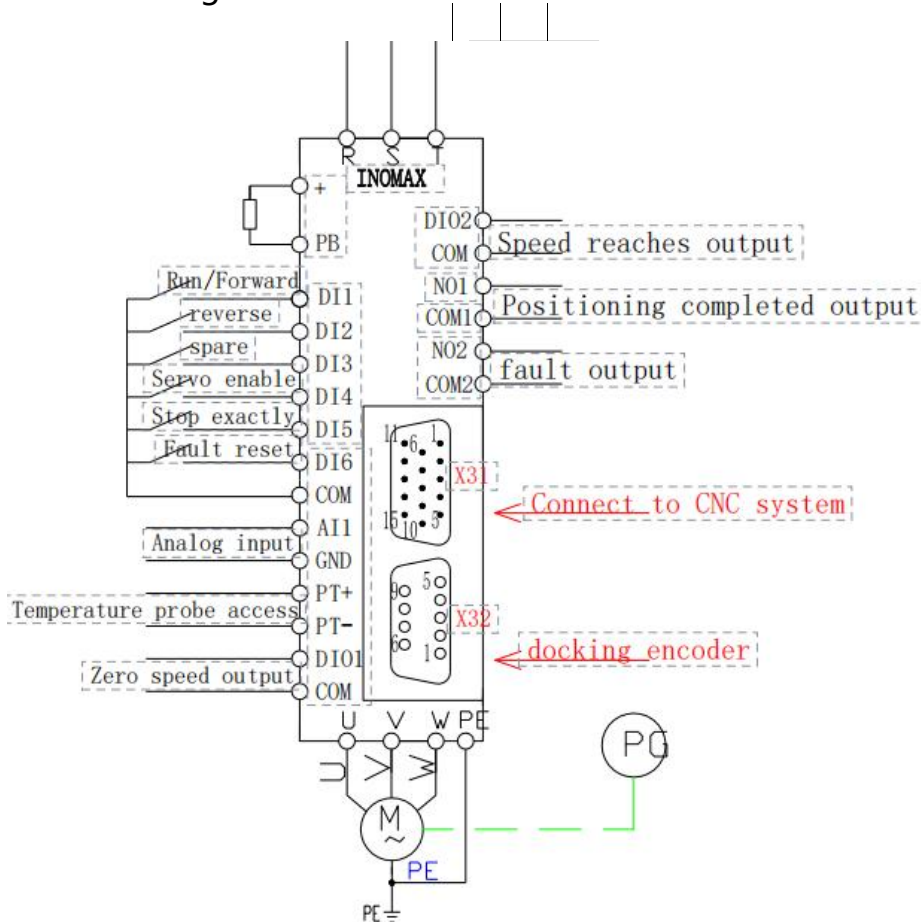


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Machine tool industry debugging instructions (1.3)

This manual is used as a reference for debugging in the machine tool industry. It requires a certain understanding of our driver. If you are using it for the first time, please cooperate with the [Quick Debugging Guide]

Wiring definition instructions



PG card head description:

X31 is the DB15 port male;

frequency division output:

1.AO+ 2.AO- 3.BO+ 4.BO- 5.ZO+ 10.ZO-

Pulse input: 11.PA+ 12 PA-

13.PB+ 14.PB-

X32 is DB9 port female; encoder

wiring: 1.A+ 2.B+ 3.Z+

4.GND 5.+5V 6.A- 7.B- 8.Z-

9.GND Shield ground

Please wire according to actual needs, and leave those that are not needed by the system blank. This figure takes differential encoding and sine and cosine encoders as examples. The interfaces of other types of encoders are defined as follows.

Collector encoder DB9: 5.+12V, 4.COM, 6.A, 7.B, 8.Z

Resolver encoder DB9: 6. Excitation positive, 2. Excitation negative, 7.SIN+, 3.SIN-, 4.COS+, 8.COS-

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wiring diagram

	Terminal	Definition	Explain
Control signal wiring :	DI1	Run/forward start and stop	Speed mode operation (the direction can be determined by the pulse direction)/forward operation terminal
	DI2	reverse start	Speed mode reverse operation terminal, the input direction is determined by the pulse direction. This terminal can be left unconnected.
	DI3	spare	
	DI4	Servo enable, speed position mode switching	Used for position control enable, for example: rigid tapping
	DI5	Accurate stop/positioning/return to zero	Used for directional tool changing and directional loading
	DI6	Fault reset	Used to reset drive alarms
	COM	Public end	DI terminal common terminal, default internal 24V zero point
	If the customer uses PNP output (external power supply), please short J8 from SINK to SOURCE		
	AI1	Analog output signal+	Default 0-10V input, -10-10 needs to be switched in 13.04
	GND	Analog input signal ground	
	PT+/PT-	Motor temperature detection	Can be connected to KTY84 or PT100, etc.
	DIO1	zero speed	Collector output, output when the speed is less than 30 rpm
	COM	Run output, common point	
	DIO2	Speed reaches output	Collector output, output when the speed reaches the set value
	COM	Speed to reach, public points	
	NO1	Positioning completed output, normally open	Relay output, output after positioning is completed
	COM1	Positioning	

		completion output, public	
	NO2	Fault output, normally open	Relay output, fault output uses normally open contact by default, normally closed is NC2
	COM2	fault output, public	
Encoder wiring			
DB9 plug	5: +5V	Encoder power supply	The definition of a square wave encoder is exactly the same as a sine and cosine encoder. The encoder shielding layer needs to be grounded to prevent interference
	4: COM	Encoder ground	
	1/6: A+/A-	Phase A pulse differential output	
	2/7: B+/B-	Phase B pulse differential output	
	3/8: Z+/Z-	Z phase pulse differential output	
CNC system given and feedback terminal wiring			
CNC system wiring DB15	11/12: PA+/PA-	System pulse A phase signal	Corresponds to CW+/CW-
	13/14: PB+/PB-	System pulse B-phase signal	Corresponds to CCW+/CCW-
	1/2: AO+/AO-	Connect to the speed receiving end of the CNC system	Feedback the constant speed to the CNC system
	3/4: BO+/BO-		
	5/10: ZO+/ZO-		
	6/15: GND	signal ground	Connect to system signal ground
power line	L1/L2/L3	AC three-phase 380V input	Be sure to check the wiring when powering on for the first time, otherwise permanent damage may occur.
	U/V/W	Driver output to motor	
	PB/+	Braking resistor	

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Spindle and debugging instructions

1. Ensure that the encoder shielding wire is connected to the grounding post of the PG card (or DB head shell to prevent interference. 2. Input the encoder resolution to 61.00 in LOC mode

3. Change 63.05 to use motor type: 0. Asynchronous motor 1. Synchronous motor.

4. Enter the motor rated parameters into 63.00-63.04 and then change 63.06 to 1 (rotation identification). Press the green start button to perform rotation identification. The machine will automatically stop after the identification.

If there is an error in identification, please check whether the wiring is correct and whether the motor parameters are reasonable (whether the rated voltage is set too high and does not match the actual back electromotive force)

5. Check whether the 61.00 encoder resolution is correct. (If there is an error in checking the encoder resolution in this step, there is usually a miswiring or interference problem. Please skip to step 7 [Exception Troubleshooting])

6. Accuracy setting of synchronous motor angle search and electrical angle offset detection (no setting required for asynchronous motor, skip this step):

For incremental encoders, the encoder only provides relative position. For the first operation after power-on, you need to obtain the initial direction of the motor's magnetic pole before running.

Set 63.07 to 0 for open-loop operation, and set the speed to 300 rpm. After each start and stop, observe whether the differential mode value of 9.06 is > 1 , and whether the common mode value of 9.07 is > 2.0 . If it is too small, increase 60.11 (search current) and test repeatedly. The maximum search current is 100%. Please adjust 63.07 back to 1 after setting. This parameter solves the problem of finding the position of the electromagnetic pole every time. If the setting is incorrect, a reversal or jump fault will occur during the first power-on operation.

Adjust 63.06 to 3 and press the start button for PM phase identification:

The result of each identification can be viewed through 61.01 (electrical angle offset). Manually rotate the spindle for more than 1 turn before performing PM identification. Rotate the spindle position multiple times and then perform PM identification until the 61.01 parameter changes little (the change angle is within 8 degrees). The purpose of this step is to correct the electrical angle offset. If the electrical angle offset is inaccurate, it will affect the motor output.

7. Closed loop trial run:

Run at a local setting of 500RPM, and observe whether the current, speed, frequency, motor noise and 1.24 encoder feedback are normal.

Abnormality troubleshooting: Change 61.08 to 0 (turn off the encoder), run the panel at 500RPM, check parameter 1.24 to see if the encoder feedback speed fluctuates around 500 rpm (± 5 RPM is normal, no sudden changes) if the feedback speed fluctuates greatly ($> 500 \pm 5$ RPM), please check whether the encoder shielding layer is grounded and the encoder coaxiality, and whether there is shaking. If the speed feedback is about 0, please check the wiring and encoder quality. If the speed difference is large, please check whether the encoder resolution is true and correct. Is the encoder wiring definition correct? If the speed deviation is small but the feedback speed is -500RPM, then reverse the 61.02 encoder direction.

After everything is normal, change 61.08 to 1 (enable the encoder) to enter the closed-loop state and conduct a trial run.

8. Adjust speed loop stiffness:

Speed loop parameter 23.00. Adjustment steps:

- a. Set deceleration time 22.01 to 0.00 seconds and zero speed delay time 19.02 to 0.5 seconds;
- b. Set a lower speed, such as 1000 rpm, start and then stop;
- c. Observe whether there is reversal during the shutdown process. If so, gradually increase the speed loop gain, and then repeat steps b and c until the reversal phenomenon disappears during the shutdown process.

The actual speed loop gain is related to the motor type. Synchronous motors are stronger than asynchronous motors, and electric spindles are stronger than spindle motors. Generally, the rated 1500-rpm spindle motor speed ring does not exceed 5, the asynchronous electric spindle (above 500HZ) generally does not exceed 12, the synchronous electric spindle (above 500HZ) does not exceed 20, ensuring normal high speed without vibration and noise, and zero speed accurate stop without jitter. , appropriate overshoot can increase fast responsiveness.

After debugging, restore the deceleration time and set 19.02 to 0

9. Set 20.00/20.01 to the required maximum forward speed and reverse maximum speed, and conduct the test.

10. After the local control test is normal, switch to REM and hand it over to the CNC system for control

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Debugging Difficulties Explanation

1. Motor parameter identification,

- a. Synchronous motor: The counter electromotive force corresponding to the rated frequency is the rated voltage or slightly less than 5%, and then take an integer for easy calculation.

For example, the back electromotive force coefficient of a permanent magnet synchronous motor is 35mV/rpm, with 2 pairs of poles (4 poles). Right now 380V corresponds to 10860rpm. Then the rated speed and frequency are 9000rpm/300Hz or

Both 10500rpm/350Hz are available.

Asynchronous motor: When using the control with rated frequency corresponding to rated voltage, the no-load current of the motor is approximately 35% of the rated current. An in-depth understanding is that when the rotation is identified according to the relationship between rated frequency and rated voltage, the obtained (62.09) saturation coefficient is approximately between 70% and 80%. The larger the saturation coefficient means that the motor is not saturated yet, and the rated frequency can be reduced. A saturation coefficient less than 70% means significant saturation, excessive iron core utilization, and the rated frequency needs to be increased. For example, for a 5.5kW/13A high-speed asynchronous electric spindle, the saturation coefficient is about 90% based on the identification of 500Hz corresponding to 380V; the saturation coefficient is identified based on the rated frequency of 300Hz corresponding to 380V.

74%, the no-load current is 3.9A, accounting for about 30% of the rated current, so 300Hz is selected as the rated frequency. The actual results show that the same motor current can produce greater force. Note: If after reducing the rated frequency, although there is still room for the saturation coefficient, the no-load current exceeds 40%, it is not appropriate to continue to reduce the rated frequency. Excessive no-load current will cause the motor to heat up.

- b. Motor type, whether asynchronous or synchronous, must be accurate. Short-circuit the three motor wires together. If the motor can be turned by hand, it is an asynchronous motor. If the motor cannot be turned, it is a synchronous motor.
- c. Data content obtained from self-learning:
 - 1. Asynchronous motor: P62.01 no-load current; P62.04 total stator inductance; P62.09 iron core saturation coefficient

Synchronous motor: P62.02 motor stator resistance; P62.06 direct axis inductance D; P62.07 Quadrature axis inductance; P62.08 Back electromotive force coefficient;

2. Encoder: P61.00 original resolution; P61.01 electrical angle offset of Z signal Quantity; P61.02 AB phase type

ii. Stationary identification, the identification parameters are:

1. Asynchronous motor: P62.02 stator phase resistance; P62.03 rotor phase resistance; P62.05 Leakage inductance coefficient

2. Terminal definition

Wiring according to the wiring diagram can effectively reduce parameter definition changes.

When the DI1 terminal is used as a start signal, the direction is determined by the pulse direction (PA/PB). When DI1 is only used as a forward signal, the reverse direction is determined by DI2. The internal default jumper is SINK (NPN internal 24V power supply). If the system To output PNP signal, please short-circuit J8 inside the DIO board from SINK to SOURCE (PNP type)

The DIO output is 2 sets of collector signals. Please pay attention to the current flow direction. The common terminal COM can only be connected to the system COM. If it is not consistent with the system, a relay can be used to transfer it.

3. Sine and cosine system pulse resolution (61.05) and frequency division output (61.06) settings

The virtual encoder resolution of the CNC system or host computer. When set to 0, the encoder resolution is used.

The sine and cosine encoder itself has a low resolution, and the higher resolution is obtained through analysis by the driver software.

In order to improve the positioning accuracy and take care of the system bandwidth and frequency, it is generally set according to the original resolution by several times (it must be a multiple of the encoder resolution)

For example: sine and cosine resolution 128 lines,

You can set 61.05=61.06=1024, then the system sends 1024 pulses to the motor to move around, and the driver

Frequency division output 1024 pulses, this value must be consistent with the spindle resolution of the CNC system,

After the setting is completed, this parameter needs to be powered off and restarted to be effective.

4. Servo enable

After being enabled, the driver enters or is understood as rigid tapping or indexing, which is essentially pure position control. How many pulses are sent from the system, how many pulses will be moved?

5. Accurate stop, directional tool change mode

Or it can be understood as planning the trajectory to a certain position so that the spindle bayonet is exactly aligned with the installation direction of the tool holder, and the system does not participate in pulse control. The position is defined as the offset of the Z pulse, specifically in parameter P40.19, and the unit is 0.001 turns. Adjust the required angle and enter the value of parameter 1.08 to 40.19. (Only for >6.05 soft pieces)

6. Position loop stiffness

The position loop rigidity depends on the encoder resolution and speed loop rigidity. In the remote REM mode, select the servo mode and enable the servo to observe the motor shaft's anti-disturbance capability. Gradually increase the position loop gain until it is close to the oscillation position gain. P40.07 is selected in the following range

- i. For square wave encoder, the value is 60 to 130Hz
- ii. For SinCos encoder, the value is 100 to 200Hz

7. humbucker setup:

This step is suitable for two sets of coils or high and low speed motors. Parameters are switched through the DI3 terminal.

Step 1: Confirm 16.05 = 0 (default)

Step 2: Debug the first set of parameters, and then save the current parameters to parameter set 1, that is, 16.05 = 6, save parameter set 1

Step 3: Debug the second set of parameters, and then save the current parameters to parameter set 2, that is, 16.05 = 7, save parameter set 2

Step 4:

Set 16.05 = 1, Load by I/O

Set 16.08 = DI3, select combination 1, load parameter set 2 if valid, load parameter set 1 if invalid, edge trigger

Step 5: In the stop state, if the external terminal DI3 changes from 0 to 1, load parameter set 2 and change from 1 to 0, parameter set 1 is loaded. You can switch during operation, but it will not be executed until it is stopped.

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Related parameter list:

category	Parameter address	Parameter content	set value	illustrate
Motor rated parameters (must be set first)	P63.00	Rated power, 0.1kW	18.5	Set this parameter according to the motor nameplate, the frequency corresponds to the speed, and the self-learning phase is completed.
	P63.01	Rated voltage, V	380	
	P63.02	Rated current, A	36	
	P63.04	Rated frequency, Hz	150	
	P63.03	Rated speed, rpm	4500	
	P63.05	Motor type, asynchronous/synchronous		
Motor identification parameters (asynchronous spindle)	P62.01	No-load current, 0.1A		View parameters, no settings required
	P62.02	Stator phase resistance, 0.001Ω		
	P62.03	Rotor phase resistance, 0.001Ω		
	P62.04	Total stator inductance, 0.1mH		
	P62.05	Leakage inductance coefficient, 0.1%		
	P62.09	Core saturation coefficient, 0.1%		
Encoder parameters	P61.00	Encoder native resolution	Set according to the actual resolution of the encoder	
	P61.02	AB phase characteristics		Dynamic self-learning automatic recognition
	P61.04	Pulse given mode	Orthogonal	In pulse control, the given mode is pulse + direction.
	P61.06	electronic gear molecule	1	This parameter only needs to be set for sine and cosine encoding. For details, see the following difficult debugging instructions 3.
Loop gain parameters	P23.00	speed proportional gain	2	Adjust stiffness parameters
	P23.01	Speed integration time	100ms	
	P23.02	Torque proportional	2.00	

		gain		
	P40.07	position proportional gain	60Hz	
Low-level optimization control	P60.00	carrier frequency,	8	
	P60.07	Maximum voltage control Bit0	0	Braking resistor access
	P60.08	Manually set braking voltage point	700V	
Process logic function	P19.05	Speed unit type	1rpm	
	P19.04	speed window	30rpm	
	P19.03	Zero speed value	30rpm	
	P20.00	forward maximum speed	30000rpm	Adjust according to actual needs on site
	P20.01	reverse maximum speed	-30000rpm	
	P21.00	Speed given signal source	P02.15	System pulse given, analog given needs to be set to AI1 conversion value
	P22.00	Acceleration time 1	0.50 seconds	Set on demand
	P22.01	Deceleration time 1	0.50 seconds	Set on demand
	P40.01	Position control enable signal source	DI4	P.02.00.03
	P40.17	Positioning completion allowable error	1024	Only sine and cosine need to be set
	P40.19	Spindle tool change accurate stop position	According to tool magazine settings	Set the exact stop offset angle
	P40.31	Spindle tool change accurate stop command source	DI5	P.02.00.04
	P10.01	Forward start signal source	DI1	P.02.00.00
	P10.11	Fault reset signal source	DI6	P.02.00.05
	P13.02	Maximum conversion value of AI1	36000	This parameter only needs to be set for analog speed regulation.
	P13.03	Minimum converted value of AI1	0	

P14.27	DIO1 collector signal output	zero speed	Stop and running speed is lower than
P14.28	DIO2 collector signal output	consistent speed	30RPM output
P14.29	Relay RO1 signal source	P06.07.00	Position close to output
P14.30	Relay RO2 signal source	Fault	
P14.31	DIO1 configuration	0	output
P14.32	DIO2 configuration	0	output
P31.01	Motor temperature detection type	KTY84	If not, do not change it, PT100 requires J14 jumper
P31.04	Motor temperature protection point	110.0°C	

The above black bold fonts need to be set by the customer according to the actual situation, and the red fonts can be entered as fixed. Others are viewing parameters

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Parameter address	Parameter content	illustrate
P01.00	Motor actual running speed	
P01.01	Motor actual operating frequency	
P01.02	DC voltage actual value	
P01.03	Motor current actual value	
P01.05	Radiator temperature	
P01.08	Mechanical angle offset	Used to capture the spindle tool change deviation angle, fill in to 40.19
P01.14	Encoder count value	
P01.15	System pulse count value	
P01.16	Encoder Z signal capture value	Each time a Z pulse is encountered, the encoder count value is latched.
P01.17	position given actual value	
P01.18	Position feedback actual value	4 times the frequency or the position value after subdivision of the sine wave
P01.21	Motor input voltage	
P01.22	Motor output torque	Percentage relative to motor rated torque
P01.23	Motor temperature actual value	Support KTY84, PT100 temperature sensor
P01.24	Encoder measures speed value	Can be used to determine whether encoder feedback is normal
P02.00	Terminal input status, DI	Can be used to determine whether external signals are received
P02.01	Terminal output status, DO	
P02.02	Analog input AI1 actual value	Determine whether it is consistent with the output of the system
P02.03	Conversion value of AI1	
P02.15	Speed conversion value of system pulse	When running pulses, the equivalent speed given value of the pulse
P09.02	Software version number	
P09.06	Differential mode signal-to-noise ratio	The signal strength during the initial angle search of the synchronous motor. If it is too small, the search current needs to be increased.
P09.07	Common mode signal to noise ratio	
P09.08	Steady state speed pulsation peak to peak	Used to determine whether the encoder installation is eccentric and causes periodic speed pulsation.

P61.09	Offset of sine wave SinA	A bias of 0 is ideal, and if the deviation is too large, it means that the read head is abnormal.
P61.10	Offset of sine wave CosB	
P61.11	Gain of sinusoidal wave SinA	The gain is 4096, which is ideal. If the deviation is too large, it means the reading head is abnormal.
P61.12	Gain of sine wave CosB	