

Searching and Tracking Process

<<<

Catalogue

Searching and Tracking Process	4
> Laser tracking process	4
Laser setting	4
Searching process	6
Types of Laser Searching&Tracking and Use Cases	7
> Searching offset	17
1D offset	17
2D offset	18
2D offset + rotation	19
3D offset (retain base user coordinate system)	20
3D offset + rotation	22
> Arc searching process	23
Arc searching process	23
Introduction of arc searching points	24
Arc searching types and use cases	25
2-point easy touch searching	26
3D offset + rotation	27
> Laser tracking process	27
Searching and tracking process	27
Tracking use cases	30
> Arc/arc voltage tracking process	31
Arc tracking	31
Arc pressure tracking	34
Arc pressure tracking parameters	34
How to determine in-range and out-of-range	37
Program	38

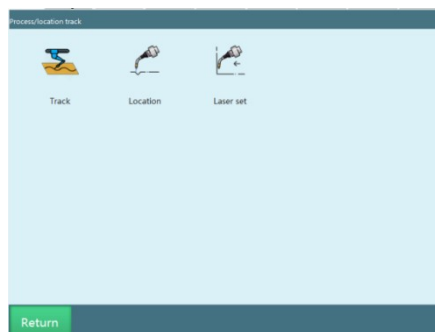
Use cases	38
-----------------	----

Searching and Tracking Process

> Laser tracking process

Laser setting

Parameter setting: Enter the "Process/Searching and tracking process" to set parameters, the file number corresponds to the file number in the instruction, and the laser is selected according to the actual use



Enter "Laser setting/Laser configuration" to set the communication between the laser and the controller

Parameter	Value	Range
Laser manufacturers	CRNT	-
Device No	1	1~99
Communication meth	modbus tcp	-
IP	192.168.1.3	-
The port number	502	1~65535
Communication statu	Disconnected	-
Read and write timeo	500	30~1000(s)
Read and write cycles	50	10~5000(ms)
Laser return value ratio	0.1	0.001~1000
Response timeout	0.3	0.001~10(s)

Buttons: Return, Modify

Laser manufacturer: Select the corresponding laser device name.

Device number: The corresponding upper computer.

Communication method: Modbus or Ethernet

IP: The IP of the connected upper computer. It is necessary to ensure that the controller, the upper computer, and the teach pendant are in the same network segment before they can be connected.

Port number: The port numbers of the teach pendant and the upper computer need to be the same.

Communication status: "Connected" will be displayed when the laser is turned on.

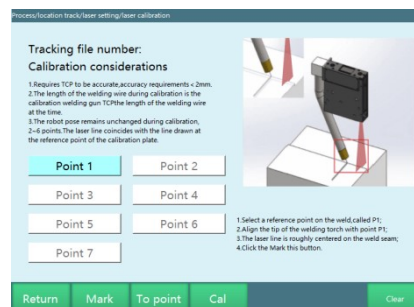
Read and write timeout: If the laser does not receive data after reading and writing for such a long time (s), it will time out

Read and write cycle: The time interval between each data reading and writing of the upper computer (ms).

Laser return value scale factor: The ratio of the actual coordinate value to the coordinate value returned by the laser.

Response timeout: In communication with the laser, the timeout period between the robot query instruction and the laser response instruction.

Enter "Laser setting/Laser calibration" to calibrate the laser



Calibrate seven points according to the diagram. When you first enter, a small white bar will pop up in the lower right corner to indicate that the laser is connected successfully. If it prompts that the initialization fails or the connection fails, you must check whether the manufacturer, ip, and port number in the laser configuration are set correctly. When calibrating, it is necessary to ensure that the weld surface is parallel to the laser, and the laser must be perpendicular to the weld. During the calibration process, the attitude needs to be kept unchanged. At the same time, it is necessary to make sure that the intersection of the weld seam and the laser can

been seen in the corresponding manufacturer's debugging software for each calibrated point without shaking. After you have calibrated the seven points, you can click "Move here" to check, and click "Calculate" if it is correct. If you find that the point is not accurate during the searching process, you need to re-calibrate the laser or tool hand.

Searching process

Enter "**Searching/[Line laser] Searching parameters**" for parameter setting

The top screenshot shows the 'Positioning par' screen. It has a 'File number' dropdown set to 1, a 'Positioning type' dropdown set to 'Line laser', and a 'Positioning par' button. At the bottom are 'Return', 'Modify', 'Clear', and 'Copy' buttons.

The bottom screenshot shows the 'Positioning par' screen with a table of parameters for 'Parameter table No. 1'.

Positioning par	
Parameter table No	1 1-99
Laser task number	1 1-999
Seek type	Correction of p Offset seek type
X direction compensatic	0 -1000~1000(mm)
Y direction compensatic	0 -1000~1000(mm)
Z direction compensatic	0 -1000~1000(mm)
Dynamic seek distance	50 1~1000(mm)
Dynamic seek speed	10 1~1000(mm/s)
Dynamic P selection	5 1-99

At the bottom are 'Return' and 'Modify' buttons.

Parameter table number: Similar to the process number of other processes, it can save the parameters of different users and can be selected in the instruction.

Laser task number: Corresponding to the previous device number.

Searching type: (1) Reference searching: After the searching point is calibrated, the robot will convert the searched point into a variable, insert the variable by instructions and walk to the point; (2) Correction searching: Based on the reference searching, on the requirements of the workpiece or weld, select 1-4 points for reference searching, then the weld can be translated left and right on the plane and rotated according to the number of points, and the robot tool

hand can still find it and follow the weld. This method is usually used in the welding of a large number of identical workpieces in the same batch.

X-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Y-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Z-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Dynamic searching distance: The distance of the robot's dynamic searching, the robot needs to visually measure how far it can reach the weld, otherwise it cannot find the weld

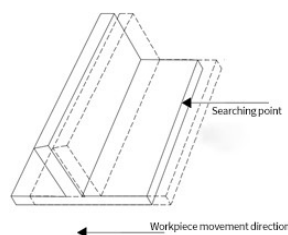
Dynamic searching speed: The speed of dynamic searching

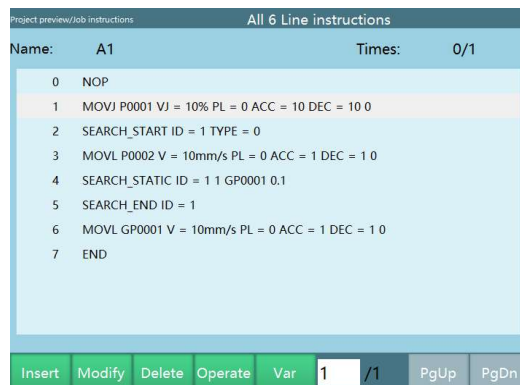
Dynamic searching point selection: Calculate how many points the laser will read within the distance according to the read and write cycle and dynamic searching distance. When the laser just touches the weld, there will be height errors or interference of non-weld gaps in other directions, so these points must be filtered out to ensure the points can be accurately found by dynamic searching.

Types of Laser Searching&Tracking and Use Cases

Single-point searching

Single-point searching (two-point, three-point, four-point searching) is to insert the corresponding number of SEARCH_STATIC instructions between the SEARCH_START and SEARCH_END instructions, and ensure that there is a moving point before each SEARCH_STATIC and the laser can find the weld on the upper computer. The single-point searching function is mainly used to check the calibration accuracy after the robot and the laser are calibrated; the realization method is to send the data of the point taken by the laser to the robot and then the robot moves to the point.





SEARCH_START: Turn on the laser

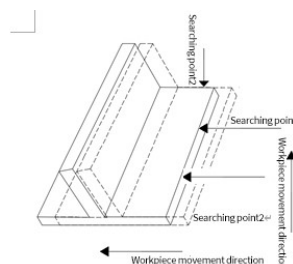
SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

MOVL: Run to the point of the previous searching

Two-point searching

The two-point searching function is mainly used for intermittent welding and straight weld applications. Two points are taken by laser and the point data is sent to the robot, then the robot walks two points to form a straight line. Two static searching points are required in the instruction



SEARCH_START: Turn on the laser

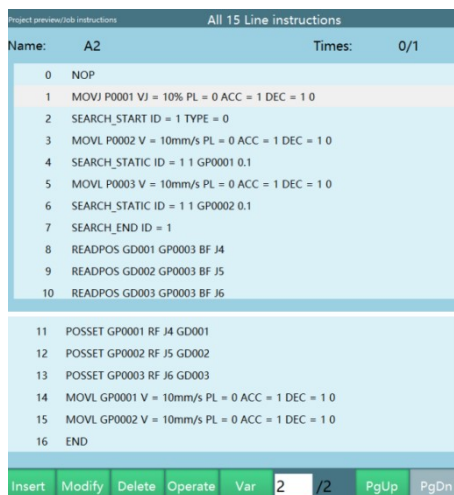
SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

MOVL: Run to the point of the previous searching

Two-point searching attitude change function

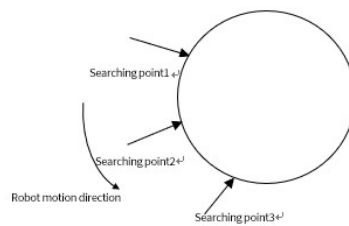
The two-point searching attitude change means searching with one attitude and welding with one attitude, which is mainly used to solve the problem that the searching attitude interferes with the workpiece during welding by changing the attitude. The instructions are the same as the two-point searching, except that the robot attitude is different during the searching, or it can be run by customizing the attitude as follows



Note: The robot's attitude change path is as follows (Variables>Global position variables>find the global position variable parameter GP0003 you set>adjust to the attitude you want to apply>click "Write to current position"), the global position used here does not conflict with the searching point, the ABC attitude value of GP0003 is taken out and assigned to the running point GP0001 or GP0002.

Three-point arc function

The three-point arc function means that the laser finds three points on the arc, and then uses the MOVC instruction to form an arc with three points. This function is mainly used in the arc workpiece welding scenarios;



Project preview/job instructions		All 12 Line instructions	
Name:	A3	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	MOVL P0004 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0		
8	SEARCH_STATIC ID = 1 1 GP0003 0.1		
9	SEARCH_END ID = 1		
10	MOVJ GP0001 VJ = 100% PL = 0 ACC = 10 DEC = 10 0		
11	MOVC GP0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
12	MOVC GP0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
13	END		

SEARCH_START: Turn on the laser

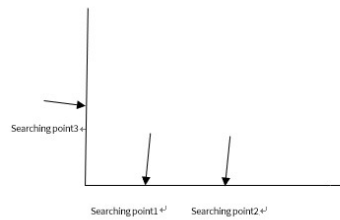
SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

MOVC: Substitute the variables saved in the previous three-point searching into the MOVC instruction, so that the robot will walk the arc according to the searching points

Three-point searching to calculate coordinate system

Three-point searching is to take three points on the two sides where the workpiece intersects, and calculate the user coordinate system through these three points. This method is used in most welding situations. If the calculated user coordinate system is different from the original user coordinate system, then the points or welds in the original user coordinate system become the points or welds in the calculated user coordinate system. Three-point offset supports one-point offset, two-point offset and rotation offset;



Project preview/job instructions		All 10 Line instructions	
Name:	A4	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	MOVL P0004 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0		
8	SEARCH_STATIC ID = 1 1 GP0003 0.1		
9	SEARCH_END ID = 1		
10	SEARCH_CALC PART = 0 TYPE = 5 GP0001 GP0002 GP0003 1		
10	SEARCH_CALC PART = 0 TYPE = 5 GP0001 GP0002 GP0003 1		
11	END		

SEARCH_START: Turn on the laser

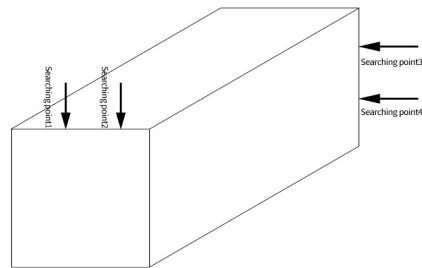
SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "3-points to calculate the user coordinate system", use the three variables found before to calculate the user coordinate system 1

Four-point searching to calculate coordinate system

The four-point searching function means to take four points on the workpiece with two points on any one side, and calculate the user coordinate system, so that each four-point searching will result in a new user coordinate system, but the trajectory within the user coordinate system will not change. Three-point searching for intersection is to search for three points on both sides of the workpiece, which can also calculate the intersection point. During four-point searching, if every two points found are not in the same plane of the workpiece, then the overall size of the workpiece can be calculated and the overall user coordinate system of the workpiece can be calculated too;



Project preview/job instructions		All 12 Line instructions	
Name:	A5	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	MOVL P0004 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0		
8	SEARCH_STATIC ID = 1 1 GP0003 0.1		
9	MOVL P0005 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0		
10	SEARCH_STATIC ID = 1 1 GP0004 0.1		
11	SEARCH_END ID = 1		
12	SEARCH_CALC PART = 0 TYPE = 6 GP0001 GP0002 GP0003 GP0004 1		
13	END		

SEARCH_START: Turn on the laser

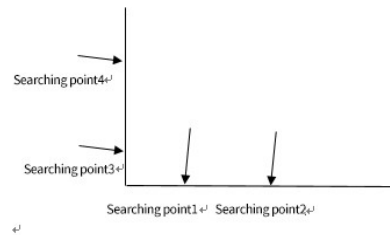
SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "4 points to calculate the user coordinate system", use the four variables found before to calculate the user coordinate system 2

4 points to determine the two lines to calculate intersection

"4 points to determine the two lines to calculate intersection" is to take four points on both sides of the intersection of the workpiece, two points on each side determine a straight line, and then the two lines intersect to determine the intersection point.



Project preview/job instructions		
All 13 Line instructions		
Name:	A6	Times: 0/1
0	NOP	
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0	
2	SEARCH_START ID = 1 TYPE = 0	
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
4	SEARCH_STATIC ID = 1 1 GP0001 0.1	
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
6	SEARCH_STATIC ID = 1 1 GP0002 0.1	
7	MOVL P0004 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0	
8	SEARCH_STATIC ID = 1 1 GP0003 0.1	
9	MOVL P0005 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0	
10	SEARCH_STATIC ID = 1 1 GP0004 0.1	
11	SEARCH_END ID = 1	
12	SEARCH_CALC PART = 0 TYPE = 6 GP0001 GP0002 GP0003 GP0004 1	
13	MOVL GP0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
14	END	

SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

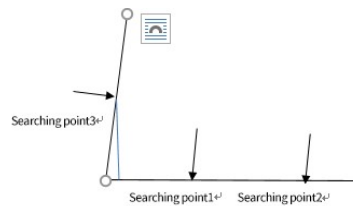
SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "4 points to determine the two lines to calculate intersection", and use the GP0001, GP0002, GP0003, GP0004 points data to calculate the intersection GP0005

MOVL: Run to the calculated intersection point

3 points to calculate the projection point

"3 points to calculate the projection point" is to take three points on both sides of the intersection of the workpiece, two points on one side determine a straight line, and the vertical foot is determined by the projection point of a point on the other side on the straight line. The value is recorded in the global variable.



Project preview/job instructions		All 11 Line instructions	
Name:	A7	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	MOVL P0004 V = 100mm/s PL = 0 ACC = 10 DEC = 10 0		
8	SEARCH_STATIC ID = 1 1 GP0003 0.1		
9	SEARCH_END ID = 1		
10	SEARCH_CALC PART = 0 TYPE = 3 GP0001 GP0002 GP0003 GP0004		
11	MOVL GP0004 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
12	END		

SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "3 points to calculate the projection point", and calculate the projection point GP0004 through the point data of GP0001, GP0002, and GP0003

MOVL: Run to the calculated projection point

Vector calculation

Project preview/job instructions		All 9 Line instructions	
Name:	A8	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	SEARCH_END ID = 1		
8	SEARCH_CALC PART = 0 TYPE = 9 GP0001 GP0002 10 GP0003		
9	MOVL GP0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
10	END		

SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "Vector calculation", select 10mm from GP0001 to GP0002 to calculate GP0003

MOVL: Run to the calculated vector point

4 points to calculate plane user coordinate system

The purpose and effect of the test:

Calculate a new user coordinate system based on the shadow by reflecting the shadow of the object on the plane.

Testing process:

First, you need to find a fixed plane and calibrate a minimum user coordinate system 1, as shown in figure ①;

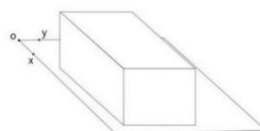


Figure ①

Then find two adjacent and intersecting sides on the workpiece, and use laser to mark two points on each side, and mark four points a1, b1, c1, d1 in total

(calibrate each point with laser single-point searching), as shown in figure ②; after four points have been calibrated, calculate and obtain the user coordinate system 2; it is necessary to find a weld L1 on the current workpiece for calibration (using MOVL);

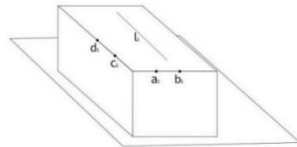
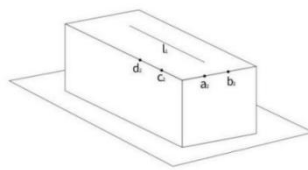


Figure ②

After the above operations are completed, offset or rotate the workpiece and perform the second calibration (a2,b2,c2,d2) at the position of the four points previously calibrated; calculate the user coordinate system 3.



Note: The above operations must be performed with a tool hand.

Instruction application for testing:

Project preview/job instructions		All 14 Line instructions	
Name:	A9	Times:	0/1
0 NOP			
1 MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0			
2 SEARCH_START ID = 1 TYPE = 0			
3 MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
4 SEARCH_STATIC ID = 1 1 GP0001 0.1			
5 MOVL P0004 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
6 SEARCH_STATIC ID = 1 1 GP0002 0.1			
7 MOVL P0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
8 SEARCH_STATIC ID = 1 1 GP0003 0.1			
9 MOVL P0006 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
10 SEARCH_STATIC ID = 1 1 GP0004 0.1			
11 SEARCH_END ID = 1			
12 SEARCH_CALC PART = 0 TYPE = 11 GP0001 GP0002 GP0003 GP0004 1 2			
13 MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
14 MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0			
15 END			

Insert Modify Delete Operate Var 2 /2 PgUp PgDn

Program preview/program command/command insertion/

Point	Type	Notes
Point 1	GP0001	More
Point 2	GP0002	More
Point 3	GP0003	More
Point 4	GP0004	More
Point 5	GP0001	More
Point 6	GP0001	More
length	0.00	mm
se User Coordinate System 1		

Confirm

The above figure is the instruction insertion process of user coordinate system 2;

Project preview/job instructions All 15 Line instructions

Name: A10 Times: 0/1

```
0 NOP
1 MOVJ P0001 VJ = 10% PL = 0 ACC = 1 DEC = 1 0
2 SEARCH_START ID = 1 TYPE = 0
3 MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
4 SEARCH_STATIC ID = 1 1 GP0001 0.1
5 MOVL P0004 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
6 SEARCH_STATIC ID = 1 1 GP0002 0.1
7 MOVL P0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
8 SEARCH_STATIC ID = 1 1 GP0003 0.1
9 MOVL P0006 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
10 SEARCH_STATIC ID = 1 1 GP0004 0.1
11 SEARCH_END ID = 1
12 SEARCH_CALC PART = 0 TYPE = 11 GP0001 GP0002 GP0003 GP0004 1 3
13 SWITCHUSER (3)
14 MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
15 MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
16 END
```

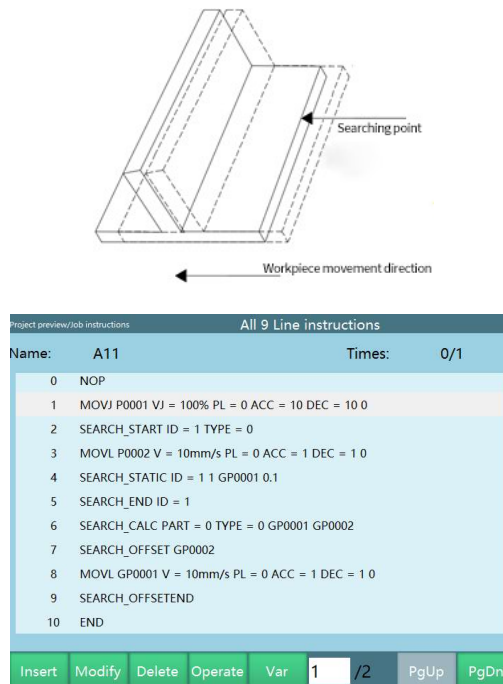
Insert Modify Delete Operate Var 2 /2 PgUp PgDn

The above figure is the instruction writing process of user coordinate system 3.

> Searching offset

1D offset

Use case: After single-point searching, the workpiece can only move in one direction, and the searching direction must be the same as the offset direction



SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

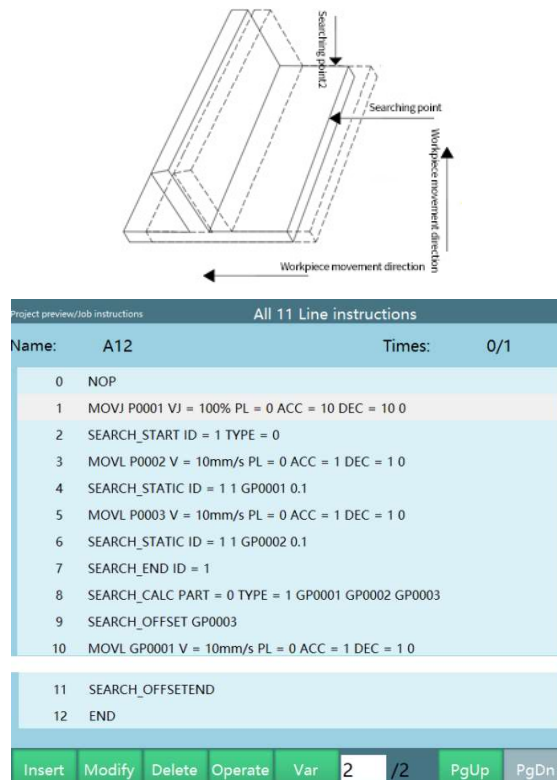
SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select a x-dimensional offset according to the searching points and the actual situation, the point to be offset is GP0001, and the offset is GP0002

SEARCH_OFFSET: Offset is to use the offset instruction to compensate the error when a large number of workpieces are welded. There are different usages of single-point to four-point offset, you can use them according to the actual situation. Use the calculated GP0002 offset to calculate the offset point of GP0001, GP0001 can be replaced with the required weld.

2D offset

After two-point searching, only the XY direction offset occurs when the workpiece is not rotated



SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

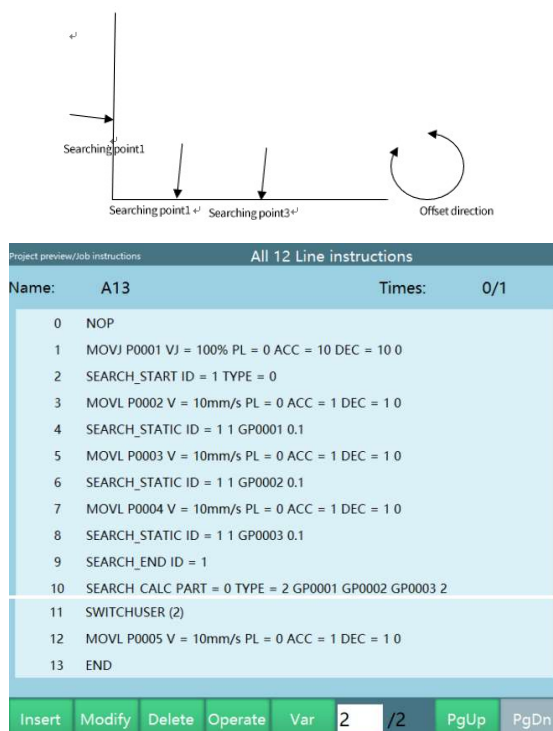
SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select a x-dimensional offset according to the searching points and the actual situation, the point to be offset is GP0001, and the offset is GP0003

SEARCH_OFFSET: Offset is to use the offset instruction to compensate the error when a large number of workpieces are welded. There are different usages of single-point to four-point offset, you can use them according to the actual situation. Use the calculated GP0003 offset to calculate the offset point of GP0001, GP0001 can be replaced with the required weld.

2D offset + rotation

After the three-point searching, the workpiece can be rotated as a whole and offset in XY directions, the first time for reference searching and the second time for correction searching when the offset occurs.



SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

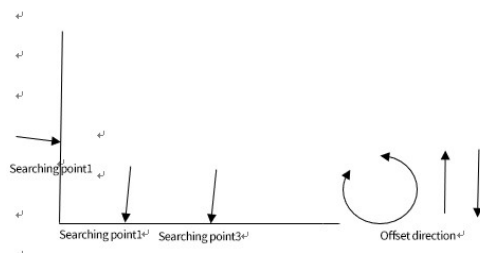
SEARCH_CALC: Select "2D offset + rotation", the point to be offset is P0005, calculate user coordinate system with three points

SWITCHUSER (2): Switch to the calculated user coordinate system

MOVL: At this time, P0005 is a user point that is taught in advance and will be offset according to the different user coordinate system calculated each time, P0005 can be replaced with the required weld seam

3D offset (retain base user coordinate system)

After three-point searching or four-point searching, the workpiece can be rotated as a whole and offset in XY directions, and two job files are required



Project preview/job instructions		
All 13 Line instructions		
Name:	A14	Times: 0/1
0	NOP	
1	MOVJ P0001 VJ = 100% PL = 0 ACC = 10 DEC = 10 0	
2	SEARCH_START ID = 1 TYPE = 0	
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
4	SEARCH_STATIC ID = 1 1 GP0001 0.1	
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
6	SEARCH_STATIC ID = 1 1 GP0002 0.1	
7	MOVL P0004 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0	
8	SEARCH_STATIC ID = 1 1 GP0003 0.1	
9	SEARCH_END ID = 1	
10	SEARCH_CALC PART = 0 TYPE = 5 GP0001 GP0002 GP0003 2	

At this point, you can copy the above program and then insert the following instructions

```

11 SWITCHUSER (3)
12 MOVL P0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
13 SWITCHUSER (2)
14 END

```

SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "Three points to calculate user coordinate system", and output the user coordinate system 2

At this time, the second job file is needed, because the previous job file is the basic user coordinate system, and the next job file is the user coordinate system after calculating the offset. You can copy this file and add the following instructions:

```

11 SWITCHUSER (3)
12 MOVL P0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
13 SWITCHUSER (2)
14 END

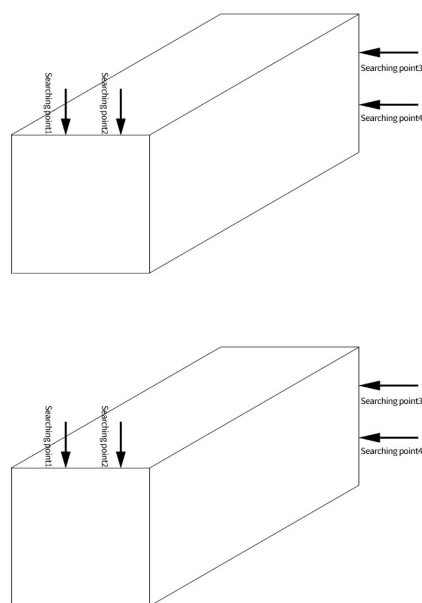
```

In the second job file, it is necessary to calculate and switch to the new user coordinate system to offset according to the difference between the user coordinate systems. P0005 must be taught in the user coordinate system 3 calculated after the first run, and must be a user point. P0005 can be replaced

with the required weld seam. After that, no matter how the workpiece rotates, as long as the laser can find the 3 points, the P0005 after offset can be calculated. After the operation is completed, the coordinate system needs to be restored to the initial coordinate system 2, so as not to affect the subsequent user points

3D offset + rotation

After 4-point searching, the workpiece can be rotated as a whole and offset in XYZ directions, and two job files are required



Project preview/job instructions

All 12 Line instructions

Name:	A15	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 100% PL = 0 ACC = 10 DEC = 10 0		
2	SEARCH_START ID = 1 TYPE = 0		
3	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
4	SEARCH_STATIC ID = 1 1 GP0001 0.1		
5	MOVL P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	SEARCH_STATIC ID = 1 1 GP0002 0.1		
7	MOVL P0004 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
8	SEARCH_STATIC ID = 1 1 GP0003 0.1		
9	MOVL P0005 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
10	SEARCH_STATIC ID = 1 1 GP0004 0.1		
11	SEARCH_END ID = 1		
12	SEARCH_CALC PART = 0 TYPE = 6 GP0001 GP0002 GP0003 GP0004 2		
13	END		

Insert

Modify

Delete

Operate

Var

2

/2

PgUp

PgDn

SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

SEARCH_CALC: Select "Four points to calculate user coordinate system", and output the user coordinate system 5

At this time, the second job file is needed, because the previous job file is the basic user coordinate system, and the next job file is the user coordinate system after calculating the offset. You can copy this file and add the following instructions:

```
12 SEARCH_CALC PART = 0 TYPE = 6 GP0001 GP0002 GP0003 GP0004 5
13 SWITCHUSER (5)
14 MOVL P0006 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
15 SWITCHUSER (2)
16 END
```

In the second job file, it is necessary to calculate and switch to the new user coordinate system to offset according to the difference between the user coordinate systems. P0006 must be taught in the user coordinate system 2 calculated after the first run, and must be a user point. P0006 can be replaced with the required weld seam.

If the ground rail is used in the searching, the device number must be selected from 1 to 4 in the laser configuration.

> Arc searching process

Arc searching process

Enter the "**Process/Searching and tracking/Searching/[Arc] Searching parameters**" to set the arc parameters

The screenshot shows a software window titled "Process/location track/location". Inside, there are two dropdown menus: "File number" with the value "1" and "Positioning type" with the value "Arc". Below these is a text input field labeled "Positioning par". At the bottom of the window, there are four buttons: "Return", "Modify", "Clear", and "Copy".

Process/location track/location/arc location parameter

Datum loc:	Turn off -	Secondary	Turn off -
Locating di	100 0.01-1000	Locating di	50 0.01-1000
Speed	15 0.01-1000	Speed	10 0.01-1000
Auto return	<input checked="" type="checkbox"/>	Auto return	<input checked="" type="checkbox"/>
Auto return	20 0.01-1000	Auto return	20 0.01-1000
Auto return	100 0.01-1000	Auto return	100 0.01-1000
Out of rang	500 0.01-1000	Out of rang	500 0.01-1000
Change po	<input type="checkbox"/>	Vector reco	0 ±1000

Return Modify

Searching file number: Corresponds to instruction file number

Reference searching: First searching

Secondary searching: In some cases, the reference searching is not very accurate or some manufacturers' reference searching is too fast, so use the secondary searching

Searching distance: The moving distance from the instruction searching start point

Speed: Searching speed

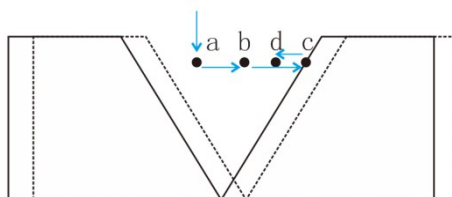
Auto return: Return after the torch touches the searching points

Auto return distance: The distance to go back from touching the workpiece

Change attitude: Turn on when performing two-point simple touch searching calculation.

Motion vector compensation: When performing two-point simple touch searching calculation, the reverse compensation is 0~5mm to prevent the welding wire from poking into the weld seam.

Introduction of arc searching points



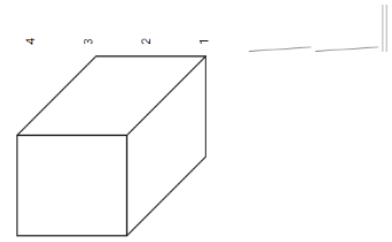
As shown in the figure: point a is the preparation point of dynamic searching; point b is the start point of dynamic searching; the robot moves along the

direction of vector ab to find the position, and the welding wire stops immediately when it touches the workpiece, indicating that the position has been found; the searching distance (point b is the start point) and the speed are set in the process parameters.

If it is required to return automatically after searching, the robot will return from c to d automatically (return distance and speed are set in the parameters). In the arc searching process parameters, select "Reference searching", configure other parameters; run the program, the program will stop at the SEARCH_CALC instruction (normal), turn off the reference searching switch in the parameters. Run the program again

Arc searching types and use cases

Calculate the new user coordinate system with two points on the plane



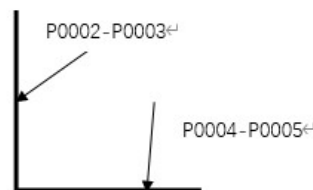
Operation process: Use the SEARCH_DYNAMIC instruction to find a total of 4 points. Select the two intersecting sides and find two points on each side according to the required plane user coordinate system, as shown in the figure above. You can adjust the specific points according to the actual situation.

Project preview/job instructions		All 12 Line instructions	
Name:	S1	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 10 DEC = 10 0		
2	SEARCH_START ID = 1 TYPE = 1		
3	SEARCH_DYNAMIC P0002 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
4	SEARCH_DYNAMIC P0003 ID = 1 TYPE = 1 GP0001 0.1		
5	SEARCH_DYNAMIC P0004 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
6	SEARCH_DYNAMIC P0005 ID = 1 TYPE = 1 GP0002 0.1		
7	SEARCH_DYNAMIC P0006 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
8	SEARCH_DYNAMIC P0007 ID = 1 TYPE = 1 GP0003 0.1		
9	SEARCH_DYNAMIC P0008 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
10	SEARCH_DYNAMIC P0009 ID = 1 TYPE = 1 GP0004 0.1		
11	SEARCH_END ID = 1		
12	SEARCH_CALC PART = 0 TYPE = 10 GP0001 GP0002 GP0003 GP0004 1 2		
13	END		
Insert Modify Delete Operate Var 2 /2 PgUp PgDn			

In the middle, you need to add MOVJ or MOVL as path auxiliary points according to the actual situation. After finding 4 points by dynamic searching, calculate the new user coordinate system by "SEARCH_CALC-two points in plane to calculate the required coordinate system", if offset is required, the method can be the same as "three points to calculate the user coordinate system"

2-point easy touch searching

Operation process: First dynamically search the touch point GP0001 in the direction perpendicular to one side of the fillet weld, then dynamically search the touch point GP0002 in the direction perpendicular to the other side of the fillet weld, and then use the SEARCH_CALC instruction to calculate the weld point GP0003 through the two points GP0001,GP0002, and the attitude of the weld point is the same as GP0001.



Project preview/job instructions		All 8 Line instructions	
Name:	S2	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 10 DEC = 10 0		
2	SEARCH_START ID = 1 TYPE = 1		
3	SEARCH_DYNAMIC P0002 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
4	SEARCH_DYNAMIC P0003 ID = 1 TYPE = 1 GP0001 0.1		
5	SEARCH_DYNAMIC P0004 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10		
6	SEARCH_DYNAMIC P0005 ID = 1 TYPE = 1 GP0002 0.1		
7	SEARCH_END ID = 1		
8	SEARCH_CALC PART = 0 TYPE = 7 GP0001 GP0002 GP0003		
9	END		

SEARCH_START: Turn on the arc signal

SEARCH_DYNAMIC: Save the point found by the arc into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the arc signal, the file number should be the same as the beginning

SEARCH_CALC: Save the found points GP0001 and GP0002 to the variable GP0003, and finally calculate the fillet weld point GP0003.

3D offset + rotation

Operation process: You need to touch a plane to find three points and then touch along the edge according to the actual needs of the user coordinate system to find the points, a total of six points, as shown in the figure above

Recent prepared job instructions		All 15 Line instructions
Name:	S3	Times: 0/1
0	NOP	
1	MOVJ P0001 VJ = 10% PL = 0 ACC = 10 DEC = 10 0	
2	SEARCH_START ID = 1 TYPE = 1	
3	SEARCH_DYNAMIC P0002 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
4	SEARCH_DYNAMIC P0003 ID = 1 TYPE = 1 GP0001 0.1	
5	SEARCH_DYNAMIC P0004 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
6	SEARCH_DYNAMIC P0005 ID = 1 TYPE = 1 GP0002 0.1	
7	SEARCH_DYNAMIC P0006 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
8	SEARCH_DYNAMIC P0007 ID = 1 TYPE = 1 GP0003 0.1	
9	SEARCH_DYNAMIC P0008 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
10	SEARCH_DYNAMIC P0009 ID = 1 TYPE = 1 GP0004 0.1	
11	SEARCH_DYNAMIC P0010 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
12	SEARCH_DYNAMIC P0011 ID = 1 TYPE = 1 GP0005 0.1	
13	SEARCH_DYNAMIC P0012 ID = 1 TYPE = 0 V = 10 mm/s PL = 1 ACC = 10	
14	SEARCH_DYNAMIC P0013 ID = 1 TYPE = 1 GP0006 0.1	
15	SEARCH_CALC PART = 0 TYPE = 8 GP0001 GP0002 GP0003 GP0004 GP0005 GP0006 2	
16	END	

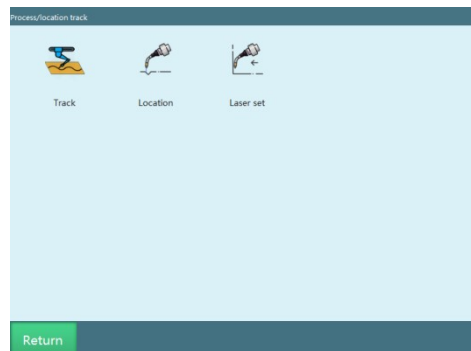
Insert Modify Delete Operate Var 2 /2 PgUp PgDn

In the middle, you need to add MOVJ or MOVL as path auxiliary points according to the actual situation. After finding 6 points by dynamic searching, calculate the user coordinate system by "SEARCH_CALC-3D offset + rotation" instruction, if offset is required, the follow-up method is the same as that of 4-point searching, and then create a same job file and teach out the weld, offset by switching the user coordinate system

> Laser tracking process

Searching and tracking process

Parameter setting: Enter "**Process/Searching and tracking**" to set parameters, the file number corresponds to the file number in the instruction, and the laser is selected according to the actual use



Enter "Searching and tracking/Laser setting/Laser configuration" to set the communication between the laser and the controller

The screenshot shows a web interface titled "Process/location track/laser setting/laser configuration". It contains several input fields and labels: "Laser manufacturers" (dropdown menu with "CRNT" selected), "Device No" (text input with "1", range "1~99"), "Communication meth" (dropdown menu with "modbus tcp" selected), "IP" (text input with "192.168.1.3"), "The port number" (text input with "502", range "1~65535"), "Communication statu" (text input with "Disconnected"), "Read and write timeoi" (text input with "500", range "30~1000(s)"), "Read and write cycles" (text input with "50", range "10~5000(ms)"), "Laser return value ratio" (text input with "0.1", range "0.001~1000"), and "Response timeout" (text input with "0.3", range "0.001~10(s)"). At the bottom, there are two green buttons: "Return" and "Modify".

Laser manufacturer: Select the manufacturer according to the laser model

Device number: The corresponding upper computer.

IP: The IP of the connected upper computer. It is necessary to ensure that the controller, the upper computer, and the teach pendant are in the same network segment before they can be connected.

Port number: The port number of the teach pendant and the upper computer need to be the same.

Communication status: "Connected" will be displayed when the laser is turned on.

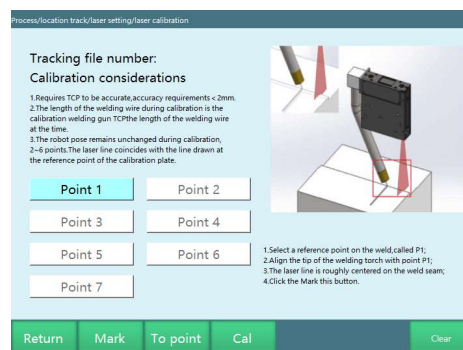
Read and write timeout: If the laser does not receive data after reading and writing for such a long time (s), it will time out

Read and write cycle: The time interval between each data reading and writing of the upper computer (ms).

Laser return value scale factor: The ratio of the actual coordinate value to the coordinate value returned by the laser.

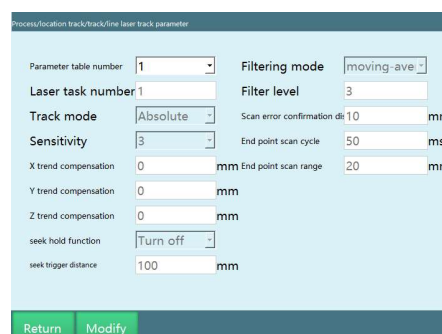
Response timeout: In communication with the laser, the timeout period between the robot query instruction and the laser response instruction.

Enter "Searching and tracking/Laser setting/Laser calibration" to calibrate the laser



Calibrate seven points according to the diagram. When calibrating, it is necessary to ensure that the weld surface is parallel to the laser, and the laser must be perpendicular to the weld. During the calibration process, the attitude needs to be kept unchanged. At the same time, it is necessary to make sure that the intersection of the weld seam and the laser can be seen in the corresponding manufacturer's debugging software for each calibrated point without shaking. After you have calibrated the seven points, you can click "Move here" to check, and click "Calculate" if it is correct. If you find that the point is not accurate during the searching process, you need to re-calibrate the laser or tool hand.

Enter "Searching and tracking/Tracking/Line laser tracking parameters" for parameter setting



Parameter table number: Similar to the process number of other processes, it can save the parameters of different users and can be selected in the instruction.

Laser task number: Corresponds to the previous device number.

Tracking mode: (1) Absolute, that is, precise tracking, in the case of known weld seam, track accurately by searching the start point or moving directly to the vicinity of the weld seam. Precise tracking can ensure that when the weld seam

offsets or tool hand changes attitude in the process of tracking, as long as the laser can identify the weld seam, it can accurately make the tool hand move along the weld seam (temporarily only supports linear motion) (2) Incremental, that is, fuzzy tracking, fuzzy tracking is used when precise tracking is not required. As long as the robot tool hand remains stationary on the weld after calibration, it will only move in the direction perpendicular to the weld according to the movement of the weld.

Sensitivity: Laser sensitivity during incremental tracking.

X-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Y-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Z-direction compensation: Compensate a certain length in the tool coordinate system of the welding seam position recognized by the laser

Searching hold function: Compensate to a certain position according to the taught weld seam during fuzzy tracking, and then keep tracking at this position.

Searching hold trigger distance: The complementary distance during fuzzy tracking, applicable to short weld seams.

Filtering mode: The filtering algorithm method for smoothing sensor data.

Filtering level: The lower the level, the smoother, the more lagging.

Scan error confirmation distance: During the tracking process, if the sensor fails to scan continuously and the robot moves a certain distance, the error will be reported and the robot will stop.

End point scan cycle: the scan cycle, the cycle is smaller in general, less than 30ms.

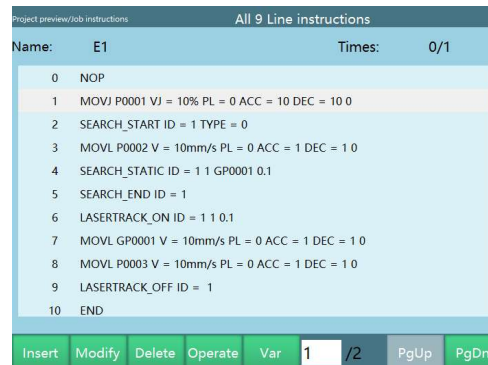
End point scan interval: Set a distance before and after the end point of teaching as the scan interval.

Tracking use cases

Linear tracking (absolute)

Determine the direction of the weld seam by teaching a straight line, and then scan and track it in real time through the laser to ensure that the weld torch can be kept on the identified weld seam for welding operations. Similar to the

principle of searching, the torch can also change its attitude during tracking. If you need to change the attitude, you only need to change the attitude at the teach point



SEARCH_START: Turn on the laser

SEARCH_STATIC: Save the weld seam found by the laser into a variable for later calculation or direct movement to the point

SEARCH_END: Turn off the laser, the file number should be the same as the beginning

LASERTRACK_ON: Turn on the laser

MOVL: Run to the point of the previous searching

MOVL: G001 is the start point, P0003 is the end point, PL must be 5, if there is obvious acceleration and deceleration, please go to the laser configuration to modify the read and write cycle until it does not stop

LASERTRACK_OFF: Turn off the laser, the file number should be the same as the beginning

> Arc/arc voltage tracking process

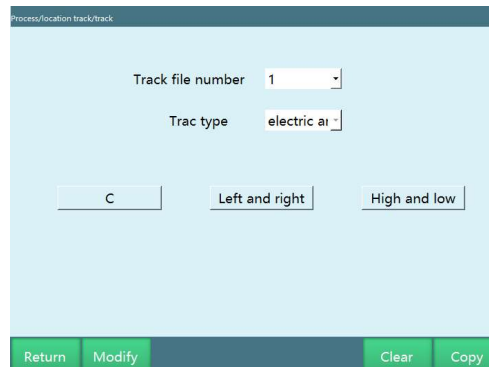
Arc tracking

1. Overview

Arc tracking is mainly suitable for the correction of the weaving welding trajectory of fillet welds and V-groove welds. It is often used in medium and thick plate welding in robot welding processes to correct workpiece deformation and partial workpiece alignment error caused by high-current welding.

2. Parameter configuration

Enter the "Process/Searching and tracking/tracking" interface, as shown in the figure below, you need to set the communication parameters, left and right compensation parameters and high and low compensation parameters in turn.

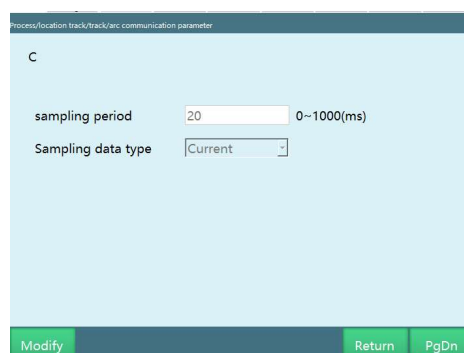


Communication parameters

Enter the "Communication parameters" interface, as shown in the figure below, and the meaning of each parameter is as follows:

Sampling period: The time period for collecting current and voltage signals during weaving welding, the recommended period is 2ms~20ms.

Sampling data type: During the weaving welding process, choose the voltage/current with larger fluctuations. For Aotai and Megmeet welders, it is recommended to select the current.



Left and right compensation parameters

Left and right compensation refers to the left and right compensation of the swing arc trajectory on the swing plane. Enter the "Left and right compensation parameters" interface, as shown in the figure below, and the meanings of each parameter are as follows:

Process/Arc tracking/Tracking/Arc left right compensation pa

Left and right

Compensation switch ☒

Deviation extraction type Mean

Start sampling period 4 1~100

Correction factor 0.01 0.001~1000(mm/A),mean value type

Compensation threshold 10 0~1000,the signal extraction deviation exceeds the threshold then compensate

Max compensation each 2 0~10(mm)

Compensation ACC 1 0.1~10,corresponding to the multiple of the current motion command ACC

Modify Return PgUp PgDn

Compensation switch: Indicates whether left and right correction is performed during weaving welding. For V-groove welds weaving welding with only high and low deviations, this switch can be turned off.

Deviation extraction type: Only the mean value algorithm is currently supported.

Start sampling cycle number: The current signal has no obvious change in the first few cycles of weaving welding, and it is invalid. Generally, sampling starts from the 3rd to 5th cycle.

Correction factor: The compensation length of the current deviation per 1A. Generally, the welding current is large and the deviation value is large, so the value should be set small; otherwise, the value should be set large. Suggested value: 0.01~0.5.

Compensation threshold: Compensate if the current signal deviation exceeds the threshold value, otherwise no compensation. The recommended value is 10. If the welding current is large, adjust it larger, and if the welding current is small, set it smaller.

Maximum compensation amount per time: Compensate once when deviation is extracted in a single cycle, maximum compensation amount per time refers to the maximum length of each compensation, and the maximum compensation amount is to prevent overcompensation caused by excessive current in sampling.

Compensation acceleration multiple: The acceleration of the left and right compensation amount, you can set it according to the deviation correction factor, if the deviation correction factor is large, set it to a large value, and if the deviation correction factor is small, set it to a small value. The recommended value is 1.

High and low compensation parameters

High and low compensation refers to the compensation in the normal direction of the swing plane. Enter the "High and low compensation parameters" interface, as shown in the figure below, the meanings of each parameter are the same as

the left and right compensation parameters. In general, the left and right compensation is large, and the high and low compensation is small, so the compensation related parameters can be adjusted appropriately.

Process/Arc tracking/Tracking/Arc high low compensation pa

High and low

Compensation switch ☒

Deviation extraction type

Start sampling period 1~100

Correction factor 0.001~1000(mm)/A,mean value type

Compensation threshold 0~1000,the signal extraction deviation exceeds the threshold then compensate

Max compensation each 0~10(mm)

Compensation ACC 0.1~10,corresponding to the multiple of the current motion command ACC

Modify Return PgUp

Arc pressure tracking

Process/location track/track

Track file number

Trac type

oltage Tracking Param

Return Modify Clear Copy

Clear parameters: Clear the parameter values set in the current tracking file number

Copy parameters: Copy the parameter values set in the current tracking file number to the process number you want

Arc pressure tracking parameters

Arc voltage acquisition

Process/Arc tracking/Tracking/Arc following parameter

Arc voltage acquisition Reference voltage control parameter

Arc voltage acq. Voltage Mo

Arc voltage acq. ms

invalid data time s

The screenshot shows the 'Arc V acquisition' tab selected. It contains three input fields: 'Arc voltage acqu' with a dropdown menu showing 'welder' and 'Arc V Modul'; 'Arc voltage acqu' with a numeric input '3' and a unit dropdown 'ms'; 'invalid data time' with a numeric input '1' and a unit dropdown 's'; and 'Arc voltage acqu' with a dropdown menu showing 'AIN1-1'.

Arc voltage acquisition equipment: Welder and arc voltage module

Arc voltage acquisition cycle: Refers to how long to collect a voltage, the unit is ms

Invalid data time: There is a period of time when the welding arc has a extra large voltage, and the data cannot be collected for calculation

Arc voltage acquisition analog port: The analog input port that needs to be connected, only available when the arc voltage module is selected

Reference voltage

The first screenshot shows the 'Reference voltage' tab with three input fields: 'Reference voltag' with a dropdown menu showing 'Weld calcul' and 'manual calcul'; 'Reference voltag' with a numeric input '1.3' and a unit dropdown 'v'; 'Calculate increm' with a numeric input '-0.3'; and 'Weld start calcul' with a numeric input '1' and a unit dropdown 's'. The second screenshot shows the same tab with the 'Weld calcul' option selected in the dropdown menu. Below the input fields, there are two buttons: 'Start collecting' and 'calculate and sav'. At the bottom of the interface, there are two buttons: 'Return' and '修改'.

Reference voltage acquisition method: It is divided into welding calculation and manual calculation. When welding calculation is selected, after the voltage is set, the reference voltage will be calculated after the welding start calculation time. If manual calculation is selected, the entire track needs to be run

Reference voltage: The user sets the voltage he wants, and when the voltage of the welder exceeds or falls below this set voltage value, deviation correction is required

Calculation increment: The voltage value that needs to be compensated, generally the target value is controlled to be a value that is a fraction of a V smaller than the calculated value

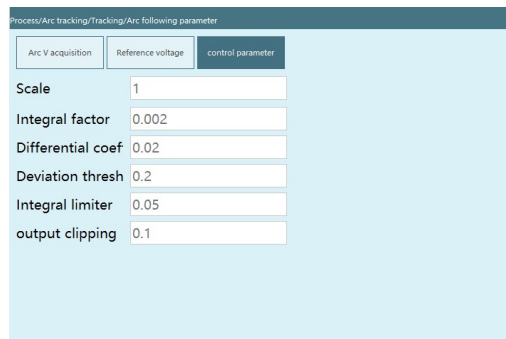
Welding start calculation time: The time required to calculate the reference voltage after welding starts, only available for welding calculation

Start collection: Only available for manual calculation. When manual calculation is selected, the arc voltage pop-up interface will be displayed. Click "Start collection" when starting operation, and click "End collection" after operation

Calculate and save: After running, click "Calculate and save", the reference voltage will be saved in the controller and displayed on the interface

Note: The reference voltage calculated by welding will not be displayed on the teach pendant, it can only be seen from the log

Control parameters



process/Arc tracking/Tracking/Arc following parameter		
Arc V acquisition	Reference voltage	control parameter
Scale	1	
Integral factor	0.002	
Differential coef	0.02	
Deviation thresh	0.2	
Integral limiter	0.05	
output clipping	0.1	

Proportional coefficient: It reflects the deviation of the system in proportion. Once there is a deviation in the system, the proportional adjustment will immediately produce an adjustment effect to reduce the deviation. Large proportional effect can speed up the adjustment and reduce the error, but the excessive ratio will reduce the stability of the system, and even cause system instability

Integral coefficient: It is to eliminate the steady-state error of the system and improve the indiscrimination degree. Because there is an error, the integral adjustment will be carried out until there is no difference, the integral adjustment will stop, and the integral adjustment will output a constant value. The strength of the integral action depends on the integral time constant T_i , the smaller T_i is, the stronger the integral action is. On the contrary, the larger T_i is, the weaker the

integral action is. Adding integral adjustment can reduce the stability of the system and slow down the dynamic response. The integral action is often combined with the other two adjustment laws to form a PI regulator or PID regulator

Differential coefficient: The differential action reflects the rate of change of the system deviation signal. It is predictable and can predict the trend of deviation changes. Therefore, it can produce advanced control effects. Before the deviation is formed, it has been eliminated by the differential adjustment function. Therefore, it can improve The dynamic performance of the system. When the differential time is selected properly, the overshoot can be reduced and the adjustment time can be reduced. The differential action can amplify the noise interference, so if the differential adjustment is too strong, it will be detrimental to the system's anti-interference. In addition, the differential response is the rate of change, and when the input does not change, the output of the differential action is zero. The differential action cannot be used alone, it needs to be combined with the other two regulation laws to form a PD or PID controller

Deviation threshold: When the deviation of the controlled quantity is greater than this value, the proportional coefficient and integral coefficient will be reduced. We generally set a larger deviation

Integral limit: Prevent the error integral from being too large

Output limit: Prevent single adjustment from being too large

How to determine in-range and out-of-range

Set the voltage of the welder, and an average voltage will be calculated through the sampling period you set

For example: the reference voltage is 20V, the compensation threshold is 5V, the reference voltage plus or minus compensation threshold, and the calculated value will be compared with the calculated average voltage. If the calculated value is outside the average voltage range, it will be compensated, if the calculated value is within the average voltage range, it will not be compensated.

compensation value per time: The maximum compensation distance in each calculation cycle. If your sampling period is set to 10ms and the maximum compensation distance per time is 1mm, then the maximum compensation distance per time means to compensate 1mm at 100ms.

Compensation length (L) calculation formula

$L = (\text{average voltage} - \text{reference voltage}) \times \text{correction factor}$

When $L >$ maximum compensation distance per time, the compensation distance is determined by the period and the maximum compensation distance per time

When $L <$ maximum compensation distance per time, the compensation distance is compensated according to the result calculated by the compensation length formula

Program

Remember to set the ignition success signal in the "Process - Welding process - Welding IO" interface

```
Project preview/job instructions      All 7 Line instructions
Name:      E2                        Times:      0/1
0  NOP
1  MOVL P0001 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
2  ARCON ID=1 TEMP=OFF(NULL NULL NULL NULL NULL NULL NULL)
3  DOUT OT#(DOUT1-1) 1 T = 0 0
4  ARCVTRACKON ID = 1 0
5  MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0
6  ARCVTRACKOFF ID = 1 0
7  ARCOFF ID=1 TEMP=OFF(NULL NULL NULL NULL)
8  END
```

Insert Modify Delete Operate Var 1 /1 PgUp PgDn

Use cases

Linear Weaving Tracking

Project preview/job instructions		All 8 Line instructions	
Name:	E3	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 100% PL = 0 ACC = 10 DEC = 10 0		
2	ARCON ID=1 TEMP=OFF(NULL NULL NULL NULL NULL NULL NULL)		
3	WVON #1		
4	ARCTACKON ID = 1		
5	MOVL P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	LASERTRACK_OFF ID = 1		
7	WVOFF		
8	ARCOFF ID=1 TEMP=OFF(NULL NULL NULL NULL)		
9	END		
Insert		Modify	Delete
Operate		Var	1 /1
		PgUp	PgDn

Arc Weaving Tracking

Project preview/job instructions		All 9 Line instructions	
Name:	E4	Times:	0/1
0	NOP		
1	MOVJ P0001 VJ = 100% PL = 0 ACC = 10 DEC = 10 0		
2	ARCON ID=1 TEMP=OFF(NULL NULL NULL NULL NULL NULL NULL)		
3	WVON #1		
4	ARCTACKON ID = 1		
5	MOVC P0002 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
6	MOVC P0003 V = 10mm/s PL = 0 ACC = 1 DEC = 1 0		
7	LASERTRACK_OFF ID = 1		
8	WVOFF		
9	ARCOFF ID=1 TEMP=OFF(NULL NULL NULL NULL)		
10	END		
Insert		Modify	Delete
Operate		Var	1 /2
		PgUp	PgDn

P0001, P0002, P0003 are the 3 points on the arc respectively.