SIEMENS

SIMOVE

ANS+

System Manual

2.2.0

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

CAUTION
indicates that minor personal injury can result if proper precautions are not taken.

NOTICE
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified persons are those who, because of their training and experience, are familiar with the installation, assembly, commissioning, operation, decommissioning and disassembly of the product and can recognize risks and avoid possible hazards.

Proper use of Siemens products

Note the following:

WARNING
Siemens products may only be used for the application described in the catalog and the associated usage information. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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1 Introduction

1.1 Requirements

Note

This documentation is related to the ANS+ Engineering Tool (ANS+ ET) version 1.7.0 and ANS+ Navigation Control (ANS+ NC) module version 2.2.0.

All screenshots have been taken out of the universal SFTP and SSH tool "MobaXterm" in combination with the SIMATIC IPC127E. Screenshots can differ in case of using the SIMATIC Open Controller 2, SIMATIC IPC227G or SIMATIC BX-21A devices.

Requirements

Operating System on an engineering or server PC

- Windows 10

Files

- ANS+ Engineering Tool file package

Installed software

- Web browser, for example Google Chrome (preferred)
- Unzip software, for example 7-Zip
- SSH tool, for example Putty, MobaXterm
- SFTP tool, for example WinSCP, MobaXterm
- Network analyzer, for example PRONETA

Devices

- Manual AGV control device, (Laser) Measurement device

1.2 Compatibility

SIMOVE ANS+ is preferably used in combination with the SIMOVE Carrier Control system. To use all SIMOVE features, it is recommended to use the latest versions of both systems. The compatibility between those systems is as follows:

SIMOVE ANS+ and Carrier Control compatibility matrix

	ANS+ NC V1.7.X	ANS+ NC V2.0.0	ANS+ NC V2.1.0	ANS+ NC V2.2.0
CC V3.0	X	X*	X*	X*
CC V3.1 HF1	X	X*	X*	X*
CC V3.2 HF1	X	X*	X*	X*
CC V3.3	X	X*	X*	X*
CC V3.3 Upd1	X	X	X*	X*
CC V3.4	X	X	X	X*
CC V3.5	X	X	X	X

* SIMOVE Carrier Control ANS+ function block compatible with limited functional scope

Compatible Hardware for SIMOVE ANS+

Note

All runtime platform variants require 4-core processors.

Runtime Platform	
SIMATIC IPC 227G	Recommended use of min. Ind OS v4.1
SIMATIC IPC BX-21A	Full functional scope
SIMATIC IPC 127E	VOA with 1 camera only
Open Controller 2	Without Motion & VOA

Laser Scanners	
SICK TiM561-2050101	Order number 1071419
SICK TiM571-2050101	Order number 1075091
SICK TiM781S-2174104	Order number 1096363
SICK outdoorScan3	MICS3-CBUZ40IZ1, order number 1094471
SICK nanoScan3	NANS3-CAAZ30AN1
SICK Picoscan100	PICS150-01000, one device
SICK microScan3 Core & Pro	Resolution 0.385° & 0.1°
SICK NAV310	Order number 1060834
Pepperl & Fuchs R2000 60m UHD	OMD60M-R2000-B23-V1V1D-1L
Pepperl & Fuchs R2000 30m UHD	OMD30M-R2000-B23-V1V1D-1L
Pepperl & Fuchs R2000 30m HD	OMD30M-R2000-B23-V1V1D-HD-1L

Laser Scanners	
Pepperl & Fuchs R2000 25m SD	OMD25M-R2000-B23-V1V1D-SD-1L
Leuze RSL235	RSL235-S/12-M12
Leuze RSL425	S,M,L,XL / CU416
Leuze RSL445	S,M,L,XL / CU429
Leuze RSL455P	S,M,L,XL / CU400P-3M12
KEYENCE SZ-V32N	
Hinson LE50821FA	

Cameras	
Intel RealSense D435	EAN 5032037110334
Intel RealSense D456	EAN 5032037225984

1.3 Terms of use

WARNING

User must secure access to the ANS+ ET

The ANS+ ET is a web-based application and has a limited user handling. It is the responsibility of the user to log out. Furthermore, the user has the responsibility to avoid access of third persons, who could misuse the tool for manipulation of data, engineered tracks or identification points. Misuse by third persons can be avoided by changing the default user passwords.

WARNING

AGV safety fields: Avoid collisions

To avoid collisions while driving manually or automatically with the ANS+ system, the safety fields of the AGV always need to be commissioned and activated.

1.4 Linux OS handling

WARNING

System files sensitive to typing errors

Linux system files are sensitive to typing errors. Before saving and leaving files, ensure that no mistype or wrong letter has been inserted into the file. Otherwise, it might be required to reconfigure the Linux OS with an external monitor and keyboard in case of failures.

Note

No password characters in the terminal

In Linux based OS, it is common that password characters are not shown in the terminal. A password therefore needs to be typed in blinded.

1.5 Cybersecurity

1.5.1 Cybersecurity information

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines, and networks.

In order to protect plants, systems, machines, and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial cybersecurity concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For more information on protective industrial cybersecurity measures for implementation, please visit (https://www.siemens.com/global/en/products/automation/topic-areas/industrial-cybersecurity.html).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates at all times, subscribe to the Siemens Industrial Cybersecurity RSS Feed under (https://www.siemens.com/global/en/products/services/cert.html).

1.5.2 Cybersecurity guidelines

Observe the following cybersecurity guidelines for a secure operation.

Operating environment

- Only operate SIMOVE ANS+ on supported hardware.
  - A list of the supported hardware devices for this version can be found in chapter Compatibility (Page 8).
- Only operate SIMOVE ANS+ in a secure network.
  - Appropriate security measures (for example firewalls and/or network segmentation) are in place.
  - Use separate network for on-premise AGV communication.
- SIMOVE ANS+ must run on Siemens Industrial OS.
  - Update Siemens Industrial OS to contain newest security patches.

Software from trusted sources

- Only install signed SW from trusted sources.
  - Instructions on how to check the certificate on ANS+ can be found in chapter ANS+ V2.2.0 installation (Page 24).

Commissioning

Initial commissioning of the software on the AGV must be done in a secure environment.

- If self-signed https / SSL certificates are used, the initial connection to ANS+ engineering tool must be done via Ethernet cable.
  After accepting the connection, a warning will be displayed permanently in the top left corner of the browser.

Replacement of self-signed SSL certificates

- As the IP of the PC hosting ANS+ varies, the connection between ANS and ANS ET uses self-signed https / SSL certificates that are generated at the initial startup of ANS+.
- It is recommended to replace the default SSL certificates with certificates from a certificate authority (CA) trusted by your company or generated by your company issued for the IP of the respective IPC (see chapter "Replacing the SSL certificates for the connection to ANS ET (Page 14)").

Secure access

- It is the responsibility of the user to log out of the ANS+ ET. An automatic logout happens after a default time of 15 minutes with no user activity.
- Furthermore, the user has the responsibility to avoid access of third persons, who could misuse the tool for manipulation of data, engineered tracks or identification points.
- To avoid the misuse by third persons, the default password must be changed at initial login.
  - The user must select a secure password.

Least functionality

- All unused network ports as well as all unused modules in ANS+ should be deactivated, so that the software is operated with least functionality.

Backup user data

- Save a backup of the software including the folder “application_data” after commissioning.
- Save the backup in a secure location outside of the runtime hardware to ensure the system can be restored in case of hardware issues.

Security updates

- All security updates that were made available for SIMOVE ANS+ must be installed.
- Siemens is not responsible for security in third party software components.

Vulnerability

Siemens ProductCERT investigates all reports of security issues and publishes security advisories for validated security vulnerabilities that directly involve Siemens products and require applying an update, performing an upgrade, or other customer action. As part of the ongoing effort to help operators manage security risks and help keep systems protected, Siemens ProductCERT discloses the required information necessary for operators to assess the impact of a security vulnerability.

- Report security vulnerabilities via Siemens ProductCERT and Siemens CERT (https://www.siemens.com/global/en/products/services/cert.html).
  Information about available security updates for ANS+ is also available via Siemens ProductCERT under security advisories.

Secure disposal guidelines

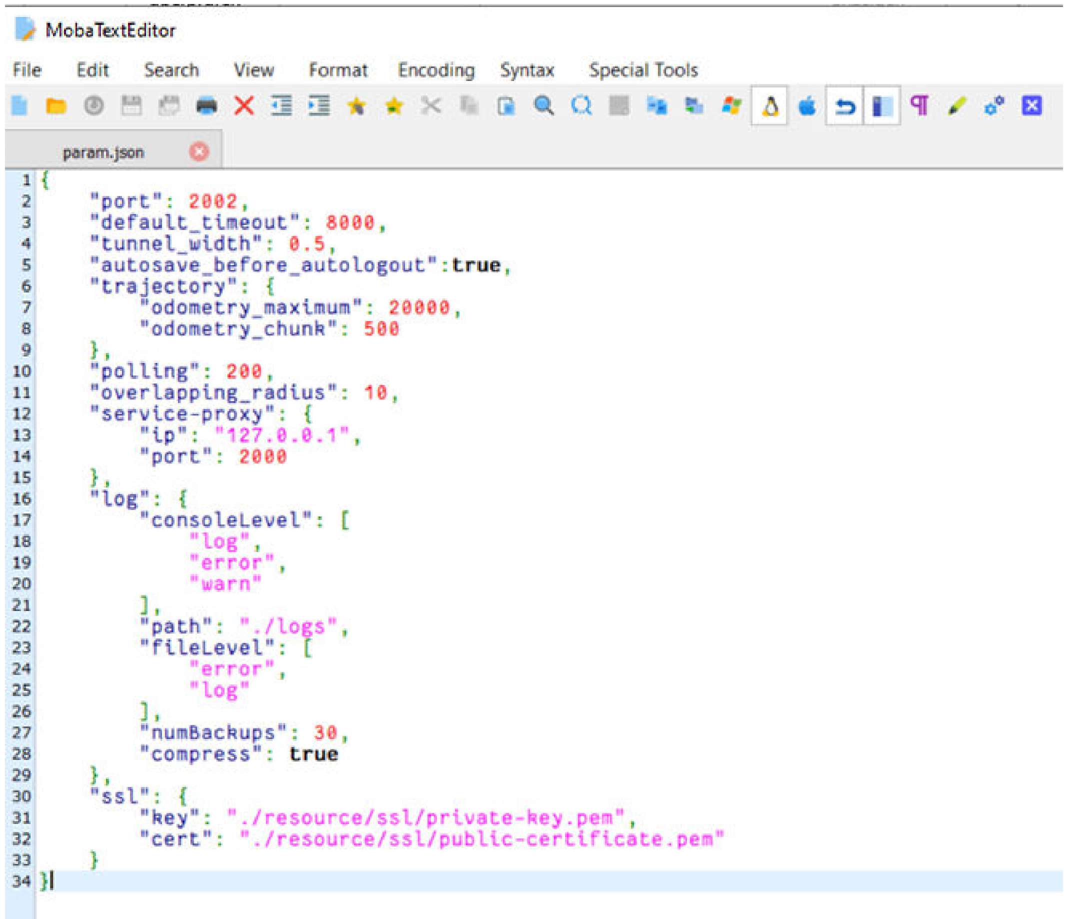
- All personal user data (atlas, user accounts, passwords, deployment commits) must be deleted before disposing of the runtime platform.

1.5.3 Replacing the SSL certificates for the connection to ANS ET

Replace the default certificates used for the connection to ANS ET by following these steps:

1. Connect to the SIMATIC Industrial OS with a SFTP and SSH tool.
2. Navigate to
   `simove_ans+/application_data/workspace/user_interface/resource/ssl`
3. Delete all existing files in the SSL folder.
4. Add your own certificate files to the SSL folder.
5. Navigate to
   `simove_ans+/application_data/workspace/user_interface/resource`
   `and open the file param.json`

6. In the section SSL, replace the key and cert file names with the file names of your own certificates.
7. Save change and restart docker container with docker-compose down and docker-compose up.




```
{
    "port": 2002,
    "default_timeout": 8000,
    "tunnel_width": 0.5,
    "autosave_before_autologout":true,
    "trajectory": {
        "odometry_maximum": 20000,
        "odometry_chunk": 500
    },
    "polling": 200,
    "overlapping_radius": 10,
    "service-proxy": {
        "ip": "127.0.0.1",
        "port": 2000
    },
    "log": {
        "consoleLevel": [
            "log",
            "error",
            "warn"
        ],
        "path": "./logs",
        "fileLevel": [
            "error",
            "log"
        ],
        "numBackups": 30,
        "compress": true
    },
    "ssl": {
        "key": "./resource/ssl/private-key.pem",
        "cert": "./resource/ssl/public-certificate.pem"
    }
}
```

Figure 1-1 Param.json

Commissioning 2

2.1 Required hardware and additional programs

SIMOVE ANS+ requires hardware with the preinstalled operating system SIMATIC Industrial OS. A description for the installation of Industrial OS on the IPC can be found within SIMATIC Industrial OS (https://support.industry.siemens.com/cs/ww/en/view/109766374).

SIMATIC Industrial OS can be installed on a SIMATIC Open Controller 2 and the SIMATIC IPC.

There are different versions currently available within SIOS:

- SIMATIC Industrial OS v2.X (Debian 10)
- SIMATIC Industrial OS v3.X (Debian 11)
- SIMATIC Industrial OS v4.X (Debian 12)

Starting with v2.2.0, ANS+ is provided within a Docker container. The tool docker-compose is used for running multi-container Docker applications. Therefore, a YAML file is provided, to start the services within docker-compose.

Note

Docker and Docker-compose as well as the kernel feature full preemption must be installed on Industrial OS in advance.

For the creation of this document, the toolbox MobaXTerm has been used. Alternatively, any other SSH client such as PuTTY and other programs for file transfer such as WinSCP can be used.

2.2 Step-by-step commissioning guidance

This chapter provides an overview of relevant components and requirements that must be commissioned and fulfilled before any ANS+ engineering process, such as mapping, is started. The illustration provides a schematic overview of all mandatory steps in the required order.

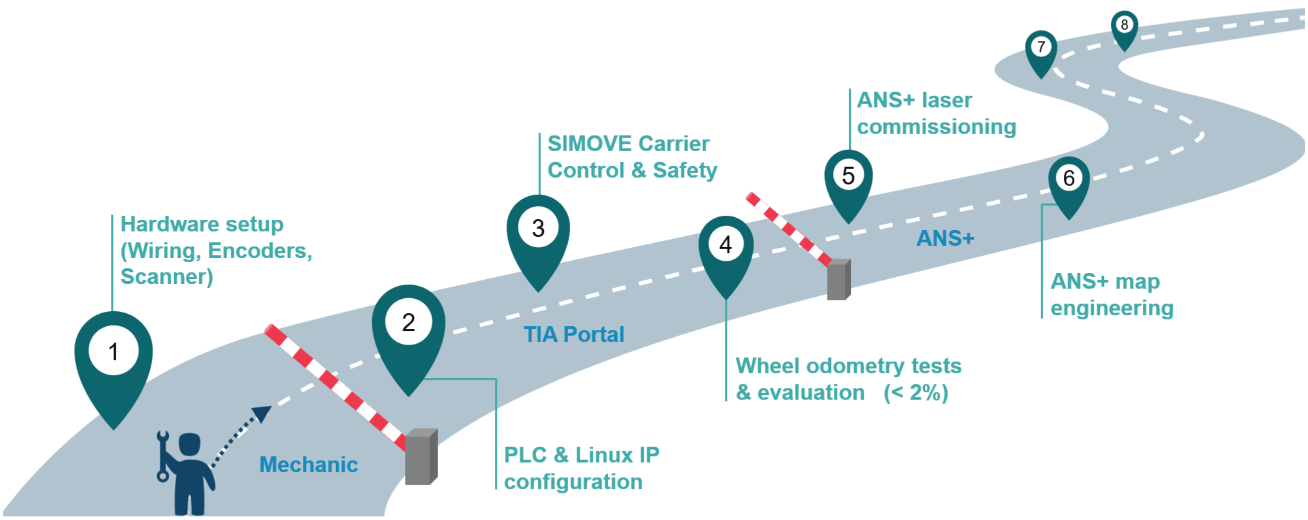


Figure 2-1 Overview of commissioning steps

2.2.1 Hardware setup

Before adjusting any software, it is necessary to finish the hardware setup of the AGV. The following list provides an exemplary overview of mandatory steps:

- Electrical wiring check
- Encoders referencing
- Laser scanner mechanical alignment

2.2.2 Network configuration

As a next step, the network configuration of the AGV needs to be set up. The main components are:

- PROFINET devices:
  TIA Portal can be used to configure IP addresses of PROFINET devices.
- SIMATIC Industrial OS:
  To adjust the SIMATIC Industrial OS IP permanently, follow the guidance described in the Industrial OS manual, e.g. using the tool “nmtui”.
- Laser scanner:
  Each laser scanner device has its own configuration software too, which can be downloaded from the related manufacturer’s webpage. The chapter "Laser configuration examples (Page 247)" provides configuration examples for ANS+ compatible laser scanner devices.

See also

Add and connect to a new device (Page 59)

2.2.3 SIMOVE Carrier Control & Safety

When the hardware and network commissioning is finished, the next step is to integrate and adjust the PLC program.

Three main functions need to be finalized before commissioning ANS+:

- Safety:
  The completion of the AGV safety program is needed for navigating with ANS+. When driving automatically, safety must be fully commissioned and always activated.
- SIMOVE Carrier Control:
  The Carrier Control (CC) library provides customers with necessary functions to set up and operate an AGV with Siemens automation technology. A detailed explanation in how to set up the Carrier Control library can be found in the document “ Getting Started”, which can be obtained via a Siemens Service Requests (see chapter Siemens Support Requests (Page 285)).
- Wheel odometry:
  A mandatory part of the SIMOVE Carrier Control library for ANS+ is the so called “wheel odometry”. This specific program calculates a relative pose out of encoder values related to the startup position of the AGV. This pose data is sent to ANS+ and used for sensor fusion. As SIMOVE ANS+ relies on this data, the precision needs to be as high as possible. The chapter "Odometry initial test (Page 19)" provides more details on how to evaluate the configured wheel odometry.

2.2.4 Odometry initial test

Note

SIMOVE CC Getting Started

PLC specific information related to the wheel odometry is described in the document “SIMOVE CC Getting Started”, which can be obtained via a Siemens Service Requests, see chapter Siemens Support Requests (Page 285).

As wheel odometry is used for sensor fusion in SIMOVE ANS+, the data must be as precise as possible. Therefore, this chapter describes a process for testing and evaluating the configured wheel odometry, which is calculated by the SIMOVE Carrier Control library.

To test and evaluate the wheel odometry, an industrial manual control device for a related AGV is required.

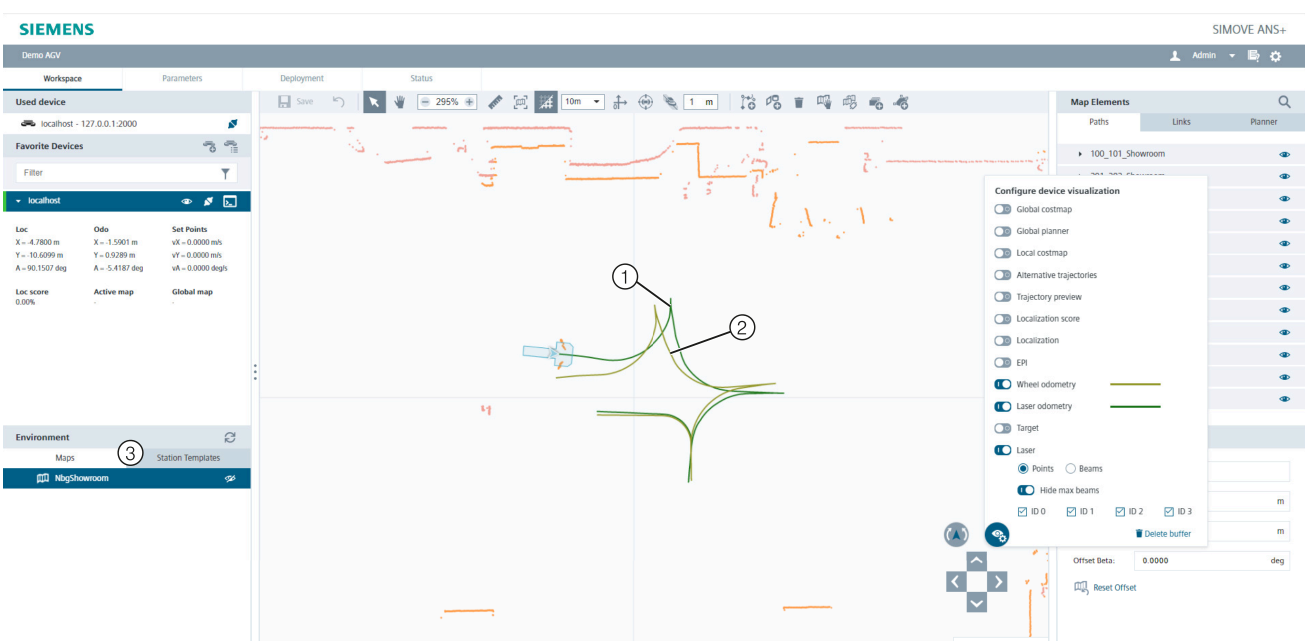
⚠ WARNING
Keep safety fields active
While driving manually with the manual control device, the safety fields always need to be commissioned and activated.

1. Start the ANS+ ET and connect to the web-based UI as described in chapter ANS+ ET User Interface (Page 35).
2. Connect to the related device in the “Favorite Devices” list, as described in chapter Add and connect to a new device (Page 59).
3. If the "Environment window" displays maps, hide all maps by clicking .
4. If the device visualization is deactivated , click the icon in the device window. The icon changes to for an active device visualization.
5. To display AGV history data, use the “visualization configuration panel”.
   Click in the world window.
6. Activate “Wheel odometry” and “Laser odometry”.

7. Before proceeding with an evaluation, ensure that the following tests have been done/passed

Test	Task	Expectation	Possible failures
"vehicle" interface connection	Any manual movement	"Odo" values change and wheel odometry history data is visualized in ANS+ ET	• Stopped PLC • PLC program failure • Wrong network configuration
Positive translation check	Manual movement in +X direction	"Odo X" value increases	• PLC program failure. • Drive commission failure
Negative translation check	Manual movement in -X direction	"Odo X" value decreases	
Positive holonomic translation check	Manual movement in +Y direction	"Odo Y" value increases	
Negative holonomic translation check	Manual movement in -Y direction	"Odo Y" value decreases	
Positive rotation check	Manual counterclockwise rotation	"Odo A" value increases	
Negative rotation check	Manual clockwise rotation	"Odo A" value decreases	

8. In case of a transferred odometry and established connection between the device and the ANS+ ET, the wheel odometry data will be visualized in the world window.



① Laser odometry
② Wheel odometry
③ Maps are hidden

Figure 2-2 Wheel and laser odometry check with manual movements

Note

Laser odometry compensates wheel odometry failures

If the wheel odometry and the laser parameter are commissioned, the laser odometry demonstrates a similar curve history as the wheel odometry. As the laser odometry can compensate wheel odometry failures, the laser odometry history represents a more accurate curve related to the physically driven path.

See also

Remote access (Page 36)

2.2.5 Wheel odometry evaluation

Note

Position accuracy

The odometry plays an important part in position accuracy of the entire AGV. Therefore, the sent odometry needs to be as accurate as possible.

A precise wheel odometry calculation has a failure tolerance of less than 1 % difference between physical measurement and software calculation for translation and rotation.

Before the evaluation process can be started, the wheel odometry initial test must be successfully finished, as described in chapter "Odometry initial test (Page 19)".

To evaluate the precision of the wheel odometry, it is necessary to compare the calculated data to a physical reference value. For this test, the AGV is moved manually with a manual control device in a specific direction, for example +X direction. When the AGV is completely stopped, the driven distance is physically measured and compared with the calculated software values. For this purpose, a laser measurement device is helpful to receive the highest measurement accuracy.

The following process is used for wheel odometry evaluation:

1. Reset the PLC wheel odometry values.
2. Mark the current AGV position on the floor.
3. Move the AGV with a manual control device in a specific direction for a certain distance, for example 1 m.
4. Once the AGV has stopped, measure the physically driven distance with a (laser) measurement device considering the previously marked position.
5. Compare the calculated wheel odometry data, which can be seen in the Carrier Control program at "MoveCtrl"-FB’s output "position", with the physically driven distance and calculate the related failure percentage.
6. To receive a precise reference value, repeat these steps at least three times for each test case in the table.

	Intended	Odometry value	Measured	Error [%]
± X / ± Y	1000 mm			
	-1000 mm			
	2000 mm			
	-2000 mm			
	3000 mm			
	-3000 mm			
± Rotation	90 deg			
	-90 deg			
	360 deg			
	-360 deg			
	2 * 360 deg			
	2 * -360 deg			
	3 * 360 deg			
	3 * -360 deg			

In case of a failure of more than 2 %, adjust the wheel odometry calculation to reduce the odometry failure.

WARNING

Wheel odometry tests

All wheel odometry tests need to be done on every AGV and after each change, which effects the wheel odometry calculation.

2.3 ANS+ V2.2.0 installation

This chapter describes the installation of the software ANS+, which can be requested through the "Siemens Support Requests (Page 285)". The following procedure provides a step-by-step guide:

1. Check the signature of the .exe file via right-click > properties > digital signatures.
   There should be a valid signature displayed, issued for Siemens AG by DigiCert Trusted G4 RSA4096 SHA256 TimeStamping CA.

   Note

   If there is no valid signature, do not continue to install this software.

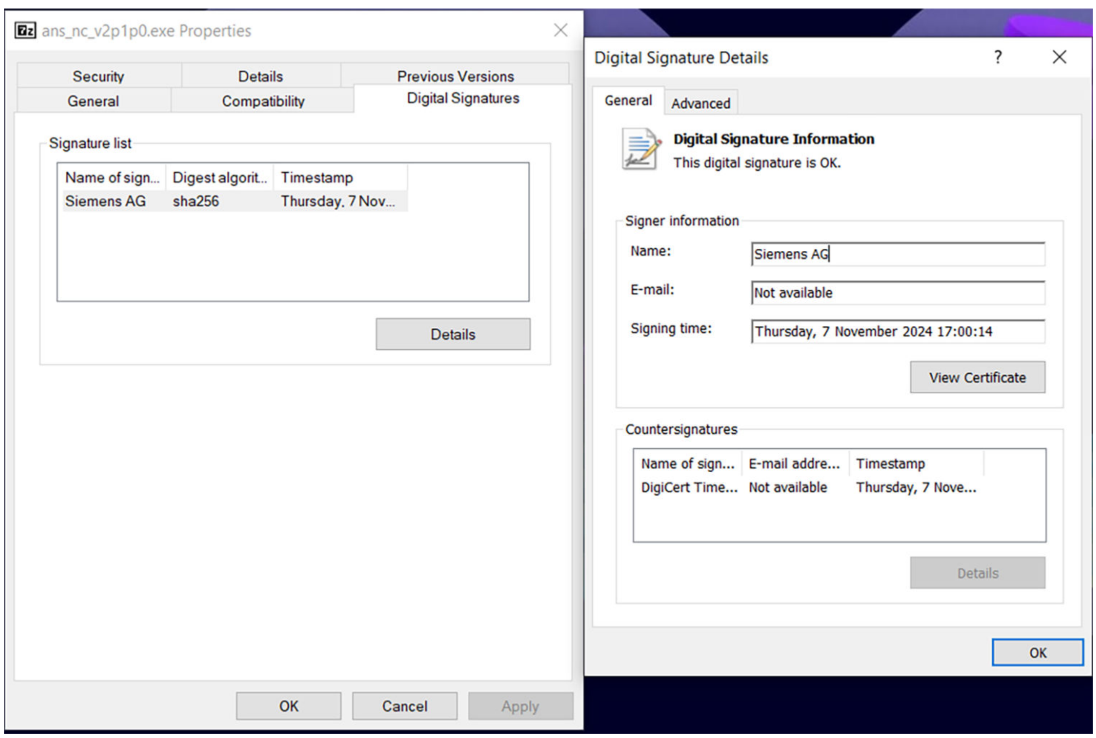


Figure 2-3 Signature of ANS+ software package to check file integrity and authenticity (example)

2. Unzip files by double click on the .exe file.
3. Connect to the SIMATIC Industrial OS with an SFTP and SSH tool and create a folder "simove_ans+" within your home directory.
   ```
   mkdir simove_ans+
   ```
4. Use an SFTP tool to copy the zipped folder "simove_ans+_v220_bundle.tar.gz" which includes the SIMOVE ANS+ software into the folder "simove_ans+".
   The file can be received via "SIMOVE ANS+" SIOS Service Request, described in the chapter "Siemens Support Requests (Page 285)".
5. Extract the folder and load the included docker image.
   ```
   cd simove_ans+
   simove_ans+_v220_bundle.tar.gz
   docker load -i simove_ans_v2p2p0.image
   ```

6. Start the application (nav_ctrl, map_engine and engineering tool).
   `docker-compose up -d`

Note

The prefix "sudo" might be required, due to the docker settings.

Start the ANS+ NC module individually to monitor the terminal output. Therefore, follow the instructions of chapter ANS+ NC module manual start (Page 26).

```
agv@ipc227g:~$ mkdir simove_ans+
agv@ipc227g:~$ cd simove_ans+
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ ls -l
total 212580
-rw-------. 1 agv agv 217680721 Mar 19 09:25 simove_ans+_v220_bundle.tar.gz
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ tar -xzf simove_ans+_v220_bundle.tar.gz
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ ls -l
total 775872
drwx------. 1 agv agv        36 Mar 19 08:50 application_data
-rwx------. 1 agv agv      1256 Mar 19 07:45 docker-compose.yml
-rw-------. 1 agv agv 217680721 Mar 19 09:25 simove_ans+_v220_bundle.tar.gz
-rwx------. 1 agv agv 576804864 Mar 19 08:48 simove_ans_v2p2p0.image
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ docker load -i simove_ans_v2p2p0.image
Loaded image: simove_ans:v2p2p0
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ docker-compose up -d
Creating et ... done
Creating nc ... done
Creating me ... done
agv@ipc227g:~/simove_ans+$
```

Figure 2-4 Successful start of all SIMOVE ANS+ modules

7. Check the currently running containers.
   `docker ps`

```
agv@ipc227g:~/simove_ans+$ docker ps
CONTAINER ID   IMAGE               COMMAND     CREATED          STATUS          PORTS     NAMES
a60cdec4d155   simove_ans:v2p2p0   "ans_et"    22 seconds ago   Up 20 seconds             et
151ba4f3573f   simove_ans:v2p2p0   "ans_me"    22 seconds ago   Up 20 seconds             me
136a9772f0e7   simove_ans:v2p2p0   "ans_nc"    22 seconds ago   Up 20 seconds             nc
agv@ipc227g:~/simove_ans+$
```

Figure 2-5 Display all running containers with `docker ps`

2.4 ANS+ NC module manual start

For commissioning, it is helpful to start the ANS+ NC module manually to see all logs and information on the SSH terminal screen. For a manual start, follow the below described process:

1. Start a SSH tool and connect to the SIMATIC Industrial OS.
2. Navigate into the ANS+ directory, where the docker-compose file is located.
3. Stop the nc module manually within an open terminal.
   ```
   docker-compose stop nc
   ```
4. Start the nc module manually within an open terminal.
   ```
   docker-compose run nc
   ```

The text "All systems running." confirms a successful start of the ANS+ navigation control module with no parameter or layout failure.

In order to undo the manual start of the ANS+ NC module and switch back to the autostart routine, follow the steps below:

1. Shut down the ANS+ NC module by either closing the terminal or pressing CTRL+C within the terminal.
2. Determine and start all modules within the autostart in the background.
   ```
   docker-compose down
   docker-compose up -d
   ```

Update 3

3.1 Preconditions

To update the ANS+ NC module and/or the ANS+ ET modules, a complete backup of the system must be done. There are two possible backup options:

- Full image: This approach is preferred, as the entire OS is saved with all its configurations. To create a full image of the device, follow the product specific backup procedure.
- "simove_ans+" directory: Another approach is to copy the default directory "simove_ans+" on the OS.

Version specific preconditions

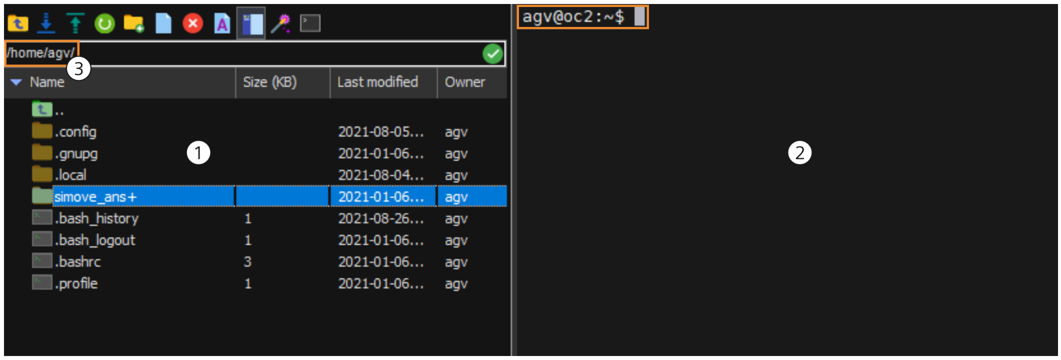
Starting with v2.0, ANS+ is containerized. SIMATIC Industrial OS integrates Docker, enabling the deployment of containerized images onto the system. The tool docker-compose is used for running multi-container Docker applications. Therefore, a YAML file is provided, to start all services.

Note

Docker and Docker-compose must be installed on Industrial OS in advance.

The following procedure provides a step-by-step guide to create a copy of the "simove_ans+" directory on the related OS:

1. Open an SFTP and SSH connection to the related operating system.

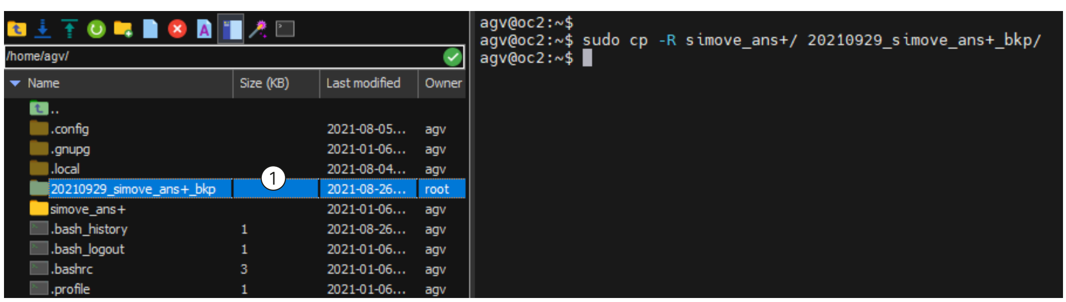


① SFTP file system
② SSH terminal
③ /home/agv/

Figure 3-1 Directory setup before updating the SIMOVE ANS+

2. To create a directory copy, follow the below listed exemplary commands in the listed order:

```
cd /home/agv/
sudo cp -R simove_ans+/ 20210929_simove_ans+_bkp/
```



① Copied backup

Figure 3-2 Successfully created SIMOVE ANS+ backup directory

See also

ANS+ update from V2.X.0 to V2.2.0 (Page 29)

ANS+ full update to V2.2.0 from V1.7.X and older (Page 32)

3.2 ANS+ update from V2.X.0 to V2.2.0

This chapter describes an ANS+ update process starting from V2.X.0 to V2.2.0.

The following procedure provides a step-by-step guide:

1. Connect to the SIMATIC Industrial OS with an SFTP and SSH tool.
2. Shut down the V2.X.0 docker container.
   ```
   cd simove_ans+
   docker-compose down
   ```
3. Check if all ANS+ containers are down.
   ```
   docker ps
   ```

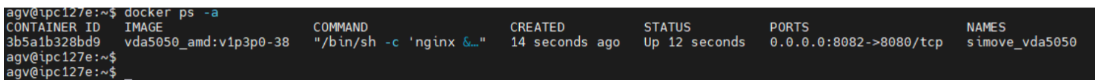


Figure 3-3 Successful stop of ANS+ modules

4. Rename the old ANS+ folder e.g. to "simove_ans+_old".
5. Create a new simove_ans+ folder.
   ```
   mkdir simove_ans+
   ```
6. Check the signature and extract the .exe file as described in chapter ANS+ V2.2.0 installation (Page 24).
7. Use an SFTP tool to copy the zipped folder "simove_ans+_v220_bundle.tar.gz" with the Simove ANS+ image into the folder "simove_ans+".
8. Follow the normal installation steps for ANS+ V2.2.0 (Page 24).

   Note

   As the structure of the application data folder has changed from version V2.1.0 to V2.2.0, it is not possible to only replace the docker image to update to V2.2.0.

9. Extract the folder and load the included docker image.
   ```
   tar -xzf simove_ans+_v220_bundle.tar.gz
   docker load -i simove_ans_v2p2p0.image
   ```

10. Start the application (nav_ctrl, map_engine and engineering tool).
    `docker-compose up -d`

```
agv@ipc127e:~$ mkdir simove_ans+
agv@ipc127e:~$ cd simove_ans+
agv@ipc127e:~/simove_ans+$ ls -l
total 430808
-rw------- 1 agv agv 441141042 Apr 10 13:18 simove_ans+_v210_bundle.tar.gz
agv@ipc127e:~/simove_ans+$
agv@ipc127e:~/simove_ans+$ tar -xzf simove_ans+_v210_bundle.tar.gz
agv@ipc127e:~/simove_ans+$
agv@ipc127e:~/simove_ans+$ ls -l
total 950064
drwx------ 4 agv agv      4096 Apr 10 13:21 application_data
-rw------- 1 agv agv      1256 Apr 10 13:24 docker-compose.yml
-rw------- 1 agv agv 441141042 Apr 10 13:18 simove_ans+_v210_bundle.tar.gz
-rw------- 1 agv agv 531705344 Apr 10 13:24 simove_ans_v2p1p0.image
agv@ipc127e:~/simove_ans+$
agv@ipc127e:~/simove_ans+$ docker load -i simove_ans_v2p1p0.image
e1325a2db1db: Loading layer [==================================================>]  84.04MB/84.04MB
a002e81c466a: Loading layer [==================================================>]  18.77MB/18.77MB
a2a1e98843a5: Loading layer [==================================================>]  428.9MB/428.9MB
Loaded image: simove_ans:v2p1p0
agv@ipc127e:~/simove_ans+$
agv@ipc127e:~/simove_ans+$ docker-compose up -d
Creating me ... done
Creating nc ... done
Creating et ... done
agv@ipc127e:~/simove_ans+$
agv@ipc127e:~/simove_ans+$ docker ps -a
CONTAINER ID   IMAGE              COMMAND     CREATED          STATUS           PORTS     NAMES
f6842b7a6fdd   simove_ans:v2p1p0  "ans_et"    19 seconds ago   Up 16 seconds              et
3e18032fabfc   simove_ans:v2p1p0  "ans_me"    19 seconds ago   Up 16 seconds              me
5af15049cb0d   simove_ans:v2p1p0  "ans_nc"    19 seconds ago   Up 16 seconds              nc
agv@ipc127e:~/simove_ans+$
```

Figure 3-4 Successful start

11. Check the currently running containers.
    `docker ps`

```
agv@ipc227g:~/simove_ans+$ docker ps
CONTAINER ID   IMAGE              COMMAND     CREATED          STATUS          PORTS     NAMES
a60cdec4d155   simove_ans:v2p2p0  "ans_et"    22 seconds ago   Up 20 seconds             et
151ba4f3573f   simove_ans:v2p2p0  "ans_me"    22 seconds ago   Up 20 seconds             me
136a9772f0e7   simove_ans:v2p2p0  "ans_nc"    22 seconds ago   Up 20 seconds             nc
agv@ipc227g:~/simove_ans+$
```

Figure 3-5 Display all running containers with `docker ps`

After successful upgrade, the parameters must be adjusted. Therefore, it is recommended to open the old user-def file and copy the necessary sections to the new user-def file.

12. Copy the following sections from the V2.2.0 user-def:
    – Section: Laser
    – Section: Robot
    – Section: Motion Vehicle

Note

The unit for "Omega Max" and "A Omega Max" has been changed from V2.0.0 to V2.1.0 (changed rad to deg).

- Section: Route Map
- Section: Odometry Buffer
- Section: Motion AGV
- Section: Motion Static Loader
- Section: Motion Flow Kraken Controller
- Section: Motion Path Planner

Note

If any changes were made to the Kalman parameters, these changes should also be copied.

3.3 ANS+ full update to V2.2.0 from V1.7.X and older

This chapter describes the ANS+ update process starting from any old version (e.g. V1.7.0) to V2.2.0.

The following procedure provides a step-by-step guide:

1. Connect to the SIMATIC Industrial OS with a SFTP and SSH tool.
2. Disable the autostart behavior and stop the modules.

```
systemctl disable ans-et
systemctl disable ans-nc
systemctl stop ans-et
systemctl stop ans-nc
```

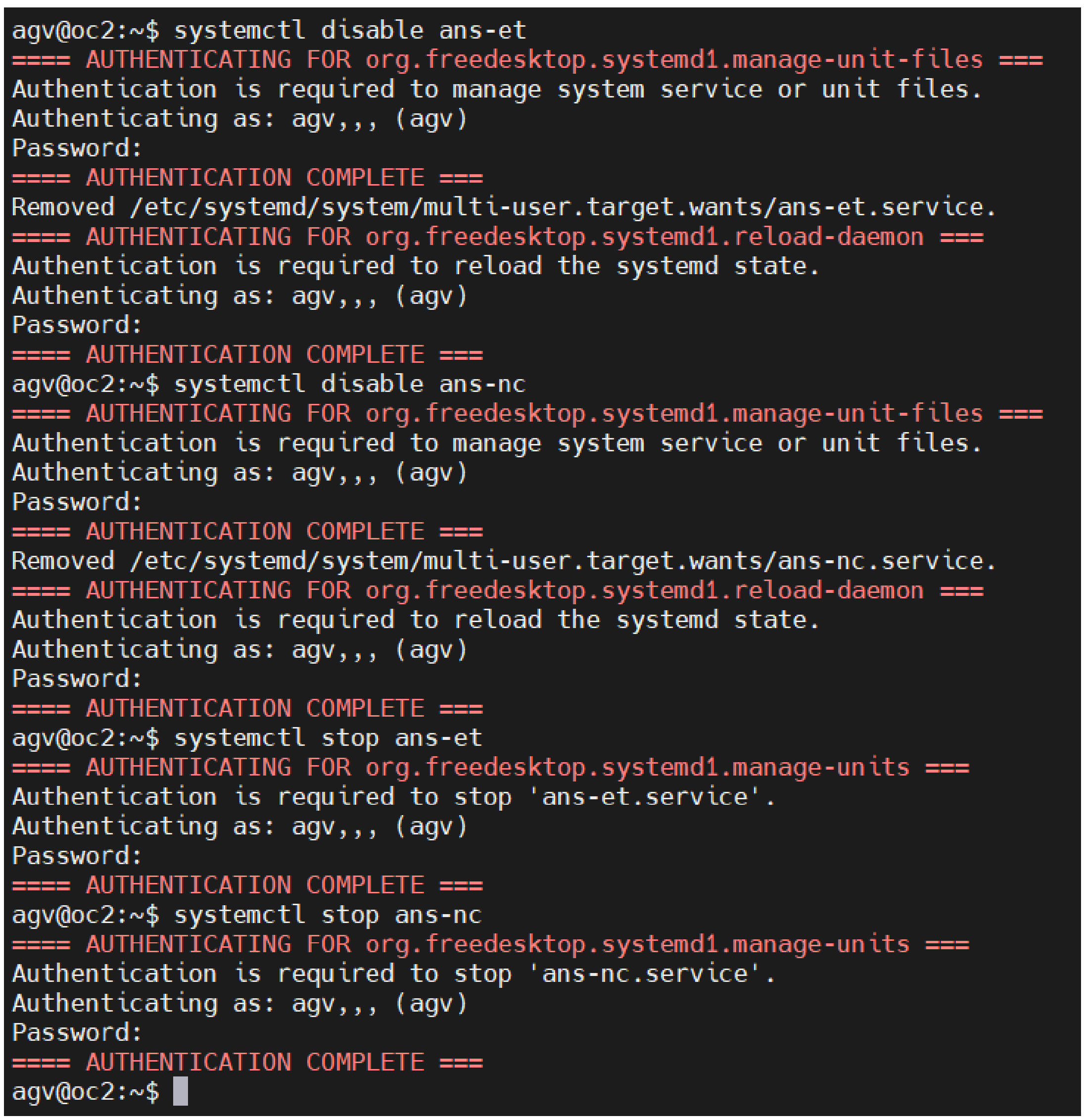


Figure 3-6 Stopping SIMOVE ANS ET and NC modules and disabling autostart behavior

3. Check if the procedure was successful and if both modules are stopped.
   ```
   systemctl status ans-et
   systemctl status ans-nc
   ```

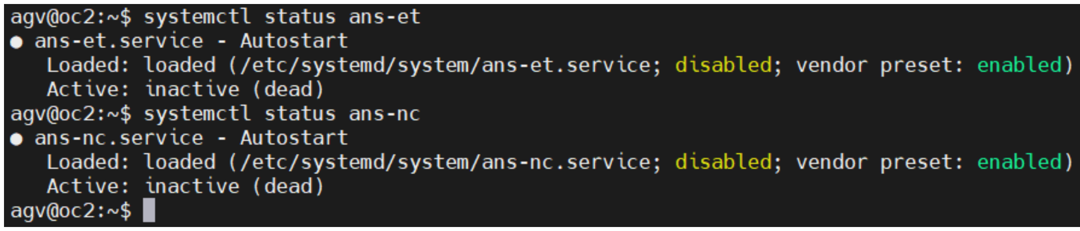


Figure 3-7 Successful stop of SIMOVE ANS ET and NC modules

4. Make sure to create a backup first, before removing the files as described previously.
5. Remove the files with the following commands:
   ```
   cd /home/agv/
   rm -rf simove_ans+
   mkdir simove_ans+
   ```
6. Use an SFTP tool to copy the zipped folder "simove_ans+_v220_bundle.tar.gz" with the Simove ANS+ image into the folder "simove_ans+".
7. Extract the folder and load the included docker image.
   ```
   tar -xzf simove_ans+_v220_bundle.tar.gz
   docker load -i simove_ans_v2p2p0.image
   ```

8. Start the application (nav_ctrl, map_engine and engineering tool).
   `docker-compose up -d`

```
agv@ipc227g:~$ mkdir simove_ans+
agv@ipc227g:~$ cd simove_ans+
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ ls -l
total 212580
-rw-------. 1 agv agv 217680721 Mar 19 09:25 simove_ans+_v220_bundle.tar.gz
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ tar -xzf simove_ans+_v220_bundle.tar.gz
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ ls -l
total 775872
drwx------. 1 agv agv        36 Mar 19 08:50 application_data
-rwx------. 1 agv agv      1256 Mar 19 07:45 docker-compose.yml
-rw-------. 1 agv agv 217680721 Mar 19 09:25 simove_ans+_v220_bundle.tar.gz
-rwx------. 1 agv agv 576804864 Mar 19 08:48 simove_ans_v2p2p0.image
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ docker load -i simove_ans_v2p2p0.image
Loaded image: simove_ans:v2p2p0
agv@ipc227g:~/simove_ans+$
agv@ipc227g:~/simove_ans+$ docker-compose up -d
Creating et ... done
Creating nc ... done
Creating me ... done
agv@ipc227g:~/simove_ans+$
```

Figure 3-8 Successful start

9. Check the currently running containers.
   `docker ps`

```
agv@ipc227g:~/simove_ans+$ docker ps
CONTAINER ID   IMAGE              COMMAND    CREATED          STATUS          PORTS     NAMES
a60cdec4d155   simove_ans:v2p2p0  "ans_et"   22 seconds ago   Up 20 seconds             et
151ba4f3573f   simove_ans:v2p2p0  "ans_me"   22 seconds ago   Up 20 seconds             me
136a9772f0e7   simove_ans:v2p2p0  "ans_nc"   22 seconds ago   Up 20 seconds             nc
agv@ipc227g:~/simove_ans+$
```

Figure 3-9 Display all running containers with `docker ps`

Note

Start the ANS+ NC module individually to monitor the terminal output.

The prefix "sudo" might be required, due to the docker settings.

See also

Preconditions (Page 27)

Siemens Support Requests (Page 285)

Support (Page 283)

ANS+ ET User Interface

4

4.1 Starting the User Interface

The ANS+ ET is a web-based application. The following illustration shows an example screenshot of the User Interface (UI) with real data.

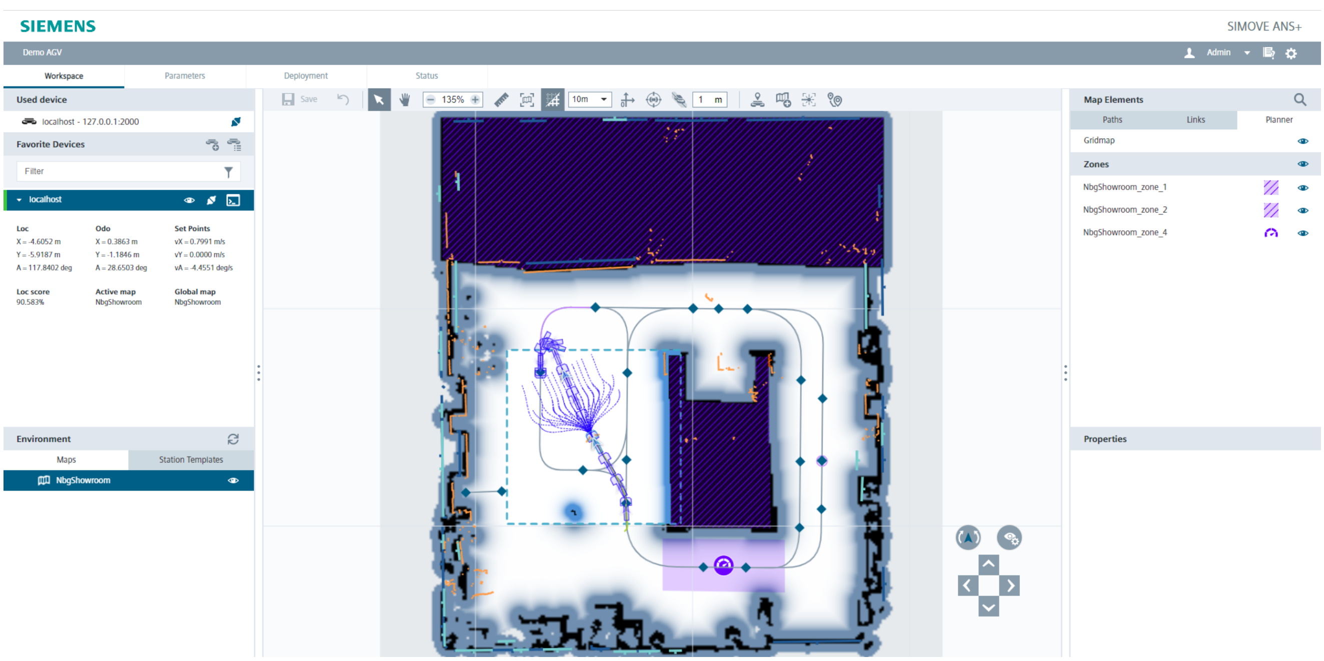


Figure 4-1 ANS+ ET UI workspace window

Web browsers

The tool is compatible with the following web browsers:

- Google Chrome (preferred)
- Mozilla Firefox
- Microsoft Edge

Using the ANS+ ET

There are two ways to use the ANS+ ET and to commission multiple AGVs:

- Remote access:
  The ANS+ ET is installed on an engineering or a server PC, which is configured to have a working network connection to all related AGVs. All changes done on the PC need to be deployed to all related AGVs.
- Direct access:
  For small projects with no server PC, a direct access to the UI is possible. In this setup, the user is directly connected to the AGV's data content and therefore engineers on the AGV itself. File deployment is not required in this case.

4.1.1 Direct access

By default, on the latest SIMOVE release images, all modules of ANS+ and the ANS+ ET are started within the boot process of the operating system.

It is only required to start a web browser with usage of the AGVs IP address and the default ET communication port “2002”:

`https://<IP>:2002/`

<IP> is the space holder for the IP address of the corresponding AGV that needs to be engineered.

Now, the web browser displays the user interface of the ANS+ ET.

Note

Accept certificate warning

In case self-signed certificates are used, the user needs to accept the warning given by the browser in order to access ANS ET.

A warning will be displayed permanently in the top left corner of the browser.

4.1.2 Remote access

To be able to start the ANS+ ET on an engineering or server PC, it is necessary to have the zipped file package of the latest ANS+ ET release version.

Example:

- "SIMOVE_ANS+_v220_Win10.zip"

The file name provides the following information:

- "v220": release version (2.2.0)
- "Win10": related operating system (Windows 10).

Preparing the file package

To start the ANS+ ET on a Windows 10 based PC:

1. Unzip the ET file package to a directory, where you have writing permissions.
   A folder is created, which contains "workspace", "dataspace" and "external dependencies" directories.
2. Update the Windows system environment variables:
   – Open the Windows environment variables screen and add a new user variable.

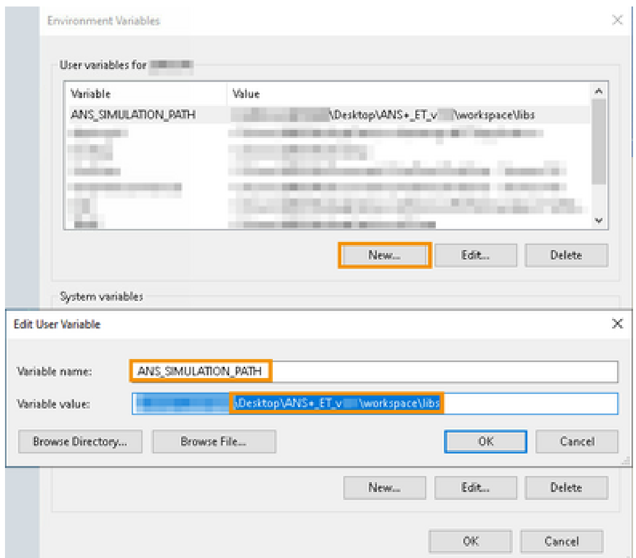


Figure 4-2 Adding a new environment variable to Windows 10

   – Press "OK" to apply the settings.
   – Select the variable "Path" and click on "Edit".

– Add a new list entry to the variable:
`%ANS_SIMULATION_PATH%`

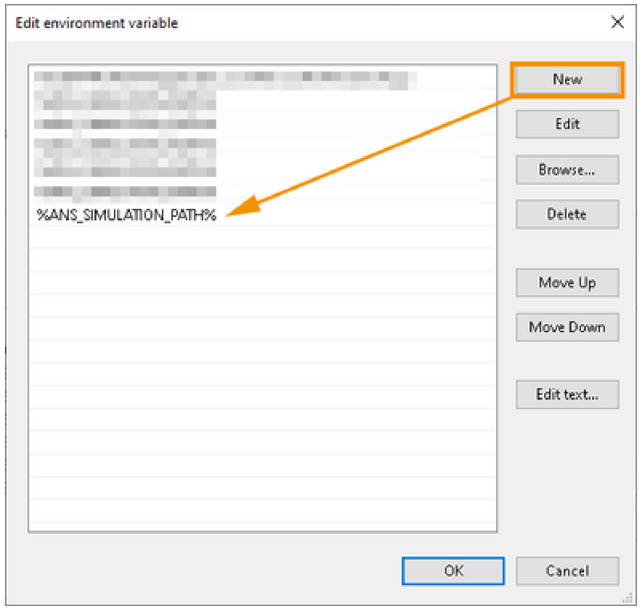


Figure 4-3 Appending a new entry to the existing environment variable "Path"

– Apply the settings of all windows by pressing "OK".

3. Navigate into the "workspace" directory within the previously unzipped file package.
   A folder structure is displayed.

Name	Date modified	Type	Size
atlas	19/04/2024 09:56	File folder	
devices	07/08/2024 10:01	File folder	
file_server	07/08/2024 10:01	File folder	
libs	07/08/2024 10:01	File folder	
map_engine	07/08/2024 10:01	File folder	
nav_ctrl	07/08/2024 10:01	File folder	
service_proxy	07/08/2024 10:01	File folder	
user_interface	07/08/2024 10:02	File folder	
simove_ans+_win10.bat	25/04/2024 08:34	Windows Batch File	1 KB

Figure 4-4 Default workspace folder structure of the ANS+ ET Windows 10 file package

4. By executing the batch file "ans+_et_<ver.>_win10.bat", all ANS+ modules are started one after another.

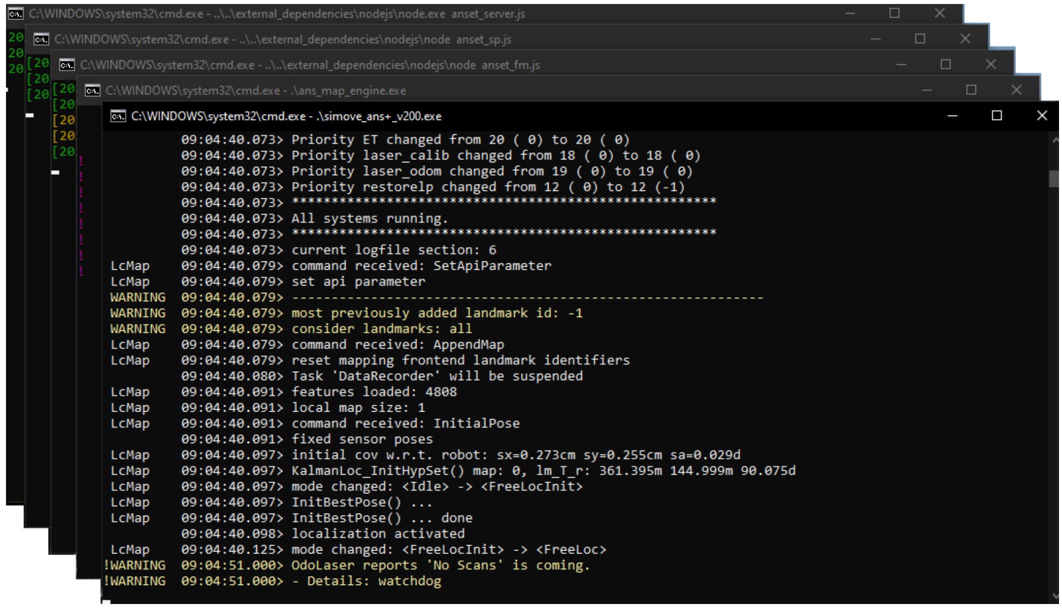


Figure 4-5 ANS+ started on Windows 10 after executing the batch (.bat) file

5. To use the user interface (UI) of the ANS+ ET, open one of the supported web browsers with the following link address:
`https://localhost:2002/`
The web browser displays the UI of the ANS+ ET, visualized in chapter Starting the User Interface (Page 35).

See also

Deployment (Page 211)

General mapping process (Page 79)

4.2 User interface login

4.2.1 Overview

Login

The ANS+ ET UI version can only be accessed by logging in. The login screen is displayed as the default screen when accessing the ANS+ ET web page.

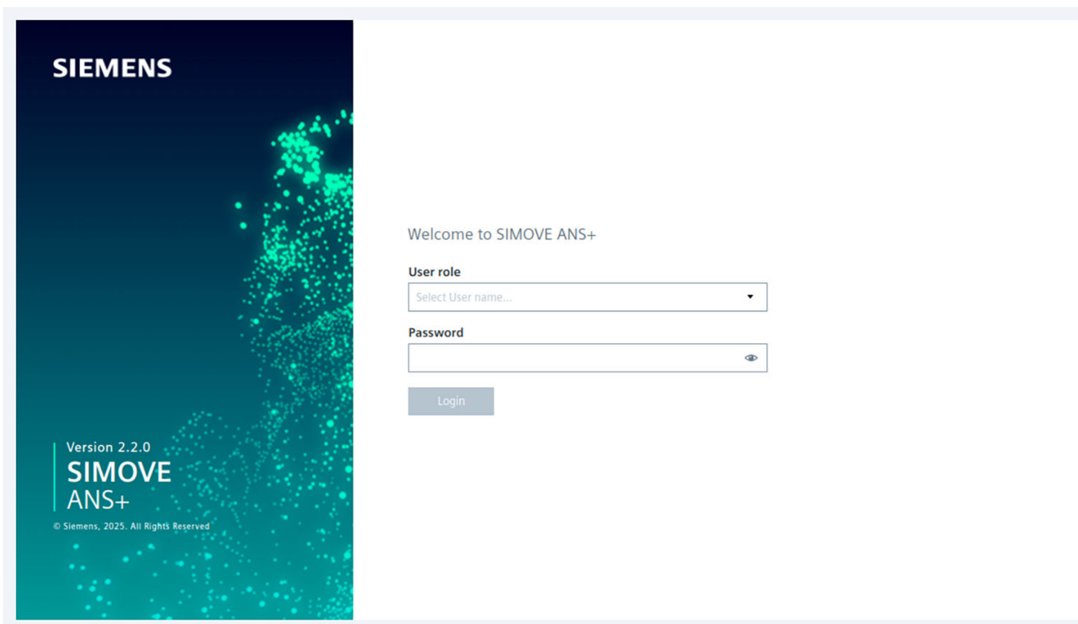


Figure 4-6 ANS+ ET login screen

The table provides an overview of the specified users for the ANS+ ET.

User	Default password	Allowed functions
Guest		Only visualization
Operator	simove123!	Visualization and maintenance with selected functions: • Set pose • Cancel • Acknowledge
Admin	simoveagv	Full access to all functions

Note

Specified users for each ANS+ ET setup

It is not possible to add new users to the data space of the ANS+ ET or to delete existing ones. The users are specified for each ANS+ ET setup, on an AGV or on an engineering PC.

Logout

User logout happens automatically after 15 minutes without user interaction.

To logout manually click the user's button and select "Logout".

4.2.2 Change password

Note

Incorrect password

After entering an incorrect password three times, the login of the engineering tool is blocked for 90 sec for this user.

- Wait and retry login afterwards.

Change default password

The default passwords given in the table above must be changed at initial user login. Therefore, a screen requesting the user to change the password before continuing is displayed automatically.

Changing the password requires the following steps:

1. Enter the current password.
2. Enter a new password and confirm the new password.

   Note

   Password requirements

   The new password must fulfill the following requirements:

   - Min. 12 characters long
   - Min. one uppercase and one lowercase letter
   - Min. one number
   - Min. one special character

3. Select "Submit".

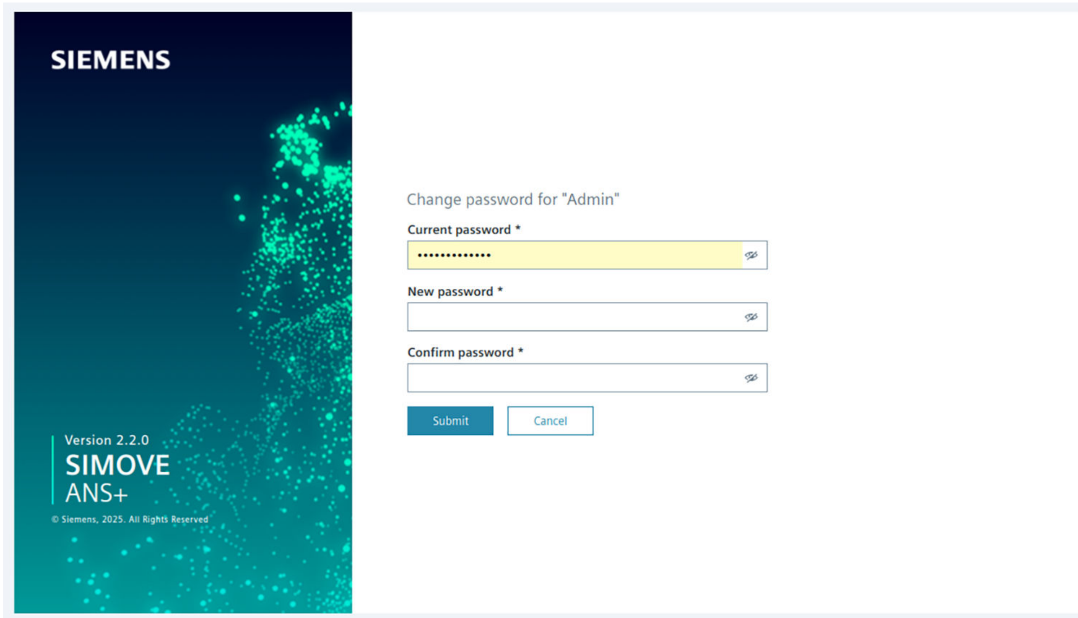


Figure 4-7 ANS+ ET user password change screen

If all entries are correct the password will be changed.

4. Click "Continue to login".
5. Login with the new password.

Change personal password

The ANS+ ET provides the possibility to change the password of a user.

1. Click the user's button.

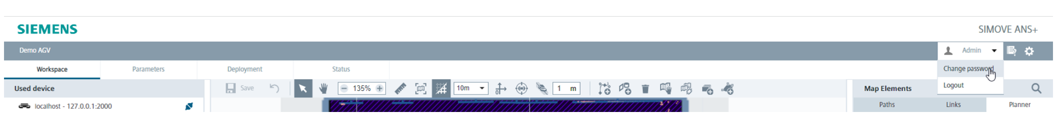


Figure 4-8 ANS+ ET user password change access

2. Select "Change password".

4.3 User Interface structure

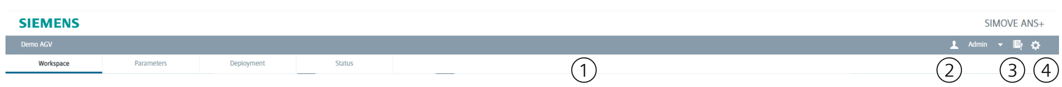
4.3.1 Header

The tool shows four main pages with different functions:

Workspace	The main engineering page to change maps or to add paths
Parameters	ANS+ NC module parametrization
Deployment	Project commitment and distribution of files
Status	ANS+ NC pending error and warning visualization

These pages can be accessed via the header of the UI. Select the corresponding tab, to switch between the pages.

The blue line underneath a tab indicates the currently active page.



① Pages
② Logged in user
③ ANS+ System Manual
④ ANS+ ET software information

Figure 4-9 ANS+ ET window header

The header provides the following tools:

- Project name:
  The project name text field can be used to differentiate several ANS+ ET instances. To change the text, click into the box and change the name. Confirm the changes with <ENTER>.

  Note

  Change project name

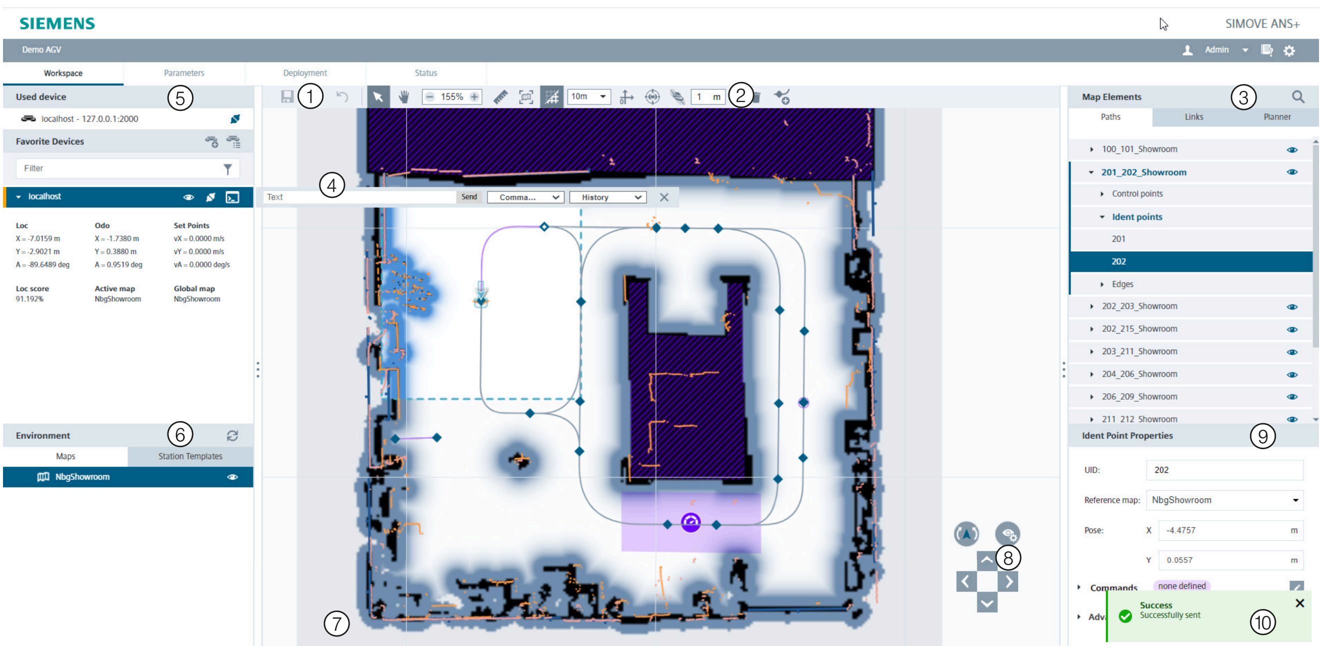
  The text is saved permanently and can only be changed by the user "Admin".

- ANS+ System Manual:
  The "ANS+ Engineering Manual" can be directly accessed within the web browser by clicking .
- ANS+ ET software information:
  By clicking the tool visualizes general information about the ANS+ ET software and OSS.

4.3.2 "Workspace" page

In the "Workspace" page, the main engineering takes place. Within this page multiple functions can be done:

- Engineering and visualization of maps, features and paths
- Visualization of the AGV related data, for example laser data or shape
- Engineering and visualization of station templates and instances



①	Workspace toolbar	⑥	Environment window
②	Dynamic toolbar	⑦	World window
③	Element window	⑧	Visualization configuration panel
④	AGV command toolbar	⑨	Properties window
⑤	Device window	⑩	Notifications

Figure 4-10 ANS+ ET "Workspace" page and related windows

Windows

To handle the different functions, the general layout of the "Workspace" page has been divided into several windows:

Device window

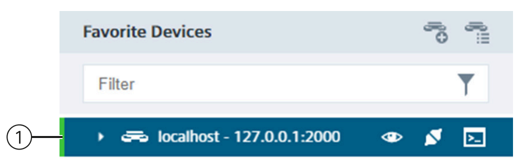
This window provides a list of different devices and can be toggled between two different views:

- "Favorite Devices"
  "Favorite Devices" is displayed by default.
  To add a single or multiple devices to the “Favorite Devices” list, refer to chapter ANS+ ET shortcuts (Page 58).
- "AGV pool"
  To toggle the view and to visualize the "AGV pool", click on the list icon .
  Within the list, all added AGVs are listed.

Each device has its own status indicator which can be seen in "Favorite Devices":

- Green: No pending issues
- Orange: Warnings
- Red: Errors

Clicking the indicator directs the user to the “Status” page, where all pending issues can be viewed.



① Status indicator

Figure 4-11 Status indicator “Workspace” page

AGV command toolbar

If the device is connected, the AGV command toolbar opens by clicking . This toolbar is used to send specific commands to the ANS+ NC module, for example, order cancelation or start recording.

Element window

Visualization of all path elements and their control points and ident points, that belong to the selected map.

Environment window

Visualization of all maps and stations, that have been found by the tool in its "atlas" directory.

Properties window

Depending on the selected element (Map, Path, Edge, Feature, Control point, Ident point), the corresponding properties are displayed.

World window

Visualization of all features and paths, that belong to the selected map in the "Map window".

Visualization configuration panel

This panel is used to configure the world window visualization, for example, to visualize AGV related data such as laser beams.

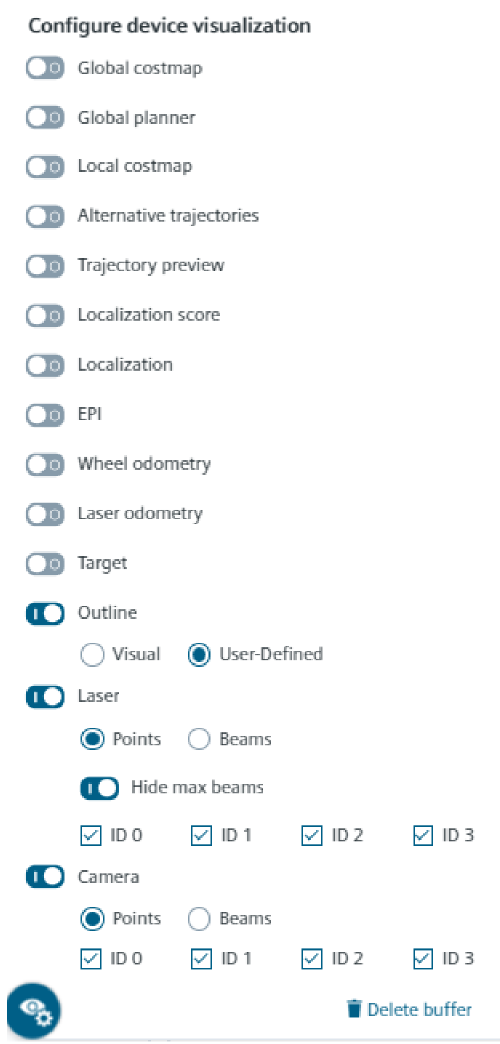


Figure 4-12 Visualization configuration panel within "Workspace" page

Toolbars

The user has to select an element before it can be changed. After the selection, the corresponding functions are displayed and can be used.

Workspace toolbar

The Workspace toolbar provides general functions, such as zoom and view movement.

As those functions are generally valid in the ANS+ ET "Workspace" page, the toolbar will not change in relation to a selected element.

Dynamic toolbar

The Dynamic toolbar provides element (AGV, Map, Path, Feature, Control point, Ident point) specific functions.

The toolbar will change its icons displayed depending on the selected element, to enable the relevant functions.

See also

Add and connect to a new device (Page 59)

4.3.3 "Workspace" page colors

Within the ANS+ ET "Workspace" page there are several different colors.

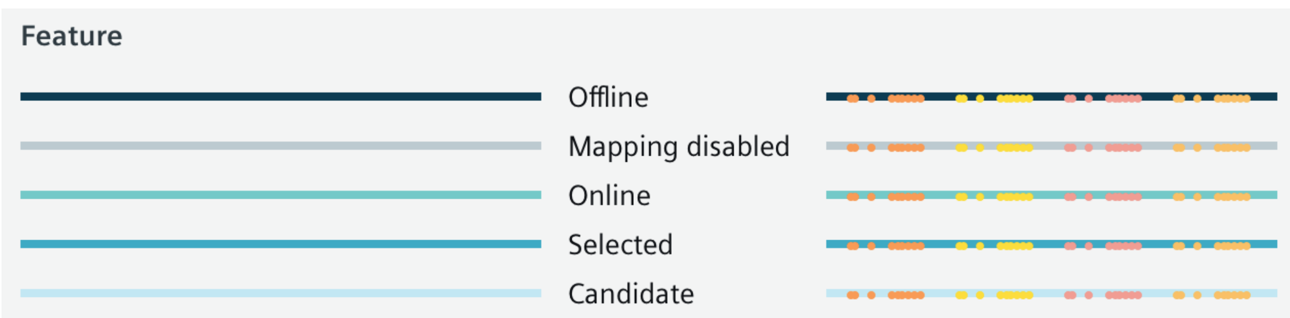


Figure 4-13 Workspace UI - Feature colors

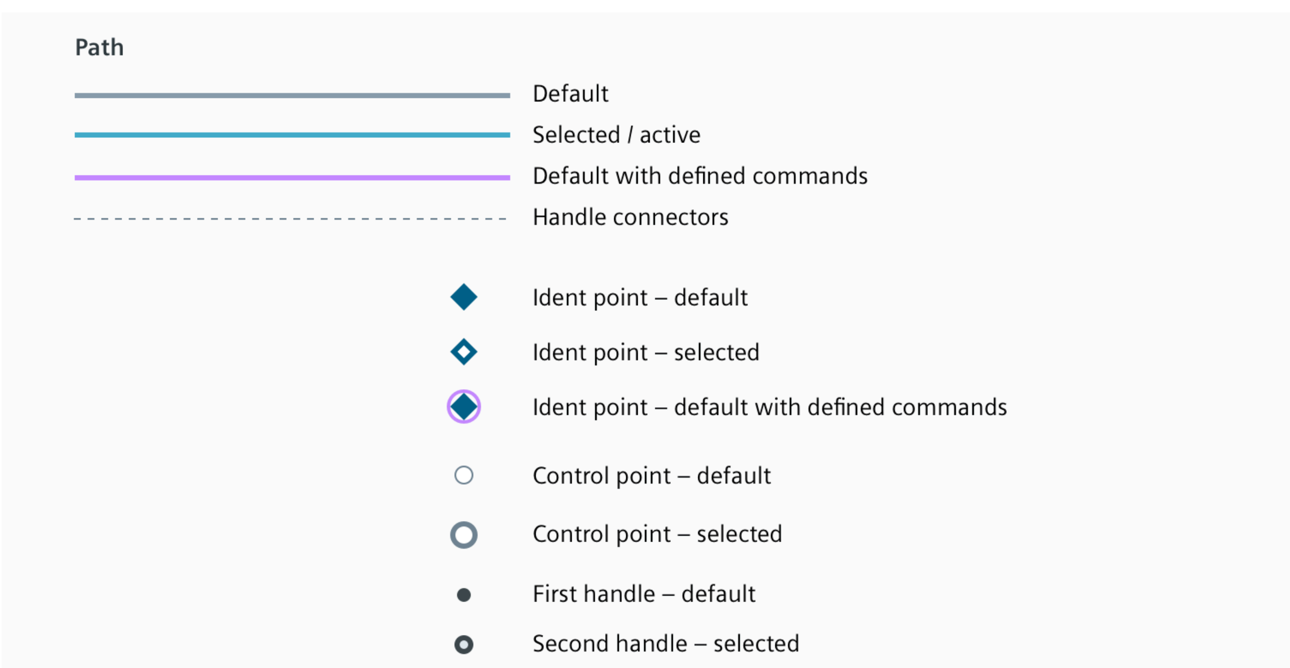


Figure 4-14 Workspace UI - Path colors

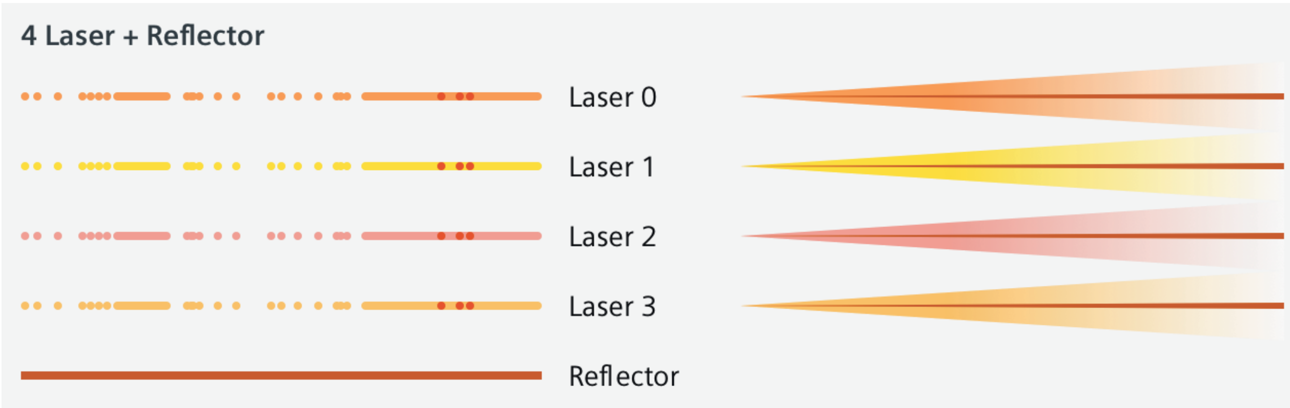


Figure 4-15 Workspace UI - Laser colors

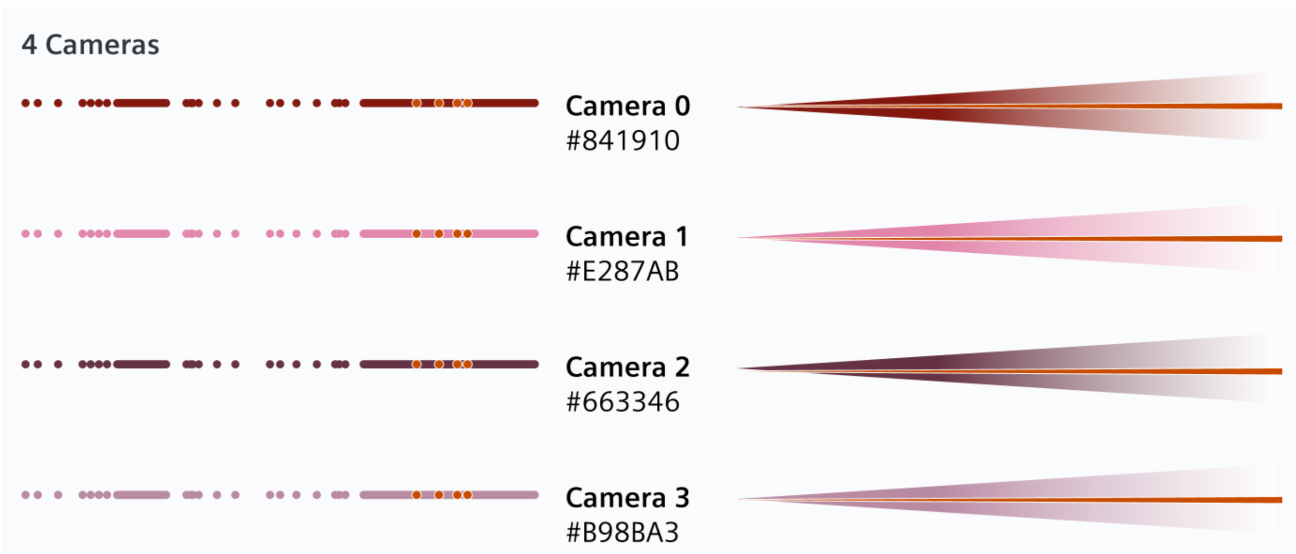


Figure 4-16 Workspace UI - Cameras

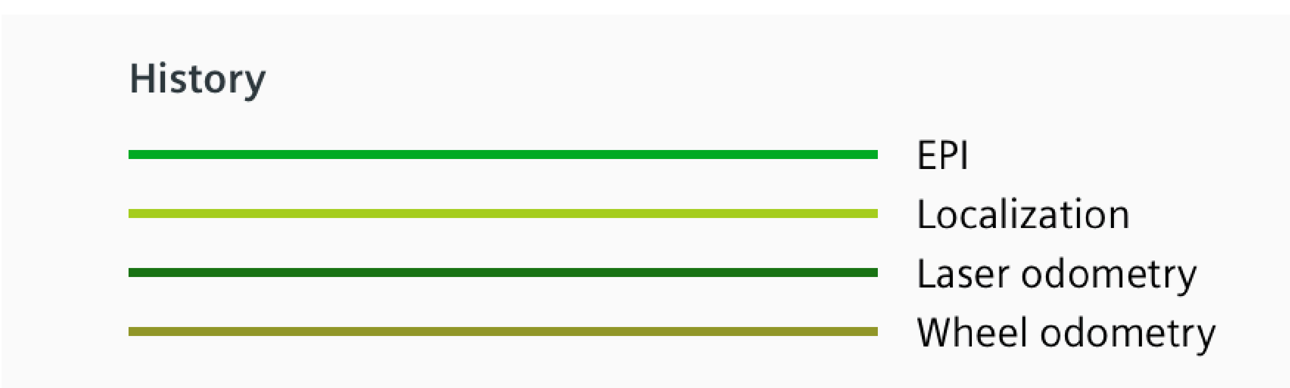


Figure 4-17 Workspace UI - History colors

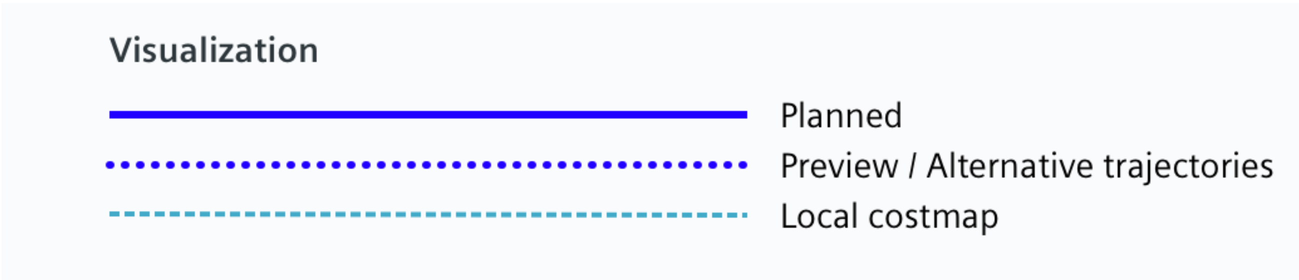


Figure 4-18 Workspace UI - Visualization colors

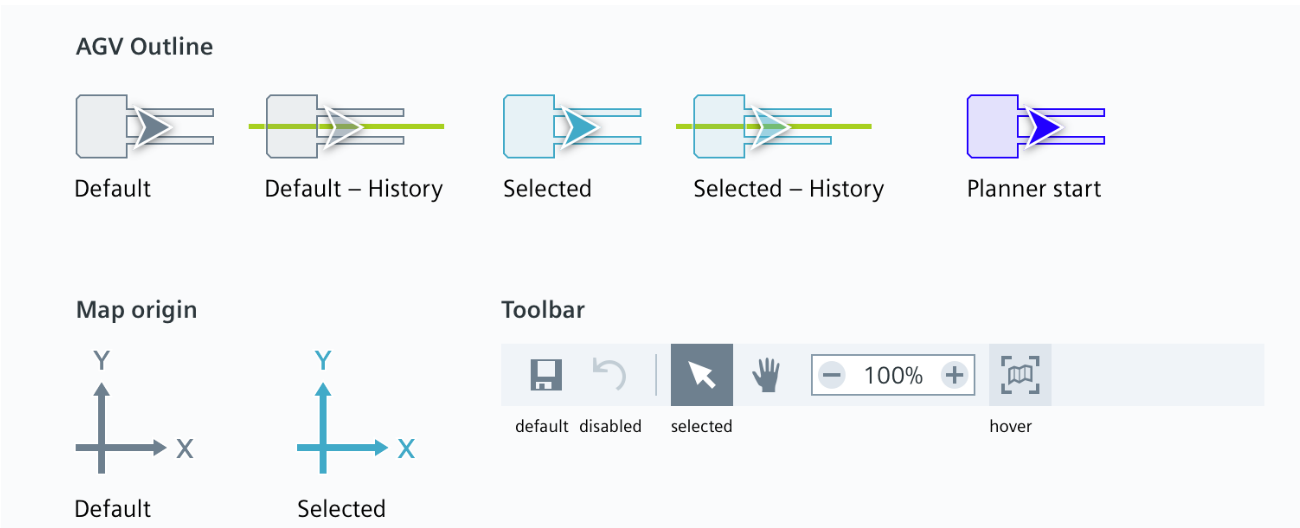


Figure 4-19 Workspace UI – Outline and origin colors

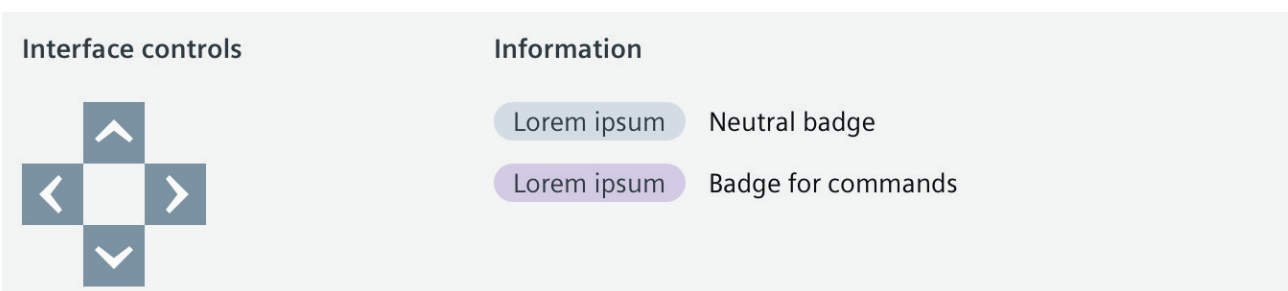


Figure 4-20 Workspace UI - Interface colors

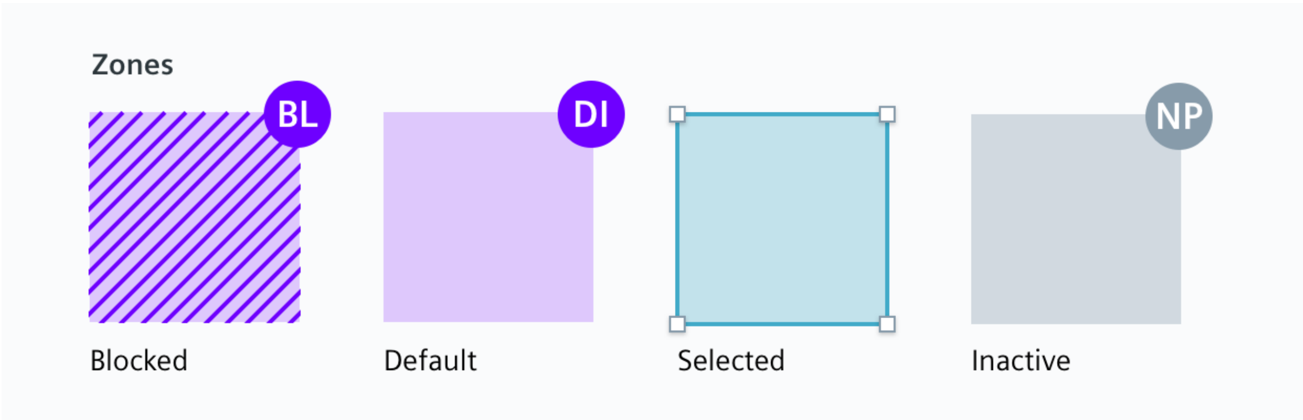


Figure 4-21 Workspace UI - Zones colors

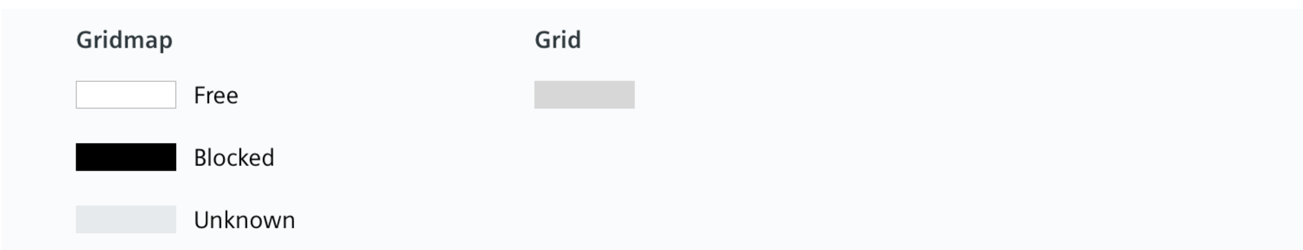


Figure 4-22 Workspace UI - Gridmap colors

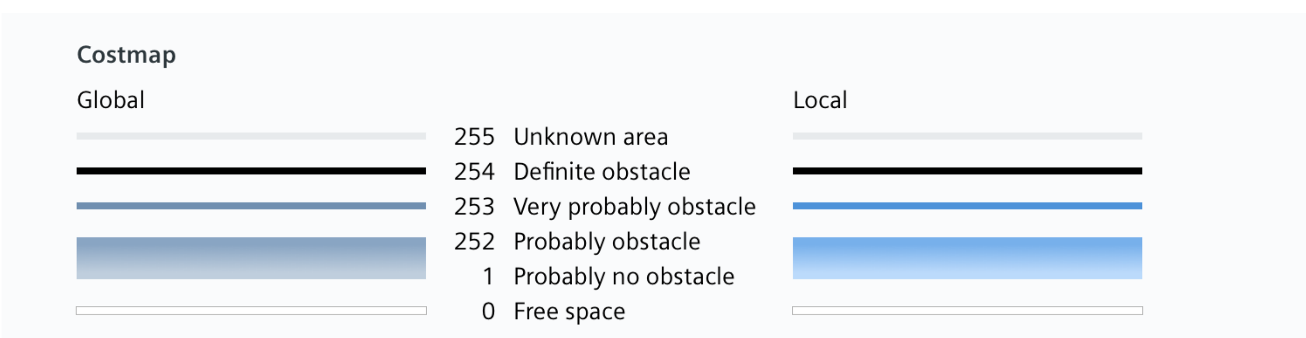


Figure 4-23 Workspace UI - Costmap colors

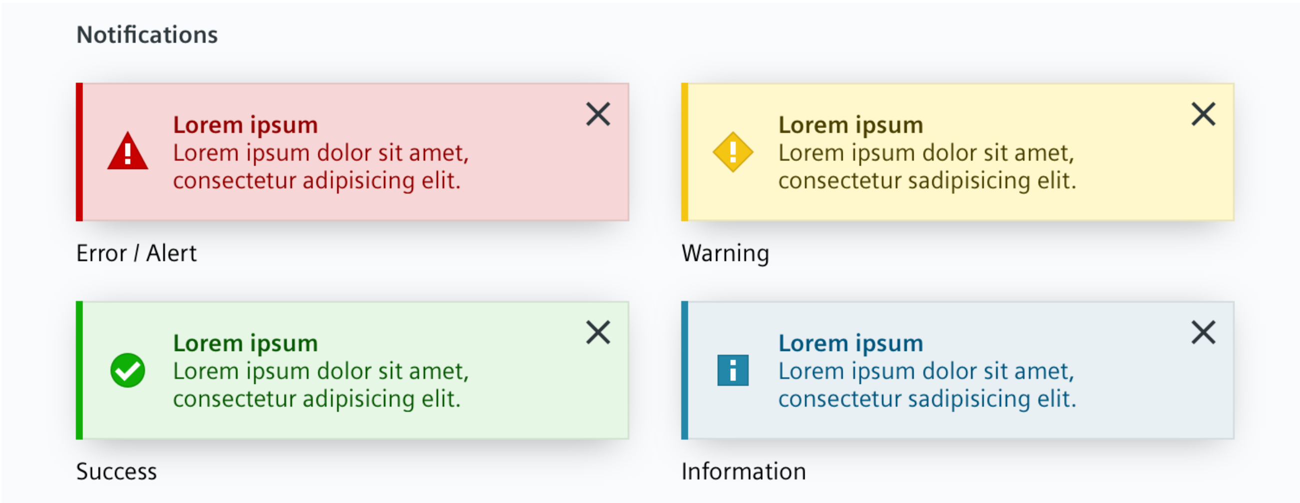


Figure 4-24 Workspace UI - Notifications colors

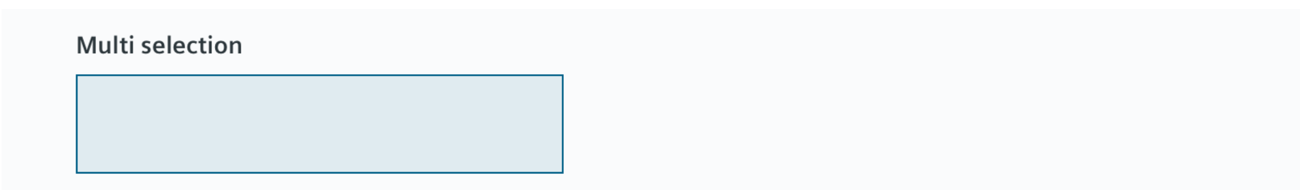


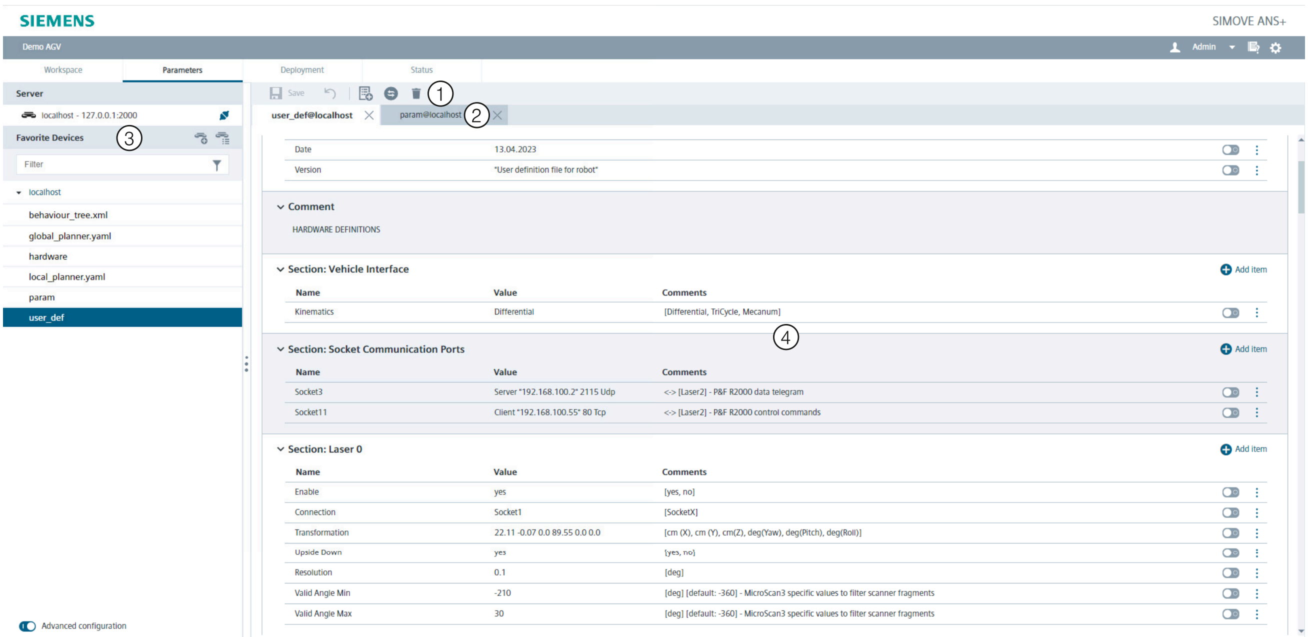
Figure 4-25 Workspace UI - Multi selection colors

4.3.4 "Parameter" page

The "Parameter" page is used to parametrize ANS+ NC modules in the "Favorite Devices" list.

Additional parameters are displayed, when selecting "Advanced configuration" within the Parameter page.

A detailed parameter description of all "user_def" parameters is provided in chapter Parametrization (Page 177).



① Parameter toolbar
② File tabs
③ Device window with related parameter files
④ Parameter window

Figure 4-26 ANS+ ET "Parameter" page and related windows

Elements

This ANS+ ET parameter page provides the following UI elements for the configuration:

Device window

This window provides a list of different devices and can be toggled between two different views:

- "Favorite Devices"
  "Favorite Devices" is displayed by default.
  To add a single or multiple devices to the "Favorite Devices" list, refer to chapter "ANS+ ET shortcuts (Page 58)".
  When connected to the AGV, the "localhost" is being displayed.
- "AGV pool"
  To toggle the view and to visualize the "AGV pool", click on the list icon .
  Within the list, all added AGVs are listed.

Each device has its own parameter files, which can be seen by expanding the device tree navigation.

Parameter window

This window visualizes all parameters related to the selected file.

Furthermore, by activating the switch , the related parameter is not shown and therefore ignored by the ANS+ NC module.

Localhost

When selecting the "localhost", the user_def data, that should be edited during the commissioning is being displayed.

The selector switch "Advanced configuration" can be selected to visualize the advanced parameters of the system like the local and global planner parameter for obstacle avoidance.

Note

When modifying values in the "Advance Configuration", proceed with caution. These changes can significantly impact driving behavior.

Note

Case sensitive

All parameters and values are case sensitive.

When changing a value, the user must stick to the displayed default value format.

Otherwise, the value will not be read by the ANS+ system.

In that case, the system will use the default parameter value as a fallback solution.

WARNING

Restart of the ANS+ NC module

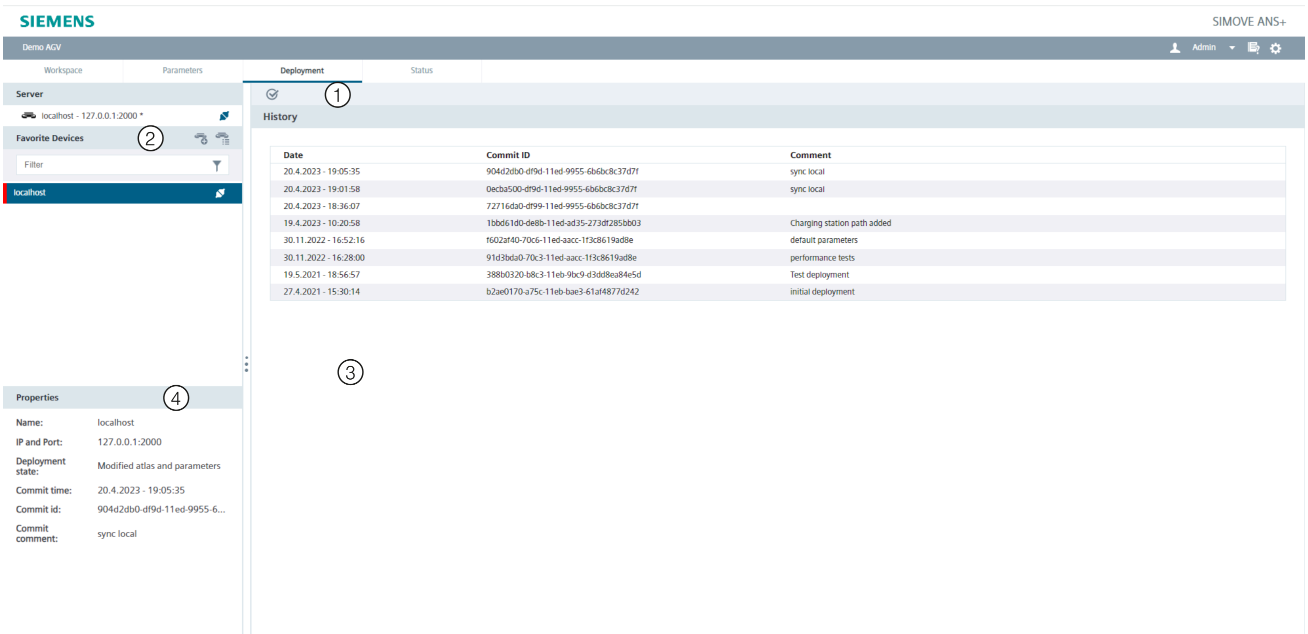
To save parameter changes, it is necessary to restart the ANS+ NC module. For further information regarding a ANS+ NC restart, refer to chapter ""Status" page (Page 55)".

See also

Overview (Page 40)

4.3.5 "Deployment" page

The "Deployment" page of the ANS+ ET allows uploading files (parameter or map files) from the AGV to the remote computer or to download files from remote to the AGV.



① Deployment toolbar
② Device window
③ History window
④ Properties window

Figure 4-27 ANS+ ET "Deployment" page

Elements

This page contains the following elements:

Devices window

This window provides a list of different devices and can be toggled between two different views:

- "Favorite Devices"
  "Favorite Devices" is displayed by default.
  To add a single or multiple devices to the “Favorite Devices” list, refer to chapter ANS+ ET shortcuts (Page 58).
- "AGV pool"
  To toggle the view and to visualize the "AGV pool", click on the list icon .
  Within the list, all added AGVs are listed.

History window

This window visualizes a list of all previously done commits of the related device.

Properties window

This window provides an overview of relevant information on the latest commit.

Toolbar

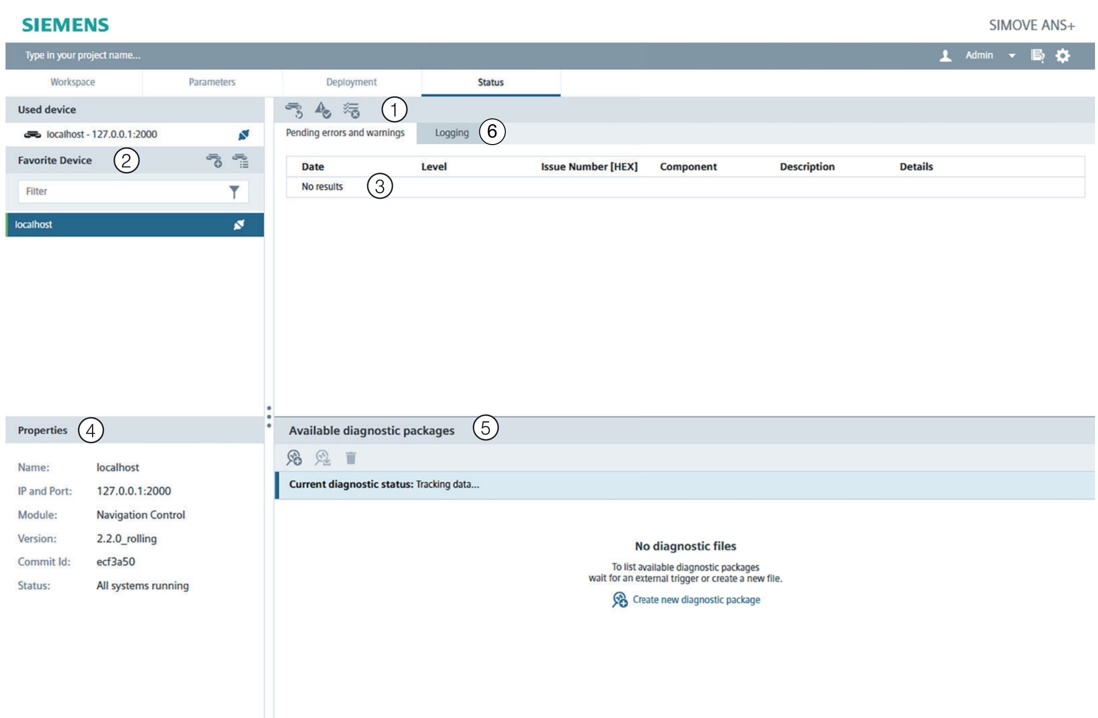
The toolbar contains all functions of the related deployment page. Upload (,) and download (,) functions of parameters and map files can only be used if at first a naming conflict is fixed and if both systems are set into a committed stage .

See also

Deployment (Page 211)

4.3.6 "Status" page

The "Status" page is used to visualize all currently outstanding errors and warnings related to a selected device.



① Status toolbar
② Device window
③ Issue window
④ Properties window
⑤ Diagnostic package window
⑥ Logs window

Figure 4-28 ANS+ ET "Status" page and related windows

Elements

This page contains the following elements:

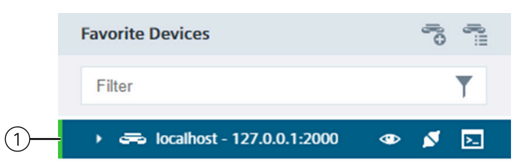
Devices window

This window provides a list of different devices and can be toggled between two different views:

- "Favorite Devices"
  "Favorite Devices" is displayed by default.
  To add a single or multiple devices to the "Favorite Devices" list, refer to chapter ANS+ ET shortcuts (Page 58).
- "AGV pool"
  To toggle the view and to visualize the "AGV pool", click on the list icon .
  Within the list, all added AGVs are listed.

Each device has its own status indicator:

- Green: No pending issues
- Orange: Warnings
- Red: Errors



① Status indicator

Figure 4-29 Status indicator "Status" page

Issue window

This window visualizes a list of all currently pending errors and warnings of the selected ANS+ NC module.

Properties window

This window provides an overview of relevant information on the selected device.

Toolbar

The toolbar contains all functions of the related status page: Restart the selected ANS+ NC module , acknowledge all cleared errors and cancel all currently outstanding tasks .

⚠ WARNING
Restart of ANS+ NC module The "restart device" function requires the provided docker-compose.yml. If this file was edited to manually start the ANS# NC module, the function leads only to a shutdown of the ANS+ NC and requires a manual restart of the module.

Note

Acknowledge an error

Before an error is acknowledgeable, the cause of error needs to be solved. For example, a failure within a sent order requires an order cancelation.

Otherwise, the acknowledge action has no impact and the error is still listed as pending.

More details about an error or warning related issue number are listed in chapter Issue reference list (Page 289).

Logs window

This window displays a textual record of status, events and operations of the system. This allows a more detailed analysis of the system behavior and provides additional information on the pending errors and warnings.

The toolbar for this window additionally contains the following elements:

- Increase text size and decrease text size
- Copy logs and download logs
- Reactivate autoscrolling after scrolling up to look through the logs .
- Additionally, the logs can be filtered displaying all messages as well as only errors and or warnings using the filter by level icon .

Logs

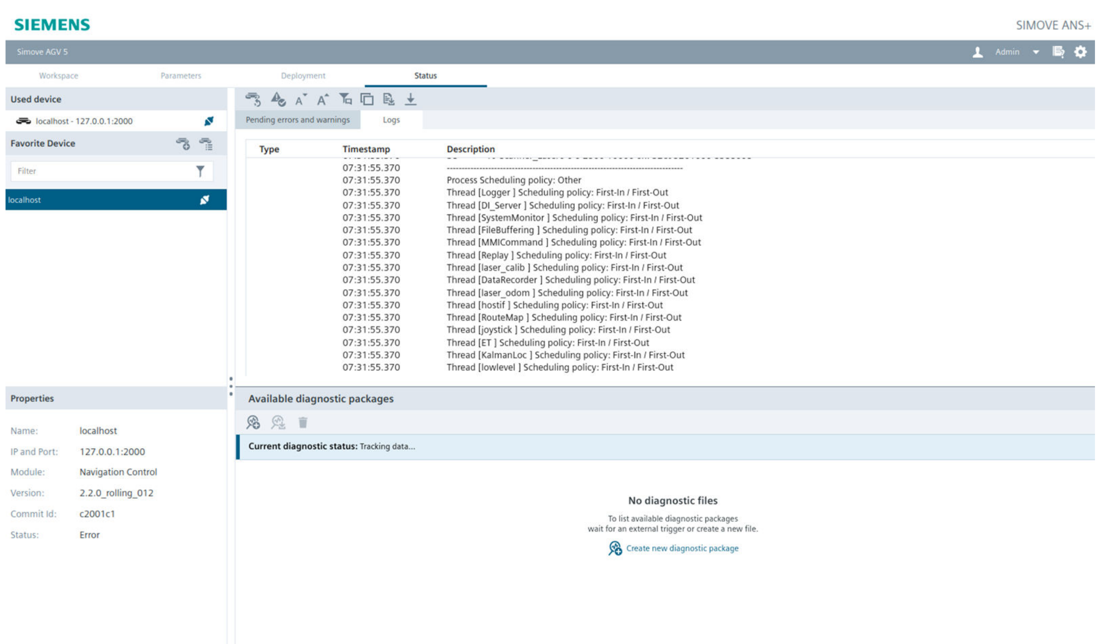


Figure 4-30 Logs Windows

4.4 ANS+ ET shortcuts

Within the ANS+ ET, there is a set of shortcuts to access different functions in a faster way, explained in the following table.

Name	Key combination	Related to page	Description
Save	<CTRL + S>	General	Save all changes
Undo	<CTRL + Z>	General	Undo the latest changes
Fit map	<CTRL + F>	Workspace	Fit the currently selected map into the grid
Refresh atlas	<CTRL + R>	Workspace	Refresh the atlas directory
Delete	<DEL>	Workspace	Delete the currently selected element
Map movement	<SHIFT + Left mouse button>	Workspace	Press and hold <SHIFT> to move the map in the grid
Control point merge	<CTRL>	Workspace	Press and hold <CTRL> to merge a new or selected control point with the position of an existing control point. Requires: Control point selection
Ident point merge	<CTRL>	Workspace	Press and hold <CTRL> to merge a new or selected ident point with the position of an existing ident point. In this case, the new or selected ident point will use the UID (Unique Identifier), position and description of the existing ident point. Requires: Ident point selection
Multi element selection	<CTRL + left mouse button>	Workspace	Remove or add map-related elements to a current single or multi selection.
Element selection	<CTRL + A>	Workspace	Select all map-related elements of a specific type, if a single element (for example feature, control point, ...) is picked.

4.5 Add and connect to a new device

4.5.1 Add and connect to a new device

To be able to use the complete online functionality of the ANS+ ET, it is necessary to have at least one working connection of the tool to a device.

Depending on whether the tool is used on a server PC or directly on an AGV, the workflow of the used devices differentiates.

Note

Network communication required

For a successful connection between a device and the ANS+ ET, it is necessary to have a working network communication with the related AGV.

If a first connection attempt fails even with a working network setup, retry the connection attempt in the UI.

If the ANS+ ET is not able to connect to a device, check the following:

1. Wait for a few seconds and retry to establish the connection.
2. Check the connection between your host PC and the AGV (for example “ping” test).
3. Check if all modules of the ANS+ are running without failure on the AGV and on the host PC.

4.5.2 Device handling on an AGV

For this workflow, it is not necessary to add new devices to the ANS+ ET dataspace, as all changes affect the already existing “localhost” device.

1. To start the UI directly on an AGV, refer to chapter Direct access (Page 36).
2. If the “localhost” device is not listed in the “Favorite Devices” list, click on , check the related checkbox of “localhost” and press again to apply the configuration.
3. Connect the ANS+ ET with the device by clicking on the connect button .
   In case of a successful connection, the icon changes its design to . Otherwise, after a timeout detection, the tool displays an error message.

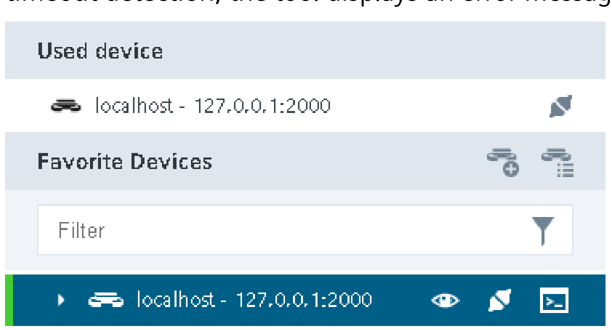


Figure 4-31 Establish a direct connection between the tool and the ANS+

4.5.3 Device handling on an engineering or server PC

For a remote connection between the ANS+ ET and an AGV, the following process is required:

1. Start the ANS+ ET and connect to the web-based UI as described in Remote access (Page 36).
2. To add an AGV to the "AGV pool" list, press .
   The dialog "Add new device" is opened.

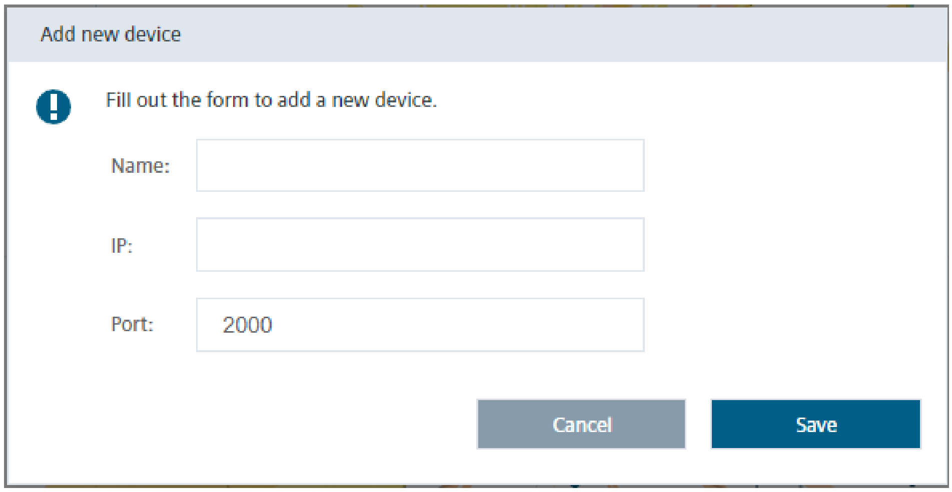


Figure 4-32 Adding a new device to the ANS+ ET

Provide the following information:

– **Name**: Name of the device, which will be displayed.

– **IP**: IP-Address of the SIMATIC Industrial OS on the related AGV.

– **Port**: If you are using ANS+ ET with its default port configuration, do not change the port ("2000").
Otherwise, change the number to the new configured port of the "Service Proxy" module.

3. To add the AGV to the "Favorite Devices" list, click .
4. Check the related checkbox.
5. Press again to apply the configuration.
6. Connect the ANS+ ET with the AGV by clicking .
   In case of a successful connection, the icon changes its design to . Otherwise, after a timeout detection, the tool displays an error message.

Initial configurations 5

5.1 Parameter setup

The parameter page "Parameter" page (Page 51) visualizes all parameters related to the selected vehicle. By default, the "localhost" is preselected. When configuring the parameter for the first time, the following parameters have to be configured:

- Section: Vehicle Interface
  - Kinematics
- Section: Laser X
  - Connection
  - Transformation
  - Start Angle
  - End Angle
  - Resolution
  - Upside Down
- Section: Robot
  - Outline Point
- Section: Motion AGV
  - Enable
- Section: Motion Vehicle
  - V Max
  - A Max
  - A Max Decel
  - Omega Max
  - A Omega Max
  - A centripetal Max

Additional information:

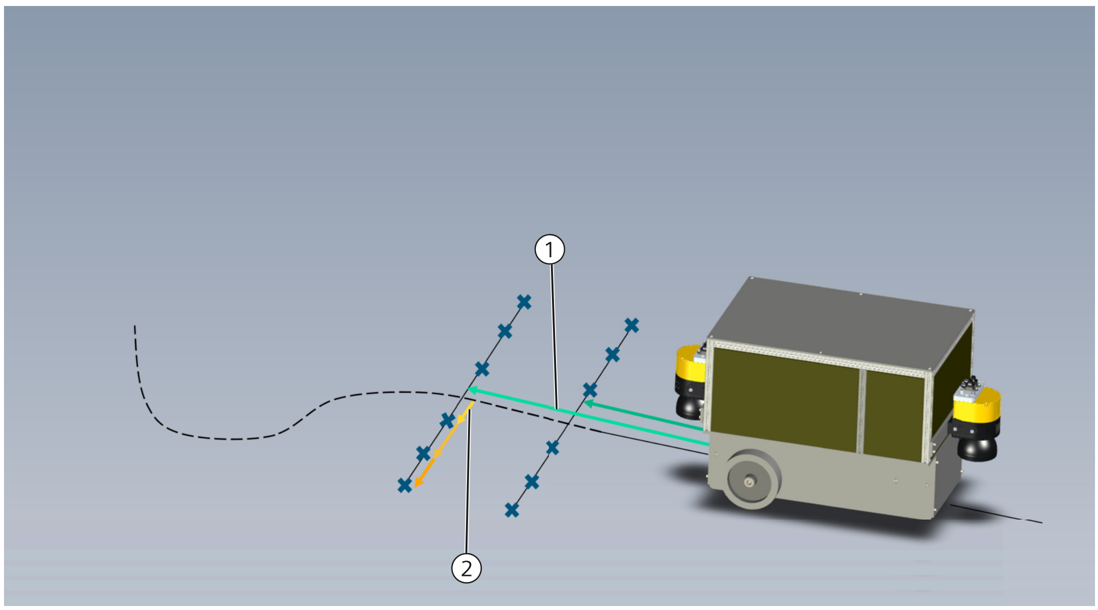
The "Enable" attribute within the Section "Motion AGV" enables the free path planning and obstacle avoidance. Therefore, the velocity setpoints within the section "Motion Vehicle" and "Motion Path Planner" are required. The setpoints should be aligned with the defined PLC velocity setpoints. Also, within the section "Motion Static Loader", the related map file (<MapName>.yaml) that is used for the global and local planner, needs to be specified.

Within the section "Motion Flow Kraken Controller" the alternative trajectories, that are used for obstacle avoidance, can be configured.

Note

If the lateral or longitudinal distances need to be adjusted, please only edit the already existing values within the section.

The longitudinal distances are specifying all alternative trajectories in +X direction, as shown with the green lines in the figure below. The lateral distances are specifying all lateral trajectory distances within the y- direction, as shown with the yellow lines in the figure below.



① Longitudinal distances
② Lateral distances

Figure 5-1 Lateral and longitudinal distances of the motion flow kraken controller

The corresponding alternative trajectories are displayed with pink and purple lines.

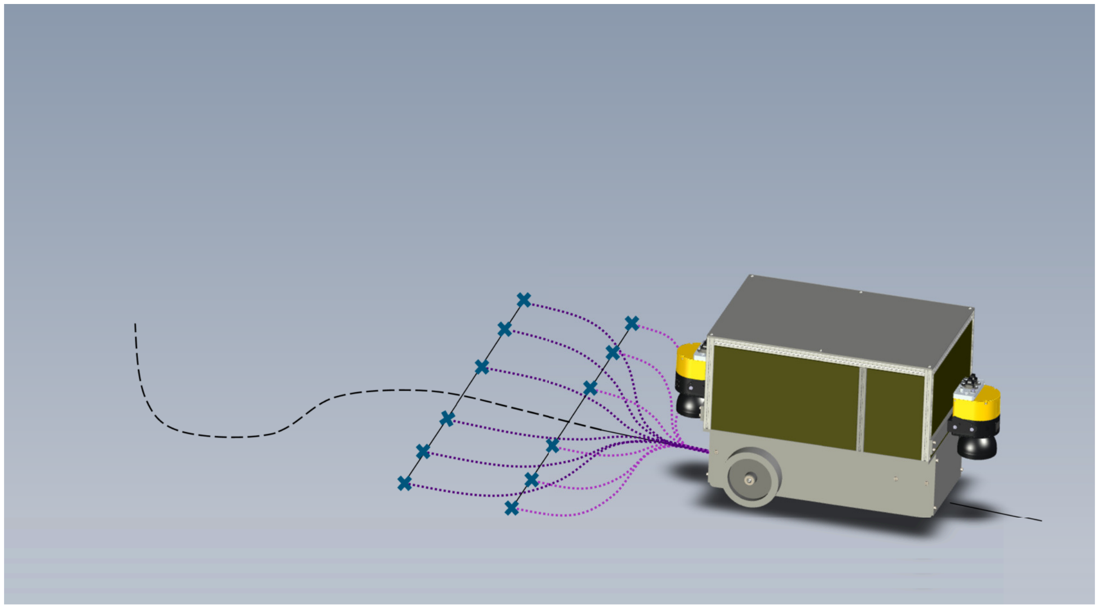


Figure 5-2 Alternative trajectories based on the lateral and longitudinal distances

After the map creation, the name of the map needs to be inserted in the following sections:

- Section: Motion Static Loader
  Map File Path: "../atlas/<MapName>.yaml"
- Section: Route Map
  Global Frame Id: "<MapName>.map"

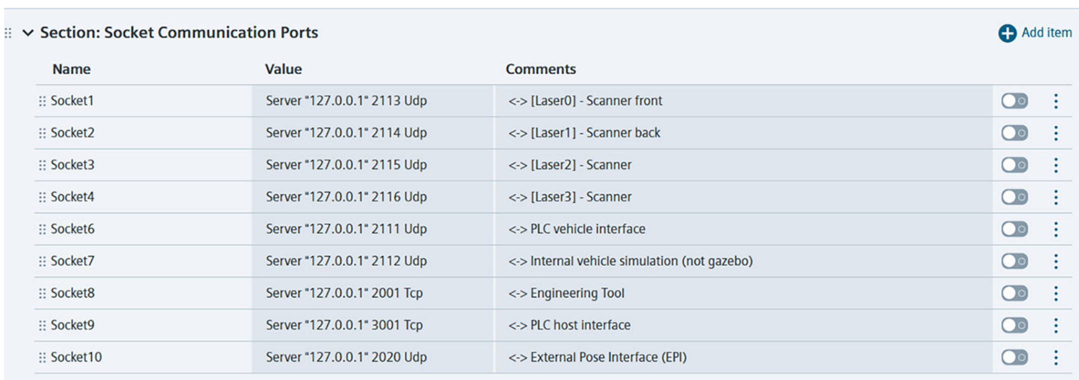
5.2 Communication ports

Note

Ports that are not actively used by ANS or other software should be deactivated in the operating system.

More detailed information on the interfaces and communication protocols can be found in the attached document “manual interface description”.

Per default, ANS+ uses the following communication ports and protocols.



Section: Socket Communication Ports

Add item

Name	Value	Comments
Socket1	Server "127.0.0.1" 2113 Udp	<-> [Laser0] - Scanner front
Socket2	Server "127.0.0.1" 2114 Udp	<-> [Laser1] - Scanner back
Socket3	Server "127.0.0.1" 2115 Udp	<-> [Laser2] - Scanner
Socket4	Server "127.0.0.1" 2116 Udp	<-> [Laser3] - Scanner
Socket6	Server "127.0.0.1" 2111 Udp	<-> PLC vehicle interface
Socket7	Server "127.0.0.1" 2112 Udp	<-> Internal vehicle simulation (not gazebo)
Socket8	Server "127.0.0.1" 2001 Tcp	<-> Engineering Tool
Socket9	Server "127.0.0.1" 3001 Tcp	<-> PLC host interface
Socket10	Server "127.0.0.1" 2020 Udp	<-> External Pose Interface (EPI)

Figure 5-3 Communication ports used by ANS+ in default settings

Additional ports might be in use depending on the laser scanners configured by the user.

These ports are enabled by default in the docker container. Depending on the version and settings of Industrial OS, it might be necessary to manually open the ports to establish a communication.

Open a port

To open port X, establish an SSH connection and type the following command in the console:

```
sudo ufw allow <Port X>
```

Close a port

To close port X, use the following command:

```
sudo ufw deny <Port X>
```

A full description of the available ANS+ interfaces and communication protocols, can be found in the document “SIMOVE AGV Interface Description”, delivered with the ANS+ runtime software.

5.3 ANS+ laser commissioning

The following section describes the commissioning and calibration of up to four laser scanners. Computing the transformation of each laser position is relevant for a successful operation of the ANS+.

1. Adjust the laser scanner (PLS) in combination with the SICK laser height measurement devices at an angle parallel to the floor.
   As a result, the PLS data tends to avoid touching the ground.
2. Check that the corresponding laser scanners are enabled in the parameter file “user_def” within the ANS+ ET and set an initial guess for each transformation as shown below.

Note

Initial guess of the laser transformation

This initial guess of the laser transformation is used for the optimization problem solved during laser calibration and must be within a range of +/- 8 cm and +/- 5° of the true values. It is advisable to set the initial guess to the transformation given in the CAD data of the AGV.

Odometry Type

As the laser commissioning is not finished at this point, the parameter "OdoWheel" has to be parameterized and used within "user_def" file. After finishing the laser commissioning, "OdoLaser" can be used.

Section: Laser 0

Name	Value
Enable	yes
Connection	Socket1
Transformation	44.44 -22.6 17.0 43.7 0.0 0.0

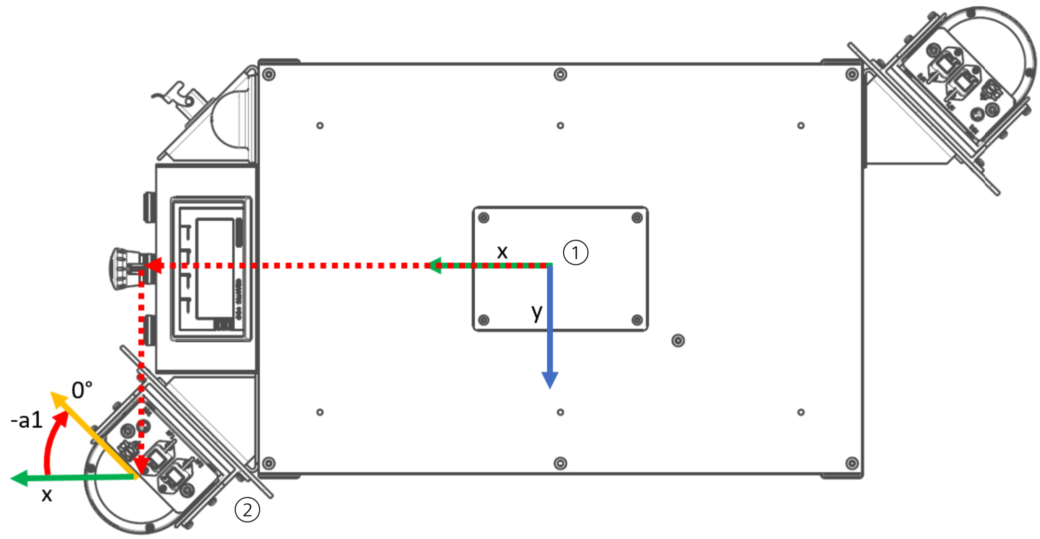
Figure 5-4 Initial guess for the laser scanner transformation based on CAD within “user_def”

Note

Laser transformation origin

The values of the laser transformation must be related to the kinematic center of the AGV.

The kinematic center may not be identical to the midpoint of the AGV.



① Kinematics center
② Laser 0

Figure 5-5 Description of laser transformation parameters

3. Restart the ANS+ NC module to apply the initial guess parameters for all laser parameters.
4. Once the module is restarted, evaluate, if the laser scanner data represents the surrounding environment correctly. This can be done by comparing laser data in the ANS+ ET and physical objects. For example, a physical object in front of the AGV needs to be visualized in +X direction or an object to the left needs to be visualized in +Y direction.
5. Reduce the maximum possible velocity for “Automatic start“ of the AGV to 300 mm/s.
If the AGV is later not able to reach the commanded target, e.g. due to lethargy or large dimensions, it is necessary to decrease the velocity or to use a higher curve radius setup in the next step.

6. Select the smallest possible curve radius for your AGV out of the following possibilities: 1 m, 2 m, 3 m. Set up the respective calibration environment as depicted below.

Note

Accuracy in calibration result

To achieve the highest accuracy in the calibration result, the smallest possible curve radius and respective calibration environment should be selected.

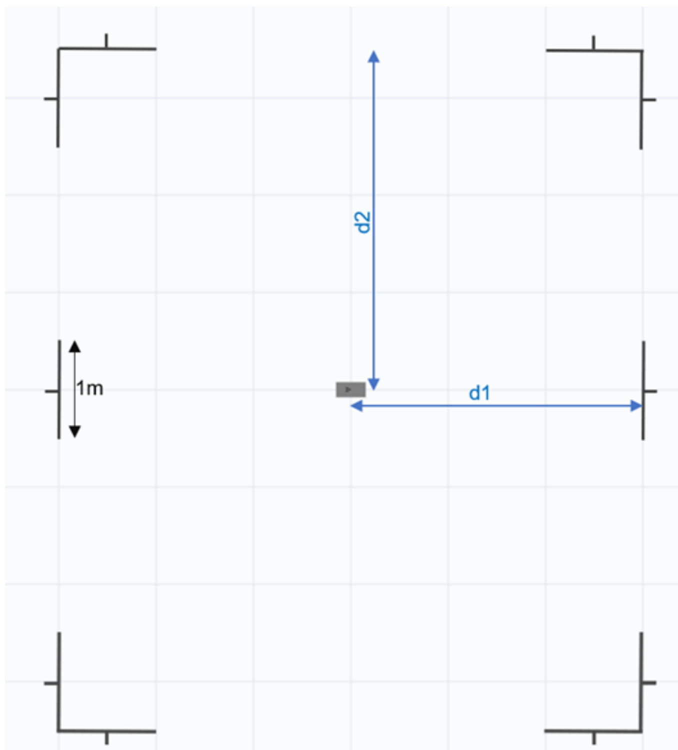


Figure 5-6 Calibration environment

Figure 5-7 Objects in the calibration environment

The line-like landmarks, as shown in the illustration "Objects in the calibration environment", must have a length of at least 1 m each for the calibration process. The landmarks are used to build the setup shown in the illustration "Calibration environment". The distances "d1" and "d2" depend on the selected curve radius. The values of d1 and d2 are given in the following table and are representing the allowed maximum:

Curve radius	Max. distance d1	Max. distance d2
1 m	3 m	3.50 m
2 m	4.50 m	6 m
3 m	6 m	8.50 m

7. Position the AGV in the center of the calibration environment facing towards the longer sides of the rectangular calibration setup (as depicted in the calibration environment in the illustration "Calibration environment").
8. Click on the “activate laser calibration process” in the ANS+ ET.

Figure 5-8 Activate laser calibration process button

9. Ensure that the calibration preconditions are fulfilled and click "Confirm".

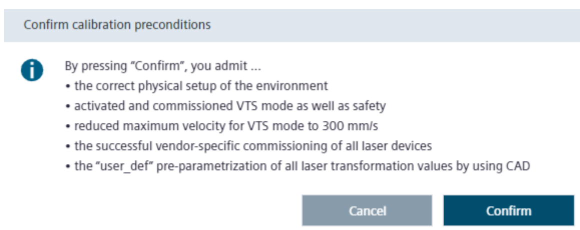


Figure 5-9 Confirm calibration preconditions before starting the calibration process

10. Select the curve radius corresponding to your calibration environment and AGV.

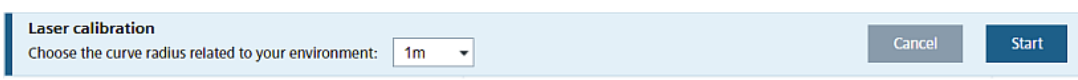


Figure 5-10 Select curve radius for AGV path

11. Click confirm to start the calibration movement.
    The AGV will now automatically drive a path consisting of target points forming a route of two eights and a straight path segment as depicted below. The movement between target points is dependent on the underlying AGV kinematic.

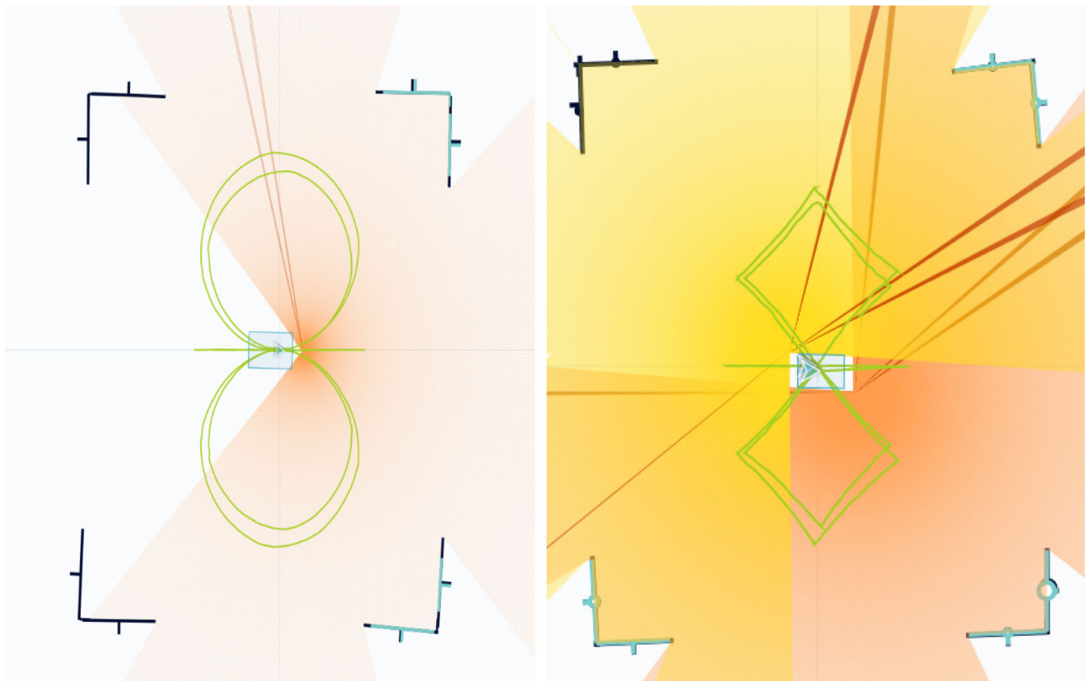


Figure 5-11 Path automatically driven during the calibration process dependent on the kinematic

This is followed by the computation of the calibration result. The current progress of the calibration is shown in the ANS+ ET.

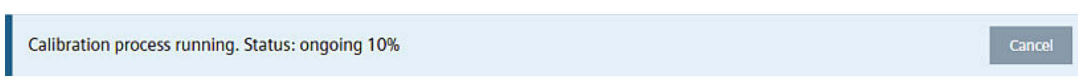


Figure 5-12 Calibration progress bar

Note

During the ongoing calibration, do not send any other drive commands to the AGV, otherwise the calibration process is canceled.

Note

The duration of the calibration process may take up to several minutes. This depends on the overall driven time period and the amount of used laser scanners.

When the calibration process is finished, the calibration results are displayed instead of the progress bar.

12. Select “Overwrite” to overwrite the current transformation set in the “user_def” parameter file with the new transformation parameters.

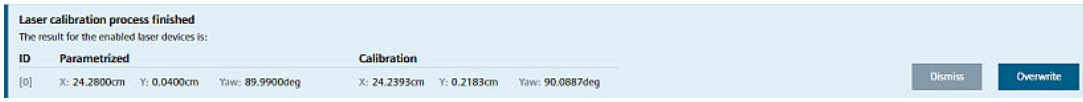


Figure 5-13 Overwrite the displayed calibration results

Note

Apply the new transformation parameters

To apply the new transformation parameters, a restart of the ANS+ NC is necessary. For further information see ""Status" page (Page 55)".

Mapping 6

6.1 Mapping

This chapter provides general information about:

- Features and their parameters
- ANS+ engineering process, how to create a feature-based map for localization and navigation in combination with the ANS+ ET

6.2 Map wording

Within one environment it is possible to use multiple maps. The most common use case for several maps is to use one global map with multiple local station maps:

- Global map
  A global map is a map which contains multiple features of the general environment.
- Station map
  Station maps only contain features of a station, for example, charging or load handling station. The SIMOVE ANS+ system only uses mapped station features, ignores completely the surrounding environment and is therefore independent of environment changes.
  This approach is used to reach the best possible accuracy in localization before stations.
  Station maps are engineered in the same way as global maps, described in chapter Station engineering (Page 163).

To be able to use several maps, that refer to each other, a map link between the maps is required. This process is explained in chapter Feature map linking (Page 104).

6.3 Feature detection

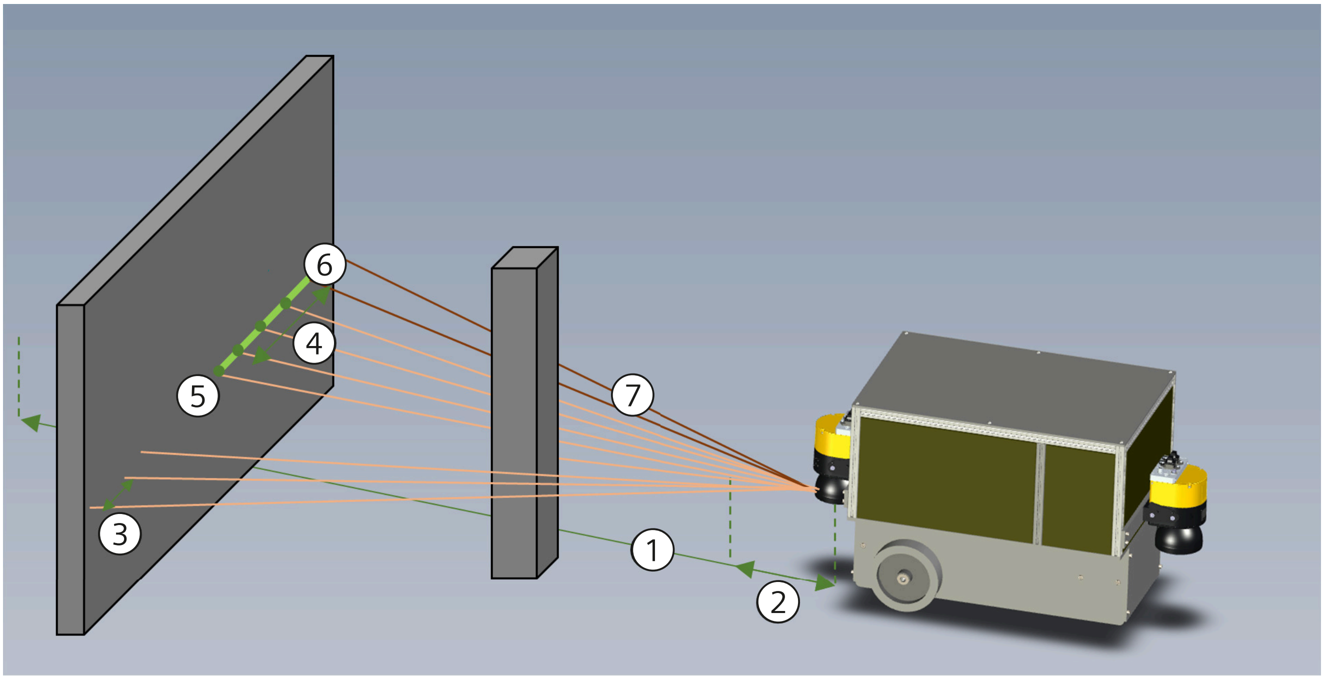
The result of the mapping process depends on the used feature parameters. For each environment or AGV type, all parameters need to be reviewed. This chapter explains the general concept behind SIMOVE ANS+ feature detection related to parameters.

Each feature recognition, which will be used for localization, is mainly based on five general parameters:

Parameter	Description
Max. distance	The maximum allowed distance between a laser and a feature. Features above this distance will be filtered.
Min. distance	The minimal allowed distance between a laser and a feature. Features below this distance will be filtered. Since some lasers have a high failure in their raw data for very close objects (< 20 cm). This parameter needs special consideration for station approaches.
Max. gap between points	If the gap between two laser points is more than the parametrized value, a new feature recognition is started. The aim is to set this value as small as possible, to receive a few long accurate features. If this value is reduced too much, too many small objects will be detected, which should be avoided.
Min. feature length or diameter	In the end, the recognized feature needs to be at least as large as the parametrized value, otherwise it will be ignored. The minimal allowed value of this parameter is 50 cm. The aim is to set this value as high as possible, to filter small fragments of the environment.
Min. Points on feature	This parameter is dependent of the laser beam resolution. In case of a low-resolution scanner, for example 0.1°, this value can be set higher. The aim is to set this value as high as possible, to filter out small fragments of the environment.

The following illustration provides a schematic overview of the feature recognition related to the described parameters. Due to the interruption, the wall is divided and only one partial feature is detected. The interrupting object is not recognized as a feature, as the overall size is less than parametrized.

There is no impact on the feature recognition if a laser device sets laser beams as high reflective. For a feature all laser beams will be used in the same way.



① Max. distance
② Min. distance
③ Max. gap between points
④ Min. feature length
⑤ Min. points on feature
⑥ Line feature
⑦ Reflective beam

Figure 6-1 Schematic overview of feature recognition

6.4 Usable feature types

For localization, different types of landmarks can be used. The tables below provide a short explanation of each feature and the resulting visualization in the ANS+ ET. Furthermore, the main default feature parameters are listed, which must be reviewed and adjusted for each project.

6.4.1 Line

Lines are besides corners the main features for localization. The parameters can be edited in the section “Kalman Polar Lines”. The parameter “MinSegLen25D” must be higher than 50cm.

The default parameters are shown in the figure below.

Section: Kalman Polar Lines

Name	Value	Comments
Polar lines represent the detected line features		
Enable Polar Lines	yes	[yes, no] - Standard line feature detection
MinSegLen25D	60	[cm] - min. length of features (Should not be set to less then 50cm!)
ScanMinRangeCm	20	[cm] - Minimum range filter for all lasers
ScanMaxRangeCm	2000	[cm] - Maximum range filter for all lasers
MinPtsInPlane25D	10	Minimum points on a line for feature detection
SpuriousMaxSize25D	2	Ignore 'n' laser points at the end of a feature for line distortion
MaxGap25D	8.0	[cm] - Maximum allowed distance between laser points for one feature association

Figure 6-2 Kalman Polar Lines default parameters

6.4.2 Corners

Corner features are created out of two lines. The parameter section for this type of feature is “Kalman Corners”. The parameter “Corner” specifies a new corner feature type with the related accepted angle that will be used for corner feature detection (including tolerance).

The free space angle specifies the free visible angle that is detected by the laser scanner. As an example, 90°, 150° and 270° angles will be detected within the default parameter setup.

The default parameters are shown in the figure below.

Section: Kalman Corners

Name	Value	Comments
Interpretion of two small line features as a corner feature		
Enable	yes	[yes, no] - Standard corner feature detection
Min Point Size	6	[cm] - Minimal amount of points on each of the two corner lines
Min Seg Len	10	[cm] - Minimal length of both corner lines
Min Side Len	20	[cm] - Minimal length of one corner line
Max Corner Gap	5	[cm] - Allowed gap between the corner laser points
Corner definitions, including tolerance angle, are not allowed to overlap between each definition!		
Corner	90 10	[deg,deg] - Accepted free space angles, 90 (free_space_angle) +- 10 (tolerance)
Corner	150 10	[deg,deg] - Accepted free space angles, 150 (free_space_angle) +- 10 (tolerance)
Corner	270 10	[deg,deg] - Accepted free space angles, 270 (free_space_angle) +- 10 (tolerance)

Figure 6-3 Kalman Corners default parameters

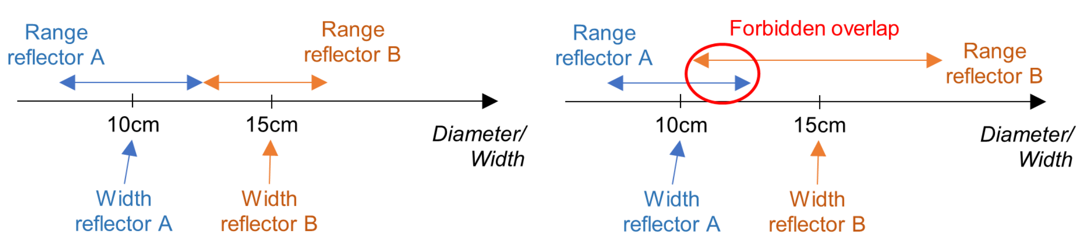
6.4.3 Reflectors

This feature uses single reflectors as a feature. The amount of reflector types for each project must be kept minimal.
The parameter section for this type of feature is “Kalman Reflectors”.

Each reflector type requires a related parameter “Reflector”, which combines three reflector values:

- Type
- Diameter / Width
- Uncertainty

The range (= diameter/width ± uncertainty) of the parameter “Reflector” is not allowed to overlap with another reflector’s range.



Allowed reflector ranges Forbidden reflector range overlap

Note

Diameter or width difference needs to be as high as possible

For each project, the diameter or width difference between two reflectors needs to be as high as possible for a better feature differentiation.

The default parameters are shown in the figure below.

Section: Kalman Reflectors

Name	Value	Comments
Enable	no	[yes, no] - Activate reflector detection | Independent from polar lines
Reflector diameters, including uncertainty range, are not allowed to overlap between each definition!		
Reflector	Wall 15 2	[<Type> [Pillar, Wall, Auto], <Diameter> [cm], <Uncertainty> [cm]]
Reflector	Pillar 10 2	[<Type> [Pillar, Wall, Auto], <Diameter> [cm], <Uncertainty> [cm]]
Point Min	4	[1] - Minimal amount of points on the diameter required for feature detection
Min Range	10.0	[cm] - Minimal cylinder detection distance under consideration of appropriate scan frame
Max Range	1500.0	[cm] - Maximum cylinder detection distance under consideration of appropriate scan frame

Figure 6-4 Kalman Reflectors default parameters

6.4.4 Cylinders

Cylindric natural landmarks can be used as a feature. The parameter section for this type of feature is “Kalman Cylinders”.

The parameter “Diameter” has to be higher than 10 cm.

The default parameters are shown in the figure below.

Section: Kalman Cylinders

Name	Value	Comments
Cylinderes represent circluar features, which are detected without any reflector		
Enable	no	[yes, no] - Standard circle feature detection
Min Diameter	10.0	[cm] - Minimum diameter of the cylinder feature
Max Diameter	30.0	[cm] - Maximum diameter of the cylinder feature
Point Min	10	[1] - Amount of points on the diameter required for feature detection
Min Range	10	[cm] - Minimal cylinder detection distance under consideration of appropriate scan frame
Max Range	1500	[cm] - Maximum cylinder detection distance under consideration of appropriate scan frame
Max Gap	5	[cm] - Maximum allowed distance between laser points on a cylinder

Figure 6-5 Kalman Cylinders default parameters

6.4.5 Line middle points

Out of a fixed specified line or segment length, a middle point is created. The parameter section for this type of feature is “Kalman LineMidPoints”.

Note

The first parameter of “Segment” has to be higher than 50 cm.

This feature is typically used for station approaches.

The default parameters are shown in the figures below.

Section: Kalman LineMidPoints

Name	Value	Comments
Enable	no	[yes, no] - Station feature for detecting middle points of a defined polar line feature
Segment	100 5 10	[<Length> [cm], <Uncertainity> [cm], <MinPointSize> [1]] Each "Segment" represents a line middle point feature type
MaxGap25D	5.0	[cm] - Maximum distance between consecutive points
Min Range	10.0	[cm] - Minimal line middle point detection distance under consideration of appropriate scan frame
Max Range	1000.0	[cm] - Maximum line middle point detection distance under consideration of appropriate scan frame

Figure 6-6 Kalman LineMidPoints default parameters

6.5 General mapping process

6.5.1 Feature Based Map

This chapter describes the ANS+ engineering process to create a feature-based map for localization and navigation in combination with the ANS+ ET.

Procedure

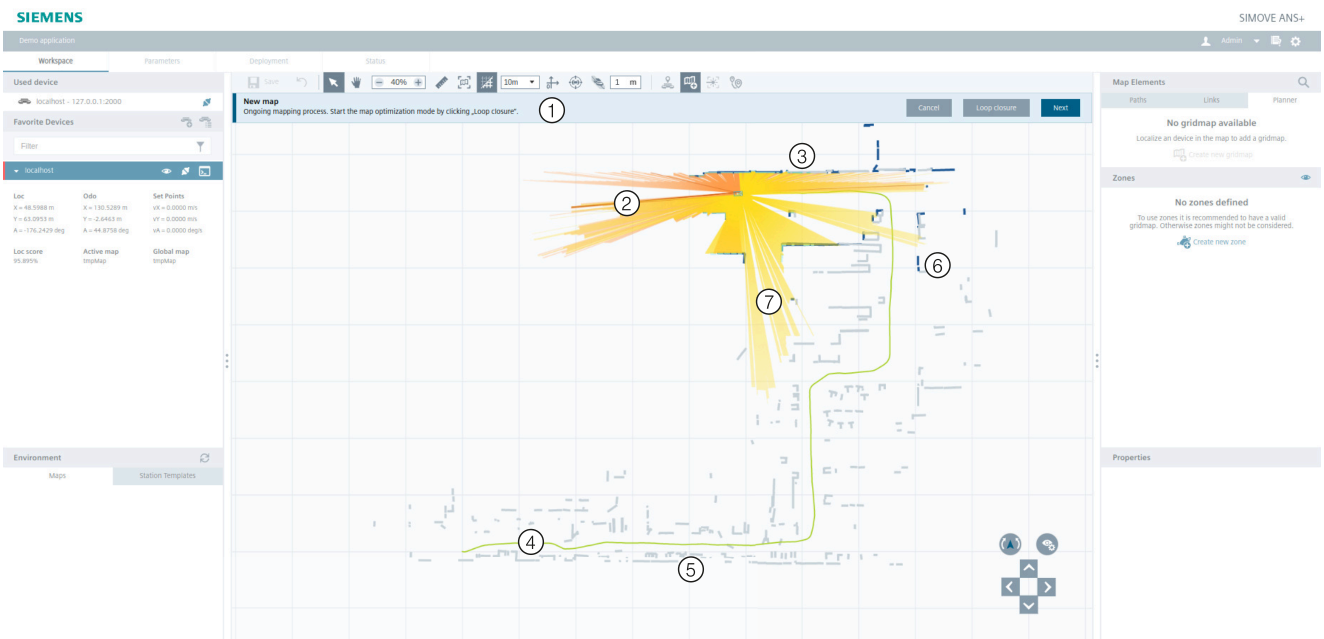
1. Start the ANS+ ET and connect to the web-based UI:
2. Connect to the related device, as described in chapter Add and connect to a new device (Page 59).
3. To start a mapping process from the previously marked position, click on the related AGV in the "Favorite Devices" list to see the corresponding functions in the "Dynamic toolbar".
4. Click on  .

5. Select "Create new map" to start mapping.

Note

Map origin

A map origin for each new generated map is per default at the position at which the mapping process has been started. The pose of the origin is changeable after the map is generated.



①   Process bar
②   Reflective beam
③   Online detected feature (turquoise)
④   Localization history (green)
⑤   Saved feature ignored for localization (grey)
⑥   Saved feature used for localization (black)
⑦   Laser data

Figure 6-7   ANS+ ET mapping data example

6. Activate the localization data over the visualization configuration panel.
   These data are needed, if the localization is facing problems with the parametrization and/or the environment during mapping.

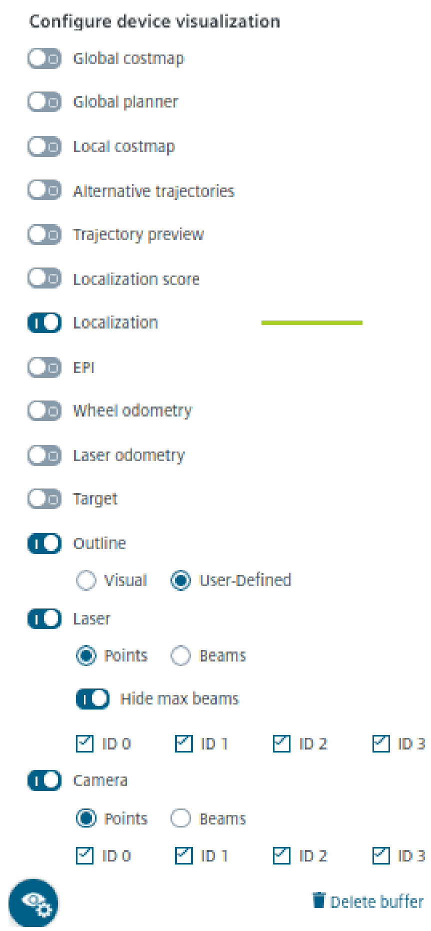


Figure 6-8 ANS+ ET localization data activation

7. Use the manual control device to **slowly** move the AGV within the relevant environment to create a new feature-based map.

8. While driving, take a continuous look into the ANS+ ET to remember which feature is created out of a static environment element and which belongs to a fragment, for example, of the floor or to a dynamic object such as other AGVs.

Note

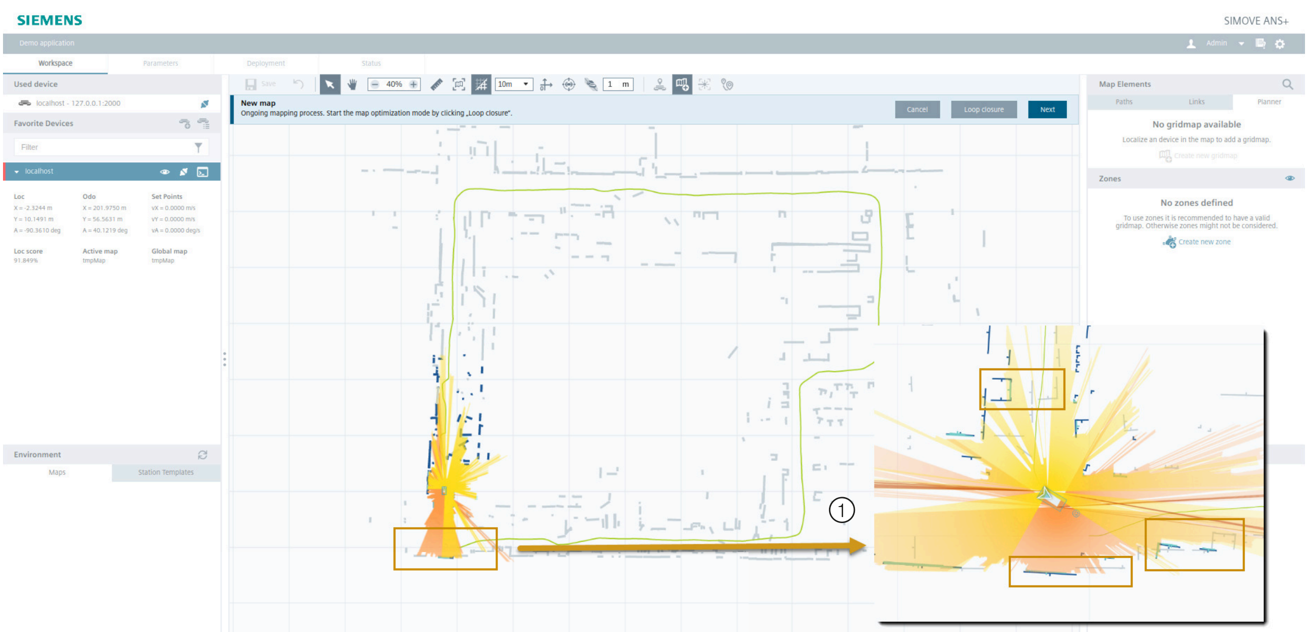
Reduce failures while mapping

To reduce failures while mapping, it is helpful to reduce the movements. Therefore, follow roughly the path the AGVs need to drive.

Mapping processes based on SLAM are in general liable to fast movements or rotations, as many different algorithms are running in the background.

Therefore, during the mapping, it is required to drive steadily and avoid impulsive movements.

In large or complex environments, the generated map may exhibit a high failure rate. This leads to an offset between a previously mapped area and new generated area. For this problem, refer to chapter "Loop closure mapping process (Page 84)".



① Offset between old and new data

Figure 6-9 Loop closure problem for already mapped areas

9. To stop the mapping process and to save the recorded map, click "Next".

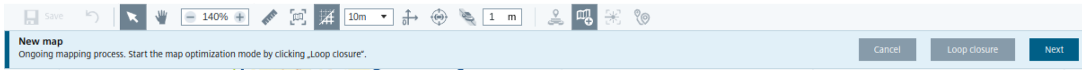


Figure 6-10 Stopping the mapping process

10. Type in your custom map name and click on "Save" to generate the map file.

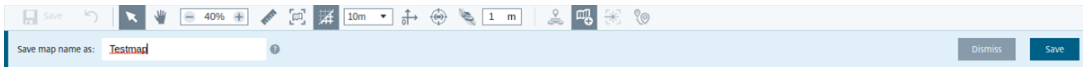


Figure 6-11 Saving the map

Note

Naming restrictions

A map name is only allowed to contain 26 characters with no spaces or other special characters.

When "Save" is clicked, the ANS+ system starts an algorithm to optimize the newly created map and to compensate tolerance failures within, for example, laser scanner(s), hardware or mechanical issues.
The bigger the size of the map and the higher the number of generated features is, the more time the algorithm requires.

Note

Failure of the generated map

If the failure in the newly generated map is too high for the optimization algorithm, for example, due to fragments or wheel odometry failure, the optimization fails. The result might be, for example, a rounded map. For this case, the map needs to be redone under consideration of chapter Loop closure mapping process (Page 84).

Once the map is created by the ANS+ NC module, the ANS+ ET automatically visualizes this map in the list.

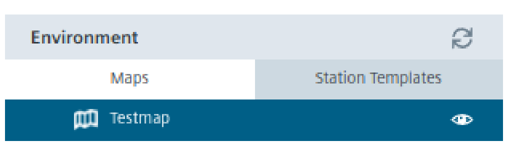


Figure 6-12 Generated map

Result

The map has been created and is now ready for its clearing. A detailed explanation of the process can be found in chapter Map engineering (Page 101).

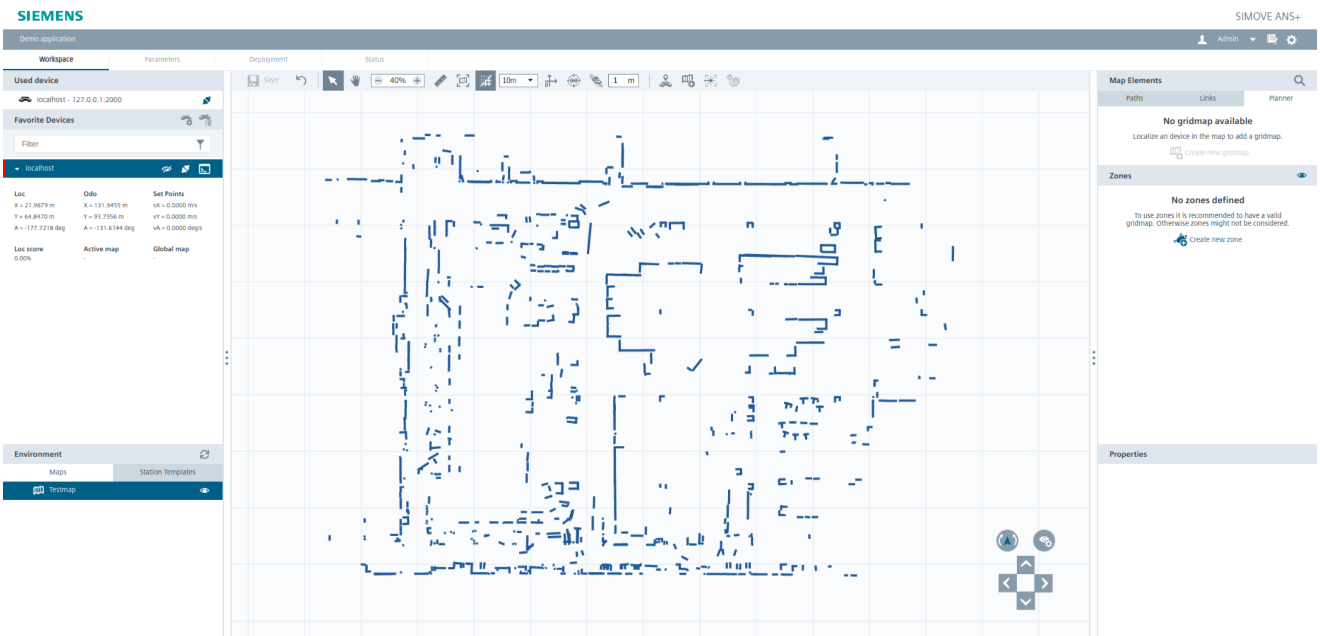


Figure 6-13 Differentiation between considered and unconsidered mapping features

See also

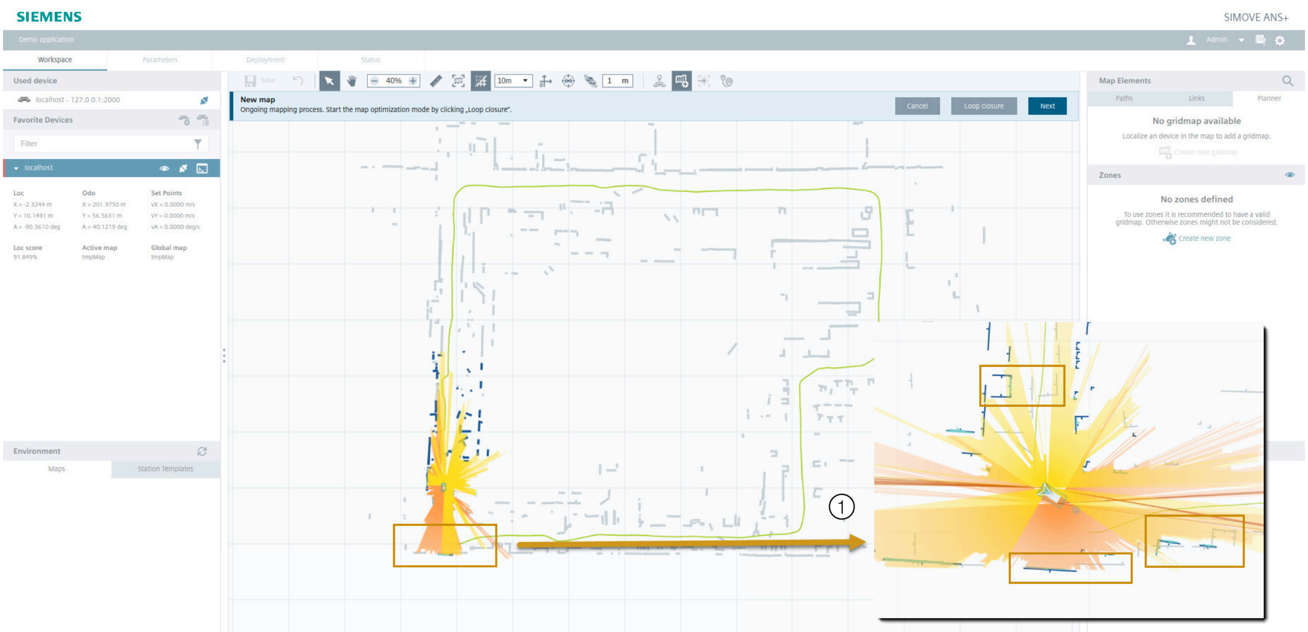
Remote access (Page 36)

Direct access (Page 36)

6.5.2 Loop closure mapping process

The mapping loop closure approach is only required in two cases:

- For large or difficult environments, in which the mapping optimization fails
- For offsets between a previously mapped area and a newly generated area of the same region.



① Offset between old and new data

Figure 6-14 Loop closure problem for already mapped areas

The following steps describe a process that solves:

1. Connect to the related device, as described in chapter Add and connect to a new device (Page 59).
2. Click .
3. Select “Create new map” to start mapping.
4. Activate the localization data over the visualization configuration panel to see if the localization is facing problems with the parametrization and/or the environment during mapping.
5. If an area is reached which has already been mapped and in which an offset occurs between previously mapped and newly generated data, click “Loop Closure”.

WARNING
Stop the AGV When a mapping approach is started directly on an AGV, it is required to stop the AGV completely before entering the loop closure approach to avoid failures. It is also mandatory to have the AGV in standstill during the entire loop closure process.

6. Move the AGV shape and its related scan data via Drag&Drop and rotate to the previously mapped features.

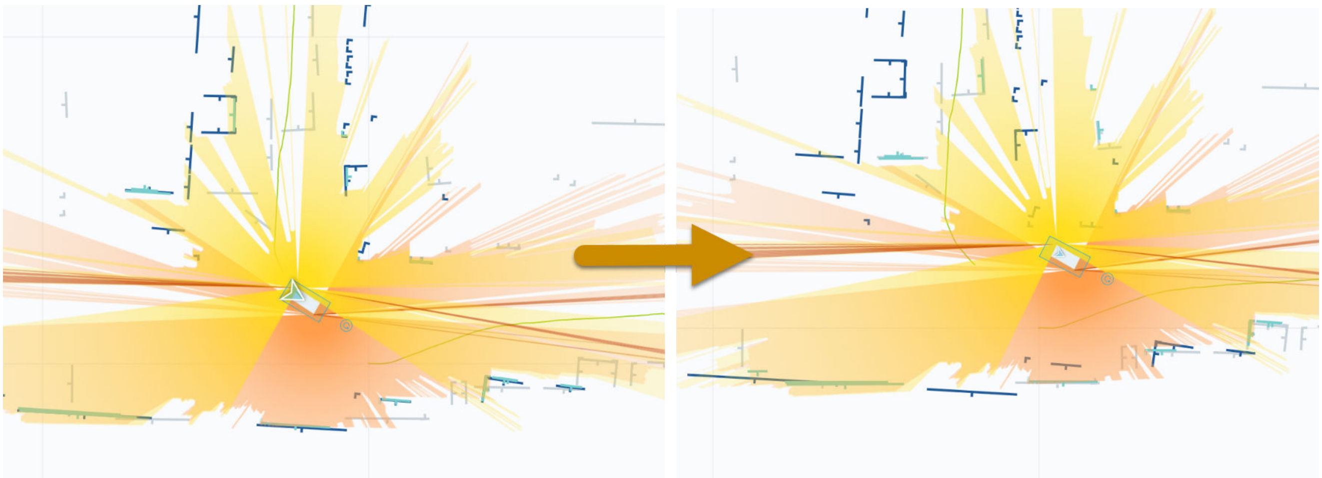


Figure 6-15 Shifted AGV pose related to prev. mapped features

---

Note

X and Y feature required

For the loop closure approach, it is mandatory to have at least one online detected X and Y feature, which can be mapped to an already mapped feature.

---

7. Click on “Optimize” to provide the new data to the map optimization.

8. Once the map optimization is done, the result is visualized in the UI.

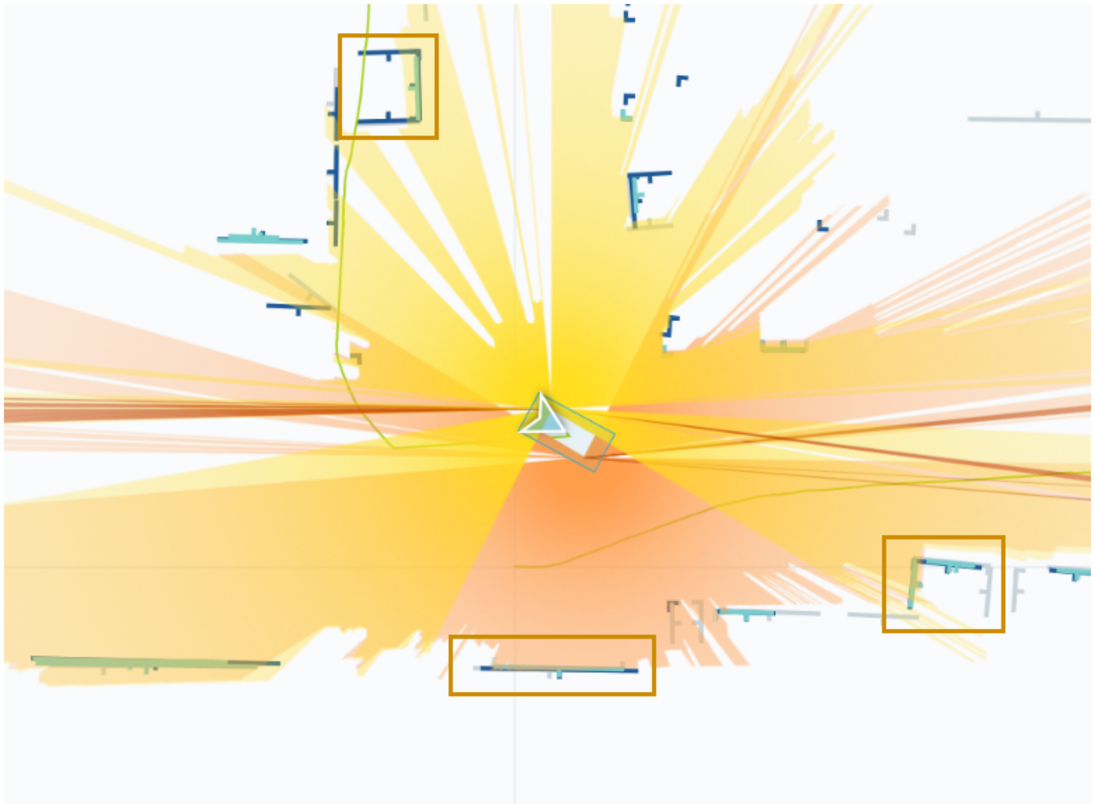


Figure 6-16 Successfully finished map optimization

9. Depending on the result, the mapping can be used and continued by pressing “Confirm” or redone with new pose data by pressing “Reset”.

10. If necessary, repeat the procedure multiple times for each reentered area during one single mapping approach.

11. To stop the mapping process and to save the recorded map, click “Next”.

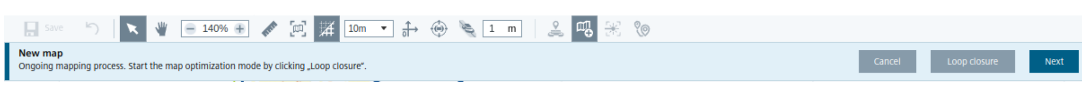


Figure 6-17 Stopping the mapping process

12. Type in your custom map name and click “Save” to generate the map file.

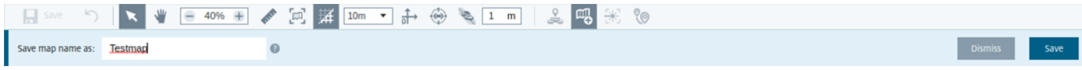


Figure 6-18 Saving the map

Note

Naming restrictions

A map name is only allowed to contain 26 characters with no spaces or other special characters.

After saving the map, a final map optimization is started.

13. When the map is created by the ANS+ NC module, the ANS+ ET automatically visualizes this map in the list.

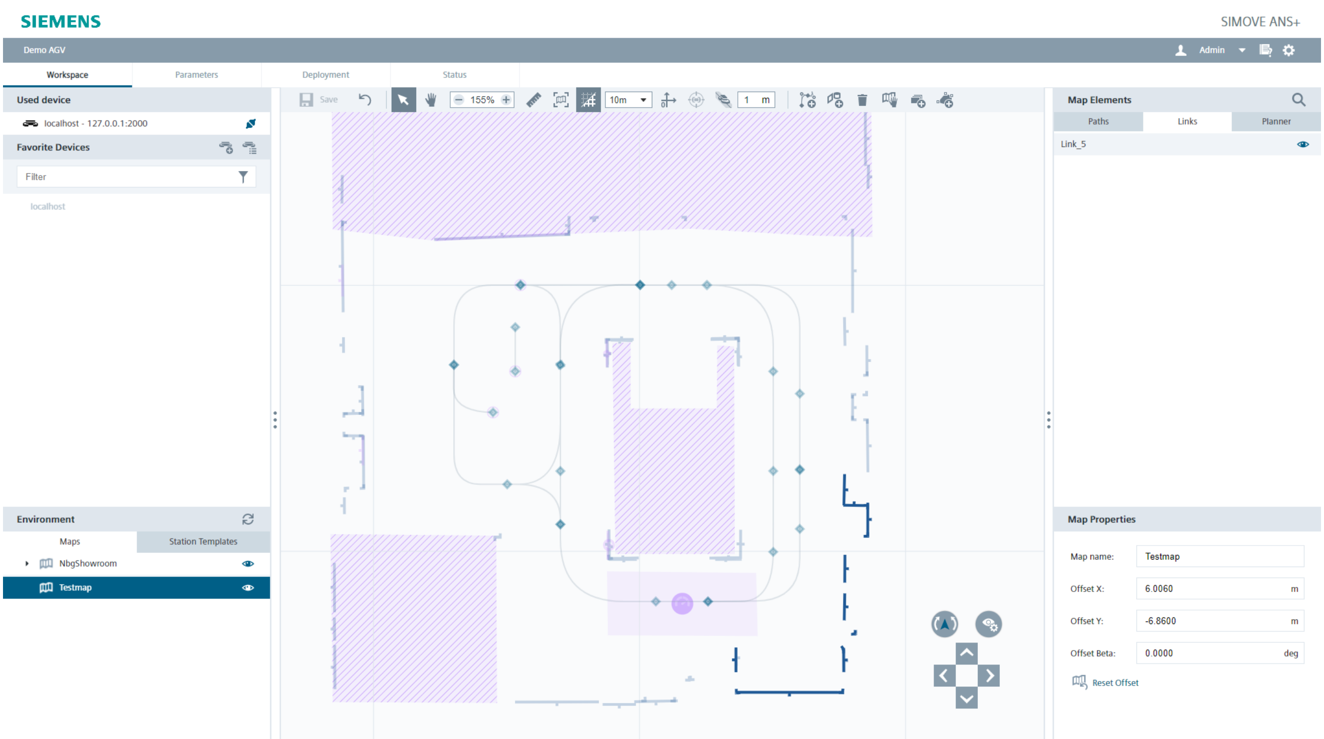


Figure 6-19 Final optimized map

Result

The map has been created and is now ready for its clearing. A detailed explanation of the process can be found in chapter Map engineering (Page 101).

6.5.3 Grid-based Map

This chapter describes the ANS+ engineering process to create a occupancy grid-based map for navigation in combination with obstacle avoidance. Within this map, the environment is discretized into cells.

Procedure

1. Start the ANS+ ET and connect to the web-based UI.
   To start a mapping process , a feature-based map has to be created and loaded into the ANS+ NC module in advanced. Afterwards, a gridmap can be generated for this feature-based map.
2. Click on  and select "Create gridmap for current map"

3. Drive within the environment where the gridmap should be computed. While driving, the computed gridmap is not shown on the screen.
4. After saving the gridmap, the visualization can be turned on/off by selecting the visibility icon within the planner tab of the Map Elements, as shown below.

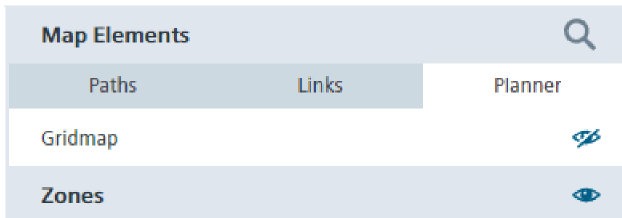


Figure 6-20 Grid-based map visualization

Figure 6-21 Generated grid-based map

Note

Only one grid-based map can be created for each feature-based map.

Result

The map has been created, as shown in the figure below and is now ready for its clearing. A detailed explanation of the process can be found in chapter Map engineering (Page 101).

During the mapping process, the recorded gridmap is not being displayed. After saving, the gridmap contains three different information for every cell of the recorded map:

- White cells represent a free area
- Black cells represent an occupied area
- Grey cells represent an unknown area

6.6 Map extension

This feature extends an already existing map with new features, but it is required to first delete all features of the related area. The advantage of this approach is that all other map-related information, for example, links or paths, can be kept in their current state.

Note

Existing features will not be deleted

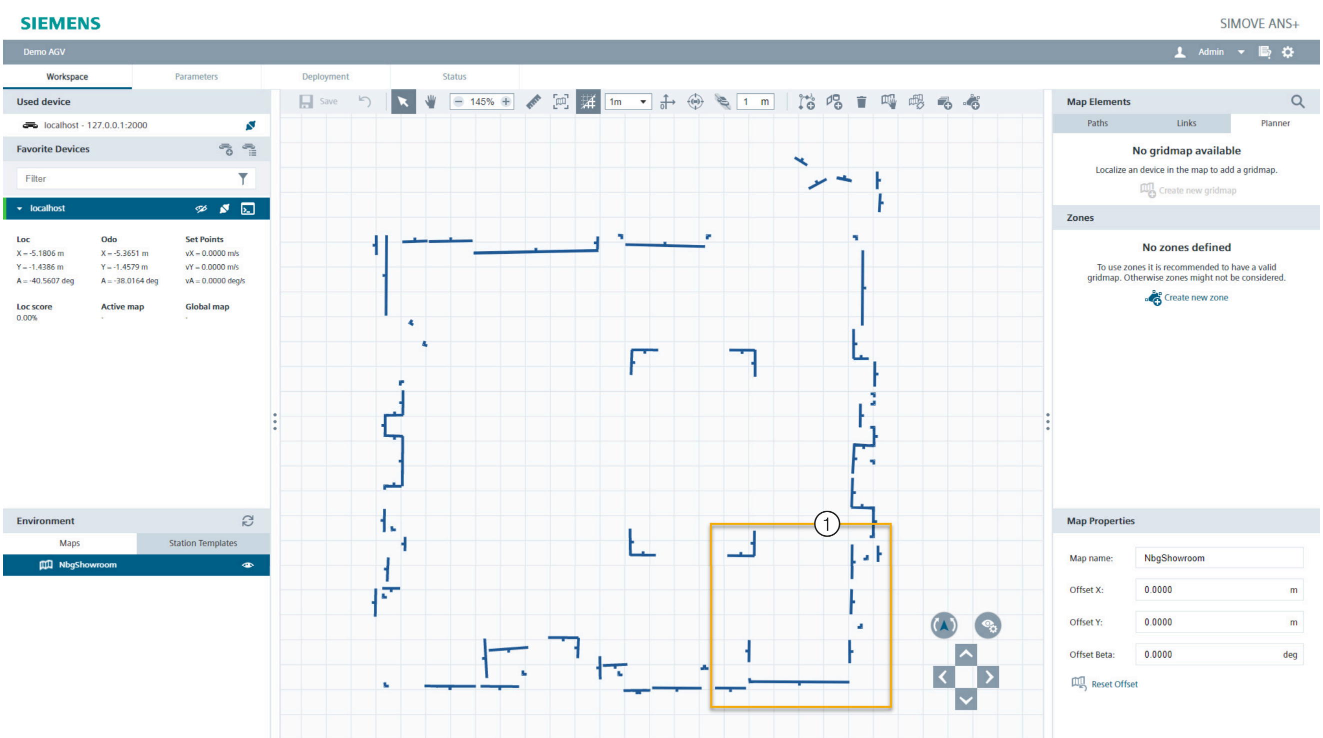
Within this process, no existing features of the extended map will be updated or deleted.

Note

Map name cannot be changed

It is not possible to change the name of an already existing map by using the map extension approach.

For the following process, the highlighted area is extended.

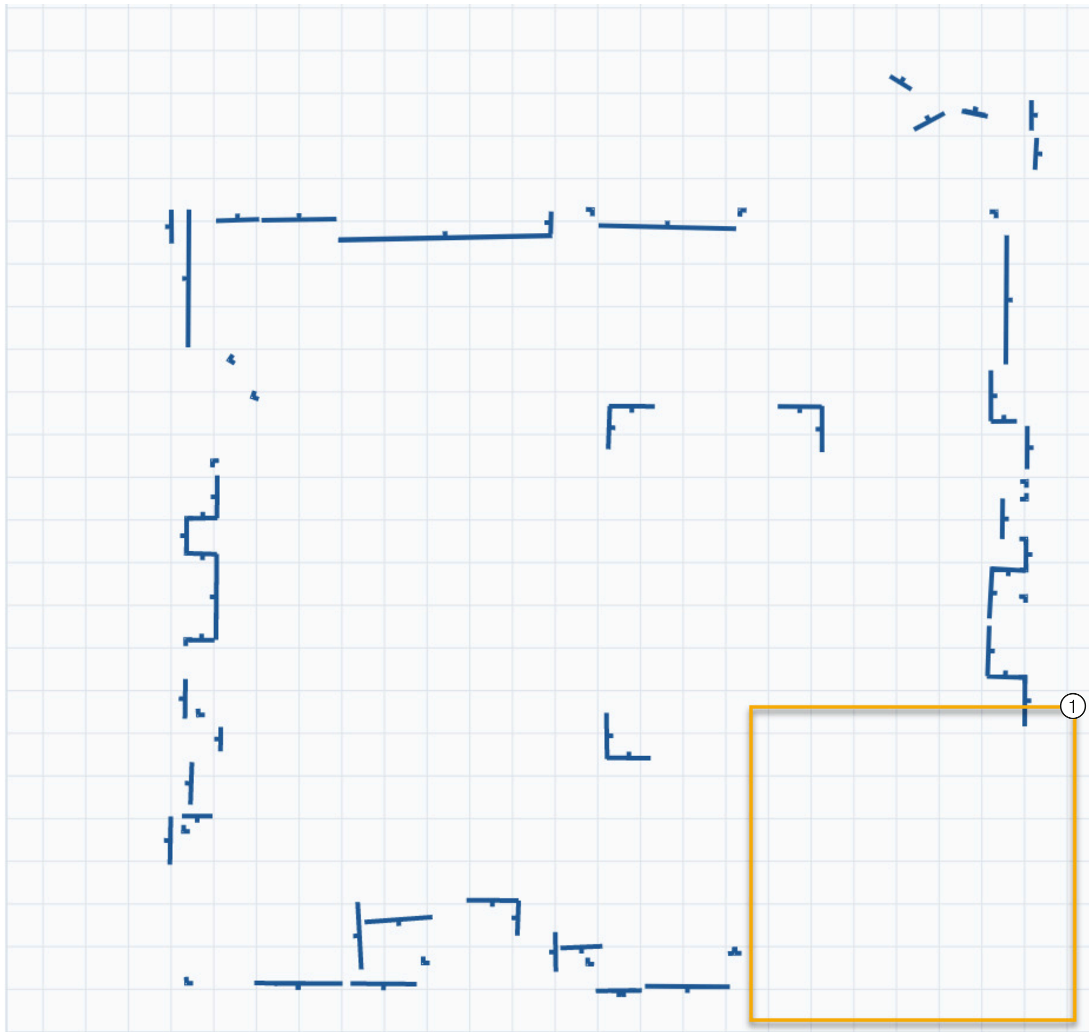


① Extended area

Figure 6-22 Area used for map extension

To extend a map, the following approach is required:

1. Delete all features in the extended area.
   If an unknown area of a map is extended, this step can be skipped.



① Cleaned area

Figure 6-23 Cleaned area

2. Save the map changes.
3. Reload the atlas data of the related AGV using the device command toolbar.

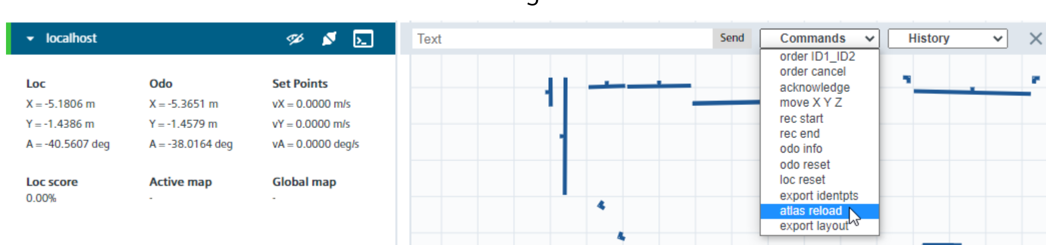


Figure 6-24 Reload AGV atlas

4. Localize the AGV in a region in which enough localization features exist and before the extended area starts.
5. Click and select "Extend current map" to start the map extension approach.

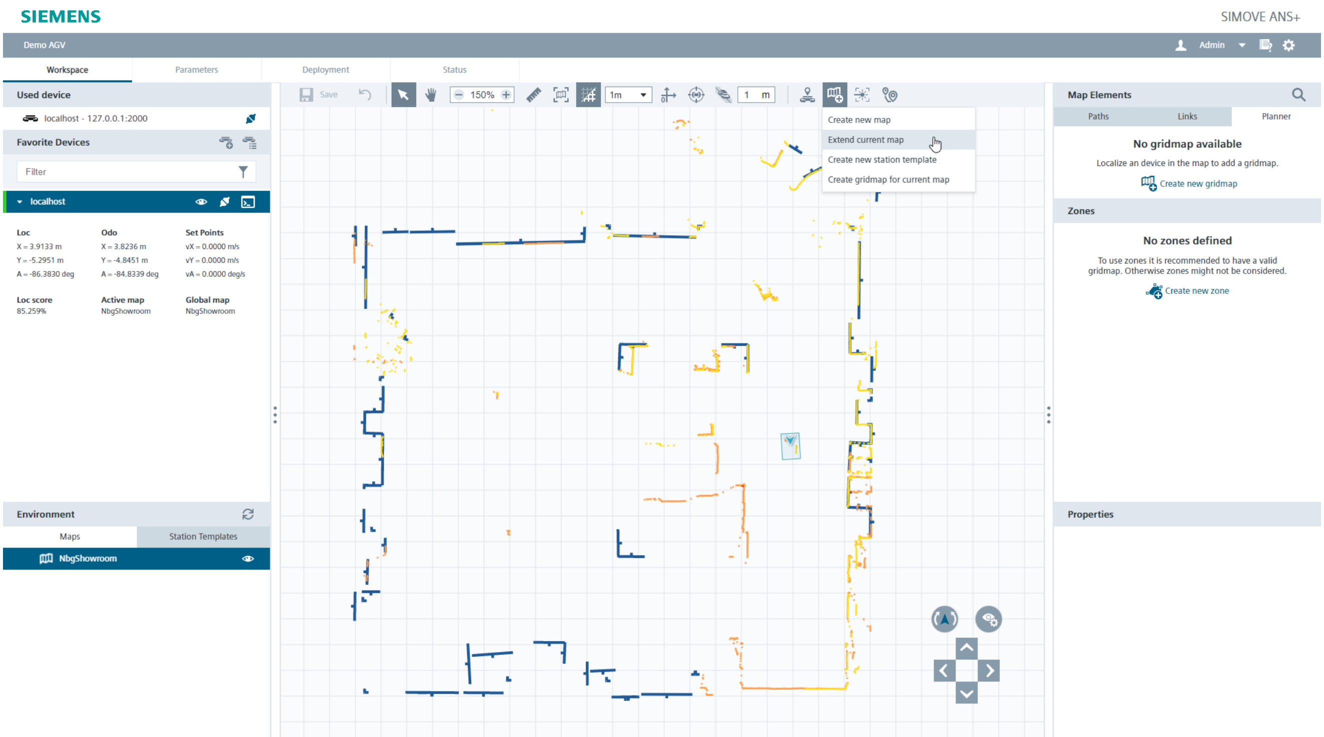


Figure 6-25 Localized AGV required to start extension approach

6. Move the AGV with a manual control device to generate all new required features.

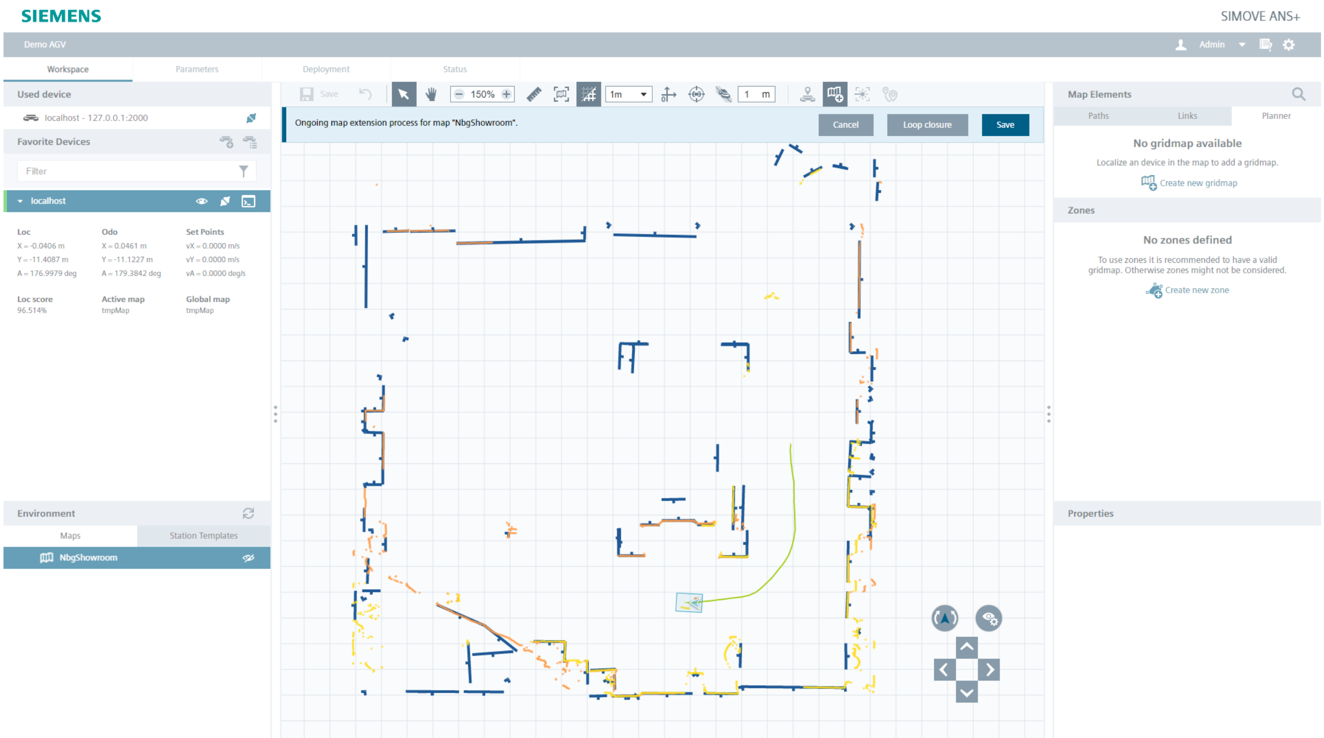


Figure 6-26 Ongoing map extension approach

Note

Loop closure approach

If a mapping offset between new and known features occurs, use the loop closure approach to align newly generated features with the already known ones, as described in chapter Loop closure mapping process (Page 84).

---

7. Once all features are generated, stop the approach by clicking "Save".
   As the already known map is extended, no new map name needs to be inserted.
   A map optimization algorithm is running in the background.
   Once the file is finished, the ANS+ ET automatically reloads its data content.

8. Clean the map by deleting all fragments or doubled features.

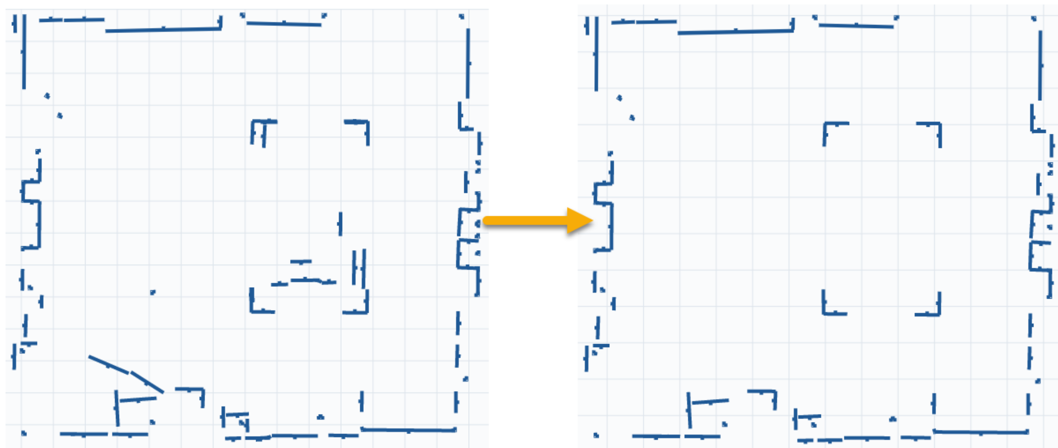


Figure 6-27 Cleaned features within the extended map

9. Save the map changes.
10. Reload the atlas data of the related AGV using the device command toolbar.

Grid map extension:

This feature extends an already existing gridmap. As an advantage of this approach, the already existing gridmap will be updated and not be overwritten or deleted.

Procedure:

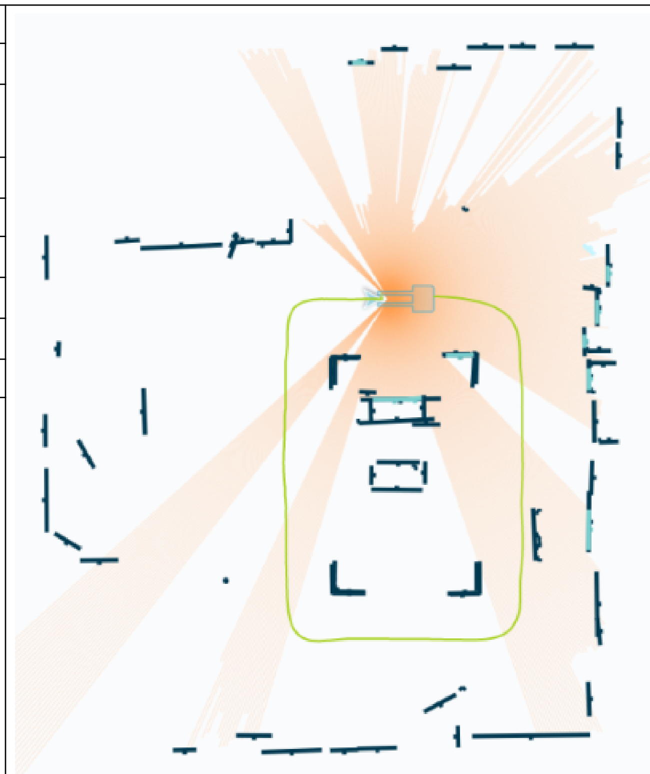
1. Start the ANS+ ET and connect to the web-based UI.
   To start an update process, a grid map must be created in advance.
2. Click on  and select "Update gridmap for current map".
3. Drive within the environment where the grid map should be updated. While driving, the computed gridmap is not shown on the screen.
4. Click on "Save" to overtake the changes.

6.7 Global mapping examples

The following three tables demonstrate an example of a mapping process within the same environment. For each mapping a different set of parameters has been used. The blue line represents the history data of the localization while mapping.

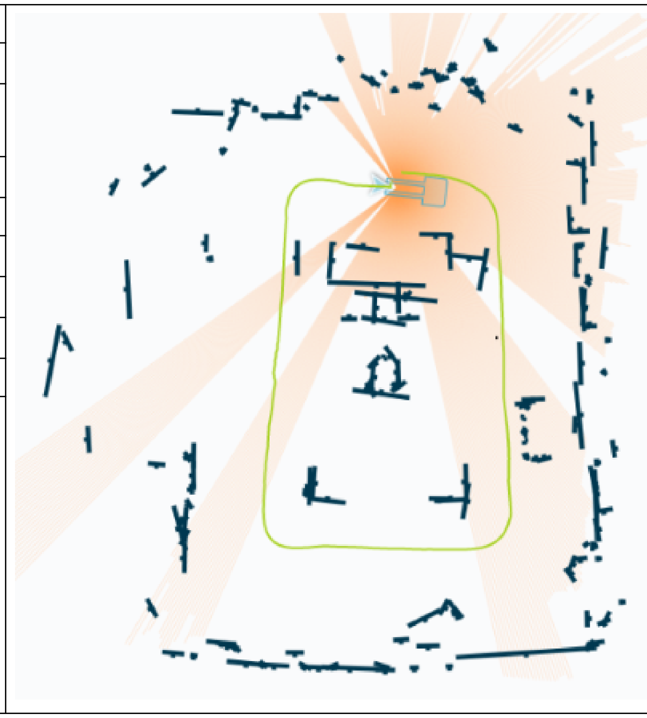
The first table represents the best parametrization, as it provides several long static line features, small corner features and nearly no tiny fragments. Tiny fragments need to be deleted manually after the mapping process which is explained in chapter Map engineering (Page 101).

Kalman Polar Lines	
• MinSegLen25D	50 cm
• MinPtsIn-Plane25D	10
• MaxGap25D	15 cm
Kalman Corners	
• Min Point Size	10
• Min Seg Len	10 cm
• Min Side Len	30 cm
Result: Good	
• No localization gaps and or jumps • Localization history illustrates the driven way	



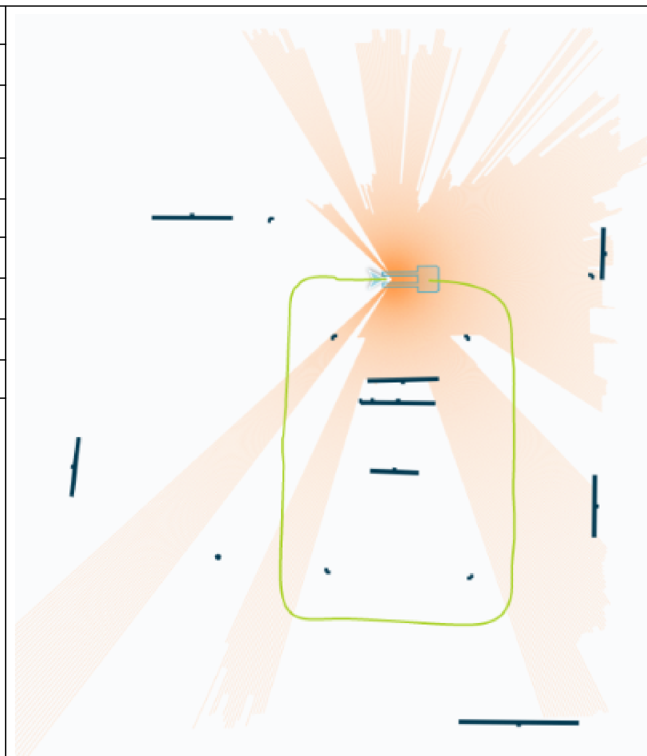
First mapping example – Best result

Kalman Polar Lines	
• MinSegLen25D	10 cm
• MinPtsIn-Plane25D	5
• MaxGap25D	5 cm
Kalman Corners	
• Min Point Size	10
• Min Seg Len	10 cm
• Min Side Len	10 cm
Result: Critical	
• Too many fragments in the map which are affecting the localization • Too many small features	



Second mapping example – Too many features

Kalman Polar Lines	
• MinSegLen25D	150 cm
• MinPtsIn-Plane25D	15
• MaxGap25D	15 cm
Kalman Corners	
• Min Point Size	20
• Min Seg Len	10 cm
• Min Side Len	50 cm
Result: Critical	
• No fragments, but insufficient features for localization	



Third mapping example – Insufficient features

See also

Remote access (Page 36)

Feature-based map clearing (Page 101)

Map engineering

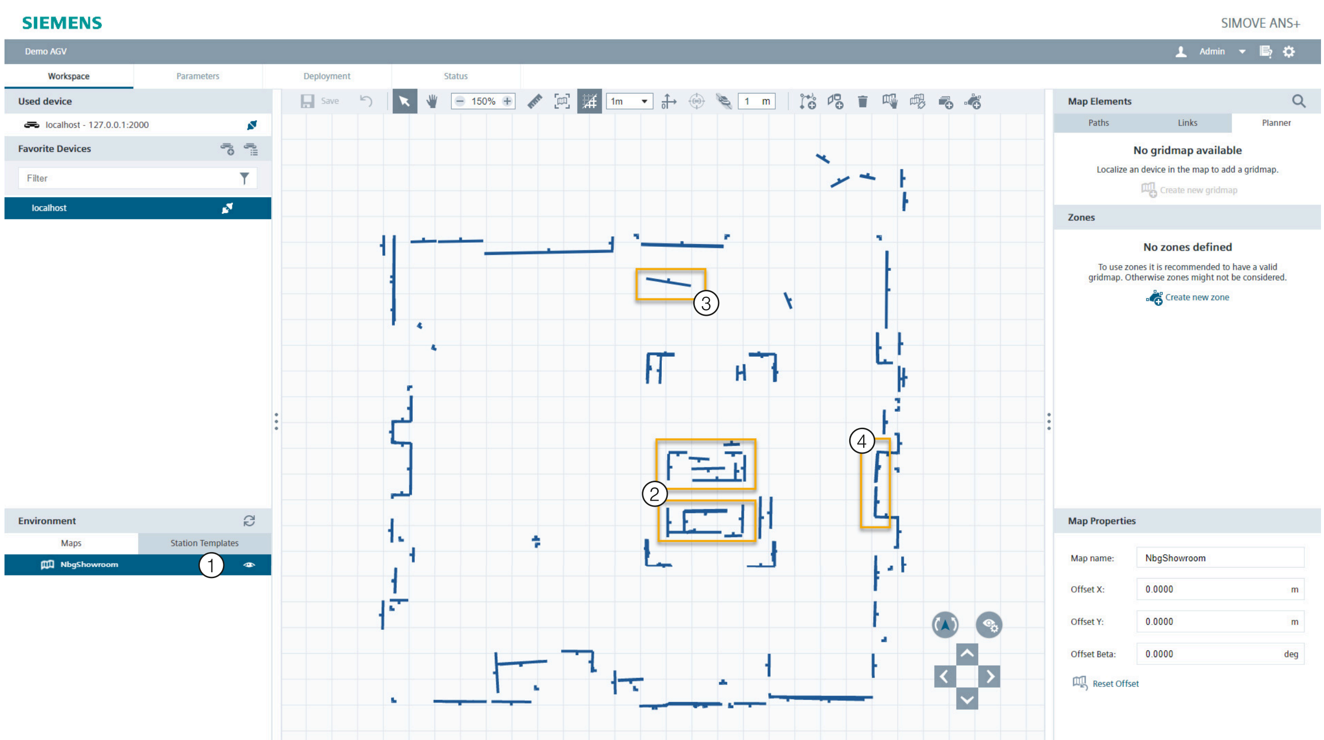
7

7.1 Feature-based map clearing

This chapter describes an engineering process for preparing a previously created map for localization and for path engineering.

Procedure

1. Click on next to the previously created map to visualize it in the world window.
2. Hide all other maps by clicking .



①	Active map
②	Other AGV
③	Floor contact
④	Doubled object

Figure 7-1 Visualization of the uncleaned map

3. In the map, remove the following features by pressing or <Del>.

Fragments	Those features are saved by the algorithm in case laser beams are touching the ground. This scenario is possible for example due to a floor unevenness, wrong mechanical laser adjustment or reflector mismeasurements.
Dyn. objects	Other AGVs in the environment may generate features, which must be removed in the engineering process. Those features are not static in the map and therefore cannot be used for localization.
Doubled objects	Features can be created twice in case of floor unevenness and/or different detection of multiple laser scanners.

4. To delete multiple features in a single step, use “feature multi-select”:
   – Click and hold the left mouse button in the world window.
   – Move the mouse and hold the left mouse button to define a selection area.
   – After releasing the mouse button, select the related map element type.
5. All marked elements can be removed by using or <DEL>.

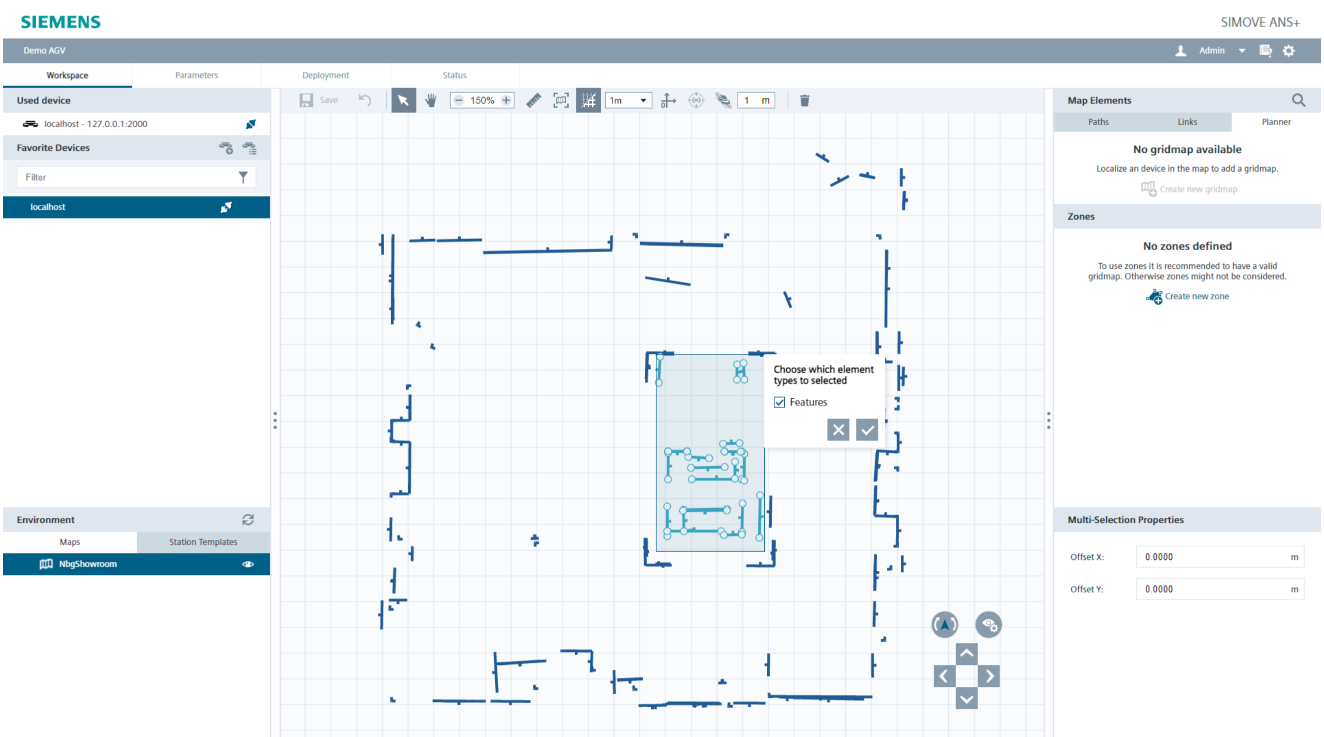


Figure 7-2 Multi-select feature to delete all selected features in one step

6. To undo steps, use or <CTRL + Z>.

Note

Do not move static features

Static features are used for localization and should not be moved or adjusted, as the ANS+ has generated these objects by using the direct laser data. Therefore, to receive the best accuracy in localization, leave the static features as they are.

7. Save the map using or <CTRL + S>.

Result

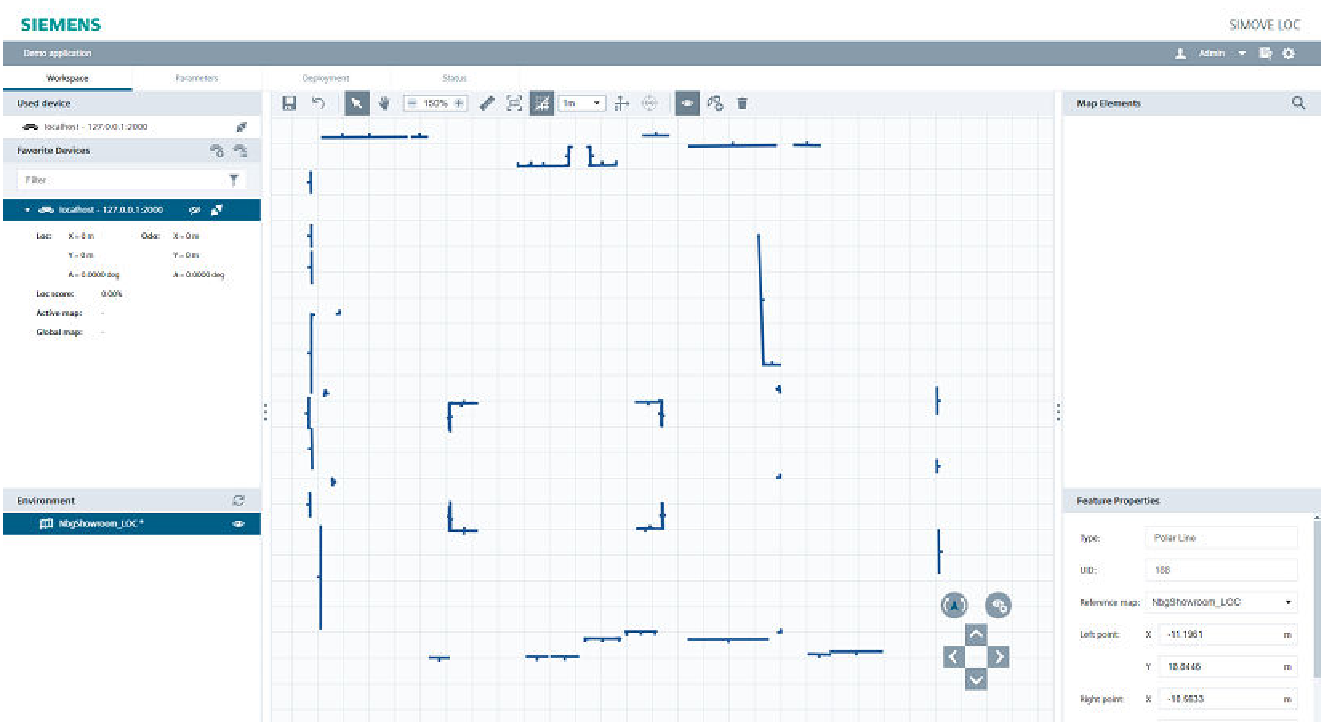


Figure 7-3 Cleared map

Within a cleared map, the file is prepared for path engineering. A detailed description on how to design paths in SIMOVE ANS+ is given in chapter Path engineering (Page 117).

7.2 Feature map linking

This chapter describes an engineering process to link two feature maps to each other, so that the ANS+ NC can change its used map for localization during runtime. This feature can be used, for example, for difficult environments, in which it is not possible to create one single global map.

Note

Only one link

It is only possible to have one link between two maps.

1. Ensure that an already final engineered map containing paths and ident points is available.
2. Create a new map starting from an ident point in the already existing map to have an overlapping zone for both maps.
3. Clear the features in the newly generated map.
4. In the ANS+ ET, activate the visualization of both maps.
   The selected map is displayed in full transparence, while all other maps are faded out. This step is shown in the illustration below with “NbgShowroom” as known and “Testmap” as newly created map.

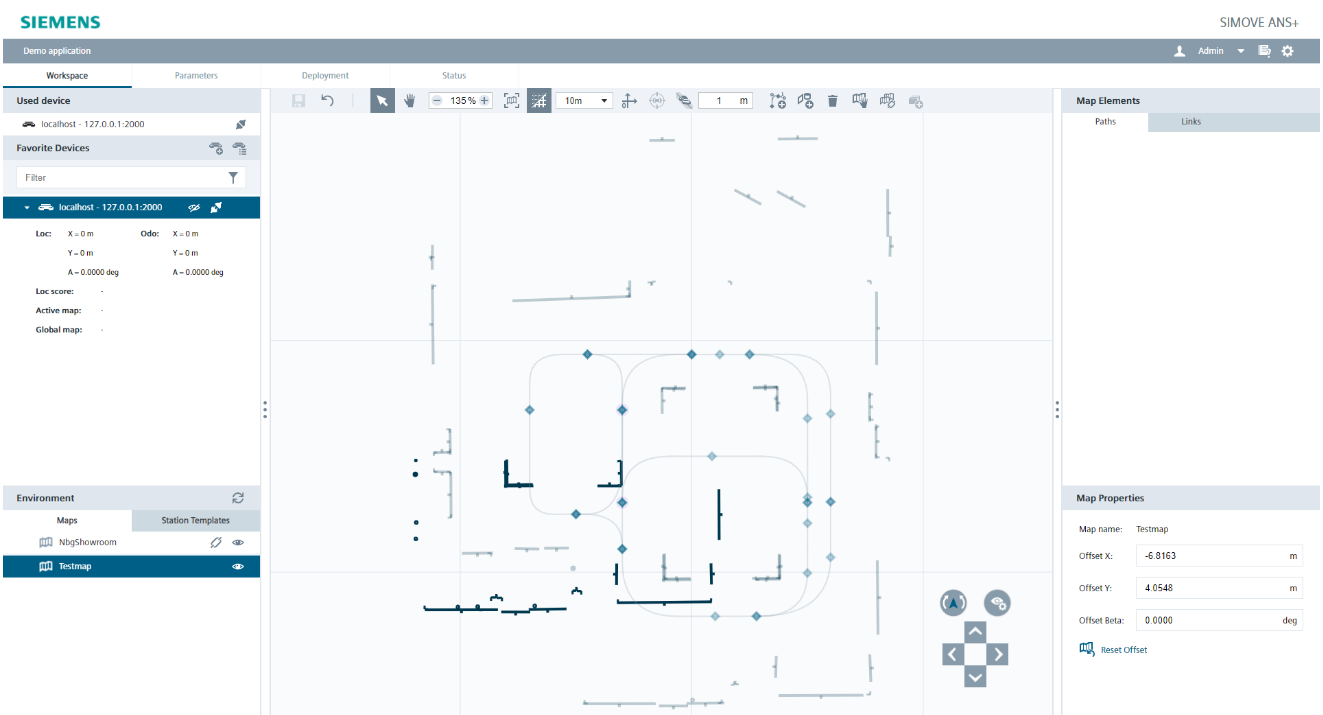


Figure 7-4 Active visualization of several maps

Before a link is created between both maps, the newly created map needs to be aligned with the reference map moved so that both maps match in their features.

5. Select the new map to receive all map related functions.
6. Click on and move the related map via Drag&Drop.

7. To change the orientation of the map, click and hold the right mouse button for a negative and the middle mouse button for a positive angle.
   Alternatively, use the offset textboxes to change the values.
   To set all offset values to zero, click .
   In the end, all features in the overlapping zone of the new map need to be exactly on the same position as the features of the reference map.

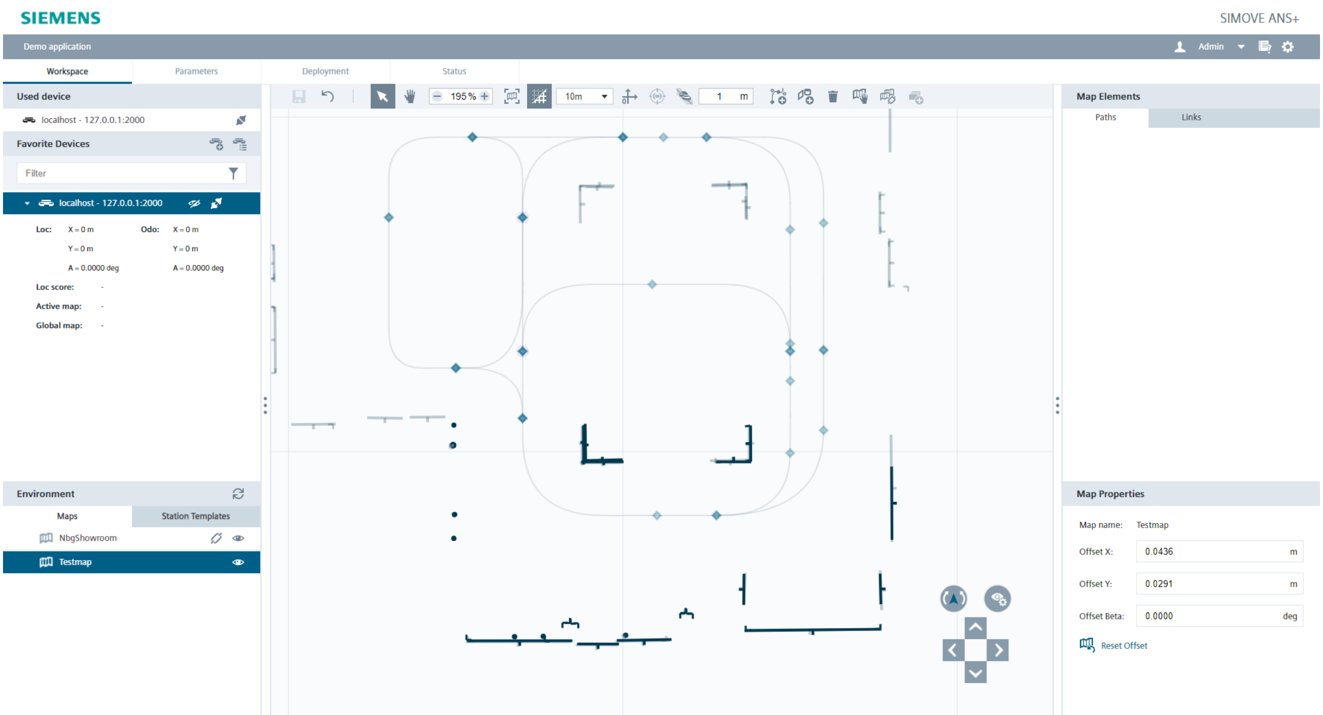


Figure 7-5 Overlapped maps

8. When the new map is in the correct position, deactivate the map movement with another click .
9. Select the newly created map.
10. Configure the reference map as linked map by setting to the known map.

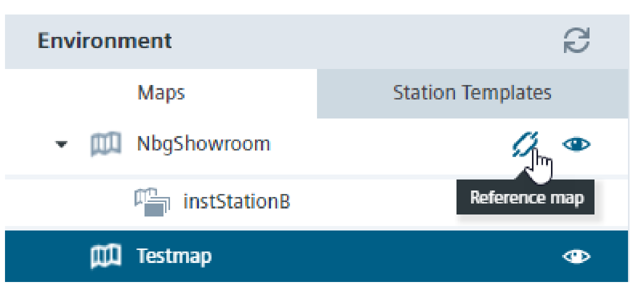
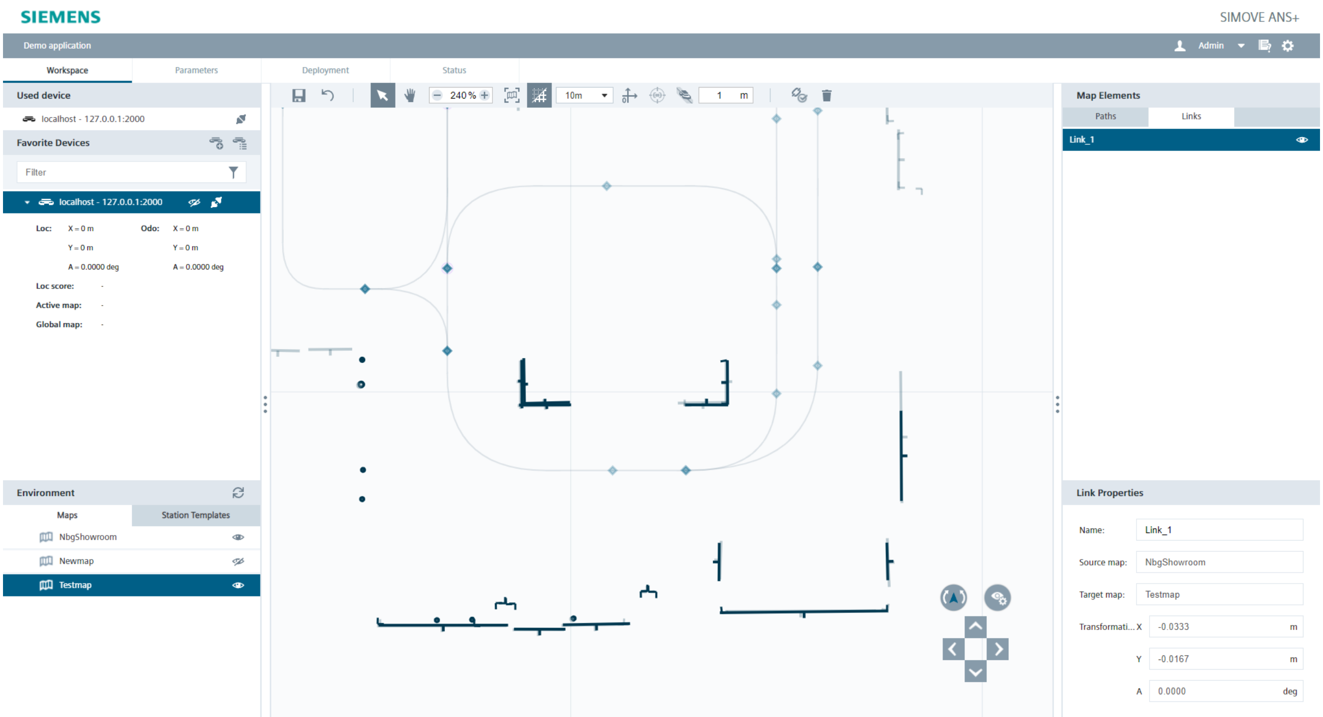


Figure 7-6 Selecting an already known map as linked map

11. Click on .

A link between both maps is created.



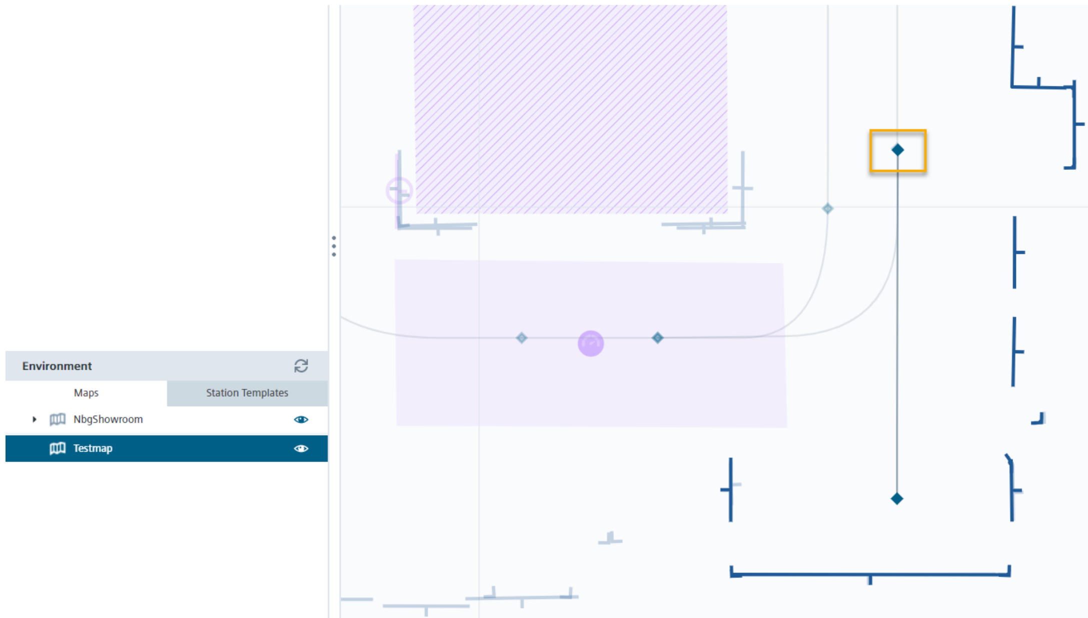
① Generated link

Figure 7-7 Final result of a map linking process

Create an overlapping ident point

To switch between linked maps automatically, the ANS+ system requires an overlapping ident point on a path in both maps at the same position. Therefore, the following steps are required:

1. In the new map, create a new path to an already existing ident point of the reference map.
2. Create a new ident point on the overlapping position.
   This new ident point needs to share the same UID as the already existing ident point of the reference map.



① Same ident point UID in both maps

Figure 7-8 Overlapped path ident points

Note

Deletion of linked maps

If one of two linked maps is deleted, it is necessary to click "Save" before generating a new map with the same name.

This ensures that the map links are updated in between.

7.3 Gridmap clearing and editing

This chapter describes an engineering process for preparing and clearing a previously created gridmap.

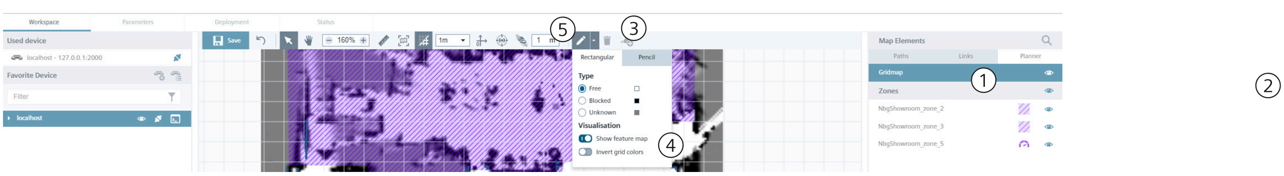
Note

Only one gridmap

It is only possible to have one gridmap per AGV.

Procedure

1. Select the map, that was used to create a gridmap first and open the planner tag within the Map Elements section.
2. Click on next to the “gridmap” to visualize it in the world window.
3. When highlighting the gridmap, two new symbols will appear in the toolbar to edit or delete the gridmap.
4. The dropdown element can be used to select if a free, blocked or unknown area should be manually drawn within the map.
5. After selecting one of this three types, the cells of the recorded gridmap can be overwritten. Therefore, select the gridmap and select the button “Edit gridmap” until it is highlighted and edit the cells, that should be overwritten.



① Select gridmap
② Activate gridmap visibility
③ Open gridmap settings toolbox
④ Gridmap settings toolbox
⑤ Edit gridmap

Figure 7-9 Edit the gridmap

In the following illustration, a gridmap is cleaned up. To do this, the map can either be cleaned up with the pencil or with rectangles. Here, "free" rectangles are used to clean up the items that were blocked unintentionally.

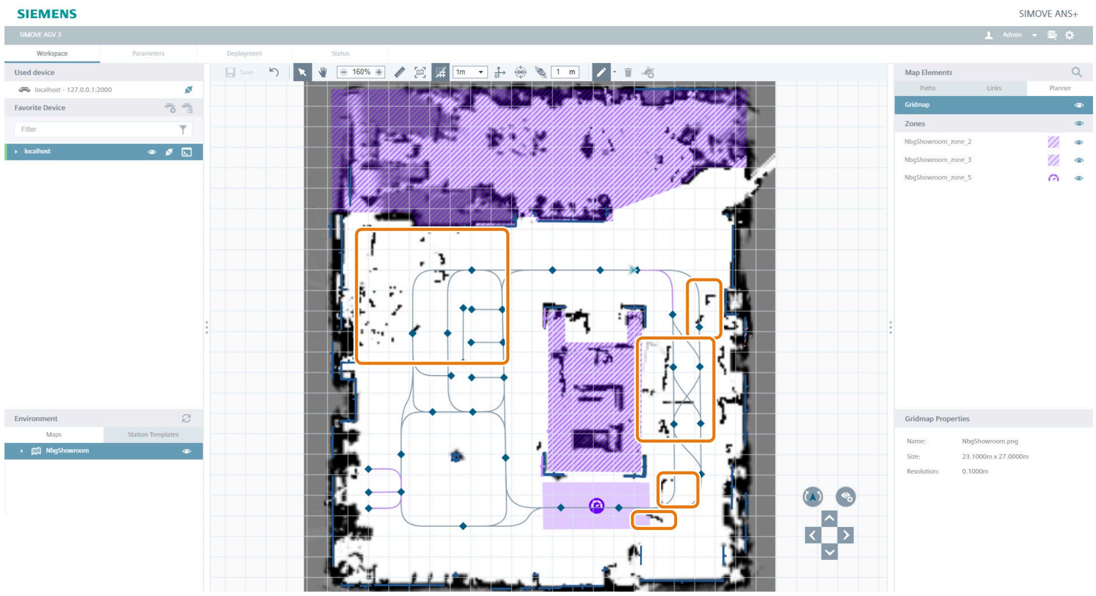


Figure 7-10 Gridmap cleaning using free rectangles

Note

After the map has been cleared, the NC must be restarted, so that the new gridmap is loaded.

The following figure shows two gridmaps. The left map before the map cleaning and the right side after the map cleaning.

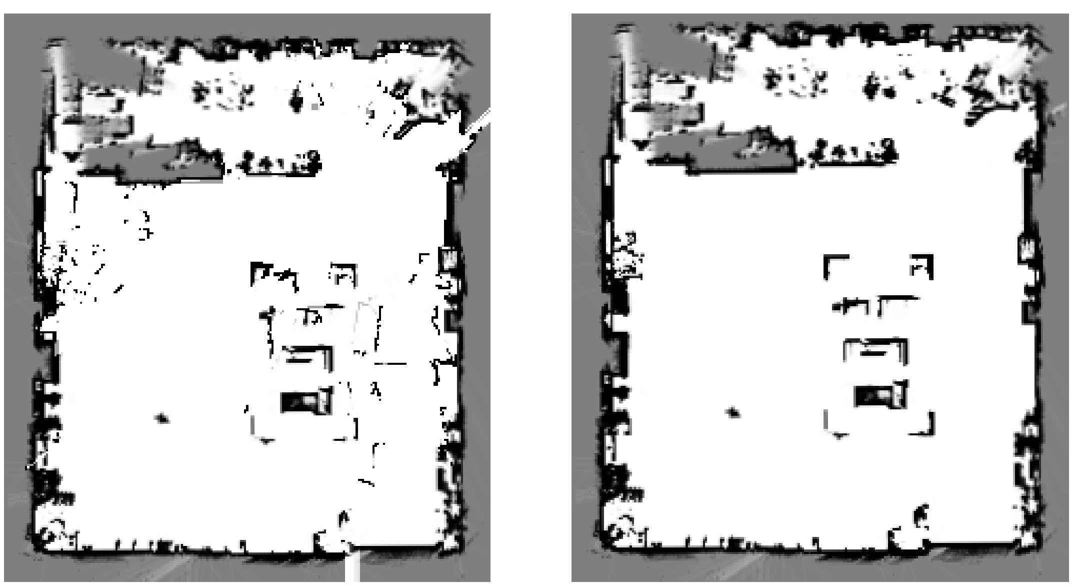


Figure 7-11 Gridmap uncleaned, cleaned

Update gridmap

Differently to the feature-based map, the gridmap is not extended, instead it is updated. If the laser scanner detects new obstacles that were not present in the previous gridmap, these are added to the map as "blocked". On the other hand, obstacles that no longer exist are also converted from "blocked" to "free".

Note

The gridmap must be cleaned again after a gridmap was updated.

7.4 Global map parametrization

Global map parametrization

If one of the following scenarios is used within an environment or path layout, it is required to define one map as global map by parametrizing “Global Frame Id”.

- Linked map(s)
- Specific orientation on an ident point.
  More information:
  - Rotation on the spot (Page 231)
- Specific edge orientation
- Holonomic movement(s) related to a global map origin.
  More information:
  - Holonomic movement (Page 233)

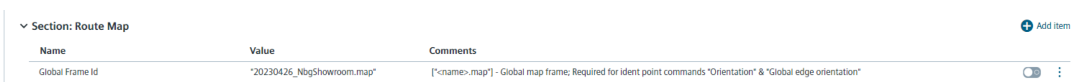


Figure 7-12 Parametrization of an overall global map origin

Note

Parameterization of a global map

Once a global map has been parametrized, all map origin related values, such as AGV pose, holonomic movements or rotations on the spot, refer to this specified origin.

In case of several global maps independent to each other, the parameter “Global Frame Id” can be commented out by activating .

The following two examples explain the concept behind the parameter “Global Frame Id”.

In the first illustration, the parameter “Global Frame Id” has been commented out. Therefore, all map origin related values, such as the pose of the AGV, refer to the origin of the corresponding map. As a result, “AGV A” has an orientation of 45° in “Map A” and “AGV B” an orientation of 0° within “Map B”.

Example 1

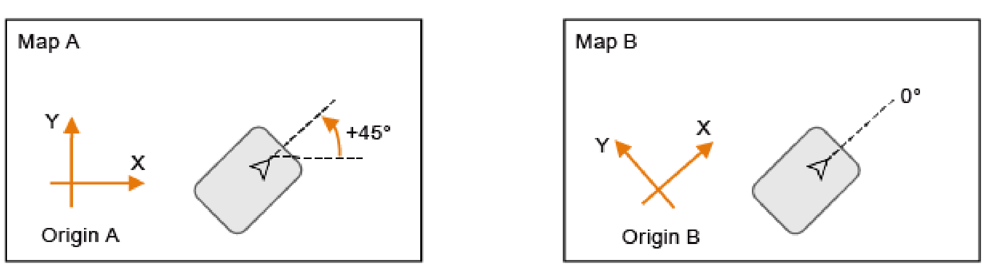


Figure 7-13 No "Global Frame Id" used - Values related to each map origin

In the second illustration, “Global Frame Id” has been set on “Map A”. Due to this change, all map origin related values of both maps are now referring to “Origin A”. That is the reason why “AGV B” has now the same orientation of 45° as “AGV A”.

Example 2

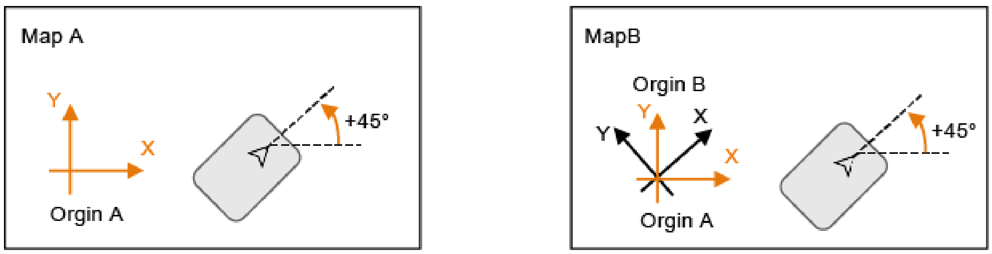


Figure 7-14 "Global Frame Id" set on “Map A” - Values related to "Map A" origin

7.5 Zone Engineering

Prerequisite

Zones are solely applicable for the "motion" functionality and for this reason “motion” has to be enabled.

Therefore, the section "motion AGV" needs to be enabled within the parameter page and also all motion related parameters need to be adjusted related to the application within the parameter page.

Zone creation

The steps describe the engineering process to create a zone within the feature-based map.

1. Select the map, in which the zone should be created and click on:

2. Create corners as an outline of the zone by clicking at the screen.

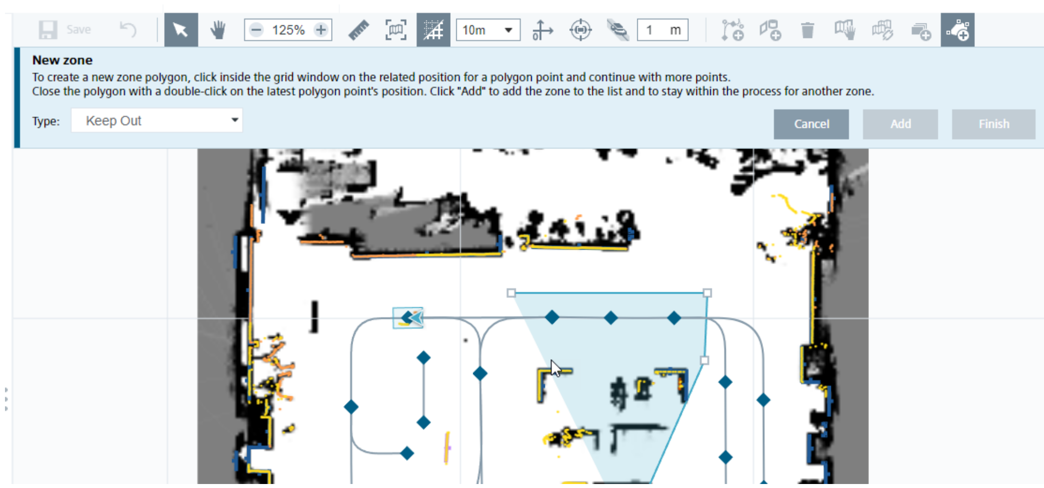
   

   Figure 7-15 Zone engineering

3. To finish the creation of a new zone, double click at the last outline point.
4. Select a type of zone that should be created. The following types are possible:
   Keep Out: Vehicle is not allowed to enter the zone
   Velocity: Vehicle velocity is set to a fix value, when driving within the zone
   One Way: Vehicle is only allowed to drive within this zone in one direction

---

Note

"One Way" zone

The 'One Way' zone is solely applicable for free path planning, as it only applies to the initial path planning process.

In case an obstacle occurs while driving, the AGV is allowed to dodge inside the 'One Way' zone and drive through, even when facing the wrong direction.

---

5. Click on "Add" to create and add the zone to the map.
   By default, every zone is saved with the name "Zone_X". X represents an internal incremental counter of the ANS+ ET.
6. Click on "Finish" to determine the zone creation process.
7. Save the changes within the layout by pressing save or < CTRL + S>.

Zone adjustment

The size and shape of the zone can be edited. Select the zone, that should be adjusted and move the outline points via Drag&Drop or select the button

to add a point to the zone outline.

Click on "Done" to finish the process.

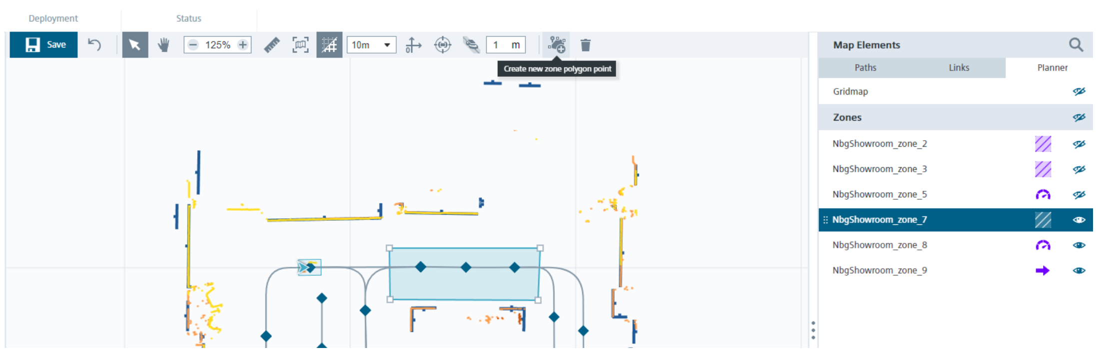


Figure 7-16 Add zone polygon point

Additionally, each zone type can be changed and the zone can be activated/deactivated. Select the zone within the Map Elements and edit the zone properties:

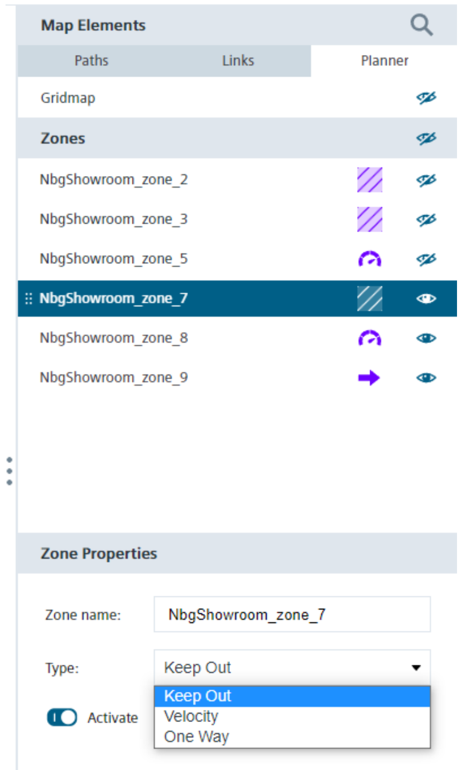


Figure 7-17 Zone window

The zone types "One Way" and "Velocity" have an additional Attribute that can be edited.

- Zone "One Way": Specify a global orientation, when driving in this zone.
- Zone "Velocity": Specify a velocity value, when driving in this zone.

Overlapping zones and prioritization

In case a “Velocity” zone is overlapping with another “Velocity” zone or multiple edges with the commands maximum speed, the priority always takes the lowest specified velocity.

Regarding the figure, would result in the following behavior:

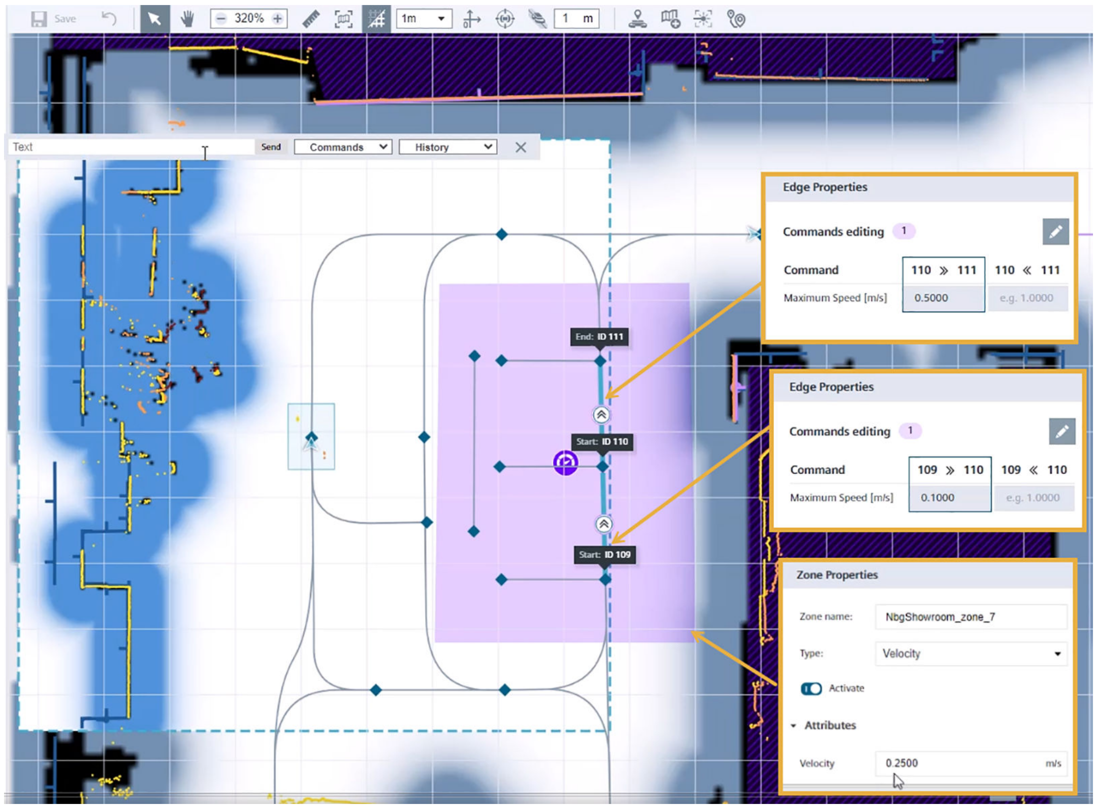


Figure 7-18 Overlapping zones and prioritization

- Driving outside the zone results in the maximum allowed velocity specified in the user_def.
- When entering the zone, the AGV drives with 0.25 m/s, as specified by the “Velocity” zone.
- When traversing edge 109 to 110, the priority takes the lowest specified velocity. In this case, it is the edge’s maximum speed, resulting in the AGV driving at 0.1 m/s.
- When traversing edge 110 to 111, the priority takes the lowest specified velocity. In this case, it is the zone’s velocity, as the edge’s maximum speed is higher. This results in the AGV driving at 0.25 m/s again.
- When leaving the zone, the AGV resumes to drive with the maximum allowed velocity, specified in the user_def.

Note

Edge command “Maximum Speed”

The edge command “Maximum Speed” only applies when commanding the AGV via orders. If free path planning is used, only the zone’s limitations will be applied, and the AGV must drive through the zone.

In addition, commanding a “Max Speed” on edge via PLC or VDA results in the same behavior as described above.

8 Path engineering

This chapter describes the general concept behind SIMOVE ANS+ layouts and a step-by-step physical and logical engineering process to create valid virtual paths. This process can be done completely offline, without any active connection to any AGV.

8.1 Layout concept

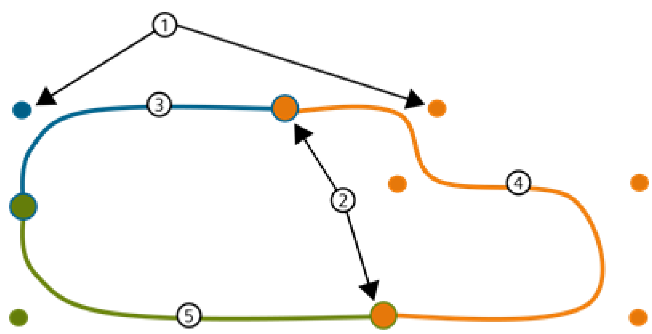
SIMOVE ANS+ is a virtual line-guided laser-based navigation system. It uses the approach of “Bézier curves” to describes its required navigation paths. In other words, every path in the tool is a “Bézier curve”.

The implemented SIMOVE motion controller (in SIMOVE Carrier Control) uses the “Virtual Track Sensor” (VTS) interface localization data of the ANS+ system to follow the specified paths in consideration of the kinematic concept. Each “Bézier curve” is defined by “Control points” with a defined beginning and ending of each curve. Those control points define the physical geometry of the virtual path.

Circle layouts and crossings

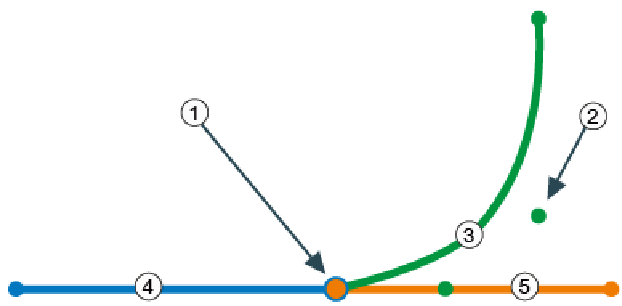
Circle layouts require at least two “Bézier curves” for one-way or three “Bézier curves” for bidirectional path direction with an overlapping beginning and ending control point (see "Bézier curves: Circle example").

Crossings are always realized as overlapping control points of different “Bézier curves”, as it is displayed in "Bézier curves: Crossing example".



1. Control points
2. Overlapping control points
3. Path 1
4. Path 2
5. Path 3

Figure 8-1 Bézier curves: Circle example



① Overlapping control points
② Control points
③ Path 3
④ Path 1
⑤ Path 2

Figure 8-2 Bézier curves: Crossing example

Ident points

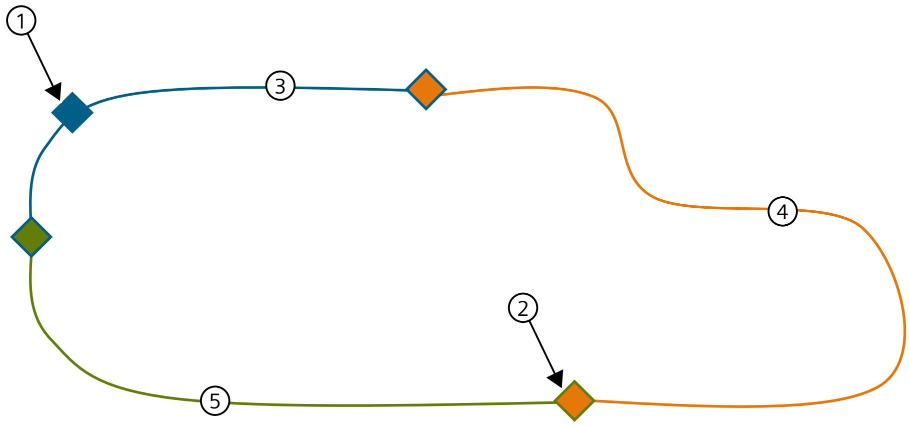
To command an AGV from one point to another, the ANS+ system requires a logical layer, as control points only define the virtual path’s trajectory.

Within the SIMOVE system architecture, every system (for example Carrier Control, ANS+, Master Control, Fleetmanager) uses the same logical abstraction layer, the “identification points” (shortly: “ident points”).

An ident point is used as a kind of interface between all systems. On the one hand, an AGV sends a position message to the master control in case of a passed ident point. On the other hand, the master control can make decisions for AGVs on those points. For the ANS+ system, the behavior of the ident points is the same as for a line-guided vehicle with, for example, RFID tags attached to the floor. The only difference is that for ANS+ those points are virtual and therefore can easily be removed or shifted.

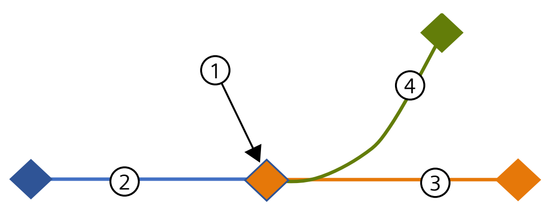
A valid SIMOVE ANS+ path layout requires ident points on every created path, at least on their beginning and ending control point, shown in "Bézier curves: Circle example with ident points". The concept behind those points is similar to the control point concept for all layouts. On the overlapping part of all paths, each corresponding path requires a separate ident point. In the given example of a crossing, displayed in "Bézier curves: Crossing example with ident points", all three paths require, beside the overlapping control points, an ident point with the same ID at the same position.

The ANS+ NC module uses this approach to automatically load the correct path for the current drive order.



① Ident point
② Overlapping ident points (same ID)
③ Path 1
④ Path 2
⑤ Path 3

Figure 8-3 Bézier curves: Circle example with ident points



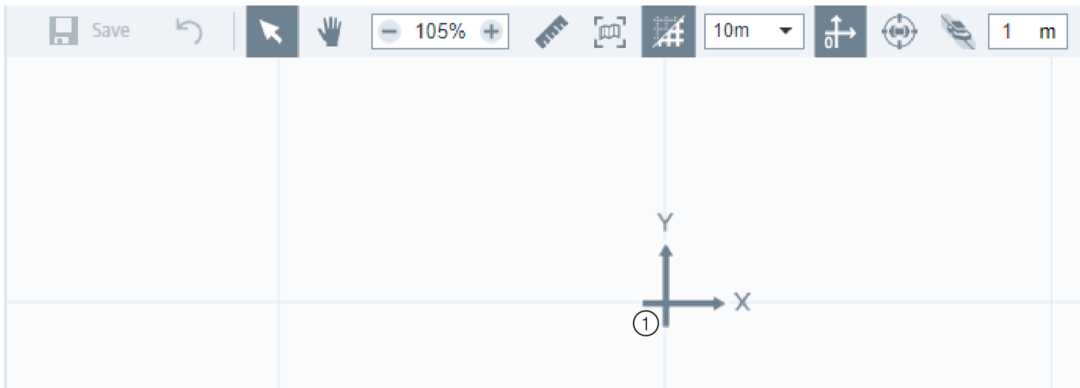
① Overlapping control and ident point (same ID)
② Path 1
③ Path 2
④ Path 3

Figure 8-4 Bézier curves: Crossing example with ident points

8.2 Physical path engineering – Control points

Control points define the physical geometry of a path. The following steps describe a process to create an exemplary circle layout. The engineering starts at the map's origin.

1. To see the map's origin position, click on .



① Map origin (x = 0 m, y = 0 m)

Figure 8-5 Visualization of the map origin in ANS+ ET

2. To create a path (= "Bézier curves") within the ANS+ ET, click on the corresponding map in which the new path should be integrated.

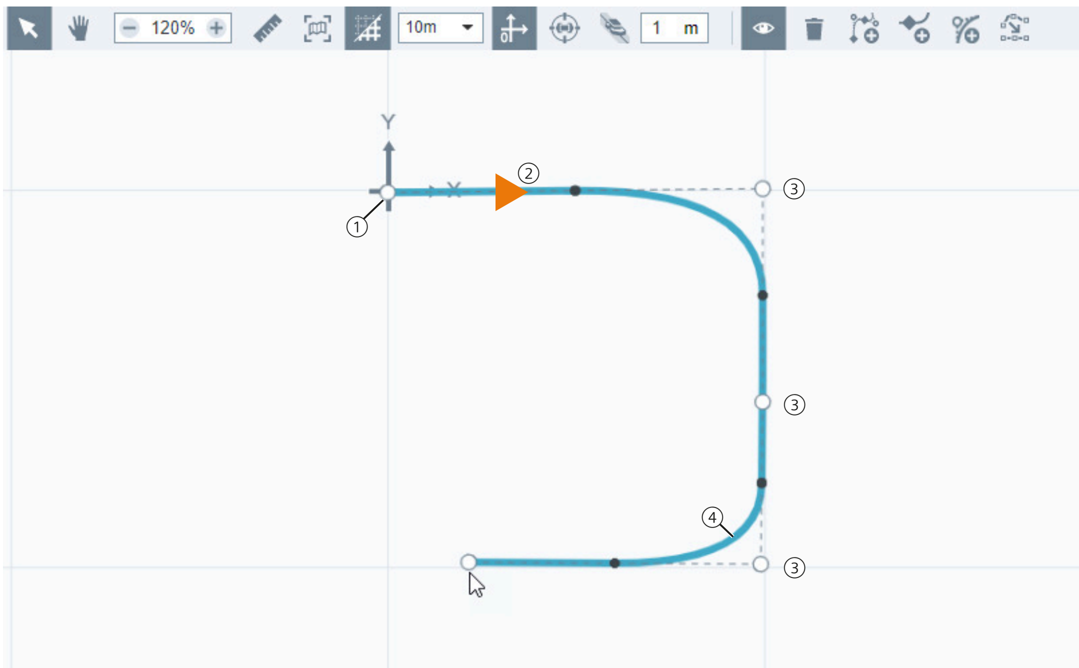
3. Click on  in the dynamic toolbar to create a path.

Note

File type

All paths are saved in the “atlas”-directory on the AGV. Those files share the specified ending “.poc”.

Each mouse-click in the map adds a new control point to the path.



①	Map origin (x = 0 m, y = 0 m)
②	Implicit movement direction
③	Control points
④	New path

Figure 8-6 Creating a new path in the ANS+ ET

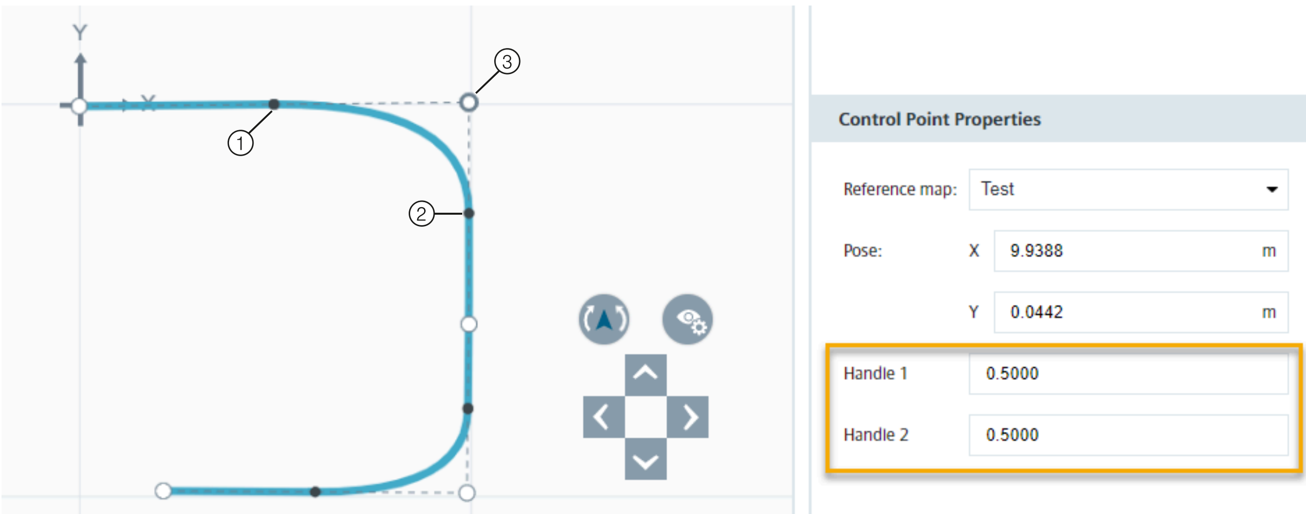
Note

Movement direction

The direction in which control points are added to a path implicitly defines the default movement direction on the path. Each path is only adjusted for one movement direction at its default configuration.

The curve itself is automatically rounded under consideration of the mathematic “Bézier curves” definition.

4. To change the angle of the curve, click on the corresponding control point of the curve. The ANS+ ET displays two additional points directly on the path, describing the last point of the curve. Those two points can be seen in the properties window on the right side with the name “Handle 1” and “Handle 2”.



① Handle 1
② Handle 2
③ Selected curve control point

Figure 8-7 Curve adjustment in the ANS+ ET

5. To finish the creation of a new path, double click at the last control point position. By default, every path is saved with the name “Path_X”. X represents an internal incremental counter of the ANS+ ET.

Note

Creating or moving a control point

While creating a new path or moving a control point, press and holding <CTRL> to grab existing control points of other paths. For this purpose, the mouse cursor has to be in a close range of a control point to apply its position to the new or selected control point.

In the end, the layout should look like one closed line.

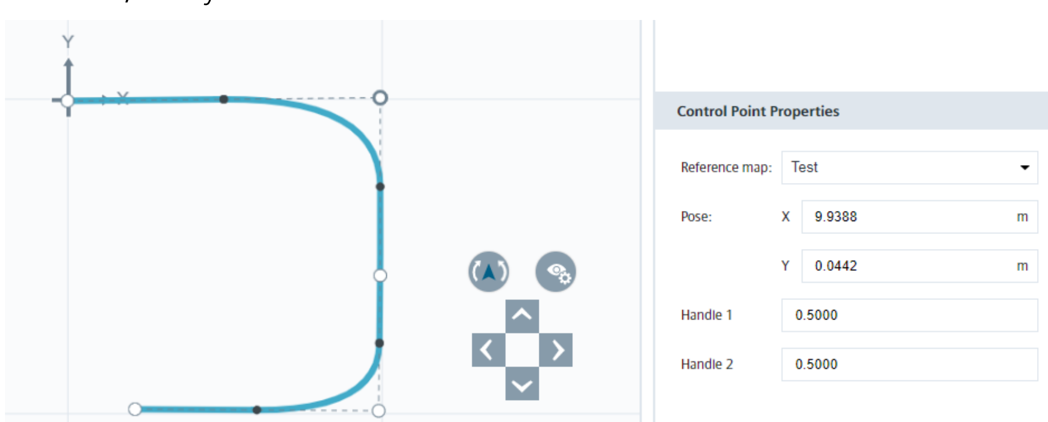


Figure 8-8 Simple circle layout in ANS+ ET

6. Save the status of the map and paths by pressing or <CTRL + S>.
7. To extend paths with a specified width, click .
   This feature can be used to check if all curves are in the correct shape and if an AGV is capable to successfully drive the defined layout.

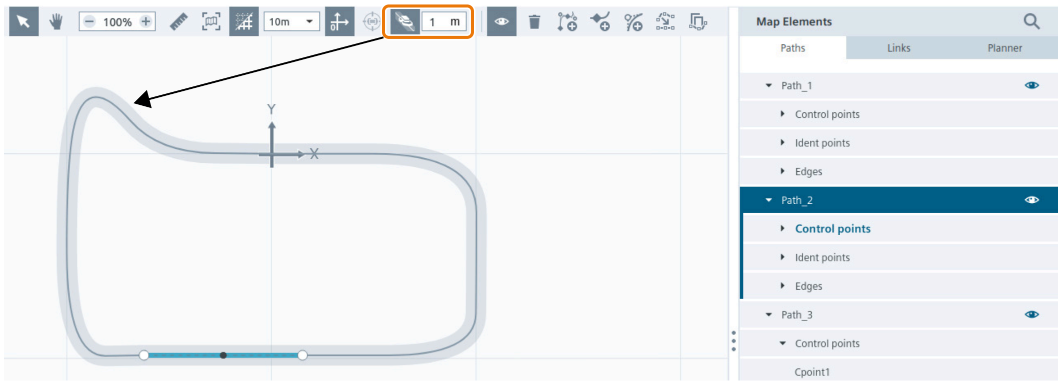


Figure 8-9 Path extension in ANS+ ET

8. To change all defined control point positions click and hold the point.

8.3 Align control points

The feature to align all selected control points will align all control points within two selected points and lead to the following behavior:

Before:

Figure 8-10 Single path before aligning process

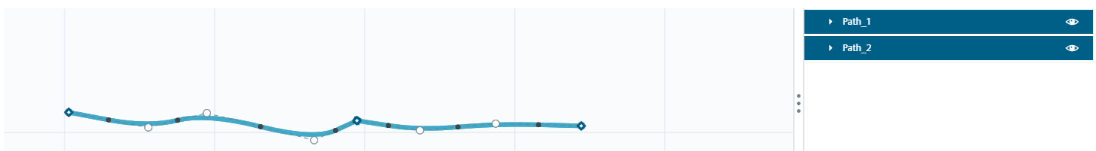


Figure 8-11 Two lined up paths before aligning process

After:

Figure 8-12 Successful aligning process

8.3.1 Align control points on a single path

The feature to align all control points in relation to two specific control points can be activated within the dynamic toolbar .

When selecting this function, all control points of the related path are visualized. Two control points have to be selected and all control points in between will be aligned, as shown in the figures below. A preview visualizes the possible result. Cancel aborts the entire process and confirm will overtake the result. To overtake the new setup into the map, saving the map is required.

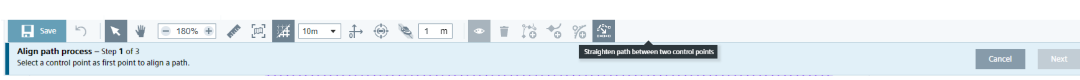


Figure 8-13 Select icon to start aligning process

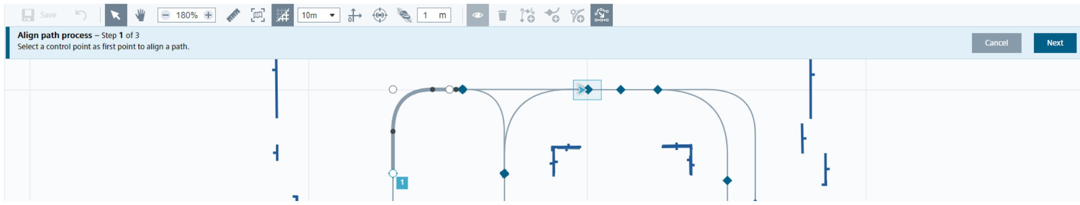


Figure 8-14 Align control points step 1

8.3.2 Align control points within two paths

Prerequisite

The feature to align control points in relation to two specific control points, on different and connected paths can be activated within the dynamic toolbar.

When selecting this function, all control points of the related and connected paths are visualized, as displayed below. Two control points have to be selected and all control points in between will be aligned.

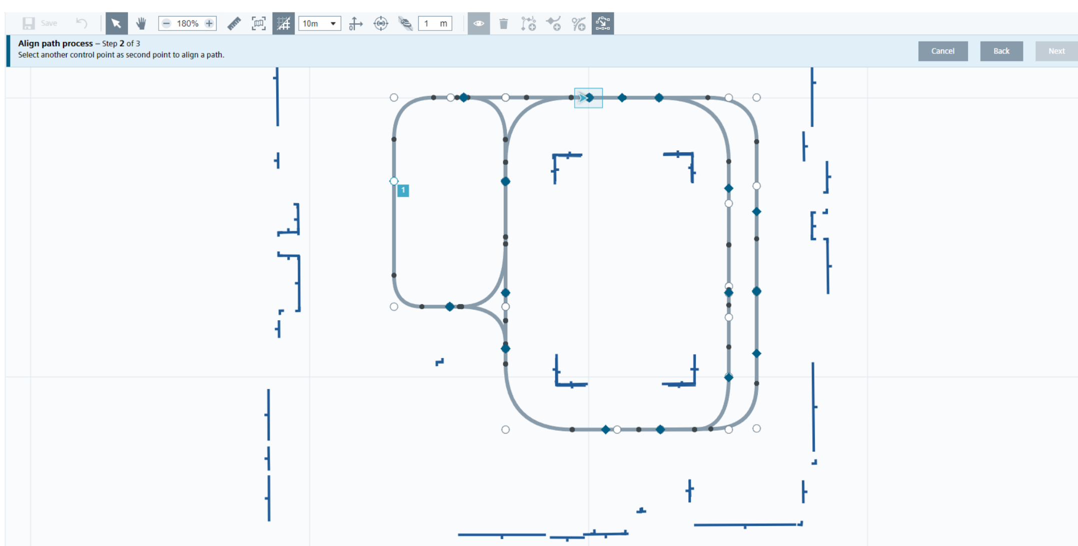


Figure 8-15 Align control points step 2

8.4 Teach control points

To align the pose of a control point in the map with a real-world robot pose, for example to determine the precise pose in front of a station, it is possible to teach the pose of a control point with the following steps.

1. Create a path with roughly positioned control points in the AGV map.
2. Manually move robot to the respective pose, for example, in front of the station.
3. To determine the robot pose in the AGV map use the set device pose button.

4. Select control point that should be moved.

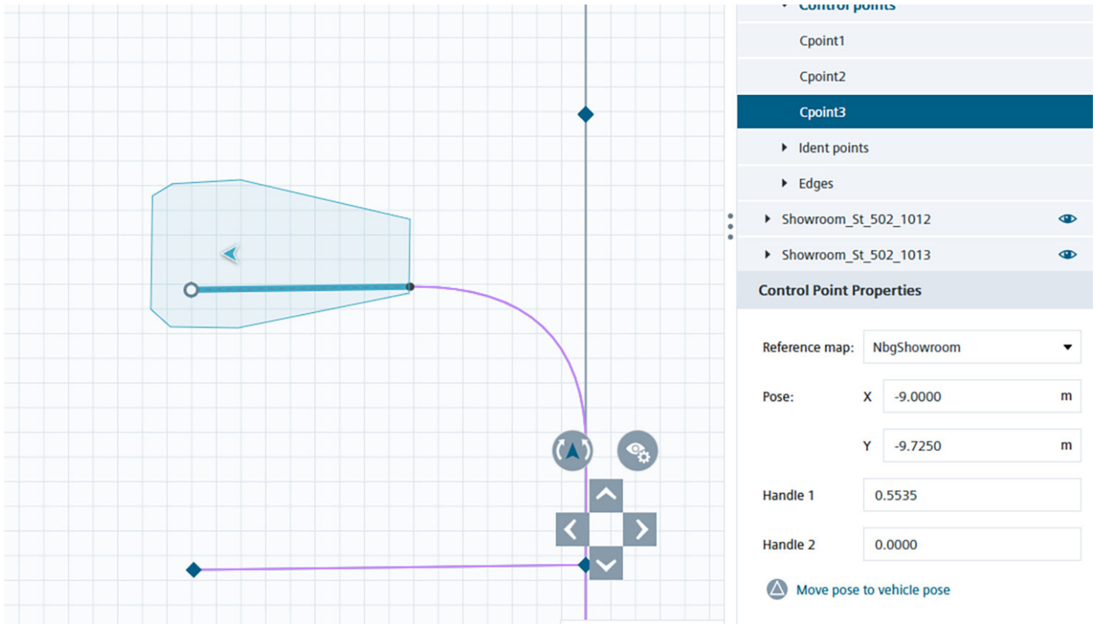


Figure 8-16 Select control point

5. Click “Move pose to vehicle pose” button.

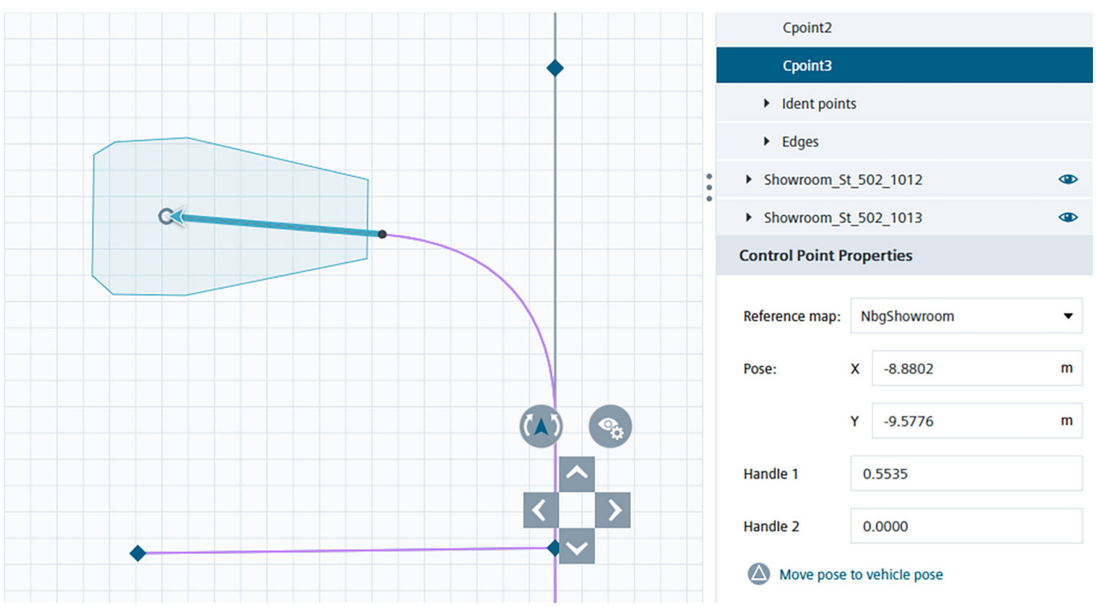


Figure 8-17 Move control point to current vehicle pose

8.5 Logical path engineering – Ident points

Ident points define the logical layer of paths. The steps describe a process to create an exemplary circle layout. The following engineering guidance starts at a map's origin.

1. To create an ident point, use one of the following approaches:

   – Select a control point and create an ident point directly on the same position by clicking .

   Note

   Existing ident points

   In case of an already existing ident point, which is on the same position and belongs to a different path, the newly created ident point will automatically use the UID and description of this ident point.

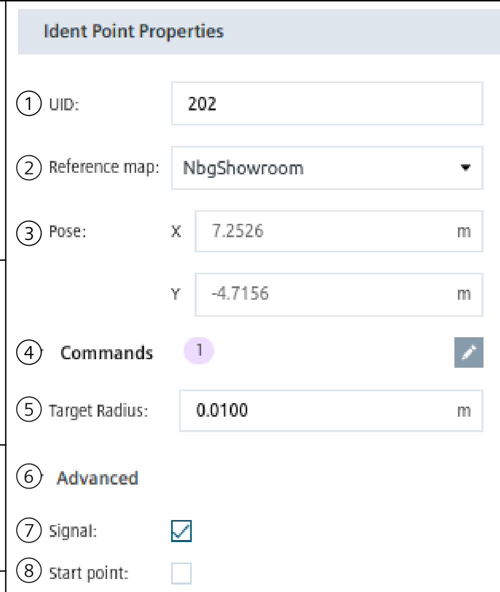
   – Select the related path and click .
   Move the mouse over the path and click on it to set the position of an ident point. Use Drag&Drop to change the position of the ident point.

   Note

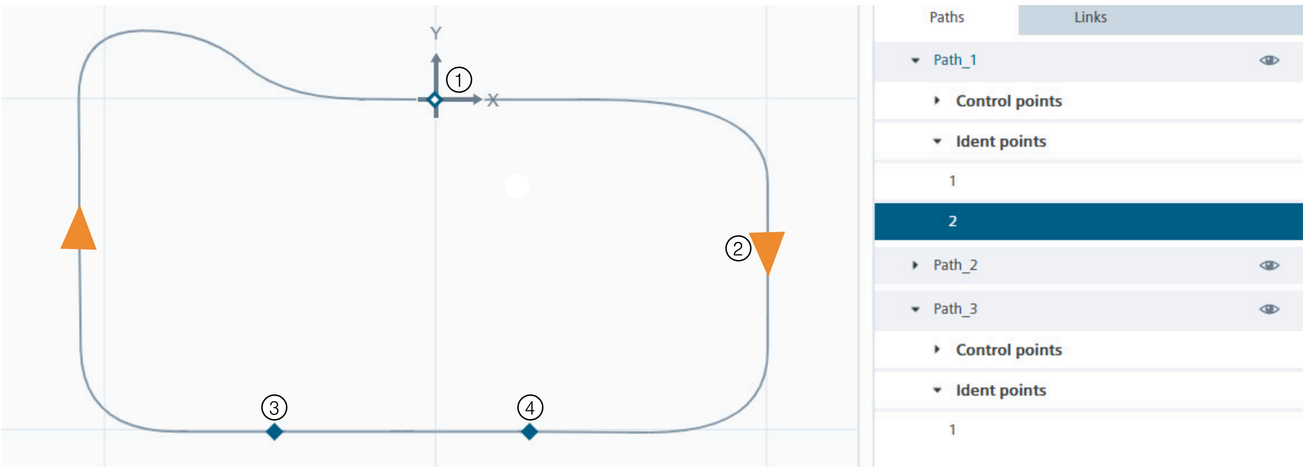
   Apply UID and description of an existing ident point

   Once an ident point is dragged for a position change, <CTRL> can be pressed and held. This enables a feature to apply automatically the UID and description of an already existing ident point on the same position.

   If an ident point is successfully created and selected, the "Ident Point Properties" window appears on the right side.

	Property	Description	Ident point properties
①	UID	Each unique ID (UID) is only allowed to be made out of numbers [0-9]. The value is passed to other systems via the specified interfaces. Current possible UID range: 1 to 65535	
②	Reference map	If the map of the related ident point is linked to another map, it is possible to transform the position related to the specified map origin.	
③	Pose	The X and Y position of the selected ident point within the map coordinate frame in meters.	
④	Commands region	Ident point commands region For more details, refer to chapter Ident point commands (Page 134).	
⑤	Ident point command	Configured ident point command	
⑥	Advanced region	Advanced region	
⑦	Signal	• Activated: Ident point will be sent to other systems via notification. • Deactivated: Ident point notification will be kept only within ANS+.	
⑧	Start point	This flag can be used for debugging purposes.	

2. In the end, the circle layout of the illustration "Simple circle layout in ANS+ ET" in chapter Physical path engineering – Control points (Page 121) can look similar to the illustration below.



① UID 1 on Path_1 & Path_3 on the map origin
② Default movement direction
③ UID 3 on Path_2 & Path_3
④ UID 2 on Path_1 & Path_2

Figure 8-18 Final simple layout in the ANS+ ET

3. Rename all created paths for a better understanding in the directory. A common best practice solution is to name every path with the following concept under consideration of the movement direction:
   `<startId>_<endId>_<mapName>`
   – startId: The name (or identifier) of the starting ident point on the path.
   – endId: The name (or identifier) of the last ident point on the path.
   – mapName: Corresponding map in which the path is saved.

   For the illustration above, a possible naming of the two paths would be the following:
   – Path_1: "1_2_Docu"
   – Path_2: "2_4_Docu"
   – Path_3: "4_1_Docu"

   Note

   Limitation of path names

   Path names are limited to 26 characters.

4. Save the map and its newly created paths including the ident points by pressing or <CTRL + S>.
5. To apply the changes into the ANS+ NC module, restart the operating device.

For a better understanding of the path engineering, a more complex layout is shown in the following illustration with a split path concept and the marked overlapping ident points.

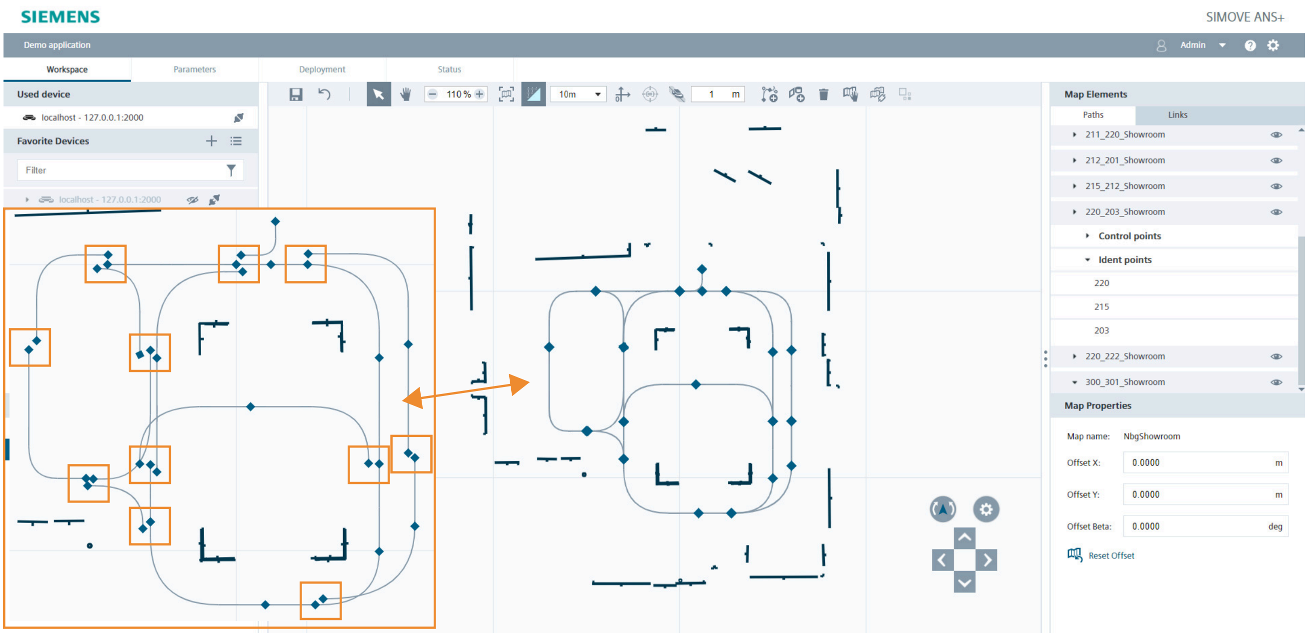


Figure 8-19 Complex layout split at path overlaps

8.6 Copy and move paths

Existing paths, along with their control and ident points as well as the applied ident point and edge commands, can be copied and pasted within the same map or across different maps. To copy and paste one or multiple paths, use one of the following approaches:

- Select one or multiple paths and press the hotkeys <CTRL + C> to copy and <CTRL + V> to paste.
- Select one or multiple paths and click on  in the dynamic toolbar.

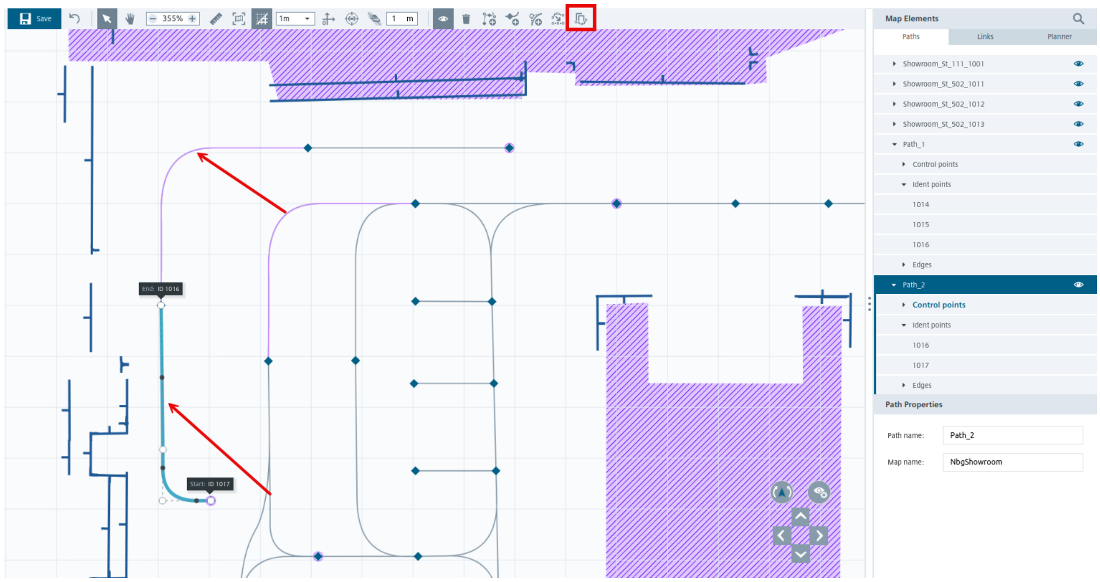


Figure 8-20 Multiple copied paths along with their specific ident point and edge commands

To move a path, hover over it with the mouse courser and hold the left mouse button down. Connecting paths can be achieved by merging control points and ident points, as described in Physical path engineering – Control points (Page 121).

Note

The names of copied paths, as well as the UIDs of their ident points, are automatically assigned.

Therefore, the ET determines the current highest UID and incrementally increases the UIDs of all newly inserted ident points one by one.

8.7 Ident point commands

It is possible to add single or multiple commands to ident points. This approach can be used, for example, in case of a Fleet Control system, which is not able to send all required layout information dynamically. By adding command strings to an ident point, the command strings are attached to the overall path layout and can therefore not be removed during runtime.

Note

Execution of commands

Commands are always fulfilled by SIMOVE ANS+ if the related ident point is part of a commanded order independent from the previous path segment. A command is executed along a path until the next ident point is reached.

To skip the execution of an ident point command, the related ident point must be left out of an order.

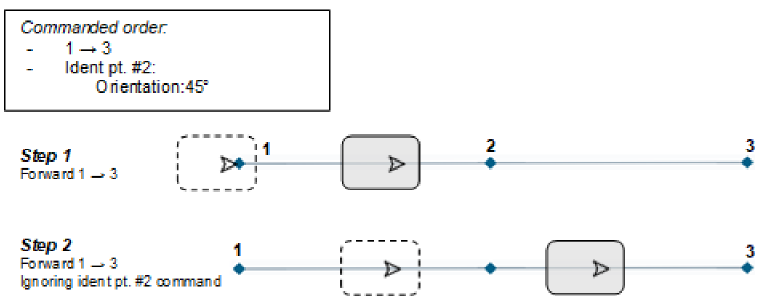


Figure 8-21 Ignoring ident point commands by skipping an ident point within an order

To add a command to an ident point, follow the described process:

1. Select an ident point.
2. In the “Ident Point Properties” window click on .
3. In the pop-up menu, select the commands that must be added to the selected ident point.
4. Change the values of the newly added commands.
5. To apply the ident point changes to the files, click "Save".
6. Use the “Refresh atlas” to apply the changes in the ANS+ NC module.

After a command is added, the ANS+ ET highlights the ident point with a purple circle in the world window.

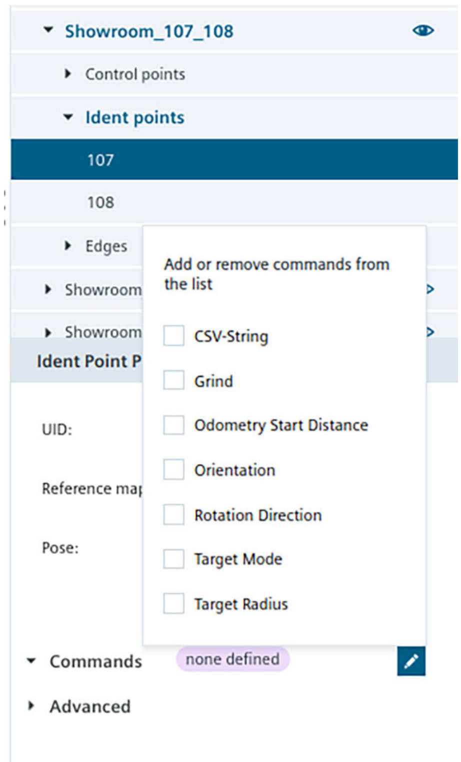
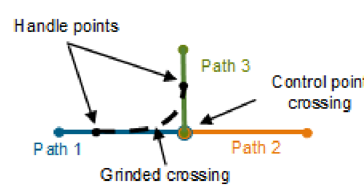


Figure 8-22 Highlighted ident point due to added commands

The following table describes all possible ident point commands and their functions:

Command	Unit	Description
CSV-String	<cmd1>,<cmd2>, ...	Directly appends the inserted CSV string to an ident point.
Grind	[yes/no]	Automatic bypassing of a control point between handle positions of the neighboring control points.  Automatic control point grinding
Odometry start distance	[m]	For x meter after starting from source ident point, only odometry data will be used for the localization. Default value: 0.01m
Orientation	[0°,360°]	Specified orientation when reaching an ident point in degree. Requires valid parameter “Global Frame Id” within “user_def” file.

Command	Unit	Description
Rotation direction	[string Enum / cw, ccw]	Specifies the rotation direction of an AGV on a certain ident point, in case a rotation is necessary here, for example, because of a specified orientation of a junction. Possible values are clockwise or counterclockwise. Default value: not set - AGV turns in direction of shortest angular distance.
Target radius	[m]	Sets the target radius of the related ident point to the specified value. Default value: 0.01 m
Target mode	[string Enum / HalfCircle, Circle]	Sets the target mode to Circle or HalfCircle. Default value: not set

All activated ident point commands have an impact to the default movement behavior of the ANS+ system, which is described in the chapter "Station engineering (Page 163)".

Note

For commands such as “Orientation” and “Rotation direction”, it might be necessary to activate the “Disable overwrite” flag in the advanced section of the ident point properties.

With “Disable overwrite”, two ident points with the same pose can be configured with different properties.
For example, if the direction of rotation should be dependent on the direction from which the point is approached.

See also

Holonomic movement (Page 233)

External Pose Interface (Page 240)

8.8 Edge commands

It is possible to add single or multiple commands to edges. This approach can be used, for example, in case of a Fleet Control system, which is not able to send all required layout information dynamically. By adding command strings to an edge, the command strings are attached to the overall path layout and can therefore not be removed during runtime.

Note

Execution of commands

Commands are always fulfilled by SIMOVE ANS+ if the related edge is part of a commanded order independent of the previous path segment. A command is executed along a path until the next ident point is reached.

To add a command to an edge, follow the described process:

1. Select a path and choose the respective edge, that should be edited.
2. In the "Edge Properties" window click on .
3. In the pop-up menu, select the commands that should be added to the edge.
4. Change the values of the newly added commands.
5. To apply changes to the files, click "Save".
6. Use the "Refresh atlas" to apply the changes in the ANS+ NC module.

After a command is added, the ANS+ ET highlights the edge with a purple line in the world window.

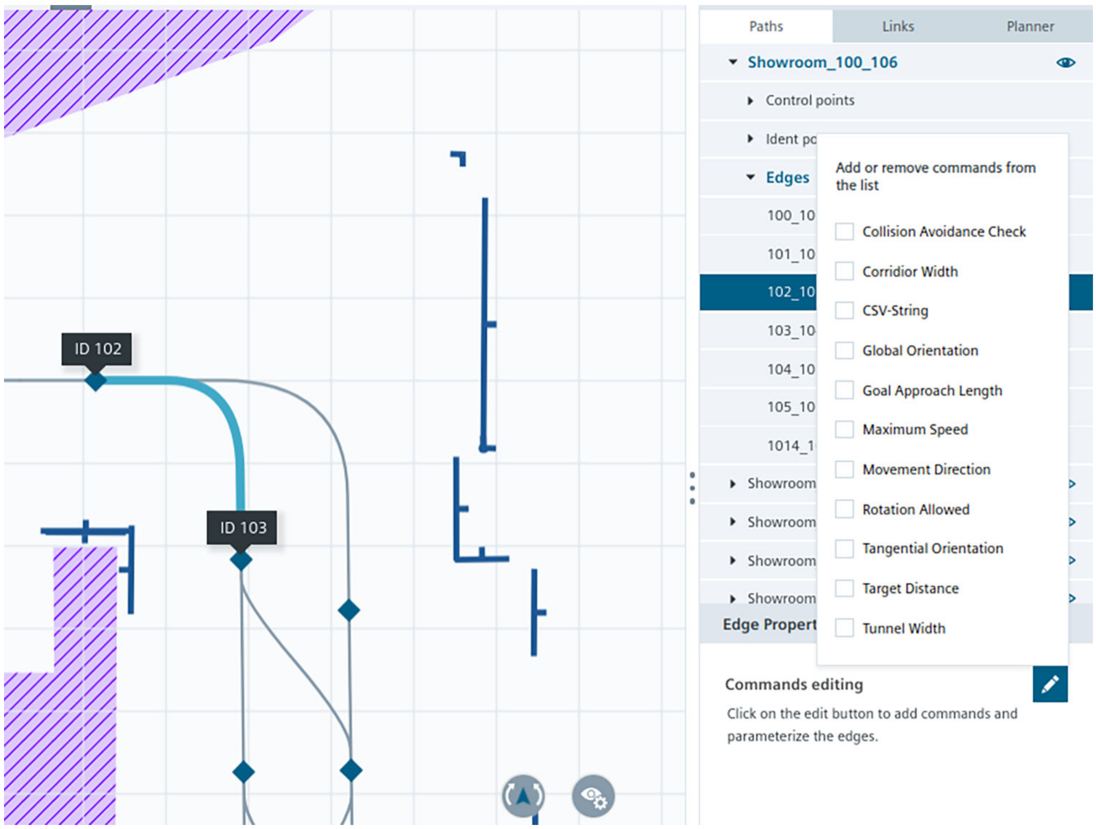


Figure 8-23 Selected path

The following table describes all possible edge commands and their functions:

Command	Unit	Description
Collision Avoidance Check	[yes/no]	Motion functionality can be disabled at an edge. For example, when entering a station, where collision avoidance should be deactivated.
Corridor (left width / right width)	[m]	Orthogonal distance to an edge that must be maintained when driving with free path planning. This value can be defined in left and right direction of the AGV movement, for example, during obstacle avoidance, in case the AGV should bypass an obstacle in one direction. **Important:** the corridor command has higher priority than tunnel width. If both values are set, corridor is used.
CSV-String	<cmd1>,<cmd2>,...	Directly appends the inserted CSV string to an ident point.

Command	Unit	Description
Global orientation	[deg]	Globally specified orientation on a path segment between two ident points in degree. Requires valid parameters for "Global Frame Id" and "Kinematics" within "user_def" file. A global orientation is only fulfillable in case of "Mecanum" kinematic. Explained in more detail in chapter Holonomic movement (Page 233).
Maximum Speed	[m/s]	The allowed maximum speed on a specific edge can be specified here
Movement Direction	[Forward/Backward]	Explicitly forces the ANS+ system to command the AGV in a tangential forward/backward orientation on an edge
Rotation allowed	[yes/no]	Allows the SIMOVE ANS+ system to rotate the AGV towards a specified global tangential or global orientation during translation movements along a path. The angle is set between edge and AGV Requires "Mechanum" for "Kinematics" parameter within "user_def" file. Explained in more detail within chapter Holonomic movement (Page 233).
Tangential orientation	[deg]	Tangentially specified orientation on a path segment between two ident points in degree. Requires valid parameters for "Global Frame Id" and "Kinematics" within "user_def" file. A global orientation is only fulfillable in case of "Mecanum" kinematic. Explained in more detail in chapter Holonomic movement (Page 233).
Target distance	[m]	Sets the target distance to the specified value.
Tunnel Width	[m]	Orthogonal distance to an edge that must be maintained when driving with free path planning (e.g. during obstacle avoidance)

When selecting an edge command, the edge will be interpreted in both directions. Therefore, the selected command has to be specified on one or both edge interpretations.

Example: The edge between the ident points 204 and 205 can be interpreted as:

- 204 to 205 (204 >> 205)
- 205 to 204 (204 << 205)

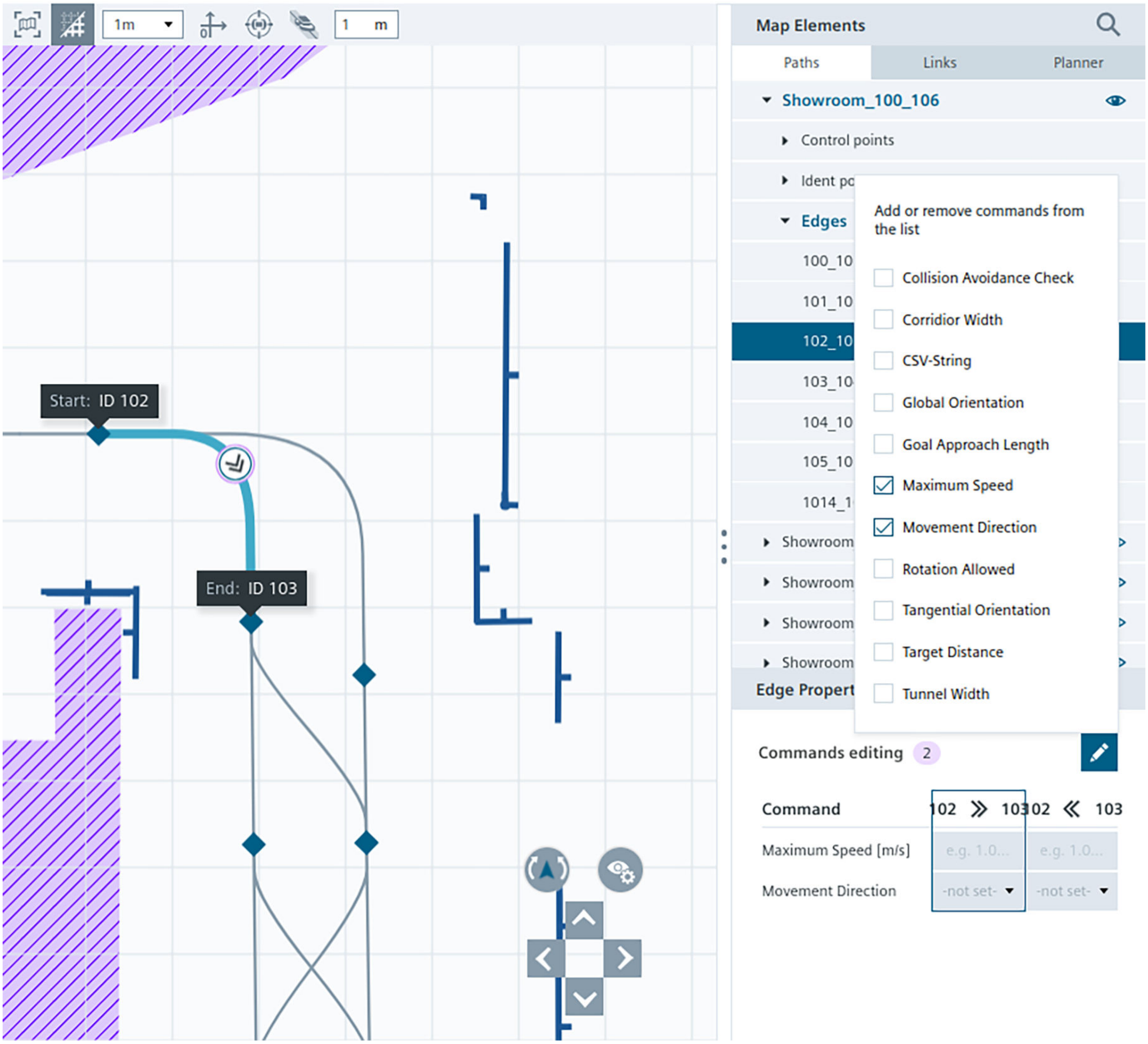
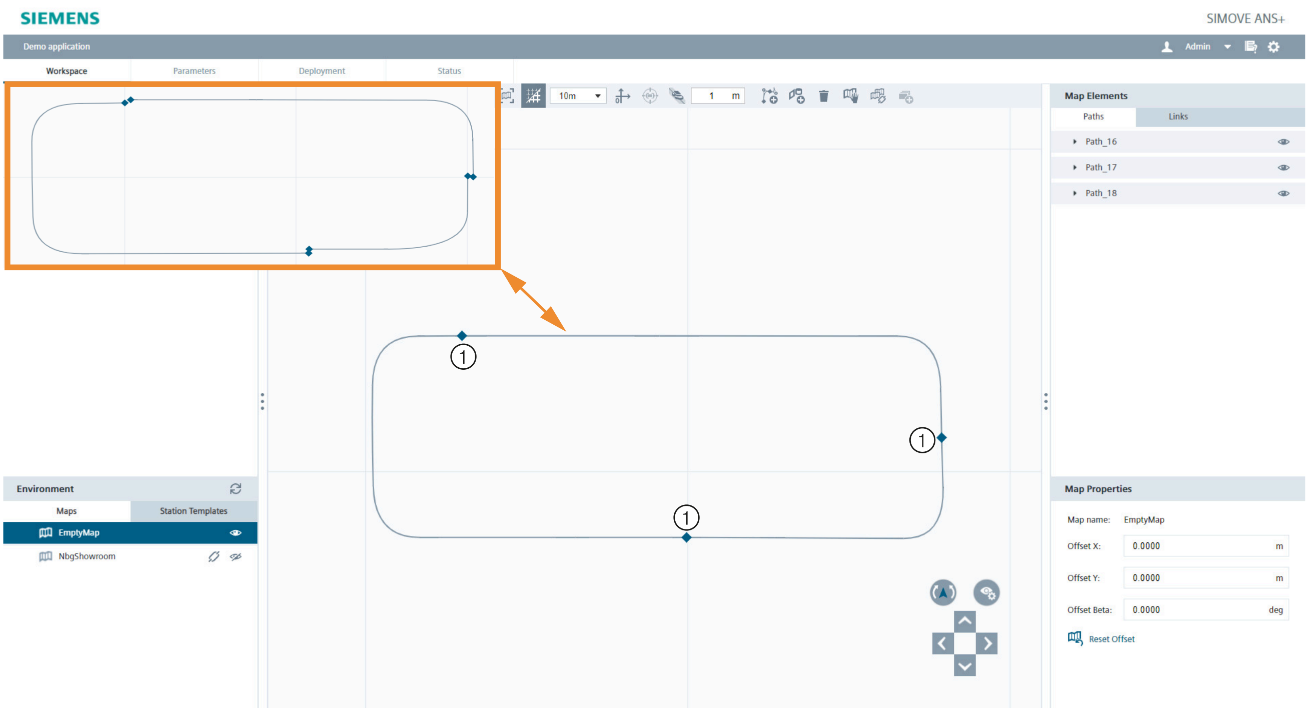


Figure 8-24 Edge commands

8.9 Common layout guidance

8.9.1 Circle

A circle layout is defined by a minimum of three paths. On each path overlap, there are control points on the same position and ident points with the same UID for each path.

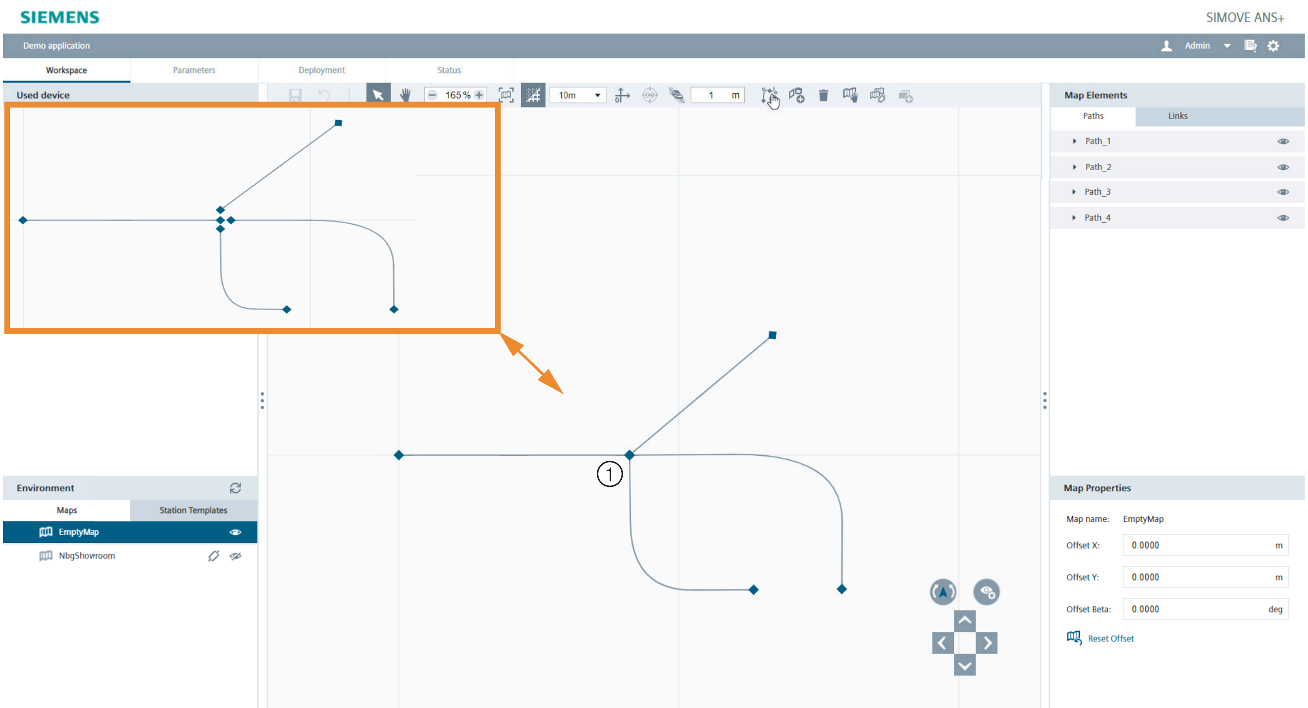


① Overlapping control points
Overlapping ident points with same UID

Figure 8-25 Exemplary circle layout

8.9.2 Junction

A junction is created by overlapping multiple paths. On each path overlap, there are control points on the same position and ident points with the same UID for each path.

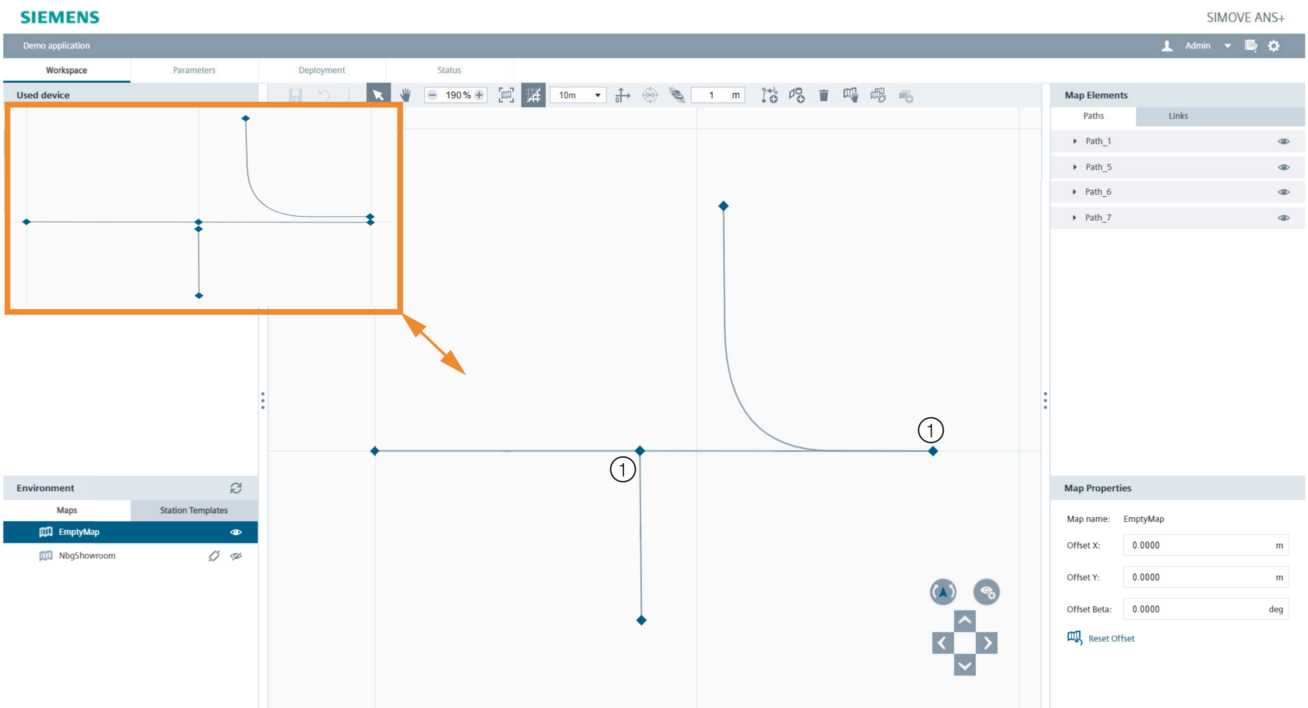


① Overlapping control points
Overlapping ident points with same UID

Figure 8-26 Exemplary junction layout

8.9.3 Dead end

Each dead end is specified with its own path. On each junction to a dead end, there are control points on the same position and ident points with the same UID for each path of the junction.

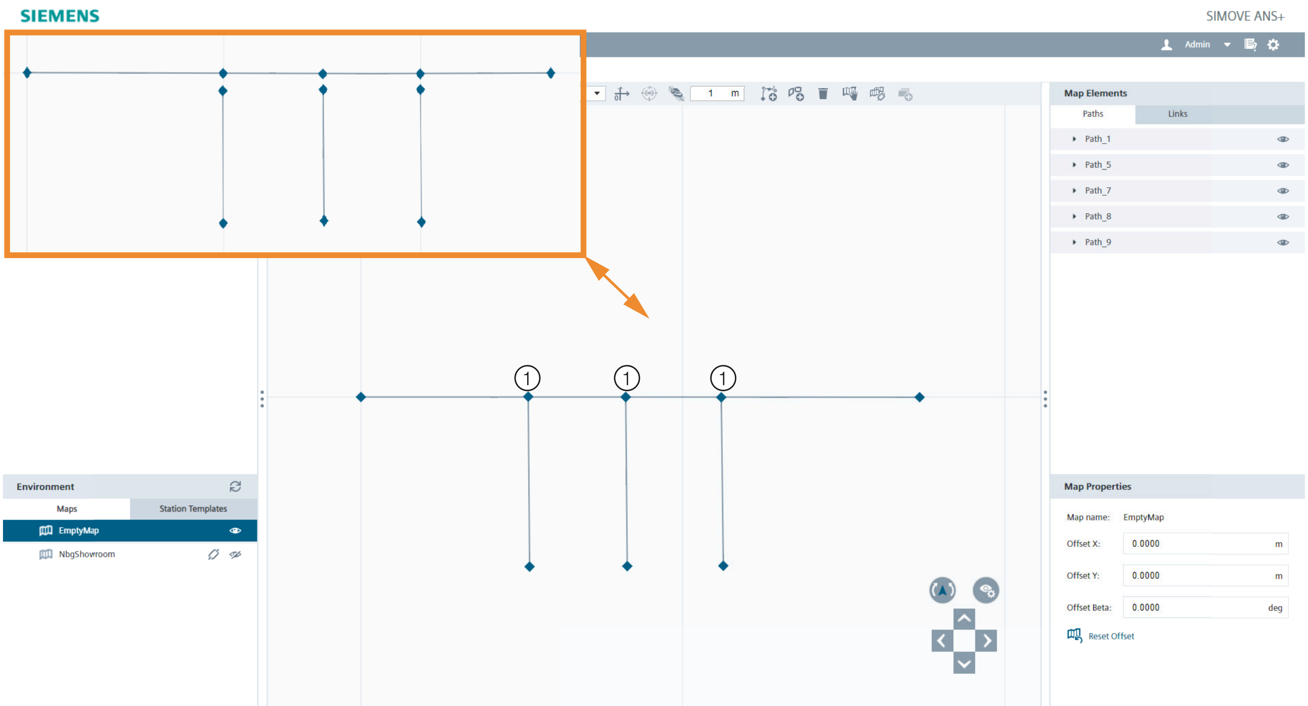


① Overlapping control points
Overlapping ident points with same UID

Figure 8-27 Exemplary dead end layout

8.9.4 Parallel stations

Following the same logic as for dead ends, each station has its own path. On each junction to a station, there are control points on the same position and ident points with the same UID for each path of the junction.

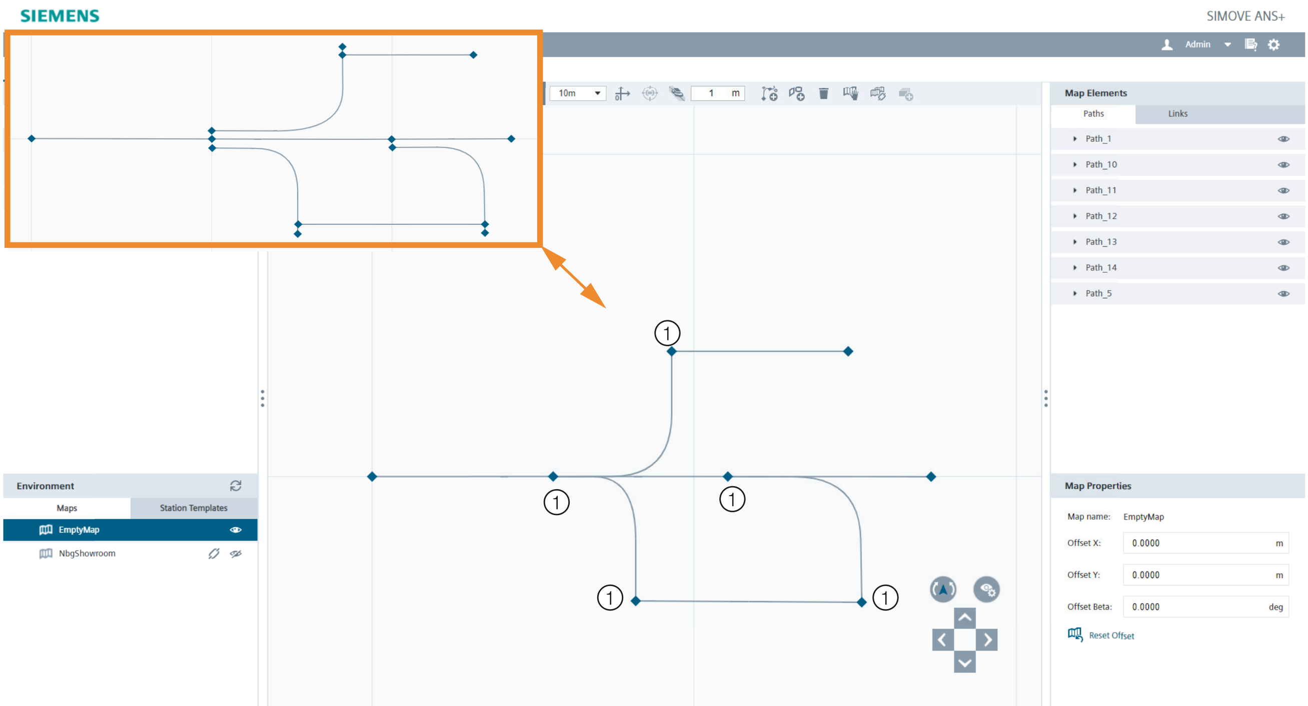


① Overlapping control points
Overlapping ident points with same UID

Figure 8-28 Exemplary stations layout

8.9.5 90-degree turn

Turns with a specific angle, most commonly is 90°, follow the same logic as junctions. Therefore, for each turn a new path is engineered. On each junction to a station, there are control points on the same position and ident points with the same UID for each path.



① Overlapping control points

Overlapping ident points with same UID

Figure 8-29 Exemplary 90°-turn layout

Free path planning 9

This chapter describes the general concept behind the SIMOVE ANS+ free path planning approach and a step-by-step logical engineering process to make usage of this functionality. Path planning lets an autonomous vehicle find the shortest and most obstacle-free path from a start pose to a goal pose. Path planning requires a feature-based map and a gridmap of the environment along with start and destination pose.

The chapter "Path engineering (Page 117)" explains virtual lines, control points and ident points in combination with a "virtual track sensor" to follow the specified paths in consideration of the kinematic concept.

In addition to this functionality, the system can perform a collision-free path planning in an already known environment. The source and destination pose within the map have to be known and reachable. The system creates a virtual path through the environment, based on the global costmap which is generated automatically by using the related gridmap. For the driving task, a velocity vector will be calculated inside ANS+, based on the defined parameter within the parameter page in the ANS+ ET (instead of the virtual track sensor). While driving, a local gridmap is used to calculate the way around obstacles that might be within the globally planned path.

Prerequisite

The following prerequisites are required:

- A global occupancy grid-based map of the environment, in which the vehicle is supposed to drive.
- An enabled "motion" functionality.
  - The section "motion AGV" needs to be enabled within the parameter page.
  - The motion related parameters need to be adjusted to the application.
- The AGV outline must include the smallest safety field and the grid map resolution as a margin. This ensures that the AGV is not stopped by activated safety fields while moving close to obstacles.

Procedure

The following steps describe the engineering process to create a free path planning task by using the ANS+ ET UI:

1. Click on "Path planning" within the toolbar.

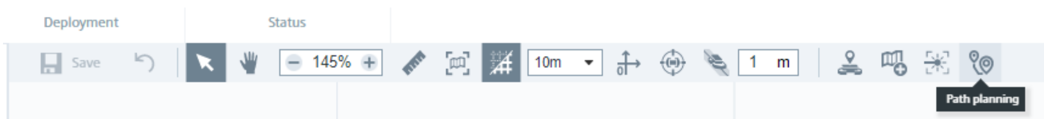


Figure 9-1 Start free path planning process

2. Select the start pose (e.g. the current AGV position) and target pose by clicking onto a valid pose within the grid map.

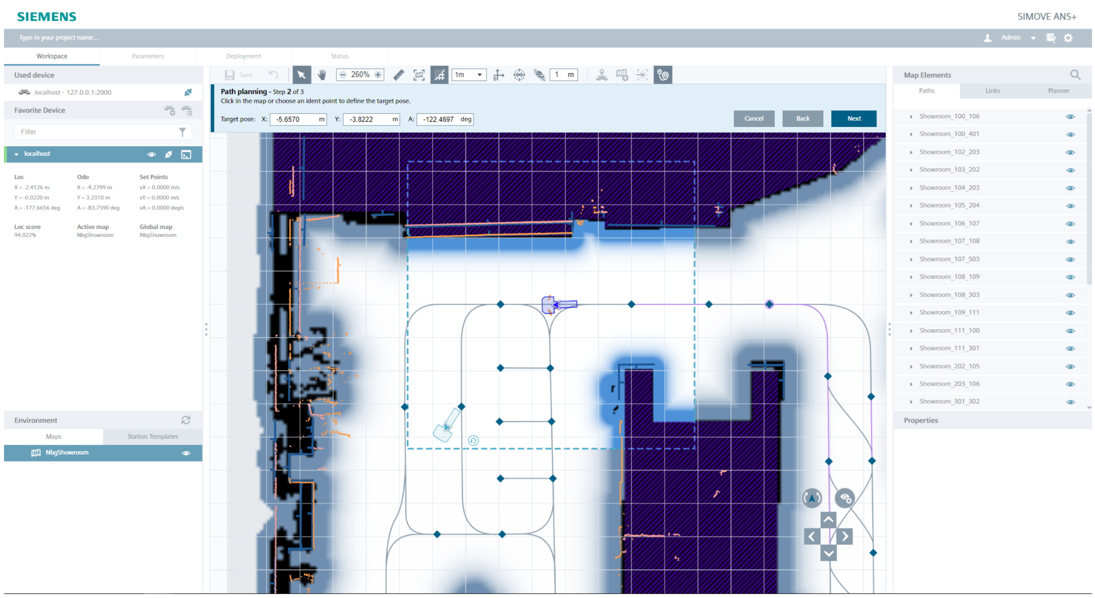


Figure 9-2 Selection of start pose and target pose

3. Check the values for start and target pose and click on "Send" to start the execution of the driving task.

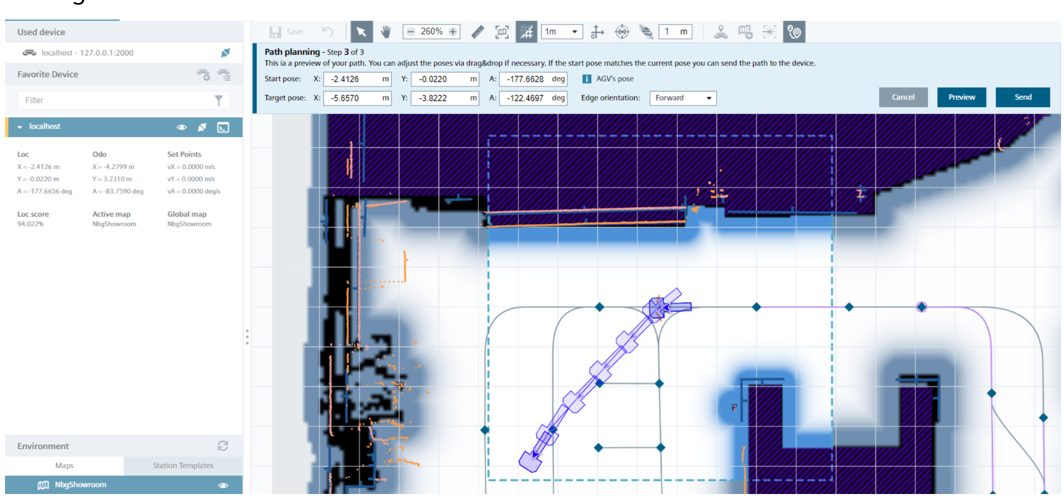


Figure 9-3 Executing of driving task

Note

Only a fixed behavior tree is available

For free path planning, one behavior tree is defined by default.

In this behavior tree, the vehicle's behavior, such as waiting for a short period of time before recalculating the path and continuing to drive, is specified.

See also

Parametrization (Page 177)

9.1 Costmaps

This chapter describes the impact of global and local costmaps on the navigation behavior of SIMOVE ANS+.

Costmaps are used for computing collision free paths for free path planning and obstacle avoidance. A costmap is only computed if the ANS+ feature "Motion" is activated.

The default parametrization of ANS+ tries to avoid navigating in areas, in which costs take place. This leads to a greater distance between the AGV and any obstacle to achieve a more fluent movement behavior.

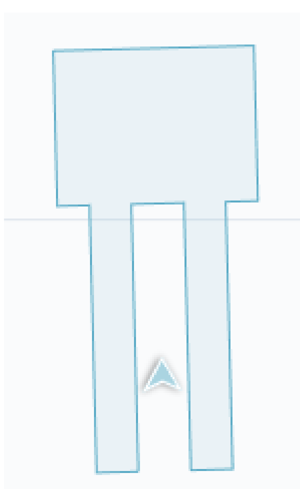
Costmaps are dynamically computed and generated by ANS+ module based on two main parameters:

- Outline
- Footprint padding

Using these two parameters, an automatic computation takes place to ease the calculation of collision-free paths.

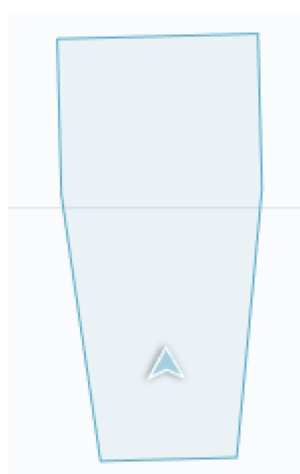
Starting with a transformation of the initial outline in the "user_def" file representing the "Visual" outline, this polygon is turned into a convex boundary ("Technical"). This new boundary is used internally for all algorithms instead of the user-specified standard outline, which is only valid for visualization tasks. By using the convex boundary and the kinematic center, a computation of the "Inscribed Radius" takes place. This value specifies the guaranteed collision-free boundary of the convex outline in any orientation to any obstacle in the map.

Standard Outline ("Visual")



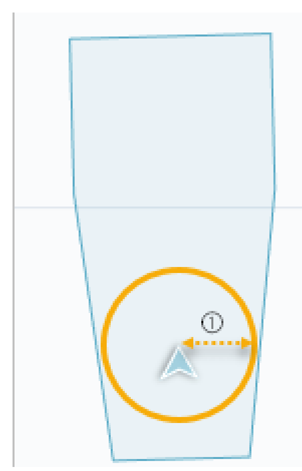
Standard outline given by "user_def" parametrization

Convex Boundary ("Technical")



Convex outline computed out of Standard Outline

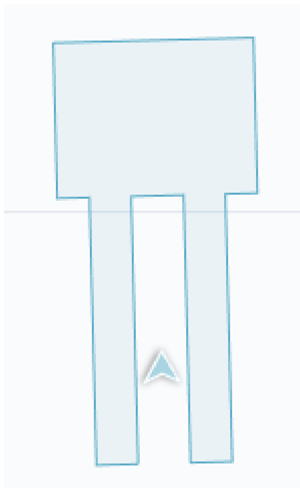
Inscribed Radius



① Inscribed Radius computed out of convex Boundary

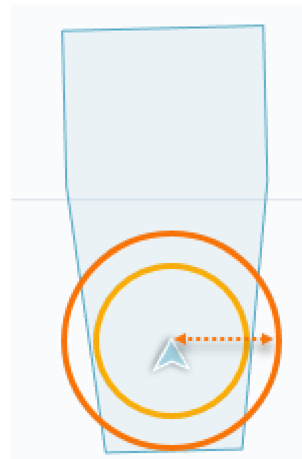
To receive the final computation radius of costmaps, the second parameter "Footprint Padding" is now added to the previously calculated inscribed radius. The padding can be parameterized differently for the global and local planner. The global padding should always be parameterized more conservatively (default: 20 cm) compared to the local padding (default: 10 cm) to give the local planner more opportunities to avoid obstacles.

Inscribed Radius



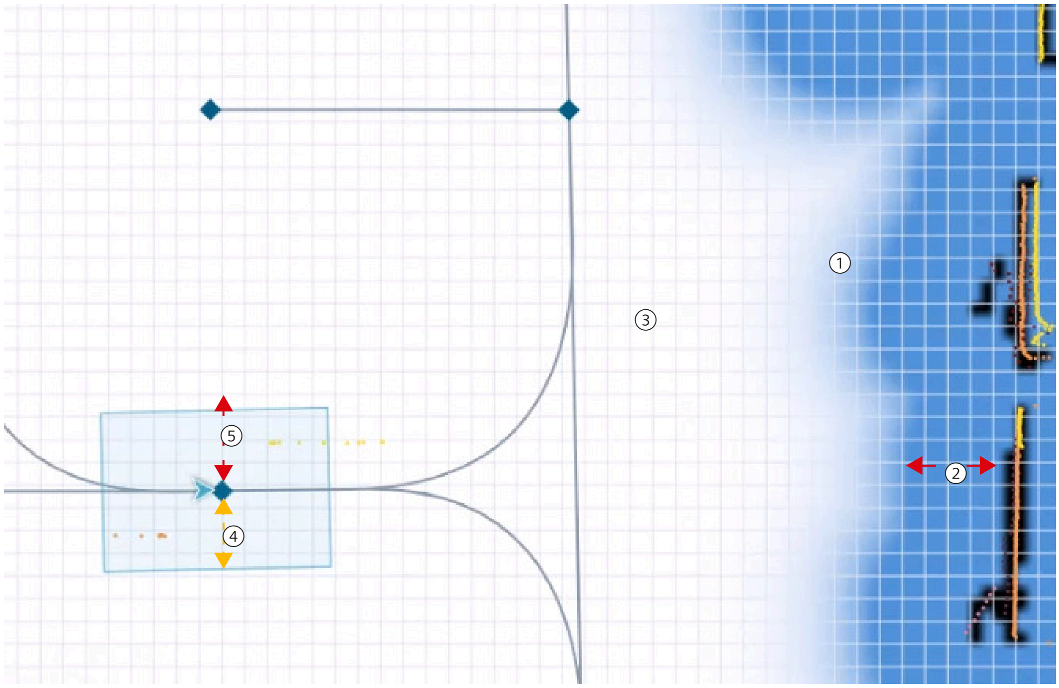
Inscribed radius
computed out of convex boundary

Inscribed Radius incl. Footprint Padding



Final collision free radius
considered for costmap generation

Once the final radius is calculated, the global costmap based on the general gridmap, as well as the local costmap based on the live data from all considered laser scanner devices, are generated by the software. The final result can be seen and visualized inside the ANS+ ET.



① Cost affected area
② Guaranteed collision
③ Free of costs
④ Inscribed radius
⑤ Final costmap computation radius

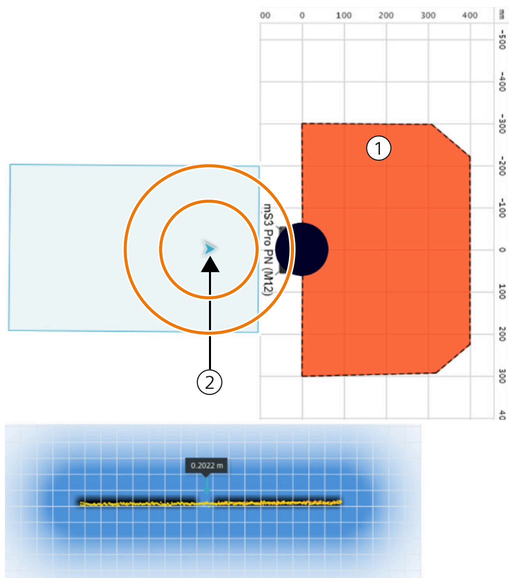
Figure 9-4 Final costmap

Note

Trajectories with activated “Motion” features are computed such that the entire convex outline of the AGV is kept out of cost infected areas. This ensures a fluent behavior.

As a "Best Practice" the smallest safety protection field should be integrated into the standard outline polygon parametrization. This is necessary to prevent the AGV from stopping due to safety field violations while avoiding obstacles.

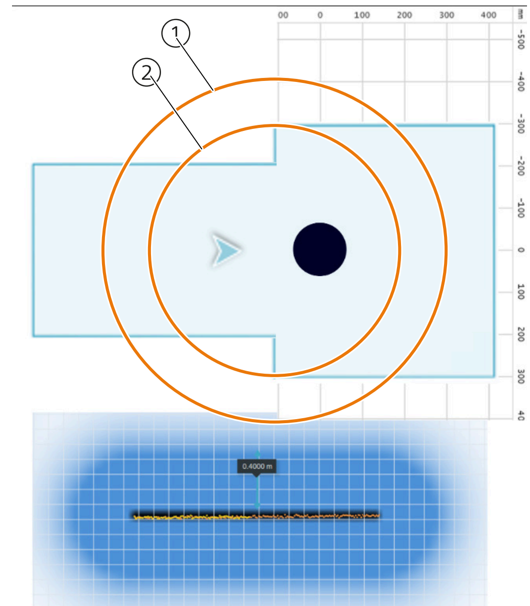
Standard outline without safety protection field



Costmap calculation without safety protection field

① Safety Protection Field
② Kinematic center

Standard outline including safety protection field



Costmap calculation including safety protection field

① Final costmap
② Inscribed radius

9.2 PLC commands for free path planning

In addition to the "Path Planning button" in the ANS+ ET, free path planning can also be commanded through the PLC interface. Therefore, please have a look at the respective function blocks of the Carrier Control Library "LSimoveC".

When using the free path planning, there are three options for commanding:

1. Free path planning from any pose within the environment to a valid ident point
2. Free path planning from a valid ident point to any pose within the environment
3. Free path planning from any pose within the environment to any other pose within the environment

The following examples are based on valid ident points that exist in the path layout (213 and 202) and invalid ident point numbers, that do not exist within the path layout (99, 999).

Example 1

Free path planning from a valid pose (x,y,a) in the environment, where the vehicle is currently standing as source information to a valid ident point (here ident point 202). Therefore, an invalid source ident point (here 99) is needed. Since the system has to know, in which angle the destination ident point should be reached, this information needs to be provided.

```
Edges[0].sourceId := 99;

Edges[0].destId := 202;

Edges[0].optRouteInfo.destCoord.x := 3141.0; //in mm

Edges[0].optRouteInfo.destCoord.y := -177.0; //in mm

Edges[0].optRouteInfo.destCoord.a := 3.116; //in deg
```

Example 2

Free path planning from valid ident point 213 to valid pose (x,y,a) within the environment using an invalid and not existing ident point 99 for destination. Here, the vehicle is standing on ident point 213.

```
Edges[0].sourceId := 213;

Edges[0].destId := 99;

Edges[0].optRouteInfo.destCoord.x := -4474.0; //in mm

Edges[0].optRouteInfo.destCoord.y := 19.0; //in mm

Edges[0].optRouteInfo.destCoord.a := 3.140; //in deg
```

Example 3

Free path planning from a valid pose (x,y,a) to an existing ident point (202). Then from an existing ident point(202) to another existing ident point (213). Both ident points (202 and 213) are placed on the same path. From that point (213) to a valid pose in the environment, to another valid pose in the environment.

```
Edges[0].sourceId := 99;

Edges[0].destId := 202;

Edges[0].optRouteInfo.destCoord.x := -4474.0; //in mm
```

```
Edges[0].optRouteInfo.destCoord.y := 19.0; //in mm
Edges[0].optRouteInfo.destCoord.a := 3.140; //in deg

Edges[1].sourceId := 202;
Edges[1].destId := 213;

Edges[2].sourceId := 213;
Edges[2].optRouteInfo.sourceCoord.x := 321.0; //in mm
Edges[2].optRouteInfo.sourceCoord.y := 2563.0; //in mm
Edges[2].optRouteInfo.sourceCoord.a := 0.365; //in deg
Edges[2].destId := 999;
Edges[2].optRouteInfo.destCoord.x := 1887.0; //in mm
Edges[2].optRouteInfo.destCoord.y := 672.0; //in mm
Edges[2].optRouteInfo.destCoord.a := 0.785; //in deg

Edges[3].sourceId := 999;
Edges[3].optRouteInfo.sourceCoord.x := 1887.0; //in mm
Edges[3].optRouteInfo.sourceCoord.y := 672.0; //in mm
Edges[3].optRouteInfo.sourceCoord.a := 0.785; //in deg
Edges[3].destId := 99;
Edges[3].optRouteInfo.destCoord.x := -4474.0; //in mm
Edges[3].optRouteInfo.destCoord.y := 19.0; //in mm
Edges[3].optRouteInfo.destCoord.a := 3.140; //in deg
```

9.3 Visual Obstacle Avoidance (VOA) Module

9.3.1 Overview

The Visual Obstacle Avoidance (VOA) module detects obstacles above and below the levels of the laser scanner within the field of view of mounted 3D cameras. It uses up to four cameras as additional input (exact number dependent on the HW used) to the ANS+ motion module. The data generated by these cameras is used solely for obstacle detection and avoidance, while the localization of the AGV is handled exclusively by laser sensors.

WARNING

VOA is not a safety function

Safety must be ensured at any time using respective safety devices.

9.3.2 Supported Hardware

The VOA module supports the following cameras:

- Intel RealSense d435 (EAN 5032037110334)
- Intel RealSense d456 (EAN 5032037225984)

It is recommended to use the original camera cables. If different ones are used, they must provide sufficient transfer rates (USB 3.0).

When using a USB multiport to connect the cameras to the IPC, ensure sufficient data transfer and power delivery (USB 3.0 with external power supply).

When using VOA, an IPC 227G, BX-21A or 127E must be used to run ANS+. The IPC 227G and BX-21A support VOA with up to four cameras, the IPC 127E is restricted to one camera due to CPU limitations.

9.3.3 Camera Mounting

All supported camera types have a horizontal field of view (FoV) of 87° and a vertical FoV of 58°.

Cameras should be mounted horizontally. It is possible to set a pitch and roll angle between -89° and 89°.

Although it is possible to decrease the field of view using the angle min and angle max parameters, it is recommended to position cameras with a free field of view, ensuring no AGV parts are visible to the cameras.

Note

For obstacle avoidance, at least two cameras with a combined FoV of about 180° in moving direction are needed.

As obstacles must be visible to the AGV at every point while passing them, it is recommended to ensure a 360° field of view while using motion.

9.3.4 Commissioning

The most relevant parameters of the VOA module are contained in the user-def file of the "Parameter" page, see Figure 9-6. Here, the sections camera ID0 to camera ID3 can be used to set the most commonly used parameters.

Section: Visual Obstacle Avoidance

Name	Value	Comments
Enable	yes	[yes/no] - Enable visual obstacle avoidance based on camera detection

Figure 9-5 Enable visual obstacle detection

Section: Voa Camera 0

Name	Value	Comments
Requires "Visual Obstacle Avoidance" enabled		
Enable	no	[yes, no]
Serial Number	"233522070851"	"<String>" - Insert here the serial number of the related camera
Camera Height	0.3	[m] - Height on which the camera is mounted
Agv Height	1.0	[m] - Total height of the agv, max height at which obstacles are considered
Floor Distance	0.1	[m] - Min height at which obstacles are considered
Is Upside Down	no	[yes, no]
Transformation Lateral	0.414 -0.076 43.8	[m(X), m(Y), deg(Yaw)]

Figure 9-6 User-defined parameters for each camera

To use VOA, the following parameters need to be set:

1. Enable section "Visual Obstacle Avoidance" in the user-def page.
2. Ensure all input cameras are connected and **enable** is set to yes.
3. Set the **serial number** of all enabled cameras. The serial number is a 12-digit number printed on a label on the camera's bottom (*Figure 9-7*). Alternatively, the serial number can be determined by connecting the camera to a computer and starting the Intel® RealSense™ Viewer. Under the section "information", the serial number of connected cameras is depicted.
4. Set if the camera was mounted **upside down** or not.
5. Set the **camera height**. This is the distance between camera and floor (absolute value).

6. Set the total **AGV height**. This is the distance between the AGVs highest point (including load) and the floor. All obstacles above AGV height level are ignored by the cameras.
7. Set the **floor distance**. AGV height and floor distance define the maximum and minimum height levels at which obstacles are still considered relevant to the motion module. The floor distance must be slightly greater than zero to filter the floor level. For uneven or reflective floors, set a value of a few centimeters above zero.
8. Set the position of the camera relative to the AGV in the **transformation lateral** parameter. Values are given in x, y, and angle, with a front-facing camera having an angle of zero. Note: For cameras, the zero angle is defined differently than for laser scanners. The origin of the cameras depth coordinate system is depicted on the image below (*Figure 9-8* and *Figure 9-9*).

Figure 9-7 Label with the camera's serial number (12-digit)

Figure 9-8 Camera coordinate system for d435

Figure 9-9 Camera coordinate system for d456

Additional parameters for the VOA module can be found in the voa_cameras.yaml (*Figure 9-10*) file. These include parameters to reduce the field of view, etc. Typically, these parameters do not need to be changed by the user.

The parameters in the yaml file include:

- Range min: [m] min distance at which obstacles are considered.
- Range max: [m] max distance at which obstacles are considered.
- Angle min: [deg] min angle at which obstacles are considered, in horizontal direction.
- Angle max: [deg] max angle at which obstacles are considered, in horizontal direction.
- Angle min vertical: [deg] min angle at which obstacles are detected, in vertical direction.
- Angle max vertical: [deg] max angle at which obstacles are detected, in vertical direction.
- Timeout frames: [ms] max time with no new camera frames until error is displayed.
- Pitch angle: [deg] positive for camera looking up, zero for horizontal, negative for camera looking down.
- Roll angle: [deg] rotation angle of the camera around the longitudinal axis. A positive roll angle lifts the left end of the camera and lowers the right end.
- Time too old max: [ms] max cycle time before the system shows warning.
- Filer window: int, size of flying pixel filter.

Section: CameraParameters3

Name	Value	Comments
enabled	false	@ "user_def" file
serial_number	238222072015	@ "user_def" file
camera_height	0.2	@ "user_def" file
agv_height	1	@ "user_def" file
floor_distance	0.05	@ "user_def" file
is_upside_down	false	@ "user_def" file
angle_min	-45	[deg] min angle at which obstacles are considered, in horizontal direction
angle_max	45	[deg] max angle at which obstacles are considered, in horizontal direction
angle_min_vertical	-45	[deg] min angle at which obstacles are considered, in vertical direction
angle_max_vertical	45	[deg] max angle at which obstacles are considered, in vertical direction
range_min	0.1	[m] min distance at which obstacles are considered
range_max	3.5	[m] max distance at which obstacles are considered
transformation	[0,0,0]	@ "user_def" file
timeout_frames	1000	[ms] max time with no new camera frames until error is displayed
pitch_angle	0	[deg] pitch angle of camera, if camera looking up or down or straight
roll_angle	0	[deg] roll angle of camera
time_too_old_max	90	[ms] max circle time
filter_window	4	size of flying pixel filter

Figure 9-10 Advanced parameter options in voa_camera.yaml file

9.3.5 Operation

The VOA module serves as an additional input for obstacle avoidance and free path planning (motion module). Obstacles between the floor distance and AGV height are added to the local costmap and considered during planning. The output from VOA is a set of 2D points that can be depicted in the ANS+ ET by enabling the respective camera ID in the config panel, similar to laser scanners (see *Figure 9-11*).

If VOA is used in combination with virtual line following and the AGV should only detect, but not avoid obstacles, enable the motion module and set the tunnel width parameter to zero. This allows the local costmap to still be used as input for potential obstacles, but the AGV stays on the virtual lines.

Important: If the motion module of ANS+ is turned off, the local costmap is ignored and the AGV will not stop in front of obstacles detected by the VOA module.

The minimum size of detected obstacles depends on the distance, environmental conditions such as lighting, as well as size and reflectivity of the object. In case of uneven and reflective floors, the minimum height of detected objects is increased. In case of the AGV moving up ramps, the collision check flag can be removed for the respective edge to ensure the ramp is not detected as an obstacle.

Direct sunlight and reflective surfaces can cause noise to the point cloud generated by the cameras and must thus be prevented. Small sets of flying pixels are pre-filtered by the VOA module. If needed, the filter window and max range difference parameters can be adapted in the voa_camera.yaml file to further reduce noise.

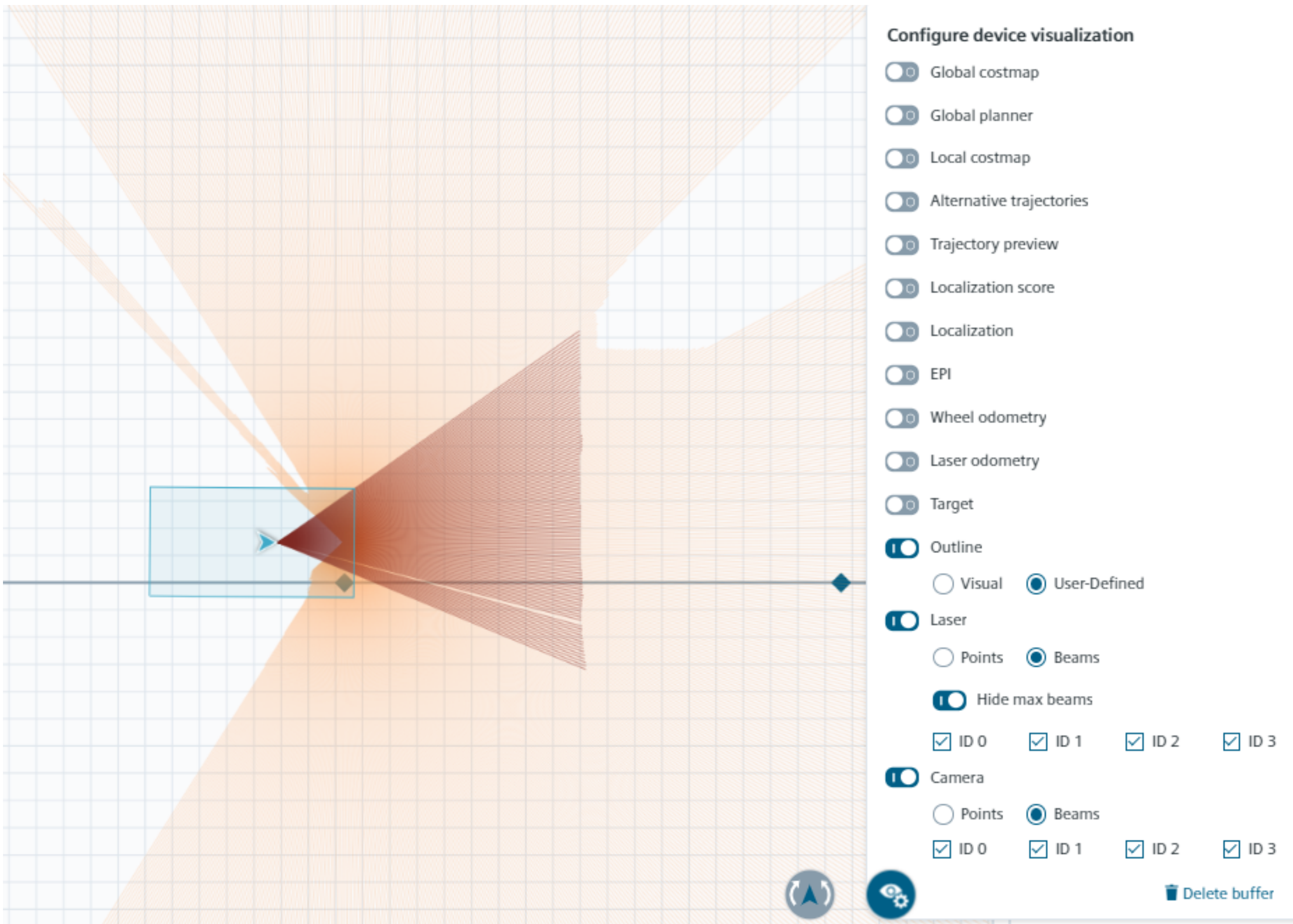


Figure 9-11 ET visualization of VOA output

10 Station engineering

SIMOVE ANS+ stations are maps with defined station features to reach the best possible accuracy in localization. This approach is used to avoid disruptive influences of global map features, for example, due to displacement.

As a global map might contain several identical station types, SIMOVE ANS+ provides so called station templates and station instances for this engineering use case. Each station type requires its own station template. Within the global map, it is possible to create multiple instances out of one template.

10.1 Generating a station template

Note

Only relevant template functions available

During the entire template creation process, the UI is blocked expect relevant template functions. To access other UI elements or pages, the process first needs to be finished or canceled.

Exact positioning

When using station templates, the localization can be optimized, when only one laser scanner is used for localization within the station features.

Therefore, the "Used Laser Device" can be edited within the template properties.

The steps describe an engineering process to create a station template:

1. Position AGV in front of the station and do not move it for the entire process.
2. Click on “Create new station template”.

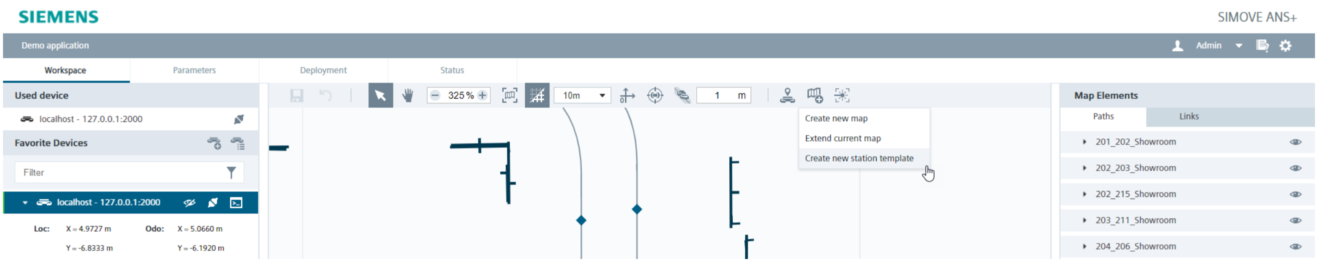
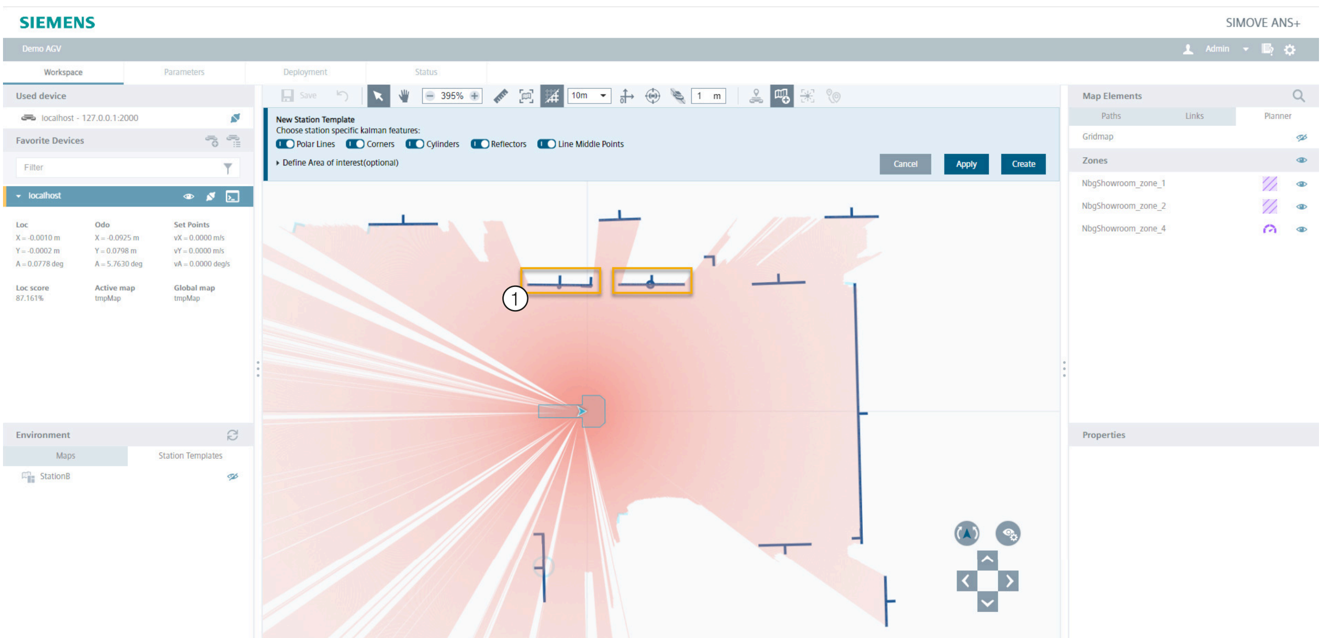


Figure 10-1 Create new station template

A template creation process is started.



1 Identical stations

Figure 10-2 New started template creation process

3. Map related station features to avoid template map failures

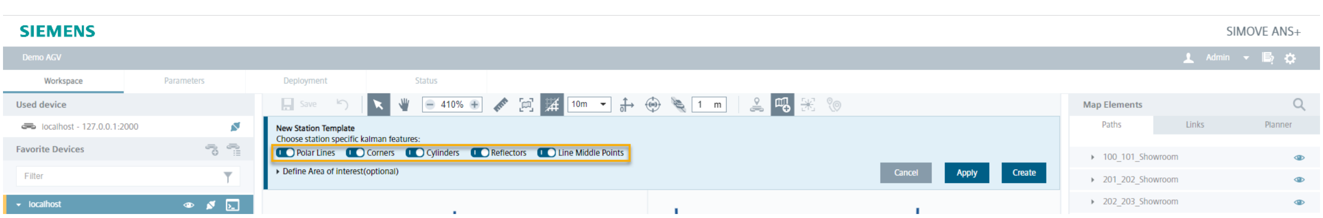


Figure 10-3 Station feature type configuration

4. Adjust the creation parameters to avoid unnecessary failures in the template. Enable only the relevant station feature types by clicking on the feature buttons.

5. The mapped station consists of a metal sheet with a specified length. For this station type, use the SIMOVE ANS+ features “Polar Line” and “Line Mid Points”.

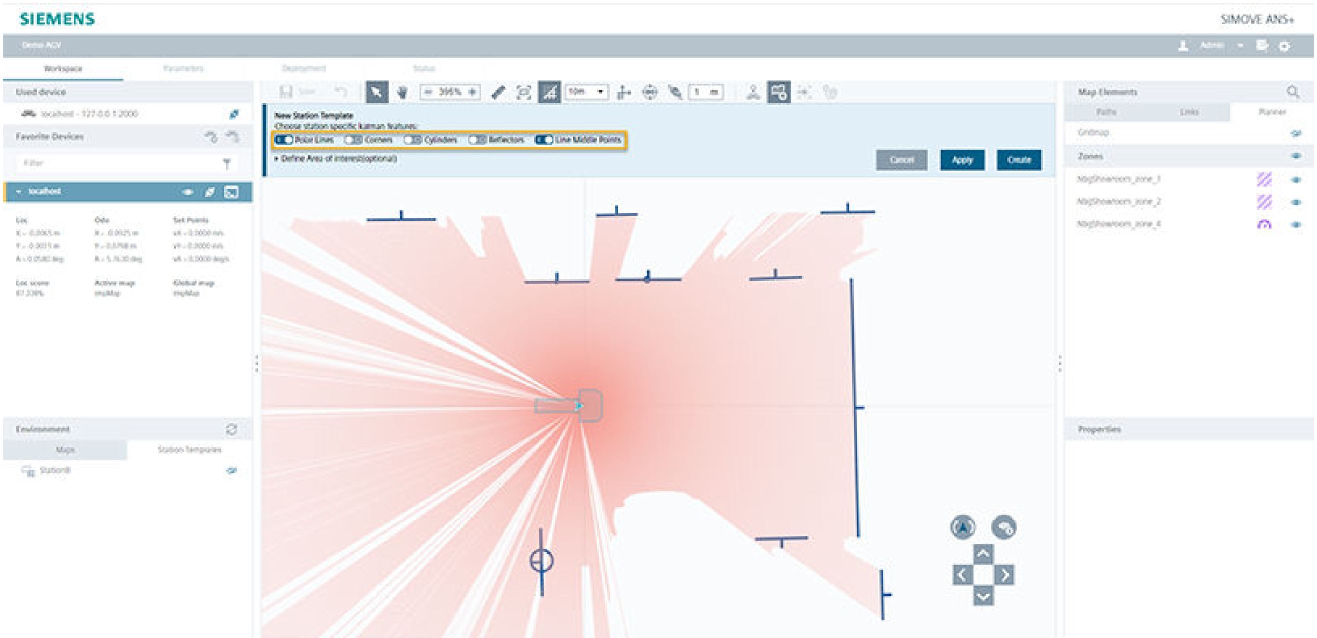
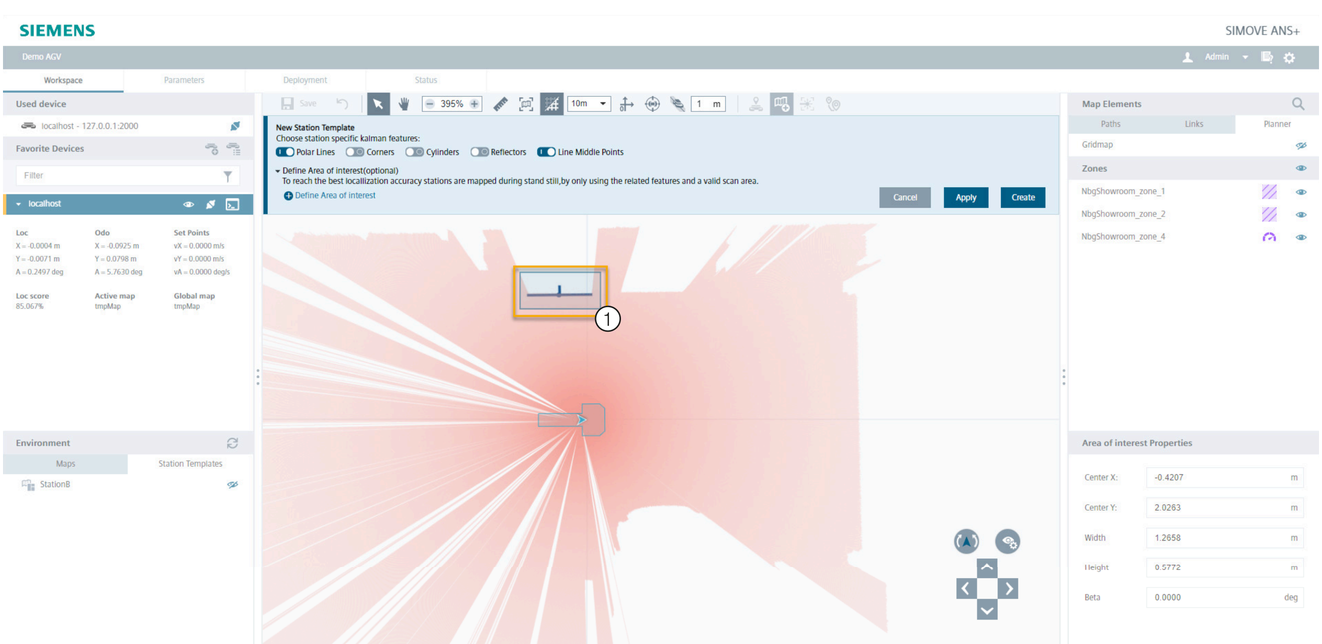


Figure 10-4 Adjusted station feature type configuration

6. To confirm the new configuration, click on “Apply”.
7. If there are additional features around a station of the same feature type, specify a certain area in the grid.
   This area is called “Area of interest”.



① Area of interest

Figure 10-5 Specified “Area of interest”

8. To confirm the new configuration including the “Area of interest”, click on “Apply”.
9. Once all parameters are configured and applied, click on “Create” and fill in a representative template name.

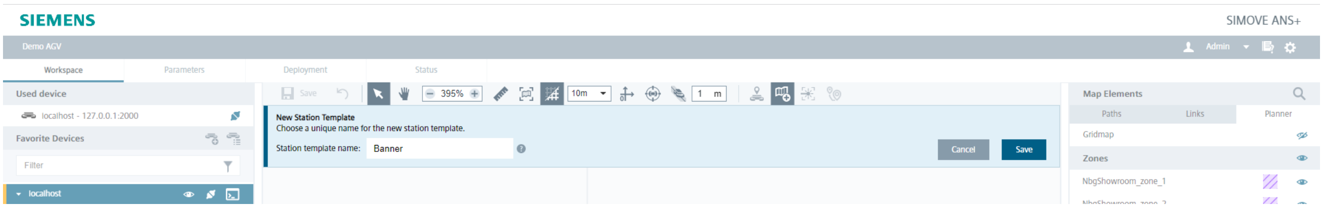
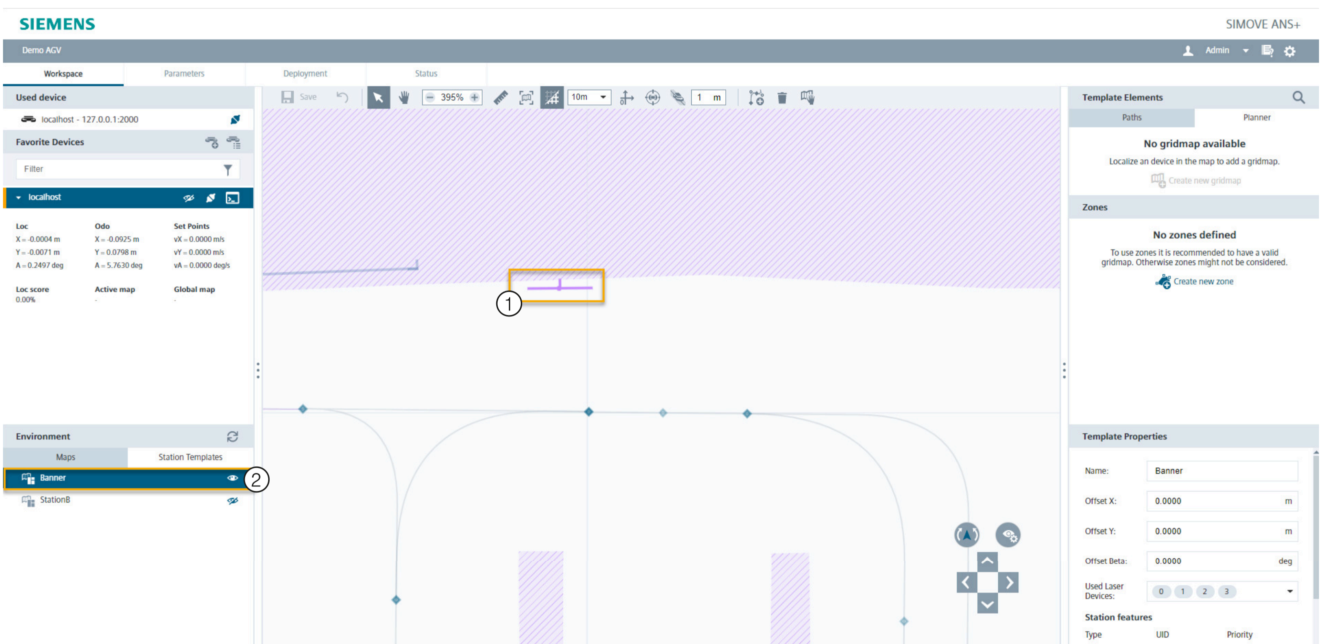


Figure 10-6 Template name

Once the template is generated, the file is automatically loaded into the ANS+ ET data content.



① Station template (purple features)

② “Station Templates” tab

Figure 10-7 Final generated and loaded station template

Note

List of station templates

All station templates are listed in the "Station Templates" tab in the "Environment" window.

10.2 Station template engineering

Once a station template is created, several configurations need to be engineered for each template before starting with station instance engineering.

Note

Station templates and station instances

Station instances are generated out of station templates. Therefore, it is recommended to first configure all templates to apply their settings directly into their instances.

Within this documentation example the following template is used:

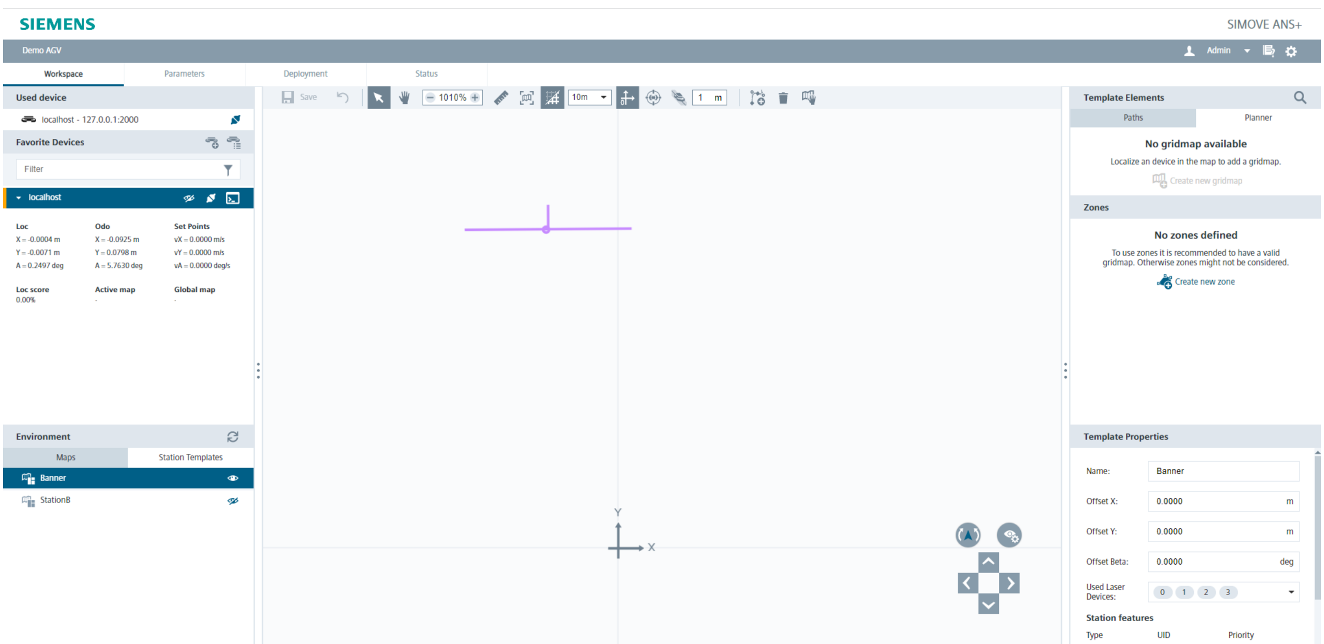
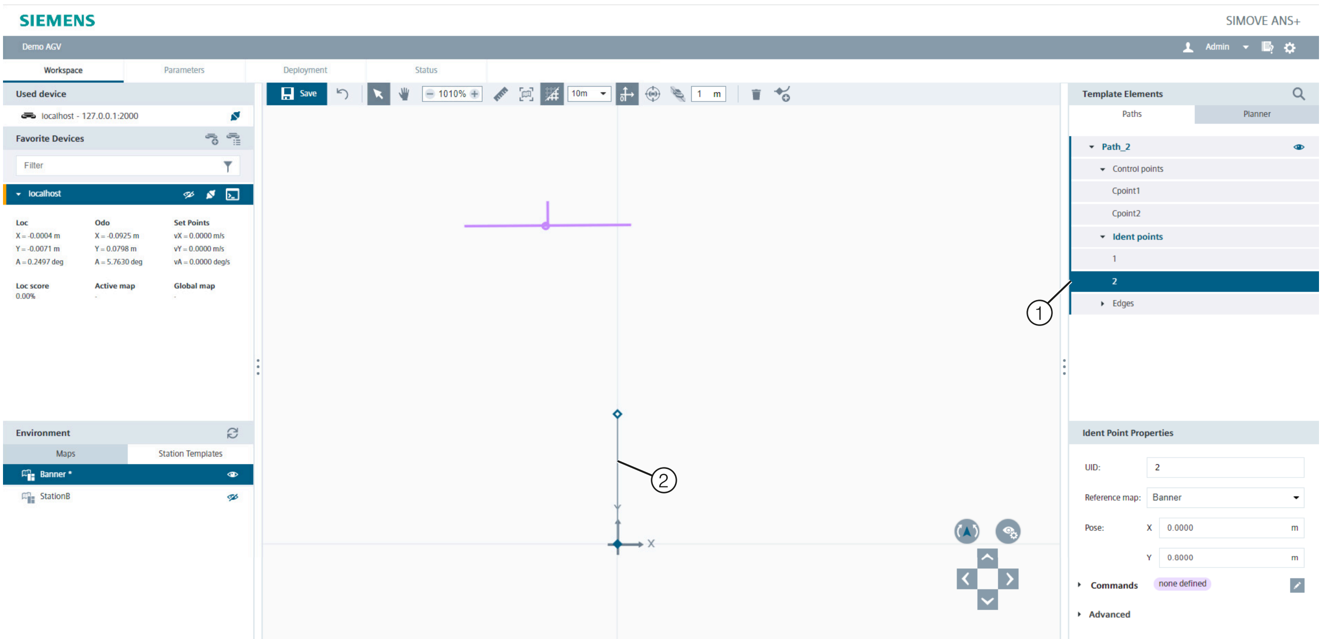


Figure 10-8 Initial state of a station template after generation

The following configurations need to be engineered for each template:

Paths

Each station requires a valid path with ident points. The UIDs of the ident points are later adjusted within the instance engineering approach, for the templates overall free temporary UIDs are required. It is also possible to fine-tune control points for each station instance in the end.



① Free temporary UID for ident points
② Station path

Figure 10-9 Station template path engineering

Station laser devices

For a station positioning approach, it might be necessary to only use specific laser scanner devices for localization. The aim of this configuration is to avoid interferences, for example, occurring due to laser calibration offsets or due to material reflection issues for a scanner, by disabling related laser devices.

> **WARNING**
>
> **Evaluation of laser point data**
>
> For each template, it is recommended to evaluate the laser point data and to disable interfering laser scanner devices.

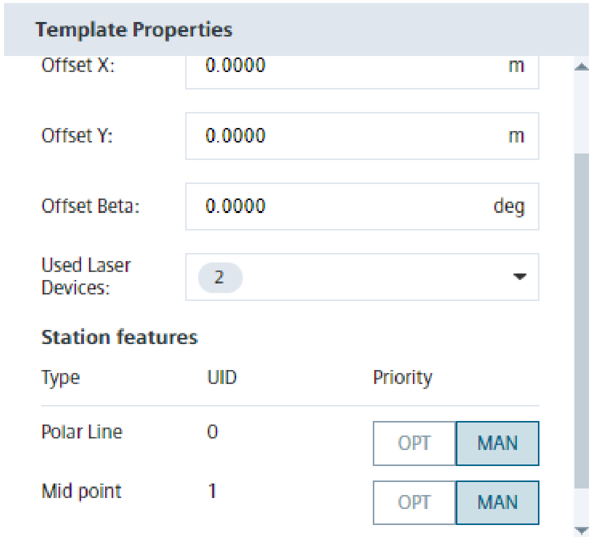


Figure 10-10 All interfering laser devices for a station template disabled

Station features priorities

Each station feature is visualized in a different shade of purple for better differentiation to normal map features. Furthermore, each station feature has its own priority setting. At their default state, which is "MAN" (= mandatory), all station features are considered as one single feature. This increases the localization accuracy.

WARNING

Visible mandatory station features

Mandatory station features need to be permanently visible for all related laser scanner devices during the entire station approach.

Therefore, ensure that at least two or more features are set to mandatory and avoid specifying all features to optional.

If an AGV is not able to detect all mandatory station features during the entire station approach, those specific features need to be set to "OPT" (= optional).

10.3 Station instance engineering

Station instances are generated out of station templates. Therefore, it is recommended to first configure all templates to apply their settings directly into their instances.

Once all templates are configured, the following step-by-step guidance can be used to create multiple station instances within a map:

1. Select the related map in which station instances shall be created.
2. Click on to start the engineering process.
3. To create multiple station instances within a single engineering process, define a prefix for all related instances. The ANS+ ET later on uses this prefix for naming the instances with an ending "_X", in which X represents an iterative counter.

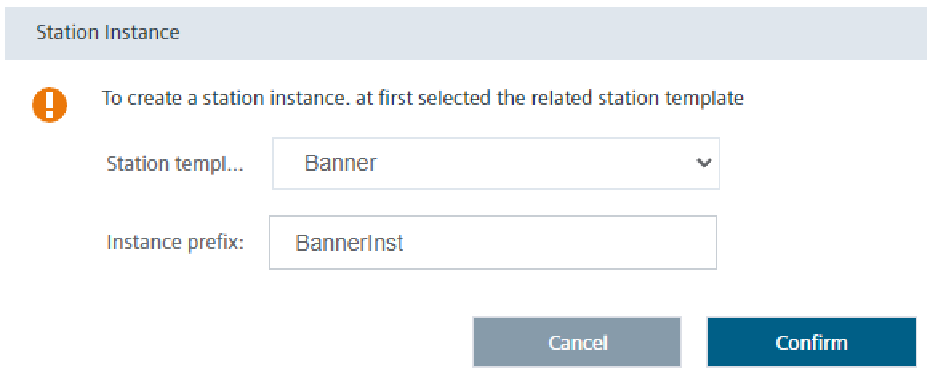


Figure 10-11 Station instance prefix naming

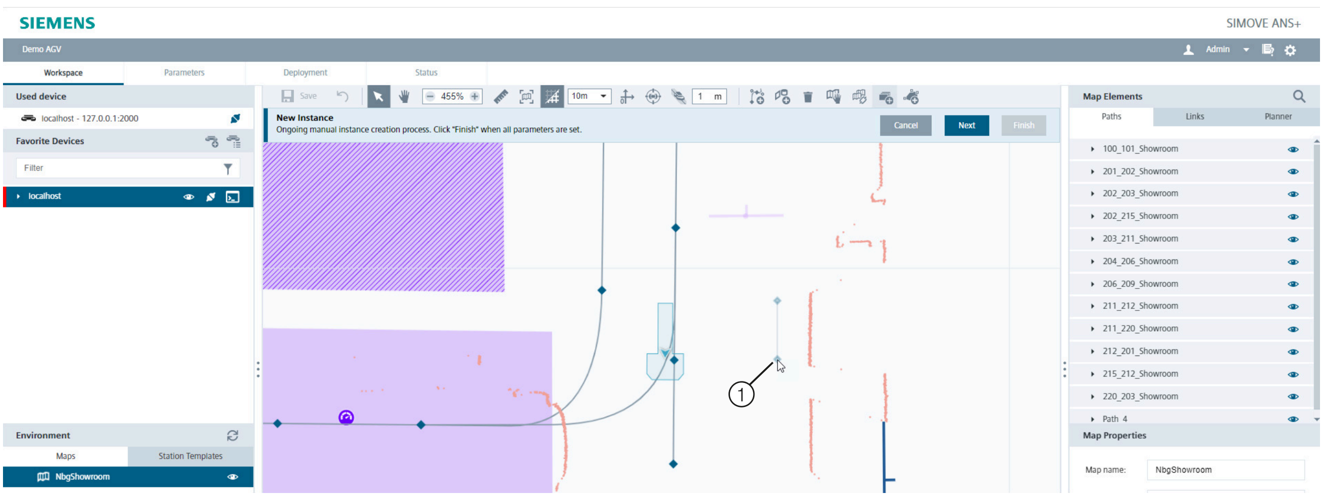
After confirming, the related station template is attached to the mouse cursor with its origin position.

4. Position the template roughly in the area in which the station features are already mapped in the global map.

Note

Unmapped features

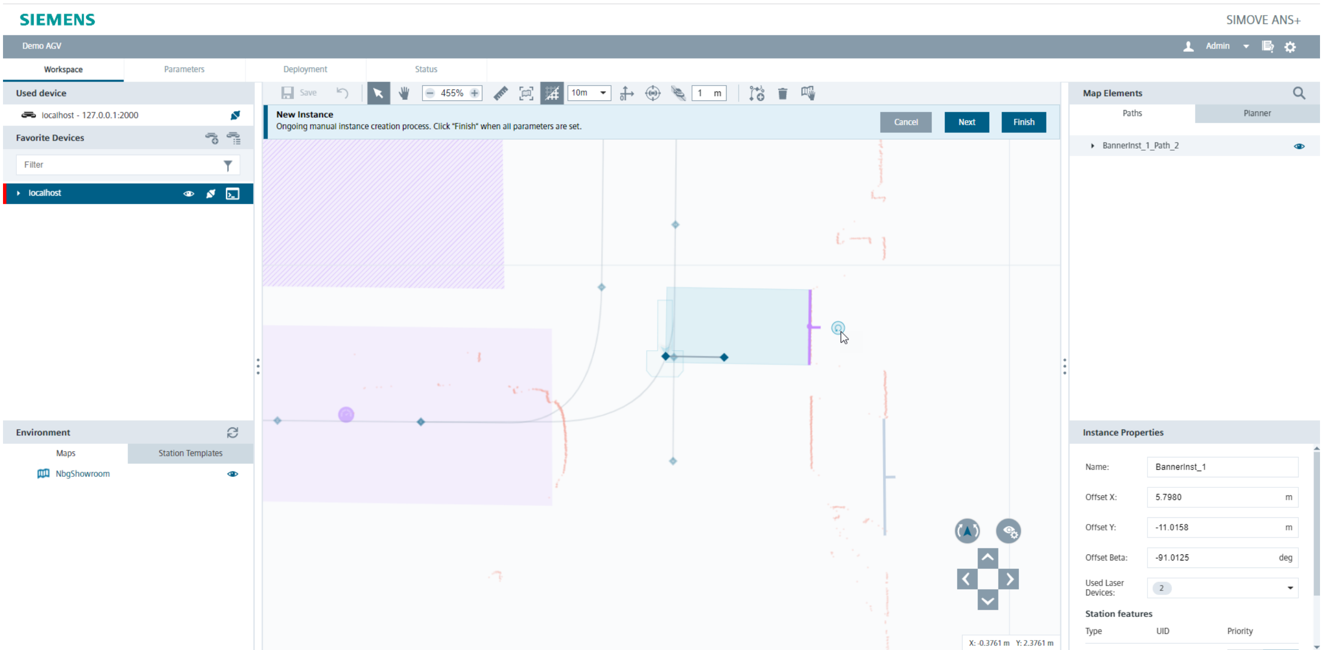
If the features of a station are not mapped in the global map, command the AGV to the related ident point in front of the station and use its laser data and feature recognition to position the instance.



① Station template

Figure 10-12 Station template attached to mouse cursor

5. Once the position is defined, use the rotate icon to specify the angle. It is possible to do a fine-tuning of the instance pose via Drag&Drop or the offset text boxes in the properties window. In the end, the station template feature needs to be on the position of the mapped or online visible feature.



① Angle correction
② Offset text boxes in the properties window

Figure 10-13 Station instance fine-tuning in positioning

6. Adjust the path related to the crossing of the global map. Use Drag&Drop or list selection of the control points to position the path correctly on the crossing.

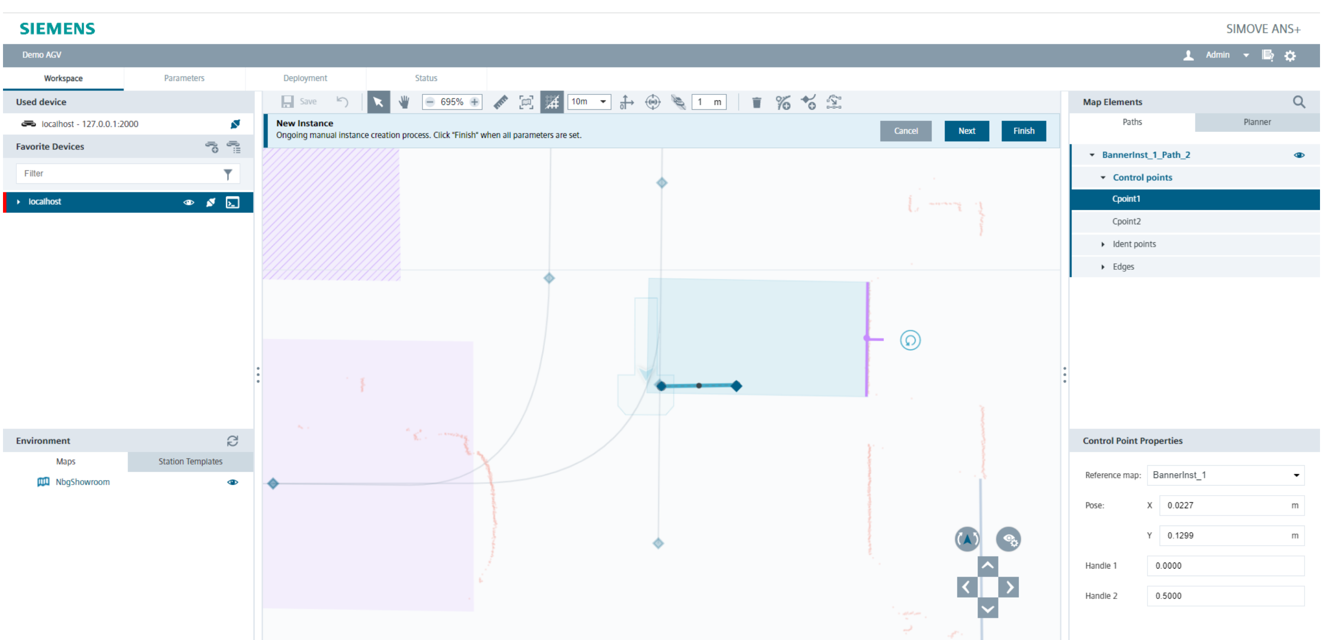


Figure 10-14 Station instance fine-tuning in positioning

7. The temporary UIDs of all ident points need to be changed to the required IDs. Click on the ident point and change the UID in the properties window.

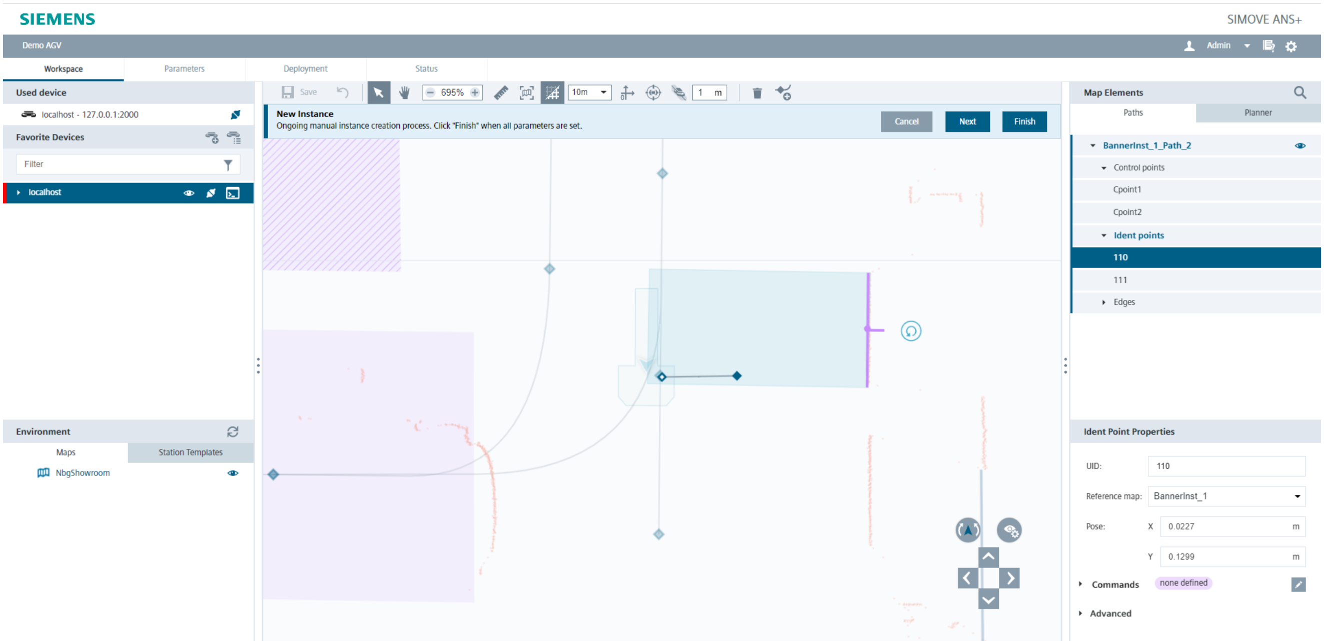


Figure 10-15 Station instance ident point configuration

8. Click "Next" to create another instance in the same step or click "Finish" to finish the engineering process.

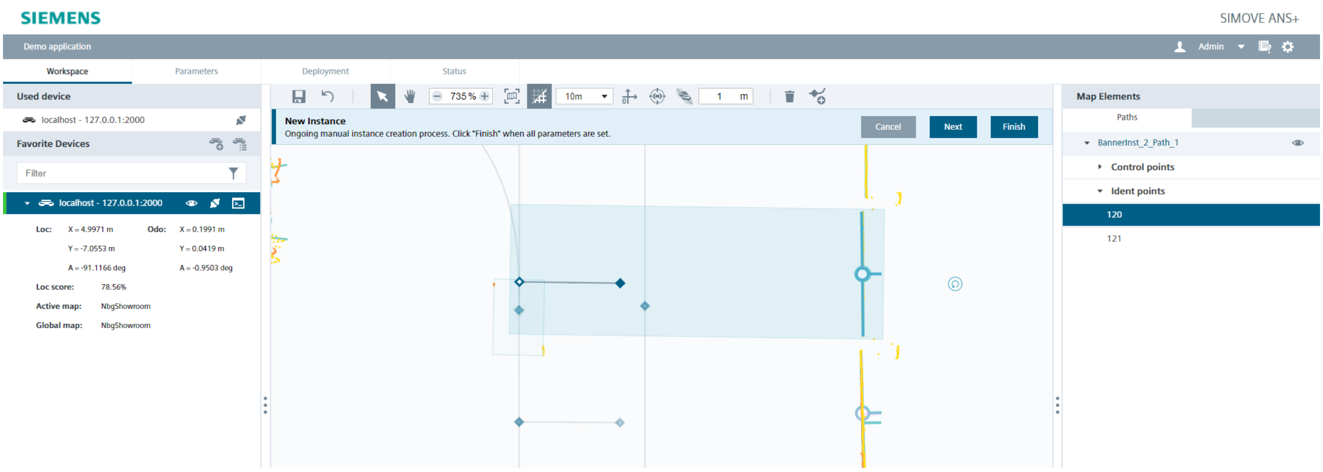
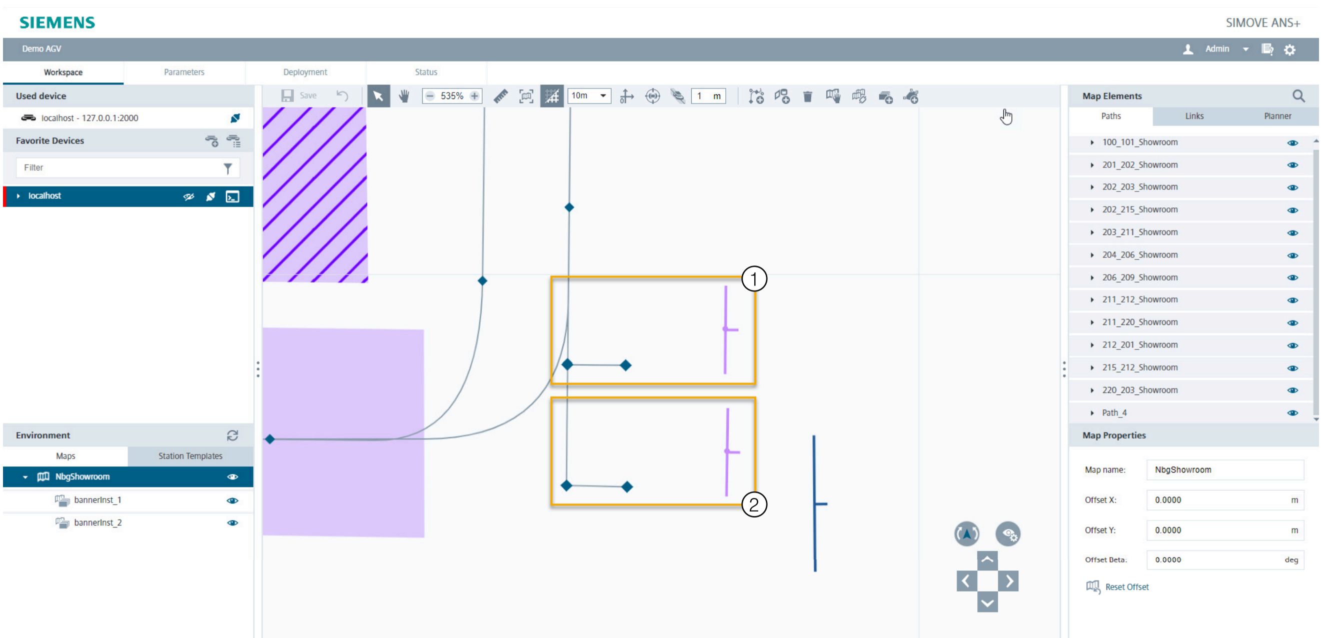


Figure 10-16 Additional station instance created within the same process

9. Save all changes and reload the AGV's atlas, as shown in "Figure 6-24 Reload AGV atlas (Page 93)", to apply the map changes.



① 1st instance

② 2nd instance

Figure 10-17 Final result of multiple created station instances

Note

Deletion of station instances

If a station instance is deleted, it is necessary to click “Save” before generating a new station instance with the same name. This ensures, that the map links between stations and the global map are updated.

Parametrization 11

11.1 Overview

This chapter describes the parametrization of the ANS+ NC module.

For this purpose, the tool offers the "Parameters" page.

More information:

- ""Parameter" page (Page 51)"

Editing parameters

The most common user parameters are defined in the “user_def” file, that is being displayed for the localhost in the parameter page.

Only adjust the parameters within this file.

To change an already listed parameter, edit the content of the column "Parameter Value".

To save the change, click on .

Note

Parameters are case sensitive

All parameter values are case sensitive. If you change a value, stick to the already listed default value format.

Otherwise the value will not be read by the ANS+ system. In that situation, the system will use the default parameter value as a fallback solution.

Restart required

All saved changes are only applied if you restart the ANS+ NC module.

Parameter handling

Add parameters to a section

1. To add a new parameter to a listed section, click next to the name of the related section.
   A new parameter line appears.
   Click on the drop-down menu and select the parameter which has to be added to the section.
2. This process can be canceled by pressing <Esc>, or by clicking on "Confirm" in case of an empty drop-down menu.

Add new sections comments

- To add a new section or comment section to the file, click on .

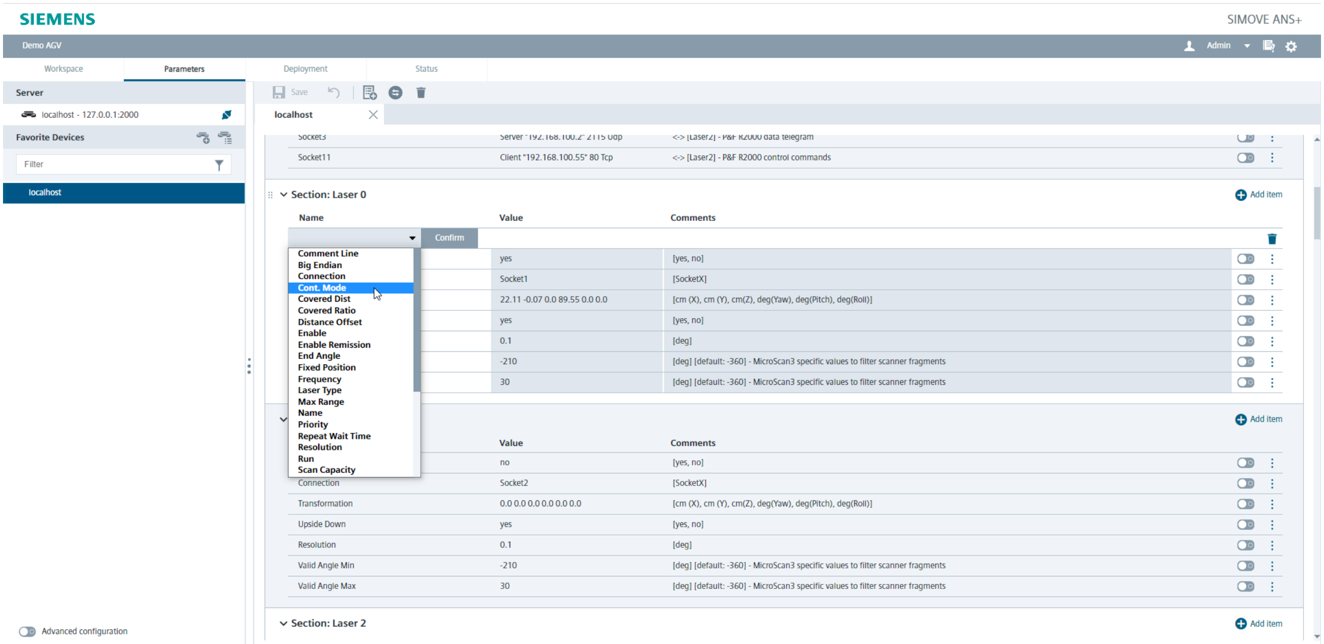


Figure 11-1 Adding a new parameter to a file’s parameter section

Delete parameters or sections

1. Delete sections and parameters by clicking .
2. Check the related section or parameter line.
3. Click "Delete" to delete the selected elements.

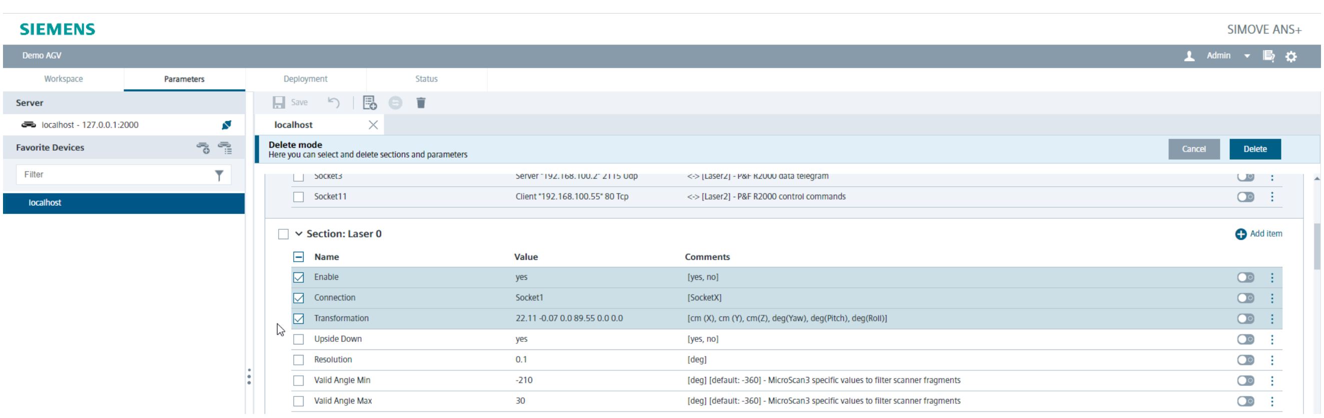
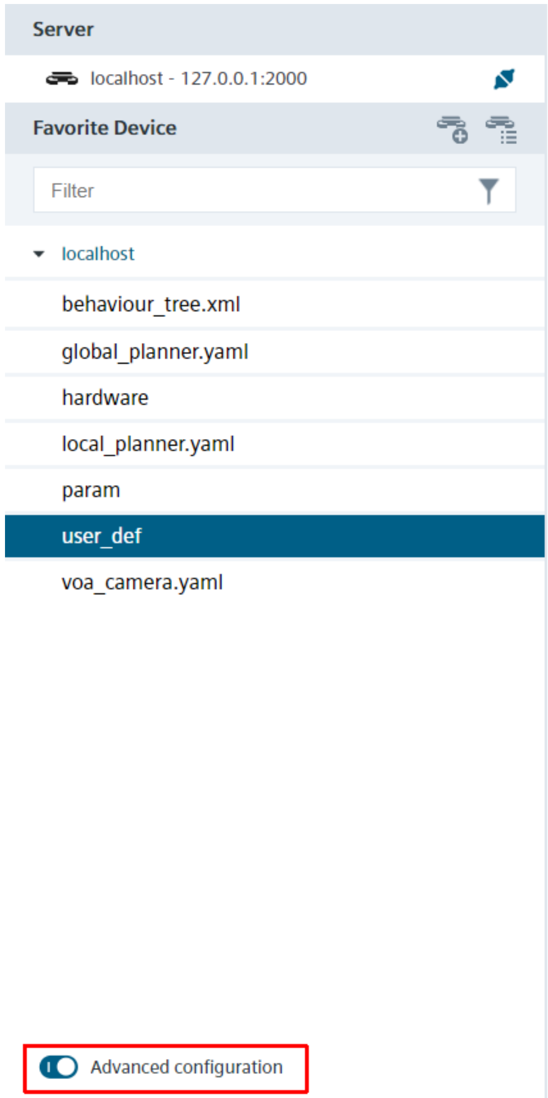


Figure 11-2 Deleting a parameter or section of the parameter file

Advanced parameters

Additional parameters can be edited by enabling of the “advanced configuration” button within the parameter page.

These values have to be adjusted carefully.



The following files can be parameterized:

user_def	All listed parameters overwrite the configurations of "hardware" and "param"
hardware	Contains all parameters for hardware settings of the ANS+ modules, like ports, IP addresses of laser configurations
param	Software configuration parameters can be found here, for example for localization, mapping or feature detection
local_planner	Parameterization of the local planner is specified within this section.
global_planner	Parameterization of the global planner is specified within this section.
behavior_tree	The behavior tree specifies the main driving behaviors like following a route, following a free path, approach, halt and replan
voa_camera	Parametrization of the camera module for visual obstacle avoidance

See also

Global map parametrization (Page 111)

Feature detection (Page 73)

Movement behaviors (Page 229)

Visual Obstacle Avoidance (VOA) Module (Page 156)

11.2 Laser parameters

The laser scanner is the most important device for laser-based navigation systems. Its parametrization and configuration have an impact on many different tasks, such as localization accuracy.

The default laser parameters are adjusted to the most commonly used laser scanner for SIMOVE ANS+: SICK "microScan3" including 0.1° laser beam resolution.

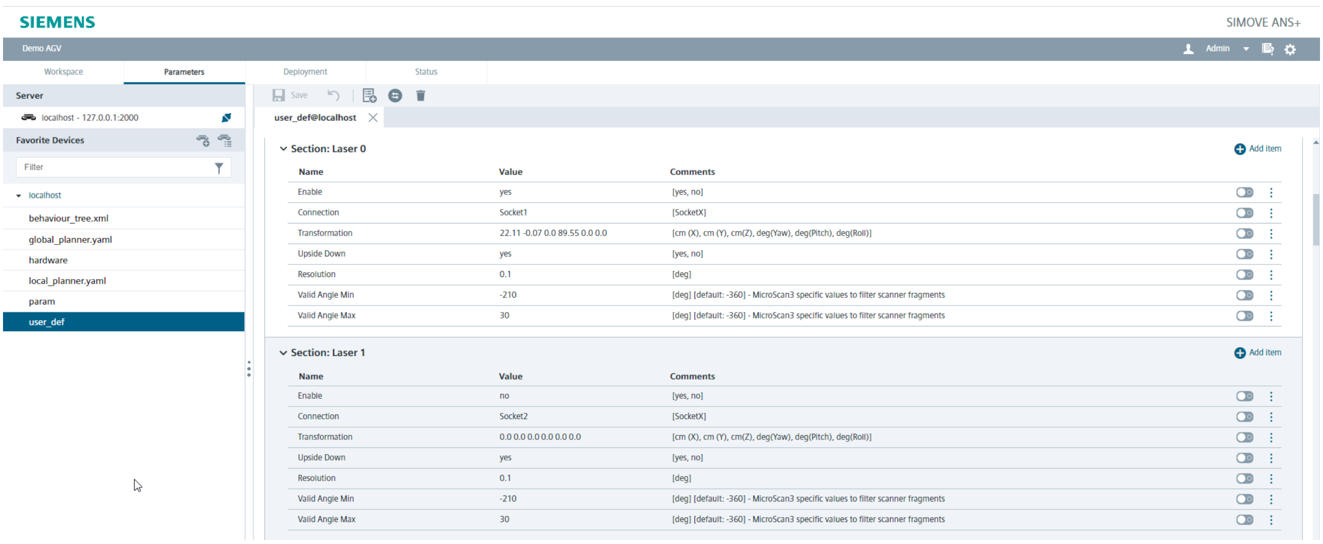
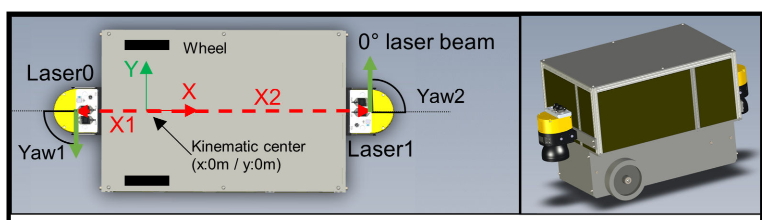


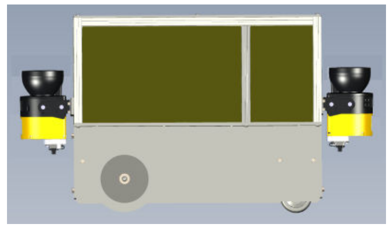
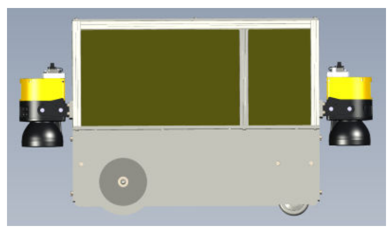
Figure 11-3 SIMOVE ANS+ "user_def" - Default laser parameters

The laser parametrization differs between all compatible scanner devices. A set of parametrization examples for different compatible scanners is provided under Map origin changes (Page 242).

The following table provides an explanation on the default laser parameters:

Table 11-1 Laser parameter explanation

Parameter name	Explanation
Transformation	Value format: X1 Y1 Z Yaw1 0.0 0.0 Unit: • Float String • X, Y, Z in [cm] • Yaw in [deg] • Space separated values Description: Transformation to kinematic center [cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)] Explanation: A transformation (TF) defines a mathematic relation between two coordinate frames. For this parameter, the configured TF specifies the distance (X1, Y1), the height (Z) and orientation (Yaw) between the related laser scanner coordinate frame and the kinematic center coordinate frame. **Note:** The value "Yaw" specifies the orientation in degree between the kinematic center +X direction and the laser 0° laser beam. The 0° laser beam can change between laser devices and is therefore described in the vendor's datasheet. A schematic overview, explaining all mentioned parameter values, is provided in the Illustration below. In the example, Y1 and Y2 are both zero, as both scanners are mounted in the centerline of the AGV.  Schematic top view of laser transformation values **Note:** The values "X","Y" and "Yaw" are automatically computed by the ANS+ NC module with the approach of automatic laser calibration for all active parametrized laser scanner devices (Page 247).

<table>
<tr><td>Upside Down</td><td colspan="2">Value format: yes / no
Unit: Boolean
Explanation: This value specifies, the mechanical mounting the related laser scanner is attached to the AGV. Both possible options are shown in the illustration.

Laser scanner mount option normal

Laser scanner mount option upside down</td></tr>
<tr><td>Resolution</td><td colspan="2">Value format: 0.1
Unit: Unsigned float in [deg]
Description: Laser angular resolution of the related laser scanner device, which needs to be synchronized with the vendor engineering tool configuration.
Note: The SICK microScan3 scanner, for example, has two resolutions depending on the ordered product: 0.1° and 0.385°</td></tr>
<tr><td rowspan="4">Valid Angle</td><td colspan="2">Value format: -360
Unit: float in [deg]
Explanation: The Valid angles can be used to restrict the field of view of the laser scanner. Therefore the laser coordinate system is used.</td></tr>
<tr><td>Valid Angle Min</td><td>The Valid Angle Min parameter can be used to set the starting point for the first laser beam to be detected.</td></tr>
<tr><td>Valid Angle Max</td><td>The Valid Angle Max parameter can be used to set the end point for the last laser beam to be detected.</td></tr>
<tr><td colspan="2">Note: If reflections from the AGV occur and the AGV therefore sees itself, the AGV can no longer drive with motion. In this case, the reflections must be parameterized using the valid angles.</td></tr>
<tr><td>Start Angle</td><td colspan="2">Value format: -47.5
Unit: float in [deg]
Description: Starting angular range which needs to be synchronized with the vendor engineering tool configuration.</td></tr>
<tr><td>End Angle</td><td colspan="2">Value format: 227.5
Unit: float in [deg]
Description: Ending angular range which needs to be synchronized with the vendor engineering tool configuration.</td></tr>
</table>

11.3 Visual Obstacle Avoidance parameters

For each connected camera of the VOA module, the most relevant parameters such as camera position and type need to be set. Especially the height levels of the camera and AGV as well as the transformation to the kinematic center must be known to give the planning algorithm correct knowledge of obstacle positions. Additionally, the section "Visual Obstacle Avoidance" needs to be enabled if any camera should be used as an input to the local costmap.

Section: Voa Camera 0

Name	Value	Comments
Requires "Visual Obstacle Avoidance" enabled		
Enable	no	[yes, no]
Serial Number	"233522070851"	"<String>" - Insert here the serial number of the related camera
Camera Height	0.3	[m] - Height on which the camera is mounted
Agv Height	1.0	[m] - Total height of the agv, max height at which obstacles are considered
Floor Distance	0.1	[m] - Min height at which obstacles are considered
Is Upside Down	no	[yes, no]
Transformation Lateral	0.414 -0.076 43.8	[m(X), m(Y), deg(Yaw)]

Figure 11-4 SIMOVE ANS+ "user_def" - Camera parameters

The following table gives an overview of the typical camera parameters and their default values.

Table 11-2 Camera parameter explanation

Parameter Name	Description
Serial Number	Value format: “123456789101” Unit: string with 12-digit number Description: Insert here the serial number (12-digits number) of the related camera. Explanation: The serial number is different for each camera and used to identify each connected camera. The 12-digit number can be found either on the bottom of the respective camera or using the Intel® RealSense™ Viewer. The serial number is different for each camera and used to identify each connected camera. The 12-digit number can be found either on the bottom of the respective camera or using the Intel® RealSense™ Viewer.  Position of the 12-digit serial number on a label of the bottom of the camera
Camera Height	Value format: 0.3 Unit: double in [m] Description: Height on which the camera is mounted. Explanation: Distance between camera and floor. This value is used to compute the minimum and maximum height levels at which the camera will later consider obstacles as relevant for the AGV and plans around them.

<table>
<tr><td>AGV Height</td><td>Value format: 1.0
Unit: double in [m]
Description: Total height of the AGV, maximal height at which obstacles are considered.
Explanation: Distance between top of the AGV and floor. Obstacles above this height level are ignored by the VOA module. It is recommended to make this value a few cm higher than the actual AGV height.</td></tr>
<tr><td>Floor Distance</td><td>Value format: 0.05
Unit: double in [m]
Description: Minimun height at which obstacles are considered.
Explanation: Minimum height level at which VOA considers obstacles. In case of uneven or reflective floors, increase the floor distance a few cm.</td></tr>
<tr><td>Is upside down</td><td>Value format: yes / no
Unit: Boolean
Explanation: Transforms the coordinates in case the camera is mounted upside down. The Is upside down equals false position is shown in the figures below in the transformation lateral row.</td></tr>
<tr><td>Transformation Lateral</td><td>Value format: 0.3 0.6 45
Unit: Double [m(X) m(Y) deg(Yaw)]
Description: Position of the camera relatively to the kinematic center.
Explanation: Set the position of each camera with respect to the AGVs kinematic center. Values are given in x, y, and angle, with a front-facing camera having an angle of zero.
Note: For cameras, the zero angle is defined differently than for laser scanners. X and Y are defined the same as for laser scanners. The origin of the camera’s depth coordinate system is depicted in the figure below.

Origin of the cameras coordinate system for an Intel RealSense d435 camera.

Origin of the cameras coordinate system for an Intel RealSense d456 camera.</td></tr>
</table>

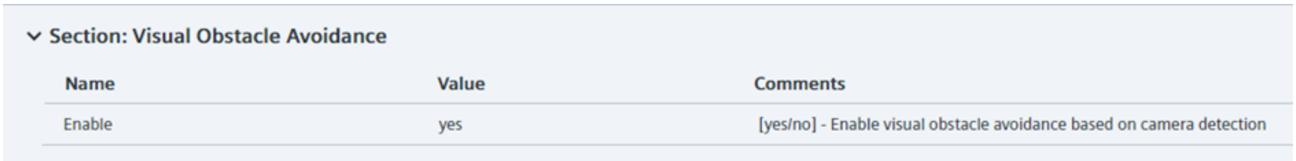


Figure 11-5 SIMOVE ANS+ "user_def" - Enable VOA module

Table 11-3 Visual Obstacle Avoidance parameter explanation

Enable	Value format: yes / no Unit: Boolean Description: Enable visual obstacle avoidance based on camera detection. Explanation: If this value is true, all enabled cameras are used as an additional input into the local costmap. Obstacles within the current field of view of the respective cameras are used for obstacle avoidance and path planning. **Note:** Visual obstacle avoidance only processes obstacles if motion is enabled as well. If motion is disabled, the local costmap is ignored and the AGV will not stop in front of obstacles detected by Visual Obstacle Avoidance.

11.4 Feature parameters

As all other parameters, the feature parameters have their own default values. Those values can be considered as a general guideline, but for each project, it is required to fine-tune them. The concept behind feature recognition is described in the chapter Feature detection (Page 73).

Each feature has its own subset of parameters. The “user_def” file provides all feature parameter sections and their main parameters:

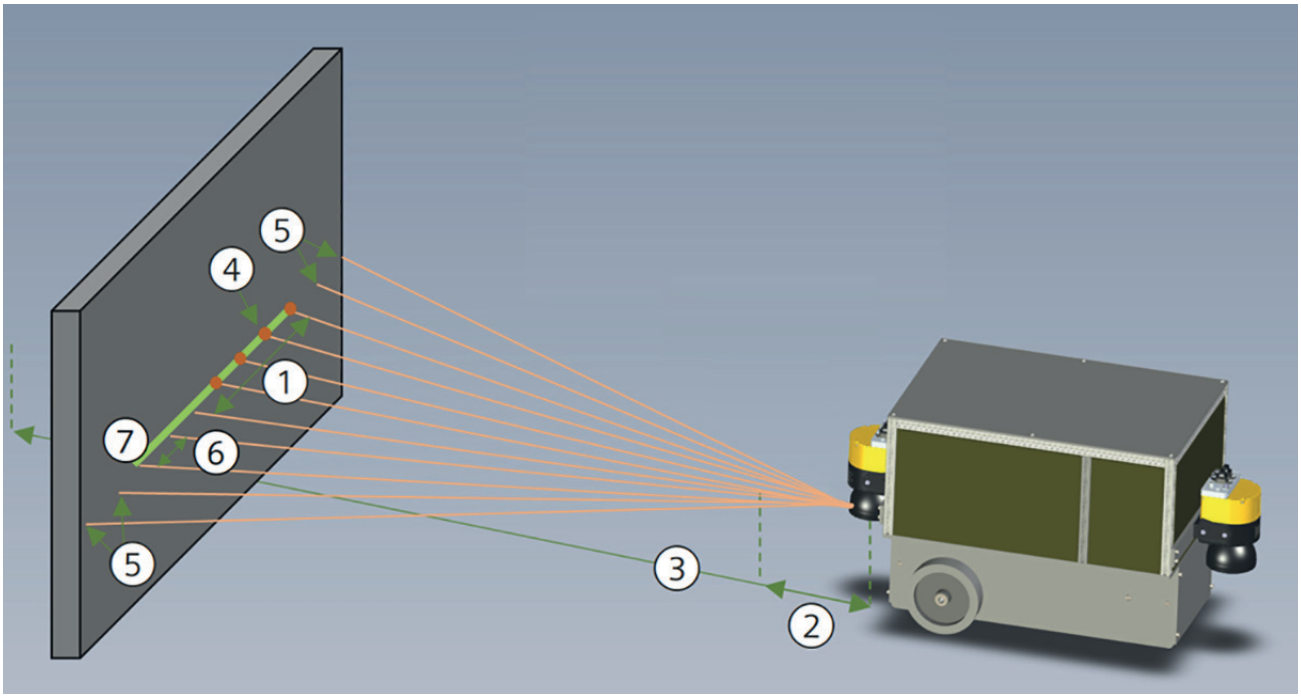
- Kalman Polar Lines
- Kalman Corners
- Kalman Cylinders
- Kalman Reflectors
- Kalman LineMidPoints

11.4.1 Kalman Polar Lines

This table lists all main parameters of the section “Kalman Polar Lines”.

Parameter name	Description
Enable Polar Lines	Value format: yes / no Unit: Boolean Description: Standard line feature detection Explanation: This value enables the polar line feature recognition. **Note**: As polar lines represent the main feature, this value should always be activated.
MinSegLen25D	Value format: 100 Unit: Unsigned Int in [cm] Description: Minimum length of features Note: The minimum length should not be set to less then 50 cm. Explanation: Specifies the shortest length of polar line features. Features below this value are ignored. The allowed minimum of this value is 50 cm. **Note**: This value should always be set to the shortest line feature in the environment. For example, if an environment provides I-Beams of 80 cm and more, the value should be set to 80.
ScanMinRangeCm	Value format: 50.0 Unit: Unsigned Float in [cm] Description: Minimum range filter for all lasers Explanation: The minimal allowed distance between all feature types and laser devices. If a feature is closer to a laser device than the parametrized minimum distance, it is ignored.
ScanMaxRangeCm	Value format: 2000.0 Unit: Unsigned Float in [cm] Description: Maximum range filter for all lasers Explanation: The maximum allowed distance between all feature types and laser devices. If a feature is far off the parametrized distance, it is ignored.

MinPtsInPlane25D	Value format: 10 Unit: Unsigned Int Description: Minimum points on a line for feature detection Explanation: Defines the minimum number of points that are necessary to create line features. If a physical landmark is noticed with less laser points, it is not detected as a polar line feature. **Note**: This value is depended on the laser beam resolution. The lower the resolution is, the higher this value can be parametrized to avoid unnecessary mapping fragments.
SpuriousMaxSize25D	Value format: 1 Unit: Unsigned Int Explanation: Due to laser data noise or fragments, polar line features can be created as a skew line. This parameter specifies the number of laser points, that are filtered at the beginning and end of a polar line feature to avoid this effect.
MaxGap25D	Value format: 10.0 Unit: Unsigned Float in [cm] Description: Maximum allowed distance between laser points for one feature association Explanation: The maximum allowed distance between two laser points for polar line feature expansion. If a polar line is recognized and created, it is expanded for every laser point that is lower than the parametrized gap distance. If a laser point exceeds this limit, the feature expansion is stopped, and a new feature is created in consideration of all other parameters. **Note**: The most common range for this parameter is 7 to 15 cm.
Laser Id 2D	Value format: 0 0 Unit: [<LaserId 0,1,2,3> <LevelId 0>] Description: Insert here the LaserID to use one or multiple specific laser(s) for general localization tasks. Explanation: If only certain laser scanners should be used for localization, they can be selected here. If the parameter is commented out, all scanners that are enabled are automatically used.



① MinSegLen25D
② ScanMinRangeCm
③ ScanMaxRangeCm
④ MinPtsInPlane25D
⑤ SpuriousMaxSize25D
⑥ MaxGap25D
⑦ Line feature

Figure 11-6 "Kalman Polar Lines" feature parameters

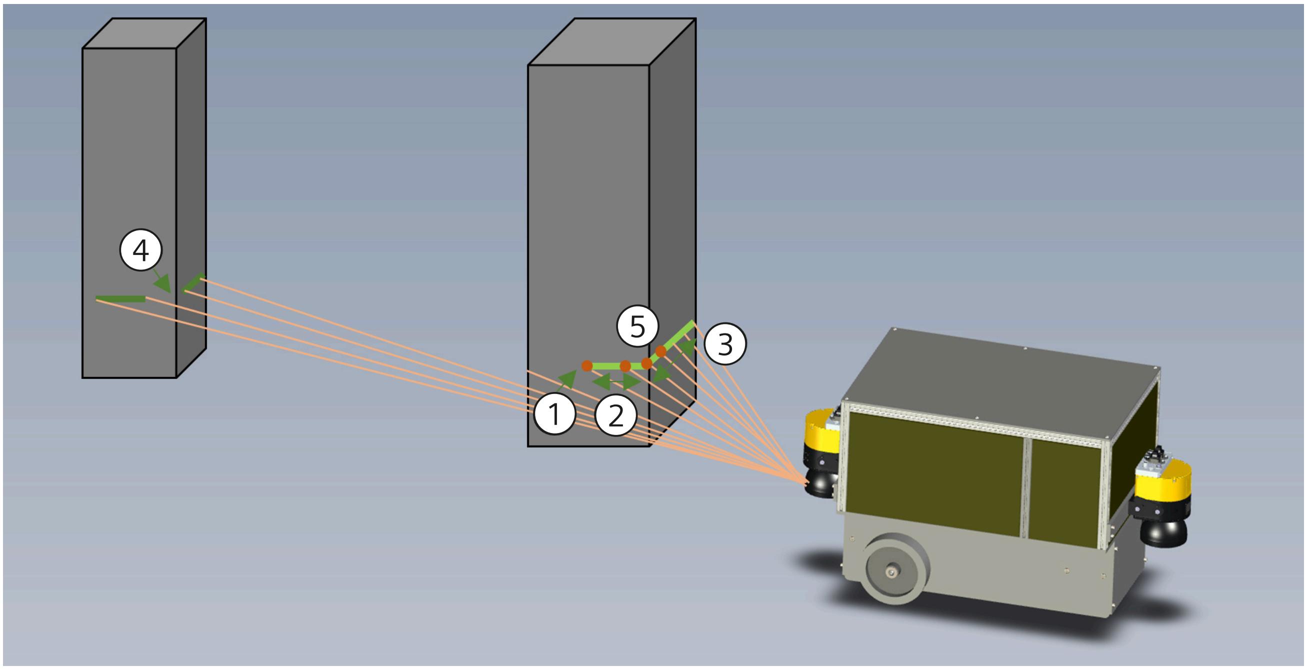
11.4.2 Kalman Corners

The following table lists all main parameters of the section "Kalman Corners".

Parameter name	Description
Enable	Value format: yes / no Unit: Boolean Description: Standard corner feature detection Explanation: This value enables the corner feature recognition.
Min Point Size	Value format: 6 Unit: Int Description: Minimal amount of points on each of the two corner lines Explanation: The minimal required number of laser points on two corner lines. If a physical corner landmark is noticed with less laser points, it is not detected as a feature. **Note:** This value depends on the laser beam resolution. The lower the resolution is, the higher this value can be parametrized to avoid unnecessary mapping fragments.

Min Seg Len	Value format: 10.0 Unit: in [cm] Description: Minimal length of both corner lines Explanation: This parameter specifies the minimal length of both corner lines. Features below this value are ignored. The allowed minimum of this value is 10 cm.
Min Side Len	Value format: 15 Unit: in [cm] Description: Minimal length of one corner line Explanation: This parameter specifies the minimal length of a single corner line. If one corner line is shorter than this value, the feature is ignored. The allowed minimum of this value is 10 cm. **Note:** For square-shaped corner landmarks, such as 10x10 cm pillars, the parameters “Min Seg Len” and “Min Side Len” need to be equal.
Max Corner Gap	Value format: 5 Unit: in [cm] Description: Allowed gap between the corner laser points Explanation: The maximum allowed gap distance between both corner lines related to the crossing point. If a corner line distance exceeds the parametrization, the corner feature is ignored.
Corner	Value: 90 10 Unit: in [deg,deg] Description: Accepted free space angles: 90 (free_space_angle) +- 10 (tolerance) Explanation: Corner features are created out of two lines. The parameter “corner” specifies the accepted angle that will be used for corner feature detection (including tolerance). The free space angle specifies the free visible angle that is detected by the laser scanner. As an example, 90° angles +-10° will be detected.

In general, a corner is created out of two small polar line features and is therefore mostly used to detect small hall columns.



① Min Point Size
② Min Seg Len
③ Min Side Len
④ Max Corner Gap
⑤ Corner

Figure 11-7 “Kalman Corners” feature parameters

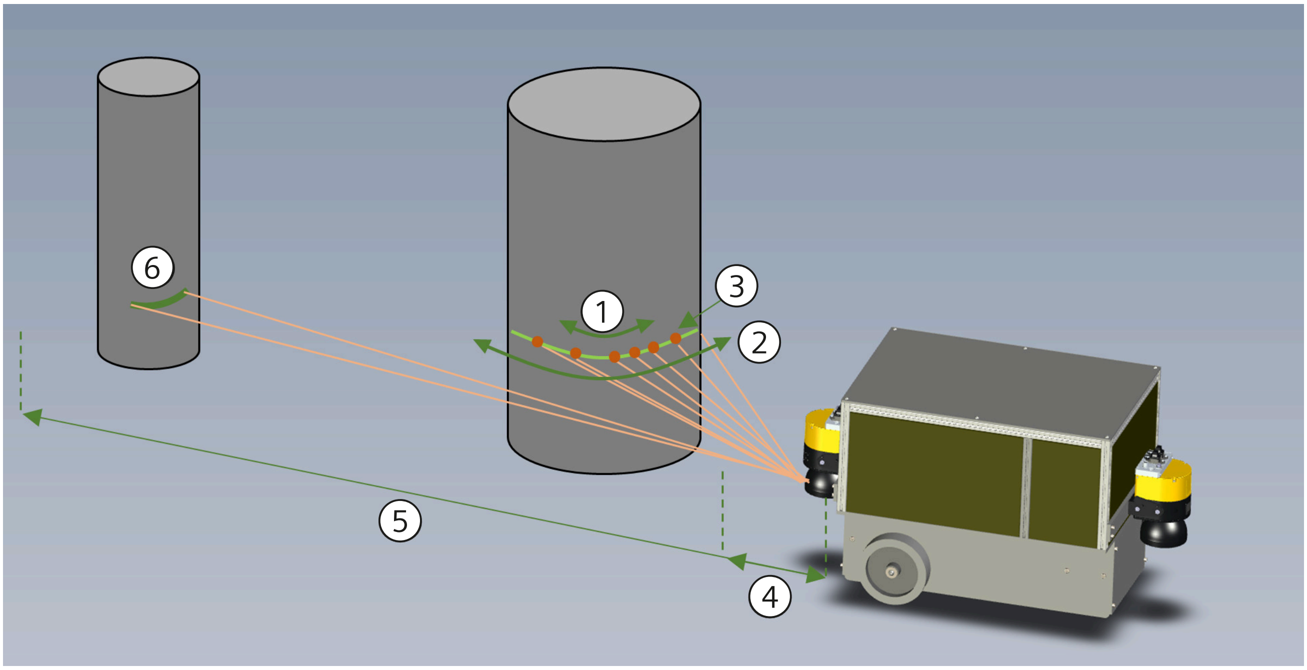
11.4.3 Kalman Cylinders

For all cylindric features and their detection, it is required to see at least 80% of the half-circle within one laser data measurement. This specification is required to differentiate between different small features in great distances, for example < 10 meters.

The following table lists all main parameters of the section “Kalman Cylinders”.

Parameter name	Description
Enable	Value format: yes / no Unit: Boolean Description: Standard circle feature detection Explanation: This value enables the corner feature recognition. Notice: For all cylindric features and their detection, it is required to see at least 80% of the half-circle within one laser data measurement.
Min Diameter	Value format: 10.0 Unit: Unsigned Float in [cm] Description: Minimum diameter of the cylinder feature Explanation: The minimal allowed diameter of cylindric landmarks to be recognized as a feature. The allowed minimum of the value is 10 cm. Features below this parametrized value are ignored.

Max Diameter	Value format: 40.0 Unit: Unsigned Float in [cm] Description: Maximum diameter of the cylinder feature Explanation: The maximal allowed diameter of cylindric landmarks to be recognized as a feature. Features above this parametrized value are ignored.
Point Min	Value format: 10 Unit: Unsigned Int Description: Amount of points on the diameter required for feature detection Explanation: The minimal required number of laser points on a cylindric feature. If a physical cylindric landmark is noticed with less laser points, it is not detected as a feature. **Note**: This value depends on the laser beam resolution. The lower the resolution is, the higher this value can be parametrized to avoid unnecessary mapping fragments.
Min Range	Value format: *2*0.0 Unit: Unsigned Float in [cm] Description: Minimal cylinder detection distance under consideration of appropriate scan frame Explanation: The minimal allowed distance between cylindric features and laser devices. If a feature is closer to a laser device than the parametrized minimum distance, it is ignored.
Max Range	Value format: 1000.0 Unit: Unsigned Float in [cm] Description: Maximum cylinder detection distance under consideration of appropriate scan frame Explanation: The maximum allowed distance between cylindric features and laser devices. If a feature is above the parametrized distance in relation to laser scanner devices, it is ignored.
Max Gap	Value format: 7.0 Unit: Unsigned Float in [cm] Description: Maximum allowed distance between laser points on a cylinder Explanation: The maximum allowed distance between two laser points for a cylindric feature point interpolation. If a laser point exceeds this limit, the feature interpolation is stopped, and all following laser points are not considered for the final feature creation. **Note**: The most common range for this parameter is 5 to 10 cm.



① Min Diameter
② Max Diameter
③ Point Min
④ Min Range
⑤ Max Range
⑥ Max Gap

Figure 11-8 "Kalman Cylinders" section parameters

11.4.4 Kalman Reflectors

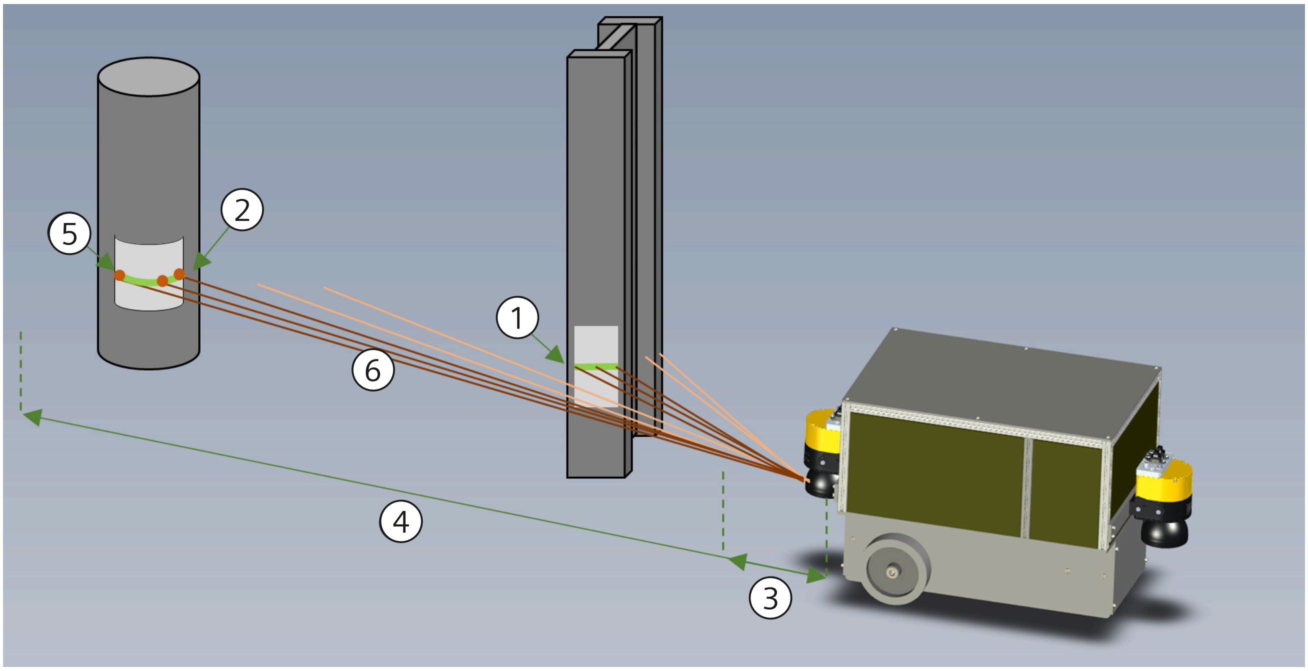
In case of reflective materials, scanner devices label laser beams as reflective beams by themselves. This information is used in SIMOVE ANS+ to differentiate between normal and reflective features. Reflectors can be used within dynamic environments to stabilize localization or to mark small objects, such as T- or I-beam hall pillars, for feature detection.

The following table lists all main parameters of the section “Kalman Reflectors”.

Parameter name	Description
Enable	Value format: yes / no Unit: Boolean Description: Activate reflector detection | Independent from polar lines Explanation: This value enables the reflector feature recognition.

Reflector	Value format: Mode Diameter Uncertainty – for example.: Pillar 10.0 2.0 Unit: • String expression • Mode Enum [Auto, Wall, Pillar] • Diameter & Uncertainty Float in [cm] • Space separated values Explanation: Each type of reflector in the environment needs to be specified with its own parameter set and its related three values. A reflector is only created if the detected width/diameter is within the given tolerance range: **-Uncertainty ≤ Diameter ≤ +Uncertainty** **WARNING** It is not allowed to overlap the width/diameter tolerance range for different reflector parameters. **Note**: It is recommended to use only one type of reflectors with a unique dimension in the same application. The uncertainty is required to specify a valid range for reflector features, as reflective beams are only set by laser devices within specific distance and angle.
Point Min	Value format: 10 Unit: Unsigned Int Description: Minimal amount of points on the diameter required for feature detection Explanation: The minimal required number of laser points on a reflector feature. If a physical reflective landmark is noticed with less laser points, it is not detected as a feature. **Note**: This value depends on the laser beam resolution. The lower the resolution is, the higher this value can be parametrized to avoid unnecessary mapping fragments.
Min Range	Value format: 20.0 Unit: Unsigned Float in [cm] Description: Minimal cylinder detection distance under consideration of appropriate scan frame Explanation: The minimal allowed distance between reflector features and laser devices. If a feature is closer to a laser device than the parametrized minimum distance, it is ignored.
Max Range	Value format: 1000.0 Unit: Unsigned Float in [cm] Description: Maximum cylinder detection distance under consideration of appropriate scan frame Explanation: The maximum allowed distance between reflector features and laser devices. If a feature is above the parametrized distance in relation to laser scanner devices, it is ignored.

The following illustration visualizes the parameters in an exemplary schematic picture.



① Reflector type: Wall reflector
② Reflector type: Cylindric reflector
③ Min Range
④ Max Range
⑤ Point Min
⑥ Reflective beam

Figure 11-9 “Kalman Reflectors” feature parameters

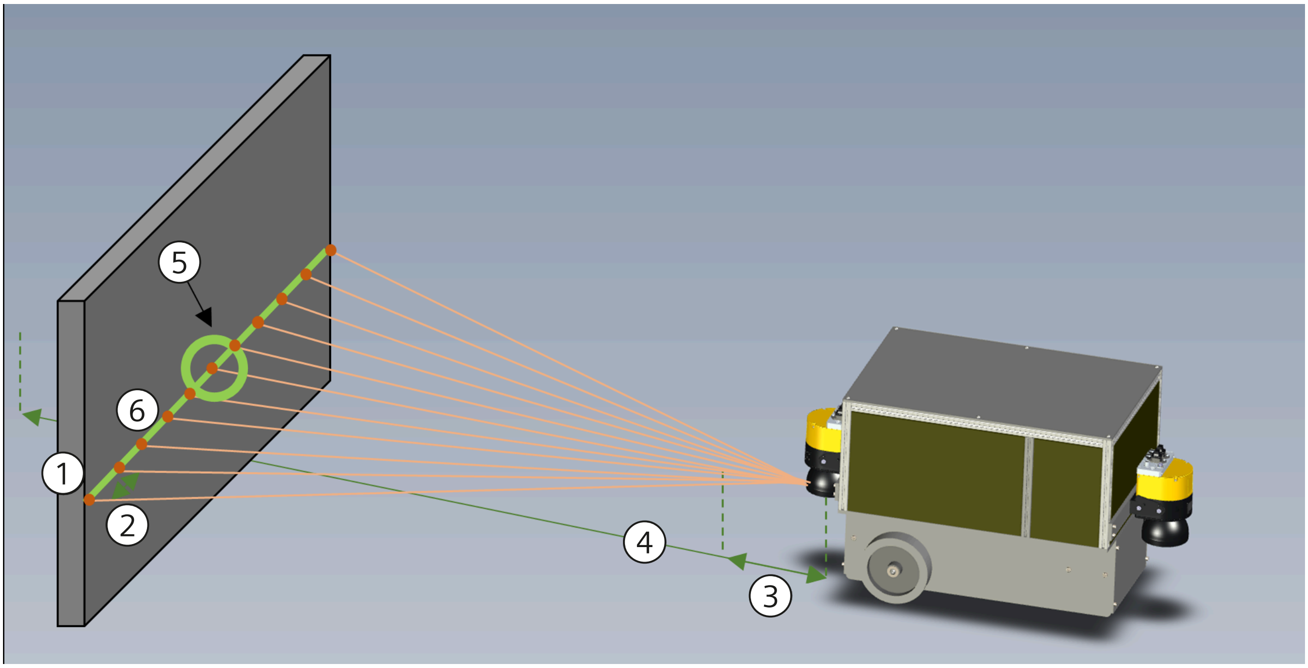
11.4.5 Kalman LineMidPoints

The following table lists all main parameters of the section “Kalman LineMidPoints”.

Parameter name	Description
Enable	Value format: yes / no Unit: Boolean Explanation: This value enables the line middle point feature recognition.

Segment	Value format: Length Uncertainty MinPoints – for example: 100 5 10 Unit: • String expression [Length, Uncertainty, MinPoints] • Length & Uncertainty Float in [cm] • MinPoints Unsigned Integer • Space separated values Explanation: Each type of segment in the environment needs to be specified with its own parameter set and its related three values. A segment is only created if the detected length is within the given tolerance range: **-Uncertainty ≤ Length ≤ +Uncertainty** **WARNING** It is not allowed to overlap the length tolerance range for different reflector segments. **Note**: The number of different segments for one project needs to be reduced to a minimum.
MaxGap25D	Value format: 5.0 Unit: Unsigned Float in [cm] Explanation: The maximum allowed distance between two laser points for line feature expansion. If a line is recognized and created, it is expanded for every laser point that is lower than the parametrized gap distance. If a laser point exceeds this limit, the feature expansion is stopped, and a new feature is created in consideration of all other parameters. For line middle points, this value needs to be adjusted, so that the entire segment length is detected without any interruption. **Note**: The most common range for this parameter is 7 to 15 cm.
Min Range	Value format: 10.0 Unit: Unsigned Float in [cm] Explanation: The minimal allowed distance between line middle point features and laser devices. If a feature is closer to a laser device than the parametrized minimum distance, it is ignored.
Max Range	Value format: 1000.0 Unit: Unsigned Float in [cm] Explanation: The maximum allowed distance between line middle point features and laser devices. If a feature is above the parametrized distance in relation to laser scanner devices, it is ignored.

The following illustration visualizes the parameters in an exemplary schematic picture. A line middle points feature is created in the middle of a fixed specified line feature (segment). With this information, an additional orientation value is created for the localization. This feature is mainly used for station approaches.



① Segment type
② MaxGap25D
③ Min Range
④ Max Range
⑤ Segment
⑥ LineMidPoint feature

Figure 11-10 “Kalman LineMidPoints” feature parameters

11.5 Navigation parameters

Within the SIMOVE system architecture, the ANS+ system commands the AGV along a virtual path or along a planned path. A hybrid behavior is used here. With active motion, the velocity vectors of the AGV are calculated directly in ANS+ and transferred to the carrier control.

In the case of holonomic driving behavior and spot rotation VTS is still used, where motion control takes place in the PLC. ANS+ automatically decides which behavior should be used for the respective application.

Nevertheless, the navigation parameters specify default guidelines for an AGV regarding the kind of movement behavior in which an engineered / planned path has to be followed.

Those behaviors can also be overwritten by Carrier Control program during runtime.

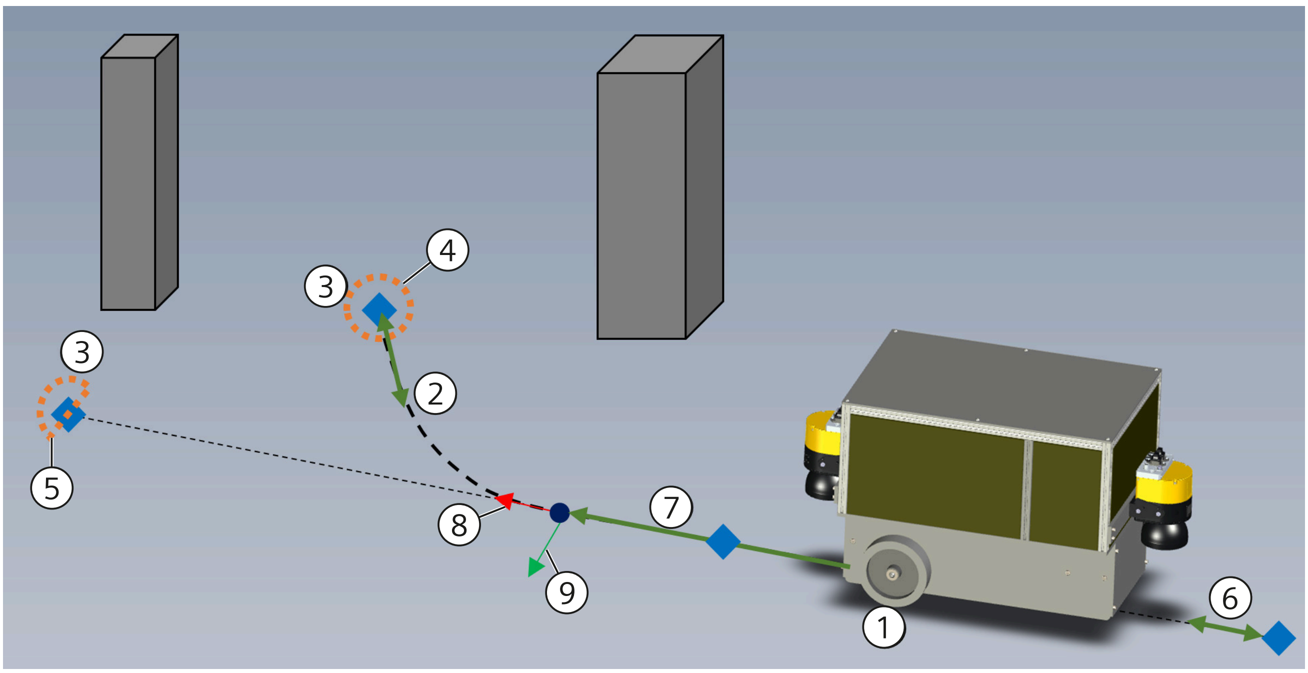
The following table lists all main navigation parameters of different parameter sections.

Parameter name	Description
Kinematics	Value format: Differential Unit: String Enum [Differential, TriCycle, Mecanum] Description: When holonomic movement "Mecanum" must be set Explanation: The general kinematic of the related AGV. The value “Mecanum” is representative for any other holonomic kinematic.
Orientation Mode	Value format: TimeOptimal Unit: String Enum [KeepForward, TimeOptimal] Description: Enables automatic fwd & bwd movement detection Explanation: This parameter specifies the default movement behavior of a commanded order. “KeepForward” forces the ANS+ to command an AGV in +X direction along a virtual path. For “TimeOptimal”, the ANS+ system is allowed to calculate and decide for the fastest movement direction (forward, backward) in relation to the commanded order.
Global Frame Id	Value format: “YourMapName.map” Unit: String format [“<MapName>.map”] Description: Global map frame; Required for ident point commands "Orientation" & "Global edge orientation" Explanation: While SIMOVE ANS+ is capable of handling multiple maps during runtime, an overlayed system is not aware of those map changes. Therefore, each project requires defining one map as the main or global map for the entire data content. All values that are received by ANS+ are calculated towards this parametrized main map origin.
Start Pose Area Dis	Value format: 3.5 Unit: Unsigned Float in [m] Description: Valid start pose distance with respect to nominal path, if <0 MaxPosUnc is taken Explanation: This parameter defines a tunnel around the respective edge within which the AGV must be located for an order to be accepted. If the AGV is not within the specified area, the order will be rejected.

Odometry Ist Range	Value format: 25.0 Unit: Unsigned Float in [cm] Description: By x cm in front of the goal, only wheel odometry data will be used Explanation: In consideration of the parametrized distance, the ANS+ system suppresses localization updates in front of the last commanded ident point. If the localization is ignored, the motion of the AGV is controlled based on wheel odometry data. This feature can be used to avoid movement failures due to localization jumps for aim approaches.
Target Radius	Value format: 1.0 Unit: Unsigned Float in [cm] Description: Radius around each destination ident point to reach goal Explanation: Specifies the size of the snap radius around commanded ident points. If an AGV is in this tolerance, an ident point is evaluated as "reached" and a notification is sent to the Carrier Control system. **Note**: The SIMOVE ANS+ target values always relate to the ident point's center position independent of the parametrized value.
Target Mode	Value format: Circle Unit: String Enum [Circle, HalfCircle] Description: Defines the area of "point reached" around an ident point Explanation: Similarly to the parameter "Target Radius", this parameter specifies the shape of the snap radius for ident point notifications. The value "HalfCircle" allows the system to try to reach a final commanded ident point's pose in the most precise way for X positioning. **Note**: By using "HalfCircle", a minimal VS ("Virtual speed") velocity may be required in the Carrier Control system to avoid minimalistic and time demanding positioning approaches.
Target Dis	Value format: 100.0 Unit: Unsigned Float in [cm] Description: Used for VTS. Distance between target and kinematic center for path regulation. A higher value ensures straighter driving behavior but shortens cornering. Explanation: Defines the distance between the kinematic center and commanded ANS+ target along a virtual path. When reducing the target distance, it is necessary to reduce the velocity of the AGV proportionally to guarantee stable movements. **Note**: The target distance can be commanded dynamically from the Carrier Control system. In this case, the transferred value overwrites this parameter.
Odometry Start Dis	Value format: 20.0 Unit: Unsigned Float in [cm] Description: For x cm after starting from source ident point, only odometry data will be used. Explanation: Starting from an initial ident point after standstill, the SIMOVE ANS+ system suppresses localization updates within the parametrized distance. If the localization is ignored, the motion of the AGV is controlled based on odometry data. This feature can be used to avoid localization jumps and therefore movement failures in narrow areas, such as stations.

Rot Only Max Omega	Value Format: 25.0 Unit: Unsigned Float in [deg/s^2] Description: Maximum angular velocity for spot rotations
Rot Only Dec Omega	Value Format: 25.0 Unit: Unsigned Float in [deg/s] Description: Maximum deceleration velocity for spot rotations

The following illustration visualizes most of the parameters in an exemplary schematic picture.



① Kinematics
② Odometry Ist Range
③ Target Radius
④ Target mode "Circle"
⑤ Target mode "Half circle"
⑥ Odometry Start Dis
⑦ Target Dis
⑧ Target +X
⑨ Target +Y

Figure 11-11 General navigation parameters

11.6 Localization parameters

The main localization parameters need to be reviewed and adjusted for each AGV type, as AGVs are complex systems in which each included technology, such as mechanic, drives, and laser, has its own tolerances and failures. With the explained localization parameters, the ANS+ system is fine-tuned to avoid failures, such as a systematic failure. A systematic failure is understood to be the deviation of a measured value from its true value.

Localization parameters define in which weighting factor incoming data from laser devices and Carrier Control system is interpreted. This parametrization has a great impact on the localization behavior and tolerance of compensating incoming underlying data failures.

Parameter name	Description
Localization Source	Value format: Laser Unit: String Enum [Laser, Epi] Explanation: With this parameter, the localization type can be switched between the default laser-based localization of ANS+ or an external pose, received over the “External Pose Interface” (EPI). For further information regarding the EPI, refer to chapter External Pose Interface (Page 240). **WARNING** Before changing the value to “Epi”, the external pose needs to be evaluated regarding, for example, localization jumps, map dimensions, localization offsets. It is only recommended to change this value if the SIMOVE ANS+ and the external system have an aligned coordinate frame and the same dimension interpretation of the environment.
Default Type	Value format: OdoLaser Unit: String Enum [OdoWheel, OdoLaser] Description: Used odometry type for navigation Explanation: With this parameter, the default odometry type is specified. The related input model is used for sensor fusion within laser-based localization. If set to “OdoWheel”, the received data of the PLC system is directly used for localization sensor fusion. If set to “OdoLaser”, the laser beams and the wheel odometry will be used together for localization. It is recommended to use odo laser, when the wheel odometry has errors (due to slippage, encoder noise, etc.) **Note:** For wheel odometry tests, the value needs to be set to “OdoWheel”.
Min Pos Error	Value format: 0.005 Unit: Unsigned Float in [m] Explanation: With this parameter, a systematic failure is assumed for the AGV position.
Min Rot Error	Value format: 0.2 Unit: Unsigned Float in [deg] Explanation: With this parameter, a systematic failure is assumed for the AGV orientation.
Rot Error	Value format: 20.0 Unit: Unsigned Float in [%] Explanation: Specifies the weighting factor between incoming odometry and laser-based orientation values. The higher the value is, the more the system relies on laser-based values.

Slip Error	Value format: 10.0 Unit: Unsigned Float in [%] Explanation: Specifies the weighting factor between incoming odometry and laser-based position values. The higher the value is, the more the system relies on laser-based values.
Start Pos Unc	Value format: -1 Unit: Unsigned Float in [m] Explanation: Tolerated localization uncertainty in X and Y for starting or reinitializing localization pose functions, for example, via PLC or ANS+ ET "setPose". If the localization is shifted too much due to feature mismatches, this parameter can, for example, be set to 0.1 m to reduce the allowed uncertainty. The special value "-1" sets the tolerance to 0.5 x "Max Pos Unc". **WARNING** If this parameter is reduced, the AGV has to be positioned exactly on the specified setup pose within the parametrized tolerance. Otherwise, localization offsets might not be compensated.
Start Rot Unc	Value format: -1 Unit: Unsigned Float in [deg] Explanation: Tolerated localization uncertainty in rotation for starting or reinitializing localization pose functions, for example, via PLC or ANS+ ET "setPose". If the localization is shifted too much due to feature mismatches, this parameter can, for example, be set to 1° to reduce the allowed uncertainty. The special value "-1" sets the tolerance to 0.5 x "Max Rot Unc". **WARNING** If this parameter is reduced, the AGV has to be positioned exactly on the specified setup pose within the parametrized tolerance. Otherwise, localization offsets might not be compensated.
Max Pos Unc	Value format: 1.0 Unit: Unsigned Float in [m] Explanation: Maximum allowed localization uncertainty error in translation. If the uncertainty exceeds the limit, the SIMOVE ANS+ failure "Loc lost" (0x2791) occurs.
Max Rot Unc	Value format: 10.0 Unit: Unsigned Float in [deg] Explanation: Maximum allowed localization uncertainty error in orientation. If the uncertainty exceeds the limit, the SIMOVE ANS+ failure "Loc lost" (0x2791) occurs.
Restore Loc Pose Enable	Value format: yes Enables automatic localization initialization after reboot.

See also

Holonomic movement (Page 233)

11.7 Motion parameters

The main motion parameters need to be reviewed and adjusted for each AGV type.

In order to use the planner functionality, a gridmap needs to be recorded in advance.

Also, the section "Motion AGV" needs to be enabled.

Note

Motion should be only activated, when the AGV has a 360-degree scanner field.

Parameter name	Description
Laser Id 2D	Value format: 0,1,2,3 Unit: enum [0,1,2,3] Description: Insert here the LaserID to use a specific laser for obstacle avoidance Explanation: Activate laser scanners for obstacle avoidance. Each laser that should be used for obstacle avoidance has to be specified here. If not specified, all lasers will be used.
Map File Path	Value format: "../atlas/NbgShowroom.yaml" Unit: string [path/filename.yaml] Description: Related yaml-map file used for global and local planner Explanation: Refers to the related yaml-map file that should be used for the global and local planner. Within this file, the global grid map is being stored.
Minimum Turning Radius	Value format: 0.3 Unit: in [m] The value specifies the minimal turning radius for global planned trajectories. It should be greater than "Min Curve Radius" at "Motion Flow Kraken Controller".
Tunnel Width	Value format: 1000 Unit: in [cm] Defines the orthogonal maximum allowed distance around a path, that the vehicle is allowed to drive (e.g. to avoid obstacles).
Approach Length	Value format: 100 Unit: in [cm] Automatically considered straight distance for planned paths in front of a goal
Min Curve Radius	Value format: 0.2 Unit: in [m] Minimal curve radius of the AGV used for alternative trajectory calculation
Longitudinal Distance	Value format: 0.2 Unit: in [m] Distance of alternative trajectories in +X-direction. Can be applied several times.
Sync Lateral Distances	Value format: 0.2 Unit: in [m] Alternative trajectory distance related to Y-direction. Can be applied several times.
V Max	Value format: 0.5 Unit: in [m/s] Max. forward speed which can still be driven even in rotation

Parameter name	Description
A Max	Value format: 0.3 Unit: in [m/s^2] Max. forward acceleration which can still be reached in rotation
A Max Decel	Value format: 0.5 Unit: in [m/s^2] Max. brake acceleration which can still be reached in rotation
Omega Max	Value format 35.0 Unit: in [deg/s] Max. rotation velocity which can still be reached with additional forward velocity
A Omega Max	Value format: 45.0 Unit: in [deg/s^2] Max. rotation acceleration which can still be reached with additional forward velocity
A centripetal Max	Value format 0.05 Unit:[0.01 ... 1] Automatic speed reduction within curves. A higher value increases the speed of the AGV within a curve. $v_{\max} = \sqrt{a_{\text{zentripetalmax}} r}.$ **Note**: The curve radius appears under the square root. This means that the vehicle will quickly decrease with more sharp curves.
Footprint Padding Local	Value format: 10 Unit: in [m] Description: Extended local footprint, <0: common footprint is taken Explanation: If activated, global and local planner yaml-file parametrization is overwritten. Extended local footprint If value < 0: common footprint is taken.
Footprint Padding Global	Value format: 20 Unit: in [m] Description: Extended global footprint, <0: twice of common footprint is taken Explanation: Extended global footprint; If activated, global and local planner yaml-file parametrization is overwritten. Extended local footprint If value < 0: twice of common footprint is taken.
Motion Combined Costmap – Width Local	Value format: 9 Unit: in [m] If activated, global and local planner yaml-file parametrization is overwritten. This value specifies the width of the local view of local planner in a square format.
V Max Goal Approach Scale	Value format: 0.5 Unit: [0.0 ... 1.0] Defines the maximum speed of the AGV during the goal approach phase, relative to V Max. This value should not be increased above 0.8 to ensure accurate positioning accuracy.

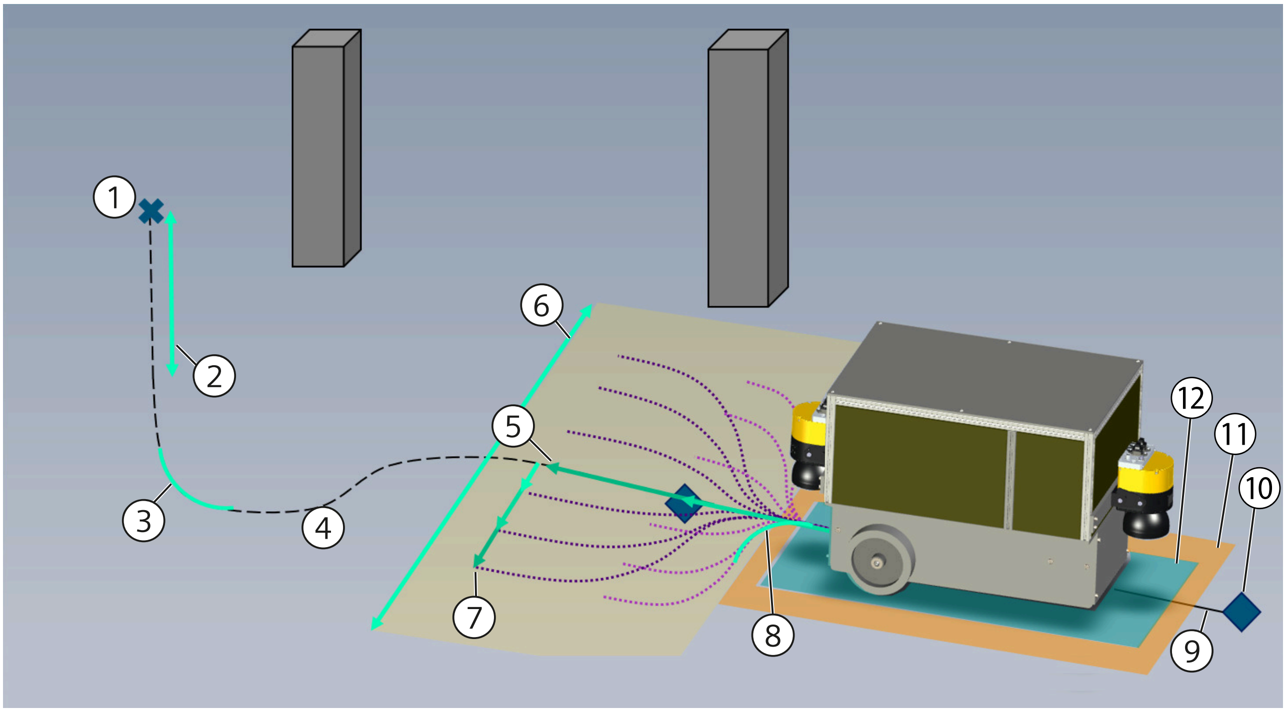
Parameter name	Description
A Max Goal Approach Scale	Value format: 0.5 Unit: [0.0 ... 1.0] Defines the maximum deceleration factor of the AGV during the goal approach phase, relative to A Max Decel. This value should not be increased to ensure accurate positioning accuracy.
Corridor Left	Value format: 500 Unit: [cm] Description: Maximum allowed distance to the left around a path to avoid obstacles Explanation: This parameter defines a corridor, in which the AGV is allowed to drive.
Corridor Right	Value format: 500 Unit: [cm] Description: Maximum allowed distance to the right around a path to avoid obstacles Explanation: This parameter defines a corridor, in which the AGV is allowed to drive.

Note

The value for the Minimum Turning Radius should be chosen greater than "Min Curve Radius" at the section "Motion Flow Kraken Controller", because the global setting needs to be greater than the local setting.

Within the section "Motion Flow Kraken Controller" the alternative trajectories, that are used for the free path planning, can be configured. The longitudinal distances specify all alternative trajectories in X-direction relative to the global or virtual path, as shown in the figure below. The Lateral Distances are specifying all lateral trajectory distances within Y-direction.

The following illustration visualizes most of the parameters in an exemplary schematic picture.



①	Command goal	⑦	Parameters "Sync Lateral Distances"
②	Parameter "Approach length"	⑧	Parameter "Min Curve Radius"
③	Parameter "Minimum Tuning Radius	⑨	Virtual track
④	Global planned trajectory	⑩	Ident point
⑤	Parameter "Longitudinal Distance"	⑪	Footprint Padding Local
⑥	Parameter "Tunnel Width"	⑫	AGV bounding box (outline)

Figure 11-12 General motion parameters

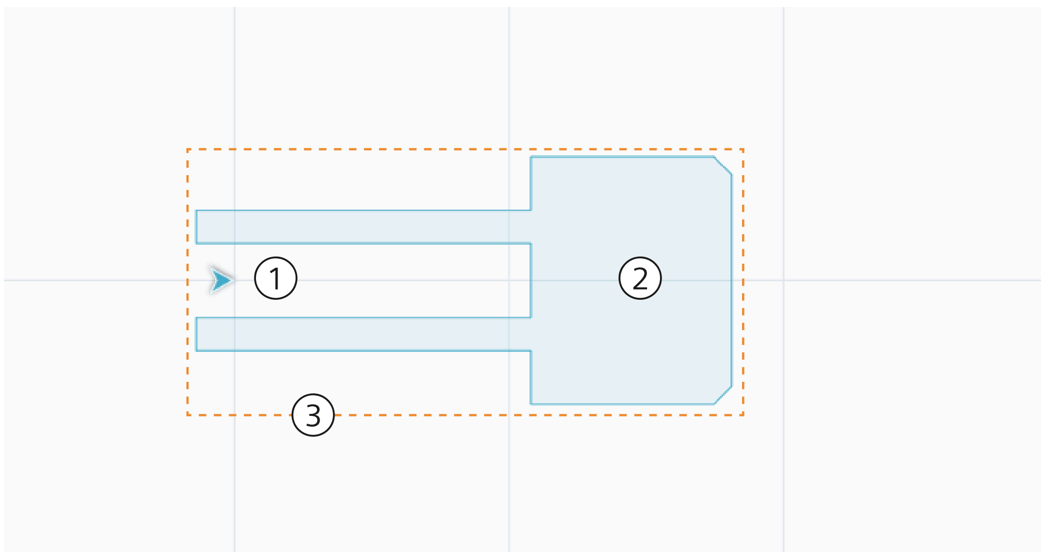
See also

Parameter setup (Page 61)

11.8 AGV shape (outline)

The AGV shape specification is mandatory to parametrize for each AGV type, as outlines are used, for example, to filter invalid laser beams. A shape is a polygon related to the kinematic center of an AGV and specified by parameters within the “user_def” file.

A shape can be parametrized in detail by using a CAD diagram. Alternatively, it is also possible to specify a “bounding box” of the AGV, which contains the full AGV shape in less detail.



① Kinematic center
② Detailed AGV shape
③ Bounding box example

Figure 11-13 Exemplary AGV shape visualization of a forklift in the ANS+ ET

This table provides an explanation of the related parameter for shape parametrization.

Parameter name	Description
Outline Point	Value format: Standard X Y – for example: Standard 108.0 25.5 Unit: • String expression [Standard, X, Y] • Standard fixed beginning • X & Y Float in [cm] related to the kinematic center Explanation: Each outline point specifies a new corner point for the shape polygon related to the AGV’s kinematic center. **WARNING** An AGV shape polygon needs to be defined clockwise. The first and the last outline point of a shape need to be equal.

The following lines represent the related parametrization for the forklift shape in the illustration above.

```
// Forklift
Outline Point : Standard -30.0 25.0   // Start point
```

```
Outline Point : Standard 50.0 40.0
Outline Point : Standard 100.0 40.0
Outline Point : Standard 100.0 -40.0
Outline Point : Standard 50.0 -40.0
Outline Point : Standard -30.0 -25.0
Outline Point : Standard -30.0 25.0   // Finish outline with start point

Outline Point : Visu -30.0 25.0       // Start point
Outline Point : Visu 50.0 25.0
Outline Point : Visu 50.0 40.0
Outline Point : Visu 100.0 40.0
Outline Point : Visu 100.0 -40.0
Outline Point : Visu 50.0 -40.0
Outline Point : Visu 50.0 -25.0
Outline Point : Visu -30.0 -25.0
Outline Point : Visu -30.0 -10.0
Outline Point : Visu 50.0 10.0
Outline Point : Visu -30.0 10.0
Outline Point : Visu -30.0 25.0      // Finish outline with start point
```

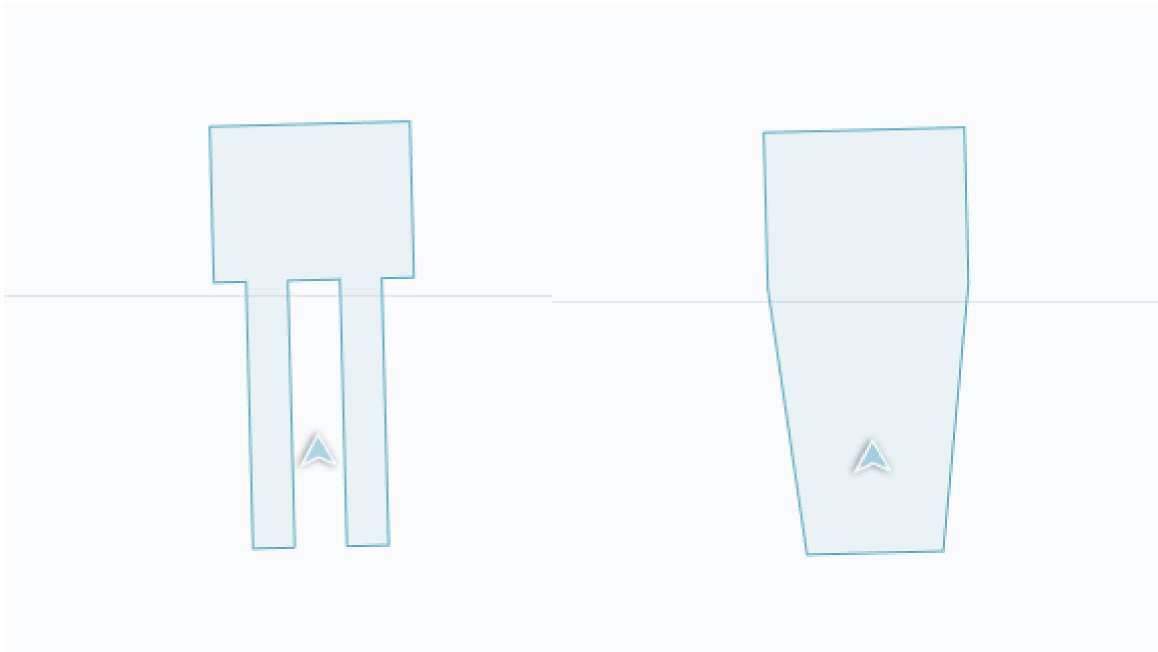
Outline Visualization

The standard outline as exemplary shown for the AGV above is per-default used for visualization, filtering of invalid beams and collisions tests for motion. This outline is used internally in the NC for all calculations. However, the standard outline must be convex for active obstacle avoidance or free path planning. Additionally, the outline must include the smallest safety field plus the grid resolution as a margin for obstacle avoidance to prevent the AGV from activating the safety fields while moving around obstacles. In case the user specifies a non-convex outline, the NC automatically computes a convex full for internal computations.

The user also has the option to define a convex hull as the standard outline as well as (different) visual outline. The visual outline should be as close as possible to the real AGV sizes and is used for beam filtering as well as visualization. If no visual outline is defined, the standard outline is used as the visual outline as well.

The following illustration shows the difference between the visual and technical outline.

The technical outline is automatically generated by the software. The user only has to define the standard outline.



Visual (FIGURE Outline_standard)   Technical (FIGURE Outline_technical

If you want to switch between the visual and technical outline in the engineering tool, this can be done in the "Configure device visualization" window.

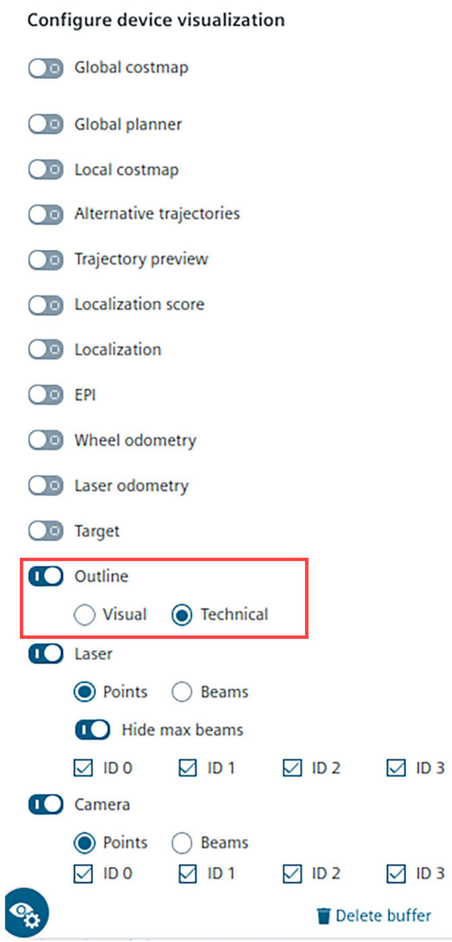


Figure 11-14 User defined Outline

Deployment

12

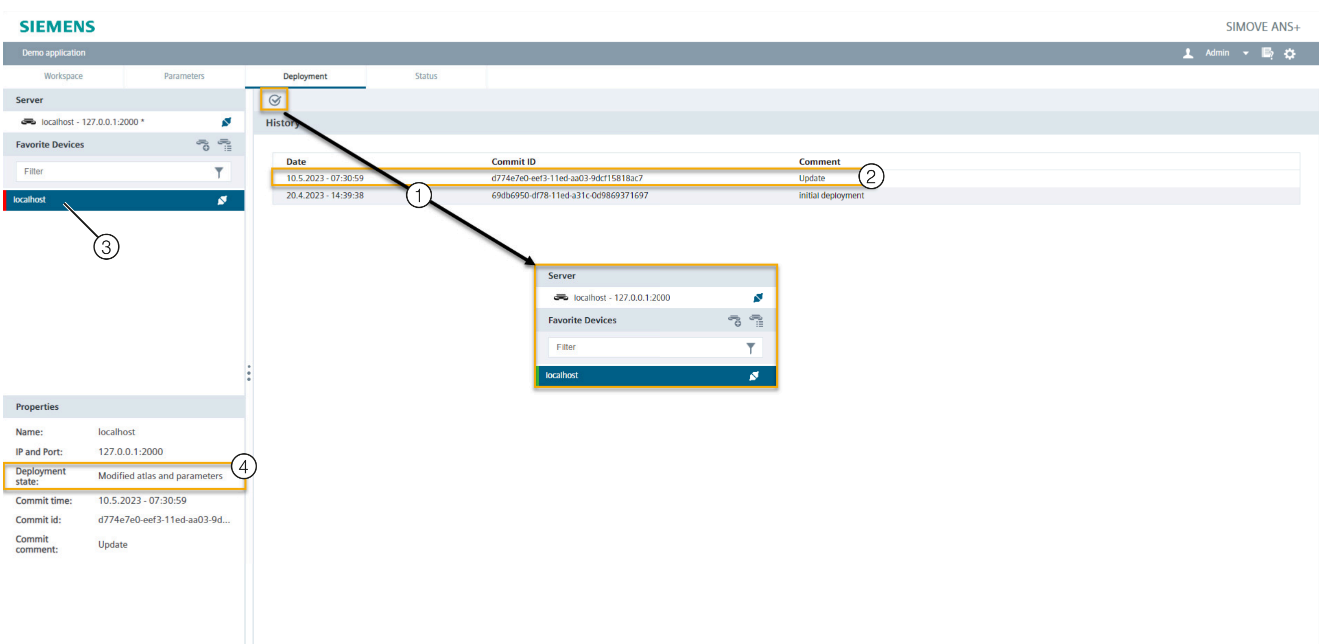
This chapter describes how to commit defined stages and transfer data remotely to ANS+.

For this purpose, the tool offers the "Deployment" page.

More information:

- ""Deployment" page (Page 54)"

Change detection



① Commitment
② Last done commit
③ Change detected
④ Detailed information where changes have been detected

Figure 12-1 Deployment: Change within current files detected

The ANS+ ET offers a function to automatically detect changes between the latest committed data stage and the current data. Furthermore, the current state of maps, paths and parameters on the AGV can be saved.

Commitment

The following procedure describes how to do a new commitment, in case for a direct use of the tool on the AGV.

1. Make all required changes to the system and test them.
   All changes will be directly written to the related files, meaning that after a restart of the ANS+ NC module, those changes will be applied by the system.
2. If all maps, paths and parameters have been successfully tested, a commit should be done to save the state of the files.
   For this purpose, click .
   The dialog "Uncommitted changes" is opened.

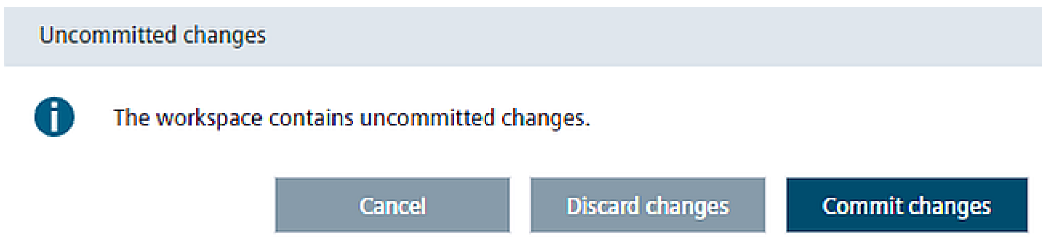
   

   Figure 12-2 Dialog "Uncommitted changes"

   The user has the following options:

Commit changes	Saves all changes within maps, paths, and parameters within a new commit.
Discard changes	All changes will be undone. The tool will set all files back to the last done commit: • Maps • Paths • Parameters
Cancel	Aborts the current process and leaves everything as it is.

3. After a successful commit, new changes can directly be tested without doing a new commitment, as all changes will be directly written to the related files.
4. In case of wrong parameterization or engineering, click "Discard changes".
   This will undo all changes between the current state and the last commit.

Remote commitment

In case of a remote connection between the tool and the ANS+ system on the AGV, all files are edited on the PC that was used to start the ANS+ ET.

To send the files (maps, paths and/or parameters) to the ANS+ system on the AGV, the deployment function needs to be used.

The following procedure describes a step-by-step guidance for a successful remote file transfer between an engineering PC and an AGV.

Note

Committed stage required

It is only possible to deploy files to remote operating systems if both systems are in the committed stage.

Procedure

1. Start the ANS+ ET on the engineering PC and connect to the web-based UI.
   More information:
   - "Remote access (Page 36)"
2. Edit all files and save their current state.
3. Select the "Deployment" page within the tool.
4. Connect to the related AGV.
   More information:
   - "Add and connect to a new device (Page 59)"
5. Click to do a commitment of the engineering PC and click on "Commit changes".
6. Select the related AGV and click to do a remote commitment of the AGV.
   If a "Name conflict" occurs, use the name of the engineering PC for the AGV.
   Both systems, the engineering PC and the AGV, are now in the mandatory committed stage and are ready for deployment.
7. Select the transfer option.
   The following file transfer options can be used, if both systems are in the committed stage:

	Parameter files download	PC → AGV
	Parameter files upload	AGV → PC
	Environment files download	PC → AGV
	Environment files upload	AGV → PC

8. After one transfer, the system requires a committed stage for another deployment again.
   All changed files on the AGV will only be applied by the ANS+ system if the system is rebooted.

13 Track integration

This chapter describes a process to handle the following two user stories with ANS+:

- **Integration of a new AGV**
  A new AGV is fully commissioned and needs to be integrated into the fleet and the track layout to be able to receive valid orders by a master control system.
- **Reintegration of an AGV**
  Due to a necessary task, such as maintenance, the AGV needs to be reintegrated into the track layout for valid orders by a master control system.

In both stories, the ANS+ is not aware of its initial position and orientation in the environment due to its boot routine. The system therefore has its localization deactivated and requires additional information to initialize its localization. The localization requires a valid pose in a map, which consists of four elements: X and Y position, orientation and map name. This information can be sent to the ANS+ system in different ways:

- **Initial order**: Each job that is sent after a boot routine or a previously completed task is an "initial order". A pose is estimated by using the first commanded ident points, position and the following path segment for orientation.
- **UID & orientation**: The system uses the ident point ID to estimate the map name and position data. The transferred orientation is used to complete the required information data.
- **Complete pose**: If all four elements are valid and sent to the ANS+ system, the complete data is used to initialize the localization.

All three types of information can be provided to the SIMOVE ANS+ by using the ANS+ ET or the SIMOVE Carrier Control, such as via HMI. This architecture has been designed to address the following track integration approaches.

Initial order

In case of an unlocalized AGV, this approach requires positioning the AGV on the position of the first commanded ident point and in the same direction as the initial path segment is commanded.

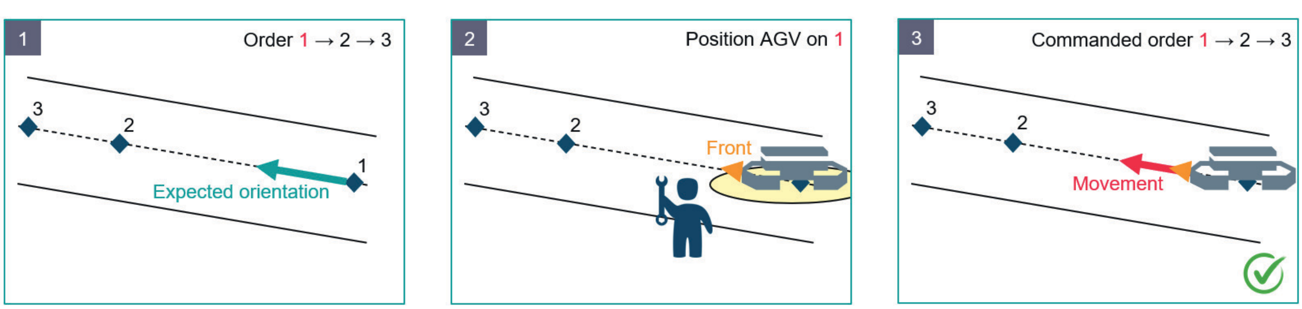


Figure 13-1 Track integration approach for initial jobs

Reverse initial order

If an AGV is unlocalized and it is not possible to position the AGV in the expected orientation, the localization must be initialized via the ANS+ ET "set Pose" function or by SIMOVE Carrier Control, such as via HMI.

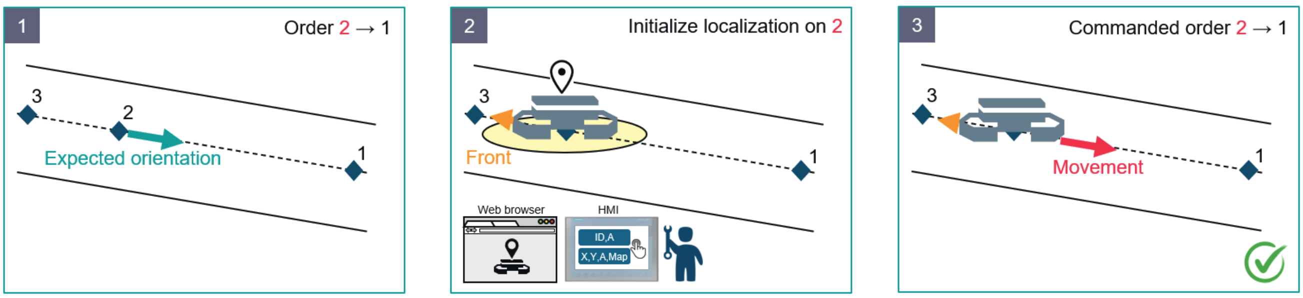


Figure 13-2 Track integration approach for reverse initial jobs

Initialization on edge

It is also possible to initialize an AGV directly on an edge belonging to a virtual path of the SIMOVE ANS+ system. In this case, it is either possible to use the ANS+ ET "setPose" function or the PLC data structure to set up the localization. For localization initialization, the following data is mandatory: X, Y, A and MapId. Once the AGV is located in the map, it is required to start the initial order with the edge at which the AGV is physically standing.

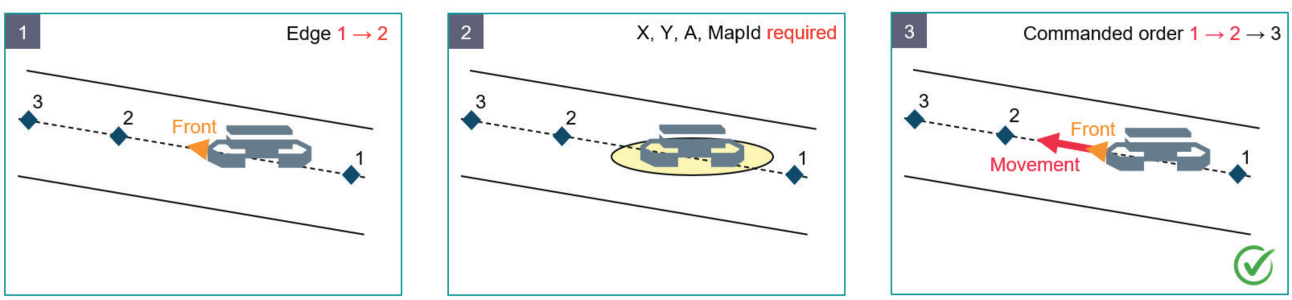


Figure 13-3 Track integration on an edge

Order cancelation

An active running order can be canceled at any time. Directly after the cancelation, the AGV will ramp down the speed and stop immediately. When stopping on the track between two ident points, the AGV can continue driving, if the segment of the path is send again. For example, when stopping between the ident points 1 and 2, the AGV will continue driving on the path, if the order 1 -> 2 (or 2 -> 1) is sent again.

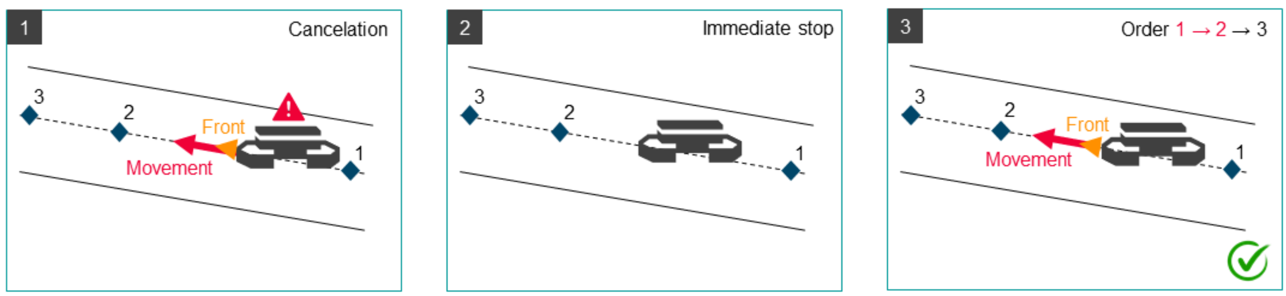


Figure 13-4 Track integration after cancelation of the order

Power loss

The SIMOVE Carrier Control permanently saves the localization pose during a running order. If a power loss occurs, the PLC automatically detects an outstanding task after rebooting. For this purpose, the last known order including the latest known localization pose is immediately sent to the ANS+ for initialization. Once the AGV is back in “Automatic Start” mode, it moves directly to the next ident point for a determined position and waits for the next Master Control job.

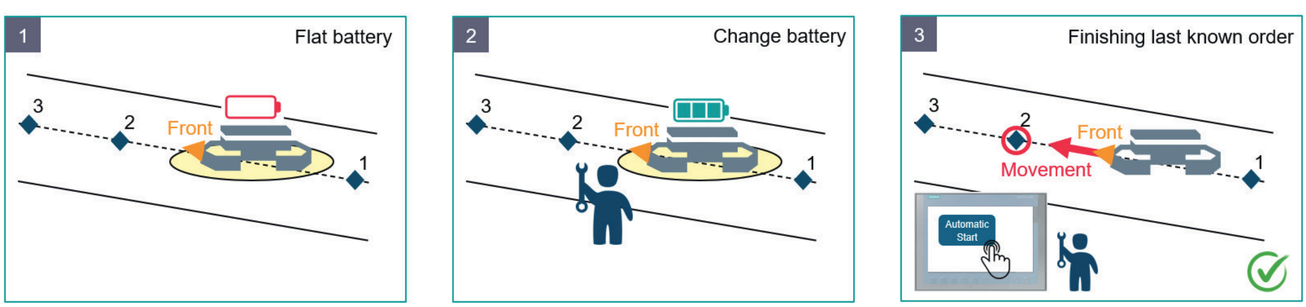


Figure 13-5 Track integration approach for power loss situations

Maintenance

In this situation an AGV failure occurs, which requires more time to solve. For this case, the current AGV’s position is marked on the ground. Afterwards, the AGV is moved with a manual control device and fixed next to the path. Once the failure is solved, the AGV is again manually positioned at its previously marked position. The AGV continues its pending order, once “Automatic Start” mode is activated. During the entire approach, the localization of ANS+ is running.

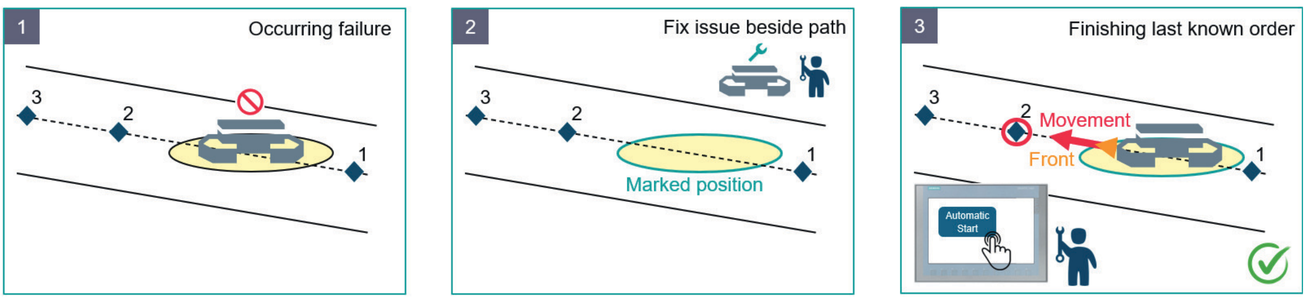


Figure 13-6 Track integration approach in case of maintenance

Planned trajectory

Free path planning can be used to bring the AGV back onto the planned track, alternatively to manually moving the AGV back to a previous position (e.g. due to maintenance). As shown in the figure below, the AGV needs to be initialized in the map, next to a path. As a prerequisite, motion needs to be activated and the AGV has to be physically able to drive from its current position in the map back to an ident point on the path.

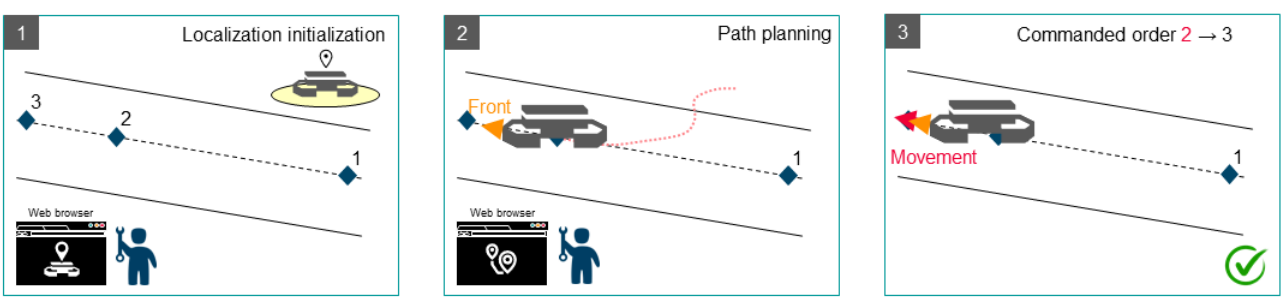


Figure 13-7 Track integration by using free path planning to merge back onto the track

Blocked paths

This chapter describes the track integration while a path is being blocked. The first line of the figure below shows a scenario, when motion is disabled and the second line shows a scenario, when motion is enabled.

Motion is disabled:

The AGV is driving on the path, until the safety field is interrupted by the obstacle on the path. Depending on the size of the safety field, the AGV is stopping on the path in front of the obstacle and will only continue, if the obstacle is being removed.

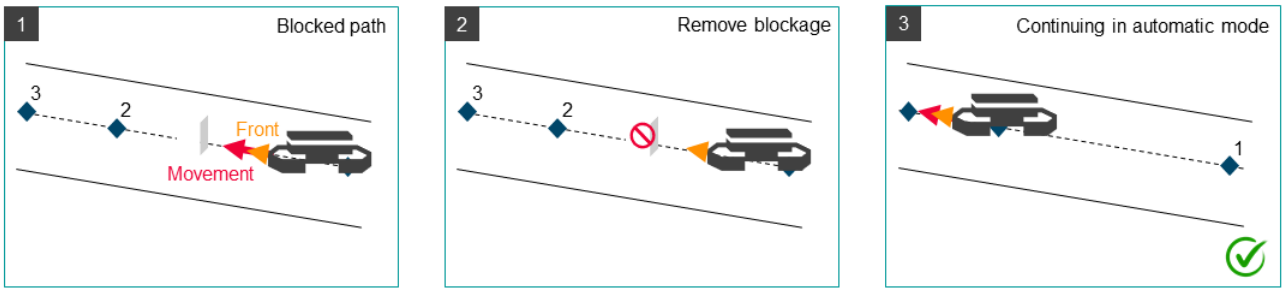


Figure 13-8 Track integration of blocked paths with motion disabled

Motion is enabled:

When motion is enabled and the preconditions for the free path planning and obstacle avoidance are fulfilled (e.g. creation of grid map and parameterization within user_def), the vehicle will drive around the obstacle, merge onto the track and continue driving on the path.

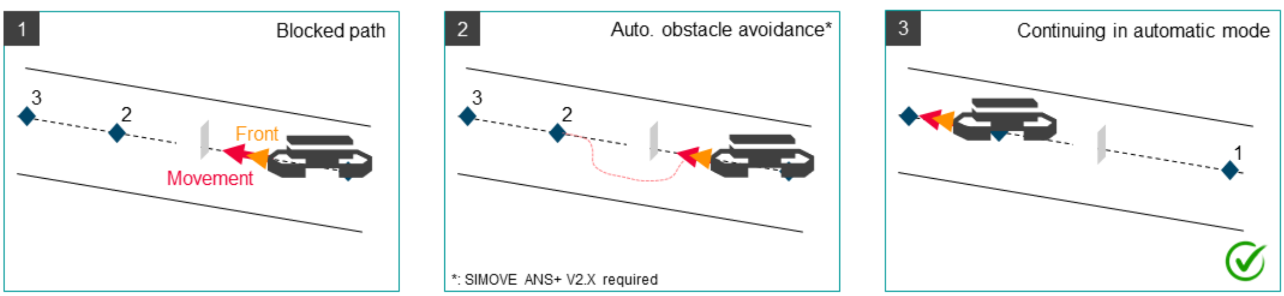


Figure 13-9 Track integration of blocked paths with motion enabled

See also

Manual movement orders (Page 221)

Advanced information 14

14.1 Manual movement orders

This chapter describes a commissioning option to manually test the designed ANS+ layout, the related maps and the movement of the AGV in relation to its localization. This procedure is used if no master control system is available.

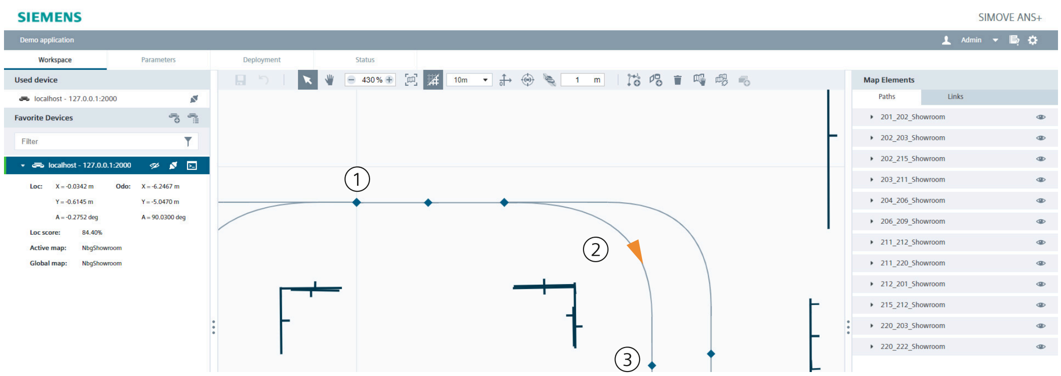
For this purpose, an established connection between the ET and the ANS+ NC module on the AGV is required (see chapter "Status" page (Page 55)). Additionally the "AGV command toolbar" (shown in illustration 2-10) is required.

WARNING
Check for correct position before starting Before using the below described order command, ensure that the related AGV is physically standing on an ident point in direction of the default movement direction of the path layout. More information: Track integration (Page 215) **Check for activated safety before starting** Since the command can be taken for commissioning, ensure that the command is used as described to avoid failures. No safety check of the command will be done.

Procedure

To avoid failures in commanding, use the following step-by-step guidance for an automatic movement of an AGV between the engineered ident points.

1. Position the AGV on an ident point with a manual control device using a manual control device. Ensure that the AGV is oriented in the movement direction of the next commanded order.
   The position of the AGV does not need to be very precise, as the ANS+ system is capable of handling position offsets at the beginning.



① ID: 1
② Movement direction order 1 → 5
③ ID: 5

Figure 14-1 AGV track integration

2. To verify the position of the AGV and the offset handling of the ANS+, click the related device and select  .

3. Click roughly on the related ident point in the map at which the AGV is physically standing.
   – With the first click of setting up the AGV pose, the X and Y coordinate are applied.
   – With a second click, the orientation of the AGV is defined.

   In the end, this pose will be transferred to the ANS+ system and used for the localization.

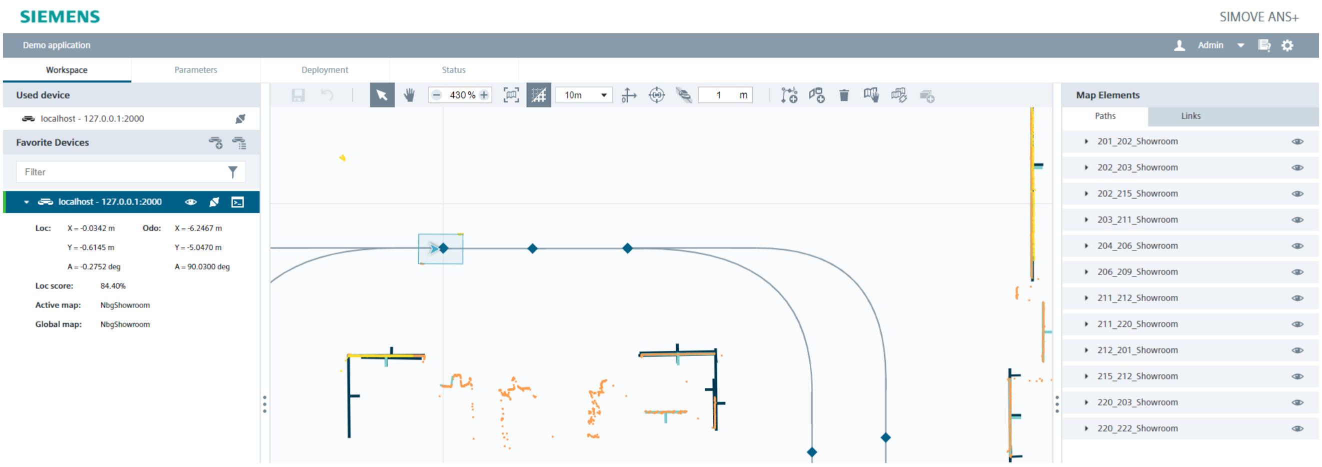


Figure 14-2 Successful manual setting of the AGV pose

By enabling the laser data visualization, the result of the localization can be evaluated:

– If the features detected online (turquoise lines) are roughly on the offline features (black lines), the localization has been set successfully and the AGV is ready for manual orders.
– If the online features do not match to offline ones, it is necessary to position the AGV manually more precisely to the trained ident point position.

4. Before commanding verify that automatic start has been activated the AGV is within Virtual Track Sensor (VTS) mode.
   The AGV is only allowed to drive with ANS+ in case of a fully activated automatic mode.
   To use the command, it is required to have an established connection to the related AGV.
5. To open the "AGV command toolbar", click .
6. Enter the AGV command.
7. To transfer the typed in order to the ANS+ NC module, press <Enter> or click "Send".

AGV commands

The AGV command can be used with the following string:

```
order <ID1>_<ID2> <ID2>_<ID3>
```

Order	Fixed beginning
<ID1>	Placeholder for the ident point name
<ID2>_<ID3>	Complete order from first to second ident point combined with a single underscore
<ID1>_<ID2> <ID2>_<ID3>	Multiple orders behind each other separated by a single space

> **WARNING**
>
> **Check for correct position**
>
> <ID1> always needs to be the ident point ID of the related ident point, at which the AGV is physically standing.

Examples

Example: Single manual order

```
order 110_112
```

The example string will be interpreted by the ANS+ NC module as follows:

1. One single drive order is passed: 110→112.
2. The AGV is currently physically standing at the ident point 110 in the defined default movement direction.
3. The AGV has to drive from the ident point 110 to 112 directly.
4. After reaching the ident point 112 no further tasks will be executed and the AGV stops at ident point 112.

Example: Different starting position

```
order 112_110
```

This string will be interpreted by the ANS+ navigation control as follows:

1. One drive order is passed: 112→110.
2. The AGV is currently physically standing at the ident point 112 in the defined movement direction.
3. The AGV has to drive from the ident point 112 to 110 directly.
4. After reaching the ident point 110 no further tasks will be executed and the AGV stops at ID 110.

Example: Multiple drive orders

```
order 110_112 112_110 110_112
```

This string will be interpreted by the ANS+ navigation control as follows:

1. Three drive orders are passed: 110→112 **|** 112→110 **|** 110→112.
2. The AGV is currently physically standing at the ident point 110 in the defined movement direction.
3. The AGV has to drive from the ident point 110 to 112, followed by another order 112 to 110 and a final order 110 to 112.
4. The AGV drives continuously at its maximum speed until it reaches the third and last drive order.
   After passing the ident point 110 within the last order, the AGV will stop at ident point 112.

14.2 Order Handling from PLC

The orders are transmitted to ANS+ via the "LSimoveC_Nav_Track_ANS_MT_Host" block (host interface) using the TCP protocol. The individual edges that the AGV should run in ANS+ are transferred to the edges input. As soon as the "release" input is true, these edges are written to the orderBuffer and transferred to ANS+.

It is only possible to transfer 4 edges to the function block at the same time. A total of 20 edges can be buffered in the function block.

In order to transfer the edges correctly to ANS+, the correct start point (sourceId) and the correct destination point (destID) must be stored in the desired edge. In addition, optional route information (optRouteInfo) can be transferred with the edge.

Note

All parameters in section optRouteInfo are optional. If they have the default value, the parameters will not be used in ANS+.

optRouteInfo		Data Type	Default Value	Description
sourceCoord		LSimoveC_ typeXYAVectorVDA		Source coordinates in x,y,a [mm, mm, deg]
	x	Real	3.402823E+38	Source coordinate x in mm
	y	Real	3.402823E+38	Source coordinate y in mm
	a	Real	3.402823E+38	Source coordinate a in rad
sourceDev		UDInt	4_294_967_295	Source deviation in mm
destCoord		LSimoveC_ typeXYAVectorVDA		Destination coordinates in x,y,a [mm, mm, deg]
	x	Real	3.402823E+38	Destination coordinate x in mm
	y	Real	3.402823E+38	Destination coordinate y in mm
	a	Real	3.402823E+38	Destination coordinate a in rad
destTargetRadius		UDInt	UDInt	Destination deviation (target radius) in mm defines a circle around the destination position, which the AGV must reach.
orientationGlobal		Real	3.402823E+38	AGV moves along the edge with a global orientation [mdeg]related to the global map coordinate system. **Note:** This driving behavior can only be performed by vehicles with holonomic movement (ANS+ Kinematics: Mecanum).
orientationTangential		Real	3.402823E+38	AGV moves along the edge with a tangential orientation [mdeg] related to the edge. **Note:** This driving behavior can only be performed by vehicles with holonomic movement (ANS+ Kinematics: Mecanum).

optRouteInfo		Data Type	Default Value	Description
tunnelWidth		UInt	65535	Defines the orthogonal maximum allowed distance around a path, that the vehicle is allowed to drive (e.g. to avoid obstacles)
maxSpeed		UInt	65535	Maximum Speed in driving direction
goalApproachLength		UInt	65535	Plan a straight goal approach with the global planer. **Note**: This parameter has only an effect with free path planning.
routeFlags		Array[0..15] of Bool		
	route Flags[1-7]	Bool	false	Reserve bits
	route Flags[8] rotationAllowed	Bool	false	Allow rotation on edge. When this bit is set to true, the AGV is allowed to start driving on the edge, while rotating to a global or tangential orientation.
	route Flags[9] collisionAvoidance Inactive	Bool	false	When the bit is set to true, the collision avoidance check will be deactivated on that specific edge
	orientation Flags[10-15]	Bool	false	Reserve bits
mapIDfromUser		Array[0..25] of Char	false	Map name

14.3 Parameter Prioritization

All ident point and edge parameters can be defined by different sources. There is a fixed hierarchy which parameters are finally used in ANS+.

1. PLC

The PLC has the highest priority and overwrites all lower-level parameters.

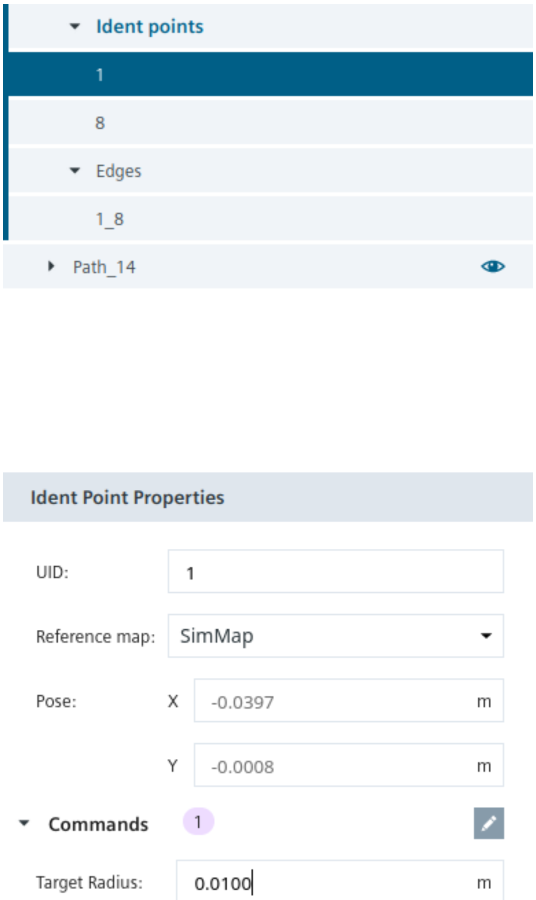
An example:

If "move backwards" is set on an edge in the ET layout and a tangential orientation of 0 degrees is sent via the PLC, the PLC overwrites the backward signal and the AGV moves forward.

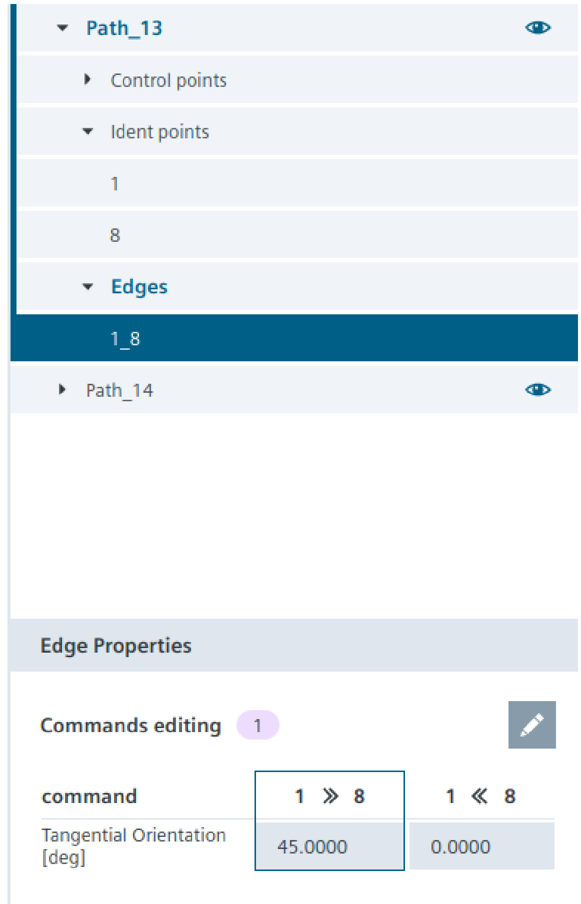
Important: If the edges and ident points are not to be commanded by the PLC, the parameters must be set to the default (maximum) values.

2. ET Path Layout

The ET layout has the second highest priority. If no valid parameters are commanded via the PLC, the parameters stored here take effect. Here, both ident point parameters and edge parameters can be stored in each created path. The edge parameters can also be specified in both movement directions.



Ident point configuration



Edge configuration

3. ET User_def

If the ident point or edge parameters are not set via the PLC or in the ET layout, the parameters stored in the user_def file take effect. These parameters are valid for all ident points and edges that are not explicitly overwritten.

14.4 Movement behaviors

14.4.1 Default

This chapter describes general information about the specified movement behaviors of SIMOVE ANS+.

Default

By default, SIMOVE ANS+ considers all AGVs to be bidirectional. This definition has been specified to ensure the same default movement behavior for all kinematics, since holonomic AGVs are able to follow a virtual line in the same way as bidirectional AGVs.

The default movement behavior can be changed by editing the parameter “Orientation Mode”.

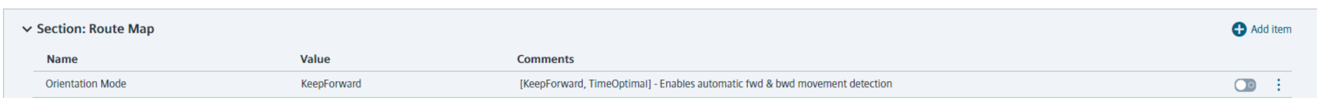


Figure 14-3 Parameter "Orientation Mode" related to default movement behavior

There are two possible values for this parameter:

- **KeepForward -** The ANS+ system always commands the AGV in +X direction for the specified default movement.

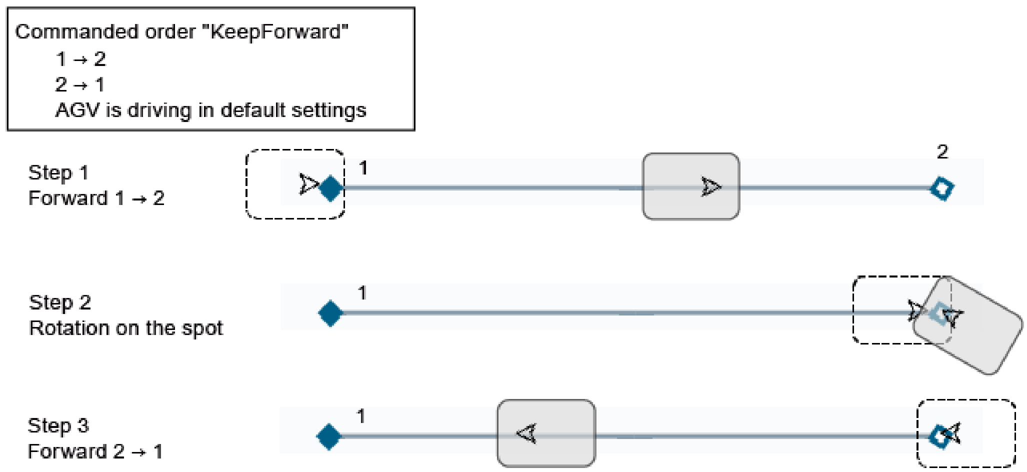


Figure 14-4 Default movement behavior of "KeepForward"

- **TimeOptimal** - This value enables an automatic forward and backward movement detection. The system is commanding the AGV in short movements to fulfill its order related to the designed path layout.

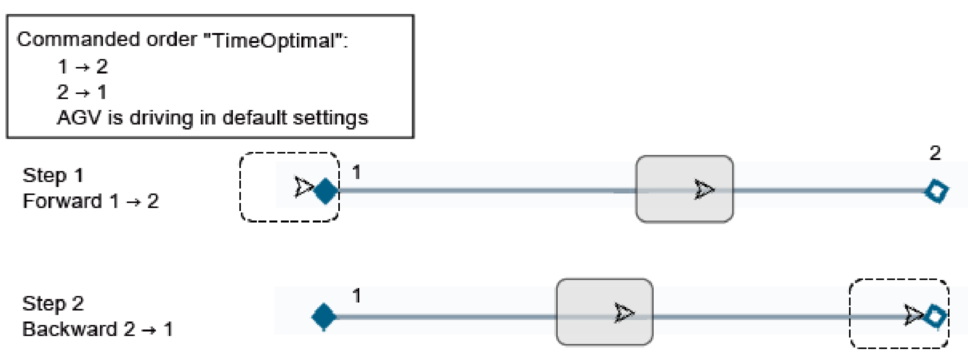


Figure 14-5 Default movement behavior of "TimeOptimal"

For specific movement behaviors, such as rotation on an ident point or holonomic movements, ident point commands need to be parametrized. More details related to ident point commands are described in the chapter Common layout guidance (Page 141). By adding an ident point command, the default behavior of the AGV is overwritten and the newly added command is executed until the next ident point is reached.

Further default behavior specifications are:

1. Ident points are confirmed only in case of a running order and if the position and the orientation have been reached by the AGV.
2. If an AGV always starts on an ident point in a specific orientation, the ident point command "Orientation", explained in more detail within chapter Rotation on the spot (Page 231), is required.
3. Rotations at the beginning of a new order, for example, due to a twisted starting pose, lead to a rotation on the spot of the AGV under consideration of the parameter “Orientation Mode” as shown in the illustration below.

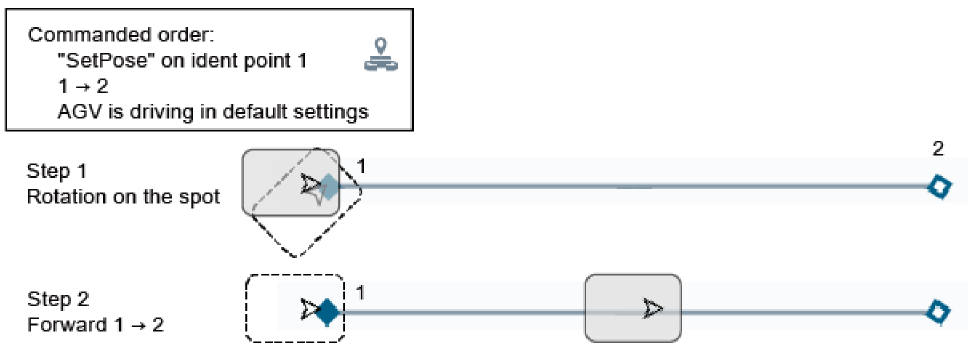


Figure 14-6 Twisted starting pose behavior

See also

Global map parametrization (Page 111)

Holonomic movement (Page 233)

14.4.2 Rotation on the spot

Most path layouts require a specific orientation on an ident point. For this purpose, the ident point command “Orientation” needs to be parametrized.

Note

The value of “Orientation” in degrees relays to the global map origin, which has to be parametrized with the parameter “Global Frame Id”.

More information on this parameter: Feature map linking (Page 104).

A movement behavior with a commanded theta on ident point “2” is demonstrated in the image below. Due to the default specifications, ident point “2” is only confirmed if the position and rotation have been reached by the AGV.

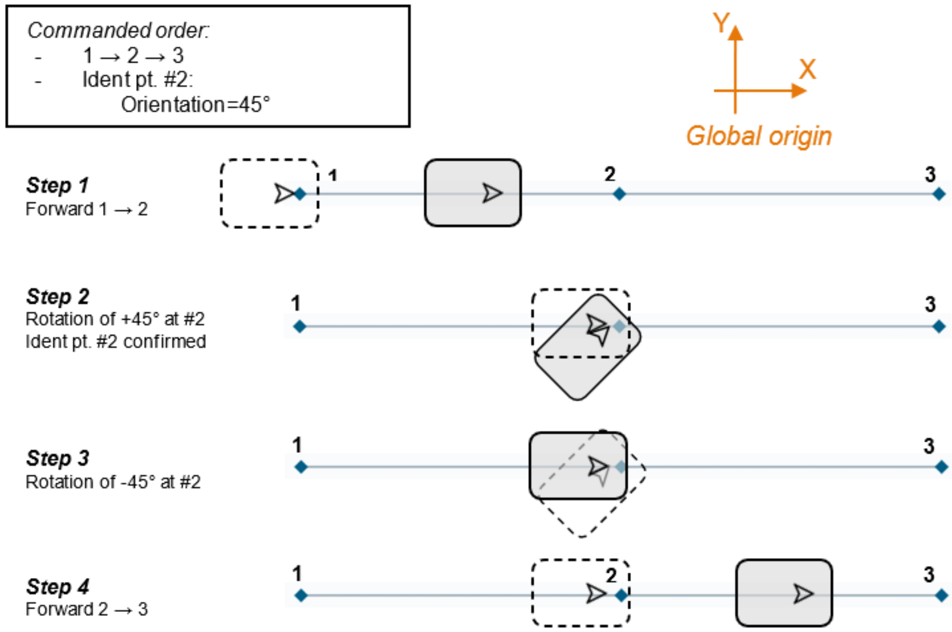


Figure 14-7 Movement behavior for Orientation

WARNING

Observe the parametrized orientation

If an AGV is starting an initial order without activated localization on an ident point, which has been parametrized with the command "Orientation", the SIMOVE ANS+ expects the AGV to be physically standing in the parametrized orientation.

See also

Global map parametrization (Page 111)

14.4.3 Movement direction on edge

For specific movement behaviors, such as moving specifically forwards or backwards, the edge parameter "Movement Direction" can be parameterized.

This command also overwrites the global parameter "KeepForward / TimeOptimal".

Selecting an edge and adding the required edge parameter will provide two columns in the Edge Properties window to be specified for both possible directions, as shown in the figure below.

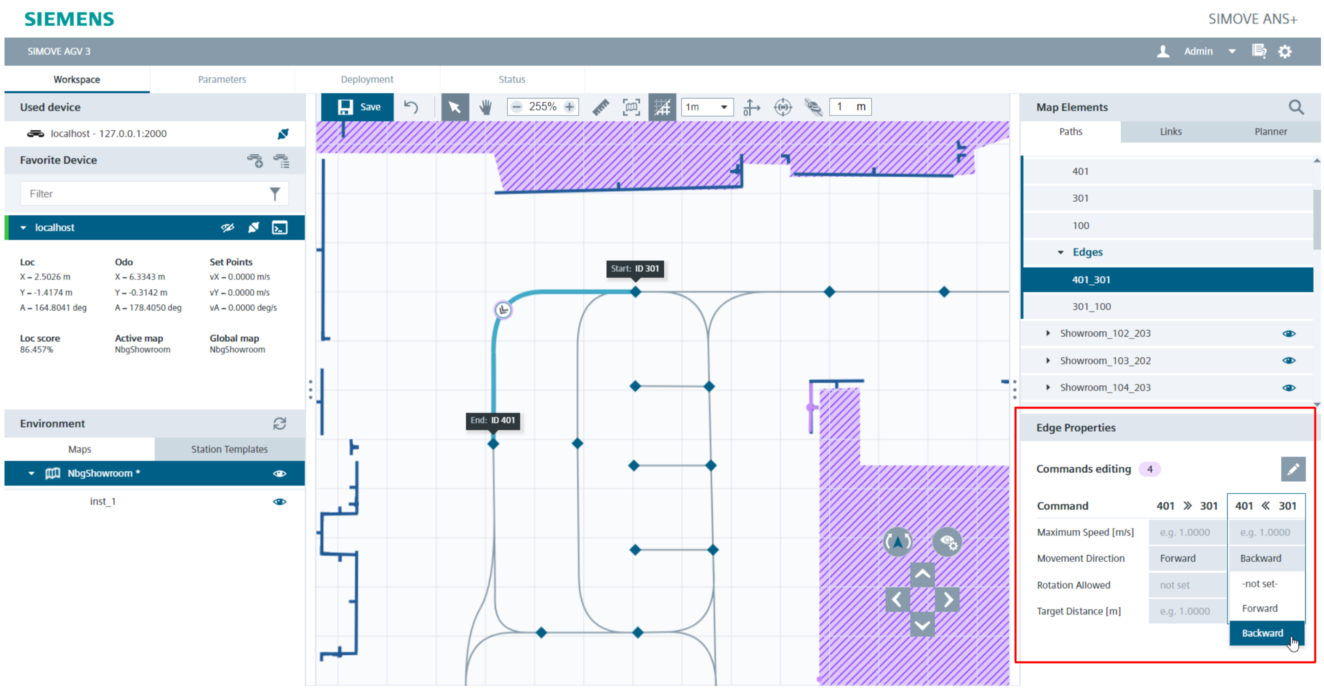


Figure 14-8 Apply edge commands with movement direction

14.4.4 Holonomic movement

Holonomic movement

Holonomic AGVs have three degrees of freedom, in contrast to bidirectional AGVs, which only have two. Due to this additional degree of freedom, holonomic AGVs can fulfill movements in Y-direction.

For this kind of special movements, additional commands have been added to the SIMOVE ANS+ system:

- **Global edge orientation**: This command describes a specific global orientation on a path between two ident points. The value in degrees relays to a parametrizable global map origin.

Note

Parametrize the global map origin

The command relays to a global map origin, which has to be parametrized with the parameter "Global Frame Id".

More information on this parameter: Global map parametrization (Page 111).

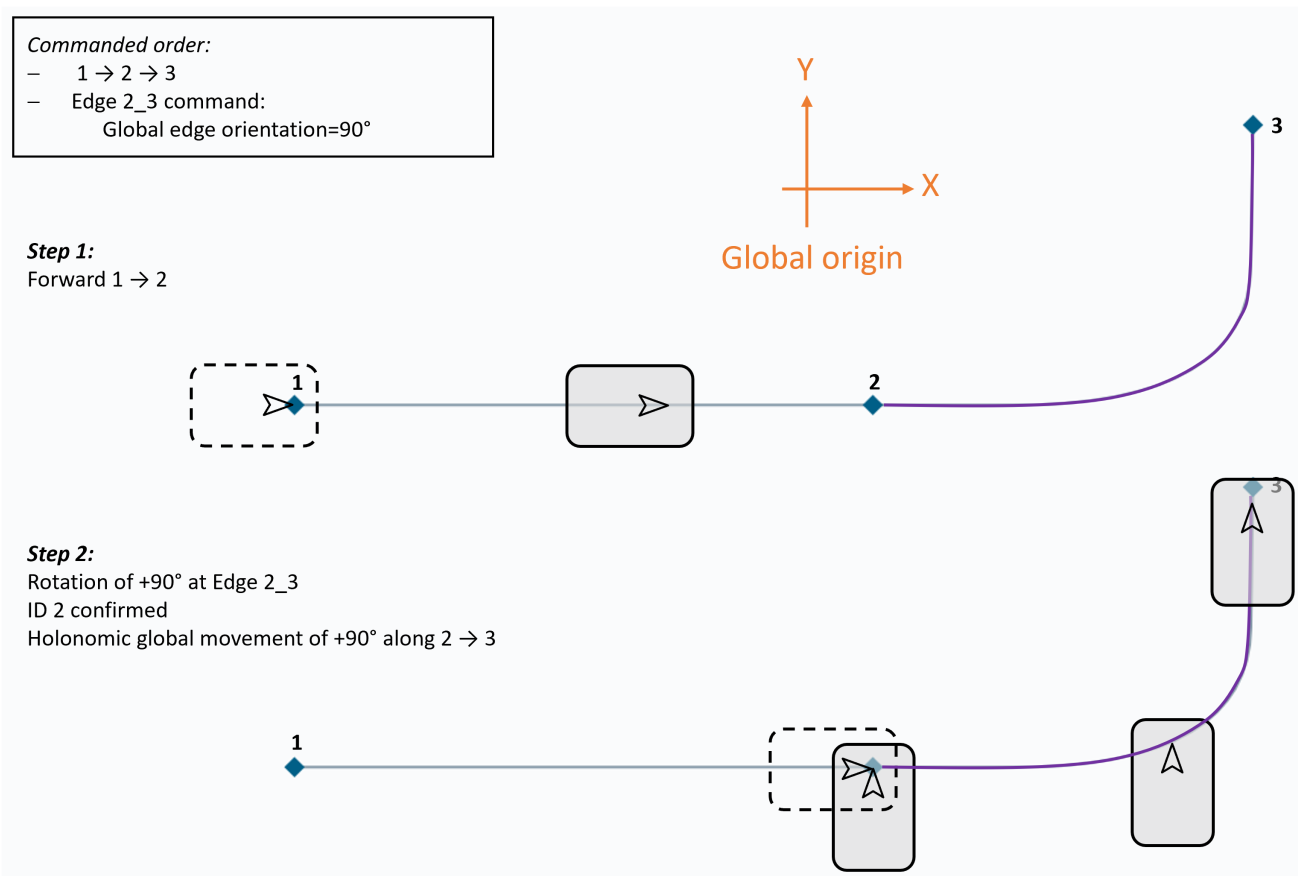


Figure 14-9 Movement behavior of "Global edge orientation"

- **Tangential edge orientation**: In case of a specified tangential orientation, the defined orientation value references the direction of the path direction in relation to the vehicle orientation. The value is specified in degrees and the command is executed until the next ident point is reached.

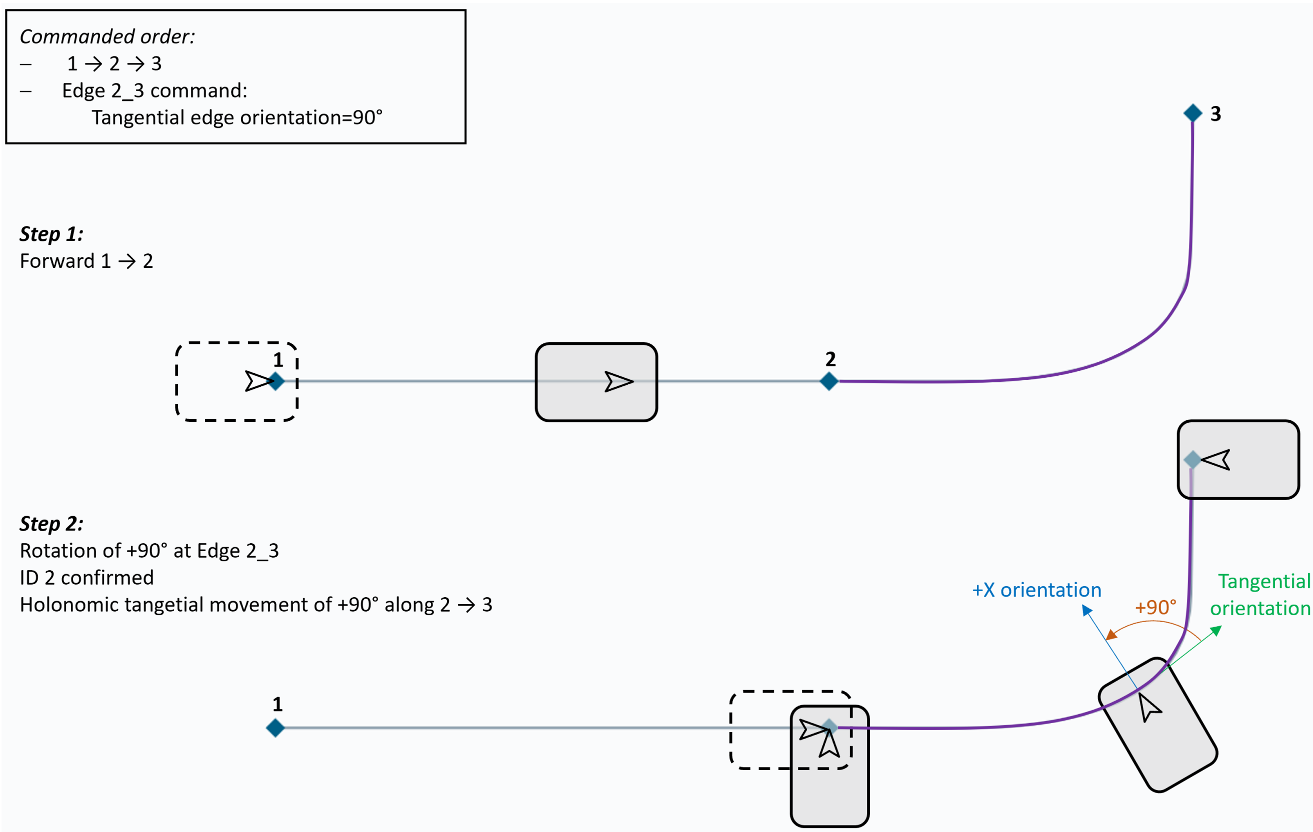


Figure 14-10 Movement behavior of "Tangential edge orientation"

- **Edge rotation allowed**: To save time in production environments, this command enables an AGV to fulfill a tangential or global direction while moving along a path.

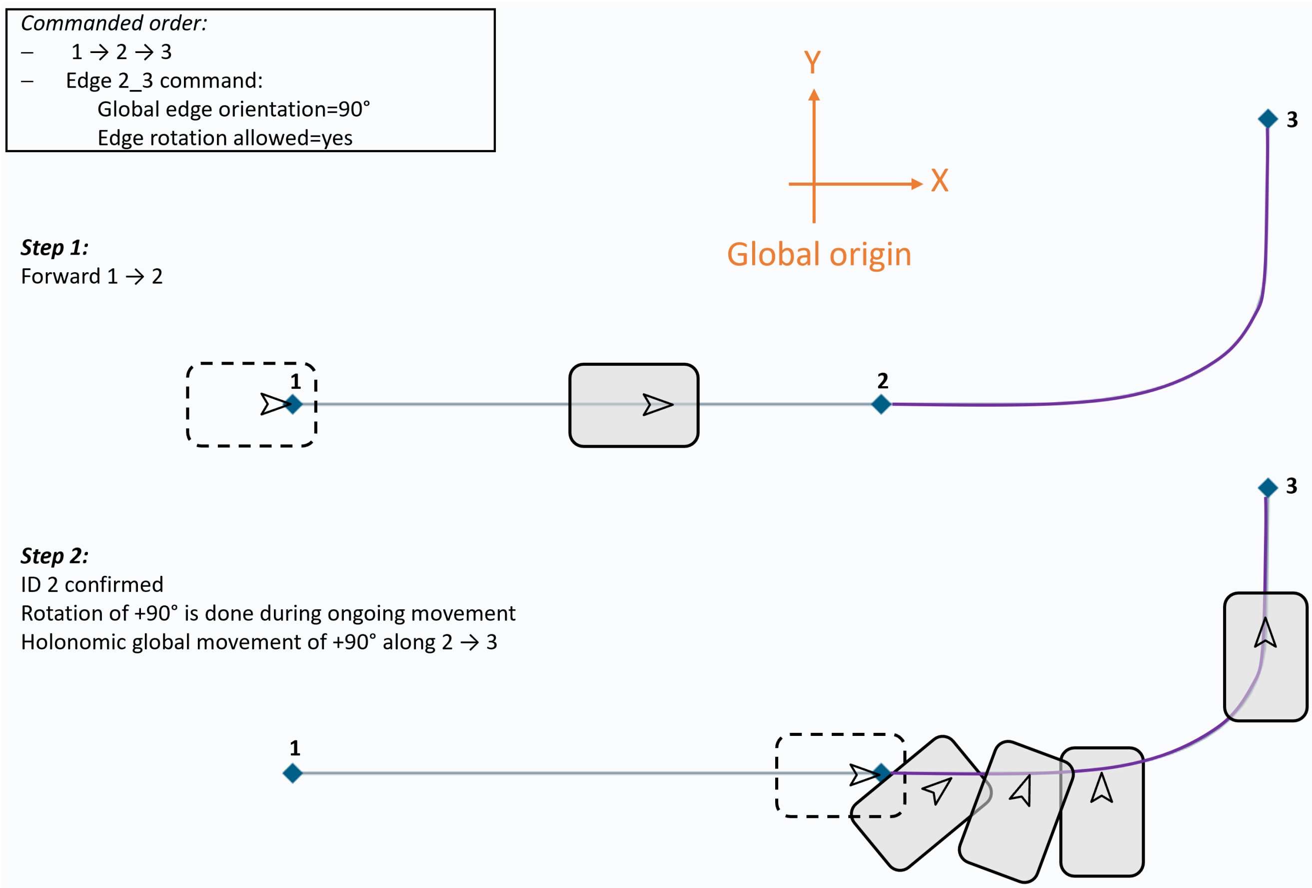


Figure 14-11 Movement behavior of "Edge rotation allowed"

Note

"Edge rotation allowed" is deactivated by default

By default, the setting "Edge rotation allowed" is deactivated. Therefore, all holonomic AGVs are fulfill the parametrized orientation before entering the following path with a rotation on the beginning ident point.

14.5 Layout export

To export layout information into a CSV file, the ANS+ NC module provides two functions. These functions can be triggered over the ANS+ ET, as shown below.

Note

With the functions "export identpts" and "export layout" the entire data of the "atlas" directory is exported and stored as a CSV file within the "atlas" folder.

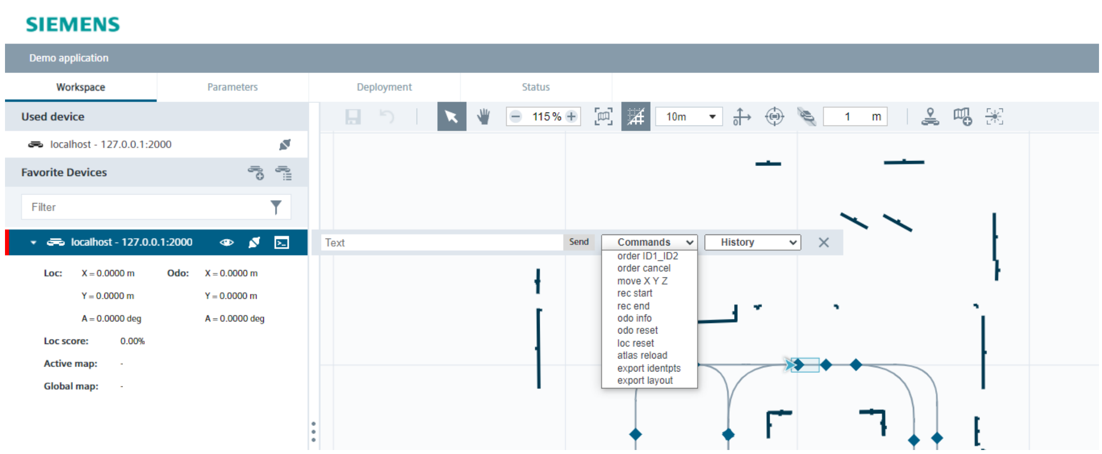


Figure 14-12 Access to ANS+ NC layout export functions

Function "export identpts"

The function "export identpts" exports all path segments into a CSV file. A path segment represents the logical connection between two ident points on a path. Therefore, this function is mainly used to receive only the logical information of all ident points and their connections of the related environment data. The following illustration shows an example CSV file, which has already been imported to Microsoft Office Excel.

SegmentName	RouteFileName	MapFileName	BiDirectional	StartName	EndName	StartX [m]	StartY [m]	EndX [m]	EndY [m]	PointFrameId
110_111	Banner_1_Path_1.poc	Banner_1.map	1	110	111	5.030	-7.873	5.730	-7.867	NbgShowroom.map
110_208	203_211_Showroom.poc	NbgShowroom.map	1	110	208	5.028	-7.869	5.026	-10.022	NbgShowroom.map
120_121	Banner_2_Path_1.poc	Banner_2.map	1	120	121	5.027	-6.760	5.727	-6.766	NbgShowroom.map
120_222	203_211_Showroom.poc	NbgShowroom.map	1	120	222	5.029	-6.754	5.027	-6.980	NbgShowroom.map
1_2	Path_1.poc	Banner.map	1	1	2	1.200	0.000	1.200	0.700	Banner.map
201_202	201_202_Showroom.poc	NbgShowroom.map	1	201	202	-6.974	-2.981	-4.476	0.019	NbgShowroom.map
202_203	202_203_Showroom.poc	NbgShowroom.map	1	202	203	-4.474	0.019	0.025	0.019	NbgShowroom.map
202_215	202_215_Showroom.poc	NbgShowroom.map	1	202	215	-4.474	0.019	-2.980	-2.989	NbgShowroom.map
203_213	203_211_Showroom.poc	NbgShowroom.map	1	203	213	0.026	0.011	1.238	0.011	NbgShowroom.map
204_205	204_206_Showroom.poc	NbgShowroom.map	1	204	205	2.526	0.019	6.026	-3.138	NbgShowroom.map
204_216	203_211_Showroom.poc	NbgShowroom.map	1	204	216	2.532	0.011	5.026	-3.236	NbgShowroom.map
205_206	204_206_Showroom.poc	NbgShowroom.map	1	205	206	6.026	-3.138	6.026	-6.944	NbgShowroom.map
206_207	206_209_Showroom.poc	NbgShowroom.map	1	206	207	6.026	-6.947	6.026	-9.343	NbgShowroom.map

Figure 14-13 Exported logical layout by using “export identpts”

The columns provide the following information:

- **SegmentName:** Name of the segment between two ident points
- **RouteFileName:** Related path file name in which the data is saved
- **MapFileName:** Related map file name to which the data refers

- **BiDirectional:**
  0: Path can be driven from starting to ending ident point
  1: Path can be driven in both directions
- **StartName:** UID of the starting ident point of the path segment
- **EndName:** UID of the ending ident point of the path segment
- **StartX [m]:** X-position of the starting ident point related to map origin of "PointFrameId"
- **StartY [m]:** Y-position of the starting ident point related to map origin of "PointFrameId"
- **EndX [m]:** X-position of the ending ident point related to map origin of "PointFrameId"
- **EndY [m]:** Y-position of the ending ident point related to map origin of "PointFrameId"
- **PointFrameId:** Map name of the related map origin, to which X and Y values are transformed. Depends on the parameter "Global Frame Id" in "user_def" file.

Function "export layout"

The function "export layout" exports the entire path layout information into a CSV file, also including the control points of a path besides the path segments. This function is used to recreate and/or redraw the full ANS+ path layout inside a different external system. The following illustration shows an example CSV file, which has already been imported to Microsoft Office Excel.

Note

The layout export sorts the individual segments of a path in ascending numerical order of a segment’s start ID as exemplary depicted in Figure 12-13. This order is not necessarily identical with the geographic order in which the AGV moves along a path (see e.g. path 203_211_Showroom.poc), as ident point numbering concepts are user specific and might jump between each other.
In that case, the respective lines in the layout export file need to be moved by the user until they meet the desired order. The control point order can remain.

RouteFileName	Type	MapFileName	SegmentName	BiDirectional	StartID	StartX [m]	StartY [m]	EndID	EndX [m]	EndY [m]	PointFrameId	Handle1	Handle2
201_202_Showroom.poc	Path	NbgShowroom.map									NbgShowroom.map		
201_202_Showroom.poc	Segment	NbgShowroom.map	201_202	1	201	-6.974	-2.981	202	-4.476	0.019	NbgShowroom.map		
201_202_Showroom.poc	ControlPoint	NbgShowroom.map				-6.974	-2.981				NbgShowroom.map	0.000	0.500
201_202_Showroom.poc	ControlPoint	NbgShowroom.map				-6.974	0.019				NbgShowroom.map	0.500	0.700
201_202_Showroom.poc	ControlPoint	NbgShowroom.map				-4.946	0.017				NbgShowroom.map	0.300	0.500
201_202_Showroom.poc	ControlPoint	NbgShowroom.map				-4.474	0.019				NbgShowroom.map	0.500	0.000
202_203_Showroom.poc	Path	NbgShowroom.map									NbgShowroom.map		
202_203_Showroom.poc	Segment	NbgShowroom.map	202_203	1	202	-4.474	0.019	203	0.025	0.019	NbgShowroom.map		
202_203_Showroom.poc	ControlPoint	NbgShowroom.map				-4.474	0.019				NbgShowroom.map	0.000	0.500
202_203_Showroom.poc	ControlPoint	NbgShowroom.map				0.026	0.019				NbgShowroom.map	0.500	0.000
202_215_Showroom.poc	Path	NbgShowroom.map									NbgShowroom.map		
202_215_Showroom.poc	Segment	NbgShowroom.map	202_215	1	202	-4.474	0.019	215	-2.980	-2.989	NbgShowroom.map		
202_215_Showroom.poc	ControlPoint	NbgShowroom.map				-4.474	0.019				NbgShowroom.map	0.000	0.100
202_215_Showroom.poc	ControlPoint	NbgShowroom.map				-2.974	0.019				NbgShowroom.map	0.900	0.500
202_215_Showroom.poc	ControlPoint	NbgShowroom.map				-2.986	-2.996				NbgShowroom.map	0.500	0.500
202_215_Showroom.poc	ControlPoint	NbgShowroom.map				-2.974	-2.981				NbgShowroom.map	0.500	0.000
203_211_Showroom.poc	Path	NbgShowroom.map									NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	110_208	1	110	5.028	-7.869	208	5.026	-10.022	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	120_222	1	120	5.029	-6.754	222	5.027	-6.980	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	203_213	1	203	0.026	0.011	213	1.238	0.011	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	204_216	1	204	2.532	0.011	216	5.026	-3.236	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	208_209	1	208	5.026	-10.022	209	2.804	-11.889	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	209_210	1	209	2.804	-11.889	210	1.044	-11.889	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	210_211	1	210	1.044	-11.889	211	-2.974	-8.993	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	213_204	1	213	1.238	0.011	204	2.532	0.011	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	216_120	1	216	5.026	-3.236	120	5.029	-6.754	NbgShowroom.map		
203_211_Showroom.poc	Segment	NbgShowroom.map	222_110	1	222	5.027	-6.980	110	5.028	-7.869	NbgShowroom.map		
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				0.026	0.011				NbgShowroom.map	0.000	0.500
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				2.526	0.011				NbgShowroom.map	0.500	0.020
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.026	0.011				NbgShowroom.map	0.980	0.603
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.026	-3.780				NbgShowroom.map	0.397	0.500
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.031	-6.753				NbgShowroom.map	0.500	0.500
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.026	-6.989				NbgShowroom.map	0.500	0.500
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.029	-7.863				NbgShowroom.map	0.500	0.500
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.026	-9.989				NbgShowroom.map	0.500	0.005
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				5.026	-11.889				NbgShowroom.map	0.995	0.515
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				1.026	-11.889				NbgShowroom.map	0.485	0.403
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				-2.974	-11.889				NbgShowroom.map	0.597	0.811
203_211_Showroom.poc	ControlPoint	NbgShowroom.map				-2.974	-8.989				NbgShowroom.map	0.189	0.000

Figure 14-14 Exported entire path layout by using “export layout”

The columns provide the following additional information:

- **Type:** The type of the related data line.
  Possible types: Path, Segment, ControlPoint
- **StartID:** UID of the starting ident point of the path segment
- **EndID:** UID of the starting ident point of the path segment
- **Handle1:** First curve description value related to the control point
- **Handle2:** Second curve description value related to the control point

Note

SIMOVE ANS+ uses for its trajectories the approach of "Bézier Curves" in the second degree, which requires for each control point two handle curve description values.

14.6 External Pose Interface

The "External Pose Interface" (EPI) is an optional interface between the ANS+ NC module and the SIMOVE Carrier Control. With this telegram, the ANS+ system can use an external localization system as source instead of its own laser-based localization source.

In the current approach, it is only possible to use either the laser-based or the EPI source for navigation and localization purposes.

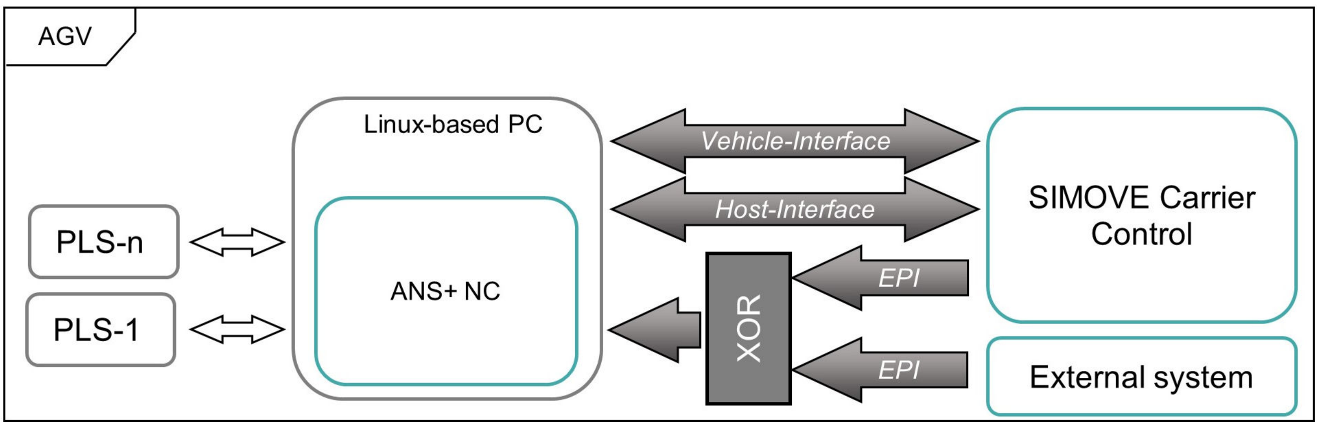


Figure 14-15 SIMOVE ANS+ interface overview

This telegram can be sent event-based or cyclic to the ANS+ NC module.

> **⚠ WARNING**
>
> **No validation of data**
>
> In case of an activated EPI, the ANS+ system will use the data provided in the telegram without any validation check and update its localization pose.

To enable the external pose interface, several parameters in different files need to be adjusted related to the external system:

- **hardware**: In this file, the related socket information, IP and port, is parametrized.

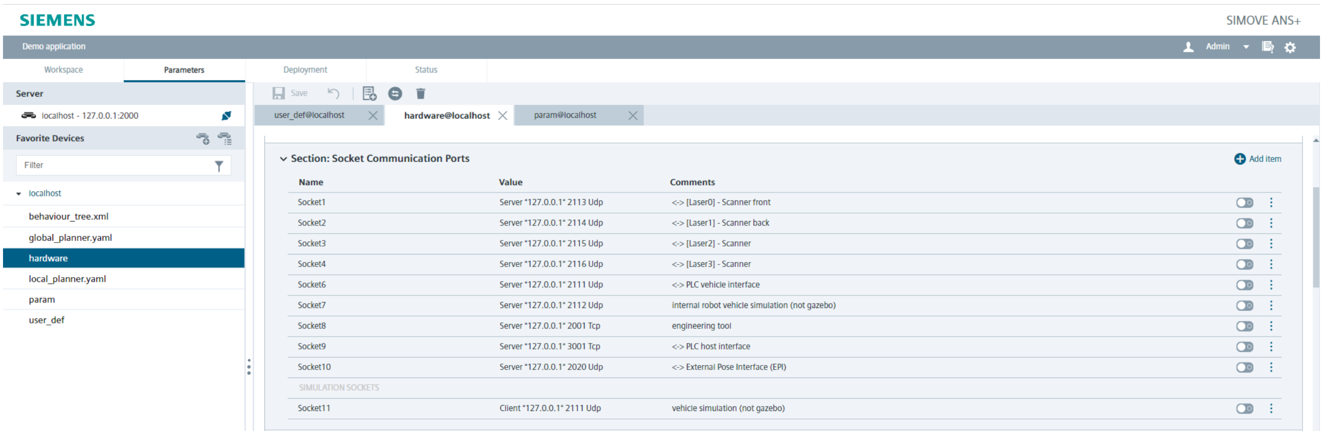


Figure 14-16 EPI – socket parameters in "hardware" file

- **param**: To enable the EPI, the enable parameter needs to be changed to "yes".

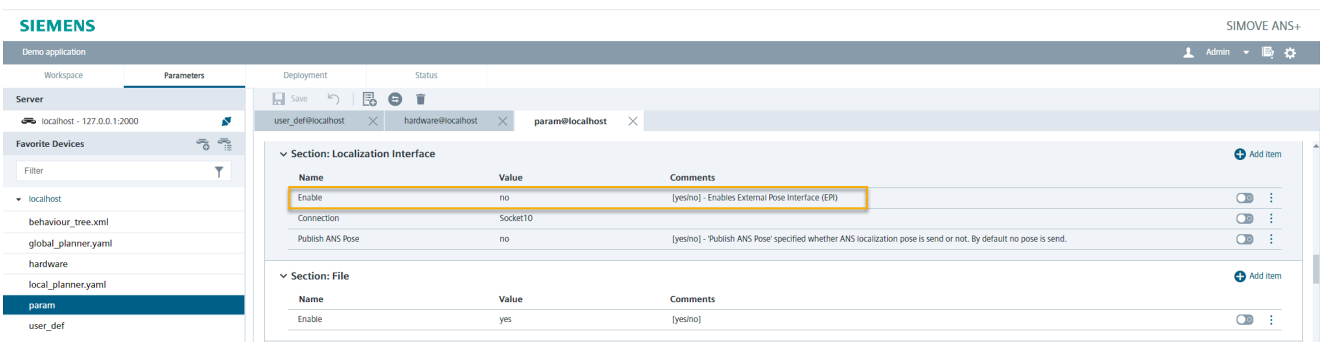


Figure 14-17 EPI – General parameters in "param" file

- **user_def**: f EPI pose data should be used, the parameter "Localization source" needs to be changed to "Epi".

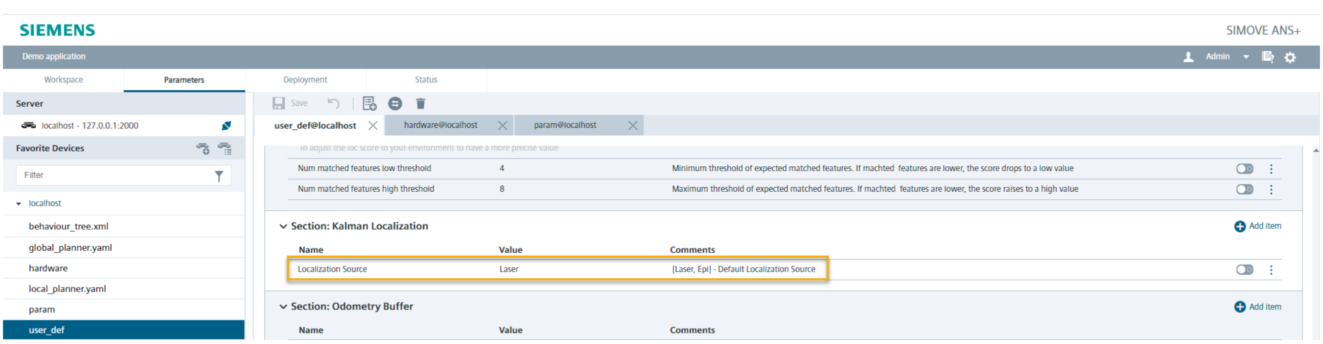
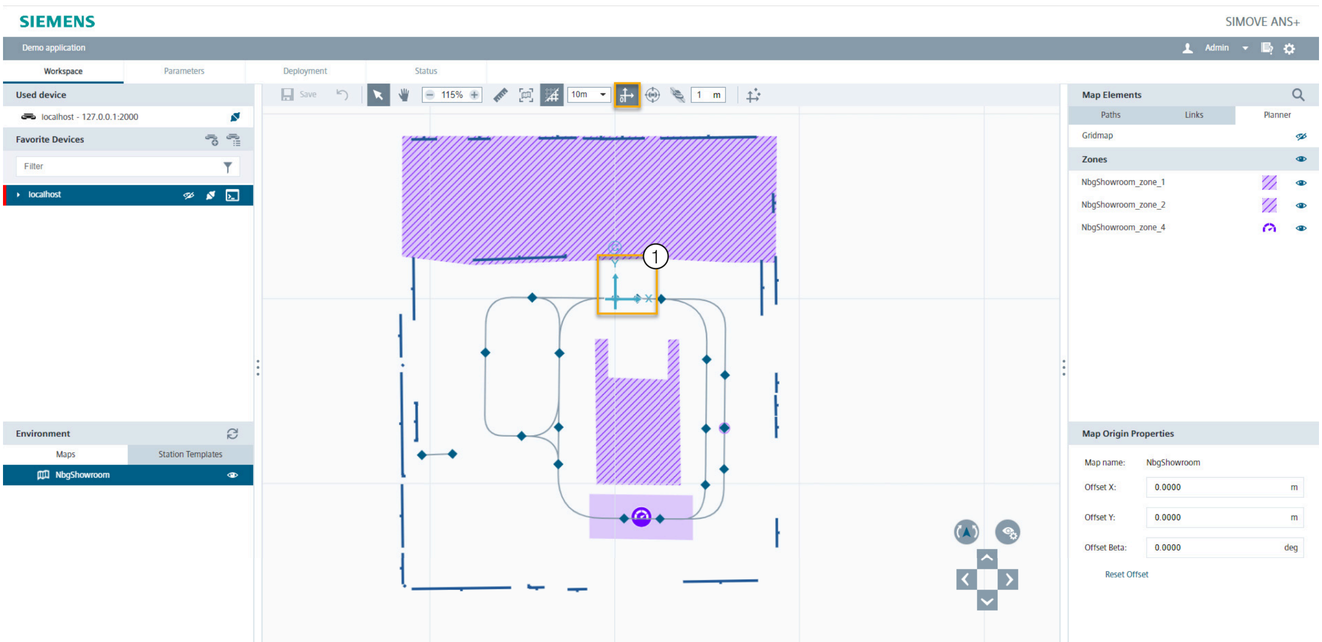


Figure 14-18 EPI – Localization parameters in "user_def" file

14.7 Map origin changes

The default pose of a map's origin is where the mapping has been started. For certain use cases, it might be necessary to change this pose.

To visualize the current pose of the map's origin, select the related map, instance or template and click on ✢ to activate its visualization in the world window.

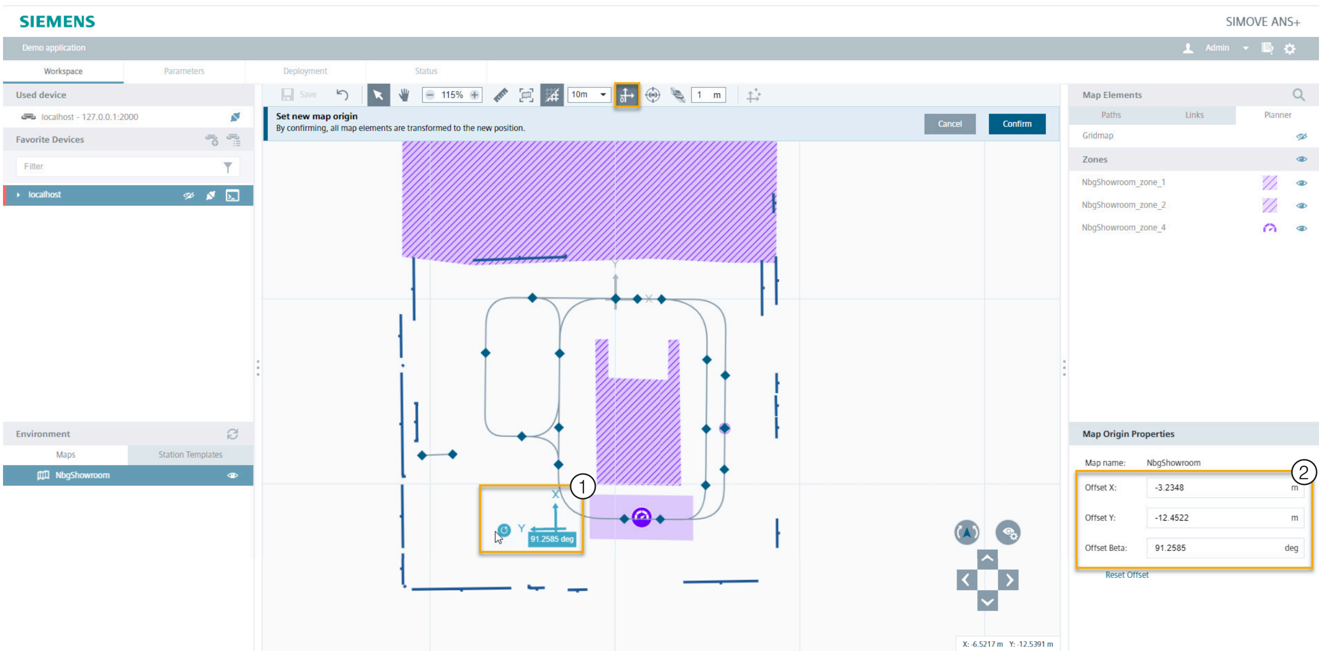


① Map origin

Figure 14-19 Map origin visualization

The ANS+ ET provides two approaches to change the pose of a map origin:

- **Drag&Drop**: Click on the map origin in the world window and shift its position via Drag&Drop or the rotate icon. Fine-tuning is possible by using the "Offset textboxes" within the properties window.



① Map origin
② Offset properties

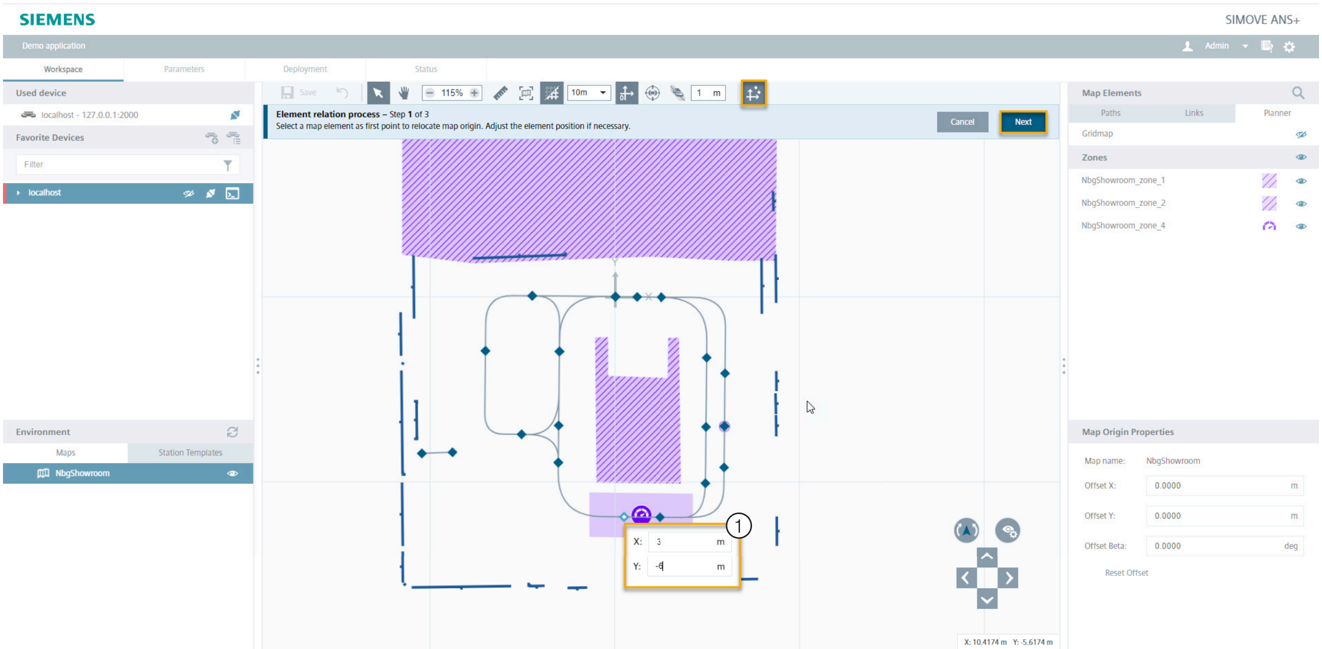
Figure 14-20 Map origin changed via Drag&Drop

- **Element relation process**: This process is used to calculate a new map origin's position. For this purpose, positions for two map elements are specified in relation to, for example, a CAD layout.

WARNING
Inserted data are not validated
It is the responsibility of the commissioner to use the correct position data for the elements. There is no validation check of the inserted data in the ANS+ ET.

1. Click on the map origin in the world window.
2. Press to start the process.
3. Click on an element in the map to specify its new position.

4. Press "Next".

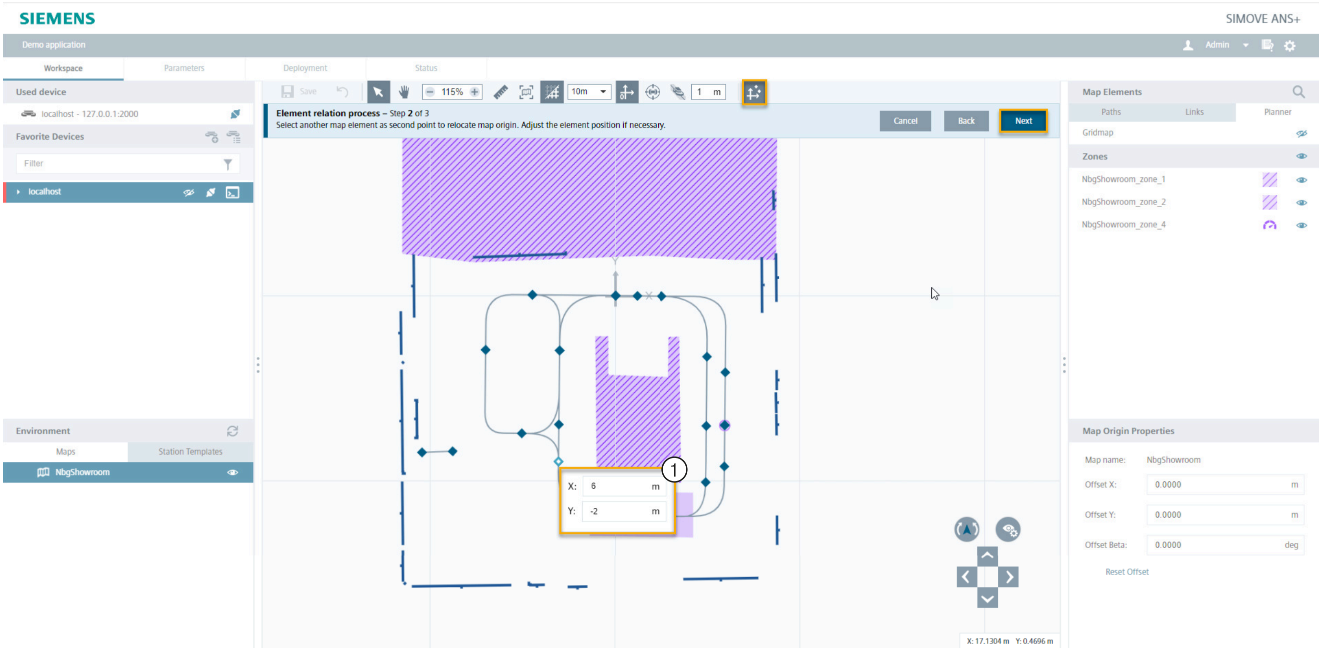


① First element

Figure 14-21 First element position adjustment

5. Click on another element for the next position definition.

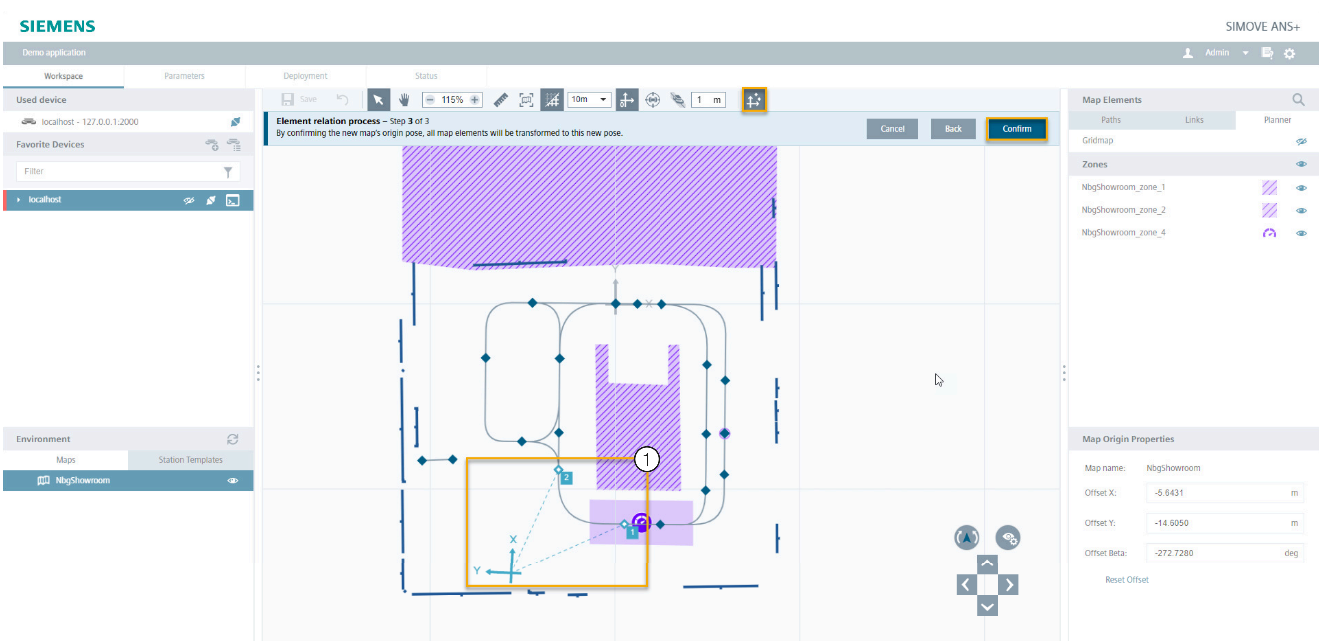
6. Press "Next" to proceed.



① Second element

Figure 14-22 Second element position adjustment

The ANS+ ET uses the given elements' position data to calculate and visualize the related pose of the map origin.



① Visualization of related pose

Figure 14-23 Second element position adjustment

7. The calculated result needs to be confirmed to apply the new pose.

8. Click "Save" to write the changes to the files.
9. To confirm this new setup to the ANS+ NC module, reload the atlas content, as shown in Figure 6-24 Reload AGV atlas (Page 93).

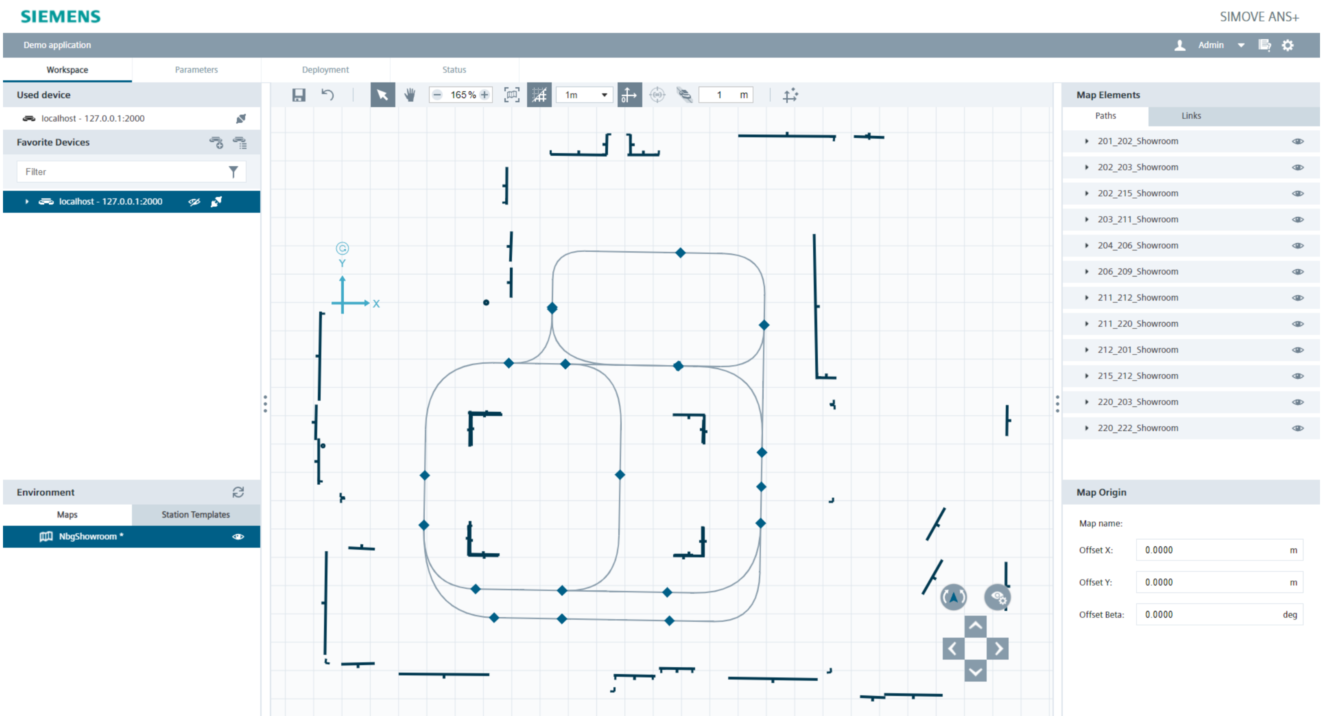


Figure 14-24 Confirmed map origin pose update

14.8 Laser configuration examples

14.8.1 SICK microScan3 Core/Pro

To be able to parametrize a SICK microScan3 device, the SICK software "Safety Designer" is required. It can be downloaded from the company's webpage.

Once the PROFINET configuration is finished and the device is commissioned, it is necessary to configure two more pages within the "Safety Designer" tool:

- Monitoring plane
- Data output

On the page "Monitoring plane", the scan resolution, highlighted in the illustration below, can be configured. Related to this configuration, the ANS+ parameter "Resolution" in the section "Laser X" requires a specific value parametrization.

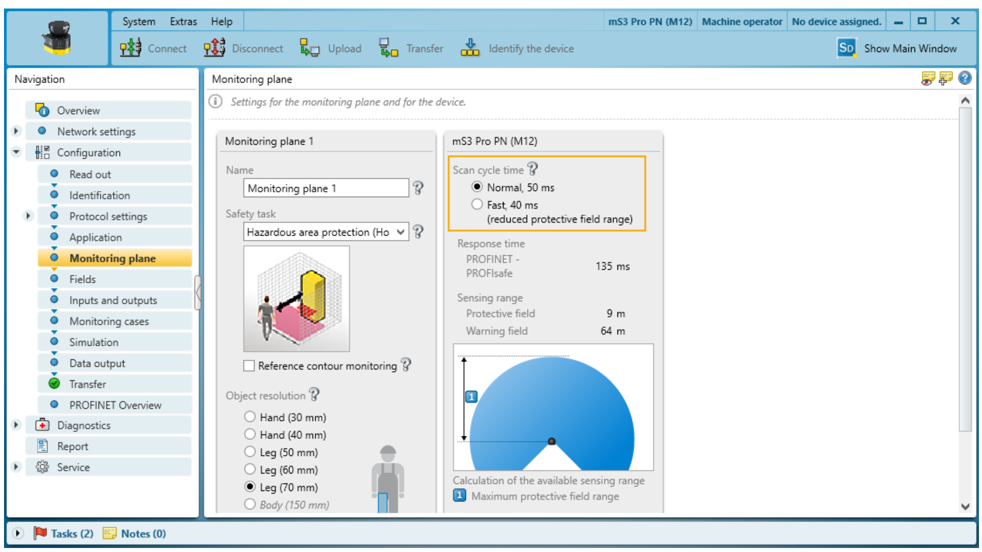


Figure 14-25 Safety Designer – "Monitoring plane" configuration page

Type	SICK Scan cycle time	ANS+ Resolution
MICS3-CBAZ40PZ1P01 MICS3-CBAZ50PZ1P01	Normal, 40 ms	0.385
MICS3-CBAZ40PZ1P01 MICS3-CBAZ50PZ1P01	Fast, 30 ms	0.51
MICS3-CBAZ90PZ1P01	Normal, 50 ms	0.1
MICS3-CBAZ90PZ1P01	Fast, 40 ms	0.125

To receive the laser measurement data at the Linux OS, the "Data output" page needs to be configured. The port differentiates between the front (2113 – "Laser 0" section) and the back scanner (2114 – "Laser 1 section) of an AGV.

If adjustments are made to the start/- end angles in the Safety Designer, it is necessary to apply the values in the ET that the Safety Desinger shows in the brackets ("results XXX,X°") , even if "results" differs from the applied angles.

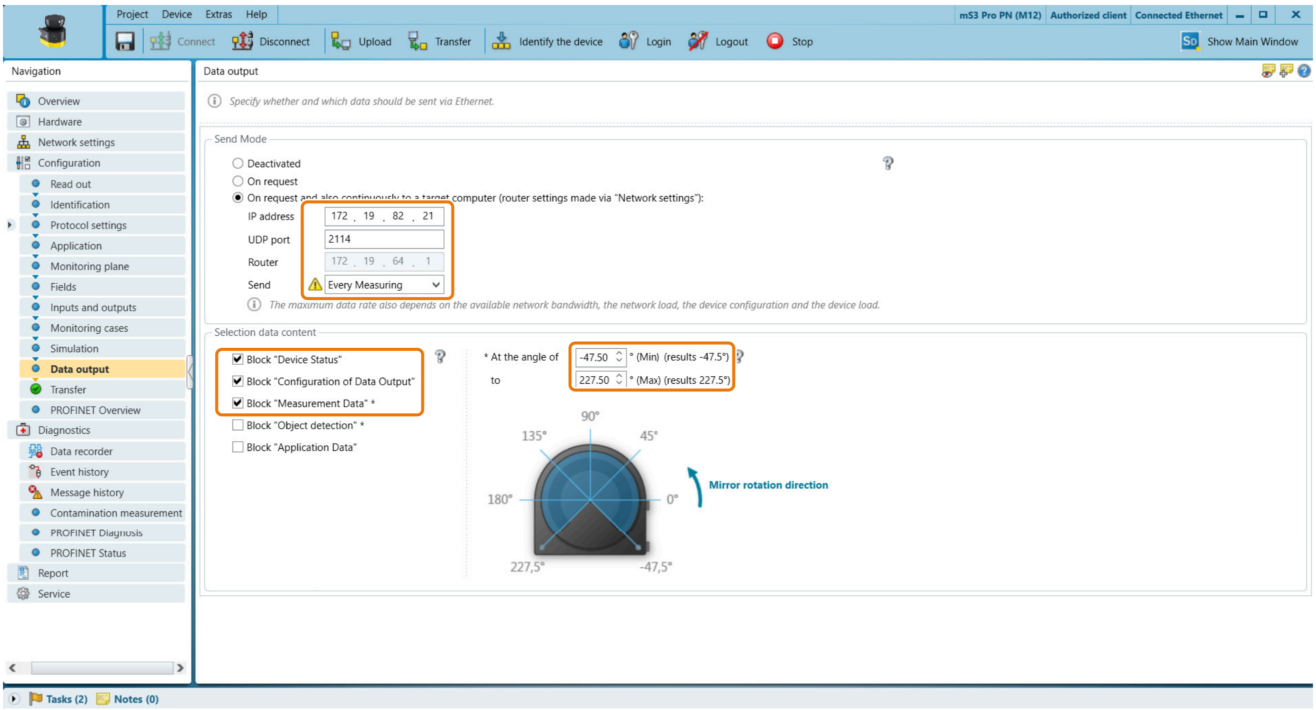
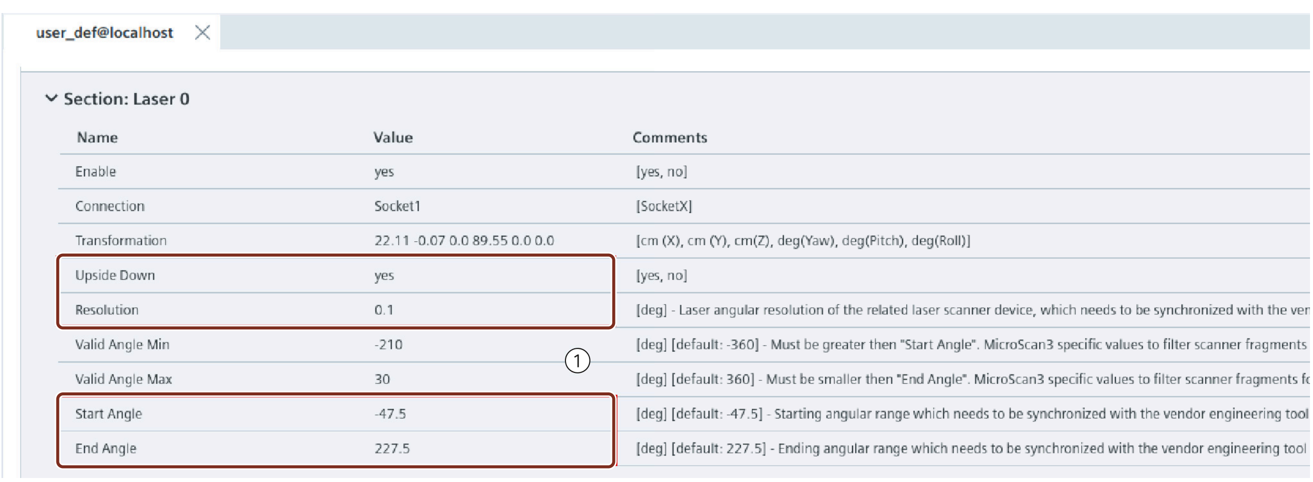


Figure 14-26 Safety Designer microScan3 – "Data output" page

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings. For the mircoScan3 device, it is required to adjust additionally the parameters "Upside Down" in case of an inverted mounting and "Resolution" in relation to the configured "Scan Resolution".



Name	Value	Comments
Enable	yes	[yes, no]
Connection	Socket1	[SocketX]
Transformation	22.11 -0.07 0.0 89.55 0.0 0.0	[cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)]
Upside Down	yes	[yes, no]
Resolution	0.1	[deg] - Laser angular resolution of the related laser scanner device, which needs to be synchronized with the ver
Valid Angle Min	-210	[deg] [default: -360] - Must be greater then "Start Angle". MicroScan3 specific values to filter scanner fragments
Valid Angle Max	30	[deg] [default: 360] - Must be smaller then "End Angle". MicroScan3 specific values to filter scanner fragments fo
Start Angle	-47.5	[deg] [default: -47.5] - Starting angular range which needs to be synchronized with the vendor engineering tool
End Angle	227.5	[deg] [default: 227.5] - Ending angular range which needs to be synchronized with the vendor engineering tool

① Parameters to change

Figure 14-27 ANS+ "user_def" – microScan3 configuration example

14.8.2 SickTIM 781

SickTIM 781

To parametrize a Sick TIM781 device, the Sick software "Sopas Engineering Tool" is required. It can be downloaded from the company's webpage.

Once the PROFINET configuration is finished and the device is commissioned, it is necessary to configure two more pages within the Sopas tool:

- Data processing
- Network → Ethernet

The main settings for the scanner data are configured within the "Data processing" page, shown in the illustration "Sopas Engineering Tool TIM781 – Data processing page".

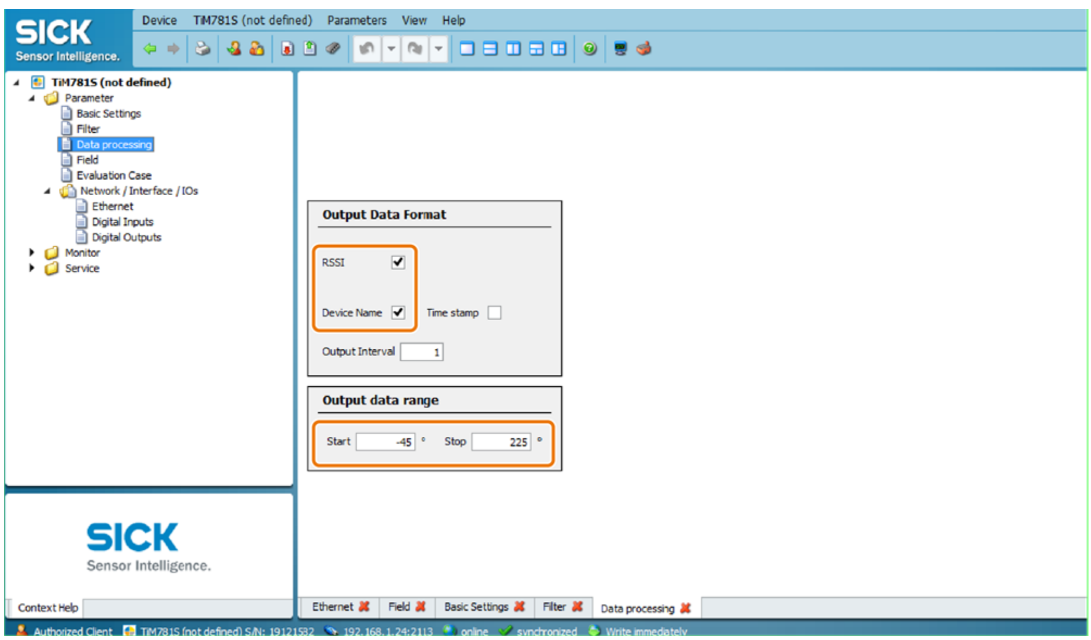


Figure 14-28 Sopas Engineering Tool TIM781 – Data processing page

Within the "Ethernet" page, two more configurations need to be done besides the IP-settings: the IP-Port and the Dialect. The Dialect has always to be set to "CoLa ASCII". The IP-Port can change between applications, but the port number needs to be the same within the SICK Tool and the ANS+ ET socket parameter.

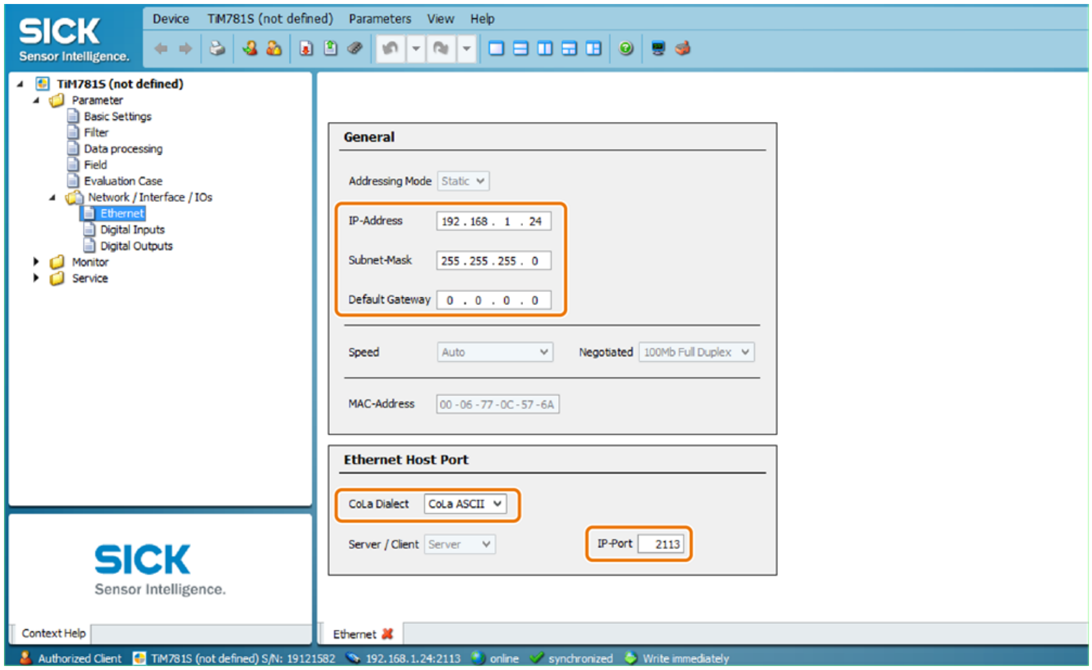


Figure 14-29 Sopas Engineering Tool TIM781 - Ethernet page

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings. For the TIM781 device, it is required to add a specific client socket connection related to the scanner settings of the Sopas "Ethernet" page. Additionally, several ANS+ parameters need to be added to the scanner section.

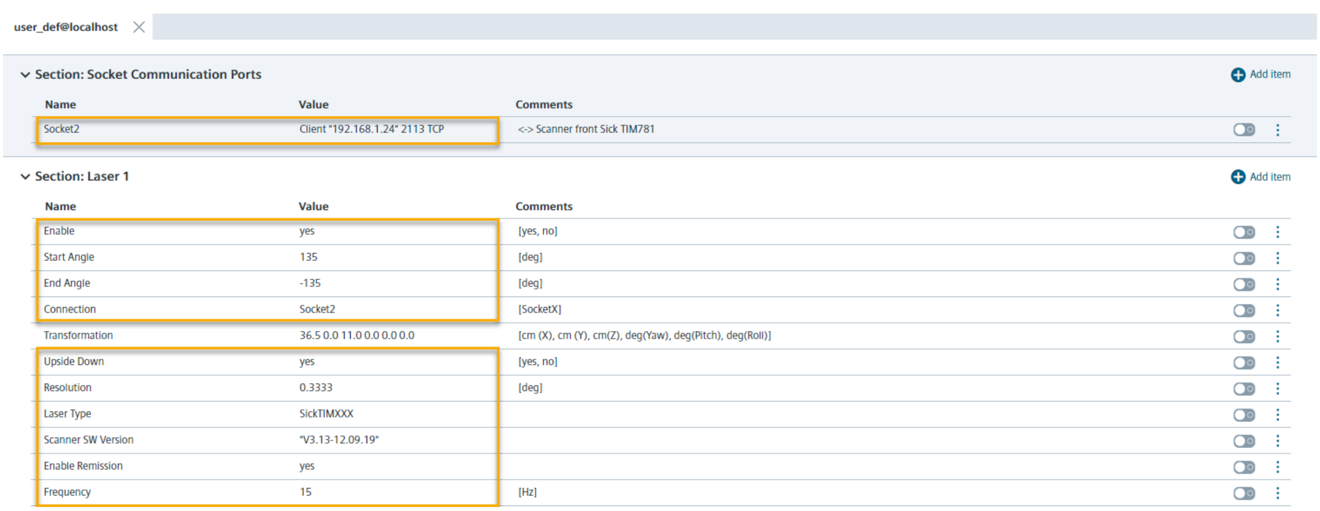


Figure 14-30 ANS+ user_def – TIM781 configuration example

14.8.3 Sick NAV310

The NAV310 scanner uses the same engineering software as SickTIM, called "SOPAS Engineering Tool". It can be downloaded from the company's webpage.

Once the PROFINET configuration is finished and the device is commissioned, it is necessary to configure two more pages within the "SOPAS Engineering Tool":

- Basic Settings
- Network → Ethernet

Within the "Basic Settings" page, it is necessary to activate the checkbox "Auto start measure". Otherwise, the scanner will not start to generate laser data.

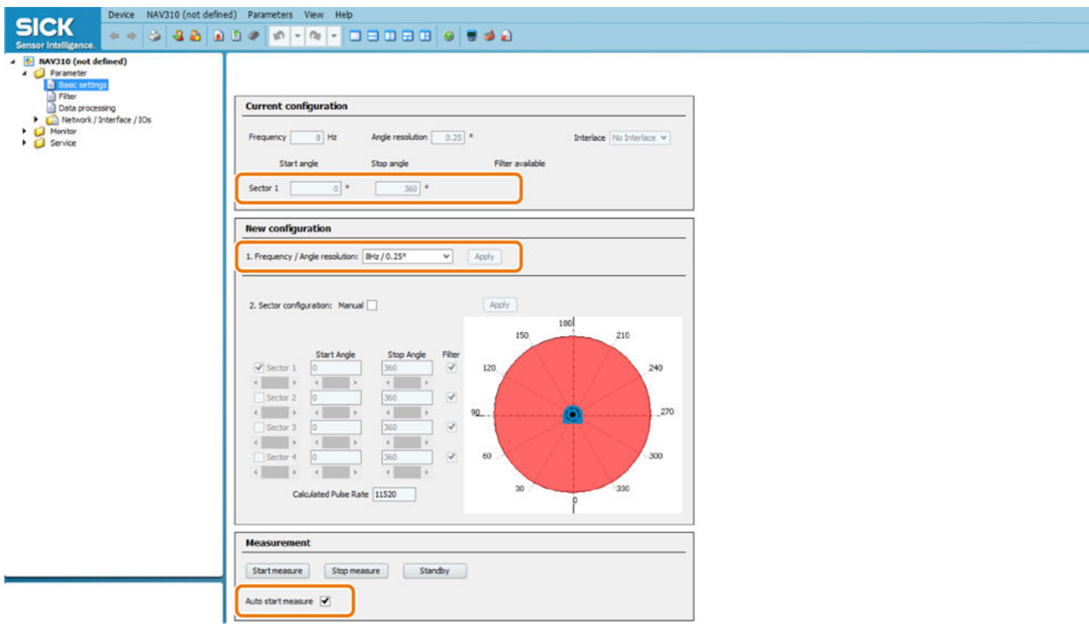


Figure 14-31 Sopas Engineering Tool NAV310 - Basic Settings page

All IP and port configurations can be done at the "Ethernet" page.

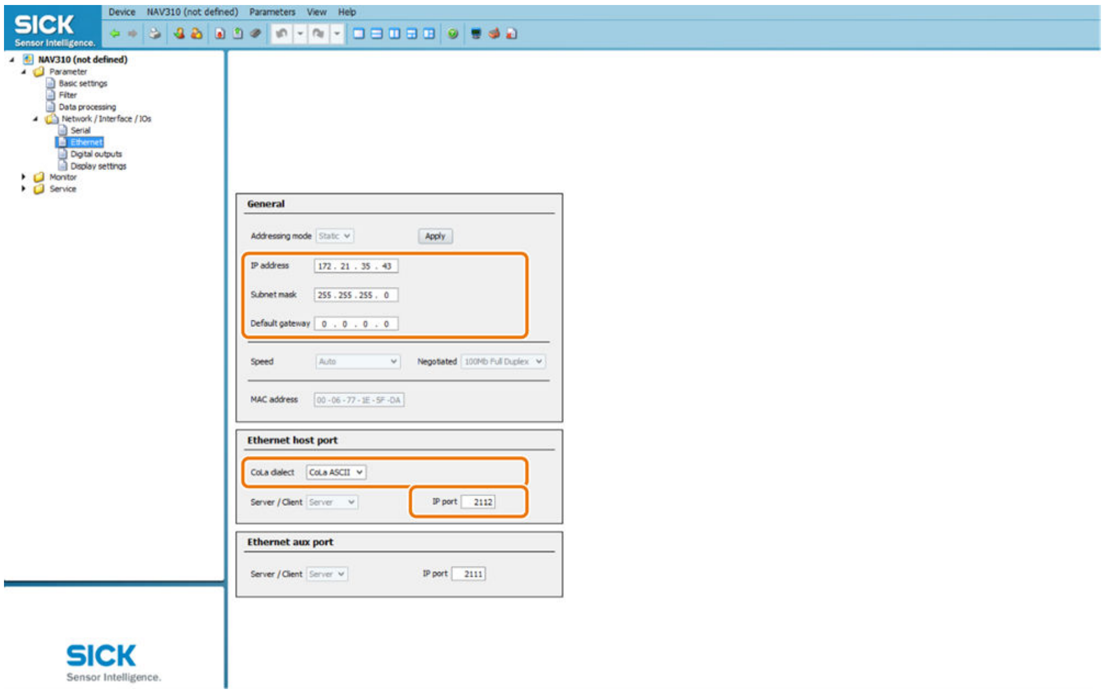


Figure 14-32 Sopas Engineering Tool NAV310 - Ethernet page

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings. For the NAV310 device, it is required to add a specific client socket connection related to the scanner settings of the Sopas "Ethernet" page. Additionally, several ANS+ parameters need to be added to the scanner section.

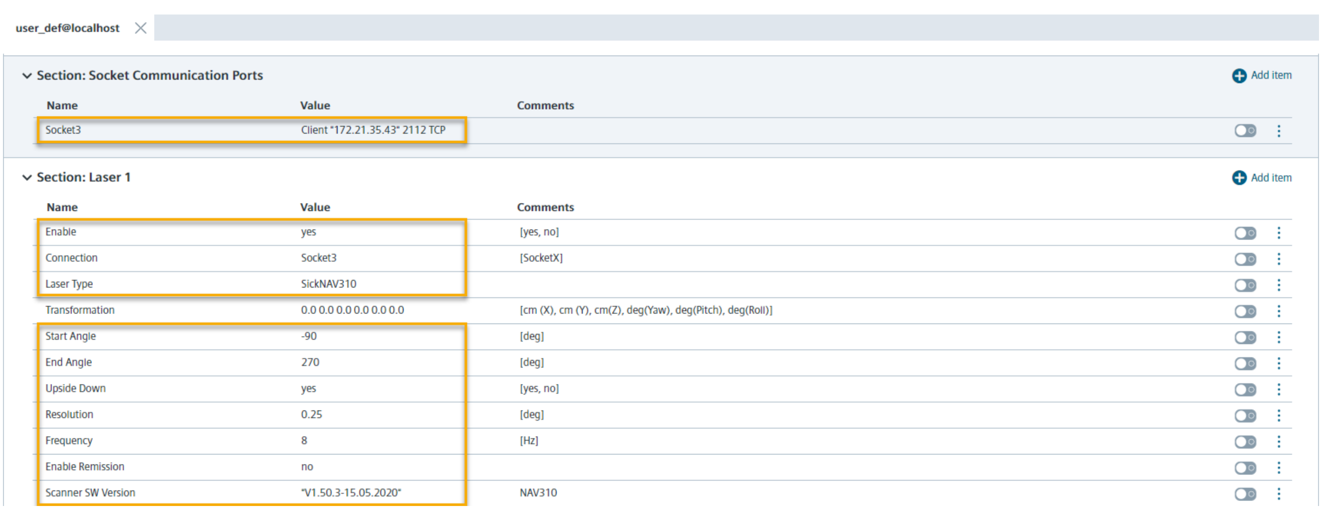


Figure 14-33 ANS+ ET user_def – NAV310 configuration example

14.8.4 SICK nanoScan3

To be able to parametrize a SICK nanoScan3 device, the SICK software "Safety Designer" is required. It can be downloaded from the company's webpage.

Once the PROFINET configuration is finished and the device is commissioned, it is necessary to configure one more page within the "Safety Designer" tool:

- Data output

To receive the laser measurement data at the Linux OS, the "Data output" page needs to be configured. The port differentiates between the front (2113 – "Laser 0" section) and the back scanner (2114 – "Laser 1" section) of an AGV.

If adjustments are made to the start/- end angles in the Safety Designer, it is necessary to apply the values in the ET that the Safety Desinger shows in the brackets ("results XXX,X") , even if "results" differs from the applied angles.

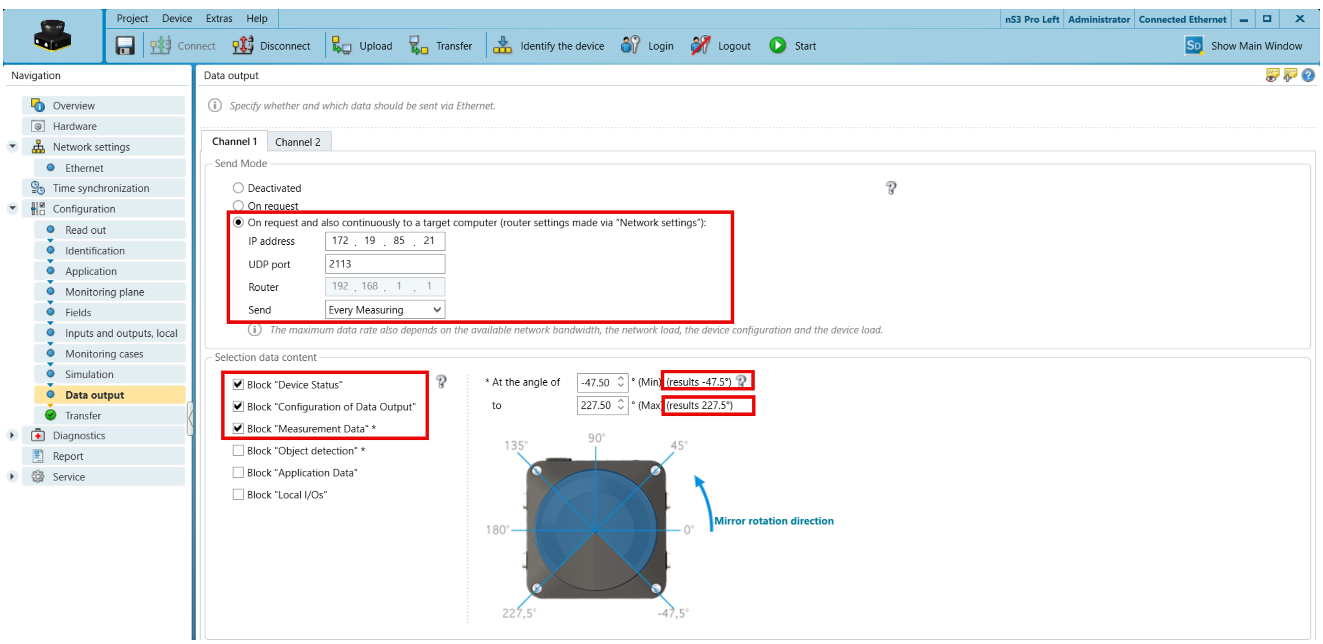


Figure 14-34 Safety Designer nanoScan3 – "Data output" page

For the nanoScan3 device, it is required to add specific parameters. Additionally, common ANS+ parameters, such as "Transformation" and/or "Upside Down" need to be configured related to the mechanical mounting of the scanner.

Section: Laser 0

Name	Value	Comments
Enable	yes	[yes, no]
Connection	Socket1	[SocketX]
Transformation	186.3 47.0 16.0 -46.15 0.0 0.0	[cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)]
Upside Down	no	[yes, no]
Resolution	0.17	[deg] - Laser angular resolution of the related laser scanner device, which needs to be synchronized with th
Frequency	33	[Hz]
Start Angle	-47.5	[deg] [default: -47.5] - Starting angular range which needs to be synchronized with the vendor engineering
End Angle	227.5	[deg] [default: 227.5] - Ending angular range which needs to be synchronized with the vendor engineering

Figure 14-35 ANS+ ET "user_def" – nanoScan3 configuration example

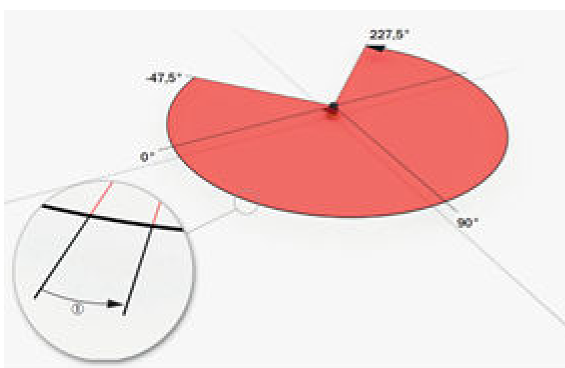
For the nanoScan3 device, the value "Frequency" needs to be adjusted in relation to the configured laser beam resolution.

Laser resolution [deg]	Frequency [Hz]
0.1	20
0.125	25
0.17	33
0.39	25
0.51	33

Note

0° beam point

The SICK miroscan3 and nanoScan3 scanners share the same 0° beam point, specified in the technical device specification of SICK. This special point is required for the ANS+ laser transformation estimation.



Source: https://cdn.sick.com/media/docs/6/36/136/operating_instructions_nano-scan3_i_o_de_im0087136.pdf

Figure 14-36 SICK mircoScan3 and nanoScan3 0°-beam point

14.8.5 SICK Picoscan 100

To parametrize a SICK Picoscan device, the SICK software "Sopas Engineering Tool" is required. It can be downloaded from the company's webpage. Within the Sopas Engineering Tool, the necessary drivers for the Picoscan can be installed by selecting install device drivers.
It is necessary to configure two pages within the Sopas tool:

- Application → Data output
- Configuration → Connection options → Ethernet

The measurement output is configured within the "Data output" page, shown in the illustration below.

The format needs to be set to LMDscandata.

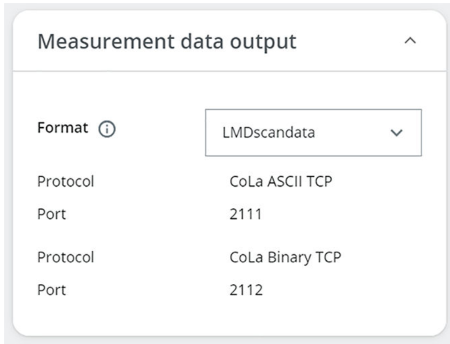


Figure 14-37 Sopas Engineering Tool Picoscan 100 – Data output settings

Within the "Ethernet" page, two more configurations need to be done besides the IP-settings:

- IP-Port
- Dialect

The Dialect has to be set to "CoLa ASCII" with legacy protocols on.

The IP-Port can change between applications, but the port number needs to be the same within the SICK Tool and the ANS+ ET socket parameter.

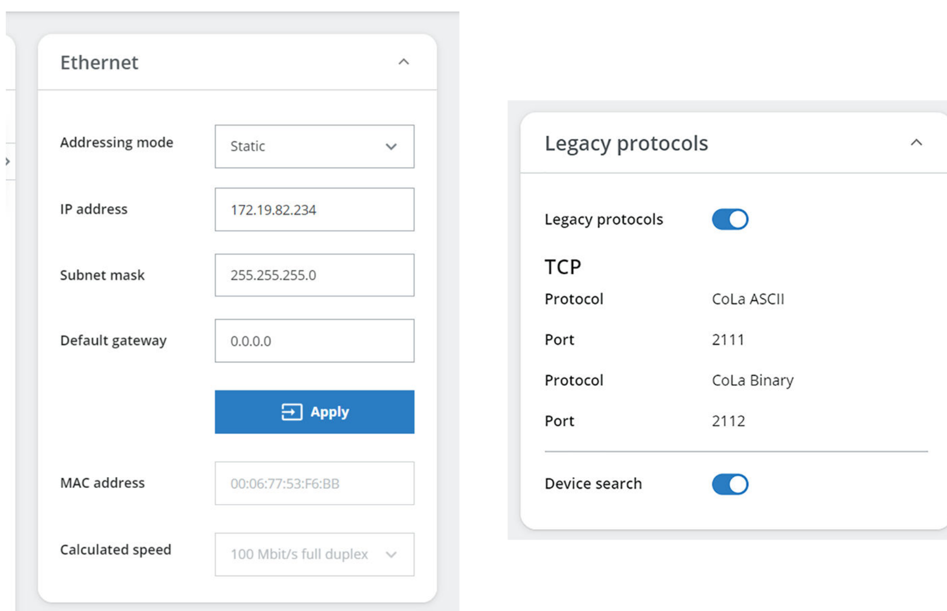


Figure 14-38 Sopas Engineering Tool Picoscan 100 - Ethernet page

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings.

For the Picoscan device, it is required to add a specific client socket connection related to the scanner settings of the Sopas "Ethernet" page. Additionally, several ANS+ parameters need to be added to the scanner section.

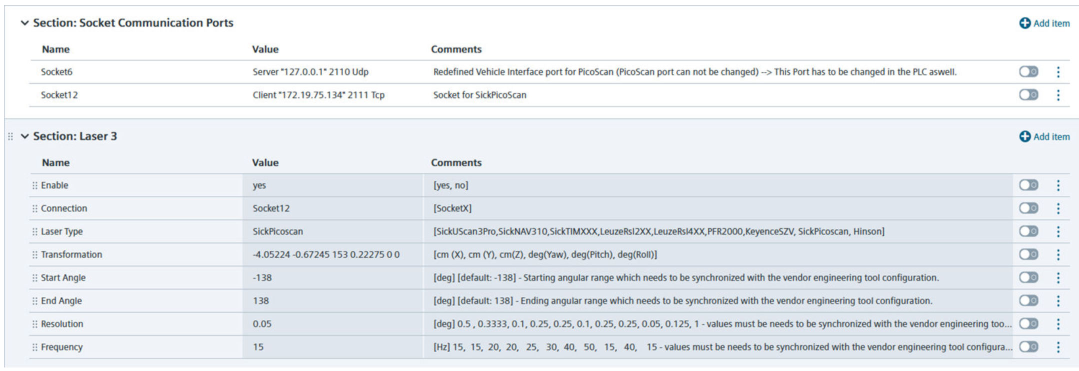


Figure 14-39 ANS+ user_def – Picoscan 100 configuration example

PLC configuration

The port on PicoScan cannot be changed. However, since this port overlaps with the standard port for the Vehicle Interface, the port for the Vehicle Interface on the PLC must also be changed for a successful connection.

- Adjust the ControlSocket parameter in the ParameterDB. This must be set to the same port as in ANS+ on Socket6.

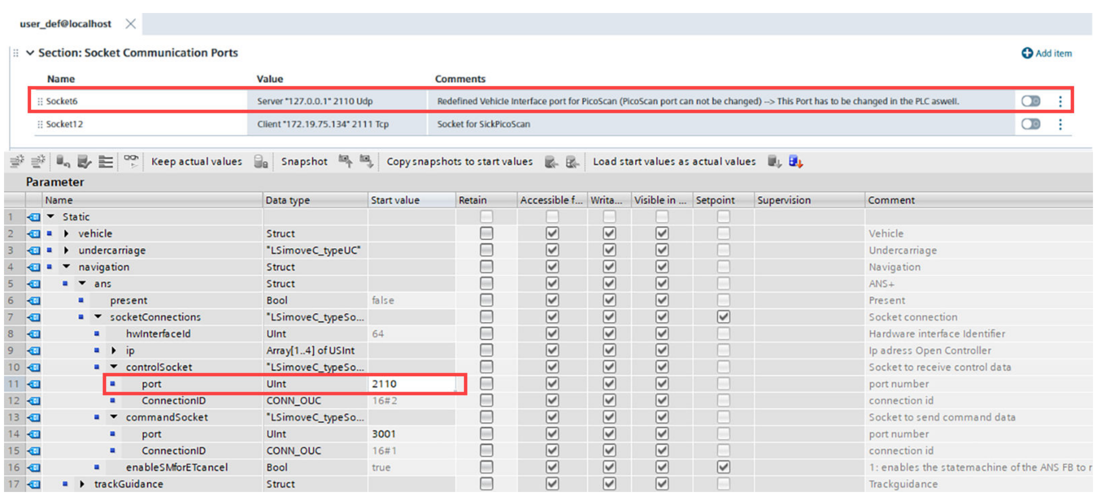


Figure 14-40 Change Vehicle Interface Ports for PicoScan

14.8.6 Leuze RSL455P

The following software needs to be installed to commission the Leuze laser scanner. It can be downloaded from the company's webpage.

In the following example, the software "SensorStudio" and "SafetyDeviceCollection-3.1.0.0" is used.

Software/driver (4)				
Type	Designation	Language	File size	Format
GSDML file	V2.34	Language-independent	12,7 KB	zip
Configuration/diagnostic software	Setup Sensor Studio V1.1.0	Language-independent	322 MB	zip
Configuration/diagnostic software	Setup Safety Device Collection V3.1.0.0	Language-independent	345,3 MB	zip
Software	RSL UDP	Language-independent	8,1 KB	zip

Figure 14-41 Leuze software for RSL455P commissioning

The following steps are required to receive the Leuze scanner data in SIMOVE ANS+:

1. Open PRONETA and set a temporary IP address of the Leuze laser scanner related to the AGV's network configuration.
2. Open the Leuze software "Sensor Studio".
3. Follow the short instruction guide from Leuze to establish an ethernet connection.

Note

Enter IP address directly

When connecting via ethernet cable, the IP address of the laser device has to be entered directly into "Sensor Studio" communication DTM before a connection can be established. After entering the IP address, click "Connect" to establish an online connection to the device.

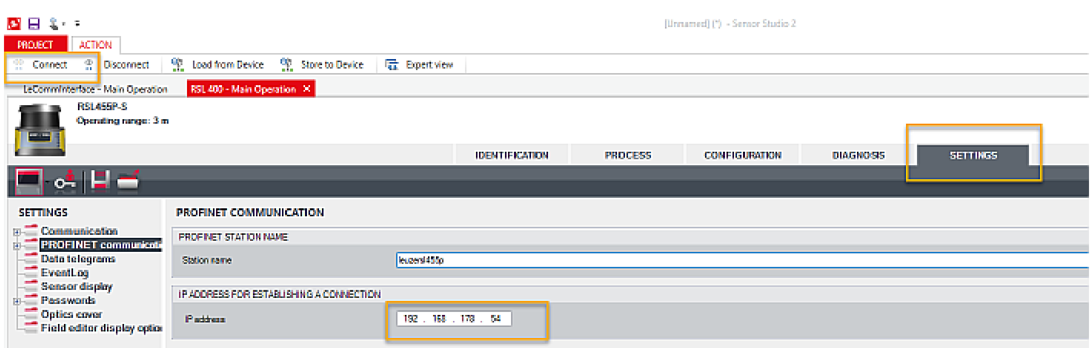


Figure 14-42 Leuze software to establish a connection

4. Specify the UDP telegram settings.
   The scanner supports an angle range between 0° and 269.9° with a resolution of 0.1°. The maximal scanner frequency can be set to 25 Hz. For this purpose, the parameter "Telegram interval" is set to 1, which represents 25 Hz.
   In order to receive laser data within SIMOVE ANS+, the data output via UDP needs to be enabled. For this purpose, the IP address of the ANS+ NC and the expected port have to be defined.

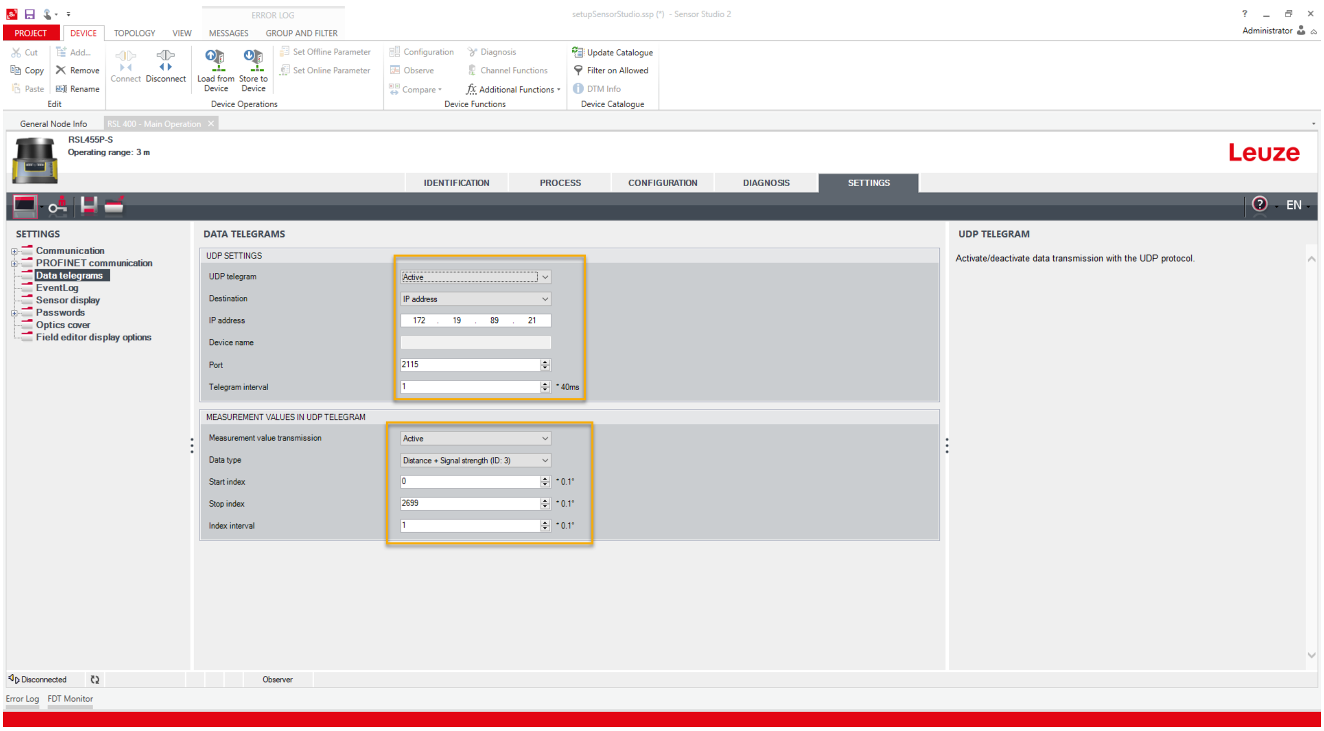


Figure 14-43 Leuze data telegram settings

5. Make sure to activate the automatic restart behavior of the scanner within the configuration tab.

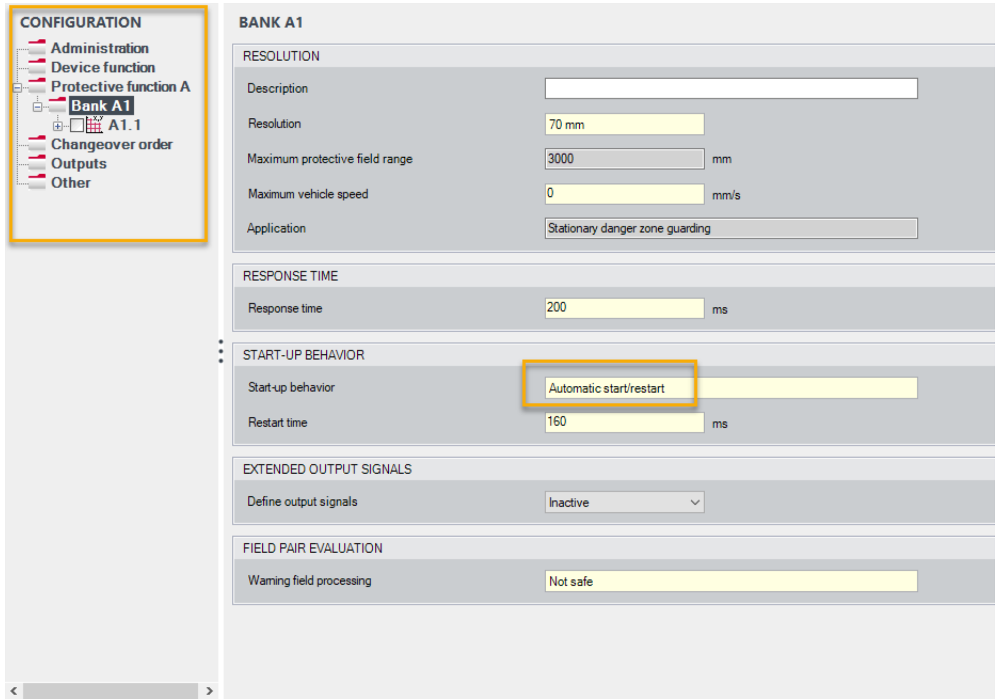


Figure 14-44 Leuze configuration settings

6. Once the scanner device has been fully commissioned and parametrized, synchronize the ANS+ laser parameters with the scanner parameters.
   For this purpose, the values for start and end angle range from 0° to +269.9° and the used scan resolution of 0.1° are set. Variable parameters, which need to be adjusted related to the AGV setup, are highlighted in the following illustration.

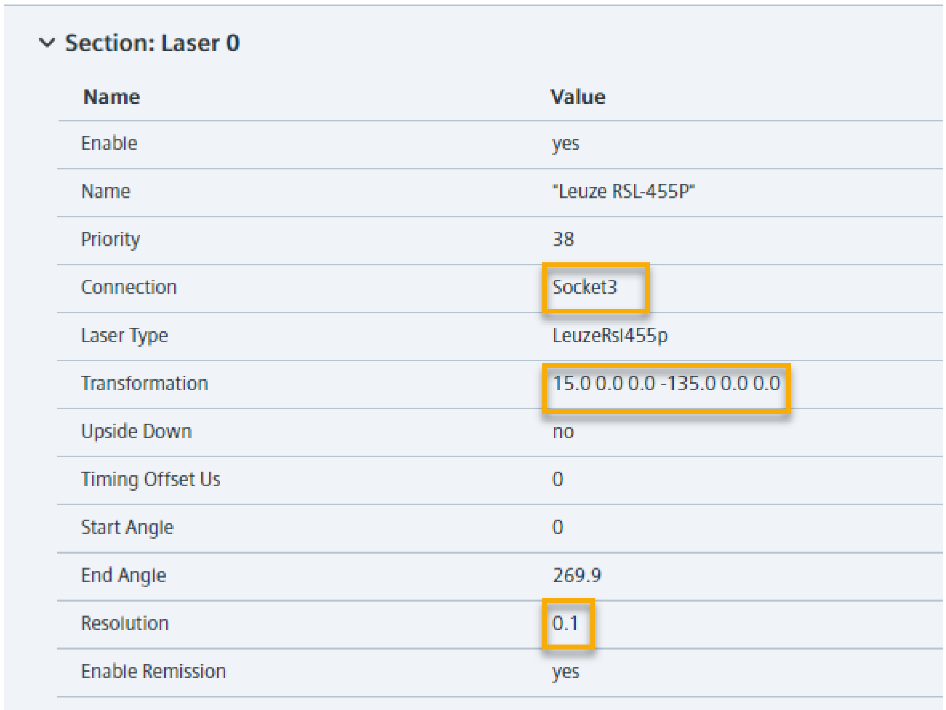


Figure 14-45 Leuze "user_def" example settings within ANS+ ET

7. Make sure to use the correct port number related to the used connection socket number (here: Connection "Socket3", Port "2115") that you specified in the Leuze telegram settings.

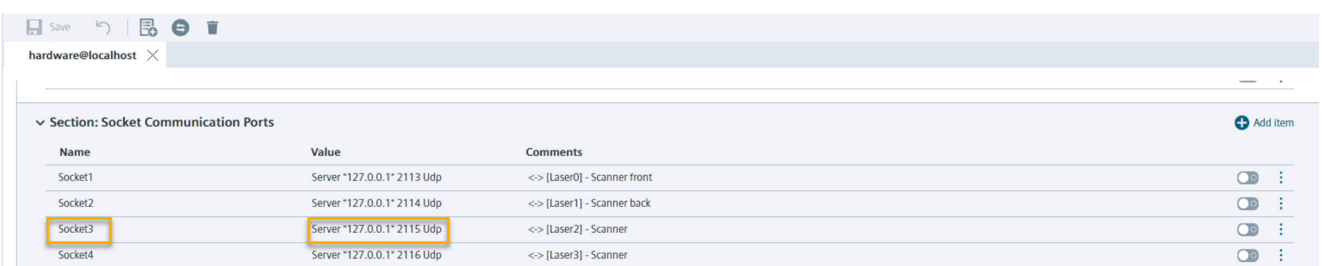


Figure 14-46 Compare telegram settings within ANS+ ET

8. Save all parameter changes and restart the ANS+ NC module to apply the configuration.

14.8.7 Leuze RSL235

The following software needs to be installed to commission the Leuze laser scanner. It can be downloaded from the company's webpage.

In the following example, the software "Sensor Studio" and "Safety Device Collection" is used.

Figure 14-47 Leuze software for RSL235 commissioning

The following steps are required to receive the Leuze scanner data in SIMOVE ANS+:

1. Open the Leuze software "Sensor Studio".
2. Connect the device via Ethernet cable or Bluetooth.
   - Search for the device in the "Sensor Studio" communication DTM.
   - Set IP address and subnet mask for the device.
   - Click "Connect" to establish an online connection to the device.
3. Follow the short instruction guide from Leuze to establish an ethernet connection.
   - Set IP address and subnet mask for the device.

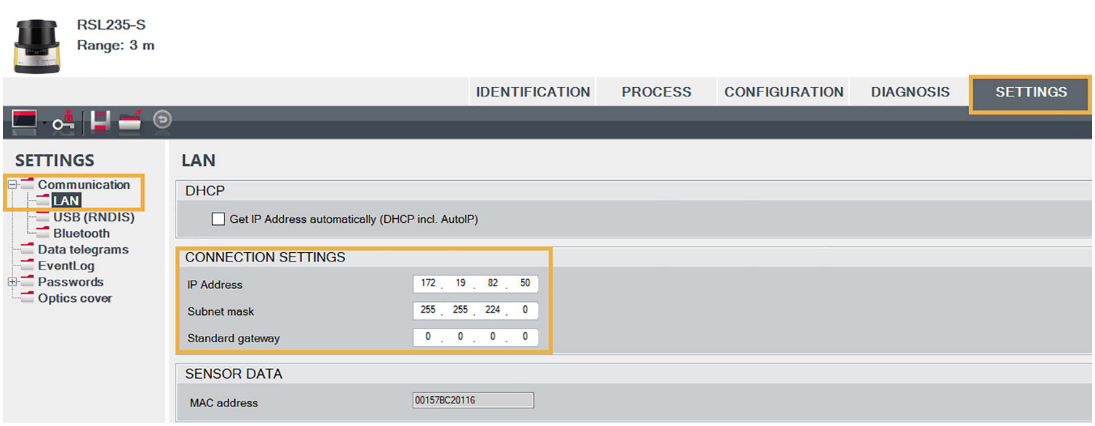


Figure 14-48 Leuze software to establish a connection

4. Specify the UDP telegram settings.
   – Select Settings → Data telegrams.

   Note

   - The scanner supports an angle range between 0° and 269.9° with a resolution of 0.2°.
     – Note that these parameters must be specified as a multiple of the given resolution, as shown in the figure below.
   - The scanner frequency is set to 40 Hz.
     – For this purpose, set the parameter "Telegram interval" to 1, which represents 40 Hz.

   – Set the IP to an address related to the AGV’s network configuration.

   – To receive laser data within SIMOVE ANS+, the data output via UDP needs to be enabled. For this purpose, define the IP address of the ANS+ NC and the expected port.

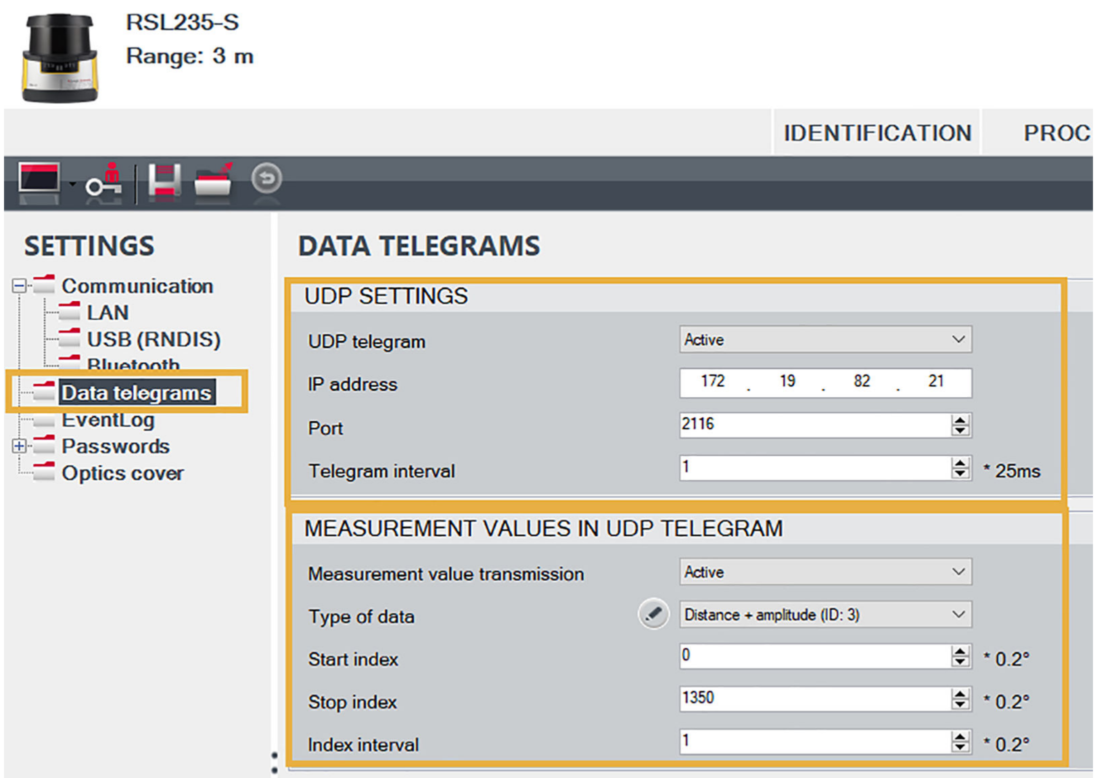


Figure 14-49 Leuze data telegram settings R235

5. Activate the automatic restart behavior of the scanner within the configuration tab.

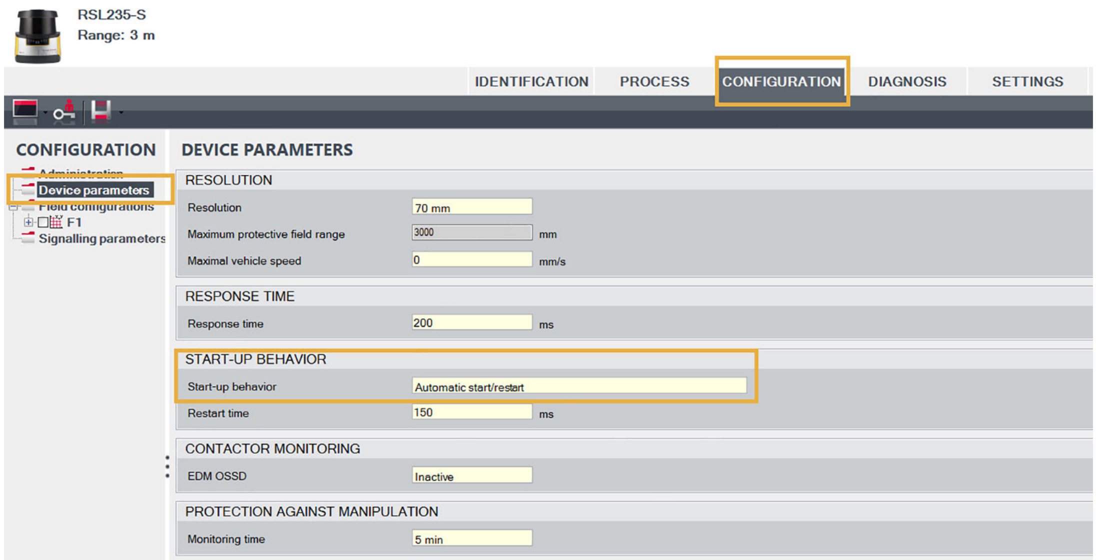


Figure 14-50 Leuze configuration settings

6. Once the scanner device has been fully commissioned and parametrized, synchronize the ANS+ laser parameters with the scanner parameters.
   - For this purpose, the values for start and end angle must exactly match 0° and +270.0°, other values will result in errors.
   - The scan resolution is set to 0.2° and the frequency accordingly to 40 Hz.

   Variable parameters, which need to be adjusted related to the AGV setup, are in the following illustration.

Section: Laser 2

Name	Value	Comments
Enable	yes	[no, yes]
Laser Type	LeuzeRsl2XX	[SickUScan3Pro,SickNAV310,SickTIMXXX,LeuzeRsl2XX,LeuzeRsl4XX,PFR2000,KeyenceSZV]
Connection	Socket4	[SocketX]
Transformation	0.0 0.0 0.0 0.0 0.0 0.0	[cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)]
Upside Down	no	[no, yes]
Start Angle	0.0	[deg]
End Angle	270.0	[deg]
Resolution	0.2	[deg]
Frequency	40	[Hz]
Enable Remission	yes	

Figure 14-51 Leuze "user_def" example settings within ANS+ ET

7. Ensure the correct port number related to the used connection socket number.
   – Here: Connection "Socket4" and Port "2116"
   – Specify the port number in the Leuze telegram settings.

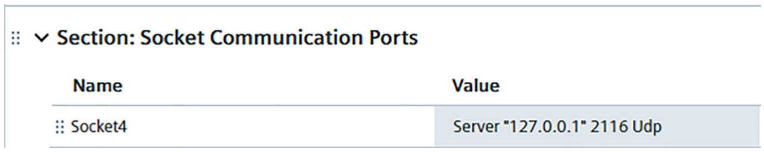


Figure 14-52 Compare telegram settings within ANS+ ET

8. Save all parameter changes and restart the ANS+ NC module to apply the configuration.

14.8.8 Pepperl&Fuchs R2000

> **WARNING**
>
> **30-minute warm-up**
>
> The vendor P&F recommends a 30-minute warm-up time for the laser device to receive the highest accuracy in measurement.

The P&F R2000 scanner requires the following software for parameterization and commissioning: PACTware (Process Automation Configuration Tool) and DTM (Device Type Manager).

A DTM is a software driver that contains all device-specific data and functions of a sensor type and provides all graphical elements and dialogs for operation. It requires a framework program, such as PACTware, in order to be used. It can be downloaded from the company's webpage. In the following example, the software "PACTware DC 5.0" and "DTM for R2000 laser scanner" were used.

In order to connect to the scanner, you have to set its IP address depending on your network topology. Afterwards, the scanner can be controlled and configured in "PACTware DC".

The following steps are required to receive the P&F R2000 scanner data in SIMOVE ANS+:

1. Adjust the laser scanner IP to your network topology, for example, by using the buttons on the device.
2. Open the PACTware DC software.

3. Use "Search new device" and select the "R2000 IP Comm" connection.
   If the R2000 comm block is not shown, the DTM installation is missing or was not successful and needs to be redone.

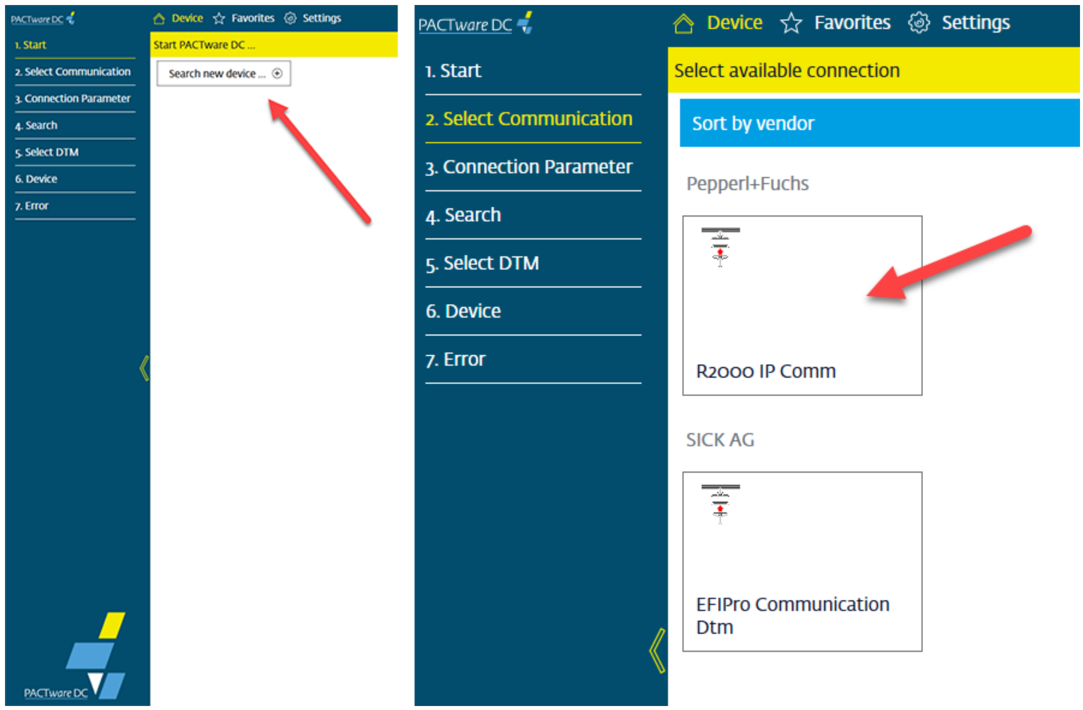


Figure 14-53 PACTware DC start procedure

4. Set the IP address of the laser scanner.

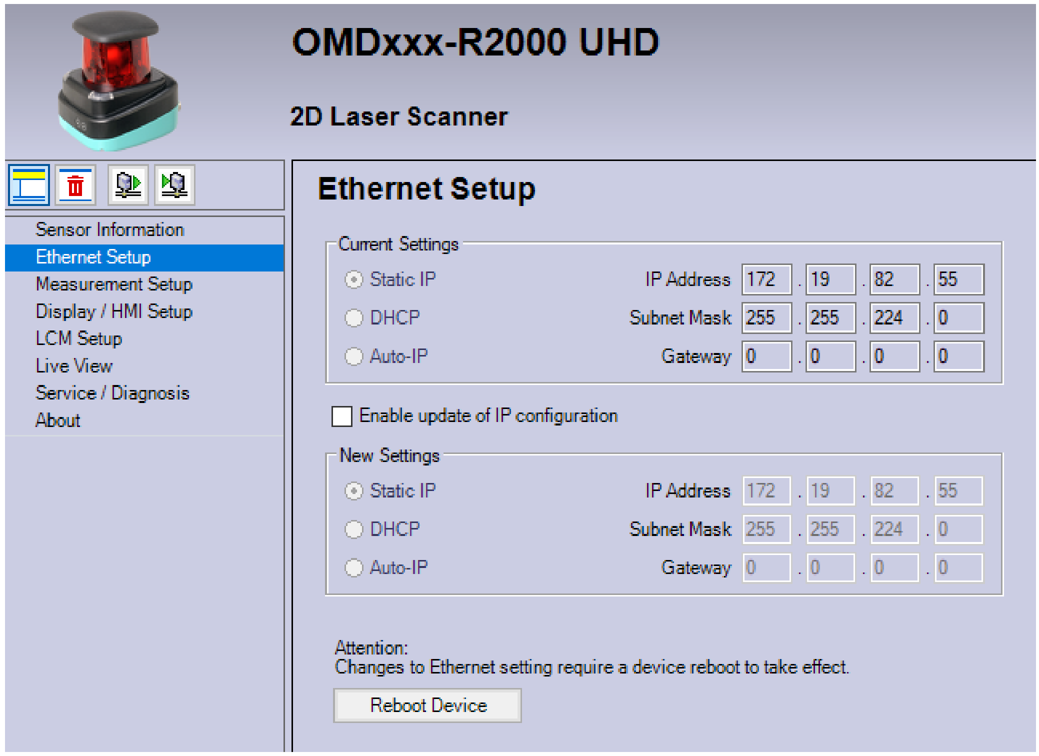


Figure 14-54 PACTware Ethernet settings

5. Set the following parameters within the tab "Measurement Setup".

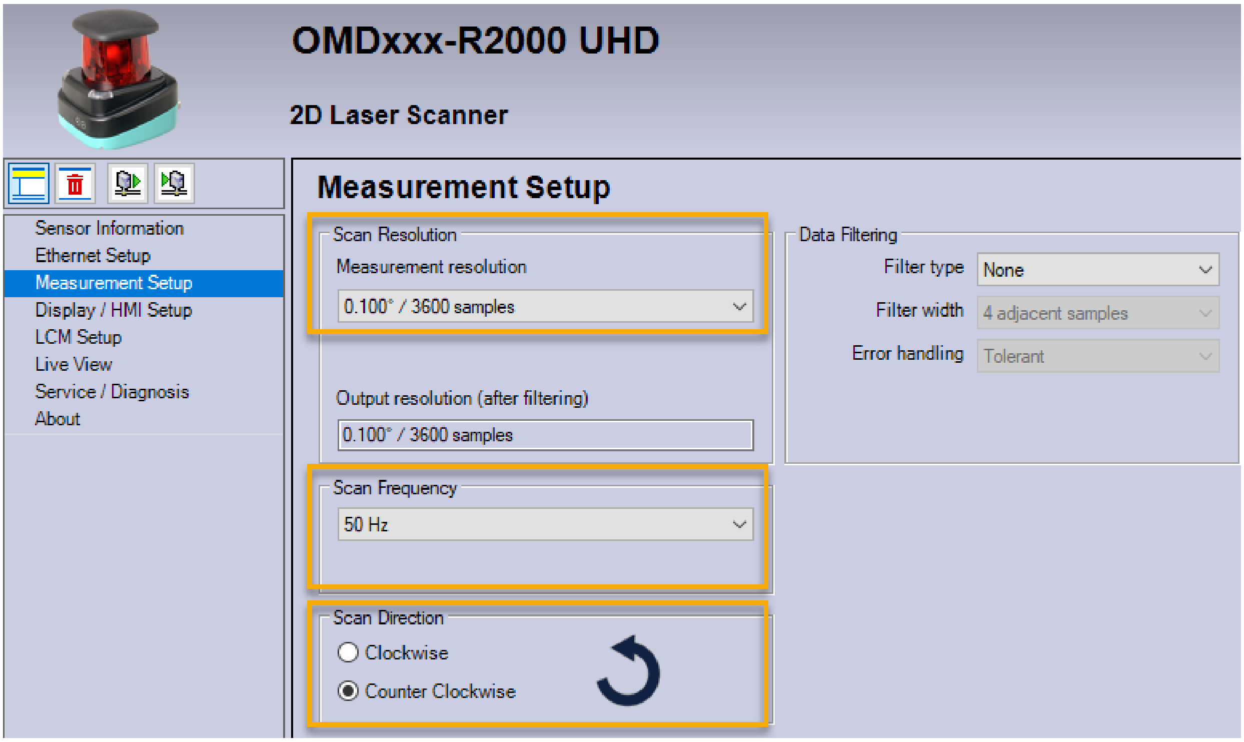


Figure 14-55 P&F R2000 measurement setup configuration example

Depending on the used R2000 type (UHD, HD, SD), different combinations between laser resolution and frequency are possible.

samples per scan	angular resolution	max. scan frequency	sampling rate (max)
25 200	0.014°	10 Hz	252 kHz
16 800	0.021°	15 Hz	252 kHz
12 600	0.029°	20 Hz	252 kHz
10 080	0.036°	25 Hz	252 kHz
8400	0.043°	30 Hz	252 kHz
7200	0.050°	35 Hz	252 kHz
6300	0.057°	40 Hz	252 kHz
5600	0.064°	45 Hz	252 kHz
5040	0.071°	50 Hz	252 kHz
4200	0.086°	50 Hz	210 kHz
3600	0.100°	50 Hz	180 kHz
3150	0.114°	50 Hz	158 kHz
2800	0.129°	50 Hz	140 kHz
2520	0.143°	50 Hz	126 kHz
2400	0.150°	50 Hz	120 kHz
2100	0.171°	50 Hz	105 kHz
1800	0.200°	50 Hz	90 kHz
1680	0.214°	50 Hz	84 kHz
1440	0.250°	50 Hz	72 kHz
1200	0.300°	50 Hz	60 kHz
900	0.400°	50 Hz	45 kHz
800	0.450°	50 Hz	40 kHz
720	0.500°	50 Hz	36 kHz
600	0.600°	50 Hz	30 kHz
480	0.750°	50 Hz	24 kHz
450	0.800°	50 Hz	23 kHz
400	0.900°	50 Hz	20 kHz
360	1.000°	50 Hz	18 kHz
240	1.500°	50 Hz	12 kHz
180	2.000°	50 Hz	9 kHz
144	2.500°	50 Hz	7 kHz
120	3.000°	50 Hz	6 kHz
90	4.000°	50 Hz	5 kHz
72	5.000°	50 Hz	4 kHz

(a) R2000 UHD devices

samples per scan	angular resolution	max. scan frequency	sampling rate (max)
8400	0.043°	10 Hz	84 kHz
7200	0.050°	11 Hz	80 kHz
6300	0.057°	13 Hz	82 kHz
5600	0.064°	15 Hz	84 kHz
5040	0.071°	16 Hz	81 kHz
4200	0.086°	20 Hz	84 kHz
3600	0.100°	23 Hz	83 kHz
3150	0.114°	26 Hz	82 kHz
2800	0.129°	30 Hz	84 kHz
2520	0.143°	33 Hz	84 kHz
2400	0.150°	35 Hz	84 kHz
2100	0.171°	40 Hz	84 kHz
1800	0.200°	46 Hz	83 kHz
1680	0.214°	50 Hz	84 kHz
1440	0.250°	50 Hz	72 kHz
1200	0.300°	50 Hz	60 kHz
900	0.400°	50 Hz	45 kHz
800	0.450°	50 Hz	40 kHz
720	0.500°	50 Hz	36 kHz
600	0.600°	50 Hz	30 kHz
480	0.750°	50 Hz	24 kHz
450	0.800°	50 Hz	23 kHz
400	0.900°	50 Hz	20 kHz
360	1.000°	50 Hz	18 kHz
240	1.500°	50 Hz	12 kHz
180	2.000°	50 Hz	9 kHz
144	2.500°	50 Hz	8 kHz
120	3.000°	50 Hz	6 kHz
90	4.000°	50 Hz	5 kHz
72	5.000°	50 Hz	4 kHz

(b) R2000 HD devices

samples per scan	angular resolution	max. scan frequency	sampling rate (max)
7200	0.050°	10 Hz	72 kHz
6300	0.057°	11 Hz	70 kHz
5600	0.064°	12 Hz	68 kHz
5040	0.071°	14 Hz	71 kHz
4200	0.086°	17 Hz	72 kHz
3600	0.100°	20 Hz	72 kHz
3150	0.114°	22 Hz	70 kHz
2800	0.129°	25 Hz	70 kHz
2520	0.143°	28 Hz	71 kHz
2400	0.150°	30 Hz	72 kHz
2100	0.171°	30 Hz	63 kHz
1800	0.200°	30 Hz	54 kHz
1680	0.214°	30 Hz	50 kHz
1440	0.250°	30 Hz	43 kHz
1200	0.300°	30 Hz	36 kHz
900	0.400°	30 Hz	27 kHz
800	0.450°	30 Hz	24 kHz
720	0.500°	30 Hz	22 kHz
600	0.600°	30 Hz	18 kHz
480	0.750°	30 Hz	14 kHz
450	0.800°	30 Hz	14 kHz
400	0.900°	30 Hz	12 kHz
360	1.000°	30 Hz	11 kHz
240	1.500°	30 Hz	7 kHz
180	2.000°	30 Hz	5 kHz
144	2.500°	30 Hz	4 kHz
120	3.000°	30 Hz	4 kHz
90	4.000°	30 Hz	3 kHz
72	5.000°	30 Hz	2 kHz

(c) R2000 SD devices

Figure 14-56 P&F R2000 frequency to resolution combinations

6. Once the laser configuration is done, transfer the setup to the laser device.

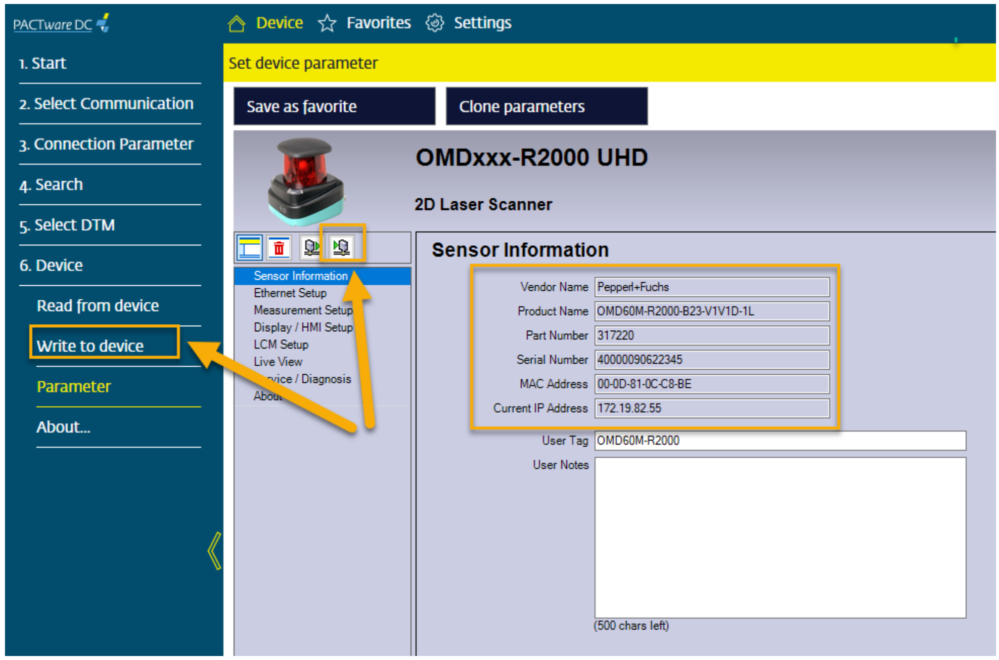


Figure 14-57 PACTware DC device view

7. Once the scanner device has been fully commissioned and parametrized, synchronize the SIMOVE ANS+ laser parameters with the scanner parameters.
The scanner is able to do a full 360° scan with a maximum range of 32 meters. The valid values for start and end angle range from -180° to +180°. Regarding the scan resolution and frequency, 0.1° and 50 Hz are used in this example. For any other combination, refer to the illustration "P&F R2000 frequency to resolution combinations".
The R2000 laser device requires two different communication ports, one for incoming data and one for outgoing control commands. Add the following lines to your “user_def” file in the ANS+ ET related to the network configuration of your AGV:

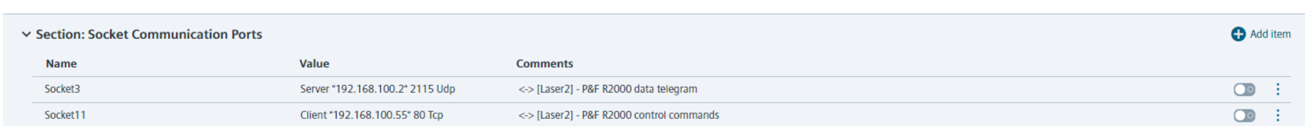


Figure 14-58 ANS+ P&F R2000 required socket parameters in “user_def”

For both sockets, use the following telegram specification:

– Data telegram: Server "<Linux IP>" <Port> Udp

– Control commands: Client "<R2000 IP>" 80 Tcp

In the following example, these IP addresses were used:

– Industrial OS IP: 172.19.82.21

– P&F R2000 IP: 172.19.82.55

8. The general laser-specific parameters need to be defined in the "user_def" file of the ANS+ ET. Variable parameters, which need to be adjusted in relation to the AGV setup, are highlighted.

Section: Laser 2 (Add item)

Name	Value	Comments
Enable	yes	[yes, no]
Name	"P+F R2000"	Pepperl & Fuchs R2000
Upside Down	no	[yes, no]
Connection	Socket3	[SocketX]
Priority	38	38
Laser Type	PFR2000	Pepperl & Fuchs R2000
Transformation	-10.995 -0.81286 160.0 -176.47919 0.0 0.0	[cm (X), cm (Y), cm (Z), deg(Yaw), deg(Pitch), deg(Roll)]
Timing Offset Us	0	[us]
Start Angle	-180	[deg]
End Angle	180	[deg]
Resolution	0.1	[deg]
Enable Remission	yes	[yes, no]
Time Stamp Recv	Source	[Source, Processed]
Frequency	50	[Hz]

Section: Pepperl+Fuchs R2000 2 (Add item)

Name	Value	Comments
Control	Socket11	
Connect Timeout	500	[ms]
Filter Type	none	

Figure 14-59 P&F R2000 laser specific “user_def” example parameters

> **WARNING**
>
> **Equal IDs**
>
> The ID within the section "Pepperl+Fuchs R2000 <ID>" must be equal to the used "Laser <ID>". This relation merges the control socket with the data telegram.

9. Save all parameter changes and restart the ANS+ NC module to apply the configuration.

14.8.9 HINSON LE50821FA

Parametrize the LE50821FA scanner

To parametrize the LE50821FA scanner, a configuration software tool can be downloaded from the companie's website.

1. Download the software and navigate to the folder “Hinson UI” and start CNS-LE-(FPGA).exe.

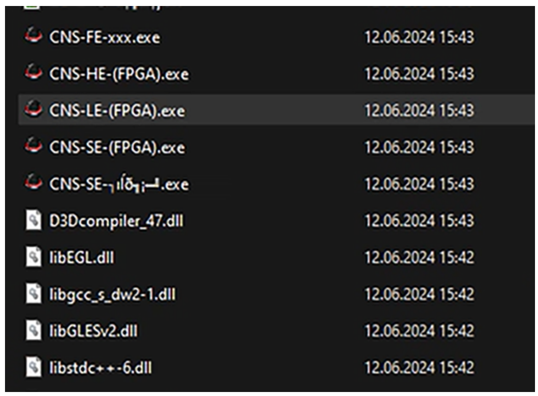


Figure 14-60 Start Hinson configuration software tool

2. The language can be changed by selecting “language”.

Figure 14-61 Select language

3. Connect to the device by clicking “Connect”.
   The default address of the device is displayed when selecting “Ethernet” and then “Refresh”.

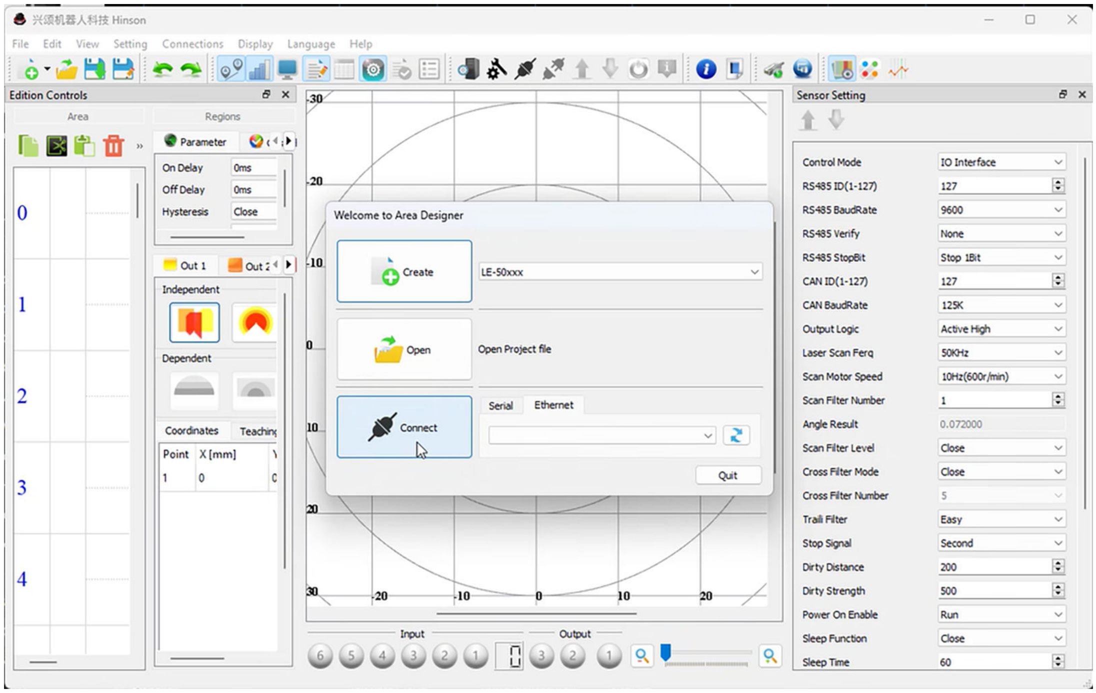


Figure 14-62 Connect to device

4. The following values need to be adapted for a later connection to the scanner ANS+:
   - Set the scan frequency to 200 kHz
   - Set the motor speed to 30 Hz
   - Set the scan filter number to 1
   - Set ethernet mode to UDP
   - Set an IP address fitting to your application

– Leave other values to the default ones

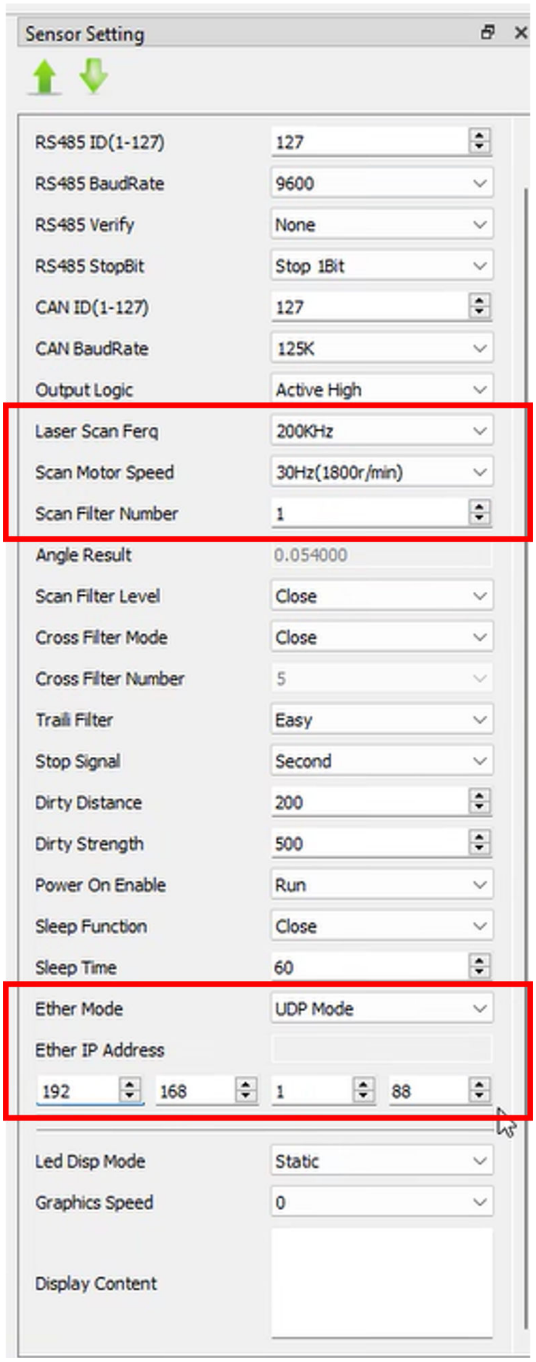


Figure 14-63 Parameter settings

5. After adapting the parameter values, click "Write all settings" and "Soft reboot" to permanently change the values on the device.

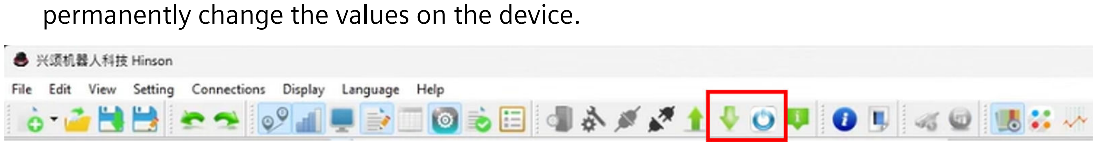


Figure 14-64 Write all settings and soft reboot

After reconnecting the laser scanner in the UI, live data from the scanner should be visible.

Synchronize the LE50821FA scanner

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings.

- Use the following ANS+ settings for a working configuration in the section of your respective Laser (here in this example with the laser IP = 192.168.1.88).
  The UDP port is 8080.

Section: Socket Communication Ports Add item

Name	Value	Comments
Socket1	Client "192.168.1.88" 8080 Udp	

Section: Laser 0 Add item

Name	Value	Comments
Enable	yes	[no, yes]
Connection	Socket1	[SocketX]
Laser Type	Hinson	[SickUScan3Pro,SickNAV310,SickTIMXXX,LeuzeRsl2XX,LeuzeRsl4XX,PFR2000,KeyenceSZV, SickPicoscan, Hinson]
Transformation	0.0 0.0 0.0 0.0 0.0 0.0	[cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)]
Enable Remission	yes	
Start Angle	0	[deg] [default: -47.5] - Starting angular range which needs to be synchronized with the vendor engineering tool co...
End Angle	360	[deg] [default: 227.5] - Ending angular range which needs to be synchronized with the vendor engineering tool co...
Resolution	0.054	[deg] 0.054, 0.045, 0.036, 0.027, 0.018
Frequency	30	[Hz] [10, 15, 20, 25, 30]

Section: Hinson 0 Add item

Name	Value	Comments
Scan Timeout Ms	1000	Timeout in ms for detecting no new laser scanner

Figure 14-65 ANS+ laser settings

14.8.10 Keyence SZ-V32N

To be able to parametrize a Keyence SZ-V32N device, the Keyence software "SZ Configurator" is required. It can be downloaded from the company's webpage.

After installation, the "SZ-V Configurator" needs to be selected within the Safety Device Configurator.

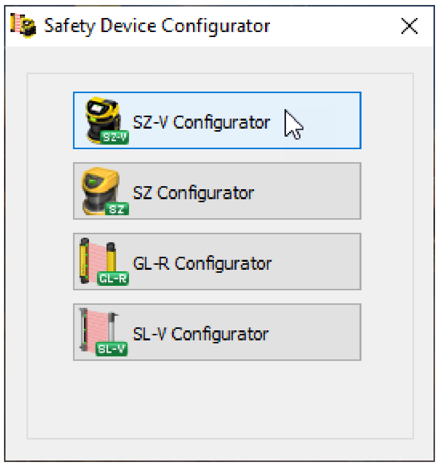


Figure 14-66 Safety Device Configurator

The following steps are selected in the SZ-V Configurator:

1. Create a new configuration file.

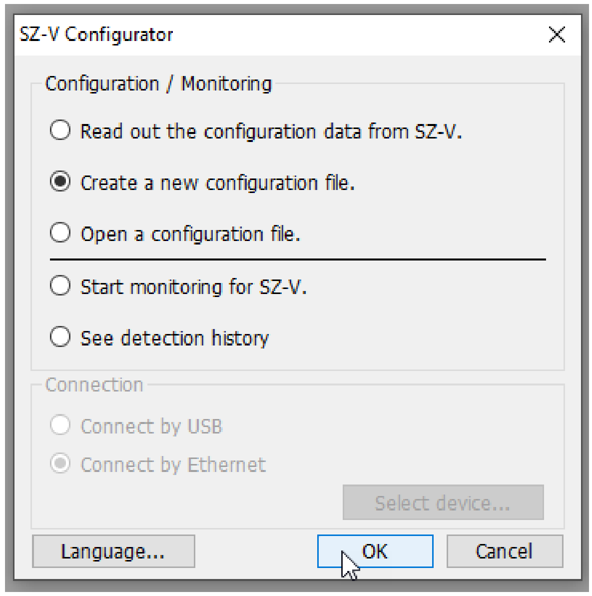


Figure 14-67 Create a new file

2. Choose “SZ-V32N” and “UDP”.

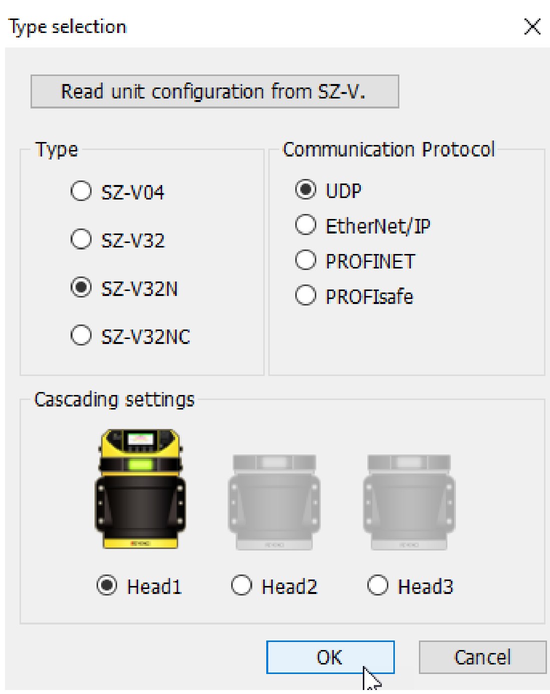


Figure 14-68 Select type

3. Connect the laser scanner via USB or Ethernet. In this documentation, a connection by Ethernet was used. Select the used Network adapter from the list and click on "search". If all network connections are working successfully, the device gets listed. Select the laser scanner from the list.

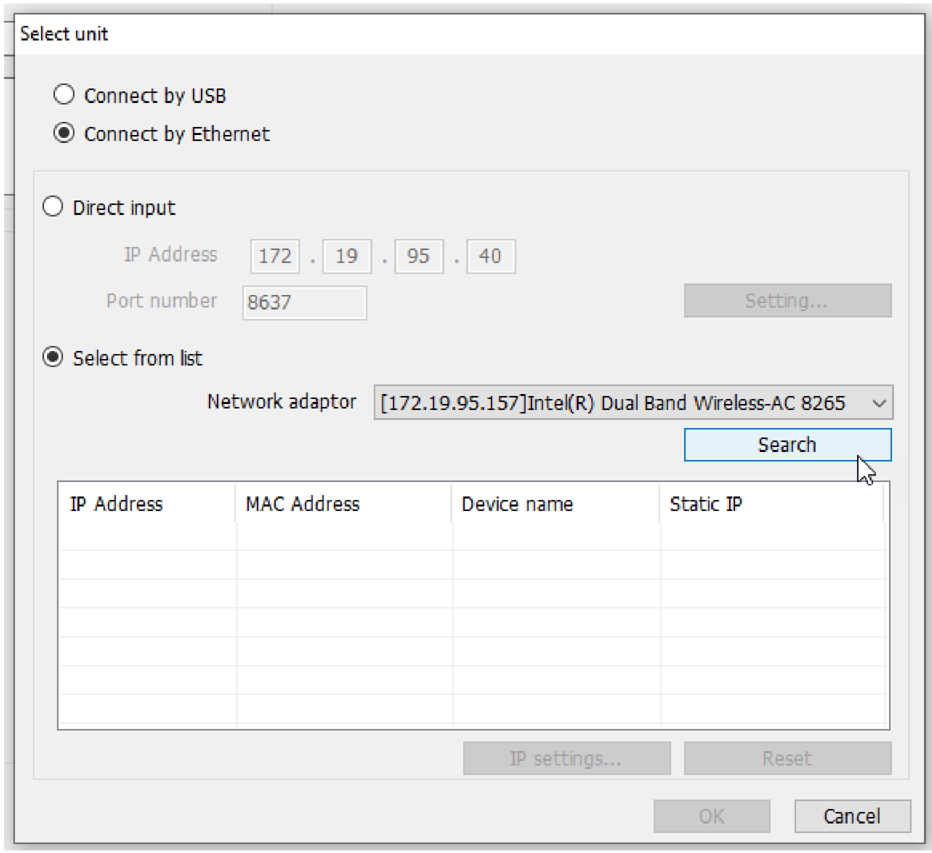


Figure 14-69 Select device from list

4. Select "Operation" on the left side of the process tabs.

5. Select the related PNP/NPN fitting to your application. This is a mandatory step of the configuration.

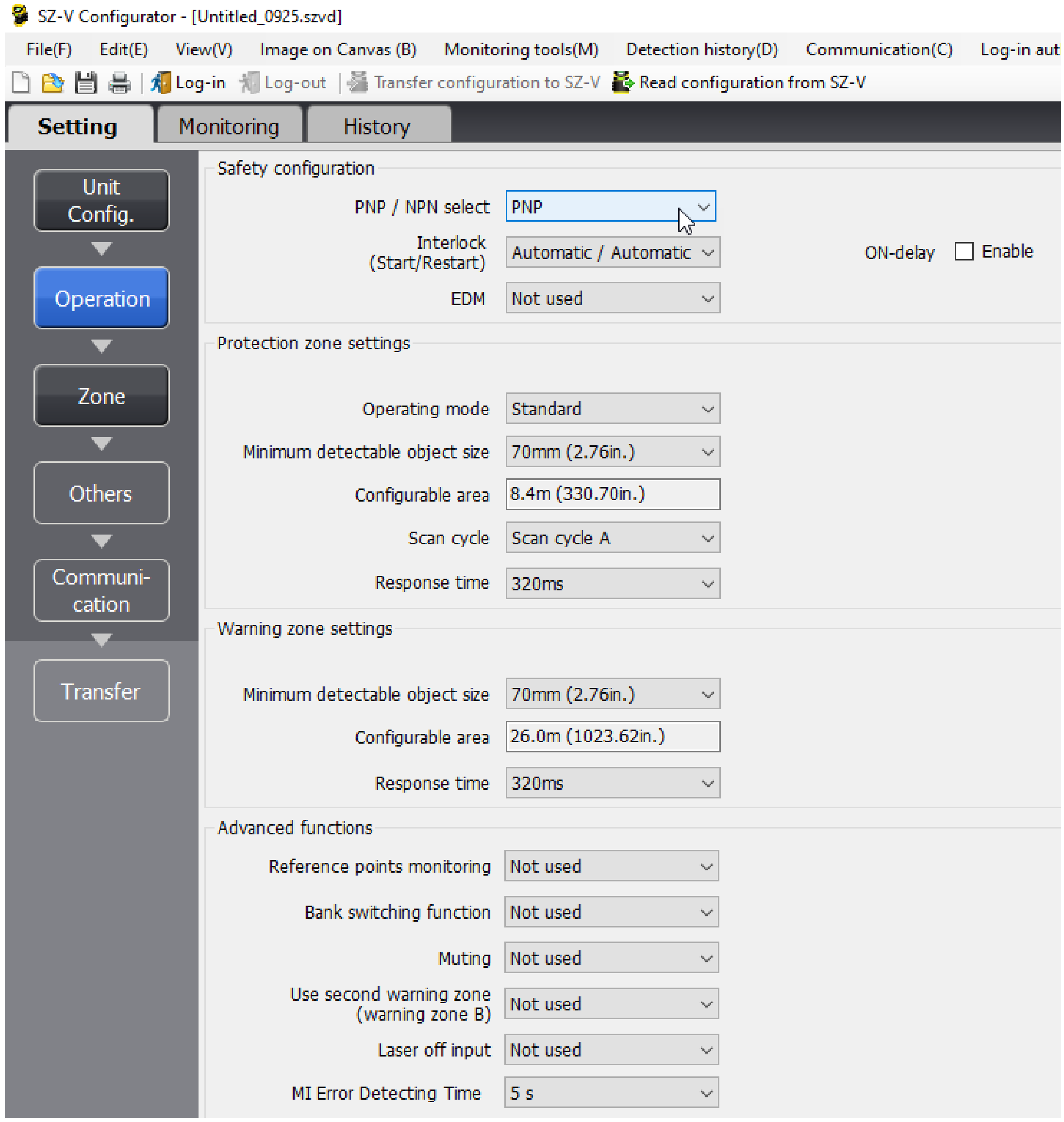


Figure 14-70 Fill out safety configuration

6. In the section "Zone", insert a safety zone, as this is also mandatory for the initial transfer of the configuration. The safety zone can also be adapted afterwards

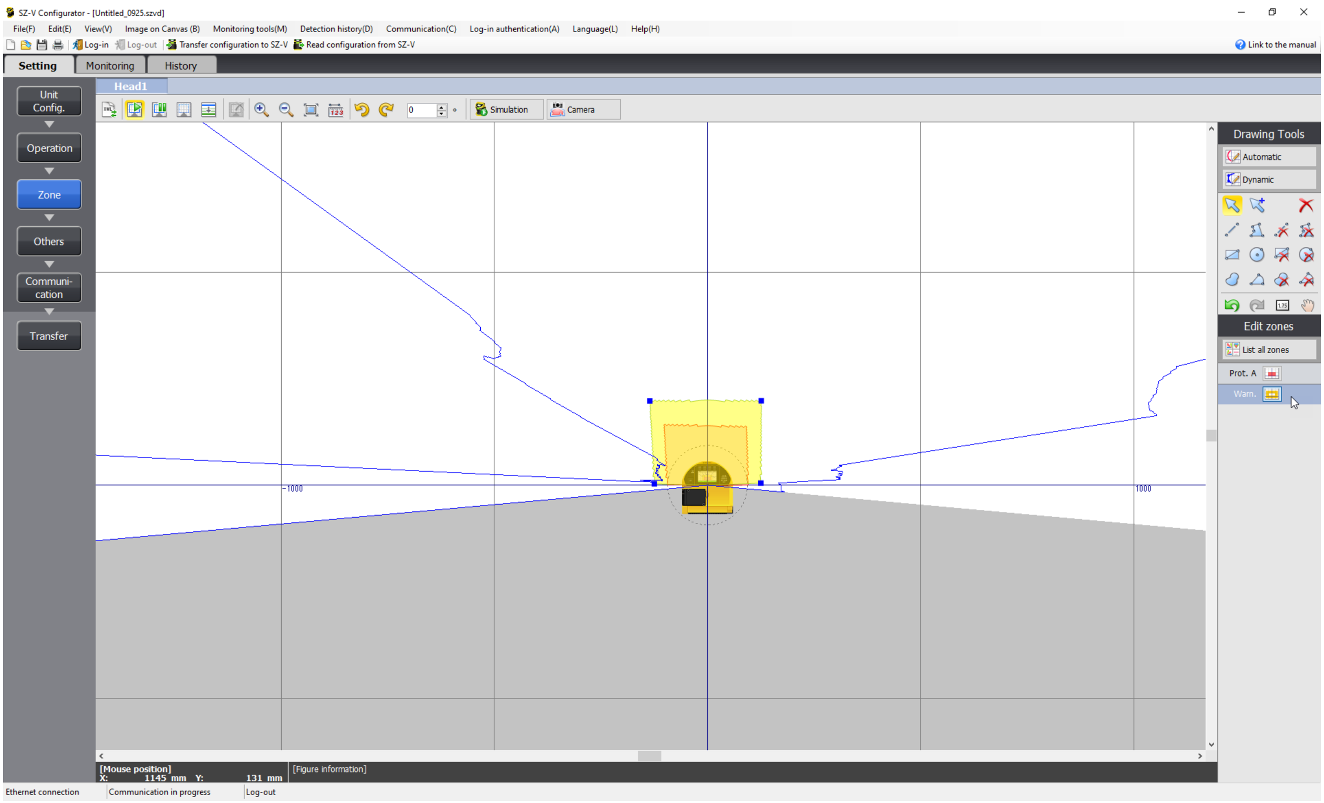


Figure 14-71 Create safety zone

7. Skip the selection "Others" for an initial configuration.
8. Set the network device configuration. An example configuration is shown below.

9. To receive the laser measurement data at the Linux OS, the measurement distance data output (UPD) has to be selected. Choose "little endian" for the UDP data.

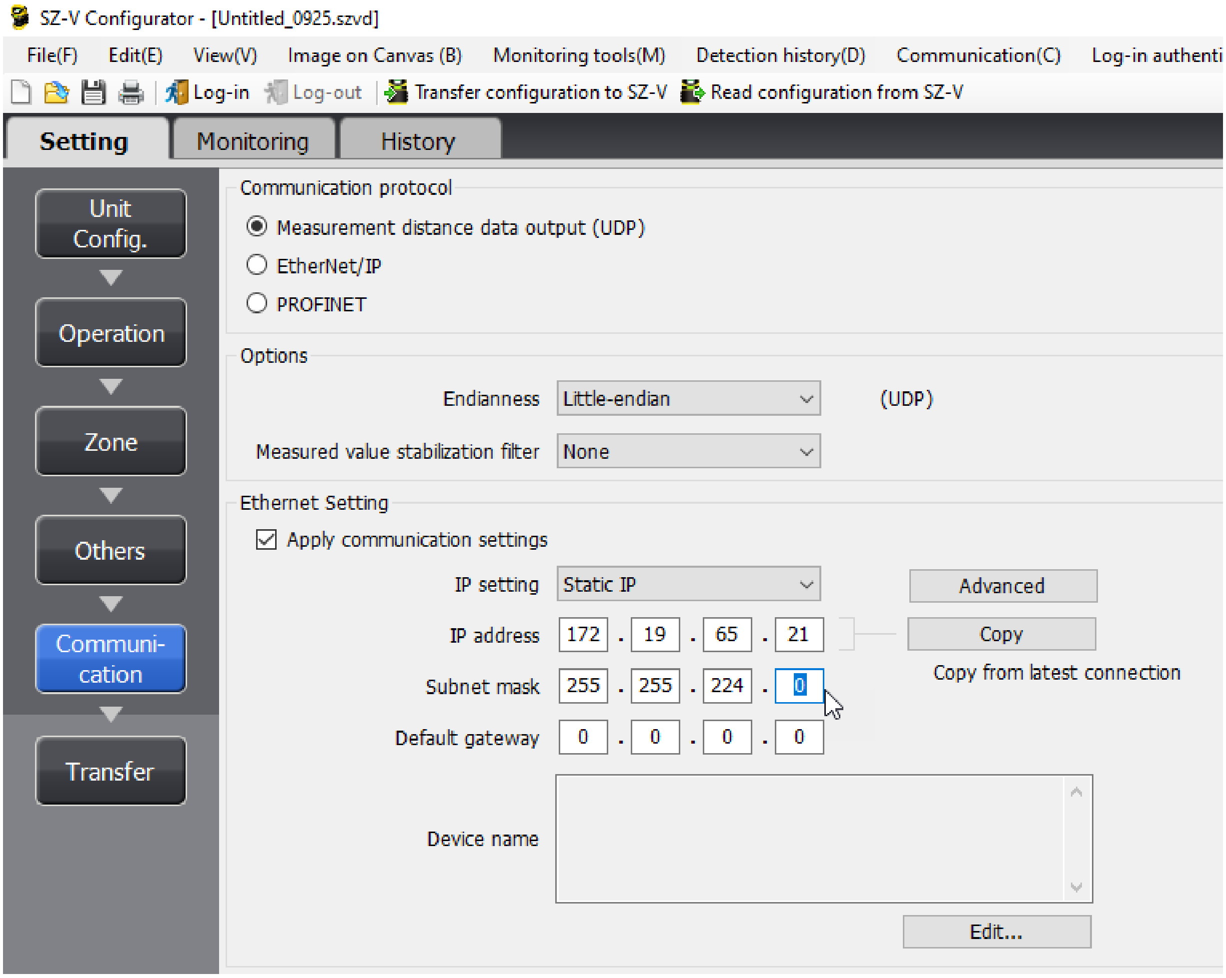


Figure 14-72 Define communication and ethernet settings

10. Check the advanced network configuration settings for the port, that is later on required for the ANS+ socket communication parameter.
    – Default value for TCP port:8637
    – Default value for UDP Command Port: 8800
11. Click on "Transfer" in order to transfer all data to the device.
12. If a login-window appears, that requires a password the default password "1111" has to be typed in.
    The configuration is transferred to the device afterwards and the configuration needs to be accepted.

Once the scanner device has been fully commissioned and parametrized, the ANS+ laser parameters need to be synchronized with those settings. Use the following ANS+ settings for a working configuration in the section of your respective Laser (here in this example with the laser IP = 172.19.65.150). In case you have changed the UDP Port (default: 8800), the port number of the socket communication ports need to be adapted as well.

Section: Laser 2

Name	Value	Comments
Enable	yes	[yes, no]
Name	"Keyence_SZ-V32N"	["string"] - Internal name for laser scanner device shown e. g. on status messages
Connection	Socket4	[SocketX] - Keyence SZ-V32N measurement data socket connection
Laser Type	KeyenceSZV	Scanner driver type
Transformation	35.0 -25.0 0.0 45.0 0.0 0.0	[cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch), deg(Roll)]
Start Angle	-5.2	[deg] - Laser beam start angle
End Angle	185.2	[deg] - Laser beam end angle
Resolution	0.2	[deg] - Laser beam angular resolution
Frequency	0	[Hz] (Default: 0) - 0 = Choose maximum frequency
Upside Down	yes	[yes, no]

Figure 14-73 ANS+ laser settings

Section: Socket Communication Ports

Name	Value	Comments
Socket4	Client "172.19.65.150" 8800 Udp	<--> [Laser 3] - Keyence network settings

Figure 14-74 ANS+ laser settings

Example configuration

```
[Section: Socket Communication Ports]
//-----------------------------------------------------------------------------
Socket4       : Client "172.19.65.150"  8800 Udp   // [Client "<IP>" <PORT> Udp] - Keyence
network settings


[Section: Laser 0]
//-----------------------------------------------------------------------------
Enable             : yes   // [yes, no]
Name                : "Keyence_SZ-V32N"   // ["string"] - Internal name for laser scanner
device shown e. g. on status messages
Connection         : Socket4   // [SocketX] - Keyence SZ-V32N measurement data socket
connection
Laser Type         : KeyenceSZV  // Scanner driver type
Transformation    : 0.0 0.0 0.0 0 0.0 0.0   // [cm (X), cm (Y), cm(Z), deg(Yaw), deg(Pitch),
deg(Roll)]
Start Angle        : -5.2   // [deg] - Laser beam start angle
End Angle          : 185.2   // [deg] - Laser beam end angle
Resolution         : 0.2   // [deg] - Laser beam angular resolution
Frequency          : 0   // [Hz] (Default: 0) - 0 = Choose maximum frequency
```

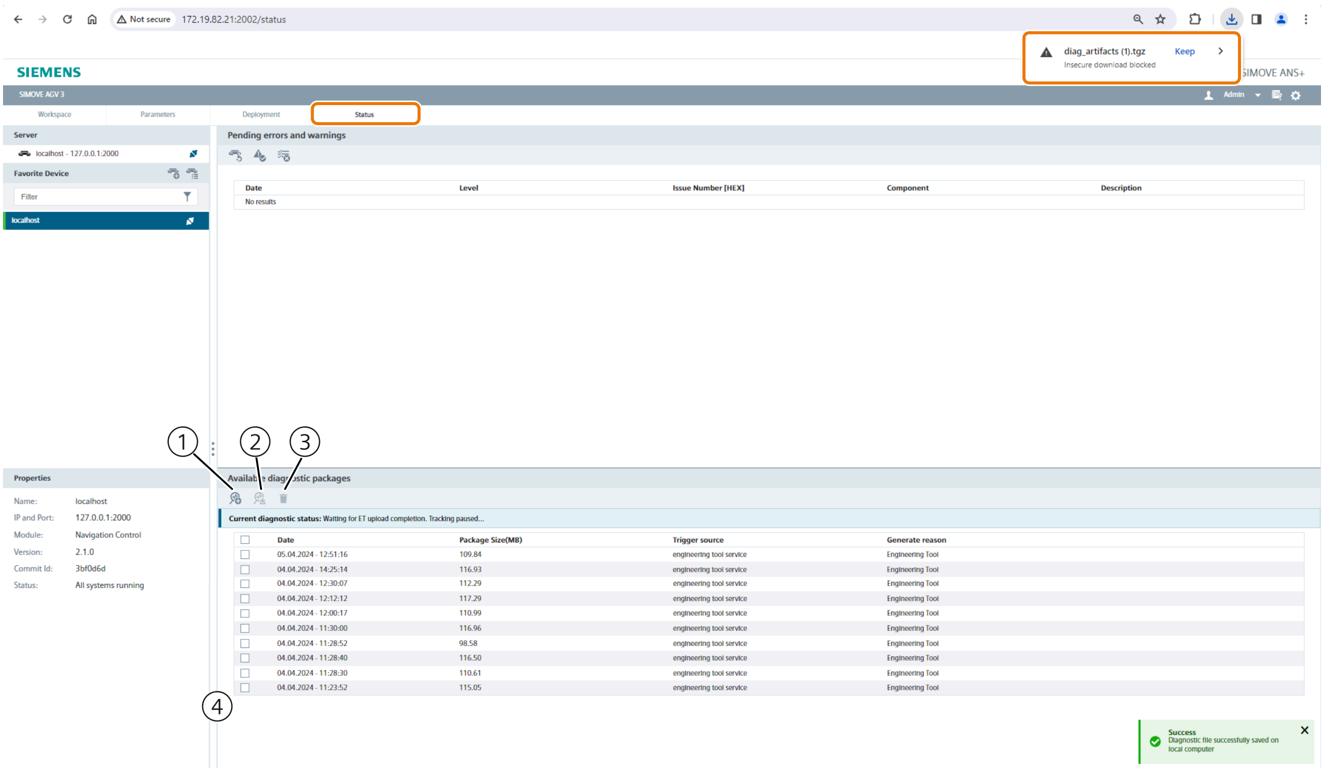
Support 15

15.1 Diagnostic Packages

This chapter describes how to generate and download a diagnostic package for support or debug purposes. A diagnostic package contains the NC module log, as well as the applied parameter settings and the recently captured traces of the raw data of all laser scanners, cameras and odometry. Therefore, it should be provided when submitting a Siemens Support Request, as described in chapter Siemens Support Requests (Page 285). With the provided data, previously occurred errors regarding parametrization or failures related to driving behaviors and commanded jobs can be analyzed and reproduced in a simulation afterwards to determine the cause of an issue. Additionally, a screen recording of the behavior with some explanation is beneficial for the analysis.

A diagnostic package can be generated in the “Status” page in the diagnostic package window as described in the following step-by-step instruction:

1. Click on "Generate new diagnostic package".
   All generated diagnostic packages are listed underneath the toolbar.
2. Select the checkbox of one or more available diagnostic packages and click on "Download selected files to local computer".
   Once the download is completed a success notification appears at the lower right corner of the ET and if the browser shows an insecure download blocked pop-up, continue by clicking "keep".



① Generate new diagnostic package
② Download selected files to local computer
③ Delete selected files from disk
④ Available diagnostic packages

Figure 15-1 Diagnostic package window

Note

The maximum number of available diagnostic packages that are being stored is limited to ten. Exceeding this limitation will automatically overwrite the last stored diagnostic package with the newly generated one.

It is additionally possible to generate a diagnostic package with an external trigger through Carrier Control. Therefore, the ANS MT Host Block provides a *generateDiagnosticPackage* input that is used to generate a new diagnostic package. The *diagnosticInfo* input consists of two char arrays that allow to assign a Trigger source and Generate reason, as shown in the figure below.

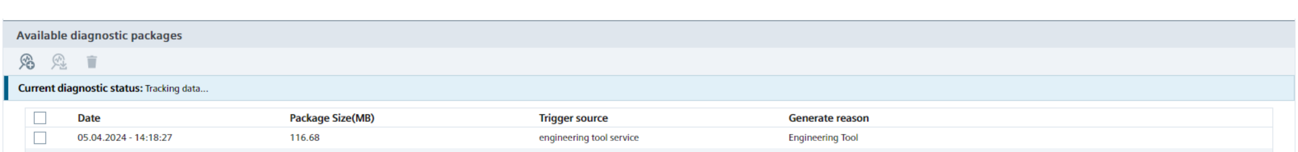


Figure 15-2 Carrier Control generated diagnostic package

15.2 Siemens Support Requests

For general questions related to ANS+, parameters or for bug reports, a Siemens "Support request" (SR) needs to be created to contact the related experts.

The following process provides a step-by-step guidance on how to create a SR:

1. Use the following link to access the Siemens Industry Online Support webpage and login to your account.
   Siemens Industry Online Support webpage (https://support.industry.siemens.com/cs/my/src?_nct=20210517154928&lc=en-DE)
2. Create a new Support Request.
3. Use the label "simove" to find SIMOVE related topics, such as SIMOVE ANS+:

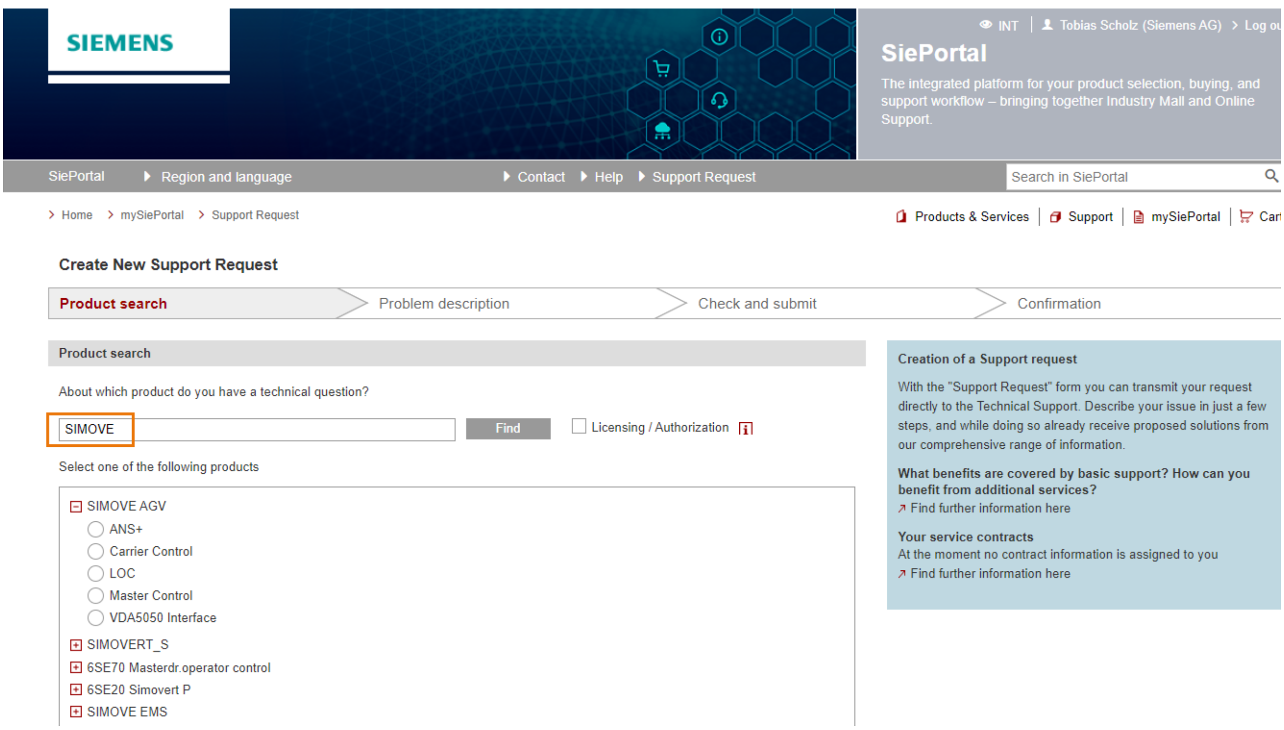


Figure 15-3 Service Request product search

4. Select the SIMOVE product that relates to the SR.
5. Click on "Next".

6. In the next screen, provide a detailed description of your request.
   If possible, upload files for a better explanation, such as record files with all related files as described in chapter Diagnostic Packages (Page 283).

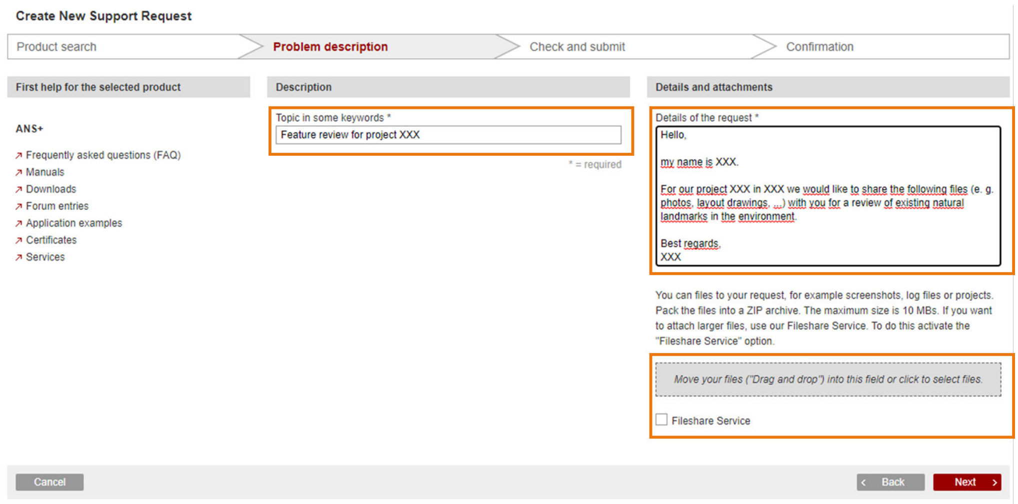


Figure 15-4 Service Request description and file upload

7. Click on "Next".

8. Select "Request by a customer" and enter all necessary information.

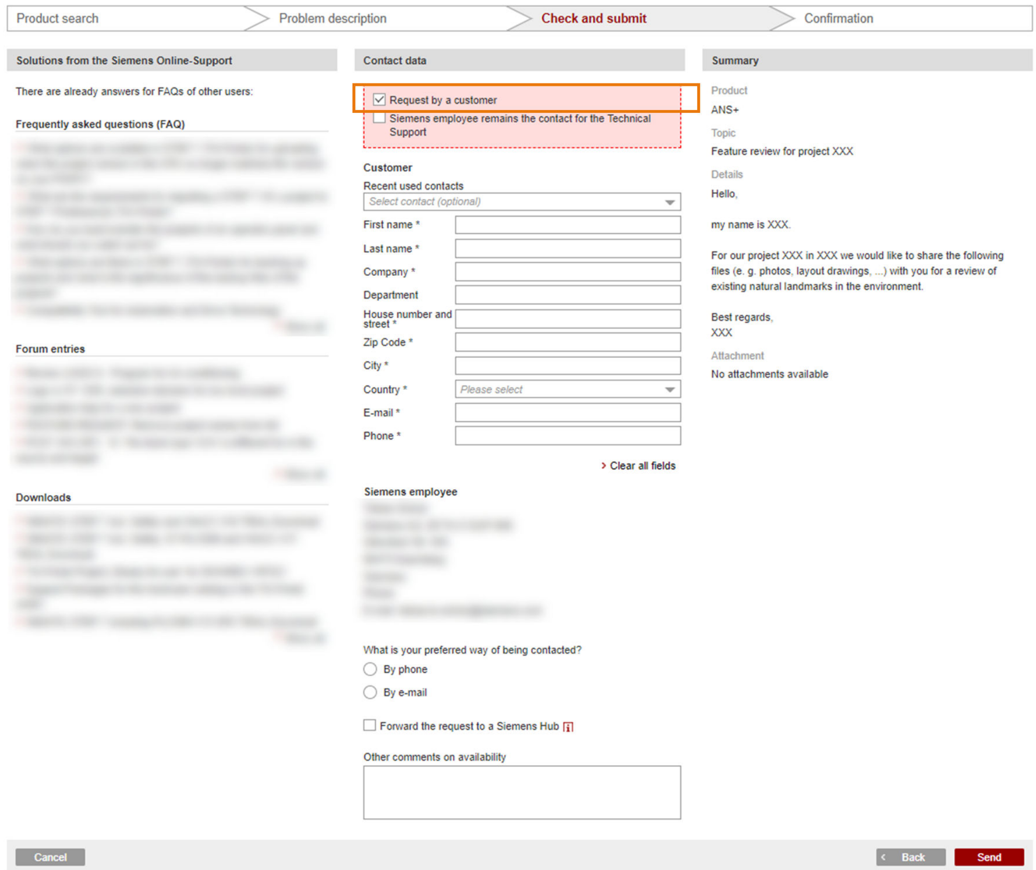


Figure 15-5 Service Request check and submit

9. Click on "Send" to submit the Service Request.

Note

Service requests are generally answered within several days.

Appendix

A

A.1 Issue reference list

Each issue and the related reaction can be redefined within the "param"-section "status" with two different parameters:

- "**Redefine Reactions**": This redefinition is only used for ANS+ internal and therefore only relevant for log files and the command line logging.
- "**Redefine Times**": By using the time redefinition, the related issue status (error or warning) of ANS+ that is transferred to the PLC can be changed.

There are three relevant internal reactions for ANS+.

Parameter value	Description
<Component>_<Issue> None	The occurred issue is suppressed within ANS+ and is therefore not transferred to the PLC.
<Component>_<Issue> Report	Each issue redefined as "Report" is listed in ANS+ as a user information.
<Component>_<Issue> Warn	"Warn" issues will be interpreted as a warning in ANS+.

By using the parameter "Redefine Times", it is possible to change the issue transfer interpretation for the PLC:

Parameter value	Description
<Component>_<Issue> 0 0 0	The related issue is transferred to PLC as a warning. Represents the corresponding issue message number within the "host"-interface warning array in the PLC program.
<Component>_<Issue> 0 0 -1	The related issue message number is transferred to PLC as an error within the "host"-interface error array.

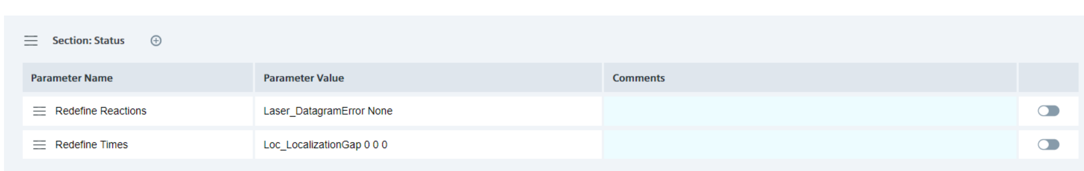


Figure A-1 Examples for ANS+ issue redefinition

The table below provides an overview of ANS+ issues with their related message number:

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Init	Parameter Error	21	Error	Error in reading one of the following files: • "hardware" • "param" • "user_def"	• Fix parametrization error.
Init	Critical Error	22	Error	Startup initialization error, e.g. due to invalid parameter detected	• Check the startup log • Check the parametrization
Init	Startup Failure	24	Error	Error in one initialization stage	• Check the startup log • Check the parametrization
SysMon	Log Queue Overrun	35	Warn	Logging queue is overflowing. To many logging messages displayed.	• Reduce message output by deactivating logging identifiers, e.g. by mmi command ml LcMap 0
ParameterFile	Critical Error	71	Error	Error in reading one of the following files: • "hardware" • "param" • "user_def"	• Fix parametrization error
Modules	Kin Assertion	B2	Error	Velocity command in y-direction but non-holonomic kinematics	• Check the kinematic "user_def" parametrization
Record	Invalid Command	D5	Warn	Invalid MMI command applied	• check applied MMI command
Record	File Write Error	D6	Warn	Writing of sensor stream information into file failed.	• Check disk space or writing permissions.
Record	File Open Error	D7	Warn	Unable to open file for writing sensor stream information.	• Check writing permissions.
Replay	Table Overflow	E1	Warn	Replay capacity reached	• Reduce replay registrations in replay section
Laser	Covered	F1	Error	Covered ratio laser beams are less than parameterized covered distance	• Check parameter "Covered Dist" and "Covered Ratio"
Laser	Checksum Error	F2	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	No Connection	F3	Error	Unable to establish connection with laser.	• Check cable or connection settings.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Laser	Warning	F4	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Scanner Error	F5	Warn	General error from laser vendor.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Scanner Fatal Error	F6	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Wrong Prot Field	F8	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Wrong Version	F9	Error	Laser implementation specific status information. Laser configuration does not match the parameters in hardware file (start angle, end angle, resolution).	• Change the parameters in hardware file according to laser configuration. • Change the laser configuration according to parameters set in hardware file using the ET of laser vendor.
Laser	Wrong Warn Field	FA	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Polluted	FB	Warn	Laser implementation specific status information.	• Connect with engineering software provided by laser vendor and check for laser errors.
Laser	Contamination Warn	FC	Warn	Contamination warning from laser device.	• Check the optics cover for damage. • Clean the optics cover.
Laser	Contamination Error	FD	Warn	Contamination error from laser device.	• Optics cover is dirty. All safety outputs in the OFF state. Clean the optics cover.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Laser	Receive Overflow	FE	Error	The laser driver workspace buffer size limit for reading laser datagrams was reached. The laser driver was not able to build valid datagrams for the data received so far. After this error is produced the workspace buffer is cleared.	• The laser driver is not able to build valid datagrams. In most cases during runtime this error comes from a network traffic overload. Check your network configuration to avoid this error.
Laser	No Measurements	FF	Error	No measurements retrieved despite of an established connection between ANS+ and laser.	• For UDP connections, this is an indicator that the connection parameters are invalid. Check the connection and laser settings in the ANS+ ET. • Laser device might use a protocol that is not yet supported. Check if laser hardware version is compatible or if protocol of laser datagrams was changed by vendor. • The laser-specific configuration in the vendor tool has been set not correctly. Recheck all laser configurations.
Laser	Datagram Error	100	Warn	Unable to retrieve laser data from received datagram.	• Laser hardware might use a protocol that is not yet supported. Check if laser hardware version is compatible or if protocol of laser datagrams was changed by vendor.
Laser2	Recv Time Ambiguous	101	Warn	• Time assignment of given (SIMOVE: TCP) telegram is ambiguous (for example on Linux startup). • ANS+ threads are too busy or have too little compositional CPU or RAM memory.	• Can be ignored in case of startup or sporadic occurrence, as this is just an information for users. • In case of static occurrence, check, for example, the network workload.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Hostif	No Connection	2721	Error	• No TCP-Connection established between PLC and Linux ("host"-interface). • Connection is broken.	• Check connection status via PING. • Check IP addresses of Linux and PLC. • Check LAN-cables.
Hostif	Buffer Overflow	2722	Error	• Related to "Buffer Size Limit" param. • Internal buffer limit exceeded.	• Check if the "host"-interface protocol version number is equal to the PLC configurations.
Hostif	No Ack Received	2723	Error	Too many connection retries without receiving acknowledge.	• Check the software logic within the CC for acknowledge handling.
Hostif	Receive Overflow	2724	Error	• No payload size given within TCP telegram. • Input buffer too small for given TCP telegram.	• Check the transferred TCP telegram size and collocation within PLC.
Hostif	Recv Time Ambiguous	2725	Warn	• Time assignment of given (SIMOVE: TCP) telegram is ambiguous, for example, on Linux startup. • ANS+ threads are too busy or having too little compositional CPU or RAM memory.	• Can be ignored in case of startup or sporadic occurrence, as this is just information for users. • In case of static occurrence, check, for example, the network workload.
Vehicle	No Connection	2741	Error	• No UDP connection established between PLC and Linux ("vehicle interface"). • Connection is broken.	• Check connection status via PING. • Check IP-Addresses of Linux and PLC. • Check LAN cables.
Vehicle	Receive Overflow	2742	Error	• No payload size given within UDP telegram. • Input buffer too small for given UDP telegram.	• Check the transferred UDP telegram size and collocation within PLC.
Vehicle	Time Negative	2743	Error	• incoming vehicle-interface timestamp is older than previous one	• Check incoming timestamps on PLC side

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Vehicle	Time Too Old	2744	Error	• UDP connection broken and re-established. • ANS+ threads blocked due to high OS RAM or CPU usage. • UDP timestamps have been sent with time gaps.	• Can be ignored after start-up due to legacy data within buffer. • Check OS RAM and CPU workload. • Check PLC timestamps or incoming UDP data rate.
Vehicle	Toggle Auto Mode	2745	Error	Signals redefined in param with reaction "Stop" require automatic mode toggling after failure is faded.	• Toggle automatic mode on the AGV to manual, and back to automatic.
Vehicle	Final Stop	2746	Error	• A signal occurred that has been redefined in param with reaction "FinalStop". • This error will be produced as additional information for user.	• Restart the AGV. • Restart the ANS+ nav_ctrl module manually. • Redefine related signal only in case of debugged failure handling.
Vehicle	Slow Down	2747	Warn	A signal occurred that has been redefined in param with reaction "ZeroSpeed".	• Redefine related signal only in case of debugged failure handling.
Vehicle	No Auto Mode	2748	Error	ANS+ receives no automatic mode from PLC via "vehicle" interface (UDP telegram). Automatic mode is required for autonomous navigation.	• Activate automatic mode on the AGV • Check if the automatic mode is transferred to the ANS+ system in the correct way.
Vehicle	Odometry Jump	2749	Warn	• Related to params "Odometry Jump Distance" and "Odometry Jump Angle". • The distance between last and new pose of UDP telegram exceeds the defined limit of "Odometry Jump Distance". • The angular between last and new pose of UDP telegram exceeds the defined limit of "Odometry Jump Angle".	• Check the calculated and transferred odometry within PLC. To reach the highest accuracy, no jumps in odometry should be calculated.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Vehicle	Recv Time Ambiguous	274A	Warn	• Time assignment of given (in SIMOVE: UDP) telegram is ambiguous, such as on Linux startup. • ANS+ threads are too busy or having too little compositional CPU or RAM memory.	• Can be ignored in case of startup or sporadic occurrence, as this is just information for users. • In case of static occurrence, check, for example, the network workload.
Pilot	Slow Down	2761	Warn	Will be activated if the manual control device (PS4) button is pressed ("X").	• Deactivate this mode by pressing "Δ" on the manual control device (PS4).
Pilot	Goal MissedX	2762	Warn	Goal within the specified target radius around the ident point could not be reached. X-offset is greater than specified.	• Check engineered layout, especially the ident point position • Check localization accuracy within the map • Check motion parameter and evaluate if the vehicle is physically able to follow the path and reach the goal with its tolerance
Pilot	Goal MissedY	2763	Warn	Goal within the specified target radius around the ident point could not be reached. Y-offset is greater than specified.	• Check engineered layout, especially the ident point position • Check localization accuracy within the map • Check motion parameter and evaluate if the vehicle is physically able to follow the path and reach the goal with its tolerance
Pilot	Goal MissedA	2764	Warn	Goal within the specified target radius around the ident point could not be reached. A-offset is greater than specified.	• Check engineered layout, especially the ident point position • Check localization accuracy within the map • Check motion parameter and evaluate if the vehicle is physically able to follow the path and reach the goal with its tolerance
Pilot	Critical Error	2765	Error	Collective error that indicates that an order cannot be fulfilled. E.g., related to insufficient parametrization.	• Create a SIOS support request with all needed data (atlas, resource data, record file, description)

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
RouteMap	Route Descr Failure	2771	Error	Route map descriptors have not successfully been started at ANS+ startup.	• Check user rights of ANS+ nav_ctrl module on the Linux OS.
RouteMap	Internal Error	2772	Error	Subsequent failure	• Check the "Status" page (Page 55) to see other outstanding failures.
RouteMap	Job Failed	2773	Error	Transferred order cannot be interpreted.	• Check engineered layout, especially the ident points and their related IDs. • Check the transferred order starting and ending ident point.
RouteMap	Job Validation	2775	Error	Sent route within order cannot be found.	• Check engineered layout, especially the ident points and their following ident points. • Check if inverse route interpretation is activated. • Check the commanded order • Check if matching ident points exist on all connected path elements
RouteMap	Deserialize Error	2777	Error	Wrong format of a "host" interface telegram (TCP), for example, instead of "AUFT", something else is sent.	• Check the transferred TCP telegram size and collocation within PLC.
RouteMap	Pilot Error	2778	Error	Error in pilot controller, e. g. target pose could not be reached	• Check target pose accuracy (via Logging)
RouteMap	Point Gap Detected	2779	Warn	An ident point added to the pilot is not equal to the path designer action point. The path designer position and route path position are supposed to be equal.	• Adjust the path layout within the ANS+ ET if it is detected on a critical position.
RouteMap	State Cancelling	277D	Warn	Phase between internal state Cancel and Stop	• Status information only

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Loc	Lost	2791	Error	Localization uncertainty reached a too high value.	• Check the detected features on the occurred position. • Create more features around the occurred position. • As a backup, increase the allowed uncertainty.
Loc	Load Map Failed	2792	Error	Failed to load or open a file within "atlas" directory.	• Check the "atlas" directory, for example, ensure that a map really exists as a file.
Loc	Localization Gap	2794	Warn	Too high distance in localization updates detected.	• Check the engineered layout within ANS+ ET. • Check the detected features on the detected position.
Loc	Initial Pose	2795	Error	Initialization of ANS+ pose was not successful. Map does not exist for initial pose.	• Check the network settings of all related devices. • Check if all ANS+ modules are running without any error. • Check the "atlas"-directory.
Loc	Station Detected	2797	Warn	• Information for the user that at least one station match was found. • Start station evaluation.	• This user information can be ignored.
Loc	Unknown Tf	2798	Error	• Transition without cache, update failed. • Selected pose transition is not possible as its not available in the atlas.	• Update atlas. • Check if pose transition is available in map.
Loc	Mapping Error	2799	Warn	• Map optimization failed. • Localization deactivated. • Unable to save / restore factor graph backup. • No map available.	• Check if localization module is enabled. • Check if mapping process was successfully started.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
ET	No Connection	27A1	Warn	Connection to the ANS+ ET cannot be established.	• Check the network settings of all related devices. • Check if all ANS+ modules are running without any error.
ET	Receive Overflow	27A2	Error	No payload size given within TCP telegram. Input buffer too small for given TCP telegram.	• Check the transferred TCP telegram size and collocation within PLC.
ET	Recv Time Ambiguous	27A3	Warn	Time assignment of given (SIMOVE: TCP) telegram is ambiguous (for example on Linux startup). ANS+ threads are too busy or having too little compositional CPU or RAM memory.	• Can be ignored in case of startup or sporadic occurrence, as this is just an information for users. • In case of static occurrence, check, for example, the network workload.
MQTT	No Connection	27B1	Warn	Unable to establish connection to MQTT Broker	• Check network configuration (Ping) • Check MQTT connection parameters
LocIf	No Connection	27C1	Warn	Connection to the external localization source cannot be established.	• Check the network settings of all related devices.
LocIf	Receive Overflow	27C2	Warn	• No payload size given within UDP telegram. • Input buffer too small for given UDP telegram.	• Check the transferred UDP telegram size and collocation.
LocIf	Unknown Tf	27C3	Error	• Inactive or incorrectly configured parameter "Global Frame Id". • Given map name not transformable to parametrized "Global Frame Id".	• Check parameter "Global Frame Id" within "user_def". • Check sent map name with "External pose interface" (EPI).
Odo	Extrapolate Too Old	27D1	Error	Odometry data is received that is older than the current extrapolation memory.	• Check the data synchronization in case of activated extrapolation. • Deactivate odometry extrapolation.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Odo	Add Queue Overflow	27D2	Error	Received odometry data cannot be associated to the latest extrapolation memory, as values rely to timestamps in the future.	• Check the data synchronization in case of activated extrapolation. • Deactivate odometry extrapolation.
OdoLaser	No Scans	27E1	Error	No measurements retrieved despite of an established connection between ANS+ and the laser device.	• For UDP connections, this is an indicator that connection parameters are invalid. Check the connection and laser settings in the ANS+ ET. • Laser device might use a protocol that is not yet supported. Check if laser hardware version is compatible or if protocol of laser datagrams was changed by vendor. • The laser-specific configuration in the vendor tool has been set not correctly. Recheck all laser configurations.
OdoLaser	Filtered Threshold	27E2	Warn	• Ratio between filtered out laser beams to original beams is greater than specified parameter filtered ratio.	• Ensure that laser is not covered. • Wheel odometry is currently used for relative displacement. • Forcing the use of laser odometry can be done by increasing the 'Filtered Ratio' parameter.
Job	Id Mismatch	2801	Error	• Last ident point of previously sent order does not match first ident point of current order. • IDs of consecutive orders are not matching.	• Check and correct drive order. • Only produced if 'Verify Order' is enabled.
Job	Double Order	2802	Error	Two following orders are equal.	• Sent drive order only once. • Only produced if 'Verify Order' is enabled.

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Job	Subroute Equal Id	2803	Error	Start and end point IDs of sent order are equal.	• Drive order is not supported, give a corrected drive order. • Verification cannot be disabled.
Job	Missed Goal	2804	Error	Initial pose of vehicle is behind end position of first job order segment.	• Check current vehicle pose and drive order
Job	Position Gap	2805	Error	• Distance between set first job position and current (initial) vehicle position is larger than currently used parameter "Max Pose Unc". • Start pose is too far from expected position.	• Place vehicle on the specified ident point as set in the Host Interface / ET.
Job	Orientation Gap	2806	Error	• Distance between set first job orientation and current (initial) vehicle orientation is larger than currently used parameter "Max Rot Unc". • Start orientation is too far from expected position.	• Set vehicle orientation as specified in the Host Interface / ET.
LaserCal	Process Failure	2811	Error	Unexpected drive command sent during the calibration process.	• Check that the master control or any user does not send commands to AGV during calibration. • Check that the Carrier Control system was able to reach the commanded VTS target

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
LaserCal	Calib Failure	2812	Error	Unsuccessful optimization of the laser transformation parameters during the automated calibration.	• Check the laser commissioning and ensure the features are visible to the laser. • Ensure that features are detected correctly during mapping. • Check the calibration setup (ensure distance between features is roughly as specified). • Check if the parametrized timeout has been exceeded.
Reset-LocPose	Write Access	2821	Warn	Unable to write data to "…/resource/locpose" or "…/resource/locposeSty" file.	• Check the rights of the "…/resource" directory for the user, which starts the runtime module.
Reset-LocPose	Init Failure	2822	Error	Unable to read data from "…/resource/locpose" or "…/resource/locposeSty" file.	Delete the following localization files and restart the NC module: • "…/resource/locpose" • "…/resource/locposeSty"
AssetLoc	No Localization	2831	Warn	Localization is not active	• Use the ANS+ ET "setPose" function to initialize the localization inside a map
Motion	Init Error	2841	Error	Initialization error during startup for module "Motion"	• Check the command line for detailed information • Check the parametrization of the "user_def" file
Motion	Behavior Tree Error	2842	Error	Behavior tree configuration invalidates process	Check the behavior tree parameters
Motion	Order Error	2843	Error	Unable to find collision-free path for applied order control point	Check if path is feasible, vehicle start and goal pose are collision free, zone do not invalidate a path
Motion	Planning Error	2846	Error	Unable to find collision-free path	Check if path is feasible, vehicle start and goal pose are collision free, zone do not invalidate a path

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
Motion	No Trajectory Found	2847	Error	Unable to follow path	Check for collision free or feasible path
Motion	Disabled	2848	Error	A motion command has been sent to the runtime, but the module "Motion" has been disabled	• Check the parametrization of the "user_def" file underneath the section "Motion AGV"
Diag	Package Dir Locked	2858	Warn	Status information that package directory is locked. During lockage no diagnostic data is recorded.	Warning disappears automatically once the lockage isn't needed anymore, e. g. for ANS+ ET diagnostic package generation.
Voa	Runtime Error	2861	Error	Visual obstacle avoidance (VOA) exception detected.	• Check the command line logs for detailed information.
VoaSensor	Initialization	2871	Error	Visual obstacle avoidance (VOA) sensor in initialization phase	Wait until the camera startup is done, approximately 10 seconds.
VoaSensor	Parameter Error	2872	Error	One or more parameters set in user_def or yaml file are invalid or out of range	• Check parameters in both files. • Check the command line logs for detailed information. (Most often a parameter is below zero that must be positive).
VoaSensor	Disconnected	2873		The respective camera was not found by the software.	• Check your cable. • Is the serial number set in user_def correct? • Check if the camera is found by the operating system by connecting to the IPC via SSH and type the command "lsusb".

Component Name	Status Issue Name	Message number (HEX)	Default Issue	Reason	Solution
VoaSensor	No Frames	2874		The camera did not start successfully and thus no frames reach the Visual obstacle avoidance (VOA) module.	• Usually occurs if your camera is not mounted as a USB 3.0 device. • Ensure a USB 3.0 cable is used and your cameras is connected to a USB 3.0. Remove and reconnect your cable. Restart ANS+. • If you are using an Open Controller 2, ensure your operating system is Industrial OS 3.2 or newer and your camera is connected to an USB 3.0 port.
VoaSensor	Time Too Old	2875		The system does not reach the default cycle time of 90 ms.	• Can be ignored and acknowledged if only occurring once at startup. • Else, check the total load on your IPC.

A.2 Changelog ANS+ NC module

Version	Date	Changes
2.2.0	02.05.2025	New features: • Detailed information on errors and warnings are visualized in status page of ANS+ ET • Logging information available in ANS+ ET, filtering of logs and download from ANS+ ET possible • Control point teach-in / move control points to current vehicle pose • Motion able to consider dynamic constraint changes of velocity and acceleration during runtime • Motion reduces padding during approach phase • Motion approach speed parameter added "v_max_goal_approach_scale" • Added edge parameter corridor left and right • Specify direction of spot rotation in ANS+ ET • Enable spot rotation in motion without setting vts velocity in CC • New laser scanner device integrated: SICK Picoscan100 • New laser scanner device integrated: Leuze RSL235 • New laser scanner device integrated: HINSON LE50821FA • Laser sick lms driver validates frequency, resolution, beam size and start angle during runtime • Explicit start pose area parameters introduced to allow larger distance from start point when using Motion • Parameter 'Enable Parameters' set to 'yes' by default and removed from param file Bug fixes: • Fixed inverted driving direction velocities when target radius is large, and vehicle stopped with large velocity in previous order • Fixed reflector detection for laser scanner SICK NAV310 • Fixed restore loc pose validity parameter • Check line feature edge orientation before optimization is started

Version	Date	Changes

2.1.0	26.04.2024	New features:
		• Integrated new feature “Diagnostic Package”
		• Integrated new feature “Visual Obstacle Avoidance” (VOA)
		• Improved Motion path tracking
		• Ident points are now sent as “reached” without any running order
		• Motion startup failures are now visualized within ANS+ ET
		• Changed Motion rotation parameter units from rad to deg
		• Enabled backwards free path planning via ANS+ ET
		• New laser scanner device integrated: KEYENCE SZ-V32N
		• Laser scanner Pepperl&Fuchs R2000 SD type is now compatible
		• Target mode “HalfCircle”/”Circle” is now dyn. Adjustable
		• After order cancelation on an edge (B > C), a new order (B > A) is now accepted
		  • Added more precise debug information for initial pose
		  • Parameters “Valid Angle Min/Max” are now related to laser coordinate frame
		• Feature “Collision Check” is now configurable via host-interface
		• Per default, all laser devices (ID 0,1,2,3) are now used for localization tasks. Following Motion logic by overwriting the parametrization with a specific laser ID, only this device is used for localization
		• Parameter “funnel width” is now automatically calculated
		Bug fixes:
		• Fixed “Restore Loc Pose” feature
		• Target position is now set to 0,0,0 after order cancelation
		• Fixed trajectory preview
		• Fixed convex outline computation
		• Fixed virtual path handling for ongoing orders
		• Fixed bug with “Maximum Speed” in Motion on 2nd edge

Version	Date	Changes
2.0.0	16.06.2023	New features: • Containerized approach • Free path planning based on required gridmap • Obstacle avoidance on free planned paths and virtual tracks based on alternative pre-defined trajectories • Edge handling • Performance optimization for mapping process • Zone handling • Corner features are now providing the free space angle • Host-Interface adjusted for new V2.0.0 features • Optimized setPose via ET • Localization initialization via Host-Interface is now done with minimal uncertainty • Host-Interface specification extended for motion parametrization (protocol V2) • Change tangential edge orientation angle interpretation • "Standstill" evaluation based on vehicle-interface flag information Bug fixes: • Default build map name set to “tmpMap” • Fixed typo “Mecanum” • Failure message for tangential edge orientation integrated, if parametrized kinematic does not support this feature
1.7.1	30.11.2022	Bug fixes: • Lost order when follow-up order is applied just when previous order is done • P&F R2000 0.014° resolution compatibility • Loc score drop between orders • Clear measurement features before localization update
		Support of Debian 11
		AGV calibration added via MMI commands
		• Bounding box integrated to consider relevant map features only
1.7.0	30.11.2021	Mapping improved including ... • ... manual loop closure • ... extend map feature • ... map optimization during mapping • ... feature and graph information improved
		Automatic laser calibration integrated
		"External pose interface" (EPI) integrated to adapt 3rd party localization systems
		Export path layout added
		In case of a canceled order ident points are send until AGV stops and order is finished
		Clear cached AGV localization pose by command “loc reset”

Version	Date	Changes
		Optional job order validation added
		Host-Interface orientation parameter added to distinguish between vector and global incoming orientation
		Fixed path indices for connector points
		Odometry stop detection added
		Laser odometry error handling updated
		Laser odometry filter ratio parameter added
		Laser odometry global orientation added
		Fix laser odometry reading minimum distance parameter
		Fix laser odometry wrong motion when laser covered
		Fix error messages in case of file open
		Support of Ubuntu 20.04
		Support of Debian 10
1.6.2	12.11.2021	Fix loc score memory leak
		Fix basic feature memory leak
1.6.1	15.01.2021	Laser odometry bug fixes
1.6.0	16.12.2020	PLC 1200er compatibility
		New Feature: ”LaserOdometry” for rough environments
		Cylinder feature can now be handled in a range of diameters. New parameters therefore added ”Min Diameter” and ”Max Diameter”
		Automatic detection of flat or circular reflector features
		Error handling for multiple lasers fixed
		Laser data loss of 25% fixed
		Update for cycle time of localization thread
		Improvement of line segmentation (with focus on line endings)
		Dynamic target distance for position controller added
		Enabled continuous switch between holonomic and non-holonomic motion behavior
1.4.0	30.10.2020	Permanent localization added
		Start localization via host interface with • Ident point ID + Orientation • Full valid pose (X, Y, Beta and map name)
		Rotation allowed feature applicable for holonomic drives
		Target radius mode added to minimize effect of target gab when approaching from opposite directions • Circle (Default) • HalfCircle
		Send AUST AB for internal errors in route management during driving
		Apply acknowledge when AUFT AB received to remove all status issues
1.3.3	05.08.2020	Added AGV to AGV calibration
		New feature type added: Corners
		Ident point action default parameters changed
		Support unique map transitions only

Version	Date	Changes
		Export track layout to file in atlas folder
		Send data via host, ET and vehicle w.r.t. a parametrized global frame identifier Parameter “Global Frame Id”
1.3.2	27.03.2020	Fix: Bug fixed for paths with more than 5 control points
1.3.1	06.03.2020	Derive direction information based on minimum orientation change between most previous stored pose when localization was running and start pose of new route segment
		Send WO at start of AUFT, even when first point is not sent to host
		Cache each ident point pose, independently whether pose is sent to host or not
1.3.0	28.02.2020	Continue after power-up
		Multi link fix
		Host interface update, supported versions: • AUFT V1, V2 • AUST V1, V2
		Vehicle interface version added to support interface with/without vda5050 information
		Vehicle interface telegram data size changed from 64 to 128 Bytes • payload size 93 Byte
		SickTIM571, SickTIM56x renamed into SickTIMXXX
		Scanner support Sick Tim 781 (safety scanner)
		Individual target radius specified at ident point action with CSV string 'tr=X_cm'
		Support path symbolic links
		Support paths with arbitrary moving directions: fwd, bwd, angle X, ...

A.3 Changelog ANS+ Engineering Tool

Version	Date	Changes
1.7.0	02.05.2025	New features: • Display detailed error information and logging information in ANS+ ET • Control point teach-in / move control points to current vehicle pose • User must change default password for each user level at initial login • Automatic user logout after default 15 minutes • “Remember me” button removed • Tracking of unsuccessful login attempts to ANS+ ET, lock ET for default 90 seconds after three failed logins • Support https • Added corridor left / right and rotation direction buttons Bug fixes: • Fixed trajectory preview for motion • Fix update of gridmaps
1.6.0	26.04.2024	New features: • Diagnostic package UI feature • Adjusted device visualization panel for Visual Obstacle Avoidance (VOA) • Free path planning in backwards direction • New UI approach for adding control points to a path • By adding new control points the ident points stick to their position • Using multi-selection on junctions, the ident points stick to their position • Using multi-selection only for edges or ident points, specific commands can be configured for the entire selection • “Snap” function is now additionally working for linked station maps • Added edge command “Target Mode” for dyn. “HalfCircle” or “Circle” configuration • Added edge command “Maximum Speed” for Motion feature • New configurations are now auto. overtaken for overlapping ident points • Grid size auto. adjusts its size related to zooming • Integrated copy path feature Bug fixes: • Removed “Goal Approach Length” as edge command • Fixed visual issue with feature map during gridmap editing • Fixed feature “Align control points” • Fixed gridmap erasing • Fixed outline visualization in case of 0.0 values • Parameter page search is again valid after switching the page

Version	Date	Changes
1.5.0	16.06.2023	New features: • Containerized approach • Manual command for free path planning • Path layout edge handling • Support of all new V2.0.0 AGV related live-data • Zone engineering • Gridmap engineering • New parameter page UI style including search bar • New visualization for new corner features • Path straighten feature for control points integrated • Map element search • Set point visualization within device tree • Updated style of the device list • Map renaming Bug fixes: • Performance increased for mapping processes of large environments • Increased “Undo”-Performance • AGV live-data is now based only on ANS+ NC localization data • Parameter page keeps the view when changing the editor • Map and path lists are now sorted alphabetical • Mutli-selection dialog disappears in case of DEL button • “Offset Beta” renamed into “Offset A” • Several fixes done for Firefox browser compatibility
1.4.0	30.11.2022	New features: • Performance increased for large environments • Added ANS+ NC version and commitId information to ”Status” page • Debian 11 compatibility • Reworked ”Save” approach • X and Y position visualization of the cursor on the grid • Path hovering • Measurement tool integrated • Removed ”ans_proto_nav” and ”system” directory • Added new UI data polling parameter Bug fixes: • „Failed to load umbrella“ ... failure • Data loss in case of path merging • Alphabetic sorting of map list elements • ”Parameter” page text editor performance fixed • Minor fixes

Version	Date	Changes
1.3.0	30.11.2021	New features: • Multi-selection • ANS+ NC AGV shape visualization • Map origin change • Station templates & instances • Added device visualization configuration panel • "Status" page for visualization of outstanding ANS+ NC failures, acknowledge, cancel and shutdown • User login with three pre-defined users • Ident and control point positions are now transformable to linked map origins • LocScore is added to the "Workspace" page • EPI, Laser and wheel odometry data are able to visualize independently
		Updated features: • Reworked the zoom handling. Selected elements are staying centered • Restructured the "Workspace" page UI related to the "device visualization configuration panel" • Updated laser colors • Map and path changes are only written to the file system in case of "Save" • New icons for deployment page • Parameter sections are now activating scrolling once reaching the upper or lower window's border • Corner features are now editable and shiftable • Reworked the ident point command engineering. Ident points with commands are highlighted in the world window • Reworked the link engineering for an easier approach. Links now relate between two map origins only • Reworked the style of the ANS+ ET version information • "localhost" device is now listed per default within "Favorite device" • Hovering of map elements improved • Improved style for tree navigation selection
		Bug fixes: • After committing it occurred, that "device.json" file within "dataspace" directory was corrupted • ET now synchronizes the connection state with NC to visualize a broken connection • "Fit map" function considers all map elements for centering • Issue fixed at which a map is visualized without existing • Ident points in linked maps are now correctly calculated • Map transparencies are now correctly visualized

Version	Date	Changes
1.2.1	16.12.2020	Path usability increased. While holding <CTRL>: • a control point is set on the position of another control point in case of close distance between each other. • an ident point applies the position, UID and description of another ident point in case of a close distance between each other.
		A control point has a new specific function to create an ident point directly on their position
		Adjusted layer visualization: • Laser beams are now shown below paths to enable path selection. • In case of control point selections, all control points belonging to the same path are now having a higher level to be able to move control points, which are underneath of an ident point. • Ident point tooltips are now showing the ident point properties related to the selected path.
		Integrated feature hover function
		Improved visualization for corner features
		AGV shape will be visualized using odometry data if no localization is activated
		Added multi feature selection by using CTRL
		Shape selection added for dialog screen "New AGV"
		Added AGV command "export"
		Added tooltip for ident point commands
		New icons integrated
		UI style adjustments
		New coloring of laser data and features
		Added map name limitation of 26 characters
		Added new feature to create directly an ident point on a control point position
		Fixed issue within bigger maps and data storage
		Fixed issue with NAT compatibility
		Fixed issue with "Fit map" function to use all kind of features for centering the map
		Fixed issues with reflector visualization
		Fixed issue by an amount of used scanner greater than two
		Fixed issue with new feature type "StationFeatures". Those features are high-lighted green turquoise
1.2.0	30.04.2020	Added AGV history for localization and odometry data
		Kinematic center visualization improved
1.1.0	28.02.2020	Offline & online parametrization integrated
		AGV command interface added
		Improved deployment
		Multi-map linking added
		More visualization details integrated into UI
		Fixes of v1.0.0
1.0.0	30.09.2019	First release
		Web-based architecture

Version	Date	Changes
		Multi-plattform supported • Windows 10 • Linux
		New design
		Multi connection
		Multi deployment
		Server handling

A.4 Service and Support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks at:

- https://support.industry.siemens.com (https://support.industry.siemens.com)

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers - ranging from basic support to individual support contracts.

You send queries to Technical Support via Web form:

- https://www.siemens.com/industry/supportrequest (https://www.siemens.com/industry/supportrequest)

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With our globally available training courses for our products and solutions, we help you achieve knowledge with practical experience, innovative learning methods and a concept that is tailored to specific customer needs.

For more information on our offered trainings and courses, as well as locations and dates, refer to:

- https://www.siemens.com/sitrain (https://www.siemens.com/sitrain)

Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog:

- https://support.industry.siemens.com/cs/sc (https://support.industry.siemens.com/cs/sc)

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app.

The app is available for Apple iOS, Android and Windows Phone:

- https://support.industry.siemens.com/cs/ww/en/sc/2067 (https://support.industry.siemens.com/cs/ww/en/sc/2067)

A.5 Links and Literature

Nr.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com (https://support.industry.siemens.com/cs/de/en/)
\2\	Link to an application example https://support.industry.siemens.com/cs/ww/de/view/109755405 (https://support.industry.siemens.com/cs/ww/en/view/109755405)
\3\	Programming Guidelines and Programming Styleguide for SIMATIC S7-1200 und S7-1500 https://support.industry.siemens.com/cs/ww/de/view/81318674 (https://support.industry.siemens.com/cs/ww/en/view/81318674)
\4\	Configuration and Application of the PROFINET I-Device Function https://support.industry.siemens.com/cs/ww/de/view/109478798 (https://support.industry.siemens.com/cs/ww/en/view/109478798)
\5\	Guideline on Library Handling in TIA Portal https://support.industry.siemens.com/cs/ww/de/view/109747503 (https://support.industry.siemens.com/cs/ww/en/view/109747503)
\6\	Reading of failsafe analog Values https://support.industry.siemens.com/cs/de/de/view/45830615 (https://support.industry.siemens.com/cs/ww/en/view/45830615)

A.6 Changelog documentation

Version	Date	Changes
2.2.0	02.05.2025	--- Documentation related to SIMOVE ANS+ V2.2.0. --- • Added chapters and sections – Cybersecurity Information – Compatible hardware – Change password – Communication ports – Teach control points – Sick Picoscan 100 – Leuze RSL235 – Hinson LE50821FA • Updated chapters and sections – Update – ANS+ V2.2.0 installation – Overview – Logout – Status page – ANS laser commissioning – Map linking – Zone engineering – Ident point commands – Edge commands – Costmaps – PLC commands for free path planning – Visual obstacle avoidance – Station instance engineering – Parameters – Issue reference list • Updated several figures

Version	Date	Changes
2.1.0	26.04.2024	--- Documentation related to SIMOVE ANS+ V2.1.0. --- • Added chapters – Costmaps – Visual Obstacle Avoidance (VOA) Module – Copy and move paths – Order Handling from PLC – Parameter Prioritization – Keyence – Diagnostic Packages • Updated chapters – Update – ANS+ V2.1.0 installation – ANS+ NC module manual start – Parameter setup – Usable feature types – Edge commands – Gridmap clearing and editing – Logical path engineering – Ident point commands – PLC commands for free path planning – Parametrization – Track integration – Movement direction on edge – SICK nanoScan3 – Support – Issue reference list • Restructured chapters – Path engineering • Added figures – Figure 4-16 Workspace UI - Cameras • Updated figures – Figure 2-3 Successful start of all SIMOVE ANS+ modules – Figure 4-6 ANS+ ET login screen – Figure 4-12 Visualization configuration panel within "Work-space" page – Figure 4-28 ANS+ ET “Status” page and related windows – Figure 5-1 Lateral and longitudinal distances of the motion flow kraken controller – Figure 5-2 Alternative trajectories based on the lateral and longitudinal distances – Figure 6-3 Kalman Corners default parameters

Version	Date	Changes
		– Figure 6-9 ANS+ ET localization data activation – Figure 8-9 Path extension in ANS+ ET – Figure 8-24 Highlighted ident point due to added commands – Figure 8-25 Selected path – Figure 8-26 Edge commands – Figure 9-2 Selection of start pose and target pose – Figure 9-3 Executing of driving task – 11-3 Advanced parameters – Figure 14-8 Apply edge commands with movement direction – Figure 14-9 Movement behavior of "Global edge orientation" – Figure 14-10 Movement behavior of "Tangential edge orientation" – Figure 14-11 Movement behavior of "Edge rotation allowed” – Figure 14-26 Safety Designer microScan3 – "Data output" page – Figure 14-27 ANS+ "user_def" – microScan3 configuration example – Figure 14-34 Safety Designer nanoScan3 – "Data output" page – Figure 14-49 P&F R2000 laser specific “user_def” example parameters – Figure 14-35 ANS+ ET "user_def" – nanoScan3 configuration example
2.0.1	15.08.2023	--- Documentation related to SIMOVE ANS+ V2.0.0. --- • Correction of file names • Updated Figure2-3

Version	Date	Changes
2.0.0	16.06.2023	--- Documentation related to SIMOVE ANS+ V2.0.0. --- • Updated structure of chapters • Updated screenshots • New added chapters: – Required hardware – ANS+ docker image installation – Manual start of the nc module – Update process to v2.0.0 – Advanced Parameters – Initial configuration of parameter – Free path planning – Planner parameters – Grid-based map (extension, clearing, editing) – Zone engineering – Align control points – Edge handling/commands • Changed chapters: – Workspace colors – Parameter page – Corner feature – Ident point commands – Movement behaviors – Issue reference list
1.3.1	30.11.2022	--- Documentation related to SIMOVE ANS+ V1.7.1 ---- • "Status" page chapter updated • „Update“ chapters updated related to new data structure • Removed “Update ANS+ ET” chapter • “Compatibility” chapter updated • Added new note for „Export Layout“ function • Screens updated related to new ANS+ ET version • ANS+ NC and ET changelogs updated

Version	Date	Changes
1.3.0	30.11.2021	--- Documentation related to SIMOVE ANS+ V1.7.0 ---- Updated SICK microScan3 illustrations Reworked "Path engineering" chapter 6 Reworked "Track integration" chapter 12.1 Issue list updated related to ANS+ NC v1.7.0 Reworked chapter "ANS+ ET user interface" Reworked chapter "Commissioning" Reworked chapter "Update" Reworked "Linux IP change" related to Ind.OS Updated "Reflector" feature description Updated "General mapping process" Updated "Holonomic movement" chapter Fixed bug for holonomic tangential command New added chapters • "Status" page • Shortcuts • ANS+ & CC compatibility matrix • SICK nanoScan3 example configuration • P&F R2000 example configuration • Leuze RSL455P example configuration • Ident point commands • Service Requests • Linux OS handling • Station engineering • Map extension • Path examples • User login • Kalman LineMidPoints • "Workspace" page colors • Map origin change • Track integration
1.2.0	16.12.2020	--- Documentation related to ANS+ NC v1.6.1 ---- Sync adjustments for HTML documentation Changed "Bézier curves" circle example three paths Changed path illustrations Added issue 0x2775 Added new chapter 12.4 for laser configuration Resorted and merged chapters Added shortcuts Added chapter 12.1 "ANS+ track integration"

Version	Date	Changes
1.1.3	20.08.2020	Added chapters "Update", "Record-files", "Movement behaviors" Added additional phrase for required tools in chapter 1. Updated illustrations due to new ANS+ ET colors Improved "Map engineering" chapter
1.1.2	29.04.2020	Updated illustrations and references to version 1.2 Added missing issue default behavior Minor changes within text Added notice within mapping process for less movements Added "doubled objects" within mapping process Adjusted chapter 2.1.1 to WIN10 OS Adjusted chapter 2.1.1 for WIN environment variables
1.1.1	07.04.2020	Added new issue "Vehicle – Time Too Old" (0x2744)
1.1.0	31.03.2020	Added new requirements for "Installed software" Added chapter "Linux IP change" Added chapter "Starting ANS+ navigation module manually" Added chapter "ANS* issue reference list" Changed Screenshot due to new ET version (v1.2.0) Removed footer "Entry-ID"
1.0.0	06.03.2020	First Version
0.1.0	02/2020	First Draft