

WELDING ROBOTICS

External Axis Operation Instruction



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1.Overview

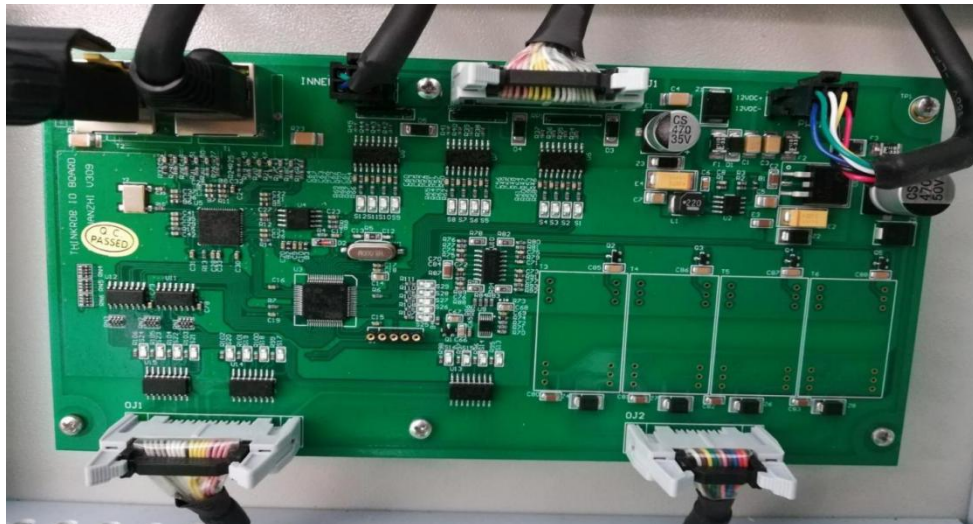
TURIN external axis is mainly divided into rotating axis and linear walking rail axis . Currently available on the original 6 axis system at most three external axes can be arbitrarily extended. So the seventh axis the eighth axis and the ninth axis are the external axes.

Extension of external axis if using TURIN system 789 axis motor drive required TURIN standard or specified brand. Non-TURIN branded motor system will not be enabled.

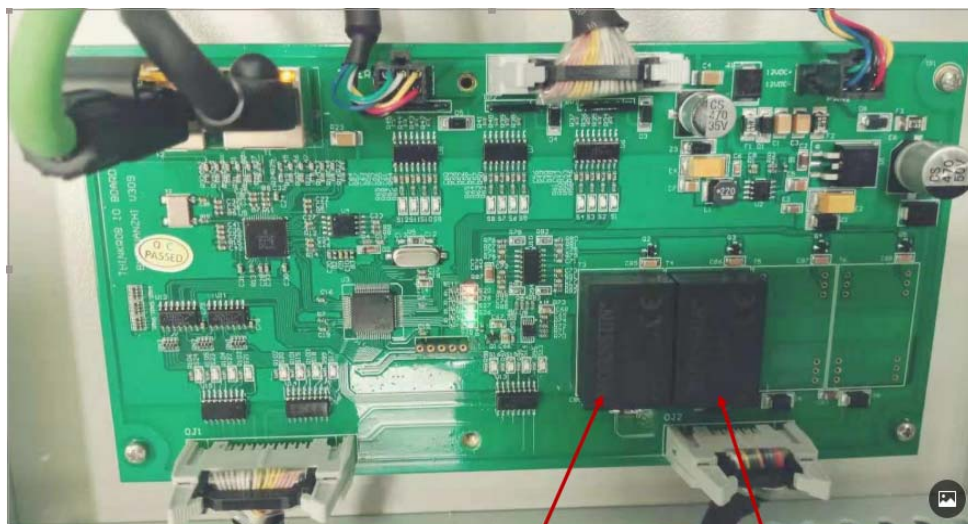
1.1. TURIN Robot IO configuration

1.1.1. Robot IO board hardware configuration

IO input uses the IO board independently developed and designed by TURIN. 12 channels of input and 4 groups of 0-10v analog output are used to directly interact with the system through the EtherCAT bus.



Standard welding robot delivered from the factory includes 12 input channels and have been used 9 inputs as low level signals, includes 4 groups of 0-10v analog output and has been used two channels, they are welding current and welding voltage.

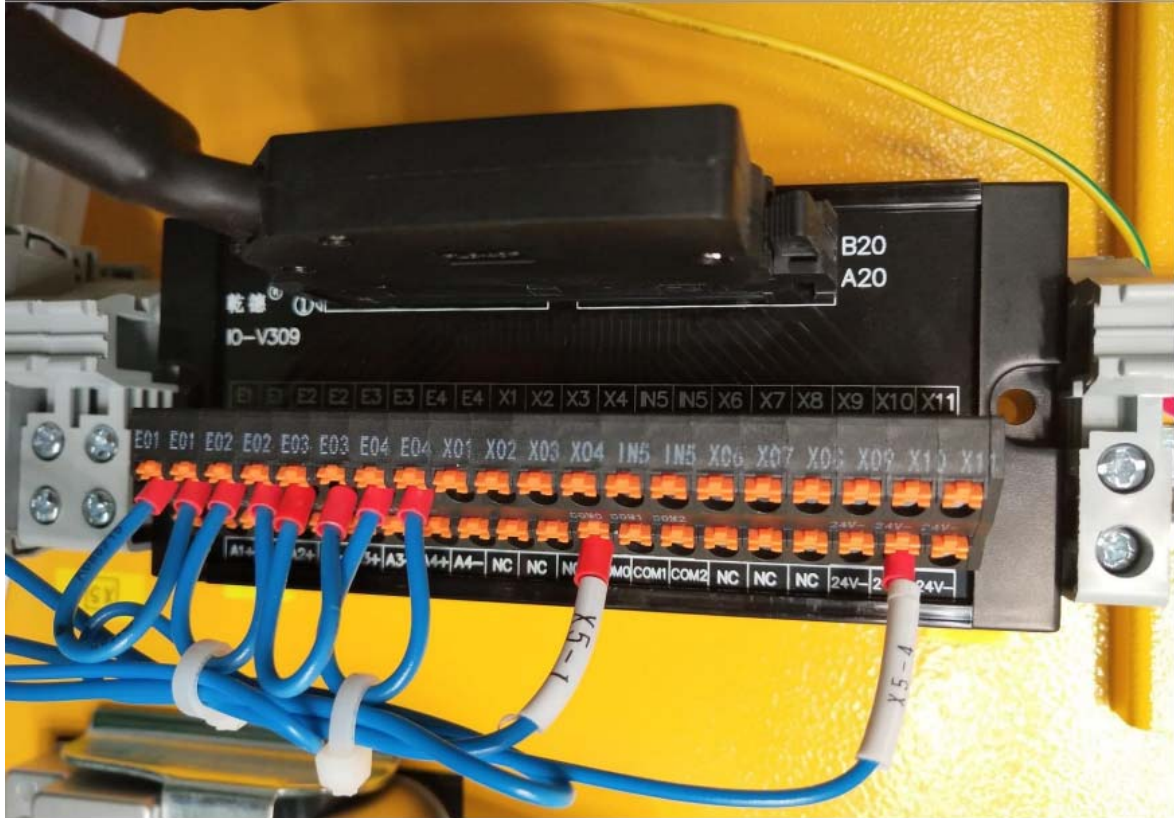


Welding current module

Welding voltage module

1.1.2. Robot IO board hardware terminals

IO device interface uses IO terminal board STB40 fast interface, 12 input and 4 groups of 0-10v analog output, and IO board connection through quick plug and unplug wiring.



E01-E04 External emergency stop B8-B20 12 inputs A1-A2, welding current A3-A4 Welding voltage

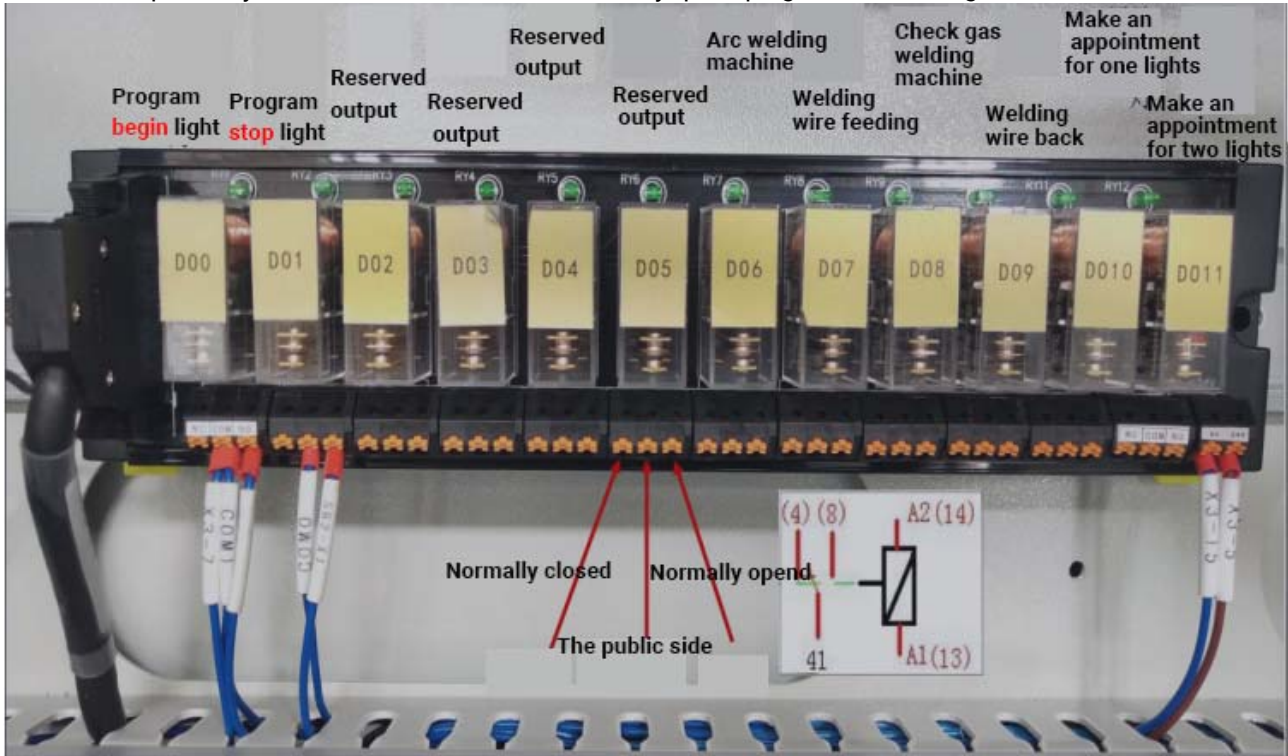
IO device interface uses IO terminal board V309 fast interface, 12 inputs and 4 sets of 0-10v analog output, and is connected to IO board by fast prefabricated cable.

IO-V309 Definition of terminals for welding input

Ox horn 40 b	Number	Note	Ox horn 40A	Number	Note
B1	E1	Cupboard door stopESD	A1	A0+	Welding current
B2		External emergency stop	A2	A0-	Welding current
B3	E2	short connection	A3	A1+	Welding voltage
B4		External emergency stop	A4	A1-	Welding voltage
B5	E3	short connection	A5	A2+	Analog quantity reservation
B6		External emergency stop	A6	A2-	Analog quantity reservation
B7	E4	short connection	A7	A3+	Analog quantity reservation
B8		The INO system is down	A8	A3-	Analog quantity reservation
B9	X1	IN1	A9	NULL	NULL
B10	X2	IN2	A10	NULL	NULL
B11	X3	IN3	A11	NULL	NULL
B12	X4	IN4	A12	COM0	Merge a point
B13	X5	IN5 stop short	A13	COM1	
B14			A14	COM2	
B15	X6	IN6	A15	NULL	NULL
B16	X7	IN7	A16	NULL	NULL
B17	X8	IN8	A17	NULL	NULL
B18	X9	IN9	A18	24V-	Internal sub
B19	X10	IN10	A19		
B20	X11	IN11	A20		

1.1.3. Robot relay hardware

The output of the robot is a 12-way relay board, which has 12 normally open contacts and 12 normally closed contacts respectively, and is connected with IO board by quick plug and line arrangement.



1.1.4. Robot IO monitoring

Prog/Run

File oper

Settings

Coord Sys

Crafts

Mon/Ctrl+

Logs

Login

Mon/Con list

Input/Output >> I/O control

Input/Output

I/O control

DA control

Encoder

Variables

User config

Background prog

Welding status

Laser track

Comm monitor

Robot input and output definition, blank customer can be customized to use

DI

Notes selection: General

DO

00		Emergency stop status signal
01		Anti collision switch signal
02		Reproduction / automatic signal
03		Hand press down signal
04		Program start signal
05		Program stop signal
06		Arcing success signal
07		
08		
09		
10		
11		

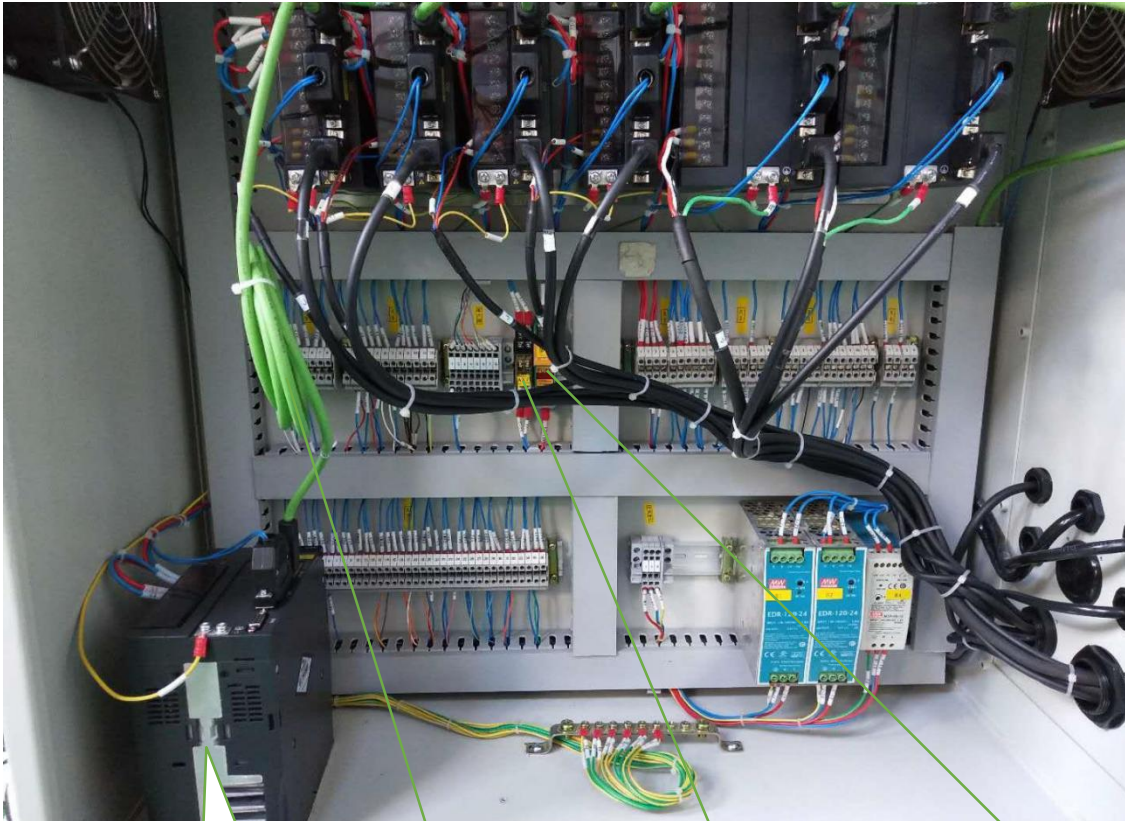
00		Program running prompt
01		Program stop prompt
02		
03		
04		
05		
06		Start and stop arc switch
07		
08		
09		
10		
11		

IO relay 02-06 five output outlets, when IO board lose its communication, the output will be forced to set 0. When IO is required to always maintain, such as the fixture needs to be always maintained, please use the last five output outlets 07-11.

2.The hardware configuration

2.1. Control cabinet wiring

Here we take the example of adding a Inovance brand motor for our 7th axis rotation axis. The following is w a picture we adding of 7th axis servos to the control cabinet. (similar operation for adding axis 8 and 9)



Add a seventh axis
driver 1pc

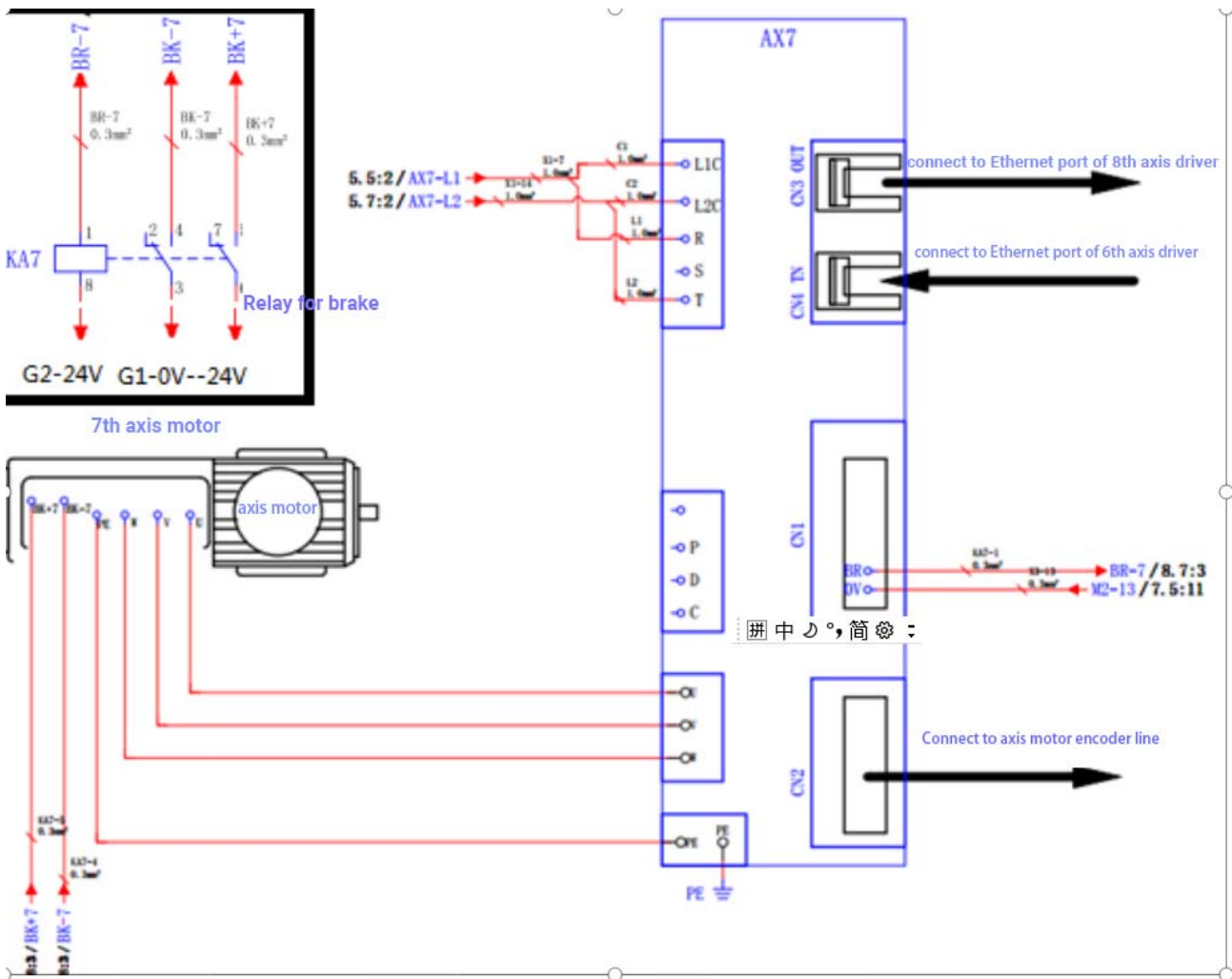
Seventh axis
communication wire 1pc

Relay for the motor
brake function of 7th
axis 1pc

Fuse of 7th axis 1pc

2.2. External axis wiring diagram

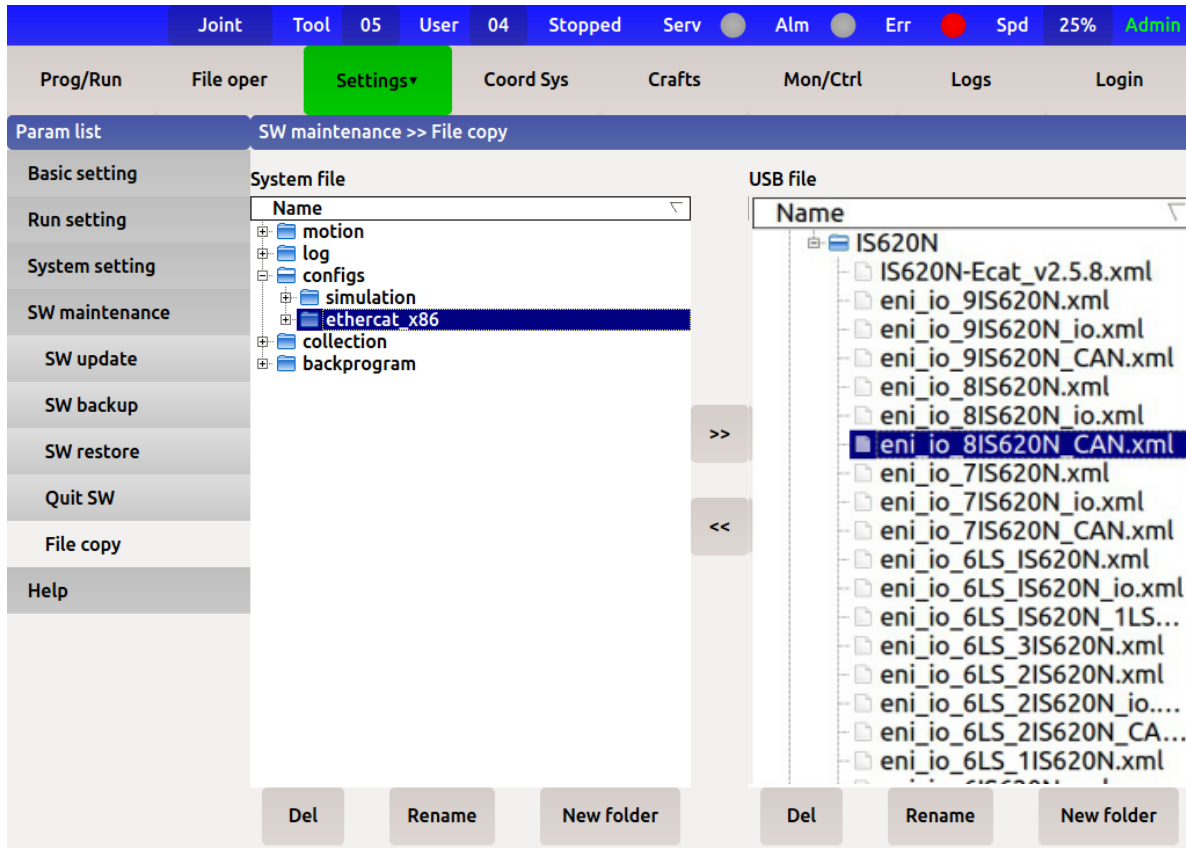
1. **Servo driver:** According to the corresponding servo brand, 220V power supply is supplied to the servo. The zero line N is directly taken from the X1 terminals, the live line L is connected to the output position of the **fuse**, and the ground line is connected to the ground terminal.
2. **Cable:** One end of the cable is connected from the output port of the sixth axis to the input port of the seventh axis (the crystal heads at both ends correspond to each other).
3. **Relay for brake:** The positive pole of the relay is connected to the 24V+ of the X3 terminal, and the negative pole of the relay connect to pin3 0f the servo IO Brake. The two common ports are respectively connected to the negative and positive port of 24V power supply for the Brake function on the X2 terminal. The corresponding two normally open contacts are connected to the BK+ and BK- of the motor.
4. **Definition of fuse wiring:** The input terminal is connected to the live wire on the left of the X1 terminal , and the output is connected to the servo driver power R.



3.System configuration

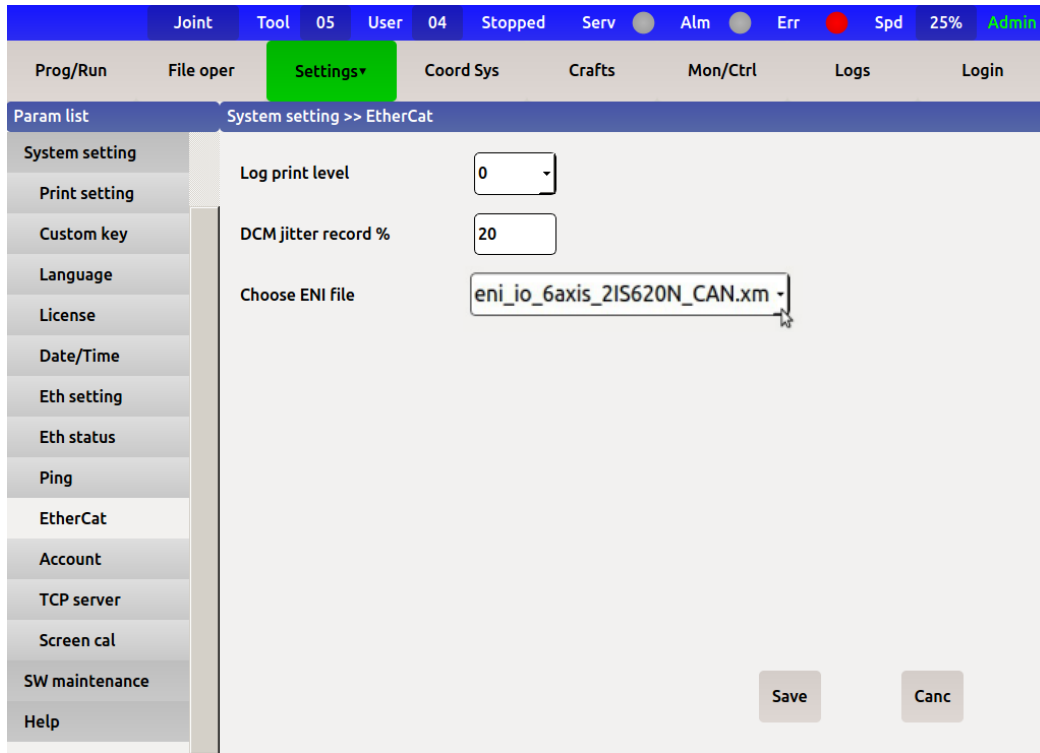
System configuration includes ENI file copy, ENI file selection, joint parameter Settings. ENI file is the communication file between the master station (TURIN control system) and slave station (servo drivers, IO board, CAN bus communication board). So any changes of servo drivers, IO board, CAN digital communication board, will need to change ENI file and the robot control system can work normally accordingly.

3.1. ENI file copy



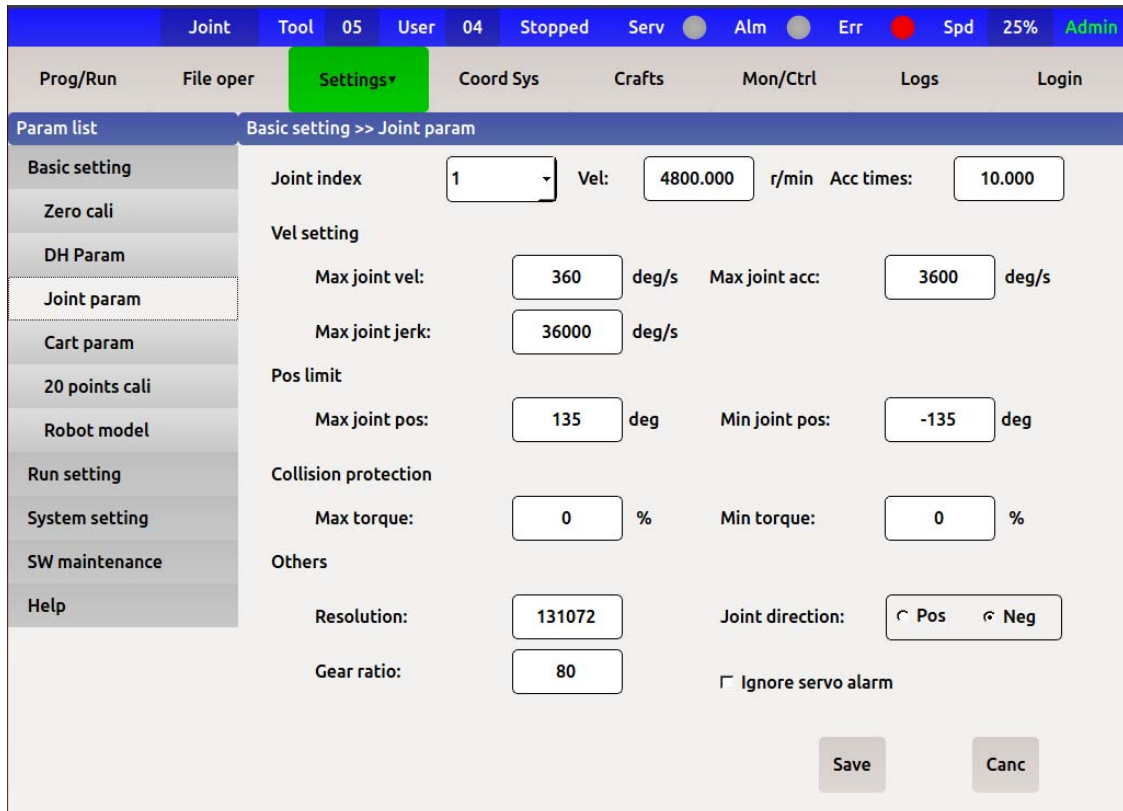
Settings – SW maintenance – File copy – select configs-ethercat_x86 in the system file, and then open the matching .xml file to its hardware configuration in the **USB file** corresponding .

3.2. ENI file configuration



Settings -- system Settings -- EtherCat -- Choose ENI file – find the copy corresponding to the hardware. xml file, click save and restart.

3.3. Setting of external axis joint parameters



1. **Joint index** : (1 to 9) joint parameters.
2. **Max joint vel** = motor maximum speed (on the motor nameplate) $\times 6 \div$ joint deceleration ratio.
3. **Max joint acc** = maximum joint velocity $\times 5$.
4. **Max joint jerk** = maximum joint acceleration $\times 5$.
5. **Max joint pos**: the soft limit of positive rotation of the axis (set according to actual needs).
6. **Min joint pos**: the axis reverses the soft limit (set according to actual requirements).
7. **Resolution**: the ratio of the numerator to the denominator of the servo drive gear. (research and control: 131072 rijing: 131072 LS: 131072 duomochuan: 524288 huichuan: 8388608 rijing :)
8. **Joint direction**: change the positive and negative rotation of the motor.
9. **Gear ratio**: the speed reduction ratio value of the motor connection. ∞
10. **Ignore servo alarm**: the servo driver alarm system is not detected.

4. Coordinate calibration of external axis

The external axis coordination calibration of TURIN can be divided into two types: rotating axis coordination calibration and walking axis coordination calibration. The rotating axis are generally used for horizontal rotation or vertical rotation of the tool shifter, and the walking axis are generally used for welding parts with a long distance, so the robot cannot reach the travel distance, so the robot is installed on the walking axis and moved with it. (no need to set and calibrate without coordination)

4.1. Calibration of rotary external axis

The screenshot shows the 'Coord Sys' settings for an external axis. The 'Ext axis num' is set to 3. The 'Calculated user param' section displays the following values:

Param	Value
7.1	542.505,0.000,773.895,-0.000,1.480,0.000,0.000,0.000,0.000
7.2	815.445,0.000,1072.672,-0.000,1.480,0.000,0.000,0.000,0.000
7.3	757.195,302.665,1072.672,-1.331,1.180,1.349,0.000,0.000,0.000
8.1	373.904,-819.205,1188.000,0.000,0.000,-65.467,0.000,0.000,0.000
8.2	180.000,-882.327,1188.000,0.000,0.000,-78.470,0.000,0.000,0.000
8.3	-20.242,-900.272,1188.000,0.000,0.000,-91.288,0.000,0.000,0.000
9.1	-20.242,-900.272,1188.000,0.000,0.000,-91.288,0.000,0.000,0.000
9.2	-117.808,-892.761,1188.000,0.000,0.000,-97.517,0.000,0.000,0.000
9.3	-250.567,-864.937,1188.000,0.000,0.000,-106.156,0.000,0.000,0.000

Simultaneous: the external axis implement linear or rotary synchronization with the robot body

Ext 1 and 2 link: when there are two external axis superimposed on the positioner structure used in conjunction.

Ext axis num: select the number of external axes.

Compute user coordinate system: record the TCP coincidence of three different angles of the positioner and the coordinates of the robot tool the three coordinate values recorded under the position. (when recording the three coordinate values, the robot should maintain the same attitude, and the TCP precision of the tool coordinate of the robot should be within 1mm)

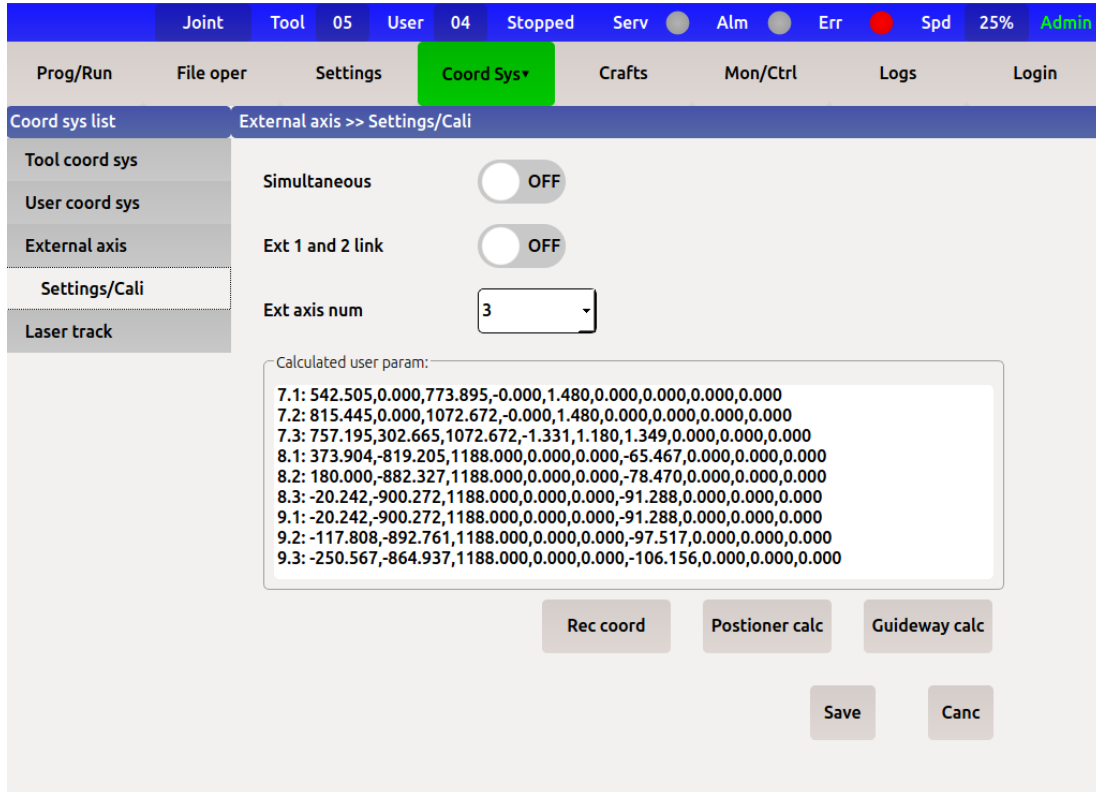
7.1 Move the seventh axis positioner to 0° , move the robot and make its TCP point align with the sharp point of the Calibration rod on the positioner and press **Rec coord**.

7.2 Move the seventh axis positioner to 30° , move the robot and make its TCP point align with the sharp point of the Calibration rod on the positioner and press **Rec coord**.

7.3 Move the seventh axis positioner to 60° , move the robot and make its TCP point align with the sharp point of the Calibration rod on the positioner and press **Rec coord**.

After the completion of the three coordinate point record, click the **Positioner calc**, and then click **Save**!
(Similar operation for 8th and 9th external axis .)

4.2. Calibration of linear external axis



The screenshot shows the 'Coord Sys' settings for the external axis. The 'Simultaneous' and 'Ext 1 and 2 link' options are turned off. The 'Ext axis num' is set to 3. A list of calculated user parameters is displayed, and buttons for 'Rec coord', 'Positioner calc', 'Guideway calc', 'Save', and 'Canc' are visible.

Calculated user param:
7.1: 542.505,0.000,773.895,-0.000,1.480,0.000,0.000,0.000,0.000
7.2: 815.445,0.000,1072.672,-0.000,1.480,0.000,0.000,0.000,0.000
7.3: 757.195,302.665,1072.672,-1.331,1.180,1.349,0.000,0.000,0.000
8.1: 373.904,-819.205,1188.000,0.000,0.000,-65.467,0.000,0.000,0.000
8.2: 180.000,-882.327,1188.000,0.000,0.000,-78.470,0.000,0.000,0.000
8.3: -20.242,-900.272,1188.000,0.000,0.000,-91.288,0.000,0.000,0.000
9.1: -20.242,-900.272,1188.000,0.000,0.000,-91.288,0.000,0.000,0.000
9.2: -117.808,-892.761,1188.000,0.000,0.000,-97.517,0.000,0.000,0.000
9.3: -250.567,-864.937,1188.000,0.000,0.000,-106.156,0.000,0.000,0.000

For the calibration of linear axis, an auxiliary TCP tip is needed (the TCP error should be controlled within 1mm as far as possible) to take three positions on the edge of a benchmark, and all three positions need to have the movement of walking axis. After the coordinate value is recorded, the result of parallel operation of robot coordinate and datum level is obtained after the point walking axis is calculated and saved successfully.

7.1 when the walking axis of the seventh axis is in a negative direction and the robot must stretch to its limit position, click **Rec coord** when the TCP coincides with the fixed thimble point of the base level.

7.2 When the walking axis of the seventh axis is the zero position and the TCP of the robot coincides with the sharp point of the datum level, click **Rec coord**.

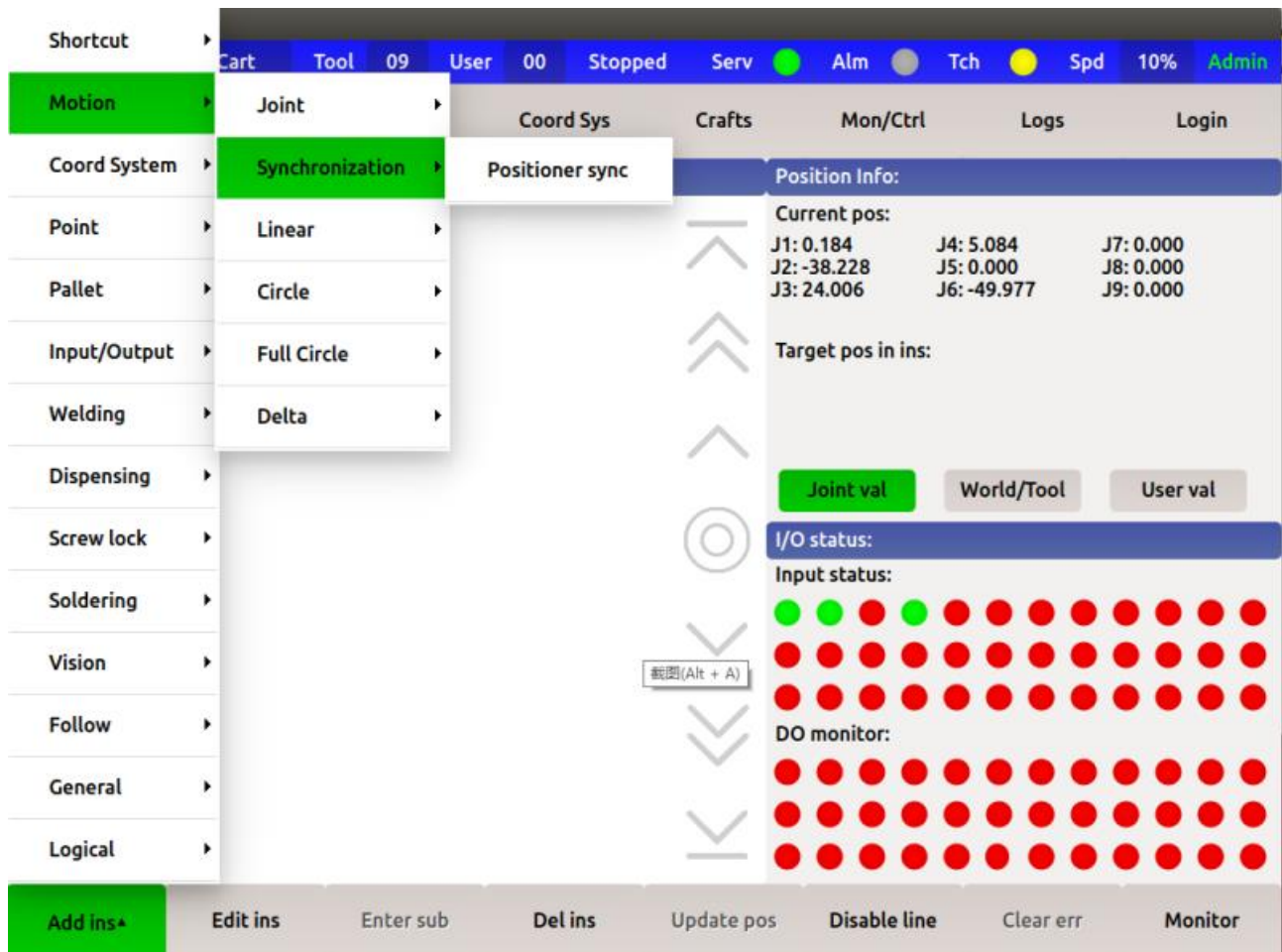
7.3 When the seventh axis is in the positive direction and the robot must stretch to its limit position, the TCP coincides with the sharp point on the datum level and click **Rec coord**.

4.3. Calibration verification of external axis

For external axis calibration verification, an auxiliary TCP tip is needed. As in calibration, the robot TCP is aligned to the auxiliary TCP tip, and the coordinate system is switched to a **positioner** with the speed switched to 5%. The seven axis are verified by j4-j4 +, and the eight and nine axis by j5-j5 +, j6-j6 +. The TCP of the robot is connected with the corresponding external axis in the process of point-and-move relocation. The point always follows the motion of the auxiliary TCP tip

5.Synchronization programming

5.1. Add synchronization commands



Prog/Run - add ins - enable on servo - motion - Synchnrization - positioner sync

Prog/Run - add ins - enable on servo - motion - Synchrnization - Positioner sync - mode selection

The screenshot displays the TURIN CNC control software interface. At the top, a status bar shows various system parameters: Cart, Tool 01, User 00, Stopped, Serv, Alm, Tch, Spd 25%, and Admin. Below this, a menu bar includes 'Prog/Run', 'File oper', 'Settings', 'Coord Sys', 'Crafts', 'Mon/Ctrl', 'Logs', and 'Login'. The main workspace is divided into several sections. On the left, a 'New SetSimultaneousMode' dialog box is open, showing a 'Positioner mode' dropdown menu with options: Independent (selected), Close, Link with J7, Link with J8, Link with J9, Sync with J7, Sync with J8, and Sync with J9. The background shows the main control screen with a 'Main prog: dddxxx.txt' label. On the right, the 'Position Info' section displays 'Current pos' and 'Target pos in ins' for joints J1 through J9. Below this, the 'I/O status' section shows 'Input status' and 'DO monitor' with corresponding indicator lights. At the bottom, a bar contains buttons for 'Add ins', 'Edit ins', 'Enter sub', 'Del ins', 'Update pos', 'Disable line', 'Clear err', and 'Monitor'. The bottom status bar shows 'Info: Open File: dddxxx.txt' and the time '17:21 V3.2.20'.

5.2. details of cooperative instructions

Close: turn off the coordination function with the positioner.

Independent: the external axis is used when the robot moves in cartesian space coordinates.

Link with J7: the seventh axis and the robot are shown to walk roughly straight line or arc trajectory.

Link with J8: the eighth axis and the robot are respectively shown to walk the approximate straight line or arc trajectory.

Link with J9: the ninth axis and the robot are respectively shown to walk roughly straight line or arc trajectory.

Sync with J7: the seventh axis cooperates with the robot to teach it to walk a precise straight line or circular path.

Coordinate with J8: coordinate 8 axis with robot to teach to walk precise straight line or circular path.

Coordinate with J9: coordinate 9 axis with robot to teach to walk precise straight line or circular path.

5.3. Program examples of synchronization

JointTool05User04StoppedServAlmErrSpd25%Admin

Prog/RunFile operSettingsCoord SysCraftsMon/CtrlLogsLogin

Main prog: posionsync.txt

001 MoveJ S=10% T=05 U=04

002 Arc start, param 01

003 Weave start, param 01

004 Set positioner sync mode Link with J8

005 MoveC S=10% T=05 U=04

006 MoveC S=10% T=05 U=04

007 MoveC S=10% T=05 U=04

008 MoveC S=10% T=05 U=04

009 Set positioner sync mode Close

010 Weave end

011 Arc end, param 01

012 MoveJ S=10% T=05 U=04

Position Info:

Current pos:

J1: 0.000J4: 0.000J7: 0.000

J2: 0.000J5: 0.000J8: 0.000

J3: 0.000J6: 0.000J9: 0.000

Target pos in ins:

J1: 0.000J4: 0.000J7: 0.000

J2: 0.000J5: 0.000J8: 0.000

J3: 0.000J6: 0.000J9: 0.000

Joint valWorld/ToolUser val

I/O status:

Input status:

DO monitor:

Add insEdit insEnter subDel insUpdate posDisable lineClear errMonitor