ROBOTICS

Application manual

Seam tracking with Fronius TPS/i

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Application manual

Seam tracking with Fronius TPS/i

RobotWare 6.11

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Original instructions.

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Overview of this manual

About this manual

This manual describes the seam tracking functionality with a Fronius TPS/i power source and contains instructions to configure it.

This manual should be read before installing and commissioning of a Robotic Arc Welding system with a Fronius TPS/i power source.

Who should read this manual?

This manual is intended for:

- Personnel responsible for installations and configurations of fieldbus hardware/software
- Personnel responsible for I/O system configuration
- System integrators

Prerequisites

The reader should have the required knowledge of:

- Mechanical installation work
- Electrical installation work
- System parameter configuration

References

Reference	Document ID
Operating manual - RobotStudio	*3HAC032104-001*
Application manual - Arc and Arc Sensor	*3HAC050988-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Technical reference manual - System parameters	*3HAC050948-001*
Operating manual - Seam tracking with Weldguide IV and MultiPass	*3HAC054886-001*
Fronius Operating Instructions TPS 320i/400i/500i/600i	*42,0426,0114,EN*

Revisions

Revision	Description
-	First revision.
A	Released with RobotWare 6.02. Restructured the introduction for a layout consistent with the other manuals.
B	Released with RobotWare 6.11. • Minor corrections. • New section added regarding limitations and best practices of *Single side tracking on page 27*. • References to new section added in sections *Limitations on page 11* and *Single side tracking (right and left) on page 23*.

Safety

Safety regulations

Before beginning mechanical and/or electrical installations, ensure you are familiar with the safety information in the product manuals for the robot.

The integrator of the robot system is responsible for the safety of the robot system.

1 Introduction to Fronius TPSi seam tracking

About Fronius TPS 320i / 400i / 500i / 600i IRC5 seam tracking

This guide describes the ABB Robotics IRC5 interface for:

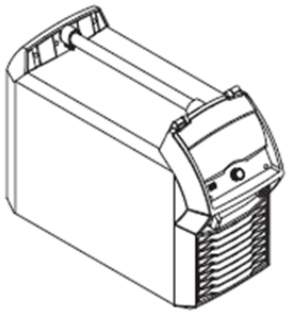
- Fronius TPS 320i/400i/500i/600i with RI-FB Inside/i interface

The power source must meet the following requirements:

- Firmware 1.8.2 or above
- RI FB Inside/I interface for D-Net / Profi-Bus / Profi-Net or EtherNet/IP

Overview

The MIG/MAG power sources TPS 320i, TPS 400i, TPS 500i and TPS 600i are completely digitized, microprocessor-controlled inverter power sources. The modular design and potential for system add-ons ensure a high degree of flexibility. The devices can be adapted to any specific situation.



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TPS/i power sources contain a selection of welding processes, procedures and welding characteristics that enable a wide range of materials to be processed in the most effective way.

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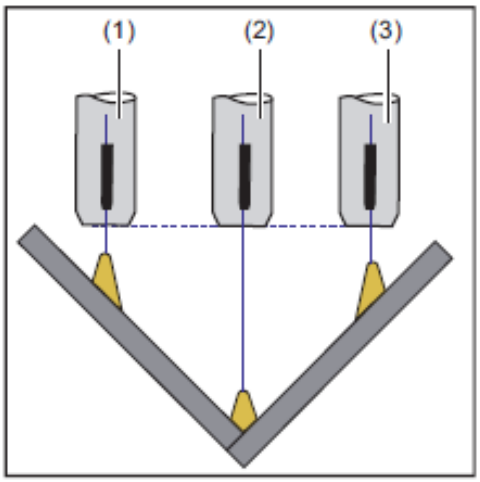
General functionality

The Fronius TPS/I Tracking Add-In is a powerful software based TAST (Through Arc Seam Tracking) RobotWare option. The function is based on a feedback signal provided by the TPS/I power source.

This feedback signal is representing a wire stick-out value to support both vertical and lateral seam tracking and is used as sensor to indicate variations in the welding current which is caused by changes in welding current and voltage.

Weaving overview (actual value for seam tracking, the values shown are examples only):



(1)
- Stickout: 10 mm
- Wire speed: 7 m/min
- Arc length correction: 0
- Actual value for seam tracking: approx. 7650

(2)
- Stickout: 25 mm
- Wire speed: 7 m/min
- Arc length correction: 0
- Actual value for seam tracking: approx. 5853

(3)
- Stickout: 10 mm
- Wire speed: 7 m/min
- Arc length correction: 0
- Actual value for seam tracking: approx. 7650

Description of the weaving function:

- The actual value for seam tracking is calculated from the welding current and welding voltage
- The actual value for seam tracking changes with the Stickout
- The actual value for seam tracking adjusts itself between 0-10000:
  - Stickout gets shorter - signal increases
  - Stickout gets longer - signal decreases

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2 Installation

2.1 Prerequisites

Robot controller software

Robot system prerequisites:

- IRC5 robot controller with main computer DSQC1000 or above
- RobotWare version 6.07 or higher with the following options:
  - [633-4] RobotWare Arc
  - [637-1] Production Screen
  - [1553-1] Tracking Interface
- One of the following arc sub-options (power source interface)
  - Standard I/O Welder
  - Fronius TPS/i Add-In

RobotStudio software

RobotStudio version 6.07 or higher.

Fronius TPS/i Tracking Add-In supported functions

The Add-In supports the following tracking functions:

- Centerline tracking
  (Corrections are applied for Y/Z)
- Height tracking only
  (Corrections are only applied to Z)
- Y-tracking only
  (Corrections are only applied to Y)
- Inverted Centerline
  (Corrections are applied for -Y/-Z on “outside corners”)
- Single side tracking Right
  (Corrections are only applied to Y Right side in path coordinate system)
- Single side tracking Left
  (Corrections are only applied to Y Left side in path coordinate system)

In a MultiMove environment, up to two robots are supported.

Limitations

- The option [815-2] Weldguide MultiPass and [1553-1] Tracking Interface cannot be used in the same robot task. Either [1553-1] Tracking Interface or [815-2] Weldguide Multipass can be used. In a MultiMove environment, each task can have one of these options.
- Adaptive functionality is not yet supported.
- Limited support of track modes. Only the modes listed above are supported.
- Aluminum welding and TPSi Seam tracking is not supported until further notice.

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- See section *Single side tracking on page 27* for more information regarding limitations and best practices.

Fronius TPS/i Tracking Add-In

The Fronius TPSi Add-In consists of the following software components:

- Ready to track Interface with a Fronius TPS 320i, TPS 400i, TPS 500i and TPS 600i welder
- Graphical Weave and Track data editor
- Graphical Widget displaying run-time data
- MultiPass support. See *Operating manual - Seam tracking with Weldguide IV and MultiPass 3HAC054886-001* for more information regarding the MultiPass instructions.

2.2 Hardware installation

Seam tracking function

No additional hardware is needed for the seam tracking function. The Fronius TPS/i seam tracking function is totally software based.

Fronius TPS/i welding interface

If you use the Fronius TPS/i welding interface, you need to set up the power source as described in *Application manual - Fronius TPS 320i/400i/500i/600i with RI-FB Inside/I interface 3HAC065012-001*.

Note

The Fronius TPS/i welding interface is available for free and can be downloaded from the **Add-Ins** tab in Robotstudio. (Common tags: RobotWare-Addin)

2.3 Software installation

2.3.1 Fronius TPS/i Tracking and Signals

Fronius TPS/i Tracking Add-In

The Fronius TPSi Seam Tracking add-in is available for free and and can be downloaded from the **Add-Ins** tab in Robotstudio. (Common tags: RobotWare-Addin)

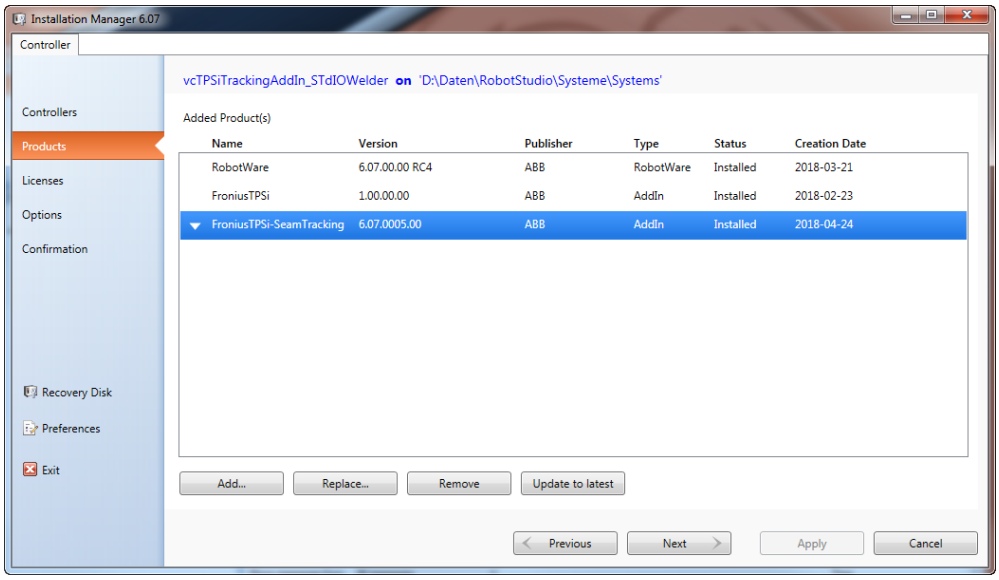
Start the Installation Manager and build your robot system.

Note

You need a valid license key for your robot controller for the option Tracking Interface [1553-1]. Tracking will be disabled if the option is missing in the controller.

Note

Do not forget to add the Fronius TPS/i Seam Tracking product in the **Products** tab. You do not need a license for the package.



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Select the option **Install Trough Arc Seam Tracking** option for each welding robot in the **Drive Module** section (**Option** tab) since the option can be installed

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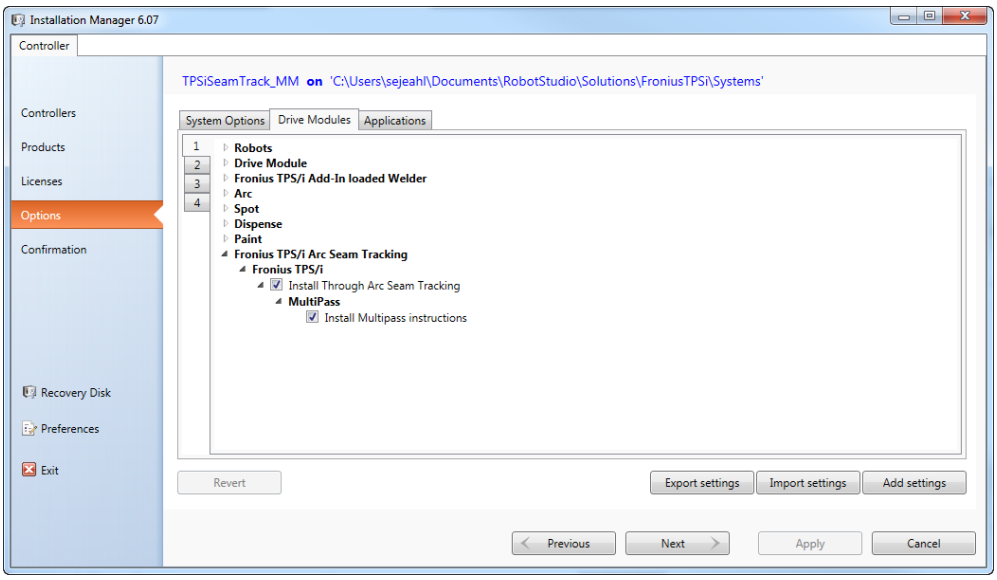
individually for each welding robot. Select **Install MultiPass instructions** to get MultiPass support.



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Apply your settings and download the system to the controller.

Feedback signal

The Fronius TPS/i power source provides a feedback signal (analog input) on the fieldbus that is used with the tracking option.

If you have chosen the TPS/i add-in package as your preferred welding interface, then the feedback signal is already pre-defined on the fieldbus and configured in the process parameters, ready to use.

If you use the StdIoWelder interface and have done your own fieldbus configuration (EIO mapping), then you must make sure to have the correct signal configuration (mapping) in your system. The feedback signal can have any names and you can follow your own naming convention. Just connect the signal in the process configuration and re-start the controller.

EIO Mapping

Parameter	Default value
Name	aiFr1SeamTrack (Can be any name)
SignalType	AI
Device	ioFroniusTPSi1 (your IO unit)
DeviceMap	112-127
EncType	UNSIGNED
MaxLog	10000
MayPys	10
MaxPhysLimit	10
MaxBitVal	10000

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2.3.1 Fronius TPS/i Tracking and Signals
Continued

EIO.cfg

- Name "aiFr1SeamTrack" -SignalType "AI" -Device "ioFroniusTPSi1"\
- DeviceMap "112-127" -EncType "UNSIGNED" -MaxLog 10000 -MaxPhys 10\
- MaxPhysLimit 10 -MaxBitVal 10000 -Category "Arc_1_R1"

2.3.2 System parameters

Overview

The Fronius TPS/i Seam Tracking function and settings are automatically activated after the controller is booted with the TPS/i Seam Tracking option. However, the system parameters for the tracking function can be modified using the FlexPendant or RobotStudio.

The parameters belong to the type *Fronius TPS/i Tracking Properties* in the topic *Process*.

For more information about system parameters, see *Technical reference manual - System parameters*.

Type Fronius TPS/i Tracking Properties

Parameter	Data type	Description
Name	string	The name of the Fronius TPS/i Tracking Equipment Properties.
Max Incremental Correction	num	The maximum allowed incremental corrections per weave. A good value is 0.5 mm. You may can increase the value but depending on the robot type and weave frequency the system might oscillate and result in bad tracking behavior Unit: mm Default value 0.5 mm Min value: 0 mm Max value:2 mm
Weave Correction Delay	num	Number of weave cycles before correction values are applied to the path. Parameter can be used to skip a number of defined cycles if the welding process is unstable in the beginning. Unit: num value Default value 1 Min value: 1 Max value: 15
Pattern Sync Threshold	num	The coordination position at the extents of the weaving pattern. It is specified as a percentage of the width on either side of the weaving center. When weaving is carried out beyond this point, a digital output signal is automatically set. Default value: 95% Min value: 0 Max value: 100
Stop Process DO	signaldo	Not yet implemented. Reserved for future use.
Feedback Signal AI	signalai	The name of the feedback signal as configured on the fieldbus.
LogFile	string	The name for the trackog log file. The logfile will be generated and stored in the robots HOME folder.

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2.3.2 System parameters
Continued

Parameter	Data type	Description
LogFile Size	num	The size of the tracklog ring buffer that is the number of sensor measurements that can be buffered during tracking Unit: measurements Default value: 1000 Min value: 1000 Max value: 10000
Number of Measurements	num	The number of measurements taken at the extents of the weave pattern. A mean value is carried out and sent as a correction if more than 1 measurement is taken Default value: 1 Min value: 1 Max value: 5
Max correction warning	Bool	If this parameter is enabled, program execution is not interrupted, when the limit for maximum correction, specified in the trackdata, is exceeded. Only a warning will be sent. Default value: FALSE
Correction Threshold	num	The minimum calculated correction in mm that are needed before the corrections are sent to the controller. Unit: mm Default value: 0.1 Min value: 0 Max value: 2
Correction Threshold Y	num	This as a unit less parameter. It is the minimum feedback value that need to be exceeded before corrections in Y are applied to the controller. Can be used to filter some noise or other disturbances. A higher value will result in a less sensitive tracking system Default value: 50 Min value: 0 Max value: 500
Correction Threshold Z	num	This as a unit less parameter. It is the minimum feedback value that need to be exceeded before corrections in Z are applied to the controller. Can be used to filter some noise or other disturbances. A higher value will result in a less sensitive tracking system Default value: 50 Min value: 0 Max value: 500
Sample Time	num	Sample time in milliseconds for the correction loop. The value is rounded to a multiple of 24. The minimum value allowed is 24 Unit: milliseconds Default value: 24 Min value: 24 Max value: 240

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Parameter	Data type	Description
Simulator used	bool	Not yet implemented. Reserved for future use. Default value: FALSE

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3 Seam tracking

3.1 Tracking methods

Introduction

A through-the-arc tracking system uses the arc as a sensor to adjust the robot path to the actual location of the part. Measuring the arc voltage and welding current, synchronized with the robot weave pattern, the stick-out length is calculated on both sides and in the middle of the weld. The stick-out length in the middle and the difference between the sides are converted in to robot vertical and horizontal corrections. It is necessary to understand that there are several tracking modes as well as understanding their relation-ship within the tracking process.

The tracking methods described below are controlled by the data type trackdata.

Note

Well-functioning seam tracking with an arc sensor requires that the welding process should be adjusted to be stable, so that the arc length can be significantly changed for seam tracking purposes without destabilizing the process. If there are drastic changes in the weld process (instability) the system will react in a drastic manor (i.e. the torch dives into the part or the torch loses the seam and wanders all over the welding surface).

The following peripheral conditions prevent seam tracking with an arc sensor:

- Disturbances in the process that interfere too strongly with the length change signals;
- De-adjustment of the process during welding (e.g. ramps);
- Inappropriate settings for the welding process

Note

Make sure you have a good and reliable welding process before activating seam tracking.

Note

Geometric Weaving shall be used for tracking.

From Firmware TPSi_V2.1.0 and onwards, Fronius provides a functionality to get an optimal stick-out based on the selected synergic line. The reference value is 5000. By selecting a reference of 5000, the robot will always use the stick-out that was defined when Fronius developed the selected synergic line.

Definition optimal stick-out - Fronius defines the optimal stick-out based on welding power. For example, at a wire feed speed of 5 m/min the optimal stick-out is 12 mm, and for 12 m/min the optimal stick-out is 15 mm.

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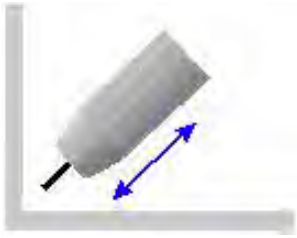
The advantage of this concept is:

- The reference value does not change if the welding power changes (same reference for wire feed speed of 1 m/min to 30 m/min)
- The reference value does not change if the process changes (same for Puls / PMC / LSC / Standard and CMT)

Torch to work tracking (height, Z direction)

In torch-to-work mode, the same contact tip to work length is maintained. The contact tip to work distance is specified as reference data stored in the trackdata. No weaving is required. Measurements are taken at a fixed frequency of 10 Hz.



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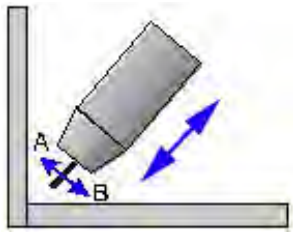
Centerline tracking

Centerline tracking is the most commonly used tracking method. For centerline tracking the height corrections are based on measurements taken in the zero crossing of the weave pattern (in the middle of the pattern), while Y corrections are based on measurement made on the sides of the weave pattern. The position of the weld can be adjusted side to side using the bias.



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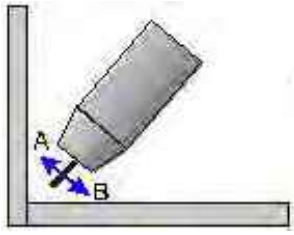
Side tracking (Y-direction only)

In this track mode only Y corrections are calculated based on measurement made on the sides of the weave pattern. The position of the weld can be adjusted side to side using the bias.



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Inverted centerline tracking

For inverted centerline tracking, make sure to use v-shaped weaving and negative height. See data types weavedata and trackdata in *Application manual - Arc and Arc Sensor*.

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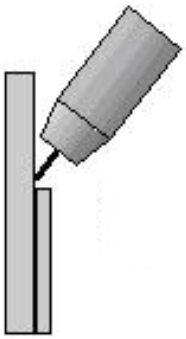
Single side tracking (right and left)

The difference between the centerline tracking method and the single side method is that when using the single side method, data from one side of the weave is used, and compared with the reference value. No corrections are applied in the Z direction, only in Y direction.

The reference value could also be used as a form of weld penetration level. A higher value for the reference value means shorter stick out and higher penetration. A higher penetration level makes the weld move further into the selected side. This method can be used when tracking a lap joint, were the arc might consume one of the sides of the grove.

The position of the weld can be adjusted to the side using the bias component in the data type trackdata.



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Note

See section *Single side tracking on page 27* for more information.

3.2 Tracking parameters

Gain_Y - Horizontal Gain

The recommended starting value is 20. This gain is used to increase or decrease the response of the cross-seam (horizontal) tracking. The lower the number the slower the system will respond to a change of seam direction. This variable impacts the stability of weld bead center. If the weld bead center position is oscillating, (snake shape weld bead) decrease this parameter. If the center position is slow to respond to a change in the center position, increase this parameter.

Gain_Z - Vertical Gain

The recommended starting value is 30. This gain is used to increase or decrease the response of the torch height (vertical) tracking. The lower the number the slower the system will respond to changes to the work surface or geometry. This variable impacts the stability of torch height. If the torch position is oscillating (moving up and down constantly), decrease this parameter. If the torch position is slow to respond to a change in position, increase this parameter.

3.3 Best practice

Installation & setup workflow

1. Install a system with the Fronius TPSi Seam Tracking add-in.
2. Configure the system to be able to weld.
3. Create a simple weld routine with weaving (e.g. for a T-joint) and develop your welddata. Use the graphical editor to define weave data.
4. Perform a couple of welds to make sure you have a stable weld process.
5. At the optional argument \Track and define your trackdata (use the graphical editor). Use Centerline tracking.
6. Check that the track system is set to 2.

   Step 7 and 8 are only needed if you don't use the reference value of 5000.
7. Block tracking and enable SeamTrack Reference value calculation in the widget (**Enable** button).
8. Weld your seam. At the end the widget will present the reference value for the height corrections and you can update your trackdata by pressing **Update Data**.

Example procedure

For this simple example (fillet joint), the following parameters have been used:

Weave parameter

Parameter	Value
Weave length	2 mm
Weave width	3 mm
Weave shape	Zig-zag
Weave type	Geometric

Track parameter

Parameter	Value
Maximum correction	20 mm
Gain Y	20
Gain Z	30
Reference	5000
Track Bias	0

Weld parameter

TPS/i has been operated in Program Mode.

Parameter	Value
Weld speed	7 mm/s
MIG PMC Process	Synergic line 3189
Wiresize	1.2 mm

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Parameter	Value
Gas	AR+15-20%CO2
Wirefeed Speed	8.5 m/min
ArcLength Correction	-1.5
Pulse/Dynamic Correction	0
ArcLength stabilizer	0.4

Simple RAPID code

```
TASK PERS weavedata wv1:=[1,0,2,2.5,0,0,0,0,0,0,0,0,0,0,0];
TASK PERS trackdata tr1:=[2,FALSE,30,[0,20,30,5000,0,0,0,0,0],[0,0,0,0,0,0,0]];

PROC rWeldSample()
    MoveJ pApproach, v1000, z50, tWeldGun\WObj:=wobjSTN1;
    ArcLStart pArcStart, v1000, sm1, wd1\Weave:=wv1, fine, tWeldGun\WObj:=wobjSTN1\Track:=tr1\SeamName:="WeldSample";
    ArcLEnd pArcEnd, v1000, sm1, wd1\Weave:=wv1, fine, tWeldGun\WObj:=wobjSTN1\Track:=tr1;
    MoveJ pDepart, v1000, z50, tWeldGun\WObj:=wobjSTN1;
ENDPROC
```

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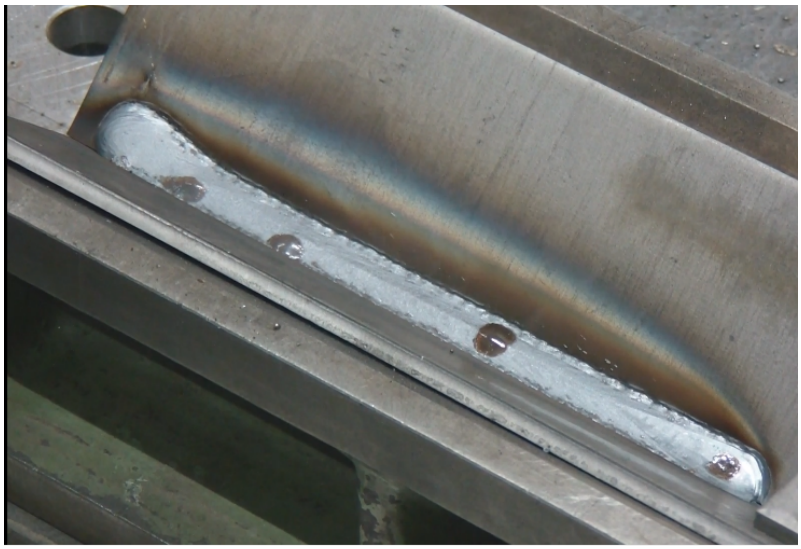
Active tracking

The robtargets for the Start/via and End positions have been offset by approximately 10 mm to the left side and then welded with active tracking. The path has been corrected and is placed in the center of the groove.



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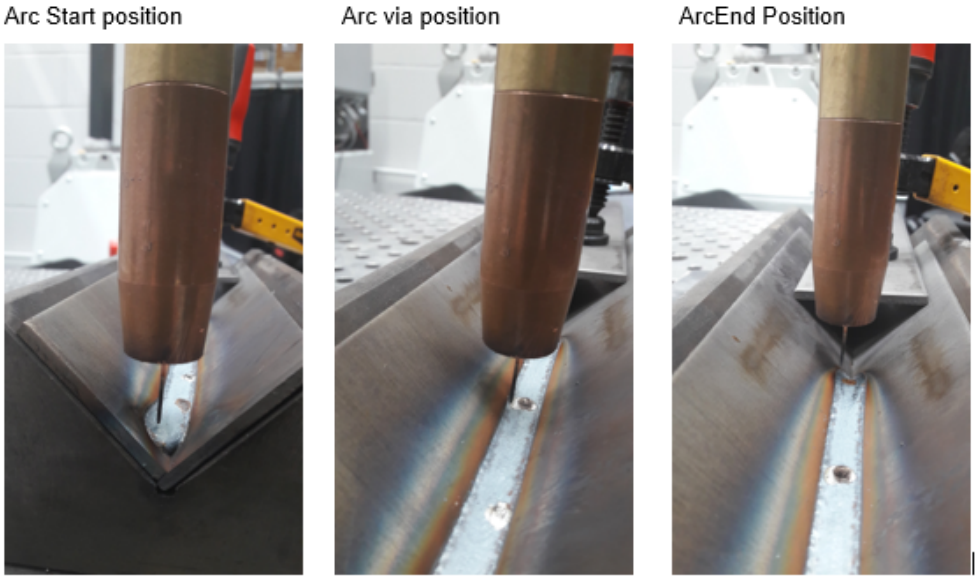
Robot position



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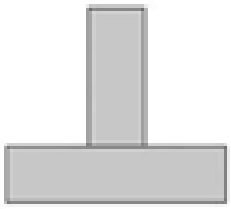
Single side tracking

Single Side tracking with Fronius TPS/i is best suited for Tee Joint type of welds.



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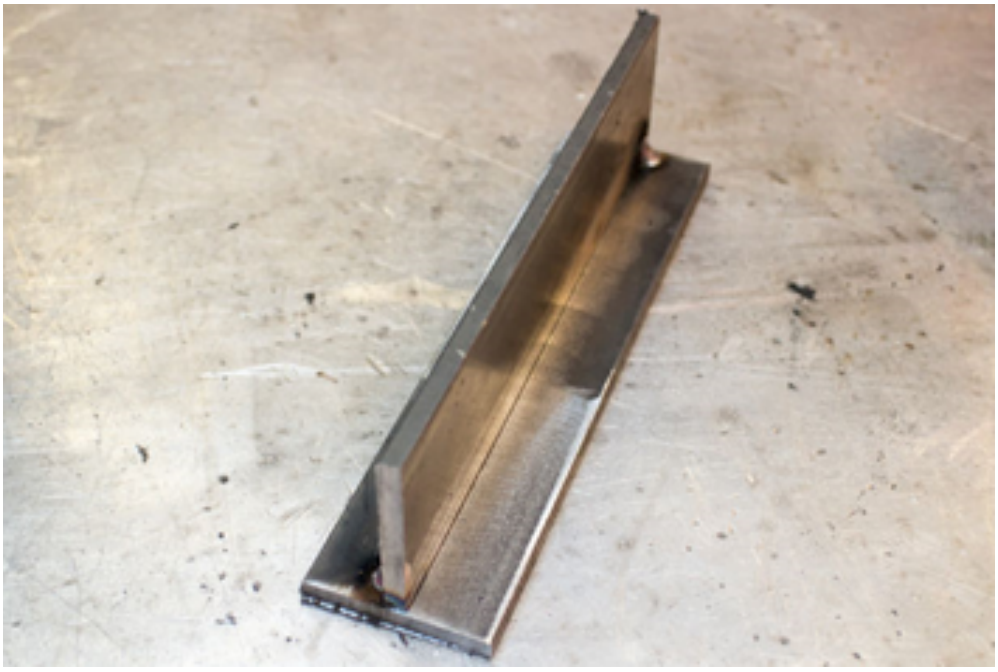

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There can be problems using Single side tracking on Overlap type of weld joints.

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The problem appears in the way that the Robot TCP can move over the edge of the top metal plate. Once the Robot TCP is over the edge, max incremental correction is applied since no side is detected. The robot will stop once the Max correction is reached.

If there is a problem or not depends on a lot of factors, the weave width for example. If the weave width is close to the edges, then there is a higher probability of getting problems.

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On overlap seams, the recommendation is to use centerline tracking with active track bias to the desired side.

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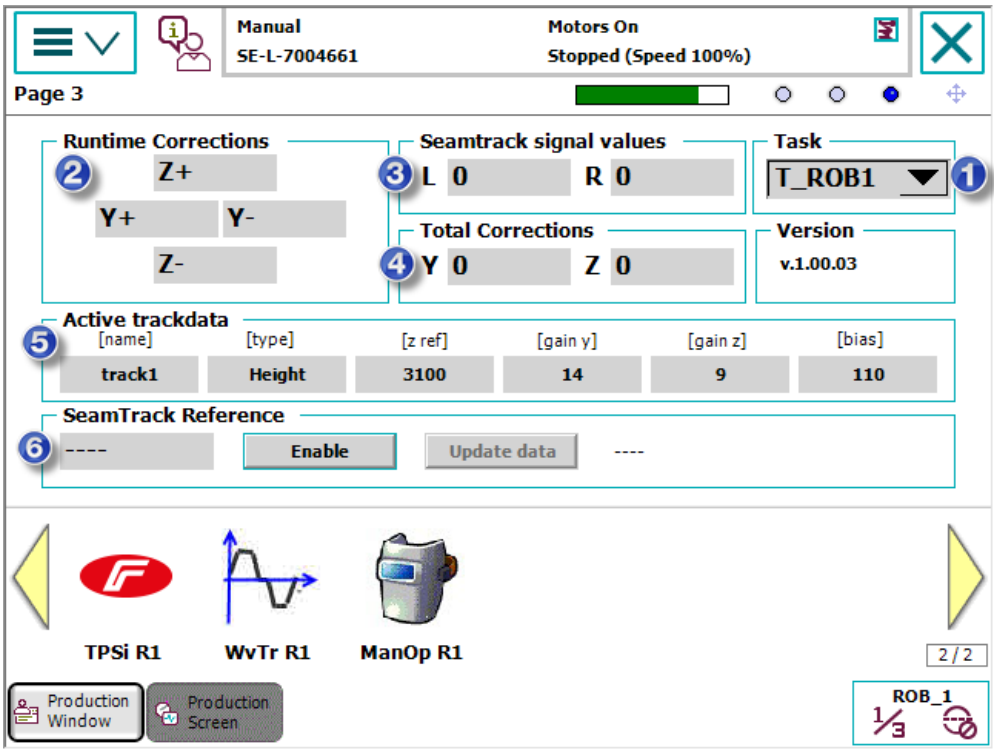
4 Runtime widget

General

The tracking runtime widget can be used to get the reference value for the height corrections. In addition, it has useful information of the current applied corrections and the accumulated corrections as well as present trackdata values.

The widget is shown on page 3 within the Production Screen Application.



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The following data is presented in the runtime widget:

1. Task selection to select the active welding robot.
2. Currently applied corrections for Y and Z direction [mm].
3. Feedback value from the welder taken on the left/right side of the weave pattern.
4. Total corrections in seam coordinate system per weld [mm].
5. Active trackdata of current weld with information about trackdata name, type (Centerline, Height, Y only), Z reference, gain y, gain z, and bias.
6. SeamTrack Reference calculation. Press **Enable** to start collecting data from the weld. Once the weld is finished, the SeamTrack Reference value will be green and the text will say Complete… If the **Update data** button is pressed, the current z ref value in the **Active trackdata** will be updated. Press the **Enable** button to disable the SeamTrack Reference calculations.

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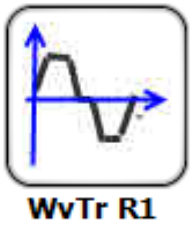
5 Weave and track data editor interface

Overview

The tracking option provides a nice and convenient way to edit weavedata and trackdata using a graphical interface (editor).

The editor can be started from the Production Screen Application. Simply start the Production Screen and press **WvTrR1** to launch the editor for Robot1. Each welding robot has its own editor.



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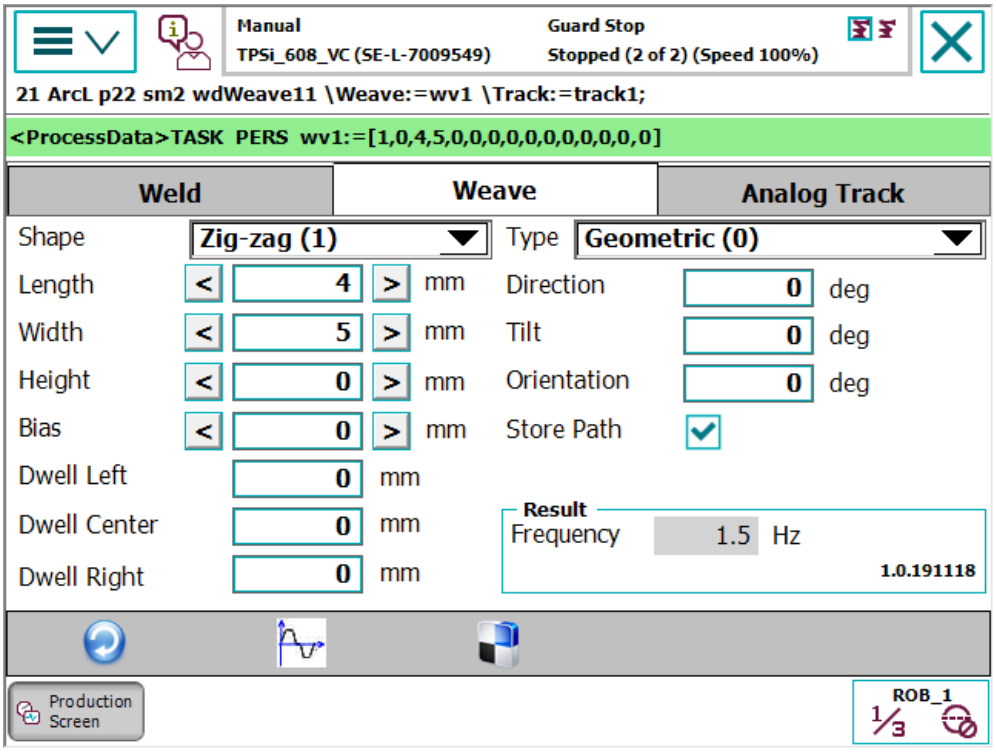
Weave editor

The **Weave** data editor tab presents the current data where the program pointer is. Data can only be changed in manual mode. Manual mode is indicated with a green status bar.



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With the help of the **Weave** data editor you can edit your current weave data. Additional information and a description of the parameters can be found in *Application manual - Arc and Arc Sensor 3HAC050988-001*.

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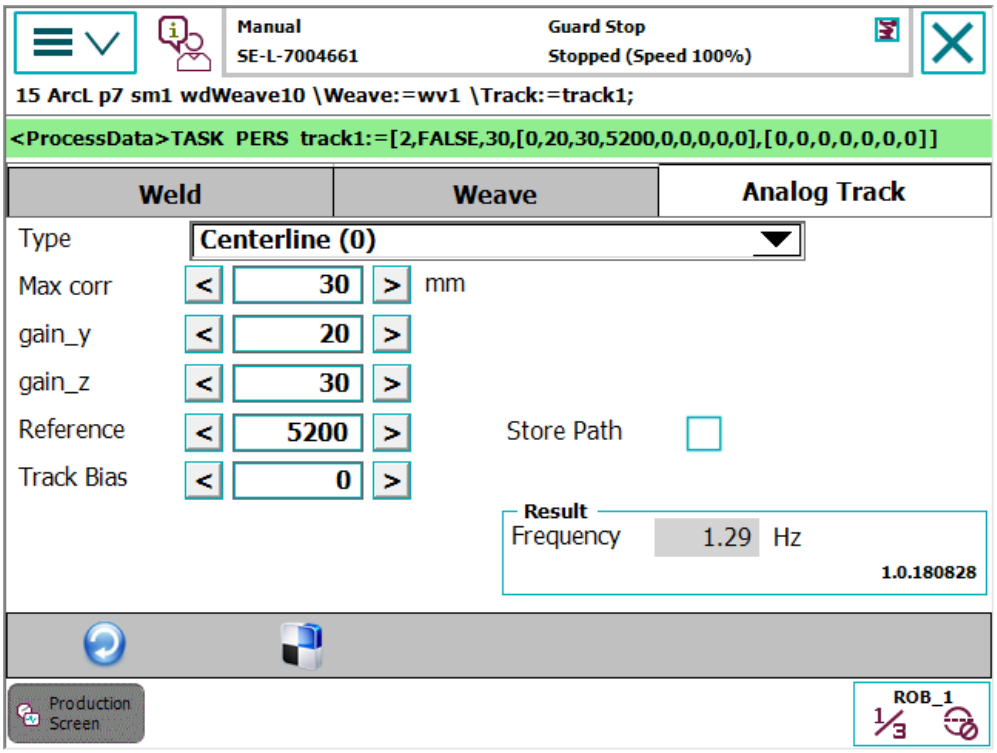
Track data editor

The **Analog Track** data editor tab presents the current data where the program pointer is. Data can only be changed in manual mode. Manual mode is indicated with a green status bar.



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With the help of the track data editor you can edit your current track data. The following parameters can be changed/set:

Parameter	Value
Type	Select your track type. The following types are supported: • Centerline • Height Only (Torch to work) • Y-Corrections only • Inverted Centerline • Single Side R + L
Max correction	The maximum allowed path correction If the TCP is offset more than max_corr by path corrections a track error is reported and program execution is stopped (depending on the Boolean Flag, MaxCorrWarning)
Gain Y	The gain_y parameters define how big of a correction is sent to the robot. The higher the number the faster the system corrects. The range of this parameter is from 1 to 100. Initial starting values for this parameter depend on weave size. Start with 30 for most weave widths and 5 for very small weave widths.
Gain Z	The gain_z parameters define how big of a correction is sent to the robot. The higher the number the faster the system corrects. The range of this parameter is from 1 to 100. Initial starting values for this parameter depend on weave size. Start with 30 for most weave widths and 5 for very small weave widths.

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Parameter	Value
Reference	The reference value for the height corrections (Z).
Track Bias	The bias parameter is used to move the TCP in the seam y direction to bias (offset) one side of the joint or the other. The range for this parameter is from -512 to +512 where +512 is the highest amount of bias achievable in the plus Y direction of the seam coordinates. Used in center line-tracking only.
Store path	A checkbox to enable the store_path component in trackdata. Used for saving the path with MultiPass.

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