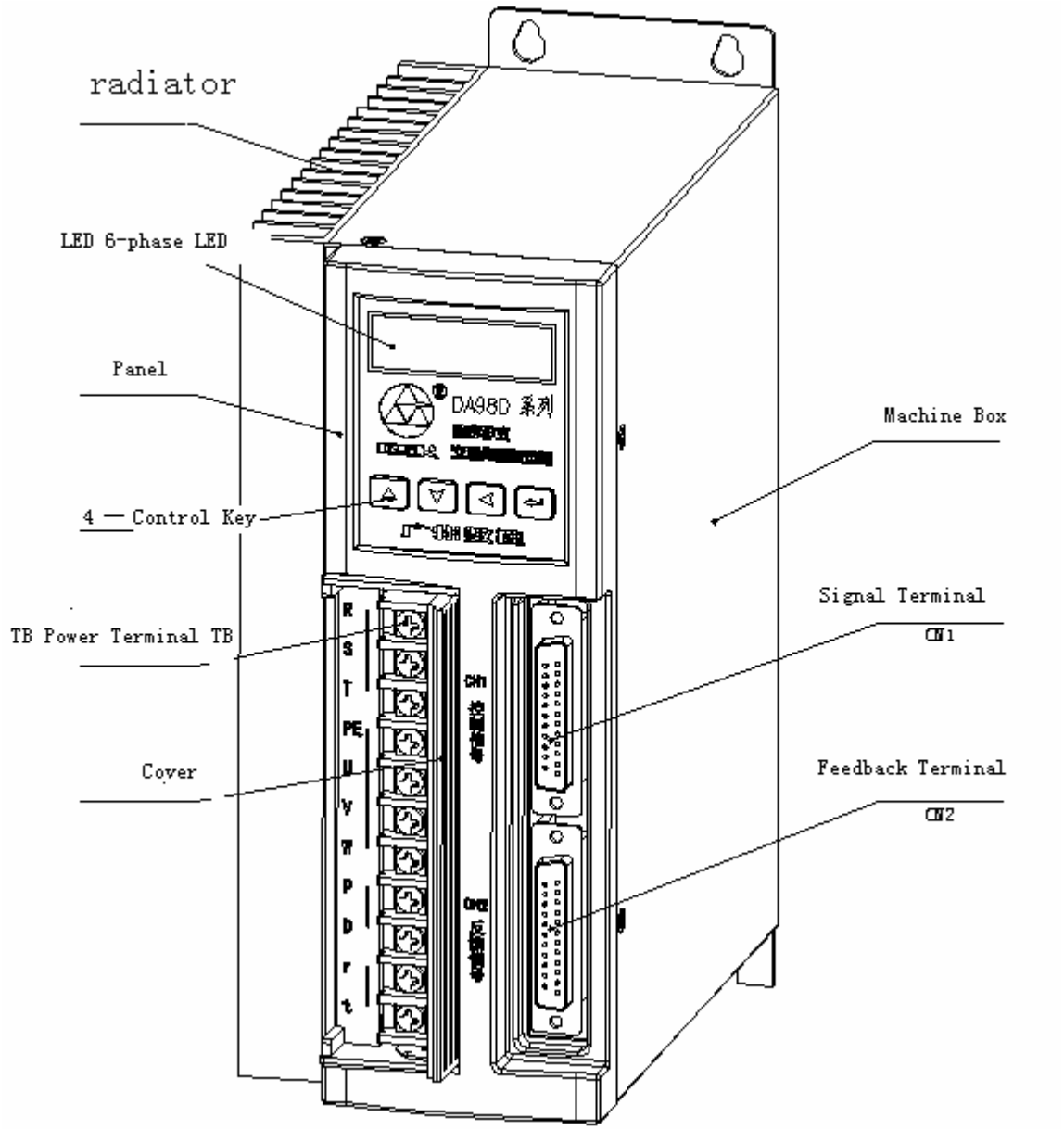


Fig. 1-1 Appearance of Servo Drive unit

2) Servo motor appearance

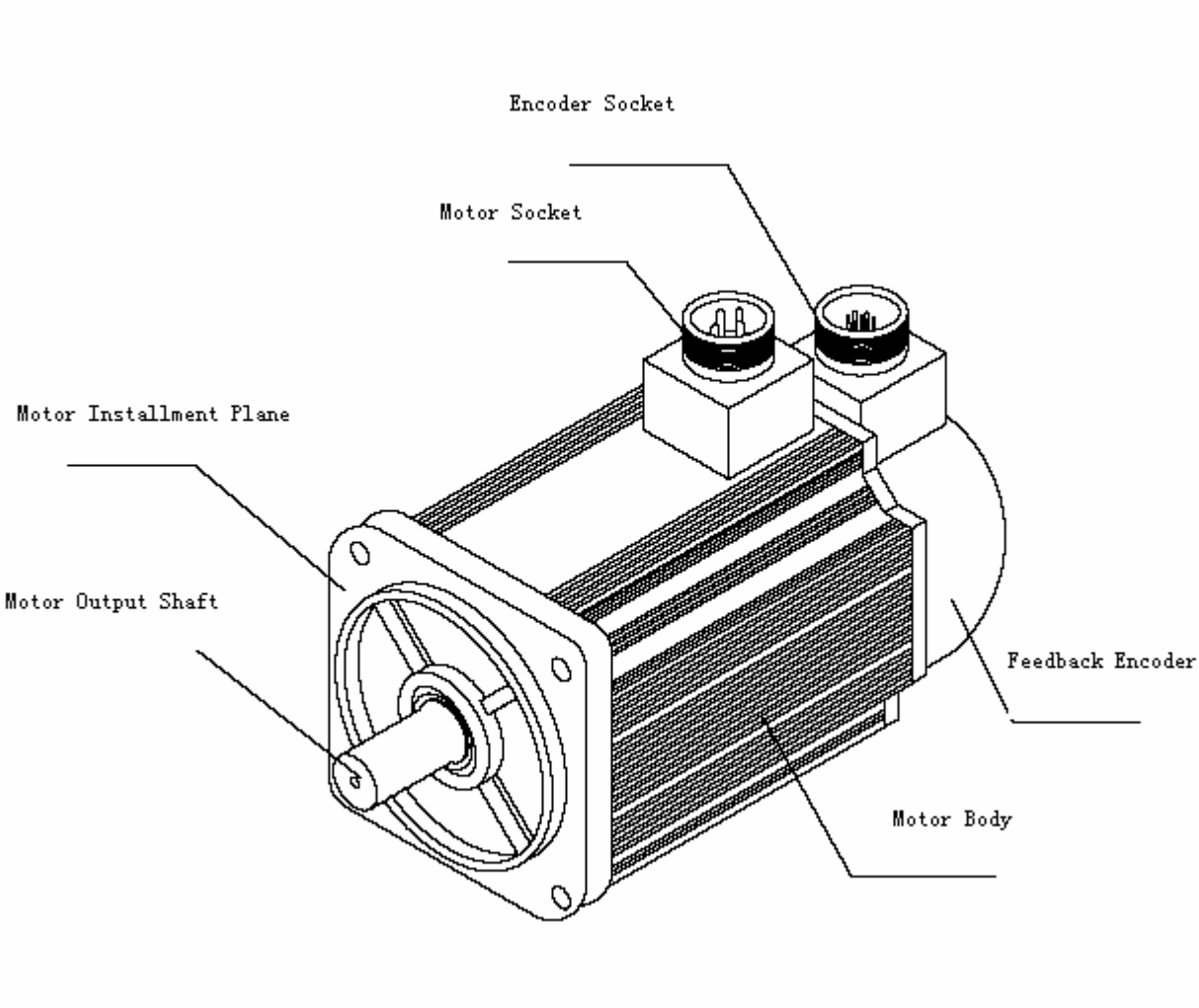


Fig. 1-2 Servo Motor Appearance

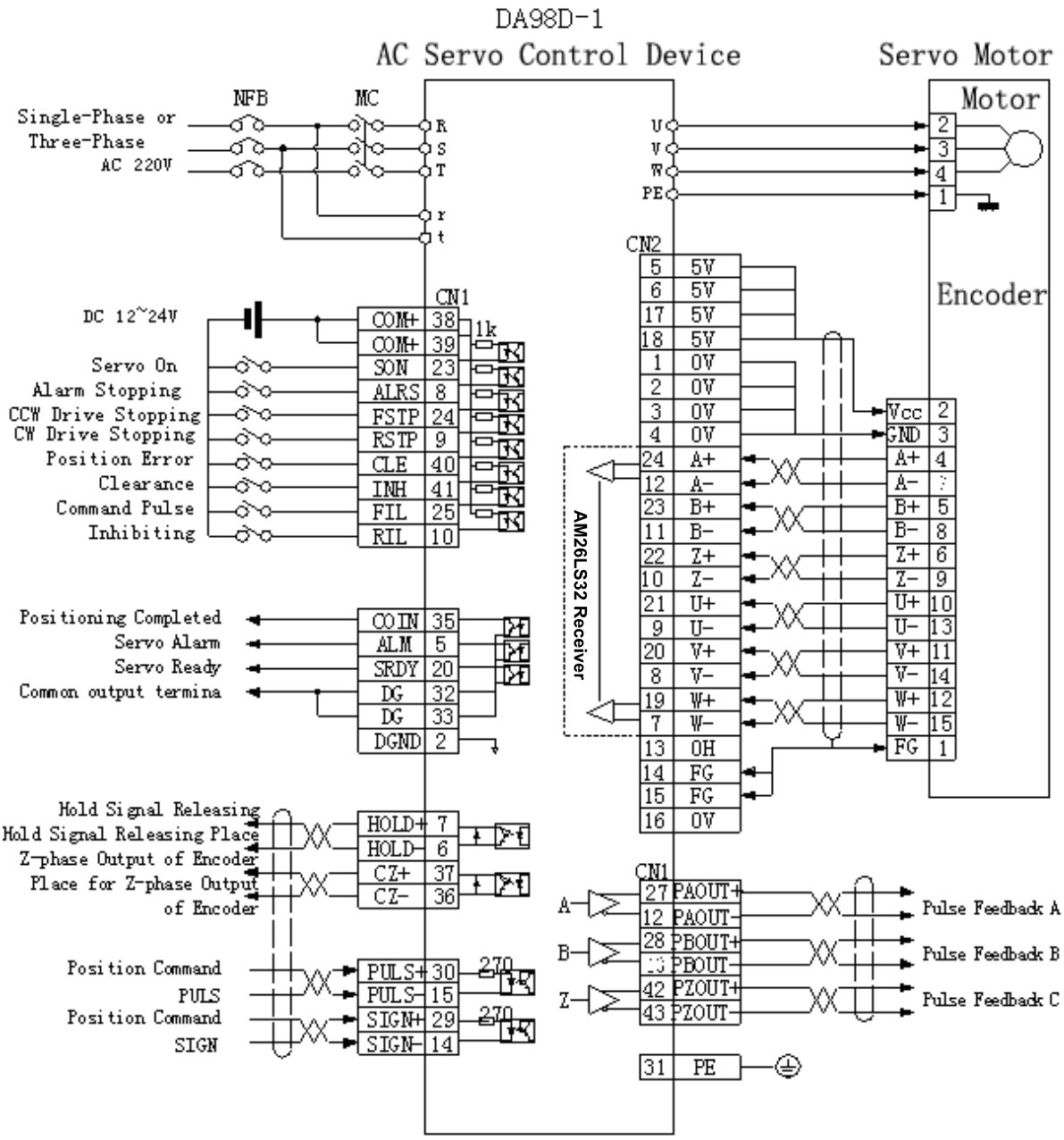


Fig. 3.1 Standard Wiring for Position Control Mode

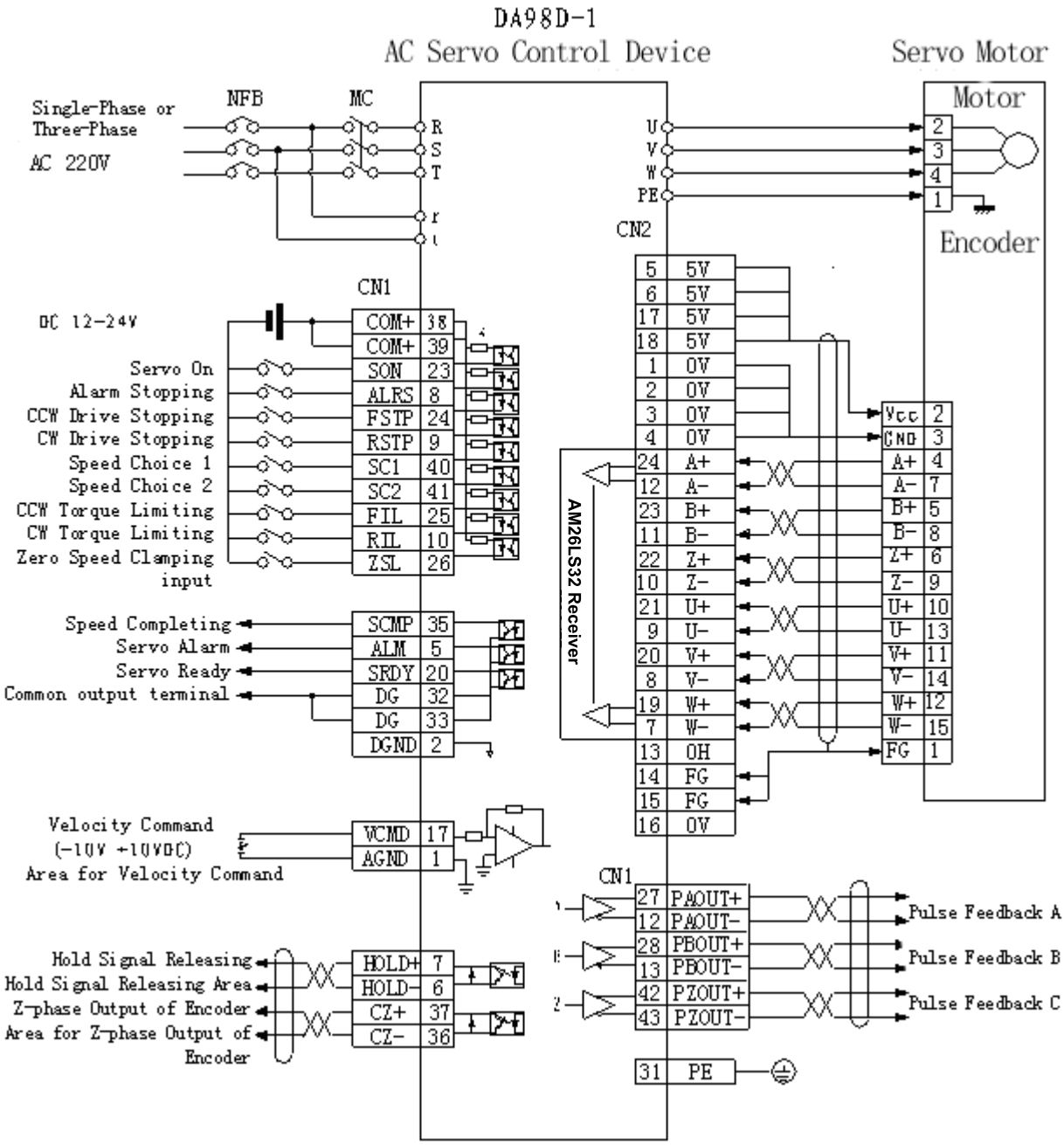


Fig. 3.2 Standard Wiring for Speed Control Mode

1) Switch Value Input Interface

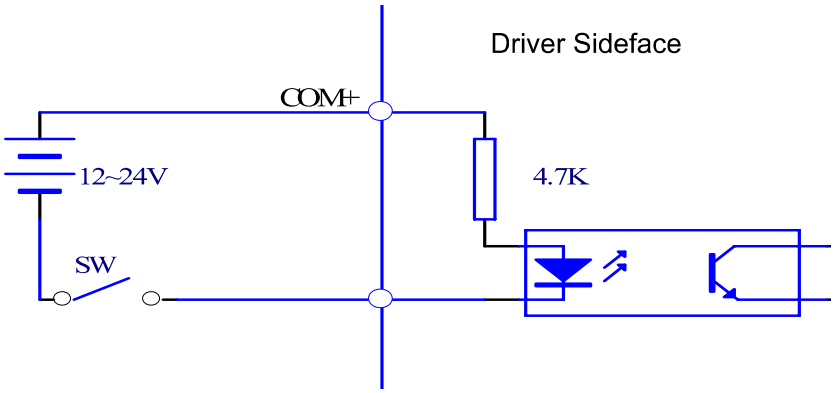


Fig. 3.4 Type1 Switch Value Input Interface

(1) Power supply is provided by the user, DC12～24V, current≥100mA;

(2) Note: if the electrodes are reversely connected, the servo driver will not work.

2) Switch Value Output Interface

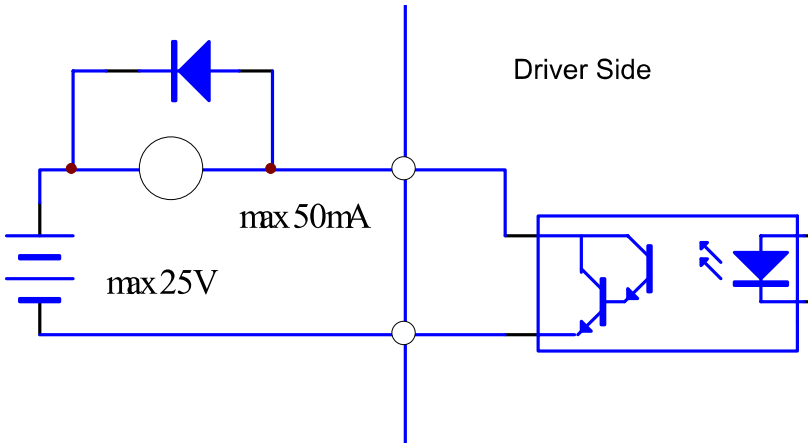


Fig. 3.5 Type2 Switch Value Ouput Interface

(1) The external power supply is provided by the user, but attention must be given to the case that if electrodes of the power supply are reversely connected, the servo drive unit may be damaged.

(2) The output is an open-circuit form of collector, with a maximal current of 50mA and a maximal external power voltage of 25V. Therefore, the load of switch value output signal must satisfy this limited requirement. If the limited requirement is surpassed or the output terminal is directly connected with the power supply, the servo drive unit will be damaged;

(3) If the loads are inductive ones like relay, two sides of the load must be reversely connected in parallel with the continuous current diode. If the continuous current diode is reversely connected, the servo drive unit will be damaged.

3) Analog Input Interface

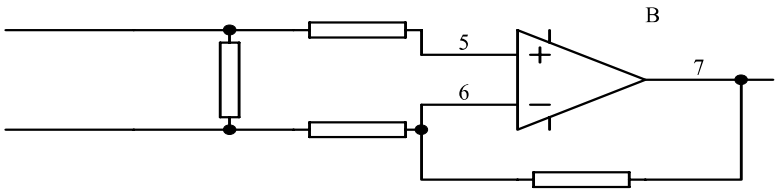


Fig. 3.6 Type4 Analog Command Input Interface

1. Input signal is connected with twisted-pair cable lines.
2. The circuit adopts the enlarged different-mode form, with an input resistance of 20K.

4) Pulse Output Interface

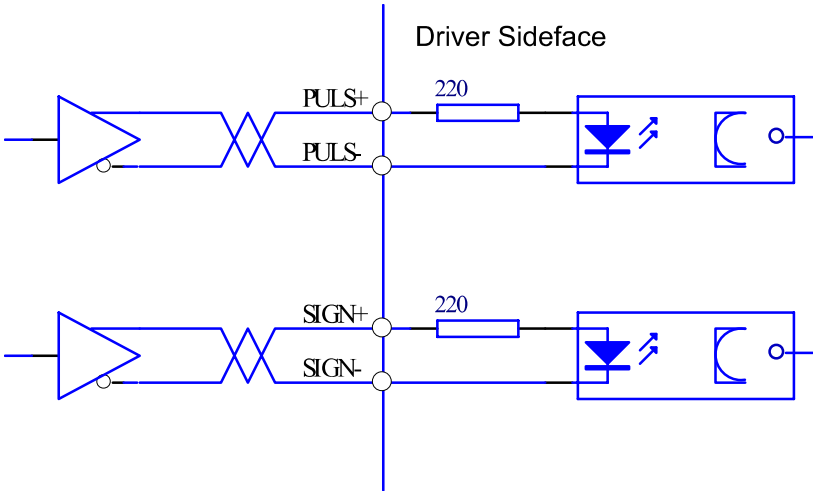


Fig. 3.7 Type3 Differential Drive Mode of Pulse Input Interface

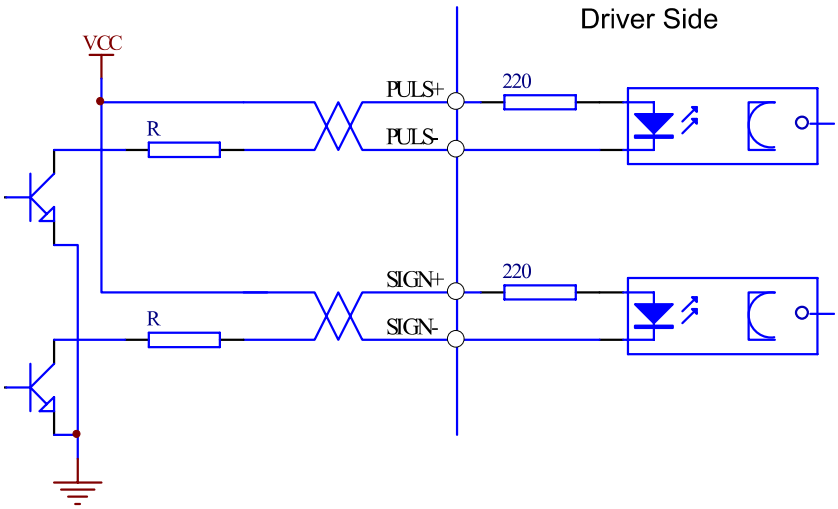


Fig. 3.8 Type4 Uni-polar Drive Mode of Pulse Input Interface

（1） For correctly transmitting pulse data, it is recommended to adopt the differential drive mode;

（2） Under differential drive mode, AM26LS31 and MC3487 or similar cable driver of RS422;

（3） The uni-polar drive mode will reduce the motion frequency. According to the requirements on the pulse amount input circuit: driving current 10～15mA and limited maximal external power voltage of 25V, empirical data are as follows: VCC=24V,R=1.3～2k;VCC=12V,R=510～

820Ω;VCC=5V,R=82～120Ω.

（4） When adopting uni-polar drive mode, the external power supply will be provided by the user, but attention must be given to the case that if the power electrodes are reversely connected, the servo drive unit may be damaged.

（5） Refer to Table 3.4 for details about the pulse input forms, in which the arrow means counting trend. Table 3.5 shows the time sequence and parameters for pulse input.

Table 3.4 Pulse Input Forms

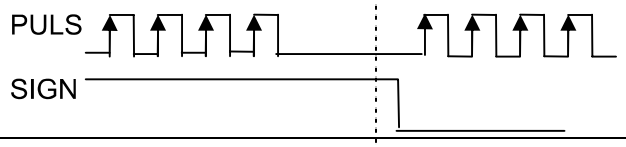
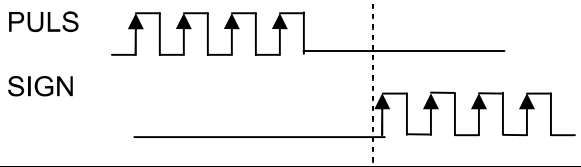
Forms of Pulse Command	CCW	CW	Set Parameter Values
Symbol for Pulse Train			0 Command Pulse＋Symbol
CCW Pulse Train CW Pulse Train			1 CCW Pulse/CCW Pulse

Table 3.5 Time sequence Parameters for Pulse Input

Parameter	Differential Drive Input	Uni-polar Drive Input
t_{ck}	>2μS	>5μS
t_h	>1μS	>2.5μS
t_l	>1μS	>2.5μS
t_{rh}	<0.2μS	<0.3μS
t_{rl}	<0.2μS	<0.3μS
t_s	>1μS	>2.5μS
t_{qck}	>8μS	>10μS
t_{qh}	>4μS	>5μS
t_{ql}	>4μS	>5μS
t_{qrh}	<0.2μS	<0.3μS
t_{qrl}	<0.2μS	<0.3μS
t_{qs}	>1μS	>2.5μS

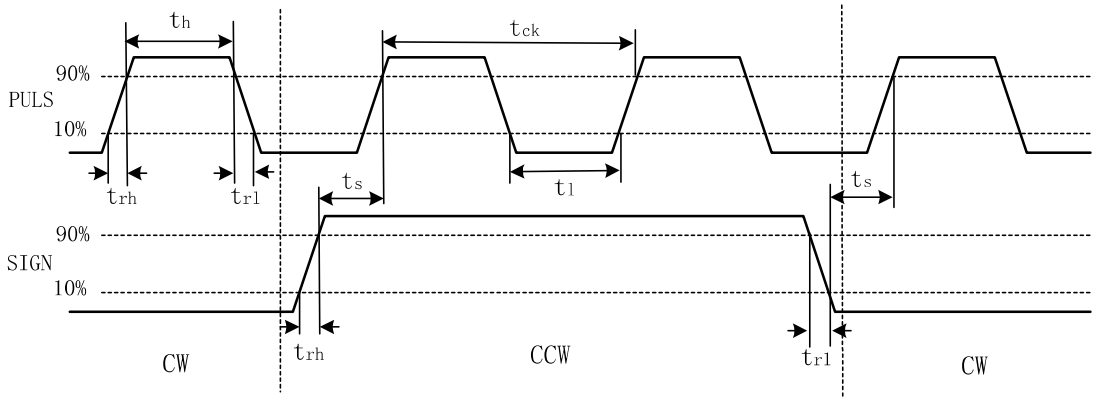


Fig. 3.9 Time sequence Diagram for Pulse＋Symbol Input Interface (Maximal Pulse Frequency:500kHz)

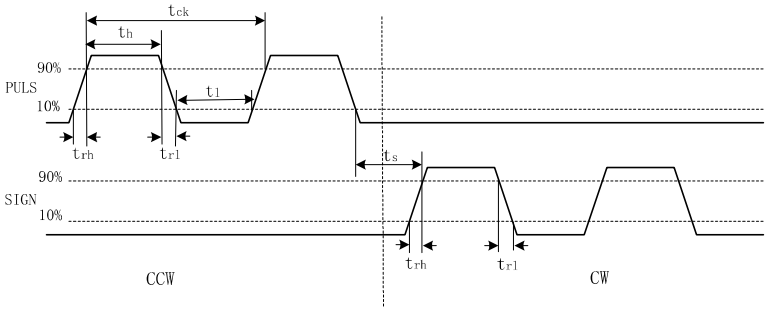


Fig. 3.10 Time sequence for CCW Pulse/CW Pulse Input Interface(Maximal Pulse Frequency:500kHz)

4) Driver Speed Signal Output Interface

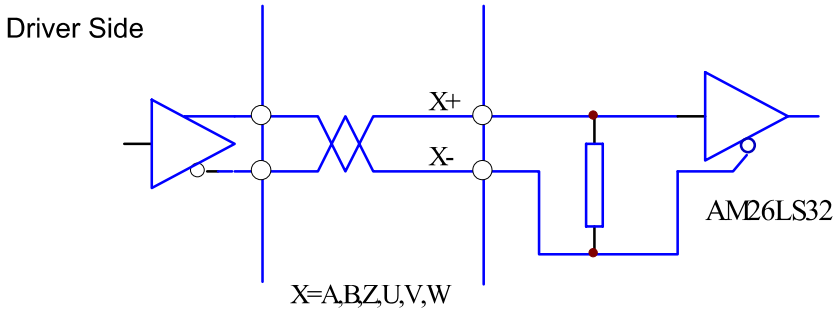


Fig. 3.11 Type5 Driver Speed Signal Output Interface

5) Input Interface for Servo Driver's Photoelectric Encoder

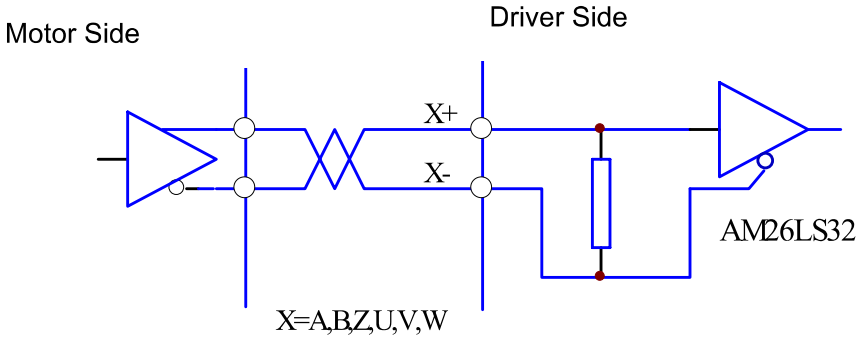


Fig. 3.12 Input Interface for Servo Driver's Photoelectric Encoder

4.2 Functions of Parameters

Table 4.2 Functions of Parameters

No	Name	Functions	Parameter range
0	Password	Prevent the parameters from being wrongly changed. Generally, when needing to set parameters, first set the parameter as the correct password, then set the parameters. After commissioning, reset the parameter back to 0 to ensure that the parameter will not be wrongly changed in the future. Passwords have different classes respectively for user parameters, system parameters and whole parameters. When changing model code parameter (PA1), the model code password must be used. Other passwords can not be used for changing this parameter. User password is 315. Model code password is 385.	0~9999
1	Model Code	Correspond to the same series of drive units and motors with different frequency classes. Different model codes correspond to different default parameter values. And when restoring the function of default parameter values, the parameter concerned must be correct. When EEPROM alarm (No.20) occurs, the parameter must be reset after the repair, then restore the default parameter value. Otherwise, the driver many not work normally or be damaged. When changing the parameter, first set the password PAO as 385, then the parameter concerned can be changed. Please refer to this chapter for detained meanings about parameters.	0~69
2	Software Version	The software version No. can be checked, but cannot be changed.	*
3	Initial Display State	Select display states of the driver screen after being electrified. 0: Display motor rotation rate; 1: Display that current position is lower by 5 (pulses); 2: Display that current position is higher by 5; 3: Display that current position command (means accumulated pulse value)is lower by 5; 4: Display that current position command (means accumulated pulse value)is higher by 5; 5:Display that position error is lower by 5; 6: Display that position error is higher by 5; 7:Display motor torque; 8:Display motor current; 9:Display linear velocity; 10:Display control mode; 11:Display position command pulse frequency; 12:Display speed command; 13:Display torque command; 14:Display absolute position of rotor during one round; 15:Display input terminal state; 16: Display output terminal state; 17:Display encoder input signal; 18:Display operation state; 19:Display alarm code; 20: Reservation.	0~20

39	Acceleration Time Constant	The set value means the acceleration time of motor ranging from 0r/min to 1000r/min The acceleration and deceleration have a linear feature. Only valid for speed control mode, invalid for position control mode. If the drive unit is used together with external position loop, this parameter shall be set as 0.	1ms ~10000ms
40	Deceleration Time Constant	The set value means the deceleration time of motor ranging from 0r/min to 1000r/min The acceleration and deceleration have a linear feature. Only valid for speed control mode, invalid for position control mode. If the drive unit is used together with external position loop, this parameter shall be set as 0.	1ms ~10000ms
41	Numerator of Output Electronic Gear Ratio	Feedback pulse from each coil of the encoder will be output through the gear within the drive unit. E.g., there are 2500 pulses in each coil of the encoder, setting PA41/42=4/5, then the A and B-phase signals output from the drive unit will be 2500 X PA41/PA42=2000 pulses/coil.	0～255
42	Denominator of Output Electronic Gear Ratio	This parameter must be more than or the same with parameter No.41.	0～255
43	Choice of Speed Command	Whether the operation speed is from internal speed or analog command: 0 Internal speed 1 Analog command	0~1
44	High Speed AD Zero Point	When restoring default value, this parameter will not be recovered.	412~1600
45	Low Speed AD Zero Point	When restoring default value, this parameter will not be recovered.	412~1600
46	Motor Rotation Direction Control	0 Normal 1 Opposite to the analog speed command 2 Opposite to the output pulse rotation direction 3 Opposite to both.	0～3
47	Analog Command Gain	Analog command is transited to speed gain.	20～3000
48	Anti-jamming Scope for Analog Command	The function is the same with parameter No.33, but the function range includes all speeds rather than zero speed only. It is recommended that this parameter not be used simultaneously together with parameter No.33.	0～1000
49	Choice of Zero Adjustment Channels for Analog Speed	0 Low speed AD for low speed and high speed AD for high speed. 1 High speed AD for both high and low speed This parameter is used only for AD zero adjusting: to improve the resolving power of analog command, AD switch with different multiplying factors are employed for high and low speed. First set this parameter as 1 to adjust zero point for high speed AD, then set the parameter as 0 to adjust zero point for low speed AD.	0～1
52	Analog Command Transition Mode	0 Speed AD is transited to speed command with curve of second order 1 Speed AD is transited to speed command with straight line.	0～1

5.2 Methods for Handling Alarms

Table 5.2 Methods for Handling Alarms

Alarm Code	Alarm Name	Operation State	Reasons	Handling Methods
1	Excessive Speed	Occur when switching on the control power	①Failure in control power board ②Encoder failure	①Replace servo driver. ②Replace servo motor.
		Occur during motor operation	Excessively high input command pulse frequency.	Correctly set the input command pulse.
			Excessively small acceleration/ deceleration time constant results in overshoot.	Increase acceleration/deceleration time constant.
			The input electronic gear ratio is excessively high.	Correctly set the ratio.
			Encoder failure.	Replace servo motor.
			Bad encoder cable.	Replace encoder cable.
			Instable servo system causes overshoot.	①Reset related gains. ②If the gains cannot be set at a proper value, reduce inertia rate for load rotation
		Occur immediately after the motor is started	Excessively large load inertia.	①Reduce load inertia. ②Replace it with driver and motor of greater frequency.
			Zero-point error in encoder.	①Replace servo motor ②Contact the manufacturer for readjusting the zero point.
			①Wrong connection of motor leads of U, V and W. ②Wrong connection of encoder cable leads	Correct wiring.
2	Over-voltage in Main Circuit	Occur when switching on control power	Failure in circuit board.	Replace servo drive unit.
		Occur when switching on main power supply	①Excessively high power voltage. ②Abnormal wave pattern of power voltage.	Examine the power supply source.
		Occur during motor operation	Disconnection of braking resistance.	Rewiring.
			①Braking transistor is damaged. ②Internal braking resistance is damaged.	Replace servo drive unit.
			Insufficient capacity in the braking return circuit.	①Reduce start/stop frequency . ②Increase acceleration/deceleration time constant. ③Reduce torque limiting value. ④Reduce load inertia. ⑤Replace it with driver and motor of greater frequency.

3	Voltage Shortage in Main Circuit	Occur when switching on main power supply	①Failure in circuit board. ②Power fuse is damaged. ③Failure in soft start circuit. ④Damaged rectifier.	Replace servo drive unit.
			①Excessively low power voltage. ②Temporary power failure for more than 20mS.	Examine the power supply.
3	Voltage Shortage in Main Circuit	Occur during motor operation	①Insufficient power capacity . ②instantaneous power failure.	Examine the power supply.
			Heat radiator overheating.	Examine load.
4	Position Excess	Occur when switching on control power	Failure in circuit board.	Replace servo driver.
		After switching on main power supply and control wire, the motor does not work when inputting command pulse	①Wrong connection of motor leads of U, V and W. ②Wrong connection of encoder cable leads.	Correct wiring.
			Encoder failure.	Replace servo motor.
			Set inspection range for position excess.	Extend inspection range for position excess.
			Position proportion gain is too small.	Increase the gain.
			Insufficient torque.	①Examine torque limiting value. ②Reduce loading capacity. ③Replace it with drive unit and motor of greater frequency.
			Excessively high command pulse frequency.	Reduce the frequency.
5	Motor overheating	Occur when switching on control power	Failure in circuit board.	Replace servo drive unit.
			①Cable disconnection . ②Internal temperature relay of motor is damaged.	①Examine cable. ②Examine motor.
		Occur during motor operation	Motor overload.	①Reduce load. ②Reduce start/stop frequency. ③Reduce torque limiting value. ④ Reduce related gain. ⑤Replace drive unit and motor of greater frequency.
			Internal failure in motor.	① Replace servo motor.
6	Saturation Failure of Speed Regulator	Occur during motor operation	Motor gets stuck by the machinery.	Examine machinery part of the load.
			Overload.	①Reduce load. ②Replace it with drive unit and motor of greater frequency.
7	Abnormal Drive Stopping		Disconnection of CCW and CW drive stopping input terminal.	Examine the wire connection and power of the input terminal.

8	Overflow of Position Error Meter		①The motor get stuck by the machinery. ②Abnormal input command pulse.	①Examine the machinery part of the load. ②Examine command pulse. ③.Examine whether the motor works after receiving command pulse
9	Encoder failure		Wrong connection of encoder.	Examine wire connection.
			Damaged encoder.	Replace motor.
			Bad encoder cable.	Replace cable.
9	Encoder Failure		Excessively long encoder cable results in low power voltage of encoder.	①Shorten cable. ②Supply power with multiple core wires connected in parallel.
10	Voltage Shortage in Control Power		Low input control power.	Examine control power.
			①Internal connectors of driver have bad performance. ②Abnormal switch power. ③Damaged chip.	①Replace drive unit. ②Examine connector. ③Examine switch power.
11	Encoder Failure	Occur when switching on control power	Failure in circuit board.	Replace servo drive unit.
		Occur during motor operation	①Excessively low power voltage. ②Overheating.	①Examine drive unit. ②Re-electrify. ③Replace drive unit.
			Short circuit between motor leads of U, V and W.	Examine wire connection.
			Bad ground contact.	Correct ground contact.
			Damaged motor insulation.	Replace motor.
			Be jammed.	①Add circuit filter. ②Keep away from jamming source
12	Excessive Current		Short circuit between motor leads of U, V and W.	Examine wire connection.
			Bad ground contact.	Correct ground contact.
			Damaged motor insulation.	Replace motor.
			Damaged driver.	Replace drive unit.
13	Overload	Occur when switching on control power	Failure in circuit board.	Replace servo drive unit.
		Occur during motor operation	Operation by exceeding rated torque.	①Examine load. ②Reduce start/stop frequency. Reduce torque limiting value. Replace it with drive unit and motor of greater frequency
			Hold brake cannot be opened.	Examine the hold brake.
			Instable motor with vibration.	①Increase gain. ②Increase acceleration/deceleration time. ③reduce load inertia.

			①One phase of U, V and W is disconnected. ②Wrong connection of encoder.	Examine wire connection.
14	Braking failure	Occur when switching on control power	Failure in circuit board.	Replace servo drive unit.
		Occur during motor operation	Disconnection of brake resistance.	Re-wiring.
			①Damaged brake transistor. ②Internal brake resistance is damaged.	Replace servo drive unit.
14	Braking failure	Occur during motor operation	Insufficient capacity in the brake loop.	①Reduce stop/start frequency. ②Reduce acceleration/deceleration time. ③Reduce torque limiting value. ④Reduce load inertia. ⑤Replace drive unit and motor of greater frequency.
			Excessively high main circuit power voltage.	Examine main circuit.
15	Counting Error of Encoder		Damaged encoder.	Replace motor.
			Wrong connection of encoder.	Examine wire connection.
			Bad ground contact.	Correct ground contact.
20	EEPROM Error		Damaged chip or circuit board.	Replace servo drive unit. .After repair, first reset driver model (parameter No.1), then restore default parameter value.
30	Z Pulse Losing in Encoder		Z pulse does not exist; damaged encoder Bad cable Bad cable shielding Bad connection between shielded wire and shielding layer Failure in encoder's interface circuit	Replace encoder Examine encoder's interface circuit
31	UVW Signal Error in Encoder		Damaged UVW signal of encoder Damaged Z signal of encoder Bad cable Bad cable shielding Bad connection between shielded wire and shielding layer Failure in encoder's interface circuit	Replace encoder Examine encoder interface circuit
32	Code Violation of Encoder's UVW Signal		Damaged UVW signal of encoder Bad cable Bad cable shielding Bad connection between shielded wire and shielding layer Failure in encoder's interface circuit	Replace encoder Examine encoder interface circuit

Chapter Six Display and Operation

6.1 Keyboard Operation

- The panel of drive unit is composed of six-phase LED nixie tube display and four keys of ▲ ▼ ◀ ↵, which are used to display states of drive units and set parameters. The specific functions of the keys are as follows :

  ▲: Increase serial number and value or forward operation.

  ▼ : Decrease serial number and value or backward operation.

  ◀: Return to the preceding layer of men or cancel the operation.

  ↵: Enter the next layer of menu or confirm the input.

Note: Press down ▲ or ▼ and hold on, the operation will be repeated. The longer the key is kept being pressed down, the faster the repetition frequency will be. .

- The six-phase LED nixie tube display can show various states and data about the system. If decimal point of all the nixie tubes or the nixie tube on the fastest right side keeps flashing, it means alarm.
- Operation is conducted according to multi-layer menu, in which the first layer is the main menu, including eight operation modes; the second layer is functional menu to the operation mode under first layer. Fig. 6.1 is a block chart for operations in the main menu, as shown in the following:

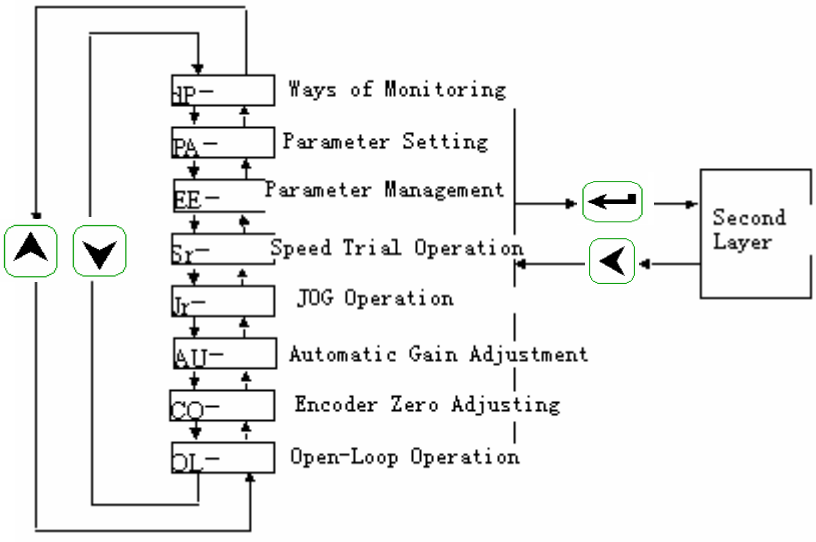


Fig. 6.1 Block Chart for Operation Mode Selection

6.2 Ways of Monitoring

Select “dP-” In the first layer and press down, then you will enter the ways of monitoring, in which there are 21 display states. Use and to select the display mode, then press down to enter the specific display state.

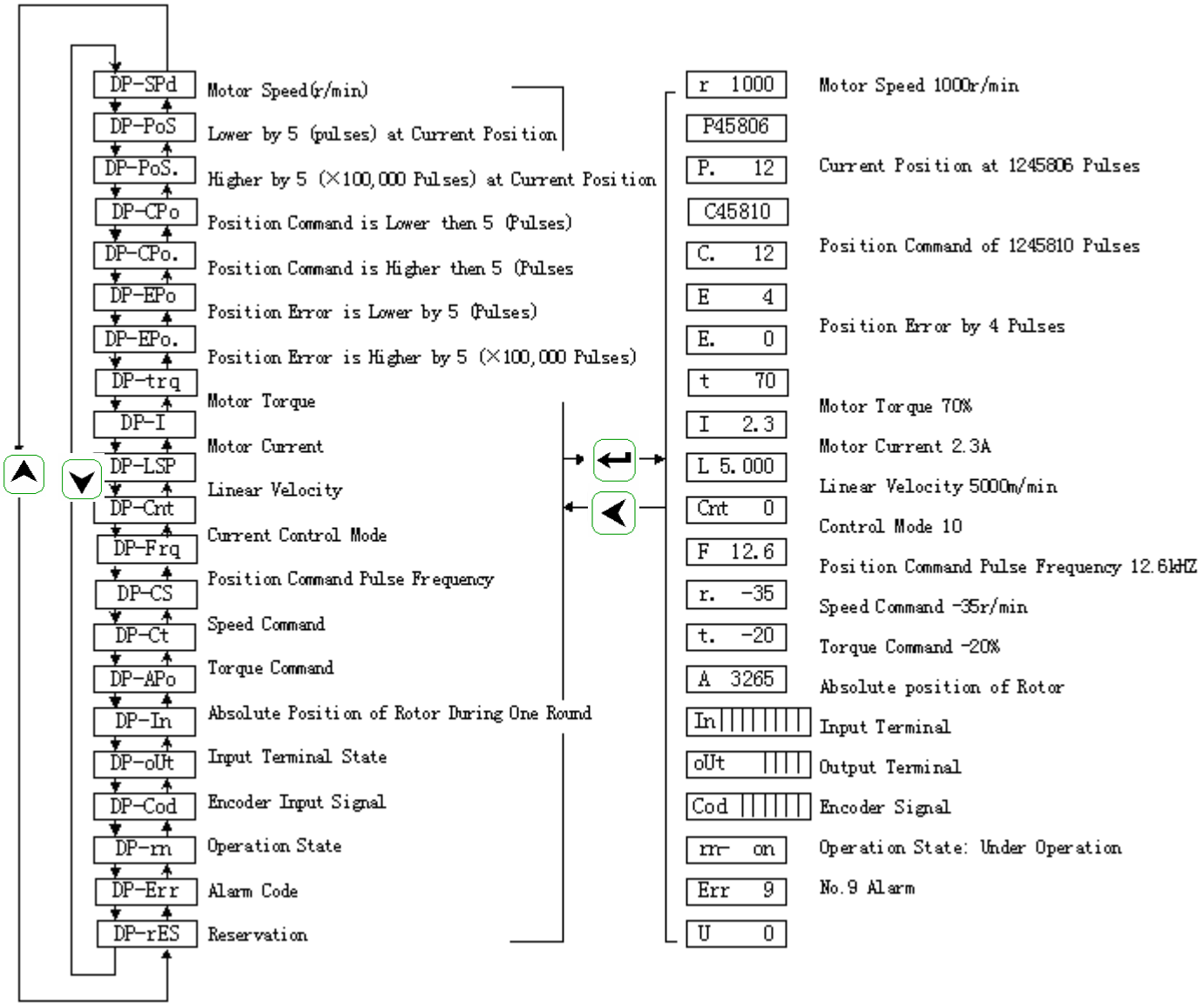


Fig. 6.2 Operation Chart for Ways of Monitoring

Note 1： Position and command pulse are both values multiplied by input electronic gear.

Note 2： Pulse unit is the internal pulse unit of the system, where it means 100,000 pulses/round. The pulse is expressed by value higher by 5 plus value lower by 5. The calculation method is: Pulse=(value higher by 5)×100,000 + value lower

130SJT-M150B	2.3	4	15	1500	8.5	3.1×10^{-3}	33	220(300)
130SJT-M150D	3.9	4	15	2500	14.5	3.6×10^{-3}	63	220(300)

Note: The user shall make a special indication if he or she wants to order motor with electricity-losing brake.

Table 8.9 Specifications on ST Series of Some Motors

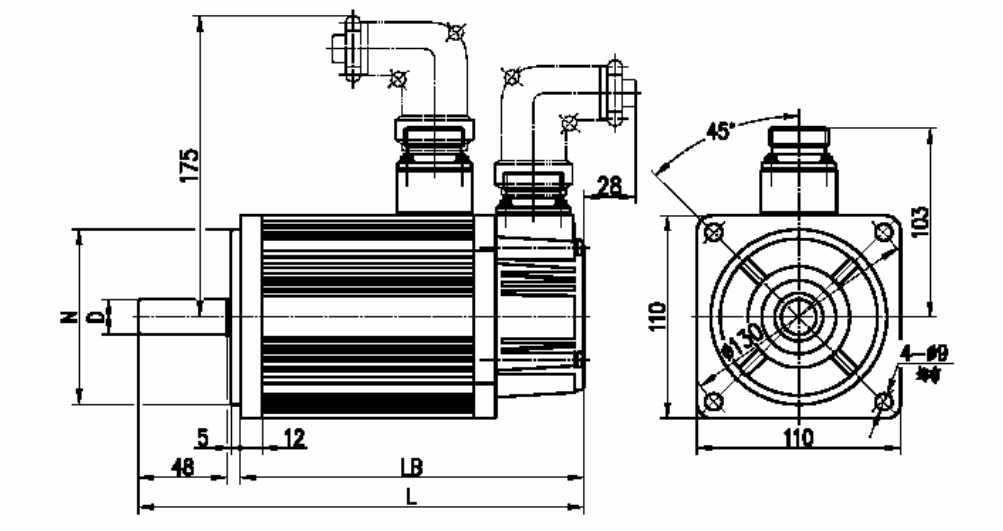
Models	Power (kw)	Zero Speed	Rated Rotation	Rated Current	Rotor Inertia	Machinery Time	Operating Voltage	Weight (kg)
110ST-M02030H	0.6	2	3000	4.0	0.33×10^{-3}	3.64	220(300)	4.2
110ST-M04030H	1.2	4	3000	7.5(5.0)	0.65×10^{-3}	2.32	220(300)	5.2
110ST-M05030H	1.5	5	3000	9.5(6.0)	0.82×10^{-3}	2.03	220(300)	5.8
110ST-M06020H	1.2	6	2000	8.0(6.0)	1.00×10^{-3}	1.82	220(300)	6.4
110ST-M06030H	1.8	6	3000	11.0(8.0)	1.00×10^{-3}	1.82	220(300)	6.4
130ST-M04025H	1.0	4	2500	6.5(4.0)	0.85×10^{-3}	3.75	220(300)	7.4
130ST-M05025H	1.3	5	2500	6.5(5.0)	1.06×10^{-3}	3.07	220(300)	7.9
130ST-M06025H	1.5	6	2500	8.0(6.0)	1.26×10^{-3}	2.83	220(300)	8.6
130ST-M07720H	1.6	7.7	2000	9.0(6.0)	1.58×10^{-3}	2.44	220(300)	9.5
130ST-M10015H	1.5	10	1500	9.0(6.0)	2.14×10^{-3}	2.11	220(300)	11.1
130ST-M10025H	2.6	10	2500	14.5(10.0)	2.14×10^{-3}	2.11	220(300)	11.1
130ST-M15015H	2.3	15	1500	13.5(9.5)	3.24×10^{-3}	1.88	220(300)	14.3

Note 1: The value within the bracket in the column of rated current is the rated current under high voltage

Note 2: The user shall make a special indication if he or she wants to order motor with electricity-losing brake

3) Figuration Dimension

(1) Figuration and installment dimension for SJT series of 110-stand model AC servo motors



Chapter Nine Order Instructions

9.1 Capacity Selecting

The determination of capacity of the servo system must comprehensively consider factors like load inertia, load torque, required positioning precision and maximal speed. The following steps are recommended for the considerations:

1）Calculating Load Inertia and Torque

By referring to related data, make a calculation on load inertia, load torque, acceleration/deceleration torque and effective torque, which will serve as the basis for choice at the next step.

2） Initial Determination of Machinery Gear Ratio

According to the required maximal speed and rotation rate of motor, make a calculation on the maximal machinery deceleration ration. This ratio and the minimal gyration unit of motor will be used to calculate whether the requirement for minimal position unit is satisfied. If a relatively high position precision is required, increase the machinery deceleration ratio (the actual maximal speed is decreased) or choose motor with higher rotation rate.

3）Calculating Inertia and Torque

The load inertia and torque can be converted to the motor shaft with machinery deceleration ratio. The converted inertial shall be no more than 5 times of the inertia of the motor rotor and the converted load torque and effective torque shall be not higher than the rated torque of motor. If these requirements cannot be satisfied, increase machinery ratio (the actual maximal speed is decreased) or choose motor with greater capacity.

9.2 Electronic Gear Ratio

Refer to Chapter Four (Table 4.2 Functions of Parameters), Chapter Six (Parameter Setting) and Chapter Seven (7.3 Adjustment) for the meaning and adjustment of electronic gear ratio G.

Under position control mode, the actual speed of load is:

command pulse speed×G×machinery deceleration ratio.

Under position control model, the actual minimal displacement of load is:

minimal command pulse itinerary×G×machinery deceleration ratio.

Note: When the electronic gear ratio G is not 1, the dividing operation of G may have a

remainder, which means that position errors exist. The maximal error is the minimal rotation value (minimal resolution) of the motor.

9.3 Stop Features

Under position control mode, there will be a difference between the command pulse and feedback pulse when using pulse train to control the servo motor. This difference will be accumulated in the position error meter and form the following relationships with the command pulse frequency, electronic gear ratio and position proportion gain:

$$\varepsilon = \frac{f^* \times G}{K_p}$$

in which,

ε: Lag Pulse (Puls);

f: Command Pulse Frequency (Hz);

Kp: Position Proportion Gain (1/S);

G: Electronic Gear Ratio.

Note: the above relationship is reached under the condition that position feed-forward gain is 0%. If the position feed-forward gain is >0%, the lag pulse will be less than that in the above calculation formula.

9.4 Calculation Method for Selecting Models of Servo System and Position Controller

1) Command displacement and actual displacement:

$$S = \frac{I}{\delta} \cdot \frac{CR}{CD} \cdot \frac{DR}{DD} \cdot \frac{1}{ST} \cdot \frac{ZD}{ZM} \cdot L$$

in which,

S: actual displacement mm;

I: command displacement mm;

δ: minimal unit of CNC mm;

CR: command frequency multiplication coefficient;

CD: command frequency division coefficient

DR: servo frequency multiplication coefficient;

DD: servo frequency division coefficient;

ST: grade division value per round of motor;

ZD: gear number of side gear of motor;

ZM: gear number of side gear of lead screw;

L: pitch of lead screw mm

Generally, S=I, which means command value equals actual value.

2) Maximal Command Speed of CNC:

$$\frac{F}{60 \times \delta} \cdot \frac{CR}{CD} \le f_{\max}$$

In which, F: command speed mm/min;

f_{max}: maximal output frequency of CNC Hz(GSK980 为 128000).

3) Maximal Speed of Servo System:

$$V_{\max} = n_{\max} \times \frac{DR}{DD} \times L$$

In which, V_{max}: maximal velocity of work bench permitted by the servo system mm/min;

n_{max}: maximal rotation rate permitted by the servo motor r/min;

Actual maximal speed of machine tools is restricted by maximal speed of CNC and the servo system.

$$\alpha = INT\left[INT\left(N \cdot \frac{CR}{CD} \right) \cdot \frac{DR}{DD} \right]_{\min} \cdot \frac{1}{ST} \cdot \frac{ZD}{ZM} \cdot \frac{L}{\delta}$$

in which, α: minimal displacement of machine tools mm;

N : natural number;

INT( ): integral number;

INT [ ]$_{min}$: minimal integral num

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