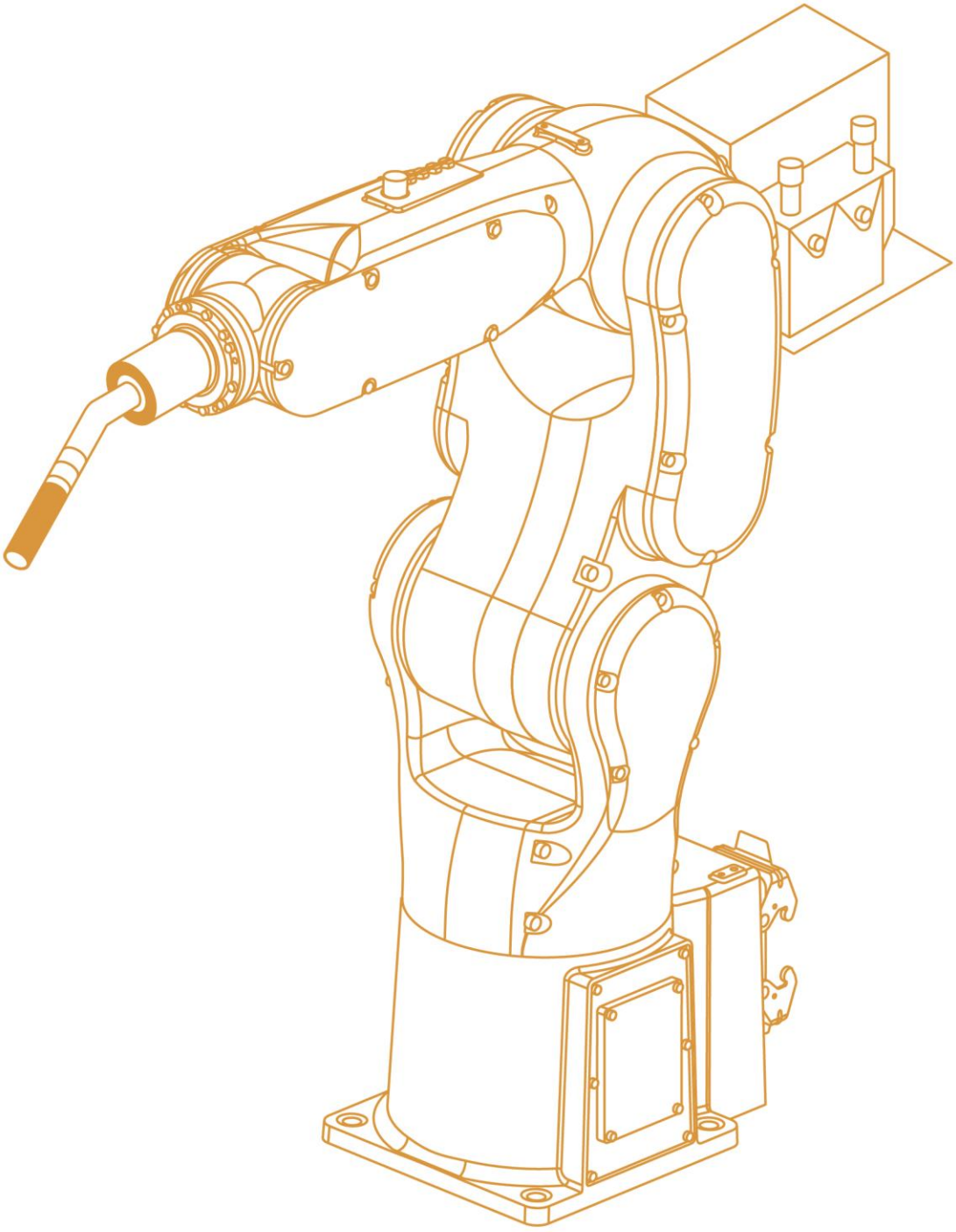
Peitian Robot

Operation Instructions of Arc Welding Function

V2.1.0



Foreword

About This Manual

This manual introduces the installation, configuration and operation method of the robot's arc welding feature pack. Reading this document will help readers install and operate the arc welding feature pack quickly and correctly.

Prerequisites

Before operating the robot, be sure to read the relevant safety instructions and operation instructions of the product carefully. Users must understand the safety knowledge and basic operation knowledge before using the robot's arc welding feature pack.

Please read the following documents when necessary:

- "Operation Manual of AIR-TP Teach Pendant"
- "ARL Programming Manual"
- "Fault and Troubleshooting Manual of AIR Series Industrial Robot System"

Target Groups

- Operators
- Product technicians
- Technical service personnel
- Robot teachers

Meaning of Common Signs

The signs and their meanings in this manual are detailed in Table 1.

Table 1 Signs used in this manual

Sign	Meaning
 Danger	Failure to follow the instructions may cause accidents, resulting in serious or fatal personal injury.
 Warning	Failure to follow the instructions may cause accidents, resulting in moderate or minor personal injury, and may also cause damage to materials only.
 Notice	You are prompted to keep in mind environmental conditions and important matters, or quick operation methods.
 Tip	You are prompted to refer to other literature and instructions for additional information or more details about operation instructions.

Manual Description

The contents of this manual are subject to supplementation and modification. Please visit "Download Center" on the website regularly to obtain the latest version of this manual in a timely manner.

Website URL: http://robot.peitian.com/

Revision History

The revision history contains the instructions for each document update. The latest version of the document contains updates to all previous versions of the document.

Table 2 Signs used in this manual

Version	Publication date	Modification description
V2.0	2019/07/31	1st official publication
V2.1.0	2019/12/31	2nd official publication Upgrade the software version to V2.6.1

Document Number and Version

The document-related information is shown in Table 3.

Table 3 Document-related information

Document name	"Operation Instructions of Arc Welding Feature pack"
Document number	BJM / SS-UG-02-021
Document version	V2.1.0
Software version	V2.6.1

Contents

1 Composition of Arc Welding System

1.1 Overall Composition of Arc Welding System

The arc welding software package combines the robot with the welding machine, and supports supports CANopen, EtherCAT, DeviceNet and analog communication. A large number of real-time data could be exchanged between robot and welding machine. In addition to the basic welding functions, the software package also supports advanced functions such as weld locating, arc pressure tracking, etc. The programming and teaching can be simplified through configuration of technology file to achieve higher welding efficiency.

The overall composition of the arc welding system is shown in Fig. 1-1.

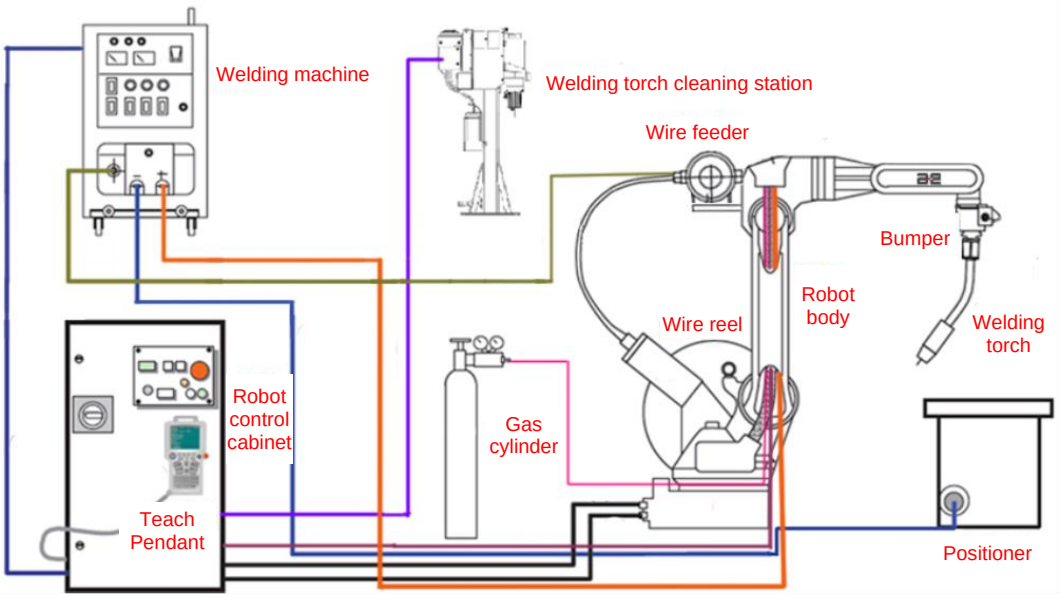


Fig. 1-1 Overall composition of arc welding system

The names and specifications of components of the arc welding robot system are detailed in Table 1-1.

Table 1-1 Names and specifications of components of welding robot system

Component	Brand	Spec.	Qty.	Remark
Robot body	AE	AIR10	1	-
Teach pendant	AE	-	1	-
Robot control cabinet	AE	ARCCD10/ARCCD12/ARCCD20	1	-
Positioner	-	Single-axis/double-axis single action/double-axis linkage	1	To be matched according to customer needs
Welding machine	Aotai/Megmeet	350MAG air-cooled/500R pulse water-cooled/WSM400R TIG water-cooled	1	To be matched according to customer needs
Welding torch	Aotai	-	1	To be matched according to customer needs
Bumper	ARC	-	1	-
Wire feeding system	Aotai/Megmeet	0.8~1.6mm	1	-
Accessories	-	Contact nozzle, gas shunt, pressure reducing valve,		To be matched according to customer needs
System software	AE	-	1	-

1.2 Welding System

The welding system is composed of the welding machine, the welding torch and the wire feeder.

1.2.1 Welding Machine

MAG-350RL welding machine

Fig. 1-2 Schematic diagram of MAG-350RL welding machine

Characteristics of basic equipment of MAG-350RL welding machine:

- Low spatter, achieving 0.8-3 mm thin plate welding.
- Low welding penetration.

The product specifications are detailed in Table 1-2.

Table 1-2 Basic specifications of MAG-350RL welding machine

Parameters	Description
Overall dimensions L×W× H(mm)	636×322×584
Weight (kg)	53
Rated input voltage	Three-phase 380V ±10%
Rated input frequency	50Hz
Rated input capacity (KVA)	14
Rated input current (A)	21
Rated output voltage (V)	31.5
Rated load duration (%)	60%
Output no-load voltage (V)	79
Output current/voltage range (A/V)	60A/17V~350A/35V
Power factor	≥0.87
Welding wire diameter (mm)	0.8, 1.0, 1.2
Welding wire type	Carbon steel, stainless steel, galvanized sheet
Gas flow rate (L/min)	15~20

Parameters	Description
Welding torch cooling method	Water-cooled/air-cooled
Enclosure protection class	IP21S
Insulation class	H

Pulse MIG-350/500RP welding machine

Fig. 1-3 Schematic diagram of Pulse MIG-350/500RP welding machine

Product characteristics:

- The pulse welding machine can be applied to all common welding materials.
- TIG welding can be achieved through double pulses when welding aluminum.

The basic specifications of Pulse MIG-350/500RP welding machine are detained in Table 1-3.

Table 1-3 Basic specifications of Pulse MIG-350/500RP welding machine

Parameters	Pulse MIG-350R/RP	Pulse MIG-500R/RP
Overall dimensions L×W× H(mm)	576×297×574	636×322×584
Weight (kg)	45	53
Rated input voltage	Three-phase 380V ±10%	
Rated input frequency	50Hz	
Rated input capacity (KVA)	14	25
Rated input current (A)	21	38
Rated output voltage (V)	31.5	
Rated load duration (%)	60%	
Output no-load voltage (V)	91	
Output current/voltage range (A/V)	25A/14V~350A/40V	25A/14V~500A/50V
Power factor	≥0.87	
Welding wire diameter (mm)	0.8, 1.0, 1.2, 1.6	
Welding wire type	Carbon steel, stainless steel, aluminum-magnesium alloy, pure aluminum, aluminum-silicon alloy, copper and copper alloy	

Parameters	Pulse MIG-350R/RP	Pulse MIG-500R/RP
Gas flow rate (L/min)	15~20	
Welding torch cooling method	Water-cooled/air-cooled	
Enclosure protection class	IP21S	
Insulation class	H	

WSM-400R welding machine

Fig. 1-4 Schematic diagram of WSM-400R welding machine

Product characteristics:

- TIG welding machine, supporting two welding types: wire-filled and wire-free.
- TIG welding features high penetration, and can be used without wire-filling or with little wire-filling so as to reduce post-processing.

The basic specifications of WSM-400R welding machine are detailed in Table 1-4.

Table 1-4 Basic specifications of WSM-400R welding machine

Parameters	WSM-400R
Weight (kg)	35
Rated input voltage	Three-phase 380V ±10%
Rated input frequency	50Hz
Rated input capacity (KVA)	18
Rated input current (A)	28
Rated load duration (%)	60%
Output no-load voltage (V)	71
Output current range (A)	4~410
Peak current (A)	4~410
Base current (A)	4~410
Arcing current (A)	4~400

Parameters	WSM-400R
Duty ratio (%)	15~85
Pulse frequency (Hz)	0.2~500
Pre-gas time (S)	0.01~9.99
Gas delay time (S)	0.1~60
Pre-gas time (S)	0.1~10.0
Pre-gas time (S)	0.1~15.0
Welding wire diameter (mm)	0.8, 1.0, 1.2, 1.6
Wire feeding type	Wire push
Gas flow rate (L/min)	Max. 25
Welding torch cooling method	Water-cooled/air-cooled
Enclosure protection class	IP21S
Insulation class	H
Special implicit parameters of robot	
Control method (rEt)	■ OFF: Near control ■ ON1: Analog remote control ■ ON2: Digital remote control
Wire feeding speed (Fd1)	OFF/0.3~7m/min
Slow wire feeding speed (Fd2)	OFF/0.3~7m/min
Jog wire feeding speed (Fdi)	0.3~7m/min
Wire drawing length (mm)	OFF~50
Wire feeding delay time (dt1)	OFF~9.9s
Wire stop delay time (dt2)	OFF~9.9s

Artsen Plus500/400 series welding machine

Fig. 1-5 Artsen Plus500/400 series welding machine

The basic specifications of Artsen Plus500/400 series welding machine are detailed in Table 1-5.

Megmeet pulse welding machine supports a variety of new process modes, which helps improve the quality of weld seam.

Table 1-5 Basic specifications of Artsen Plus 500/400 series welding machine

Parameters	Artsen Plus500 Artsen Plus500R	Artsen Plus400 Artsen Plus400R
Volume	300×480×620	
Weight	52KG	
Control method	All-digital	
Wire feeding drive control mode	Photoelectric encoder disc feedback + independent chip high-speed loop control	
Input voltage	3-phase 380Vac (-25%, + 15%), (285~437V)	
Input frequency	45~65Hz	
Input capacity	24KVA (23KW)	
Input power factor	0.93	
Efficiency	85%	
Rated no-load voltage	85V	
Rated output current	500A	400A
Rated voltage/current range	12~45V (accuracy: 0.1V)	
	30 ~ 500A	30 ~ 400A
Rated duty cycle	60%@500A@40℃	100%@400A@40℃
Welding wire diameter	Φ0.8/1.0/1.2/1.6/SP mm	
Welding method*	■ Smooth short-circuit transition ■ Short arc pulse transition ■ High-frequency pulsating energy control ■ High-speed intermittent welding ■ Constant penetration welding	
Welding time sequence	2 steps, 4 steps, special 4 steps, spot welding, intermittent welding	
Arc characteristics	-7~+7	
Robot communication (for robot welding machine only)	Analog/DeviceNet/CAN Open/Megmeet CAN/RS-485/EtherNet/IP **	
Insulation class	H	
Protection class	IP23S	
Host environment	Industrial heavy load, -39℃~+ 50℃, humidity ≤95%	
Circulating cooling water tank (optional)		

Parameters	Artsen Plus500 Artsen Plus500R	Artsen Plus400 Artsen Plus400R
Rated power	260W	
Rated voltage	400Vac	
Cooling water capacity	6.5L	
Cooling water flow rate	3.5L/min	
Max. cooling water lift	30m	
Flow rate alarm/water temperature alarm	Yes	

1.2.2 Welding Torch

Composition of welding torch

The introduction and precautions of components of the welding torch are detailed in Fig. 1-6.

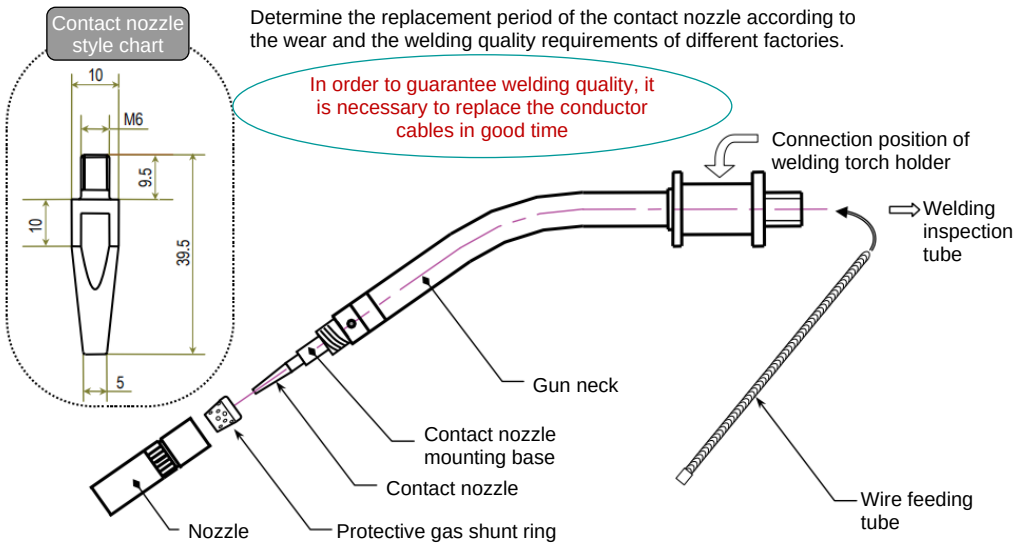


Fig. 1-6 Introduction and precautions of components of welding torch

Precautions

- The welding torch should be configured with the European interface (as shown in Fig. 1-7), and the type should be selected according to the load factor, cooling method and suitable welding materials.
- Generally the water cooling method should be used when the robot is in a long-time operation state in order to ensure good welding effect and the safety of the welding torch.
- When welding the carbon steel, CO2 itself will have a cooling effect, so the air cooling method can be also used when welding at low current.

Fig. 1-7 European interface of welding torch

Tip

When a water-cooled welding torch is used, the water-cooling machine should be filled with pure water, which should be prevented from freezing.

1.2.3 Wire Feeder

Composition of wire feeder

The wire feeder of the robot welding system is divided into two parts:

- The wire feeder control box is the control part.
- The wire feeding mechanism is the actuation part.

The wire feeder control box is separated from the wire feeding mechanism, which is convenient for users to upgrade the interface without replacing the wire feeder, and also reduces the bearing load of the robot. The schematic diagram of the wire feeder is shown in Fig. 1-8.

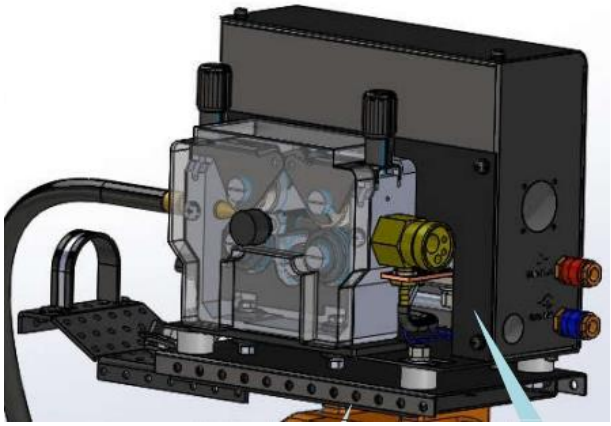


Fig. 1-8 Schematic diagram of wire feeder

Product characteristics

- The grating feedback wire feeding motor features high wire feeding accuracy, high wire feeding force and high anti-jamming ability to ensure stable welding.
- It is applied with the damping disc shaft, which features good braking performance.
- It is applied with four-wheel drive wire feeding, which features high wire feeding force and stable wire feeding.
- The wire feeding wheel is easy to replace without tools.
- It is compact and light, and is suitable for installation on robots, helping robots move freely.

Principle of selecting welding wire

- The welding wire should be selected according to the composition and mechanical properties of the base metal to be welded. When selecting the welding wire, please consult the welding wire manufacturer and the applicable objects.

- The welding current has a certain effect on the wire feeding speed. The maximum wire feeding speed is usually 15 mm/min, and the maximum current for small diameter wires has an upper limit. If high current is used while the metal in the molten pool is insufficient, the appearance of weld seam will be affected adversely, and the low welding penetration will cause welding cracks.

The principle of selecting the welding wire is given in Table 1-6.

Table 1-6 Specifications of welding wire

Type of welding wire	Welding wire diameter (mm)	Applicable current range (A)
Solid welding wire	0.6	40~90
	0.8	50~120
	0.9	60~150
	1.0	70~180
	1.2	80~350
	1.6	300~500
Flux-cored welding wire	1.2	80~350
	1.6	200~450

1.3 Coordination Relationship of Welding System Equipment

The coordination relationship between the welding system equipments is shown in Fig. 1-9.

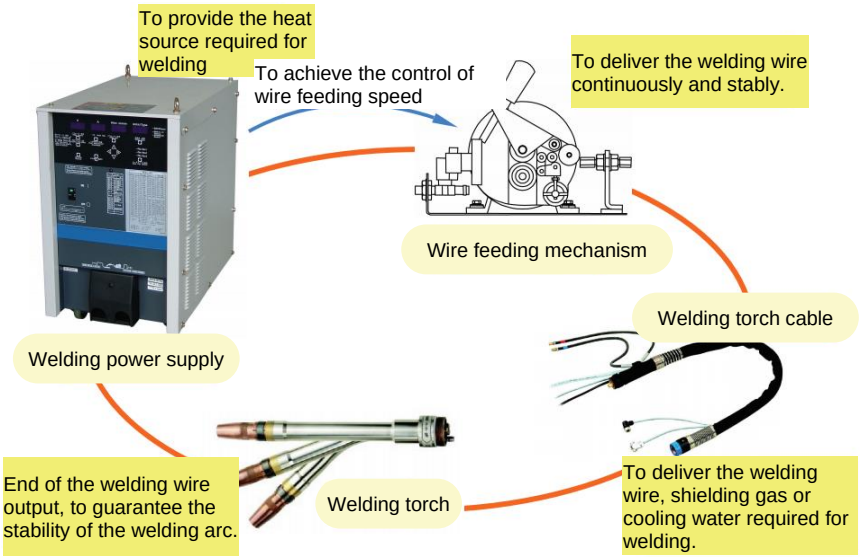


Fig. 1-9 Coordination relationship between welding system equipments

2 Communication Debugging Description of Control Cabinet and Welding Machine

2.1 Debugging Instructions for Integrated Cabinet Welding System

2.1.1 Devicenet Fieldbus Communication

The schematic diagram of Ethercat-Devicenet module is shown in Fig. 2-1.

Fig. 2-1 Ethercat-Devicenet module

The wiring diagram of BECKHOFF EK1100 is shown in Fig. 2-2.

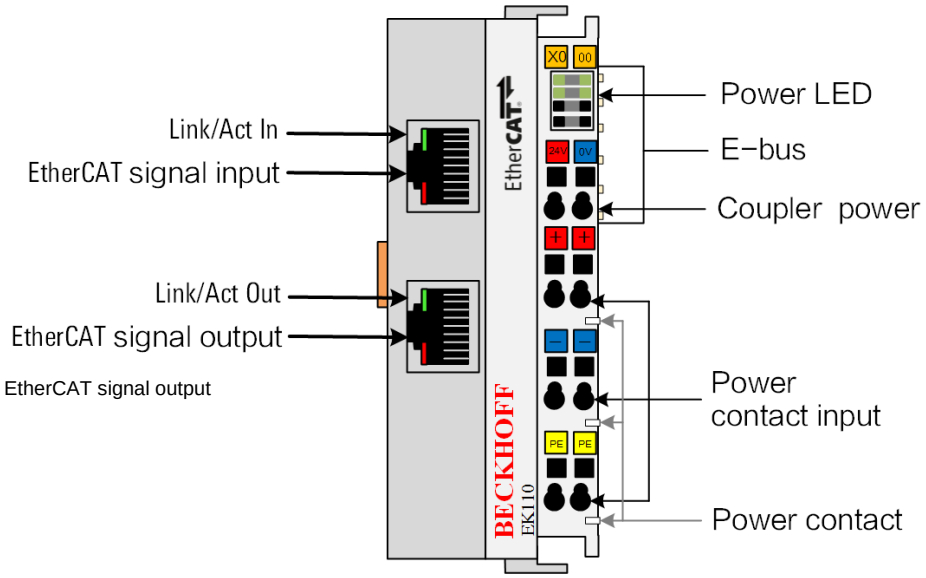


Fig. 2-2 Wiring diagram of welding machine and BECKHOFF EK1100

The wiring diagram of welding machine and BECKHOFF EK1100 is shown in Fig. 2-3.

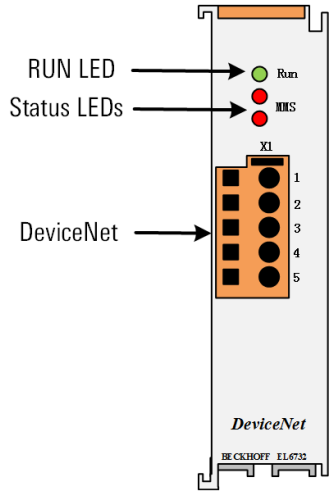


Fig. 2-3 Wiring diagram of welding machine and BECKHOFF EK1100

Communication connection between welding machine and control cabinet

The communication connection between the welding machine and the control cabinet is shown in FigureFigure 2-4.

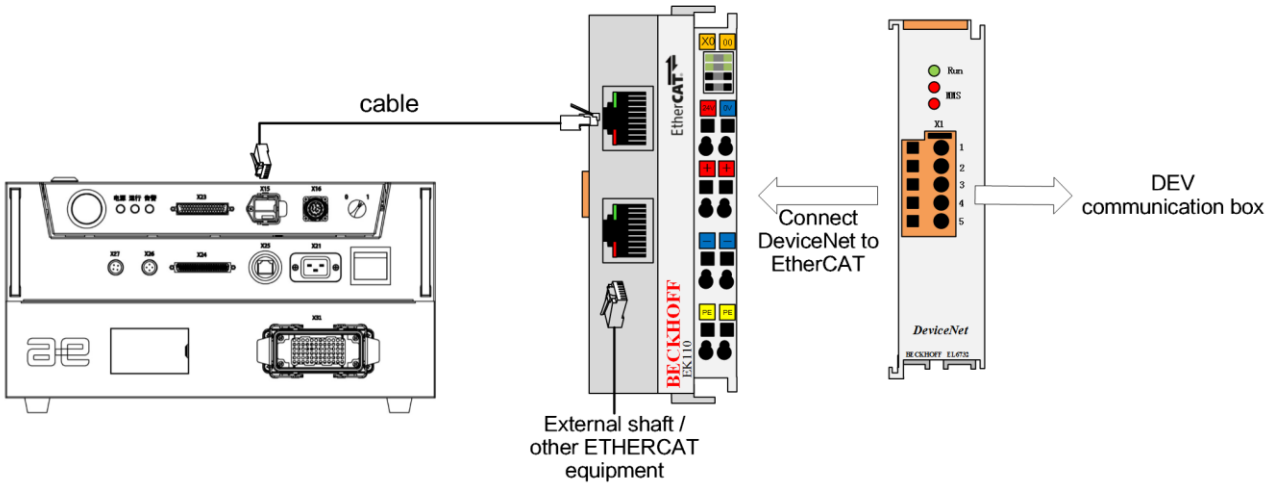


Figure 2-4 Communication connection between welding machine and control cabinet

> **Tip**
>
> If a second-generation control cabinet is used, connect the network cable to the X004A interface of the control cabinet.

Debugging instructions:

1.After connecting the wire as shown above, the PLC slave should be selected as Aotai EHTHERCAT slave.

2.The DEV communication box of the welding machine should be configured with a slave ID of 1 and a baud rate of 250kbps.

2.1.2 Ethercat Industrial Ethernet Communication

In Ethercat industrial Ethernet communication, the control cabinet needs an external communication controller. The ATR-EtherCAT communication controller implements the mutual conversion between the EtherCAT communication protocol on the robot side and the HDLC communication protocol inside the welding machine, ensuring the real-time and stability of the communication. The connection method is shown in Figure2-5.

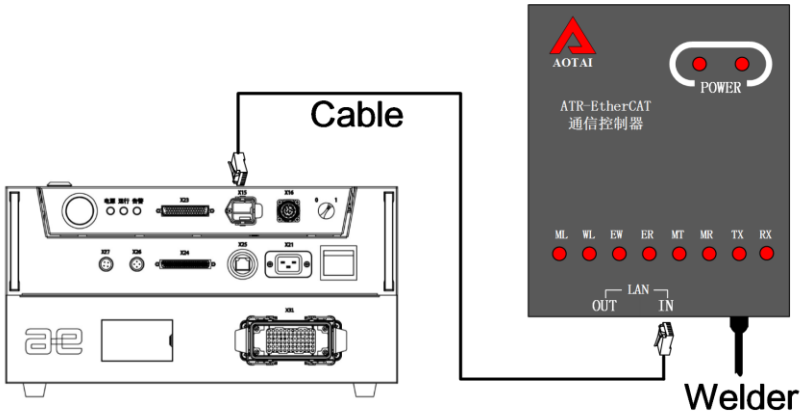


Figure2-5 Communication between welding machine and control cabinet

> **Tip**
>
> If a second-generation control cabinet is used, connect the network cable to the X004A interface of the control cabinet.

Debugging instructions:

1. After connecting the wire as shown above, the PLC slave should be selected as Aotai EHTHERCAT slave.

2. When the transition light MI stays on, it indicates that the communication between the welding machine and the control box is normal.

2.1.3 CANopen bus communication

Robot digital interface

The pin sequence of the robot digital interface aerial plug on the digital communication box is shown in Figure 2-5, and the pin definitions are shown in Table 2-1.

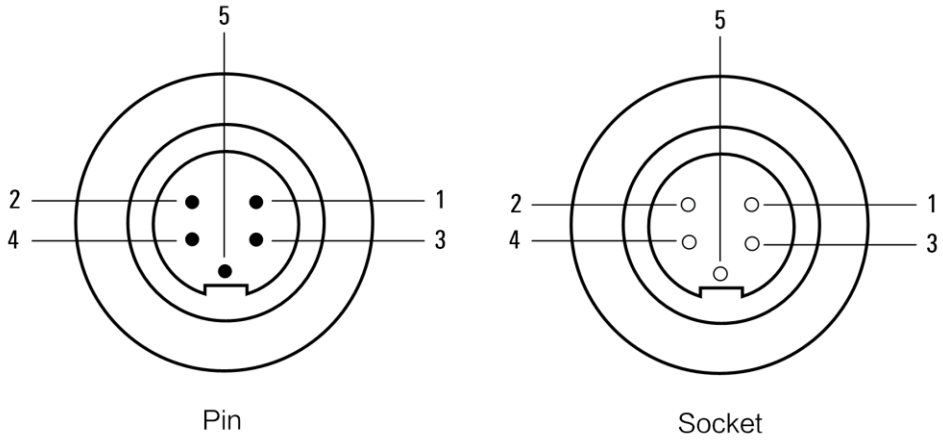


Figure 2-6 Robot digital interface aviation plug

Table 2-1 Aviation pin definition

Pin number	Colour	Signal name	Features
1	Red（18AWG）	24V power supply	Robot power signal
2	White（22AWG）	CAN_H signal line	Communication line CAN_H
3	Black（18AWG）	Ground	Robot power ground
4	Blue（22AWG）	CAN_L signal line	Communication line CAN_L
5	Shielded wire	Shielded wire	Shell PE

Pin number	Colour	Signal name	Features
	(18AWG)		

CANopen bus

CANopen bus can be used for CANopen bus communication mode and analog communication. CANopen bus diagram and pin definition are shown in Figure 2-7

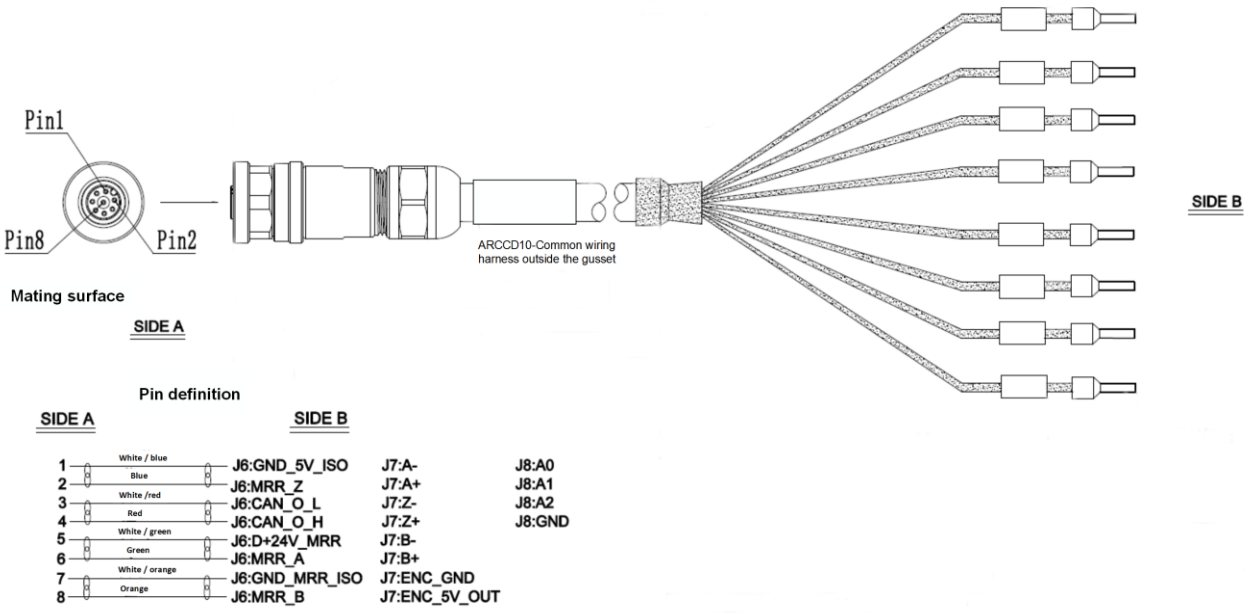


图 2-7 CANopen bus diagram

Wiring relationship between CANopen bus and robot digital interface

The connection relationship between CANopen bus and robot digital interface is shown in Table 2-2.

Table 2-2 Wiring relationship between bus and robot digital interface

CANopen bus SIDEB		Robot digital interface	
Pin number	name	Pin number	Signal name
1	CAN_O_L	4	CAN_L signal line
5	CAN_O_H	2	CAN_H signal line
8	USER_GND	3	Ground

2.1.4 Connection method of analog welding machine

The MCB-IEB pin definition of the robot control cabinet is shown in Figure 2-8. Pin descriptions are shown in Table 2-3.

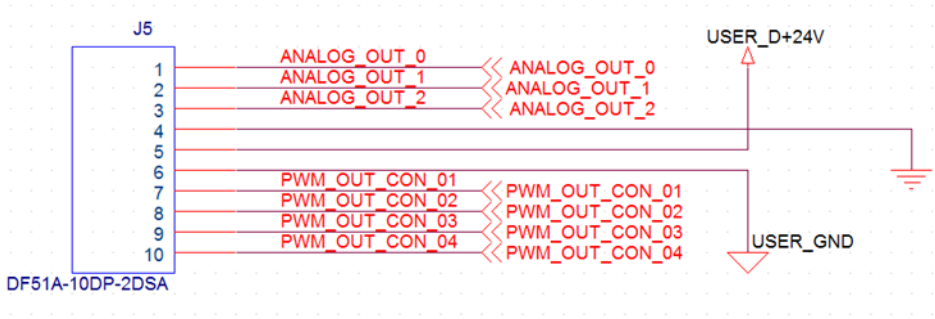


Figure 2-8 Robot control cabinet MCB-IEB pin definition

Table 2-3 Pin description

Number	Name	Meaning
1	ANALOG_OUT_0	Analog output 0
2	ANALOG_OUT_1	Analog output 1
3	ANALOG_OUT_2	Analog output 2
4	GND	Ground
5	USER_D+24V	PWM isolated 24V power supply
6	USER_GND	PWM isolated ground
7	PWM_OUT_CON_01	PWM output 1
8	PWM_OUT_CON_02	PWM output 2
9	PWM_OUT_CON_03	PWM output 3
10	PWM_OUT_CON_04	PWM output 4

Analog configuration instructions

At present, the suitable analog welding machine is the Megmeet Ehave 350 series. The welding machine is connected to the robot with an analog interface through the DB15 communication terminal on the back of the welding machine. The DB15 communication terminal pin number sequence is shown in Figure 2-9. The DB15 communication terminal pin definitions are shown in Table 2-4.

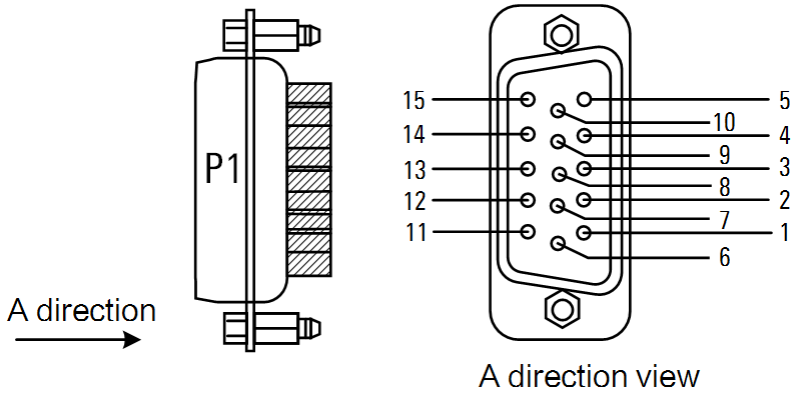


Figure 2-9 DB15 interface definition

Table 2-4 DB15 communication terminal pin description

Pin number	Communication cable DB15 color	Signal name	Features
1	Black 1	24V power supply	The positive pole of the DC power supply is provided by the robot to the welding machine.
2	Black 2	Arcing signal	The I / O signal is output by the robot to the welding machine to control the power output of the welding machine. The low level is valid.
3	Black 3	Reverse wire feed signal	The I / O signal is output by the robot to the welding machine to control the wire feed motor to reverse, and the low level is valid.
4	Brown 1	Arcing success signal	The I / O signal is output by the welding machine to the robot, and the arc start success signal is fed back. When OFF, the low level is valid, and when ON, the high level is valid.
5	Brown 2	Reserve	Reserve
6	Brown 3	Analog signal common ground	Common ground for 7, 13, 14, and 15-pin analog signals.
7	Orange 1	Welding current signal	The analog signal is output by the welding machine to the robot, and the actual welding current value is fed back.
8	Orange 2	I / O signal common ground	1, 2, 3, 4, 9, 11 pin I / O signal common ground.
9	Orange 3	Forward wire signal	The I / O signal is output by the robot to the welding machine and controls the forward rotation of the wire feeding motor. The low level is valid.
10	Purple 1	Reserve	Reserve
11	Purple 2	Gas detection signal	The I / O signal is output by the robot to the welding machine, and controls the gas supply solenoid valve switch. The low level is valid.
12	Purple 3	Seek signal	The I / O signal provides a successful positioning signal to the robot.
13	Blue 1	Given voltage signal	The analog signal is output by the robot to the welding machine with a given voltage value.
14	Blue 2	Given current signal	The analog signal is given by the robot to the welding machine with a given current value.
15	Blue 3	Welding voltage signal	The analog signal is output by the welding machine to the robot, and the actual welding voltage is fed back.

Table 2-5 shows the corresponding relationship between the control cabinet AO output and the Megmeet welder end。

Table 2-5 Correspondence between AO output of control cabinet and Megmeet welding machine

Control cabinet AO output		Megmeet Welder End	
1	AO1	13	Given current
2	AO2	14	Given voltage
6	GND	6	Analog public

IO configuration instructions

The "X24" port of the robot control cabinet is a user IO interface. X24 is transferred to the user IO terminal module through the user IO terminal module cable to achieve its terminal block transfer function.

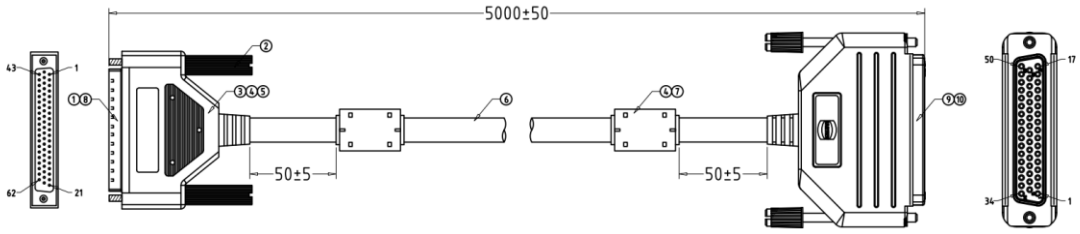


Figure 2-10 IO terminal module cable

The top view of the user IO terminal module is shown below. The board has three connectors J1 / J2 / J3, with J2 on the left, J3 on the top, and J1 on the bottom. J2 is connected to the user IO terminal module cable. J1 is DI terminal block and J3 is DO terminal block, which is connected to the welding machine.

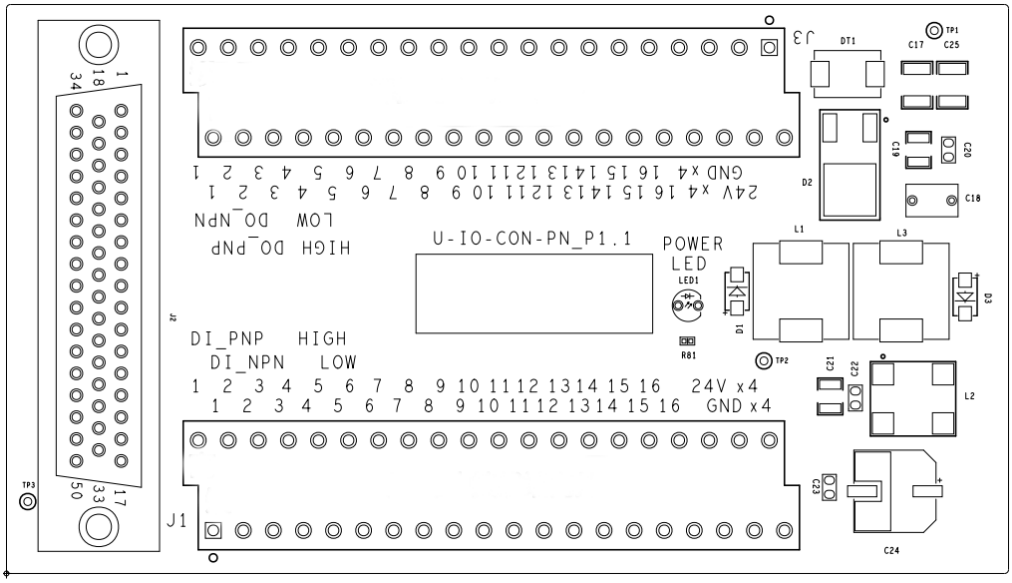


Figure 2-11 User IO terminal module

The figure below is a photo of the side view of J1.

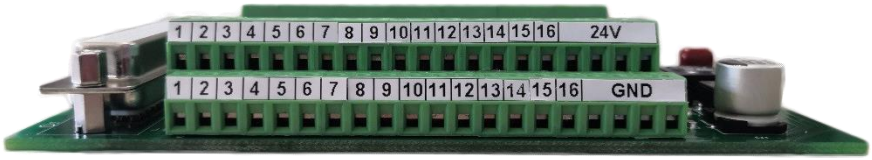


Figure2-12 Photo of J1 side view

The pin definition of the J1 connector is shown in the following table.

Table 2-6 Pin definition of J1 connector

Pin	Name	Label
1	OPERATED_DI_NPN_1	1
2	OPERATED_DI_NPN_2	2
3	OPERATED_DI_NPN_3	3
4	OPERATED_DI_NPN_4	4

Pin	Name	Label
5	OPERATED_DI_NPN_5	5
6	OPERATED_DI_NPN_6	6
7	OPERATED_DI_NPN_7	7
8	OPERATED_DI_NPN_8	8
9	OPERATED_DI_NPN_9	9
10	OPERATED_DI_NPN_10	10
11	OPERATED_DI_NPN_11	11
12	OPERATED_DI_NPN_12	12
13	OPERATED_DI_NPN_13	13
14	OPERATED_DI_NPN_14	14
15	OPERATED_DI_NPN_15	15
16	OPERATED_DI_NPN_16	16
17	D+24V_IO_IN-	GND
18	D+24V_IO_IN-	
19	D+24V_IO_IN-	
20	D+24V_IO_IN-	
21	OPERATED_DI1	1
22	OPERATED_DI2	2
23	OPERATED_DI3	3
24	OPERATED_DI4	4
25	OPERATED_DI5	5
26	OPERATED_DI6	6
27	OPERATED_DI7	7
28	OPERATED_DI8	8
29	OPERATED_DI9	9
30	OPERATED_DI10	10
31	OPERATED_DI11	11
32	OPERATED_DI12	12
33	OPERATED_DI13	13
34	OPERATED_DI14	14
35	OPERATED_DI15	15
36	OPERATED_DI16	16
37	D+24V_IO_IN+	24V

Pin	Name	Label
38	D+24V_IO_IN+	
39	D+24V_IO_IN+	
40	D+24V_IO_IN+	

The figure below is a side view of J3.

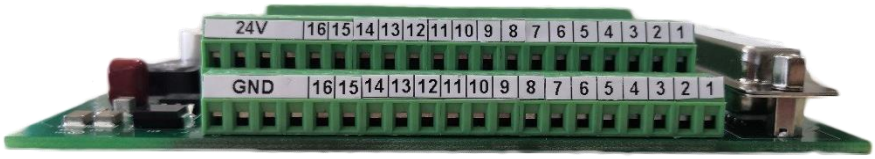


Figure 2-13 Photo of J3 side view

The pin definition of the J3 connector is shown in the following table.

Table 2-7 J3 connector pin definition

Pin	Name	Label
1	D+24V_IO_IN-	GND
2	D+24V_IO_IN-	
3	D+24V_IO_IN-	
4	D+24V_IO_IN-	
5	OPERATED_DO_NPN_16	16
6	OPERATED_DO_NPN_15	15
7	OPERATED_DO_NPN_14	14
8	OPERATED_DO_NPN_13	13
9	OPERATED_DO_NPN_12	12
10	OPERATED_DO_NPN_11	11
11	OPERATED_DO_NPN_10	10
12	OPERATED_DO_NPN_9	9
13	OPERATED_DO_NPN_8	8
14	OPERATED_DO_NPN_7	7
15	OPERATED_DO_NPN_6	6
16	OPERATED_DO_NPN_5	5
17	OPERATED_DO_NPN_4	4
18	OPERATED_DO_NPN_3	3
19	OPERATED_DO_NPN_2	2
20	OPERATED_DO_NPN_1	1
21	D+24V_IO_IN+	24V

Pin	Name	Label
22	D+24V_IO_IN+	
23	D+24V_IO_IN+	
24	D+24V_IO_IN+	
25	OPERATED_DO16	16
26	OPERATED_DO15	15
27	OPERATED_DO14	14
28	OPERATED_DO13	13
29	OPERATED_DO12	12
30	OPERATED_DO11	11
31	OPERATED_DO10	10
32	OPERATED_DO9	9
33	OPERATED_DO8	8
34	OPERATED_DO7	7
35	OPERATED_DO6	6
36	OPERATED_DO5	5
37	OPERATED_DO4	4
38	OPERATED_DO3	3
39	OPERATED_DO2	2
40	OPERATED_DO1	1

2.2 Debugging Instructions for Standard Cabinet Welding System

The schematic diagram of DeviceNet PCI board is shown in Fig. 2-14.

Fig. 2-14 DeviceNet PCI board

The specific steps for debugging are as follows:

Step 1. The Devicenet installation file will be installed automatically when ARCS is upgraded. The different Devicenets have different device numbers and serial numbers, which can find on the Devicenet board. Now the device number and serial number are changed in the install_cifx.sh script.

Step 2. The Badu rate is adjusted to 2# position, namely 500 kbps.

Step 3. The slave ID is set to 5 and the compact cabinet is set to 1.

Step 4. The Devicenet is connected to 24V power supply, the top port is connected to 0V, and the bottom port is connected to +24V.

Step 5. Aotai Devicenet interface box indicator is on.

The definition of Aotai Devicenet interface box indicator is shown in Table 2-8.

Table 2-8 Aotai Devicenet interface box indicator

Indicator	Description
D1	It will be on when the main control chip of the welding machine is successfully connected to the Devicenet module.
D2	It will be on when the Devicenet module fails.
D3	It will be on when the Devicenet is successfully connected to the master.
D4	It will be on when the Devicenet module fails to connect to the master.
D5	It turns off when the main control chip of the welding machine does not receive the correct Devicenet data within 500 ms.
D6	It will be off when the main control chip of the welding machine fails to receive the corrected welding data within 500 ms.
D7	The main control chip sends data indication to the welding machine.
D8	The main control chip receives the data indication from the welding machine.

2.3 Configuration of PLC Slave

The robot may be connected to a variety of I/O devices. When the required I/O device is selected in the configuration of PLC slave, the system will automatically assign the corresponding I/O address mapping for the device to complete the I/O interaction between the robot and the equipment.

Step 1. On the main interface of the teach pendant, click "System"-> "System Configuration"-> "PLC Slave Configuration" option, as shown in Fig. 2-15.

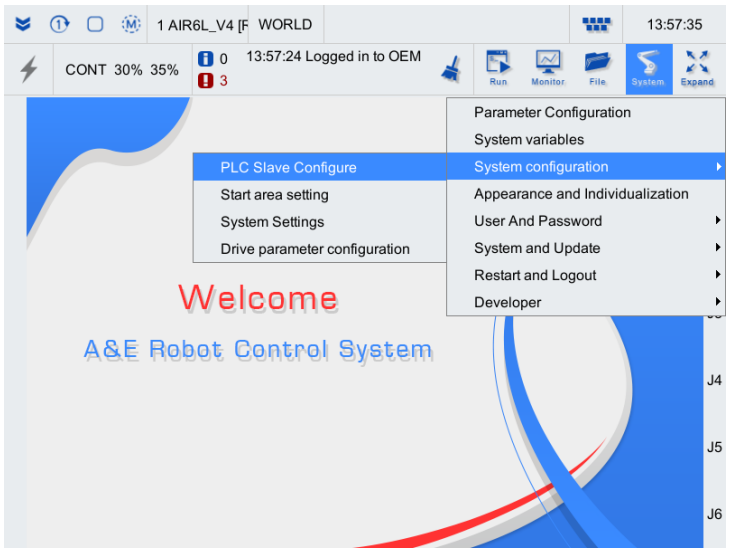


Fig. 2-15 Configuration selection of PLC slave

Step 2. In the pop-up "PLC Slave Configuration" dialog box, select the option to be configured (the first PLC slave configuration cannot be modified) and click the "Configuration" button, as shown in Fig. 2-16.

Fig. 2-16 "PLC Slave Configuration" floating window

Step 3. In the pop-up dialog box, select "PLC Slave station Type", as shown in Fig. 2-17. The conversion modules that are related to the welding machine are BECKHOFF DeviceNet conversion module, MFDB (first-generation control cabinet gusset digital welding machine CAN communication, analog welding machine communication) and IEB (second-generation control cabinet gusset CAN communication, analog welding machine communication).

Tip

- When connecting with Aotai welding machine, select the BECKHOFF DeviceNet conversion module.
- When connecting with Megmeet welding machine, select MFDB using first-generation control cabinet.
- When connecting with Megmeet welding machine, select IEB using second-generation control cabinet.
- When using an analog welding machine, two AO signal types must be selected.

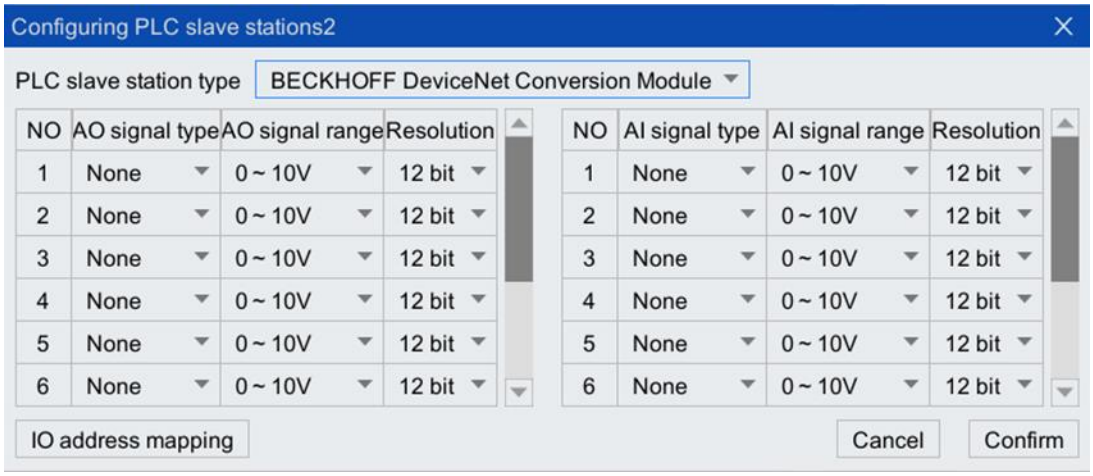


Fig. 2-17 Configuration interface of PLC slave

Step 4. Click "IO Address Mapping" to view the set IO type, physical address head, physical address end, logical address head and logical address end, as shown in Fig. 2-18.

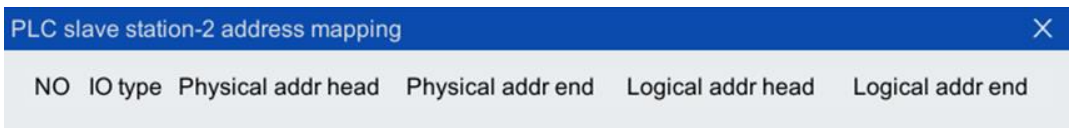


Fig. 2-18 View IO address mapping

Step 5. After the configuration is completed, click "Confirm", a prompt dialog box will pop up, and then click "Yes", the configuration will take effect after power off and restart, as shown in Fig. 2-19.

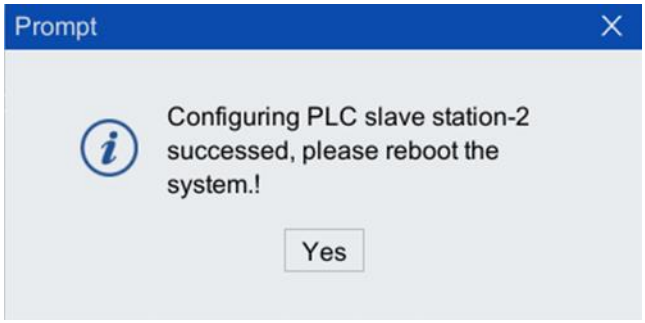


Fig. 2-19 Prompt dialog box

3 Installation, Uninstallation and Authorization of Arc Welding Feature Pack

3.1 Access Level of System Parameter Configuration

When operating the AIR-TP teach pendant for the first time, the user interface at the first login will be prompted. The user can choose:

- Teacher: Access level 4

The user can perform operations such as programming the robot's running program, and modify some parameters. The initial login password is: PEACE.

- Operator: Access level 5

The user can view the robot's position, basic parameters, and operation conditions, without the permission of modifying the program or parameters. The initial login password is: LOVE.

> Tip
>
> The ordinary users can log into the teach pendant only with OEM or Teacher only.

3.2 Installation and Upgrade of Arc Welding Feature Pack

Before installing the arc welding feature pack, please check whether the HMI/ARCS version has been upgraded to the version that matches with the feature pack. The installation steps are the same as the upgrade steps.

The steps are as follows:

Step 1. Copy the installation package to the root directory of USB.

Step 2. Log into the teach pendant with the teacher or higher permission, and then insert the USB above.

Step 3. Click "Expand" button to pop up the drop-down list shown in Fig. 3-1.

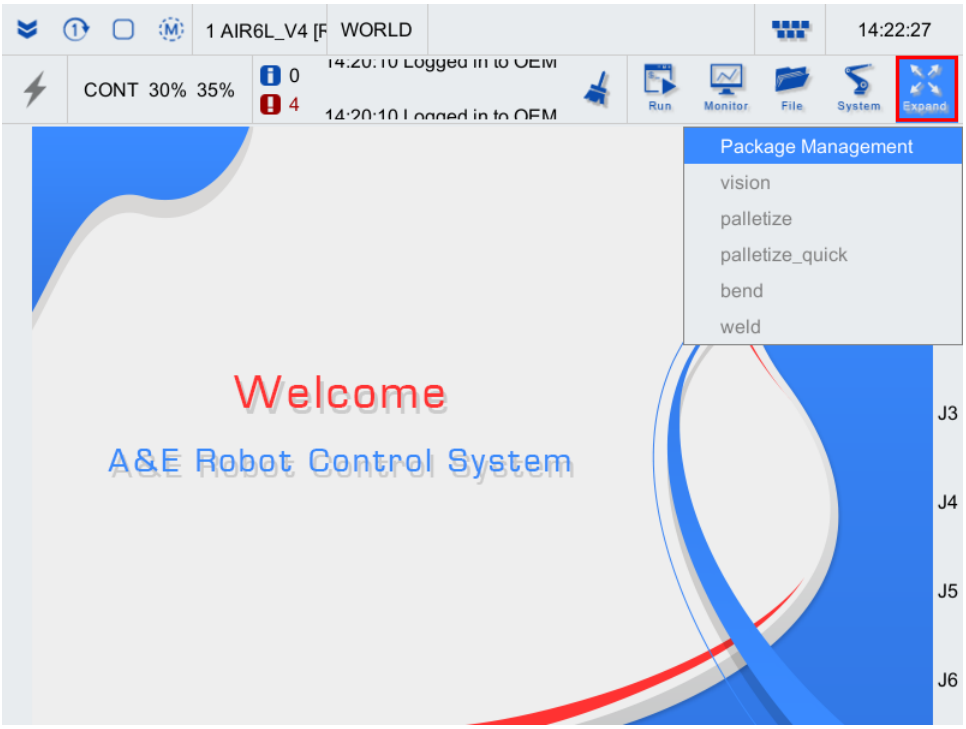


Fig. 3-1 List of feature pack

Step 4. Click "Package Management" to pop up the package management interface shown in Fig. 3-2.

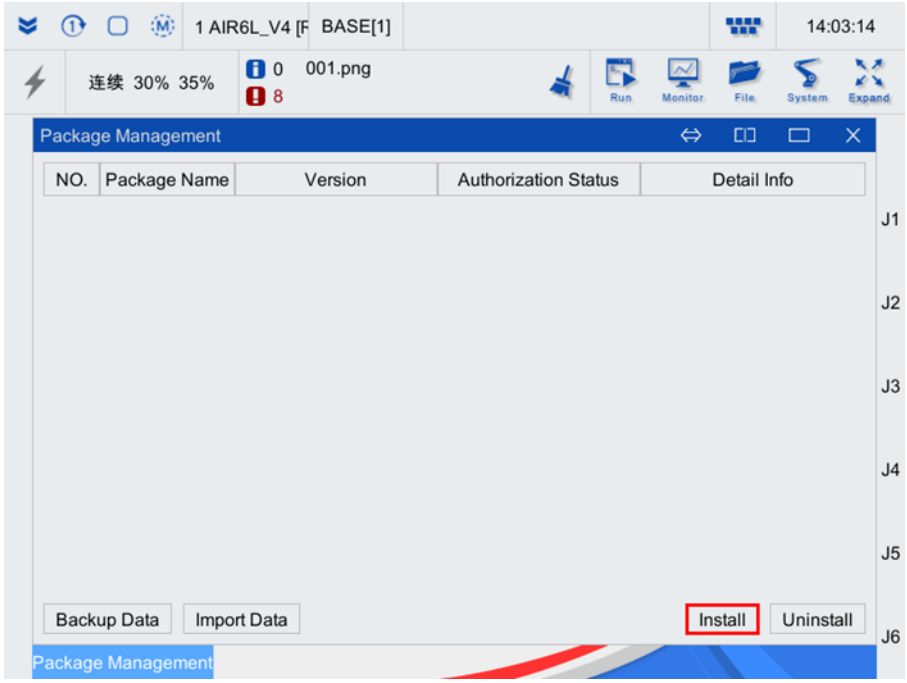


Fig. 3-2 Management interface of feature pack

Step 5. Click "Install" button to pop up the "Select Package Version" dialog box shown in Fig. 3-3.

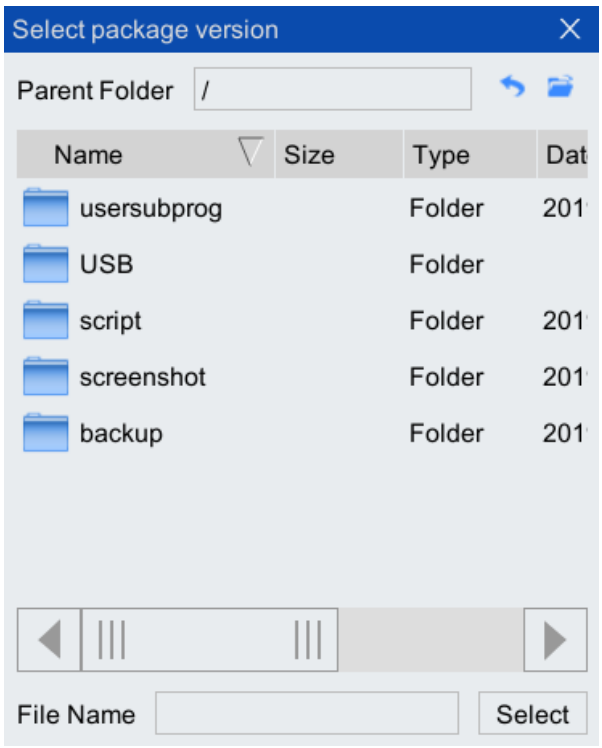


Fig. 3-3 "Select Feature Pack Version" dialog box

Step 6. Double-click "USB" folder, find the arc welding package installation file under the USB folder, enter the interface shown in Fig. 3-4, and then click "Select" button.

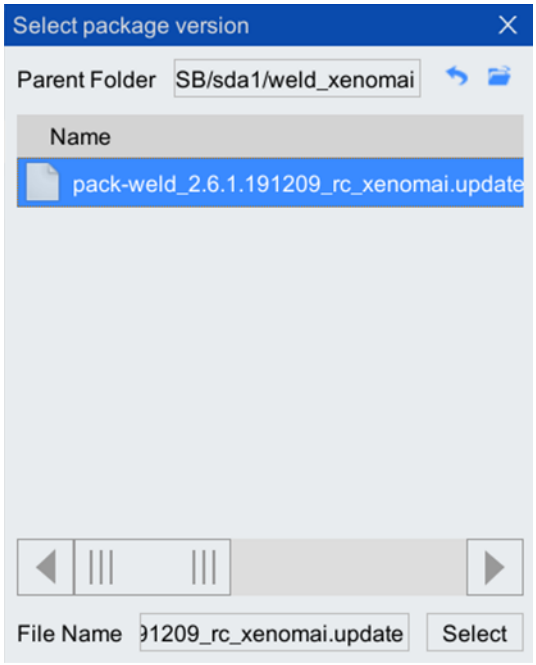


Fig. 3-4 Selection interface of install feature pack

Step 7. A dialog box shown in Fig. 3-5 will pop up to prompt whether to upgrade. After checking, click "Yes" button.

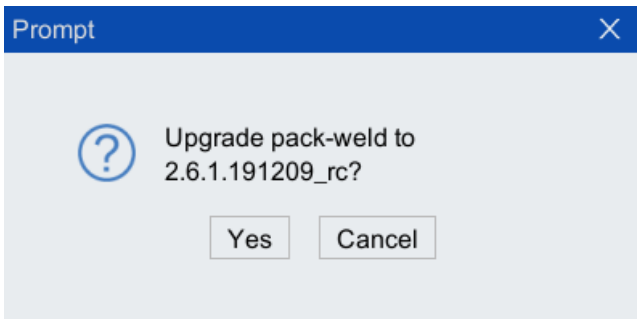


Fig. 3-5 Dialog box

Step 8. After the progress bar is updated, the "Install Upgrade" dialog box shown in Fig. 3-6 will pop up. At this time, the device can be powered off and restarted to complete the feature pack upgrade.

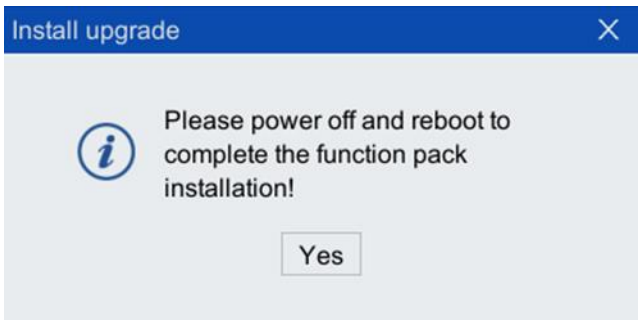


Fig. 3-6 "Install and Upgrade" dialog box

3.2.1 Uninstallation of arc welding feature pack

The steps to uninstall the arc welding feature pack are as follows.

Step 1. Click the "Expand" button to pop up a drop-down list, as shown in Fig. 3-7.

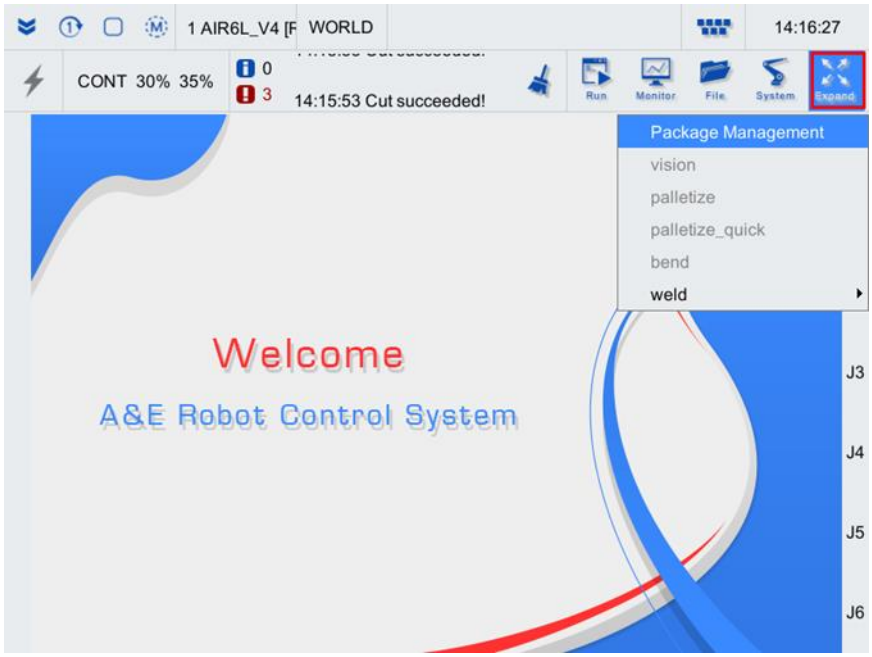


Fig. 3-7List of feature pack

Step 2. Click "Feature Pack Management" to pop up the feature pack management interface, as shown in Fig. 3-8.

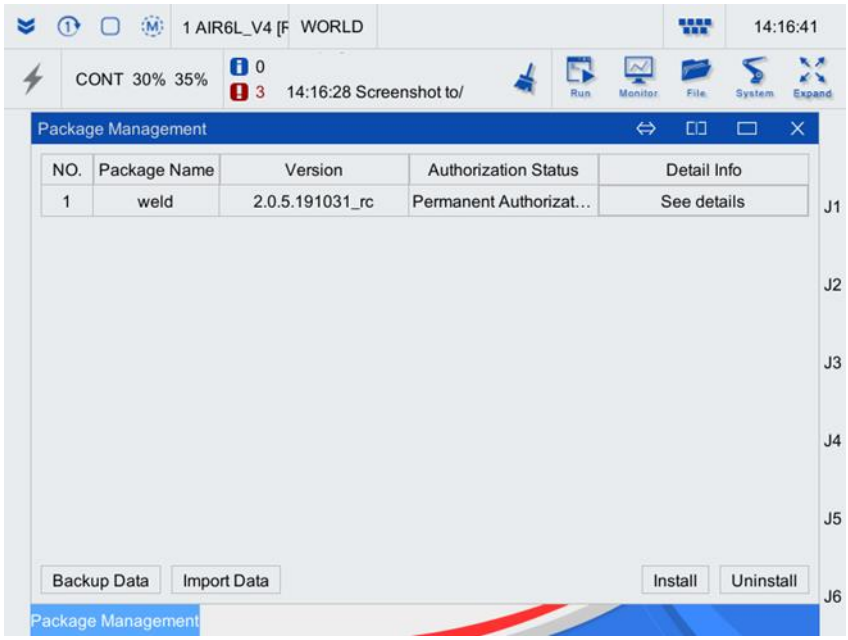


Fig. 3-8 “Feature Pack Management” box

Step 3. Select the line where the arc welding feature pack is located, and click the "Uninstall" button to pop up the dialog box, as shown in Fig. 3-9.

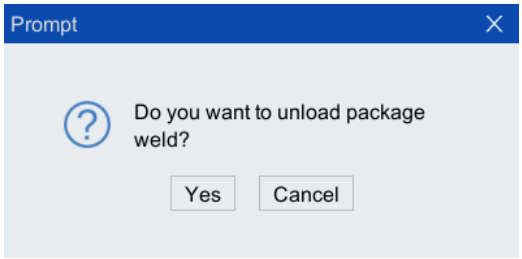


Fig. 3-9 “Feature Pack Management” dialog box

Step 4. Click the “Yes” button. After the uninstallation is completed, the dialog box shown in Fig. 3-10will pop up. Click "Yes", and the uninstallation of the feature pack will be completed.

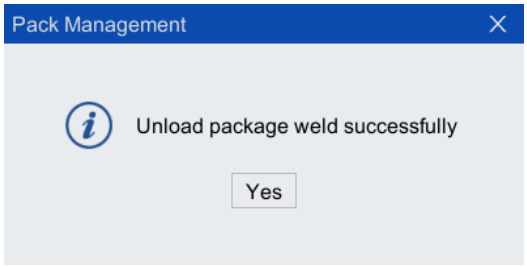


Fig. 3-10 “Uninstalled Successfully” dialog box

3.3 Authorization of arc welding feature pack

After the package is installed, you must obtain authorization before using it.

The specific authorization process is as follows:

Step 1. Contact the relevant personnel of the company to obtain the corresponding authorization file.

Step 2. Put the obtained authorization file into a USB, and then insert the USB into the USB interface on the teach pendant.

Step 3. Click the "System" button in the top right corner on main interface of the teach pendant, and then select the "System and Update"-> "Authorization Import" option in the drop-down list, as shown in Fig. 3-11.

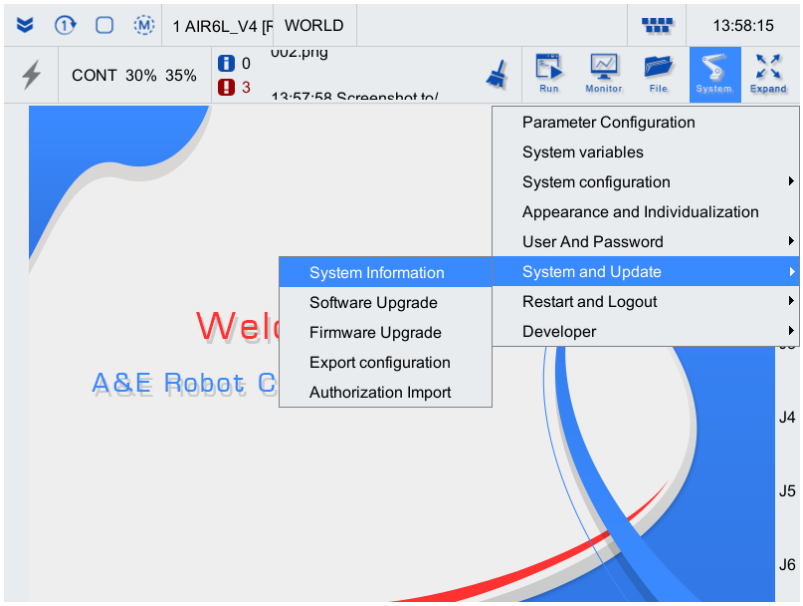


Fig. 3-11 Main interface of teach pendant

Step 4. Click "Authorization Import" to pop up the "Choose an authorization file" dialog box shown in Fig. 3-12. Find the authorization file under the USB folder and click to highlight it. Click the "Select" button to start authorization.

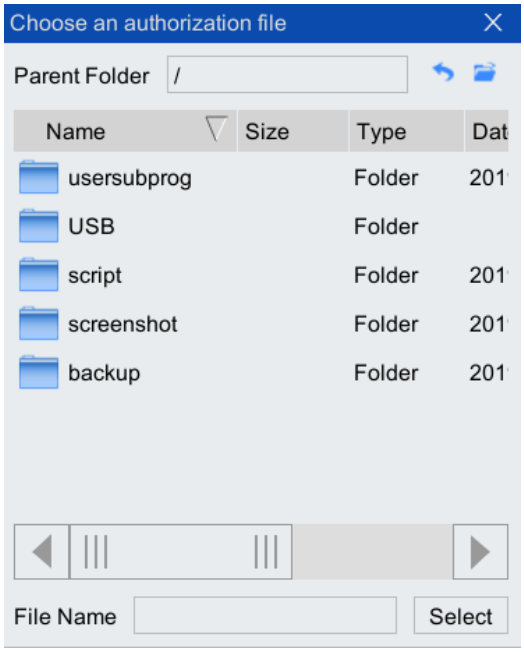


Fig. 3-12 “Select Authorization File” dialog box

Step 5. After the authorization is successful, the dialog box shown in Fig. 3-13will pop up. Click “Yes” to complete the authorization.

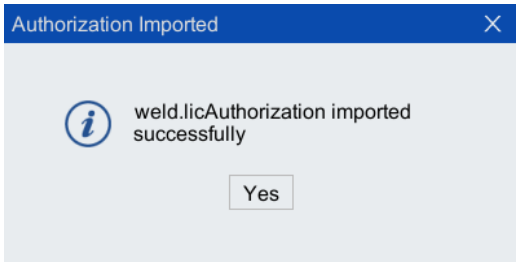


Fig. 3-13 “Select the Required Authorization File” interface

Step 6. After the authorization is successful, power off and restart it.

3.4 Check of configuration

After the authorization is completed, you can check whether the authorization is successful on the teach pendant.

The steps are as follows:

Step 1. Click the "Expand" button to pop up the drop-down list, as shown in Fig. 3-14.

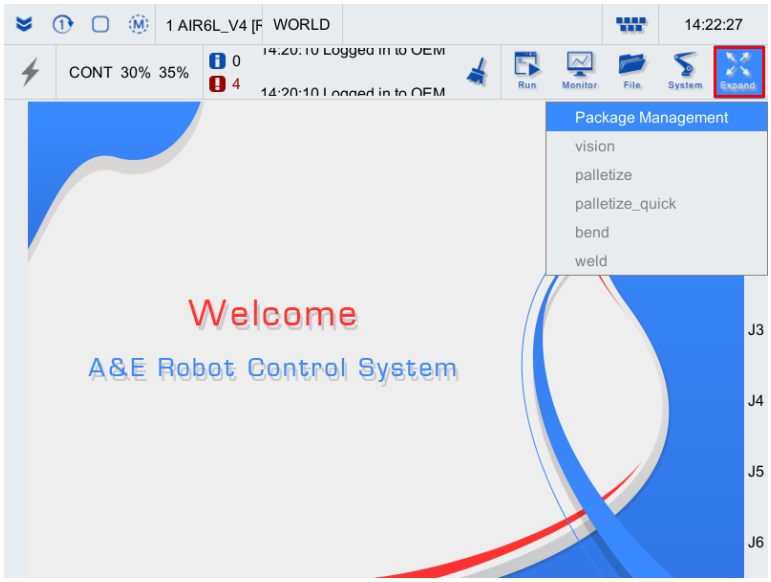


Fig. 3-14 List of feature pack

Step 2. Click "Package Management" to pop up the feature pack management interface, as shown in Fig. 3-15. Check the "Authorization Status" to determine whether the authorization is successful.

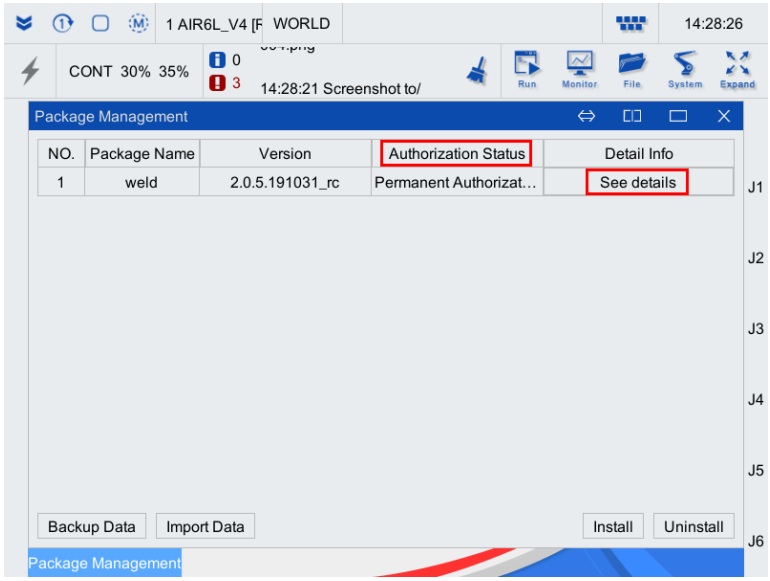


Fig. 3-15 “Feature Pack Management” interface

Step 3. Click "See details" to view the details about the feature pack, as shown in Fig. 3-16.

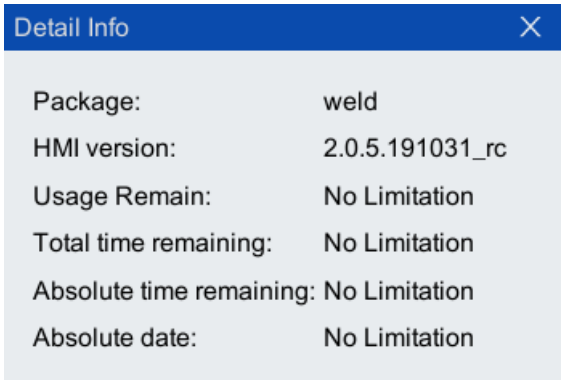


Fig. 3-16 “View Details” interface

4 Arc Welding Function

On the main interface of the teach pendant, click "Expand"-> "weld" to pop up a drop-down submenu, as shown in Fig. 4-1.

The submenu contains the configuration items as follows:

- Weld operation
- Device config
- Laser calibration
- Technology file
- Reference pos

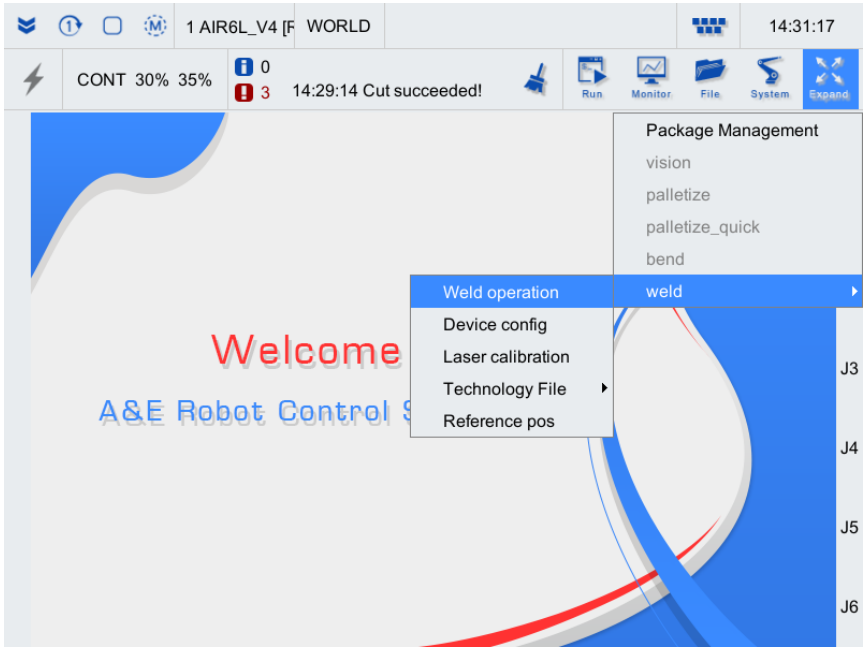


Fig. 4-1Configuration list of arc welding function

4.1 Weld operation

On the main interface of the teach pendant, click "Expand"-> " Weld"->"Weld Operation" option to pop up the floating window, as shown in Fig. 4-2.

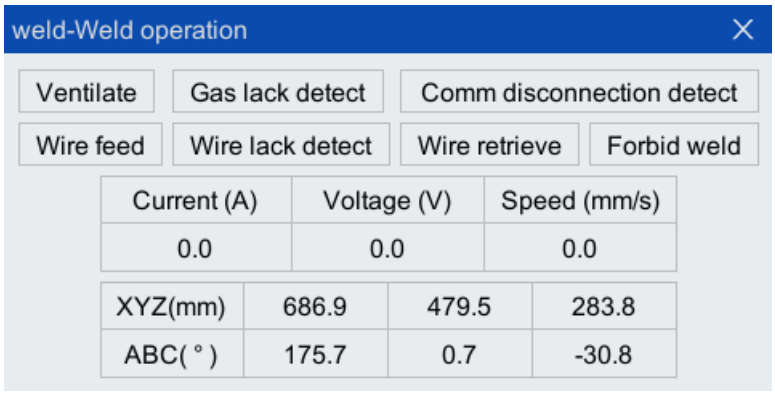


Fig. 4-2 "Arc Welding Operation" floating window

The description of buttons is shown in Table 4-1.

Table 4-1Description of buttons

Button	Description
Ventilate	The air supply is controlled manually.
Gas lack detect	It refers to the detection of welding machine air lack
Comm disconnection detect	It refers to the detection of welding machine communication disconnection
Wire feed	The wire feed is controlled manually.
Wire lack detection	It refers to the detection of welding machine wire missing
Wire retrieve	The wire drawing is controlled manually.
Forbid Weld	It refers to the instruction that prohibits the start of the robot arc welding.

The description of parameters is shown in Table 4-2.

Table 4-2 Description of parameters

Parameter	Description
Current (A)	It refers to the current of welding machine
Voltage (V)	It refers to the voltage of welding machine
Speed (mm/s)	It refers to the TCP speed
XYX (mm)	It refers to the position of the tool end relative to the robot in Cartesian coordinate system.
ABC (°)	It refers to the angle of the tool end relative to the robot in Cartesian coordinate system.

4.2 Device config

On the main interface of the teach pendant, click "Expand"-> "weld"-> "Device config" option to pop up the floating window, as shown in Fig. 4-3.

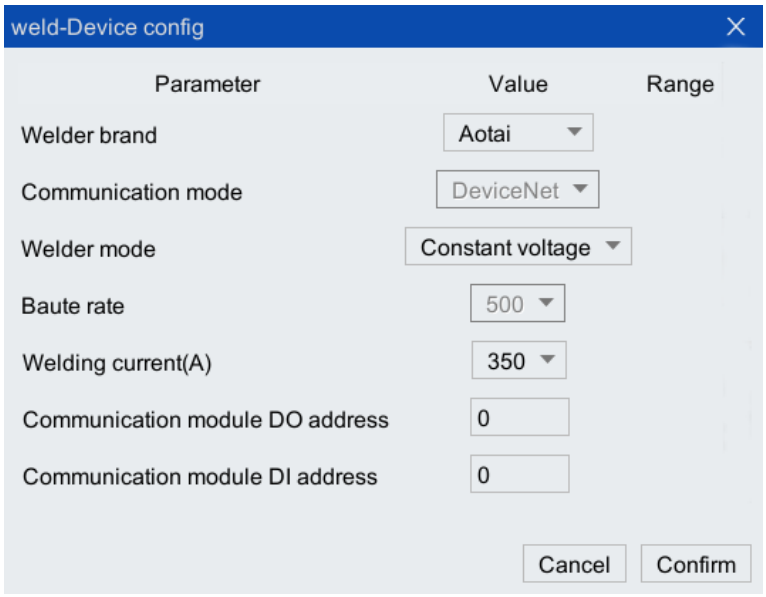


Fig. 4-3 Arc Welding-Equipment Configuration

The description of parameters is shown in Table 4-3.

Table 4-3 Description of parameters

Parameter	Description
Welder brand	The welding machine should be of a brand that supports digital communication. The supported types are as follows: ■ Aotai ■ Megmeet
Communication mode	After the welding machine brand is set, the arc welding feature pack will configure different communication modes. ■ The corresponding communication mode of Aotai is DeviceNet. ■ The corresponding communication mode of Megmeet is Can.
Welder mode	Welding machine mode has two options: ■ Constant voltage ■ Pulse
Baud rate	■ Aotai baud rate is 500 ■ Megmeet baud rate is 125
Welding current (A)	The welding current will be selected according to the type of welding machine. The types 350A and 500A are available for Aotai and Megmeet.
Communication module DO address	It refers to the corresponding input start logic address in the input PLC slave address in the communication module DO address.
Communication module DI address	It refers to the corresponding input start logic address in the input PLC slave address in the communication module DI address.

Tip

After the welding machine brand is set, the arc welding feature pack will configure I/O addresses of different welding machines. For the viewing method of the corresponding start logic address of the input PLC slave address in the DO and DI addresses of the communication module, please refer to “Step 4 in 2.3 Configuration of PLC slave".

4.3 Laser calibration

On the main interface of the teach pendant, click "Expand"-> "weld"-> "Laser calibration" option to pop up the floating window, as shown in Fig. 4-4.

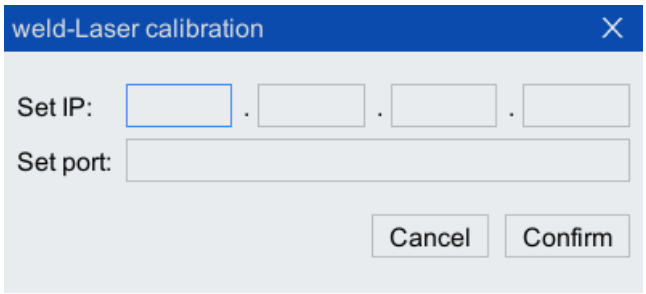


Fig. 4-4 “Arc Welding-Laser Calibration” window

The description of parameters is shown in Table 4-4.

Table 4-4 Description of parameters

Parameter	Description
Set IP	It refers to the IP address of the laser sensor.

Parameter	Description
Set port	It refers to the port number of the laser sensor.

After setting the IP and port number, click "Confirm" to pop up the dialog box, as shown in Fig. 4-5 & Fig. 4-6. Calibrate P1~P6 according to the operation method shown below.

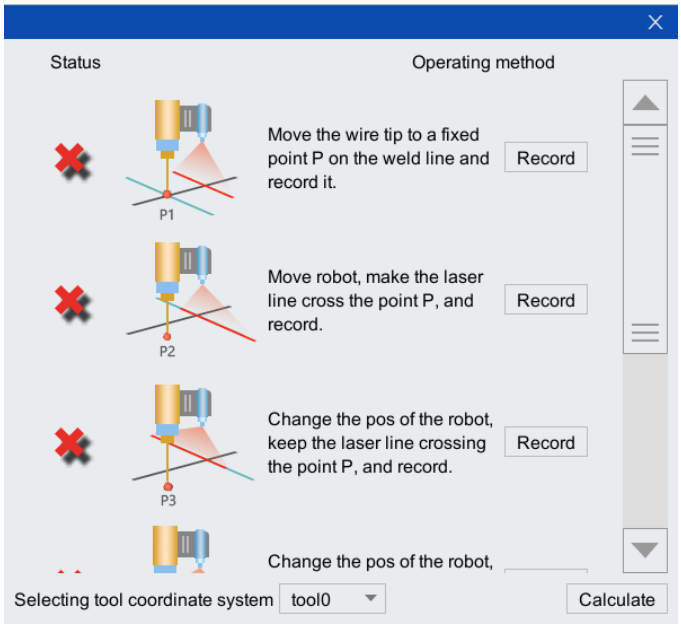


Fig. 4-5 "Operation Method" dialog box 1

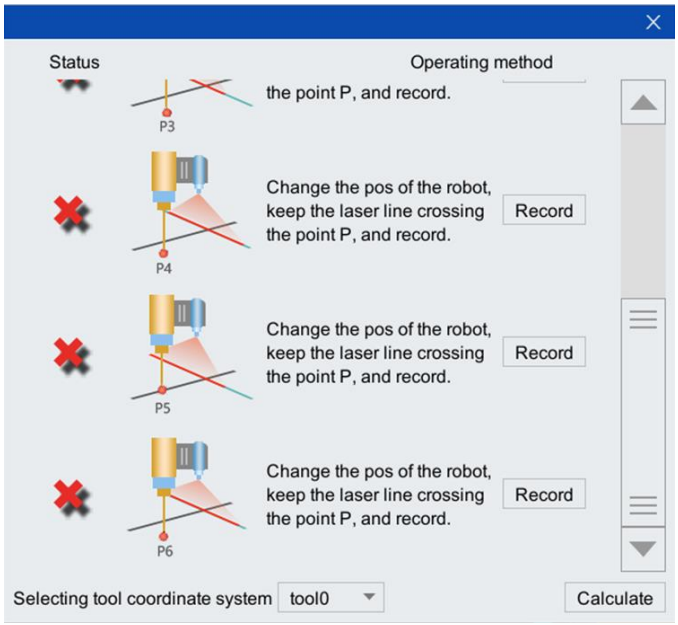


Fig. 4-6 "Operation Method" dialog box 2

The steps are as follows:

Step 1. Select the name of the tool coordinate system to be calibrated in the "Tool Coordinate System".

Step 2. Calibrate the point P1, move the tip of the welding wire to a certain point P on the weld, and click "Record". Once recorded successfully, ✘ ahead will turn into √.

Step 3. Calibrate the point P2, move the robot, make the laser line pass the point P, click "Record". Once recorded successfully, ✘ ahead will turn into √.

Step 4. Calibrate the point 3, change the robot pose, make the laser line pass the point P, and click "Record". Once recorded successfully, ✘ ahead will turn into √.

Step 5. Calibrate the point P4, change the robot pose, make the laser line pass the point P, and click "Record". Once recorded successfully, × ahead will turn into √.

Step 6. Calibrate the point P5, change the robot pose, make the laser line pass the point P, and click "Record". Once recorded successfully, × ahead will turn into √.

Step 7. Calibrate the point P6, change the robot pose, make the laser line pass the point P, and click "Record". Once recorded successfully, × ahead will turn into √.

Step 8. Click the "Calculate" button to calculate the error. If it exceeds the range, it should be re-calibrated. If it is within the range, the calibration will be completed.

4.4 Technology file

The process file is a group of process parameters to be saved by the user. In the process of generating the welding instruction, the saved process parameter file can be selected without re-setting all parameters, which simplifies the user's programming.

Tip

This section describes how the user fills in and saves the process file. For the specific application scenarios of process files, please refer to Section 6 “Program Editor Inserts Arc Welding Instruction".

On the main interface of the teach pendant, click "Expand"-> "weld"-> "Technology file" option to pop up the " Technology file" submenu, as shown in Fig. 4-7. The submenu contains the configuration files as follows:

- Arcon File
- Arcoff File
- Arcpara File
- Arcweave File
- Multilayer File
- Weldtrack file
- Vibstart File
- Vibend File

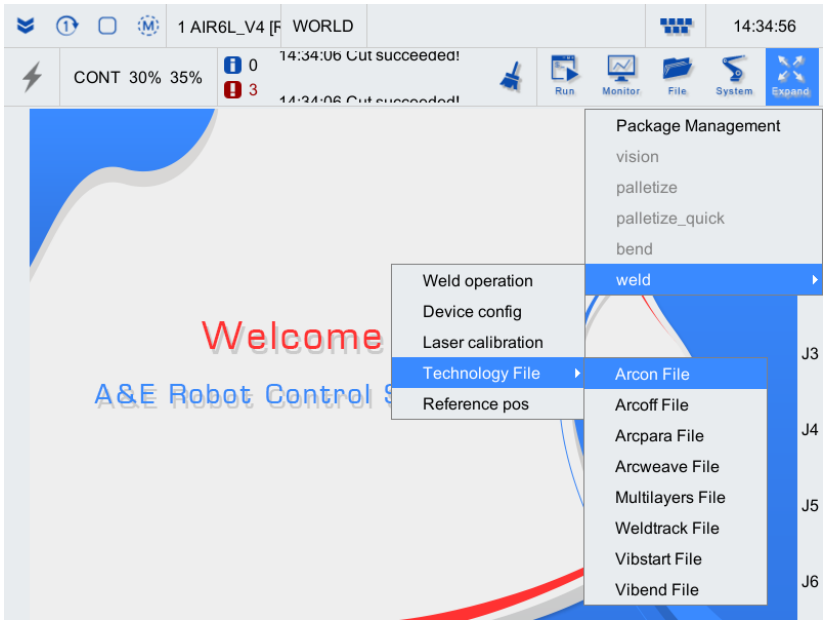


Fig. 4-7 Arc welding process library editing area

4.4.1 Arcon file

On the main interface of the teach pendant, click "Expand"->"weld"-> "Technology file"-> "Arcon File" option to pop up the floating window, as shown in Fig. 4-8.

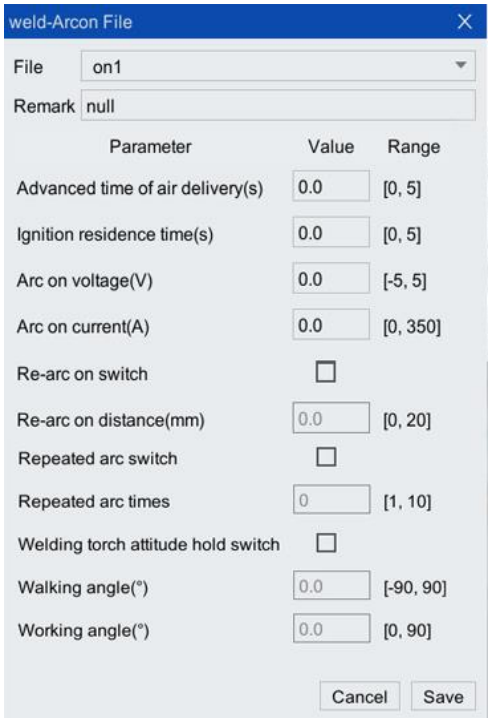
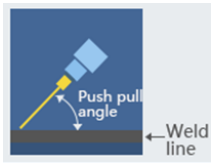
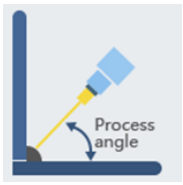


Fig. 4-8 Arc-on process file

The description of parameters is shown in Table 4-5.

Table 4-5 Description of parameters

Parameter	Value range	Description
File	You can set maximum 48 arc-on files.	It refers to the name of the arc-on file. The arc-on file saves the parameters required for arc-on. When calling the arc-on instruction, the process file can be called directly.
Remark	-	It refers to the remark name of the arc-on file, which is convenient for the user to call and query the arc-on file. The default remark name of the start arc file is null
Advanced time of air delivery (s)	0~5	It refers to the air supply before welding, which protects the weld pool.
Ignition residence time (s)	0~5	It refers to the dwell time after arc-on, which increases the heat input of the arc-on point.
Arc on voltage (V)	-5~5	It refers to the voltage value during welding, which can be divided into the centralized and dualized adjustments. Aotai only supports the centralized adjustment, and Megmeet supports both of them.
Arc on current (A)	0~350	It refers to the current value during welding.
Re-arc on switch	-	When restarted after arc-off in the welding process, the robot will return a certain distance along the current trajectory and then continue the arc welding.
Re-arc on distance (mm)	0~20	It refers to the distance to be returned when non-arcing is found.
Repeated arc switch	-	During welding, if the surface of the workpiece such as oil is not easy to arc-on, you can enable the repeated arc strike, and after the arc strike is successful, continue to weld. If the arc strike still fails after the specified number of attempts, there will have an alarm.
Repeated arc times	1~10	It refers to the number of arc-on attempts.
Welding torch attitude hold	-	It indicates that welding torch pose hold is enabled

Parameter	Value range	Description
switch		
Walking angle (°)	-90~90	It refers to the push-pull angle 
Working angle (°)	0~90	It refers to the process angle 

4.4.2 Arcoff file

On the main interface of the teach pendent, click "Expand"->"weld"->"Technology file"-> "Arcoff File" option to pop up the floating window, as shown in Fig. 4-9.

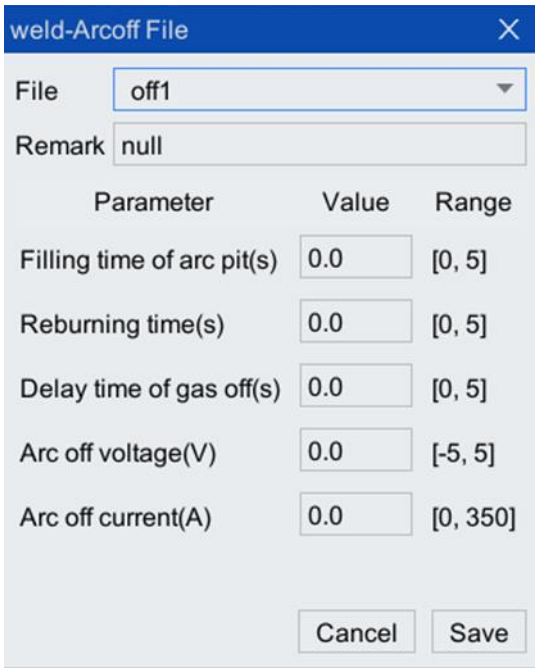


Fig. 4-9 A total of 16 arc-off process parameter files

The description of parameters is shown in Table 4-6.

Table 4-6 Description of parameters

Parameter	Value range	Description
File	You can set maximum 12 arc-off files.	It refers to the name of the arc-off file. The arc-off file saves the parameters required for arc-off. When calling the arc-off instruction, the process file can be called directly.
Remark	-	It refers to the remark name of the arc-off file, which is convenient for the user to call and query the arc-off file. The default remark name of the arc-off file is null
Filling time of arc pit(s)	0~5	It sets the dwell time at the arc end, which guarantees the arc end process.

Parameter	Value range	Description
Reburning time (s)	0~5	After the welding is completed, the time is set to melt the welding wire to prevent the weld drop at the tip of the welding wire from forming a small ball at the end of the welding wire due to the failure of transitioning to the weld pool.
Delay time of gas off(s)	0~5	The protective air is cut off in a delayed manner to protect the weld pool.
Arc off voltage (V)	-5~5	It refers to the current used to fill the crater.
Arc off current (A)	0~350	It refers to the voltage used to fill the crater.

4.4.3 Arcpara file

On the main interface of the teach pendent, click"Expand"->"weld"->"Technology file"->"Arcpara File" option to pop up the floating window, as shown in Fig. 4-10.

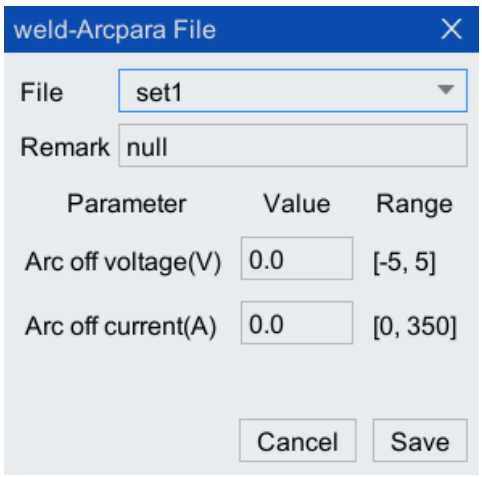


Fig. 4-10 Interface of setting configuration parameter process file

The description of parameters is shown in Table 4-7.

Table 4-7 Description of parameters

Parameter	Value range	Description
File	You can set maximum 48 configuration files.	It refers to the name of the configuration file. The configuration file saves the configuration parameters required for welding. When calling the configuration welding parameter instruction, the configuration file can be directly called.
Remark	-	It refers to the remark name of the configuration file, which is convenient for the user to call and query the configuration file. The default remark name of the configuration file is null
Arc off voltage (V)	-5~5	It refers to the arc-off voltage
Arc off current (A)	0~350	It refers to the arc-off current

4.4.4 Arcweave file

On the main interface of the teach pendent, click"Expand"->"weld"-> "Technology file"-> "Arcweave File" option to pop up the floating window, as shown in Fig. 4-11.

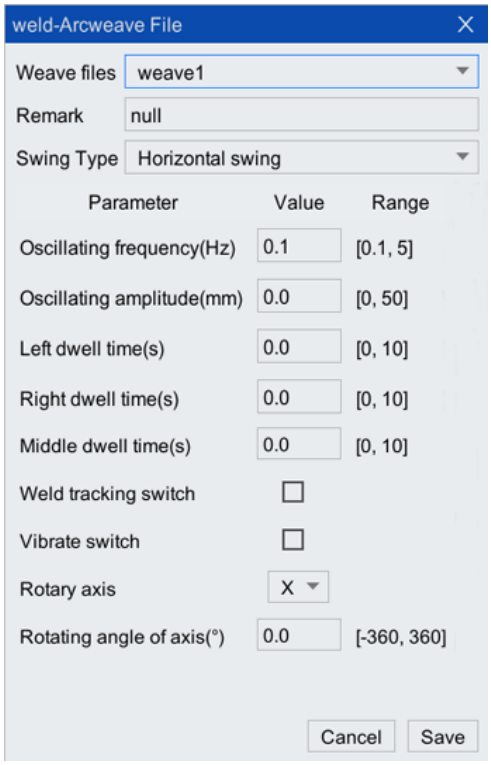


Fig. 4-11 Interface of setting weave parameters

The description of parameters is shown in Table 4-8.

Table 4-8Description of parameters

Parameter	Value range	Description
Weave files	You can set maximum 16 weave files.	It refers to the name of the weave file. The weave file saves the parameters required for weave welding. When calling the weave welding parameter instruction, the weave file can be called directly.
Remark	-	It refers to the remark name of the weave file, which is convenient for the user to call and query the weave file. The default note name of the weave file is null
Oscillating frequency (Hz)	0.1~5	It refers to the frequency of the welding torch weave trajectory
Oscillating amplitude (mm)	0~50	It refers to the amplitude of the welding torch weave trajectory
Left dwell time (s)	0~10	It refers to the dwell time at the peak of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
Right dwell time (s)	0~10	It refers to the dwell time at the trough of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
Middle dwell time (s)	0~10	It refers to the dwell time at 1/2 cycle of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
Weld tracking switch	-	It indicates whether the arc pressure tracking is enabled.
Vibrate switch	-	The start vibration parameter will gradually increase or decrease its amplitude at the start or end of the weave to improve the smoothness of the movement
Rotary axis	■ X ■ Y ■ Z	Three options are available for the rotation axis: ■ X axis ■ Y axis ■ Z axis

Parameter	Value range	Description
Rotating angle of axis (°)	-360~360	It refers to the rotation angles of XYZ axis

4.4.5 Multilayer file

On the main interface of the teach pendent, click the "Expand"->"weld"-> "Technology file"-> "Multilayer File" option to pop up the floating window, as shown in Fig. 4-12.

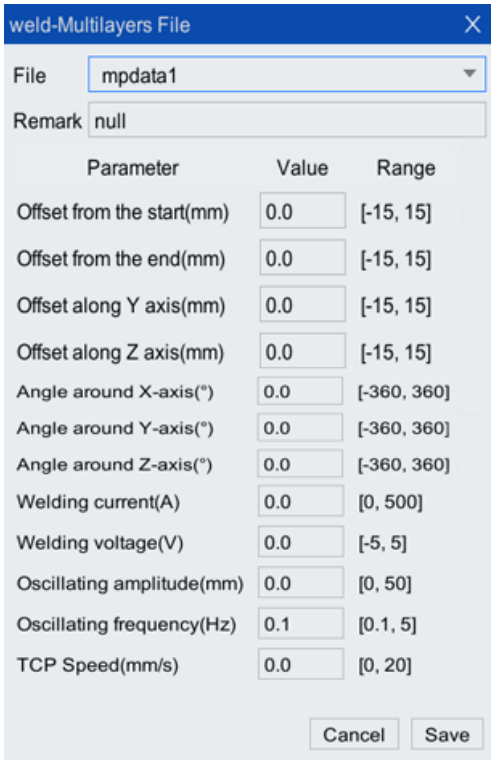


Fig. 4-12 Interface of setting multi-layer multi-run parameters

The description of parameters is shown in Table 4-9.

Table 4-9 Description of parameters

Parameter	Value range	Description
File	You can set maximum 16 multi-layer multi-run welding files.	It refers to the name of the multi-layer multi-run file. The multi-layer multi-run file saves the parameters required for multi-layer multi-run welding. When calling multi-layer multi-run instruction, the multi-layer multi-run file can be called directly.
Remark	-	It refers to the remark name of the multi-layer multi-run file, which is convenient for the user to call and query the multi-layer multi-run file. The default remark name of the multi-layer multi-run file is null.
Offset from the start (mm)	-15~15	It refers to the offset of the welding torch from the starting point.
Offset from the end (mm)	-15~15	It refers to the offset of the welding torch from the end point.
Offset along y axis (mm)	-15~15	It refers to the offset of the welding torch along the y axis.
Offset along z axis (mm)	-15~15	It refers to the offset of the welding torch along z axis.

Parameter	Value range	Description
Angle around x-axis (°)	-360~360	It refers to the rotation angle of the welding torch around x axis.
Angle around y-axis (°)	-360~360	It refers to the rotation angle of the welding torch around y axis.
Angle around z-axis (°)	-360~360	It refers to the rotation angle of the welding torch around z axis.
Welding current (A)	0~500	It refers to the welding current.
Welding voltage (V)	-5~5	It refers to the welding voltage.
Oscillating amplitude (mm)	0~50	It refers to the weave amplitude of the welding torch.
Oscillating frequency (Hz)	0.1~5	It refers to the weave frequency of the welding torch.
TCP speed (mm/s)	0~20	It refers to the TCP speed of the welding torch.

4.4.6 Weldtrack file

On the main interface of the teach pendent, click the "Expand"->"weld"-> "Technology file"-> "Weldtrack File" option to pop up the floating window, as shown in Fig. 4-13.

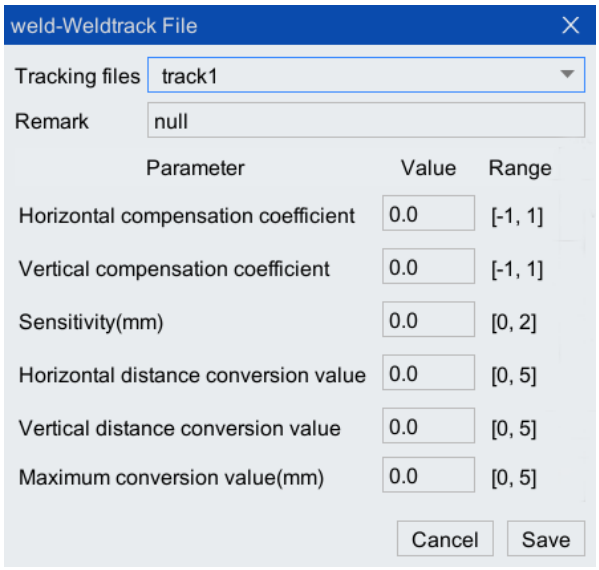


Fig. 4-13 Interface of setting weld locating parameters

The description of parameters is shown in Table 4-10.

Table 4-10 Description of parameters

Parameter	Value range	Description
File	You can set maximum 16 weld locating files.	It refers to the name of the weld locating file. The weld locating file saves the parameters required for weld locating. When calling the weld locating, the weld locating file can be called directly.
Remark	-	It refers to the remark name of the weld locating file, which is convenient for the user to call and query the weld locating file. The default remark name of the weld locating file is null.
Horizontal compensation	-1~1	It refers to the conversion factor of compensation distance in the horizontal

Parameter	Value range	Description
coefficient		direction of weld locating.
Vertical compensation coefficient	-1~1	It refers to the conversion factor of compensation distance in the vertical direction of weld locating.
Sensitivity (mm)	0~2	No compensation will be made when the weld locating is less than the value.
Horizontal distance conversion value	0~5	The weld locating is fine-tuned for the second time based on the horizontal compensation factor.
vertical distance conversion value	0~5	The weld locating is fine-tuned for the second time based on the vertical compensation factor.
Maximum conversion value (mm)	0~5	No compensation will be made when the weld locating is more than value.

4.4.7 Vibstart file

On the main interface of the teach pendent, click "Expand"->"weld"-> "Technology file"-> "Vibstart File"option to pop up the floating window, as shown in Fig. 4-14.

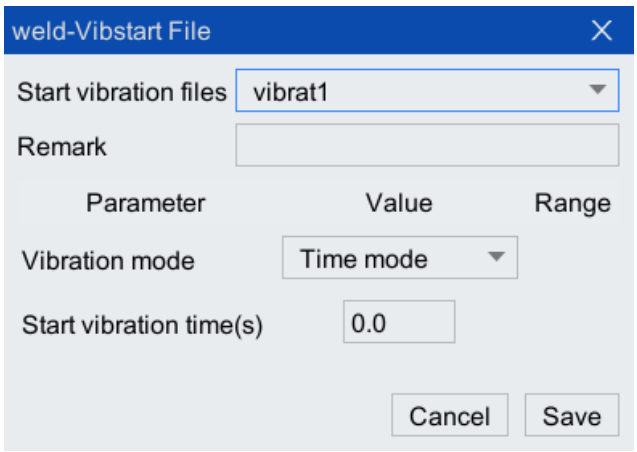


Fig. 4-14 Interface of setting start vibration parameters

The description of parameters is shown in Table 4-11.

Table 4-11 Description of parameters

Parameter	Value range	Description
Start vibration files	You can set maximum 16 start vibration files.	It refers to the name of the start vibration file. The start vibration file saves the parameters required for start vibration. When calling the start vibration instruction, the start vibration file can be called directly.
Remark	-	It refers to the remark name of the start vibration file, which is convenient for the user to call and query the start vibration file. The default remark name of the start vibration file is null.
Vibration mode	■ Time mode ■ Distance mode	Two start vibration modes are available for the welding torch: ■ Time mode ■ Distance mode
Start vibration time (s)	-	It refers to the time when the welding torch starts its vibration.

4.4.8 Vibend file

On the main interface of the teach pendent, click the"Expand"->"weld"-> "Technology file"-> "Vibend File" option to pop up the floating window, as shown in Fig. 4-15.

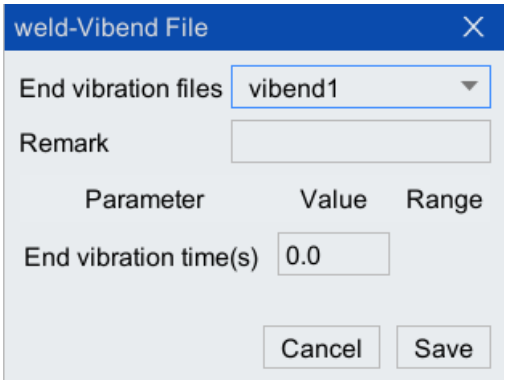


Fig. 4-15 Interface of setting end vibration parameters

The description of parameters is shown in Table 4-12.

Table 4-12 Description of parameters

Parameter	Value range	Description
End vibration files	You can set maximum 16 end vibration files.	It refers to the name of the end vibration file. The end vibration file saves the parameters required for end vibration. When calling the end vibration instruction, the end vibration file can be called directly.
Remark	-	It refers to the remark name of the end vibration file, which is convenient for the user to call and query the end vibration file. The default remark name of the end vibration file is null.
End vibration time (s)	-	It refers to the time when the welding torch ends its vibration.

4.5 Reference pos

The reference pose is used to keep the angle between the welding torch pose and the weld unchanged, without being restricted by the teaching pose.

On the main interface of the teach pendent, click "Expand"-> "weld"-> "Reference Pos" option to pop up the floating window, as shown in Fig. 4-16.

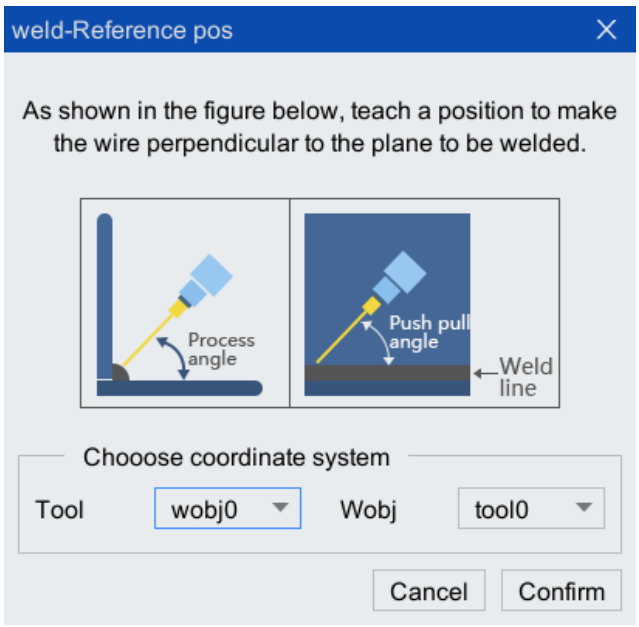


Fig. 4-16 "Reference Pose" floating window

The description of parameters is shown in Table 4-13.

Table 4-13 Description of parameters

Parameter	Description
Tool	It refers to the name of the workpiece coordinate system selected.
Wobj	It refers to the name of the tool coordinate system selected.

Tip

When the function is enabled, you must define a welding torch reference pose, which, in practice, should be the pose when the welding wire is perpendicular to the surface of the workpiece. It is required to be approximately vertical when teaching. After the reference pose is recorded, the robot will move on the trajectory according to the set travel angle and push-pull angle. The travel angle and push-pull angle will be based on the reference pose, that is, positive when rotated counterclockwise, negative when rotated clockwise.

4.6 Interface of arc welding database

The arc welding database saves the arc welding data, through which you can view and set the process files. The parameters of the process file generated on the process file interface are also saved in the database. In addition, the data in the positioning flag and the positioning register can also be viewed in the database.

Step 1. On the main interface of the teach pendent, click "System"-> "Parameter Configuration" option, as shown in Fig. 4-17.

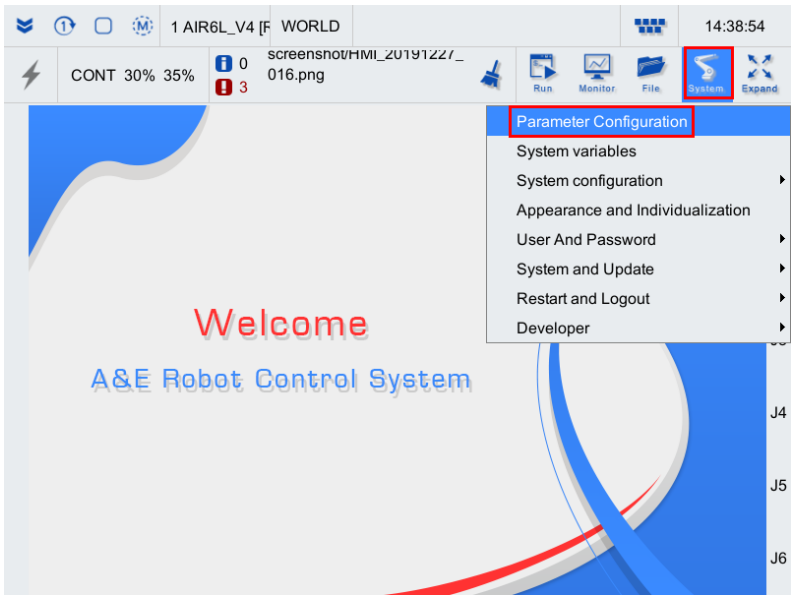


Fig. 4-17 Main interface of teach pendant

Step 2. On the pop-up "Parameter Configuration" interface, click the "globalwelding" tab, as shown in Fig. 4-18.

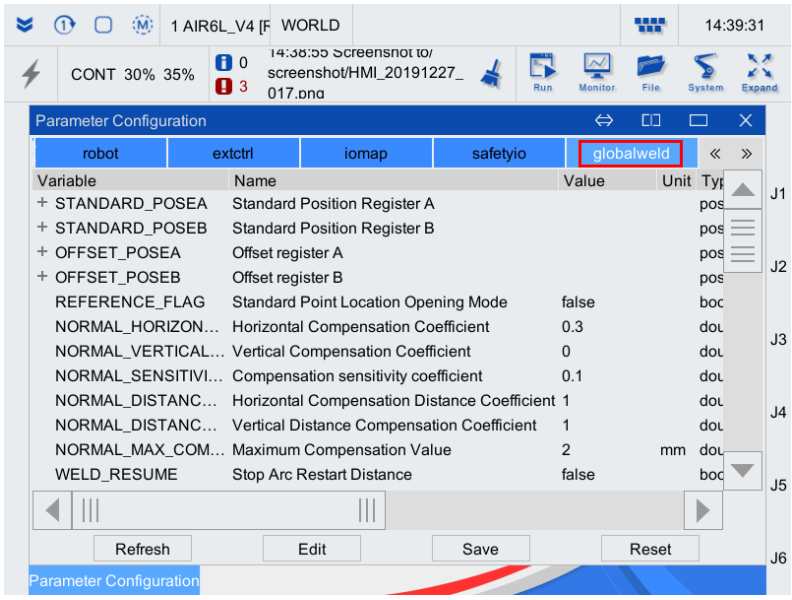


Fig. 4-18 Interface of arc welding database

Step 3. Click to highlight the variables you want to edit or view, and click the "Edit" button. Then you can view or edit the variables.

5 Insert Arc Welding Instruction in Program Editing Area

The steps to insert the instruction in the program editing area are as follows:

Step 1. Click "File"-> "File Management" on the main interface, enter the "File Management" interface and click "New" to create an .arl program, as shown in Fig. 5-1.

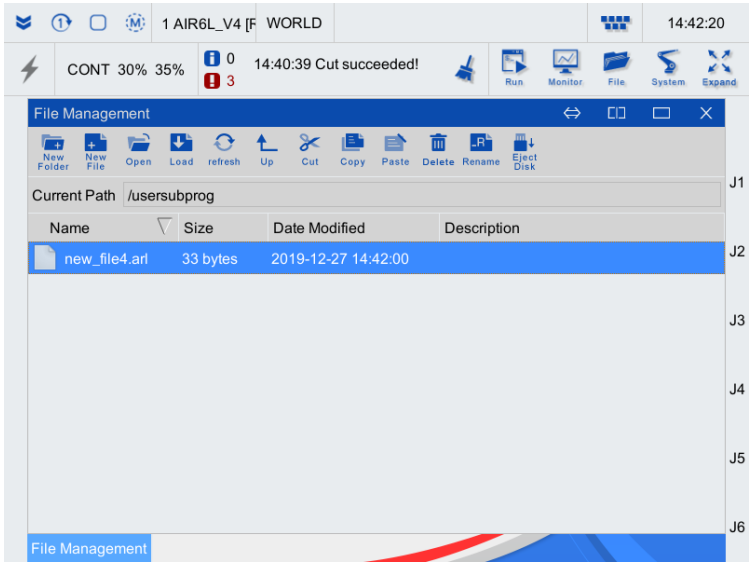


Fig. 5-1 “File Management” interface

Step 2. Double-click the file to open it in the program editor. All arc welding instructions can be inserted in the program editor, as shown in Fig. 5-2.

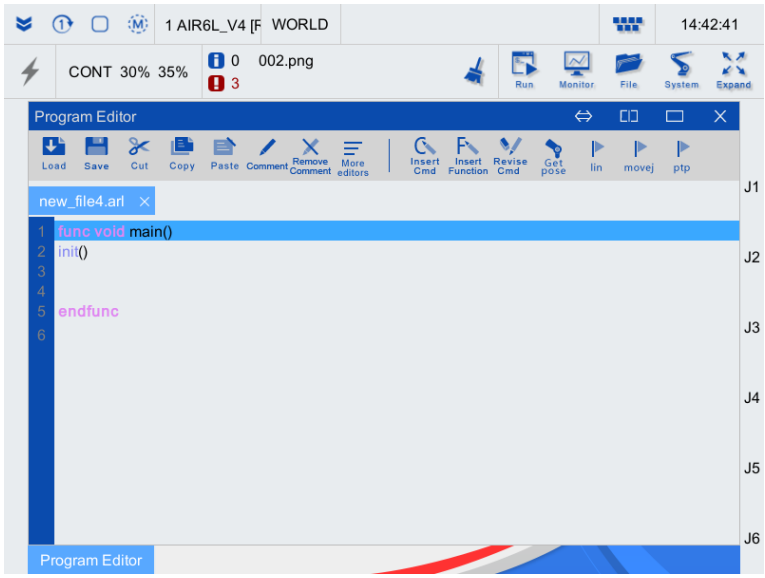


Fig. 5-2 Program editor

Step 3. Click "Insert Cmd"-> "Package"-> "weld" to pop up the drop-down list of arc welding. You can set the weave instruction, welding instruction, advanced functions and fish scale welding, as shown in Fig. 5-3.

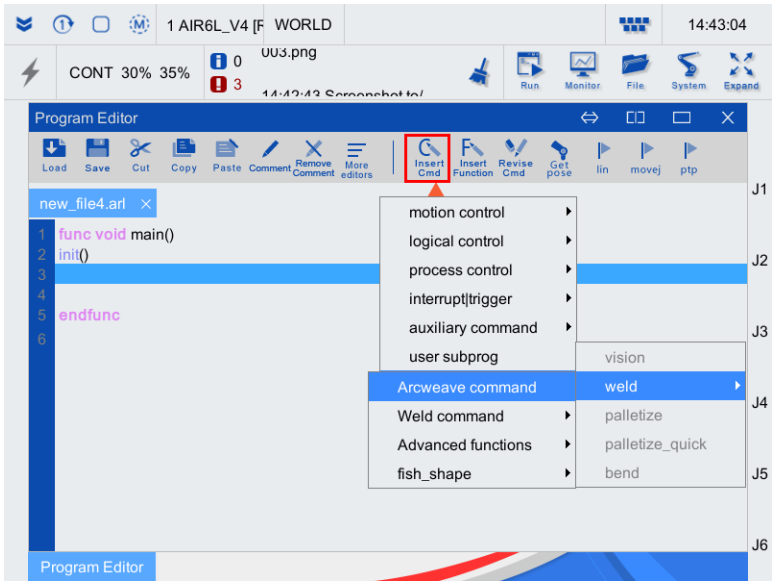


Fig. 5-3 Path to enter the program editing area

Tip

All instructions are input in the interface input mode by default. You can also choose to import them from the process file. For editing and saving of the process file, please refer to Section 4.4. The format of the interface input is different from that of the selecting process file. The specific format will be given in each instruction.

5.1 Weave instruction

The steps to import files from the process database and setting parameters are as follows:

Step 1. On the program editor interface, click "Insert Cmd"-> "Package"->"weld" > "Arcweave command" to pop up the interface, as shown in Fig. 5-4.

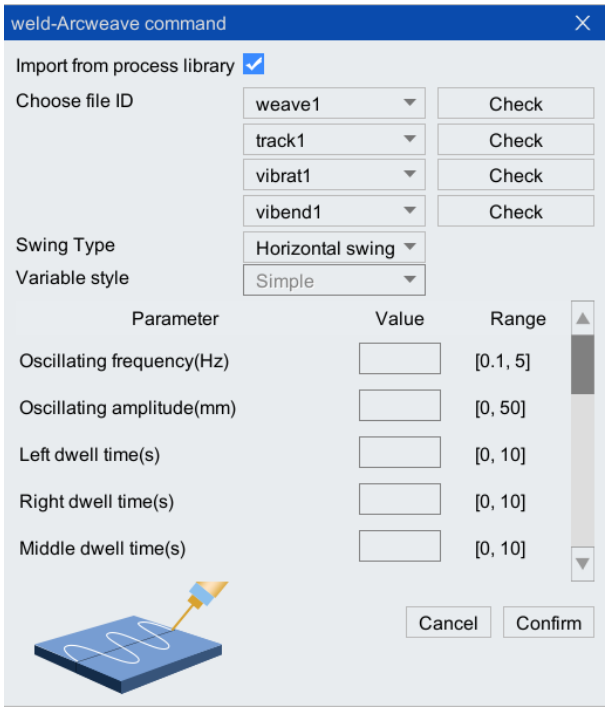


Fig. 5-4 Import parameters of weave instruction from process database file

Step 2. Highlight the check box “Import from Process library”.

Step 3. Select the name of the file to be imported in "Choose file ID".

Step 4. Select the "Swing Type" name.

Step 5. Set the parameter value.

The weave instruction is described below:

Instruction format

startweave weave:$WEAVE_FILE_ID[0] (read process file format)

endweave

startweave weave:weave1 (user fills in the parameter format)

endweave

startweave weave:{ weave_type 0, frequency 1, amplitude 10, dwell_left 2, dwell_right 2, dwell_middle 2, track true, vibrat true, swing_angle 0, radius 0, axis 0, rotation_angle 10 }, vibrat:{ vibmode 0, vibtime 10 }, track:{ horizontal_compensation 0.1, vertical_compensation 0.1, sensitive 0.1, horizontal_distance_transform 0.1, vertical_distance_transform 0.1, max_compensation_value 1 }

endweave vibend:{ vibendtime 10 } (expanded display mode)

Description of instruction

The weave instructions startweave and endweave must be used in pairs, which both indicate the start and end of the weave respectively. The movement instructions after startweave and before endweave will superimpose the weave trajectory based on the original trajectory according to the set weave parameters.

The user is recommended to use the two instruction formats of reading process and user-filled parameters as much as possible, which both are concise. The format of user-filled parameter is taken an example to describe the instruction parameters below.


Tip

The subsequent instructions are described by default in the format of user-filled parameter.

Description of parameter

The description of the weave instruction parameters are shown in Table 5-1.

Table 5-1 Description of weave instruction parameters

Parameter	Name	Meaning
weave_type	Weave type	It refers to the weave trajectory types supported by the system
frequency	Weave frequency	It refers to the weave frequency of weave trajectory
amplitude	Weave amplitude	It refers to the weave amplitude of weave trajectory
dwell_left	Left dwell time	It refers to the dwell time at the peak of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
dwell_right	Right dwell time	It refers to the dwell time at the trough of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
dwell_middle	Middle dwell time	It refers to the dwell time at 1/2 cycle of the weave trajectory. During dwell, the robot will advance in a straight line at the current point.
track	Whether to enable weld locating	It indicates whether the arc pressure tracking is enabled
horizontal_compensation	Horizontal compensation factor	It refers to the conversion factor of compensation distance in the horizontal direction of weld locating
vertical_compensation	Vertical compensation factor	It refers to the conversion factor of compensation distance in the vertical direction of weld locating

Parameter	Name	Meaning
sensitive	Sensitivity	No compensation will be made when the weld locating is less than the value
horizontal_distance_transform	Converted value of horizontal distance	The weld locating is fine-tuned for the second time based on the horizontal compensation factor
vertical_distance_transform	Converted value of vertical distance	The weld locating is fine-tuned for the second time based on the vertical compensation factor
max_compensation_value	Max compensation value	No compensation will be made when the weld locating is more than the value
vibratemode	Whether to start vibration	The start vibration parameter will gradually increase or decrease its amplitude at the start or end of the weave to improve the smoothness of the movement
vibtime	Start vibration time	It refers to the running time when the weave is increased to the set amplitude at the start of weave
vibendtime	End vibration time	It refers to the running time when the weave is increased to the set amplitude at the end of weave
axis	Rotation axis	The weave plane can be rotated around a certain rotation axis
rotation_angle	Rotation angle of axis	It refers to the angle around which the weave plane is rotated around a certain axis

5.2 Welding instruction

There are three welding instructions as follows:

- arcon
- arcoff
- arcset

Click "Insert Cmd"-> "Package"-> "weld" > "Weld command" to enter the auxiliary programming interface of welding instruction, as shown in Fig. 5-5.

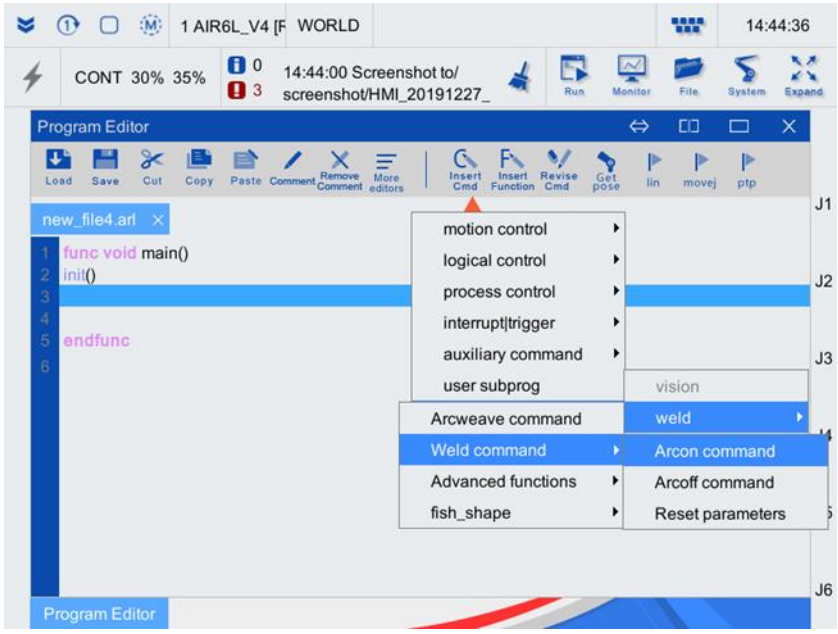


Fig. 5-5 Interface of auxiliary programming of welding instruction

5.2.1 Arcon instruction

Highlight the check box "Import from Process Library", select the arc-on file to be imported in "Choose File ID", and click "Confirm" (see Fig. 5-6) to generate the arcon instruction.

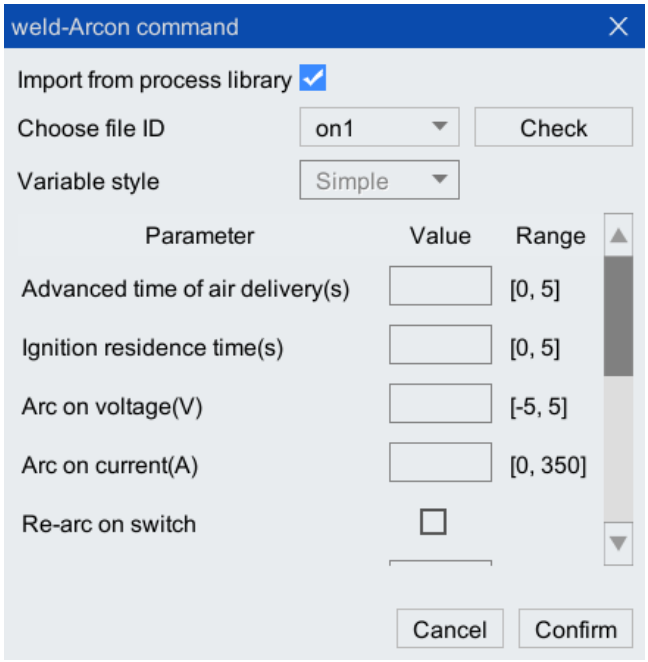


Fig. 5-6 User-filled arcon parameter

When "Import from Process Library" is not checked, you can modify the parameters of the arc-on file in the parameter settings below, and then click "Confirm" to modify the arcon instruction. The interface of modifying the arcon instruction is shown in Fig. 5-7.

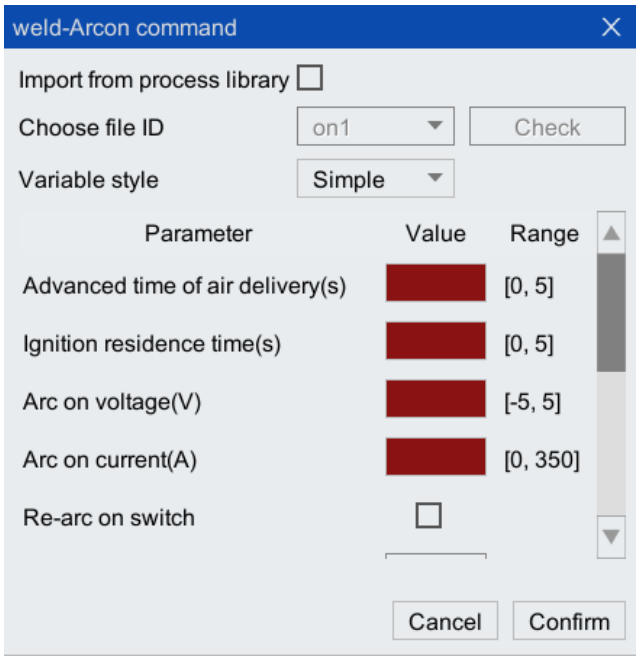


Fig. 5-7 Modify arcon process parameters

The arc-on instruction is described below:

Instruction format

arcon on: $ ARCON_FILE_ID [0] (read process file format)

arcon on: on1 (user-filled parameter format)

arcon on:{preflow_time 1, ignition_stay_time 1, voltage 1, current 100, weld_resume true, resume_distance 5, rearcon true, rearcon_numbers 3} (expanded display mode)

Description of instruction

It refers to the arcon instruction.

Description of parameter

The description of arcon instruction parameter is shown in Table 5-2.

Table 5-2Description of arcon instruction parameter

Parameter	Name	Meaning
preflow_time	Pre-flow time	It refers to the air supply before welding, which protects the weld pool
ignition_stay_time	Ignition dwell time	It refers to the dwell time after arc-on, which increases the heat input of the arc-on point.
voltage	Arc-on voltage	It refers to the voltage value during welding, which can be divided into the centralized and dualized adjustments. Aotai only supports the centralized adjustment, and Megmeet supports both of them.
current	Arc-on current (A)	It refers to the current value during welding.
weld_resume	Restart after arc-off	When restarted after arc-off in the welding process, the robot will return a certain distance along the current trajectory and then continue the arc welding.
resume_distance	Restart distance after arc-off (mm)	It refers to the distance to be returned when restarted after arc-off.
rearcon	Enable repeat arc strike	During welding, if the surface of the workpiece such as oil is not easy to arc-on, you can enable the repeated arc strike, and after the arc strike is successful, continue to weld. If the arc strike still fails after the specified number of attempts, there will have an alarm.
rearcon_numbers	Number of repeat arc strikes	It refers to the maximum number of repeat arc-on attempts by the robot

5.2.2 Arcoff instruction

Highlight the check box "Import from Process Library", select the arc-off file to be imported in "Choose File ID", and click "Confirm" (see Fig. 5-8) to generate the arcoff instruction.

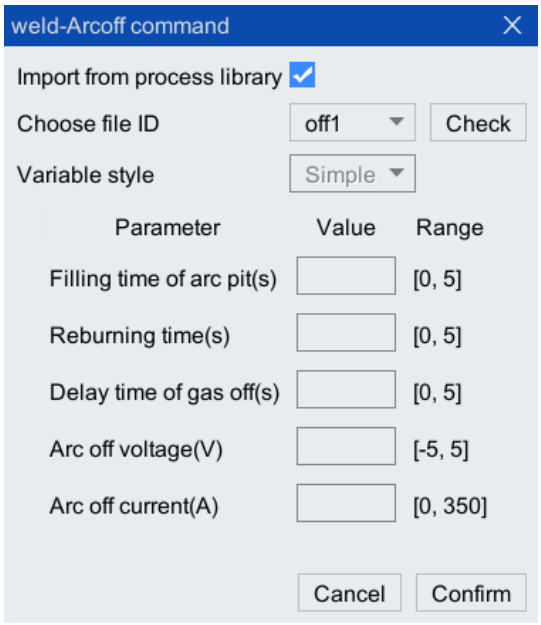


Fig. 5-8 User-filled arcoff parameter

When "Import from Process Library" is not checked, you can modify the parameters of the arc-off file in the parameter settings below, and then click “Confirm” to modify the arcoff instruction. The interface of modifying the arcoff instruction is shown in Fig. 5-9.

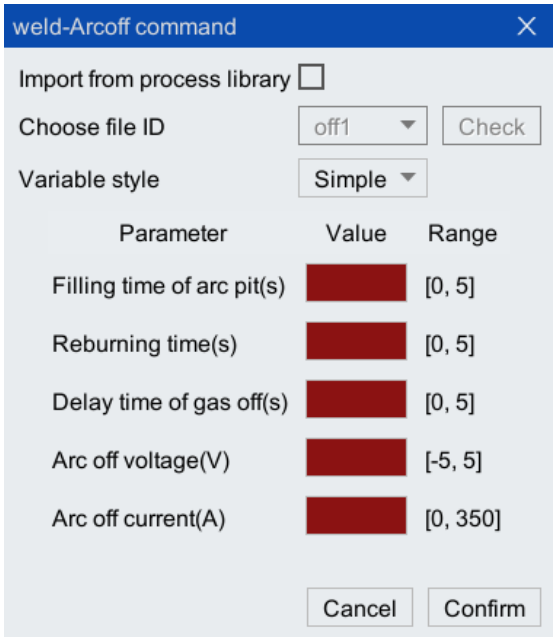


Fig. 5-9 Interface of user-filled arcoff parameters

The arc-off instruction is described below:

Instruction format

arcoff off:$ARCOFF_FILE_ID[0]

arcoff off:off1

arcoff off:{endcracter_time 1, burnback_time 1, postflow_time 1, voltage 1, current 100}

Description of instruction

It refers to the arcoff instruction.

Description of parameter

The description of arcoff instruction parameter is shown in Table 5-3.

Table 5-3Description of arcoff instruction parameter

Parameter	Name	Meaning
endcracter_time	Arc crater filling time	It sets the dwell time at the arc end, which guarantees the arc end process.
burnback_time	Burn-back time	After the welding is completed, the time is set to melt the welding wire to prevent the weld drop at the tip of the welding wire from forming a small ball at the end of the welding wire due to the failure of transitioning to the weld pool.
postflow_time	Post-flow time	The protective air is cut off in a delayed manner to protect the weld pool.
voltage	Arc-off current	It refers to the current used to fill the crater.
current	Arc-off voltage	It refers to the voltage used to fill the crater.

5.2.3 Arcset instruction

Highlight the check box "Import from Process Library", select the arcset file to be imported in "Choose file ID", and click "Confirm" (see Fig. 5-10) to generate the arcset instruction.

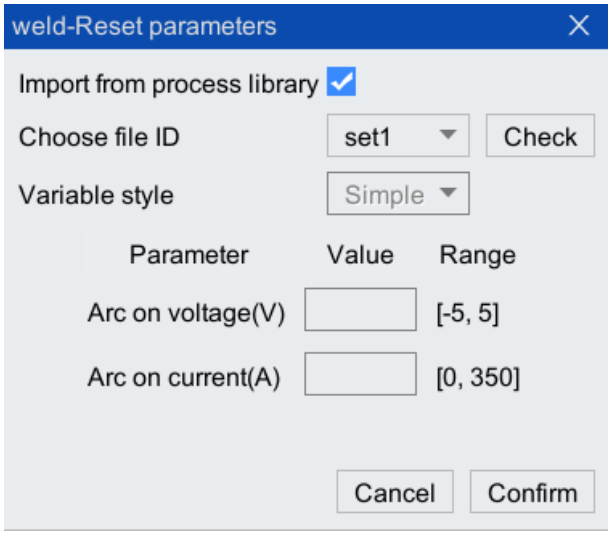


Fig. 5-10 User-filled arcoff parameter

When "Import from Process Library" is not checked, you can modify the parameters of the arcset file in the parameter settings below, and then click “Confirm” to modify the arcset instruction. The interface of modifying the arcon instruction is shown in Fig. 5-11.

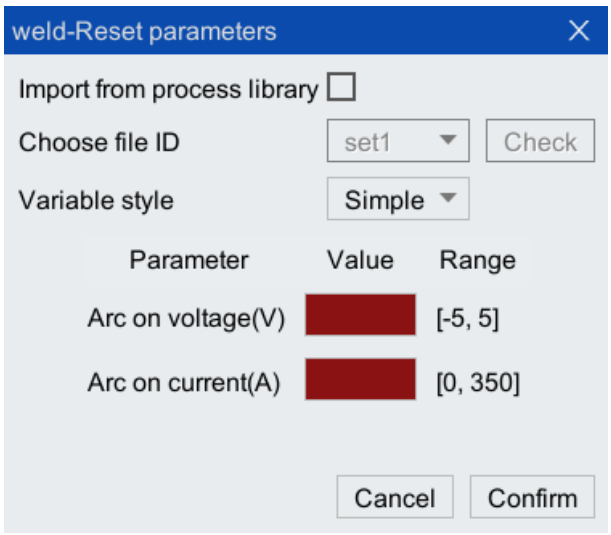


Fig. 5-11 Interface of manually-input arc welding parameter resetting

Instruction format

arcset set:$ARCSET_FILE_ID[0] (read process file format)

arcset set:set1 (user-filled parameter format)

arcset set:{voltage 1, current 100} (expanded display mode)

Description of instruction

It resets the arc welding parameters.

Description of parameter

The description of arcset instruction parameter is shown in Table 5-4.

Table 5-4 Description of arcset instruction parameter

Parameter	Name	Meaning
voltage	Arc-on voltage	It refers to the modification of the voltage value set by the welding instruction
current	Arc-on current (A)	It refers to the modification of the current value set by the welding instruction

5.3 Advanced function

5.3.1 Multi-layer multi-run welding

Click "Insert Cmd"-> "Package"-> “weld”->"Advanced Functions"-> "Multilayers" to enter the auxiliary programming instruction interface of the multi-layer multi-run welding, as shown in Fig. 5-12.

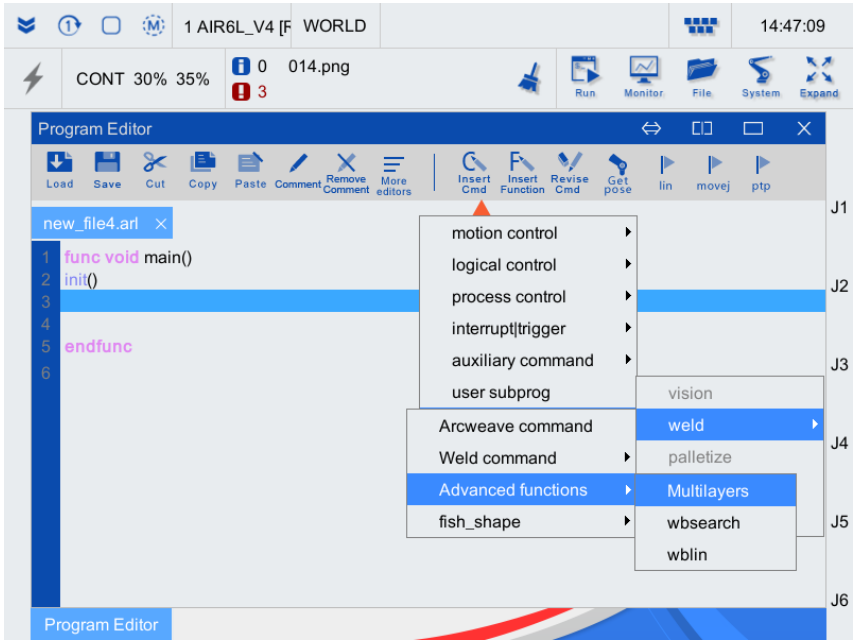


Fig. 5-12 Insert multi-layer multi-run instruction

Highlight the check box "Import from Process Library", select the multi-layer multi-run file to be imported in "Choose file ID", and click "Confirm" (see Fig. 5-13) to generate the multi-layer multi-run instruction.

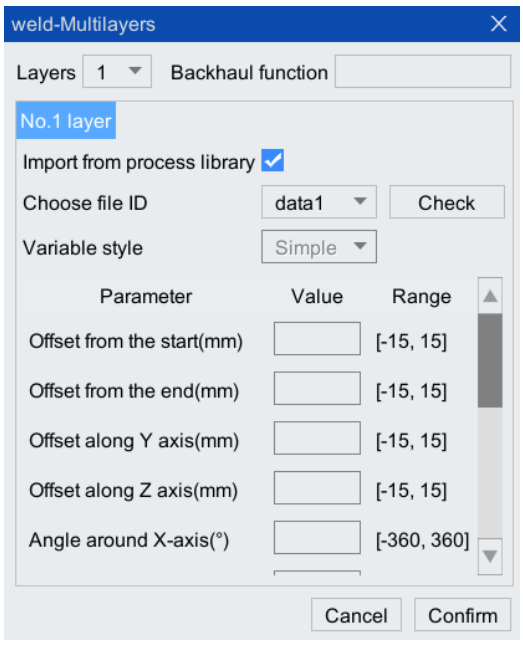


Fig. 5-13 Interface of editing multi-layer multi-run instruction

When "Import from Process Library" is not checked, you can modify and configure the multi-layer multi-run parameters in the parameter settings below, and then click “confirm” to modify the multi-layer multi-run instruction. The interface of modifying the multi-layer multi-run instruction is shown in Fig. 5-14.

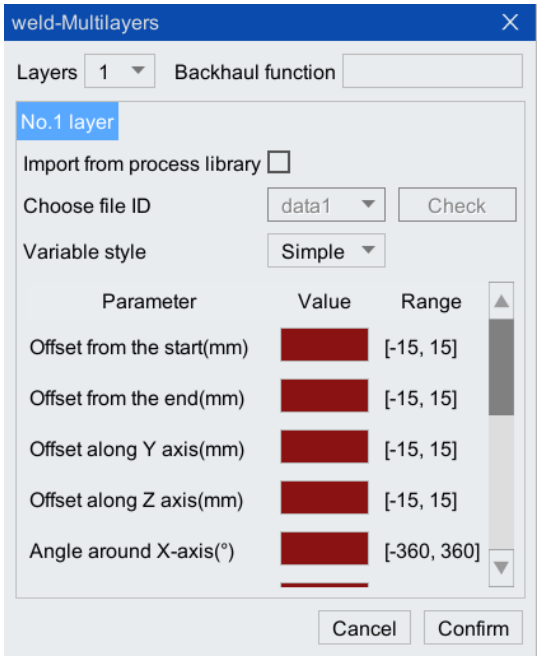


Fig. 5-14 Interface of manually-input multi-layer multi-run parameter resetting

Instruction format

mpstart

mpend

mplayer data: $MULTIPLY_FILE_ID [0], do: func () (read process file format)

mpstart

mpend

mplayer data:data1, do:func() (user-filled parameter format)

mpstart

mpend

mplayer data:{x_s 0, x_e 0, z 1, y 1,rx 0, ry 0, rz 0, current 100, voltage 1, amplitude 1, frequency 1}, do:func() (expanded display mode)

Description of instruction

It refers to the multi-layer multi-run welding instruction.

Description of parameter

The description of the multi-layer multi-run welding instruction parameter is shown in Table 5-5.

Table 5-5 Description of multi-layer multi-run welding instruction parameter

Parameter	Name	Meaning
x_s	Offset from the start point	It refers to the offset at the start point of the original trajectory
x_e	Offset from the end point	It refers to the offset at the end point of the original trajectory
y	Offset from y axis	It refers to the offset in the horizontal direction of the original trajectory

Parameter	Name	Meaning
z	Offset from z axis	It refers to the offset in the vertical direction of the original trajectory
rx	Rotation angle around x axis	It refers to the rotation angle around x direction of TCP coordinate system of the original trajectory
ry	Rotation angle around y axis	It refers to the rotation angle around y direction of TCP coordinate system of the original trajectory
rz	Rotation angle around z axis	It refers to the rotation angle around z direction of TCP coordinate system of the original trajectory
current	Welding current	It refers to the set current value of each weld
voltage	Welding voltage	It refers to the set voltage value of each weld
amplitude	Weave amplitude	The parameter will change the weave amplitude when required to cooperate with weave
frequency	Weave frequency	The parameter will change the weave frequency when required to cooperate with weave

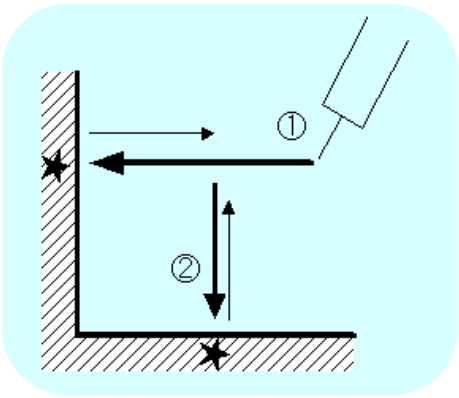
6 Advanced Function of Arc Welding

6.1 Weld search

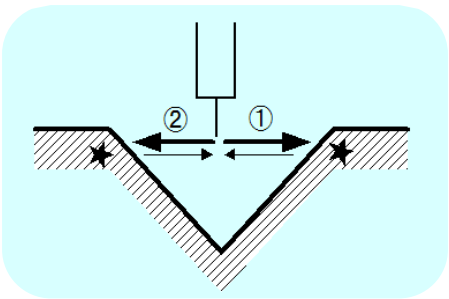
Description of function

It is a means to detect the position offset of the workpiece. When the consistency of the workpiece fails to meet the requirements for the weld, it is used to automatically determine the offset of the weld before welding.

For example, the position of the weld shown in Fig. 6-1is determined by touching the weld in two directions.



(a)



(b)

Fig. 6-1 Schematic diagram of weld search function

Description of principle

Fig. 6-2shows the detailed illustration of the weld search principle. When the weld search function is enabled, the welding wire will have a low voltage of 24 V. When the welding wire touches the workpiece, a loop will be formed and the relay will be triggered to send a contact signal.

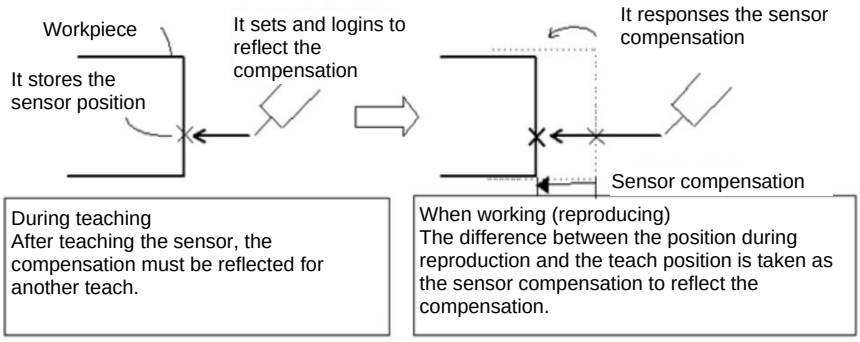


Fig. 6-2 Detailed illustration of weld search principle

When teaching, you must measure the reference position of the workpiece, and then detect the position of a workpiece during (reproduction. The two positions are calculated to obtain the offset of the weld.

Form

There are 5 forms of weld search in arc welding package:

- T_1D: For workpieces that translate in only one direction.
- T_2D: For workpieces that translate in two directions.
- T_3D: For workpieces that translate in three directions.
- TR_2D: For workpieces that move and rotate within the plane.
- TR_3D: For workpieces that move and rotate within space.

Program example

Program example of 3D translation:

```
func void main()
$REFERENCE_FLAG=ture // Seek instruction start flag. (Requires manual insertion)
lin p:p30,vp:5%,sp:-1%,t:$FLANGE,w:$WORLD
weldsearch pst:p42,pmd:p43,v:v9,s:s30,t:$FLANGE,w:$WORLD,strg:0 // Find the offset in the first direction.
lin p:p44,vp:5%,sp:-1%,t:$FLANGE,w:$WORLD
weldsearch pst:p45,pmd:p46,v:v9,s:s30,t:$FLANGE,w:$WORLD,strg:1 // Find the offset in the second direction.
lin p:p47,vp:5%,sp:-1%,t:$FLANGE,w:$WORLD
weldsearch pst:p48,pmd:p49,v:v9,s:s30,t:$FLANGE,w:$WORLD,strg:2 // Find offset in 3rd direction,
wblin p:p50,v:v10,s:s31,t:$FLANGE,w:$WORLD,style:“T_3D” // The first insertion is the starting point of the weld.
wblin p:p51,v:v10,s:s31,t:$FLANGE,w:$WORLD,style:“T_3D” // The second insertion is at the end of the weld.
endfunc
```

> **Tip** The positioning start instruction "$ REFERENCE_FLAG" is set to “true” during the first positioning of the weld, and the value needs to be changed to “false” when performing the positioning of the welding afterwards.

6.2 Arc pressure tracking

Description of principle

Fig. 6-3 shows the detailed illustration of arc pressure tracking principle. The arc sensor tracks the weld by detecting changes in the welding current.

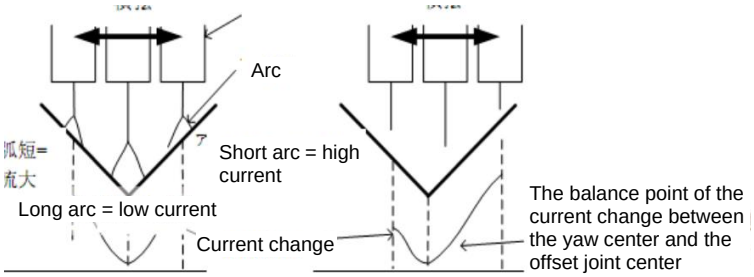


Fig. 6-3 Detailed illustration of arc pressure tracking principle

The principle is that when the weave welding is applied to the fillet weld, the welding current intensity will change at both ends and the center of the weave due to the change in arc length. The offset between center of the weave and center of fillet weld will be the balance between the left and right changes in the welding current. The arc sensor will capture the change in the welding current for position compensation. The basic function of the arc sensor is to control the weld offset caused by the thermal deformation and reverse warping of the welding material.

Precautions for use

During use, attention should be paid to the followings:

- When the surface of the weld is involved with situations that affect the detection of the arc sensor, such as big welding spot, welding slag, leftover wire tip, it must be cleaned before use.
- TCP adjustment must be accurate.
- A good effect will be obtained at high current (above 250 A).
- It is recommended for MAG welding.
- It is recommended for pulse welding.
- The welding plate thickness is recommended to be at least 8 mm.
- The arc pressure tracking must be used in conjunction with weave.

7 Application Example of Arc Welding

The steps to generate the arc welding application are as follows:

Step 1. Open a new .arl program in the program editor, and click "Insert Cmd"->"Package"->"Weld"-> "Arcweave command", as shown in Fig. 7-1.

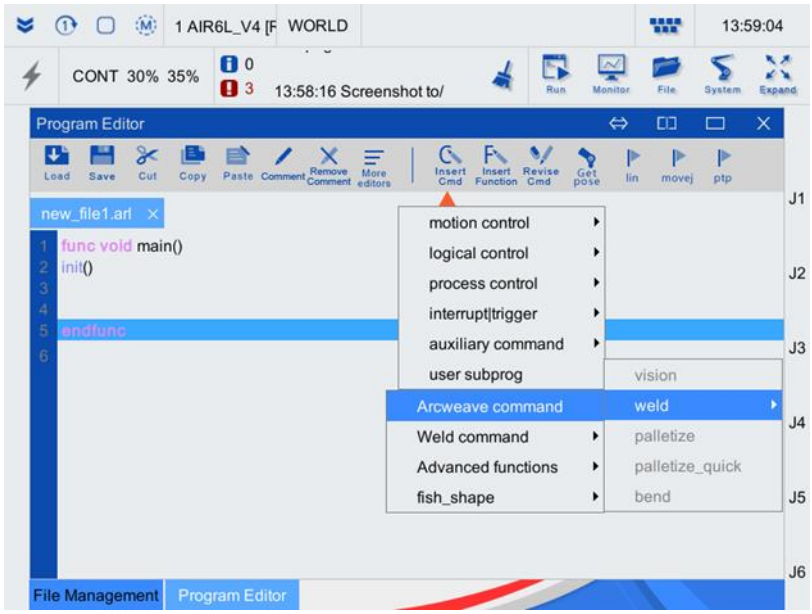


Fig. 7-1 Menu to insert weave instruction

Step 2. Complete the process file import or parameter configuration on the pop-up " weld-Arcweave command" interface, and then click "Confirm". It generates the start weave instruction automatically, as shown in Fig. 7-2.

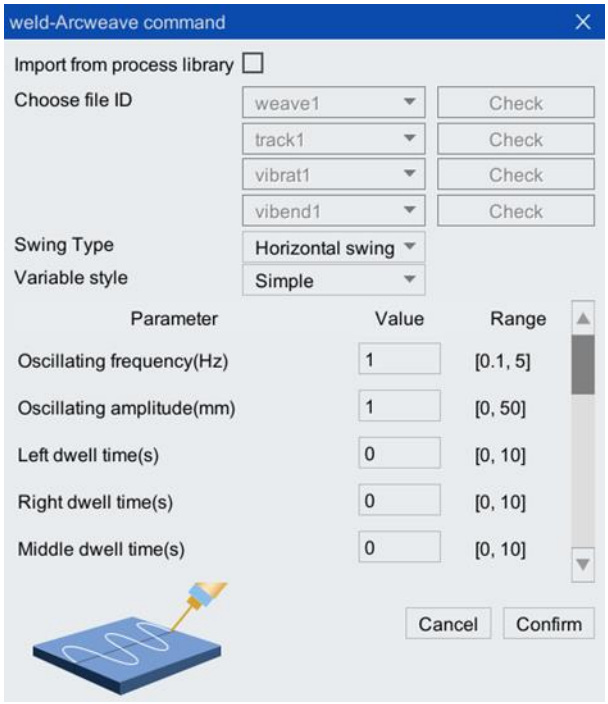


Fig. 7-2 "Arc Welding-Weave Instruction" interface

Step 3. Click "Insert Cmd"-> "Package"-> "weld"-> "Weld command"-> "Arcon command". It generates the welding arcon instruction automatically, as shown in Fig. 7-3.

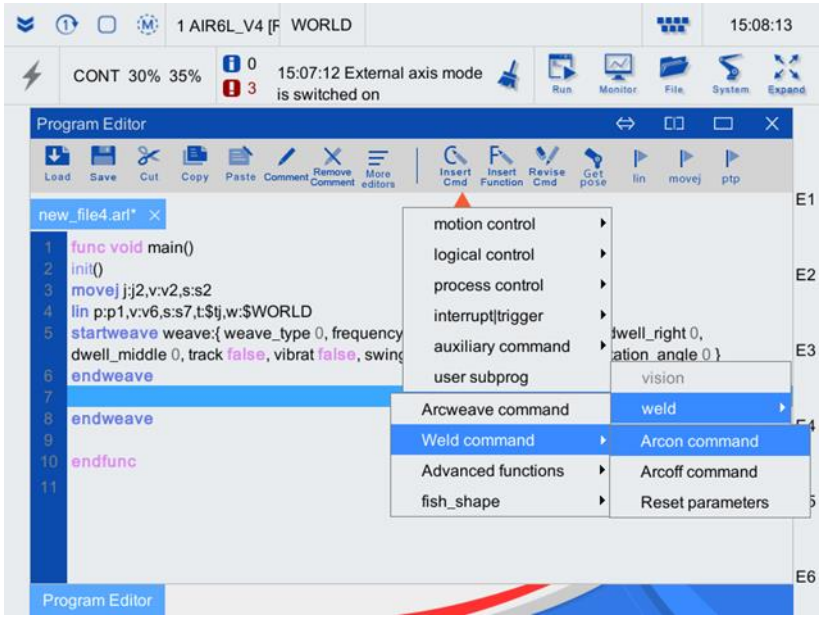


Fig. 7-3 "Arcon Instruction" menu

Step 4. On the pop-up "weld-Reset parameters" interface, complete the process file import or parameter configuration, and then click "Confirm". The reset parameter instruction will be generated automatically, as shown in Fig. 7-4.

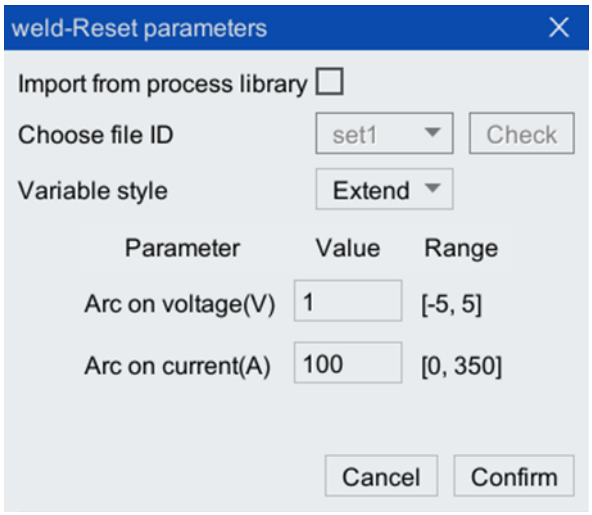


Fig. 7-4 "Arc Welding-Reset Parameter" interface

Step 5. Click "Insert Cmd"-> "Package"-> " weld "-> " Weld command "-> "weld-Arcoff command". Pop up the interface shown in Fig. 7-5, complete the process file import or parameter configuration, click "Confirm" to generate the arcoff instruction automatically.

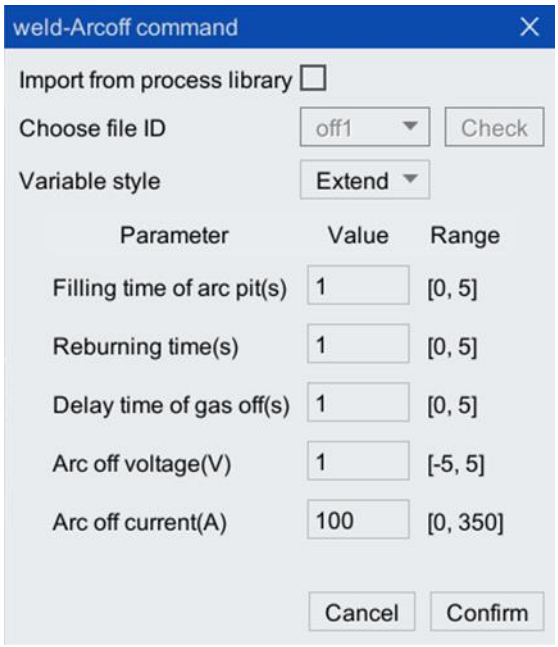


Fig. 7-5 "Arc Welding-Arcoff Instruction" interface

The generated arc welding application is as follows:

```
func void main()
init()
movej j:j2,v:v2,s:s2
lin p:p1,v:v6,s:s7,t:$tj,w:$WORLD
//start of weave
startweave weave1:{weave_type 0, frequency 1, amplitude 1, dwell_left 0, dwell_right 0, dwell_middle 0, track false, vibrate false, swing_angle 0, radius 0, axis 0, rotation_angle 0}
arcon on:{preflow_time 1, ignition_stay_time 1, voltage 1, current 100, weld_resume true, resume_distance 5, rearcon true, rearcon_numbers 3}//arc-on
lin p:p2,v:v14,s:s15,t:$tj,w:$WORLD
cir m:p3,p:p4,v:v6,s:s7,t:$tj,w:$WORLD
arcset set:{voltage 1, current 100} //modify arc welding variables
cir m:p5,p:p6,v:v6,s:s7,t:$tj,w:$WORLD
//arc-off
arcoff off:{endcracter_time 1, burnback_time 1, postflow_time 1, voltage 1, current 100}
endweave //end of weave
endfunc
```

Peitian Robotics Technology Co., Ltd.

Service hotline: 400 990 0909

Official website: http://robot.peitian.com

WeChat official account

Official website