

NAV200

Laser Positioning System for Navigational Support



Software versions

Software/Tool	Function	Version
NAV200	SICK firmware for NAV200 Laser Positioning System	V 4.1.X
NAV200 Setup	SICK configuration software under Windows™	V 1.0.X



The NAV200 Laser Positioning System is intended for use only in industrial environments. Use in residential areas can cause RF interference.

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SICK AG Waldkirch
Auto Ident, Reute Plant
Nimburger Strasse 11
D-79276 Reute
Germany

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Latest version of the operating instructions

For the latest version of these operating instructions (PDF), see www.sick.com.

Quick Finder

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- **Where is everything?**
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Installation procedure (overview)

1. Check the delivery to make sure that none of the components is missing.
 2. Mount the NAV200 on an automated guided vehicle (AGV) and align the scanning plane parallel to the travelled area.
 3. Connect the NAV200 to the PC via the RS 232 data cable.
 4. Connect the NAV200 to the 24 V DC power supply using the cable socket supplied.
 5. Switch on the supply. The NAV200 initializes and changes to "Standby" mode.
 6. Install the CD-ROM-based NAV200 Setup configuration software on the PC (minimum requirement: Windows 98™).
 7. Start the NAV200 Setup configuration software.
 8. Choose the required language for the user interface.
 9. Set up data communication between NAV200 and PC.
 10. Configure the NAV200 with the NAV200 Setup configuration software.
To do this, determine the positions (co-ordinates) of the used reflectors in NAV200 Setup as follows:
 - more exact method: measure the reflector positions manually on site and enter them directly in NAV200 Setup or acquire them as structured data in an ASCII file and adopt in NAV200 Setup
 - less exact method: measure reflector data using the NAV200 ("Mapping" mode), (automatic transfer to NAV200 Setup)
 11. Transfer the reflector data permanently to the NAV200 ("Download" mode).
 12. Save the reflector data as a project on the PC.
 13. Test the successful detection of the reflector positions entered.
For this, move the AGV with the NAV200 in one of the defined layers.
 14. Call up "Positioning operation" mode in NAV200 Setup.
Select the appropriate layer and the "All seen reflectors measured" option in the data entry fields.
 15. Check the detected reflectors in the NAV200 Setup display.
 16. Change to the next layer etc. with the AGV and repeat steps 14 and 15 each time.
 17. Close the NAV200 Setup configuration software.
 18. Terminate data communication between NAV200 and PC.
 19. Switch off the power supply for NAV200.
 20. Disconnect the RS 232 data cable from the PC and connect it to the vehicle computer.
 21. Switch on the power supply for NAV200 again.
The NAV200 initializes and changes to "Standby" mode.
- The NAV200 is ready for operation with the **application-specific** settings.

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Abbreviations used

AGV	Automated Guided Vehicle
LED	Light Emitting Diode
USB	Universal Serial Bus

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Information for designing the system

The following sections are recommended for support in designing the NAV200 system:

- [Section 2 Safety information, Page 13](#)
- [Section 3 Product description, Page 17](#)
- [Section 4 Installation, Page 39](#)
- [Section 5 Electrical installation, Page 41](#)
- [Section 6.4 NAV200 Setup Configuration Software, Page 50](#)
- [Section 7 Maintenance, Page 73](#)
- [Section 9 Technical data, Page 77](#)
- [Section 10.2 Available accessories, Page 80](#)
- [Section 10.5 Reproduction of the EC Declarations of Conformity, Page 83](#)

1 About this document

1.1 Function of this document

This document gives instruction in the operation of laser positioning systems NAV200.

In operation, the NAV200 Laser Positioning System continuously determines its own position and orientation within an industrial area using fixed reflectors. Mounted on an automated guided vehicle (AGV), the NAV200 Laser Positioning System transfers this positional data on the course to the vehicle computer of the AGV, which steers the vehicle on the programmed route of the AGV. The NAV200 Laser Positioning System is configured with the NAV200 Setup configuration software or directly via the vehicle computer using software telegrams.

The document includes information on

- integrating the NAV200 laser positioning system in an overall system for vehicle control
- Assembly and electrical installation
- Commissioning (startup)
- Operation and configuration (parameter setting)
- Maintenance
- Replacing the system

Note The NAV200 Laser Positioning System is referred to simply as "NAV200" in the remainder of the document.

1.2 Target groups

The target groups for this document are persons involved with the following activities

1.2.1 Assembly, electrical installation, device replacement

Specialist technical staff such as service technicians or works electricians

1.2.2 Commissioning, configuration, maintenance

Specialist technical staff such as technicians or engineers.

1.2.3 Operation

Specialist technical staff for operation and control of the positioning system

1.3 Level of information

This document contains all the information required for the assembly, electrical installation and commissioning of the NAV200 with the **factory default settings**.

Step-by-step instructions are given for all activities.

Configuration (parameter setting) of the NAV200 for the **application-specific conditions on site** (entry of fixed reflector co-ordinates) and operation for the reflector detection test by the NAV200 (positioning operation) can be performed either with the NAV200 Setup configuration software that runs under Windows™ on a PC or, alternatively, from the vehicle computer using software telegrams.

The request for positional data by the vehicle computer in continuous operation is initiated using software telegrams programmed by the user.



The software telegrams available are described in the *NAV200 Telegram listing* (No. 8009595).

More detailed information on the NAV200 and on laser measurement is available from SICK AG, Auto Ident Division. On the Internet at **www.sick.com**.

1.4 Symbols used

Some of the information in this documentation is specially highlighted to simplify quick access to this information.



WARNING

Warnings!

Warnings protect against physical injury or protect the NAV200 from serious damage.

- Always read and follow warnings carefully.

Reference Italics are used to refer to more detailed information.

Note Notes provide information on special features.

Explanations Explanations provides background information on technical aspects.

Recommendations Recommendations provide advice on how to carry out a task more effectively.

TIPS Tips explain setting options in the NAV200 Setup configuration software.

COMMUNICATION This font denotes a term in the user interface of the NAV200 Setup configuration software.



This symbol denotes a section that describes the steps involved in using the NAV200 Setup configuration software.



This symbol refers to supplementary technical documentation.



You have to do something here. This symbol denotes a single-step operating instruction. Multi-step operating instructions are listed in numerical order.

2 Safety information

2.1 Authorized personnel

To ensure that the NAV200 operates correctly and safely, it must be installed and operated by sufficiently qualified personnel.

Repairs on the NAV200 must only be carried out by trained and authorized SICK AG service personnel.

The operating instructions must be made available to the end user. The end user must be given expert instruction and encouraged to read the operating instructions.

The following qualifications are required for the different activities:

2.1.1 Assembly and maintenance

- Practical technical training
- Knowledge of the current safety directives at the workplace.

2.1.2 Electrical installation and device replacement

- Practical electrical training
- Knowledge of the current electrical directives
- Knowledge related to operation and control of the navigation system

2.1.3 Commissioning, operation and configuration

- Knowledge of the mechanical and electrical parameters of the navigation system and the characteristics of the navigation system with regard to operation and control
- Basic knowledge of the Windows™ operating system used
- Basic knowledge of data transfer processes

2.2 Intended use

The NAV200 is used for determining the position of automated guided vehicles (AGVs) on a course on the programmed route. Mounted on an AGV, the NAV200 continuously measures the positions of detected reflectors, with reference to the stored positions of these reflectors, and uses this information to calculate its own instantaneous position and orientation on the course. During the journey, it outputs this data to the vehicle computer of the AGV in the form of co-ordinates. As a result, the vehicle computer can correct the course of the AGV appropriately in order to keep it on the route.

The NAV200 is a system for use in internal areas.



The NAV200 must not be misused as a device for personal protection as defined in the applicable machinery safety standards.

In the case of any other use or modifications to the system, including during assembly and electrical installation, or modifications to the SICK software warranty, all warranty claims against SICK AG will be forfeited.

Note Do not open the NAV200. Opening the device will invalidate the manufacturer's warranty.

2.3 General safety information and protective measures

- Read the general safety information thoroughly and observe it during all activities involving the NAV200. Also observe the warnings given before the instructions in the individual sections.

2.3.1 RF interference



The NAV200 is intended for use solely in industrial environments. Use in residential areas can cause RF interference.

2.3.2 Electrical installation work



Danger of injury through electrical current!

The NAV200 operates with a 24 V DC power supply. High voltage is produced in the device when it is operating.

- Do not open the housing.
- Observe the usual safety precautions when working on electrical systems.

2.3.3 Laser radiation



Laser radiation!

The NAV200 uses a **Class 1** laser.

The laser outlet aperture is a 1 cm diameter circular area in the centre of window area of the rotating scanner head.

The invisible infra-red radiation emitted is safe to eyes.

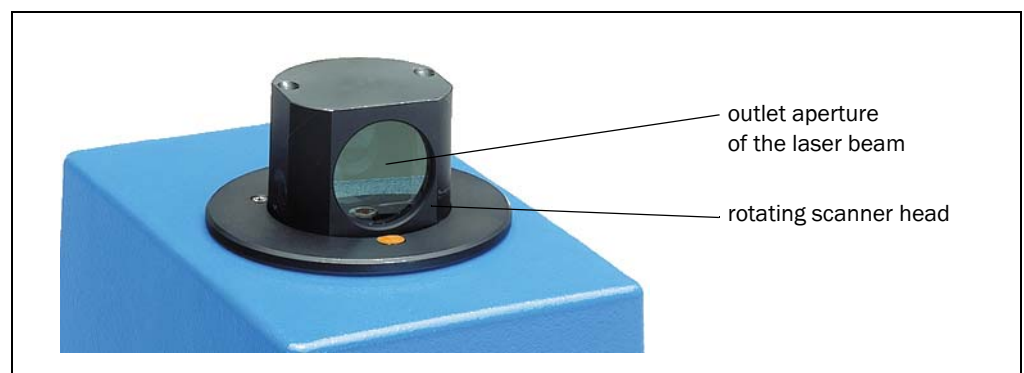


Fig. 2-1: Window area in the scanner head of the NAV200

Caution — use for other than the intended purpose can lead to exposure to dangerous radiation.

- Do not open the housing (opening does not stop the laser switching on)
- Use for other than the intended purpose can lead to the laser class being exceeded.
- Observe the latest version of the laser protection regulations.

Laser power

The laser operates with a wavelength of $\lambda = 855 \text{ nm}$ (infrared radiation).

The emitted beam poses no risk to a person's eyes or skin. The laser beam is invisible to the human eye.

The product is classified as Laser Class 1 in accordance with EN/IEC 60825-1 and 21 CFR 1040.

No regular maintenance is required to ensure that the Class 1 laser classification is maintained.

Laser warning label

The laser warning label (Fig. 2-2) on the NAV200 is located within the rating plate, above the electrical connections.

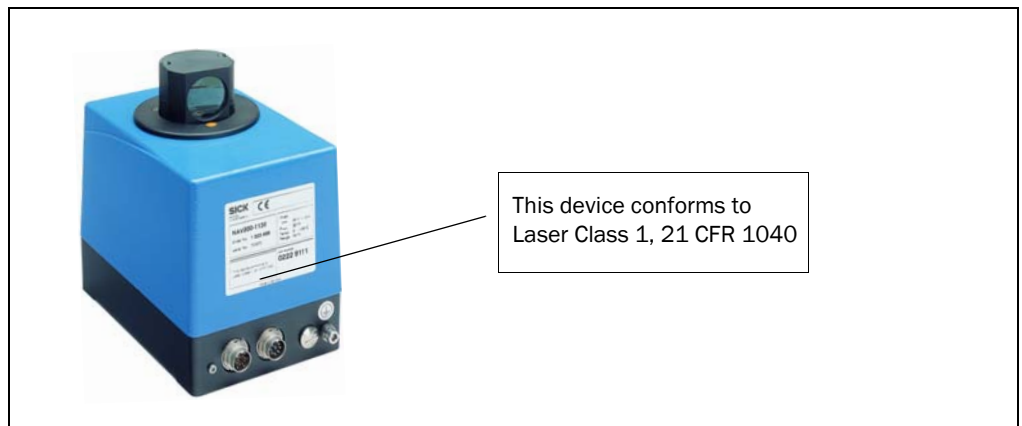


Fig. 2-2: Laser warning label attached to the NAV200

Note If the NAV200 is mounted on an AGV such that the laser warning label is obscured, an additional warning label (not included in the scope of delivery) must be attached to the AGV, next to the outlet aperture of the laser beam!

2.4 Quick Stop and Quick Start

2.4.1 Switching the NAV200 off

- Switch off the 24 V DC supply for the NAV200.

The NAV200 retains the last configuration stored in the nonvolatile reflector memory. The most recent measurement data determined using Mapping and stored in the working memory of the NAV200 is lost.

2.4.2 Switching the NAV200 on again

- Switch on the 24 V DC supply for the NAV200.
The NAV200 starts up in "Standby" mode.
The configuration held in the nonvolatile reflector memory is activated after a change to either "Mapping" or "Positioning operation" (position measurement) mode.

2.5 Environmental aspects

The NAV200 is constructed in such a way that it causes the least possible damage to the environment.

2.5.1 Energy consumption

The maximum power consumption of the NAV200 is 24 W.

2.5.2 Disposal after final removal from service

Always dispose of unusable or irreparable equipment in an environmentally-responsible manner, in accordance with the waste disposal regulations applicable in the particular country involved. The design of the NAV200 enables its separation into recyclable secondary raw materials and special waste (electronic waste).

For more details on this, see [Section 7.3 Disposal, Page 74](#).

SICK AG does not currently take back devices that have become unusable or irreparable.

3 Product description

3.1 Design of the system

3.1.1 Scope of delivery (without data cable)

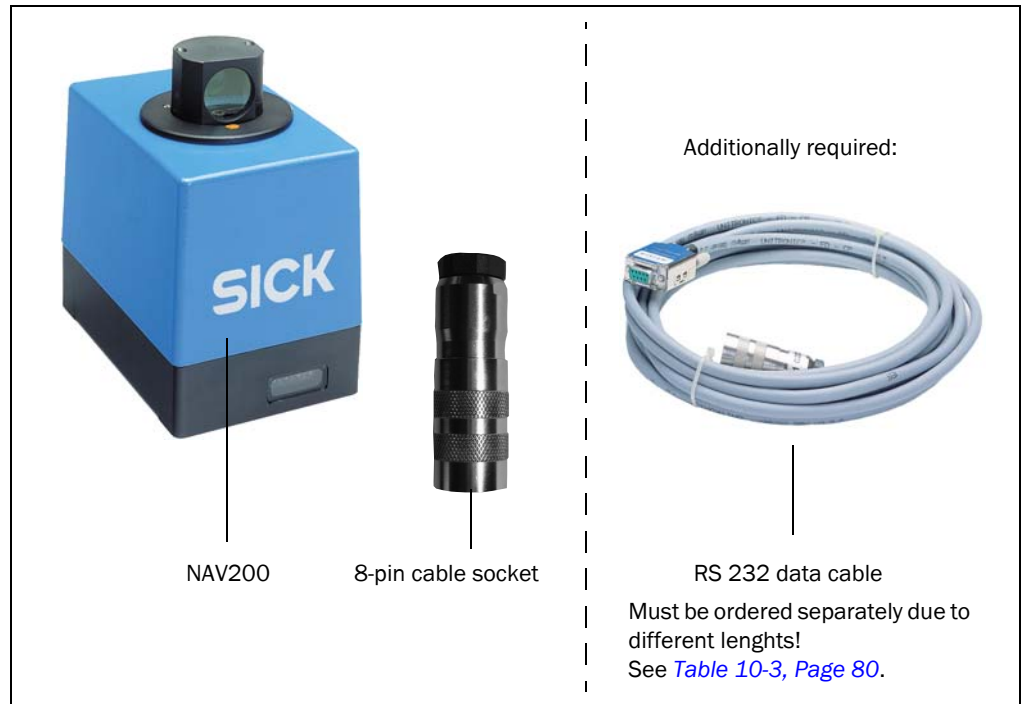


Fig. 3-1: NAV200 laser positioning system with cable socket

The delivery package of a NAV200 comprises:

- NAV200 with rotating scanner head
- 8-pin cable socket for power supply (No. 6024722)
- Information sheet (device information)
- CD-ROM (No. 2040168) with
 - NAV200 Setup configuration software for Windows™
 - NAV200 operating instructions in German and English (PDF)
 - NAV200 telegram listing in German and English (PDF)
 - The freely-available "Acrobat Reader" PC software for reading PDF files
- Screw kit (No. 2026277) for fixing the NAV200, consisting of
 - 4 x hexagon socket (Allen) screws M4 x 10 mm (0.39 in) - A2
 - 4 x washers 4.3 - A2
 - 4 x spring lock washers B4

The required RS 232 data cable must be ordered separately.

Note The latest versions of all the current publications/documentation included in the scope of delivery are available for download at www.sick.com.

[Section 10.2 Available accessories, Page 80](#) also gives an overview of the accessories available, e.g. the required RS 232 data cable.

3.1.2 System requirements

As part of a navigation system, the NAV200 is controlled by a supervisory unit - the vehicle computer. Application-specific software that enables communication between vehicle computer and NAV200 is required for this task.



The user can write suitable software for his application on the basis of the software telegrams described in the NAV200 *telegram listing* (No. 8009595).

Other requirements are:

- Sub-division of the area to be travelled into separate layers
- Mounting of fixed reflectors in these layers
- Accurate measurement of the reflector positions (co-ordinates) from a common origin (zero point) of the area
- Transfer of this layer-related reflector data to the NAV200

SICK offers "Diamond Grade" reflective film as an accessory for constructing suitable reflectors, see [Section 10.2 Available accessories, Page 80](#).

The sub-division and equipping of layers with reflectors is described in [Section 3.3 Operating conditions, Page 22](#).

Other requirements for commissioning and operating a NAV200 are:

Mounting:

- Flat mounting surface (support, not included in the scope of delivery) for mounting the NAV200 on an automated guided vehicle (AGV). The NAV200 is mounted parallel to the area travelled.

Electrical connection

- Bringing the power supply (24 V DC \pm 25 %) into the 8-pin cable socket (included in the scope of delivery).
- A supervisory vehicle computer (host) with an RS 232 data interface for processing the measurement data.

Commissioning/Configuration

- PC with RS 232 serial data interface, CD disk drive, mouse and Windows 98™, Windows ME™, Windows 2000™ or Windows XP™ operating system.
- RS 232 data cable No. 6024723 (5 m (16.4 ft))/No. 2030334 (6.5 m (21.3 ft))

3.1.3 Product features and functions (overview)

Powerful NAV200:

- Use on courses with a maximum of 40 layers and a maximum of 32 reflectors per layer
- Detection of reflector marks in a 360° scanning angle
- Range 1.2 m to 28.5 m (3.94 ft to 93.5 ft)
- Position measurement accuracy ± 4 mm to ± 25 mm (± 0.16 in to ± 0.97 in) (depending on mean distance to reflector)
- Angular accuracy $\pm 0.1^\circ$
- Mounting position with optical axis parallel to the area travelled, overhead mounting also possible

Safety and convenience for the user:

- Robust, compact metal housing (max. IP 65), CE mark
- Laser Class 1
- Future-proof through firmware update via serial data interface (Flash PROM)
- Future-proof NAV200 Setup configuration software
- Maintenance-free

Convenient configuration/operation:

- Convenient NAV200 Setup configuration software
- Command interface with software telegrams for measurement, modification and storage of reflector co-ordinates
- Four status-display LEDs

Modes:

- Standby (manual entry of the reflector positions in the NAV200)
- Mapping (automatic measurement of the reflector positions by the NAV200)
- Positioning operation (continuous position measurement by the NAV200)
- Upload (reading the reflector positions stored in the NAV200)
- Download (transferring new reflector positions to the NAV200)
- Reflector co-ordinates (reflector measurement) in the local co-ordinate system of the NAV200)

External data communication:

- RS 232 serial data interface to the vehicle computer (host) and to the PC for configuring the NAV200

Electrical interfaces

- Power supply (24 V DC \pm 25 %)
- RS 232 data interface

Type of connection:

- RS 232 data interface, 14-pin chassis-mount plug on device
- Power supply ("Power Supply 24 V DC" connection): 8-pin chassis-mount plug on device

3.1.4 Applications

Typical applications for the NAV200 are:

- Shuttle systems
- Self-propelled stackers
- Automated guided transport systems generally

3.1.5 View of the device

**Legend:**

- | | |
|---|---|
| ① Scanner head, rotating | ⑦ "RS 232 data interface" connection
(14-pin chassis-mount plug) |
| ② Light outlet/inlet aperture | ⑧ "Power Supply 24 V DC" connection
(8-pin chassis-mount plug) |
| ③ Status indicator (LEDs 4 x) | ⑨ Fuse (3.15 A slow-blow) |
| ④ RS 232 data cable
(see Table 10-3, Page 80) | ⑩ Functional earth terminal |
| ⑤ 9-pin D-Sub socket for
Host/PC connection | ⑪ Tapped holes in baseplate (4 x)
(not visible here) |
| ⑥ 14-pin cable socket for | ⑫ Laser warning label |
| | ⑬ 8-pin cable socket |

Fig. 3-2: Arrangement of the NAV200

3.2 How the NAV200 works

When mounted on an automated guided vehicle (AGV), the NAV200 continuously measures its own current position as the AGV moves on the route. When requested, it transfers the positional data to the vehicle computer of the AGV. The vehicle computer steers the AGV along the programmed and hence preset route and — using the NAV200 — corrects any course deviations that occur. On each request, the vehicle computer informs the NAV200 of the current speed of the AGV on the course.

The NAV200 calculates its own position and orientation on the basis of fixed reflectors positioned in the environment, whose co-ordinates it detects — two-dimensionally — in a 360° scanning angle using a laser beam invisible to the human eye (*Fig. 3-3*). One revolution of the scanner head here is equivalent to a scan and each revolution generates one reading per detected reflector.

The co-ordinates of the reflectors used are stored in the nonvolatile reflector memory of the NAV200 as a reference datum. With a change to "Mapping" or "Positioning operation" (position measurement) modes, the NAV200 loads the reflector data from its reflector memory into the internal working memory.

Reflector data stored in the NAV200 is assigned in groups to so-called layers. Each layer represents a permanently defined area in the overall course that the AGV travels over. By changing over to the associated layer, the NAV200 always only uses the reflectors that belong to the area it is currently travelling in with the comparison measurement for the detection. The changeover is made by the vehicle computer, dependent on the vehicle location.

Three detected reflectors in a layer are sufficient for position measurement. For position measurement, the NAV200 measures the distances to and angles of the reflectors and works out its own position from this data.

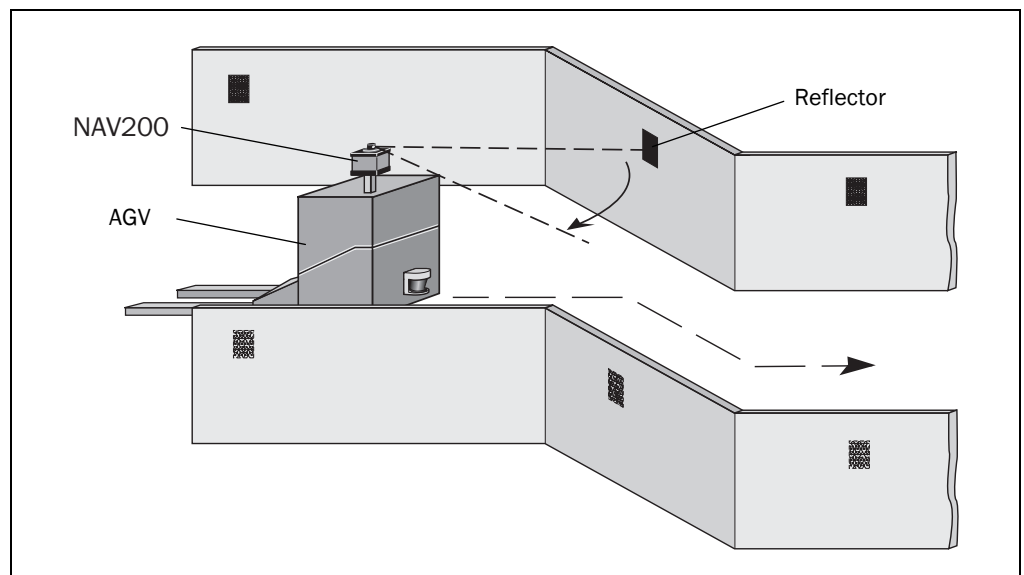


Fig. 3-3: Position measurement of the NAV200 by detection of reflector arrangements

3.3 Operating conditions

3.3.1 Installation requirements

The mounting position of the NAV200 should be chosen such that the scanning plane formed by the rotating optical axis runs parallel to the area travelled. The scanner head can be positioned above or below (overhead mounting) the scanner housing here. A clear view over the entire 360° scanning width must be ensured from the mounting position of the NAV200. With overhead mounting, the mounting bracket should be selected so that the restriction of vision occurs **in or against the direction of travel**. This will ensure an adequate view of the reflectors along the route.

The reference point (co-ordinates origin) on the NAV200 lies on the central axis of the scanner head. In an ideal case, the central axis of the scanner head would lie in the navigational point of the vehicle. If the mounting position of the NAV200 in the longitudinal axis of the vehicle is offset either in front of or behind the turning point, this deviation must be taken account of mathematically in the programming of the vehicle computer.

Note With the normal installation (scanner head at the top), the scanner head rotates clockwise when viewed from above. With overhead mounting, on the other hand, the rotation is counter-clockwise. This must be taken into account and adapted if necessary for the display of the measurement results in the NAV200 Setup configuration software (see also [Fig. 6-7, Page 57](#)).

The functional earth of the NAV200 must be electrically connected to the chassis of the AGV as part of the electrical installation, see [Section 5.2.3 Screening concept, Page 41](#).

3.3.2 Designing reflector arrangements

Reflector arrangements should be designed so that the NAV200 has a clear view of at least 3 reflectors from any position. A clear view of 4 to 5 reflectors is recommended to also ensure reliable positioning when several AGVs are operating. As equal a number of reflectors as possible should be fitted on both sides of the route here. An asymmetrical arrangement of the reflectors is required for an unambiguous assignment of the reflector position measurements to the reflector arrangement of the layer, see [Section 3.3.5 Reflector arrangements within a layer, Page 27](#).

At positions where high positioning accuracy is required, like docking stations or curved areas, for example, the NAV200 requires 4 or more reflectors within a distance of the restricted radius of action to be defined here. In addition, the angular difference between 2 reflectors measured by the NAV200 must not be more than 120°.

At positions where the NAV200 is brought on to the route, at least 4 to 6 reflectors must fall within the range of the NAV200. In addition, the angular difference between 2 reflectors measured by the NAV200 must not be more than 120°.

With flat reflectors, the detection angle of the reflector must be considered, see [Section 3.3.3 Reflectors, Page 22](#).

3.3.3 Reflectors

The NAV200 assigns the readings acquired from its environment to the stored reflector positions. To do this, it must distinguish between the reflectors and other reflective objects. For this, the NAV200 checks the readings against characteristic values that are stored in its memory. These characteristic values apply for Diamond Grade 3000X reflective film (No. 5304334), available as an accessory at SICK AG.

Note Other brands of reflective film may not be correctly detected by the NAV200.

Styles

The reflector marks can be in the form of reflector strips (reflector bars) or cylindrical reflectors. Reflector strips have a limited detection angle and are especially suitable for wide-area applications. Cylindrical reflectors can be detected from any angle and are especially suitable for use in narrow aisles.

Note Only **one type of reflector** must be used within a layer.

Reflector height

The overall height and vertical position of the reflectors should be selected so that the measurement beam hits the reflectors, even with uneven floors. The maximum range of the system is 28.5 m (93.5 ft). The minimum height of the reflectors can be derived from this, depending on the nature of the floor and the resulting measuring distance. The measurement beam of the NAV200 diverges by 16 mm (0.63 in) per metre of measuring distance. Appropriate consideration must be given to possible tilting of the AGV due to uneven floors. Common reflector overall heights are between 500 mm (19.7 in) and 750 mm (29.6 in).

Reflector width and reflector diameter

The minimum width of flat reflectors is 100 mm (3.88 in). The width of flat reflectors can vary within a layer, provided that the minimum width is maintained. There is no restriction on the vertical width of the reflector.

The minimum diameter of cylindrical reflectors depends on the measuring distance. For distances up to 15 m (49.2 ft), the minimum diameter is 80 mm (3.11 in). For distances above 15 m (49.2 ft) the minimum diameter is 100 mm (3.88 in). The **diameter of cylindrical reflectors must be constant** within a layer.

Detection angle with flat reflectors

In order to detect a reflector, the measurement beam emitted by the scanner head of the NAV200 must be reflected back to the scanner head. When the measurement beam hits the reflector at right angles (detection angle = 0°), a flat reflector acts like a mirror. But the special Diamond Grade 3000X reflective film also reflects the measurement beam back to the scanner head when it hits the film at different detection angles. The detection angle is not dependent on the measuring distance. [Fig. 3-4](#) shows the detection angle of flat reflectors with optimal alignment of the reflective film to the measurement beam, see also the following section ["Alignment of the reflective film"](#):

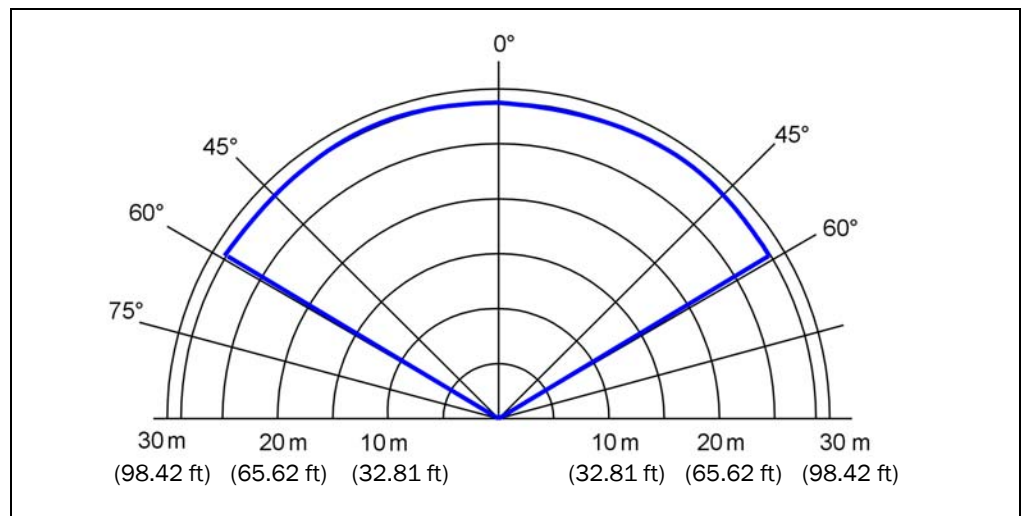


Fig. 3-4: Detection angle with 100 mm (3.88 in) wide reflector strips made of Diamond Grade 3000X reflective film (0° = vertical striking of the measurement beam)

Alignment of the reflective film

The reflective properties of Diamond Grade 3000X reflective film depend on the alignment. The alignment varies with the date of manufacture of the reflective film. In earlier versions of the film, the structure of the microreflectors can be seen by the naked eye. With the new film, the structure is so fine that the human eye is no longer capable of resolving it. The detection angle given in [Fig. 3-4, Page 23](#) can only be achieved with the following alignments:

- Vertical alignment of the honeycomb separator strips with reference to the scanning plane (production date of the reflective film before July 2002).

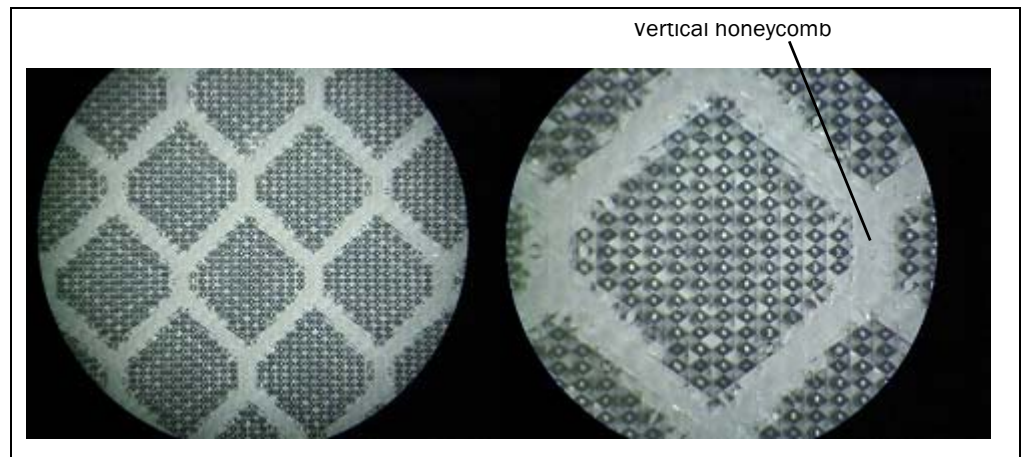


Fig. 3-5: Alignment of Diamond Grade 3000X reflective film, production date before July 2002

- Horizontal alignment of the honeycomb separator strips with reference to the scanning plane (production date of the reflective film after July 2002).

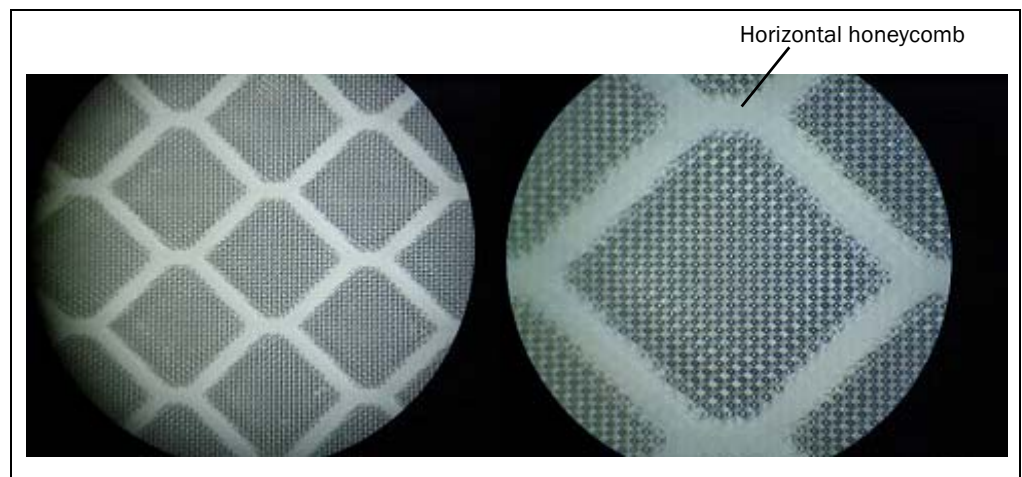


Fig. 3-6: Alignment of Diamond Grade 3000X reflective film, production date after July 2002 (version currently supplied)

Reference points of the reflectors

In order to determine the co-ordinates of a reflector unambiguously with the NAV200, the reflector area must be reduced to a reference point.

- With reflector strips, the reference point is located at the point of intersection of the vertical centre line with the scanning plane; this is normally halfway up the reflector.
- With cylindrical reflectors, the reference point is located at the point of intersection of the vertical central axis of the cylinder with the scanning plane; this is normally halfway up the reflector.

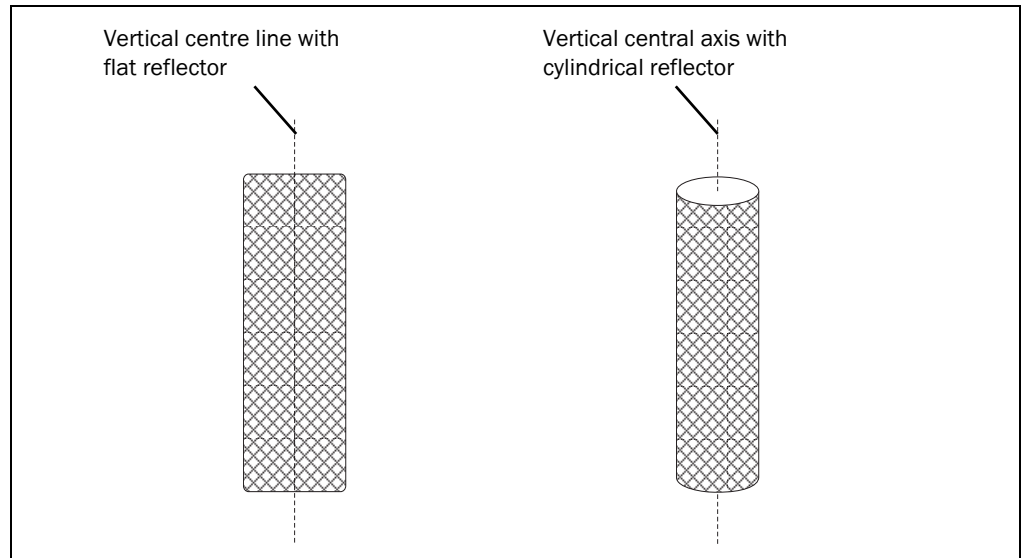


Fig. 3-7: Vertical centre line with flat reflectors and vertical central axis with cylindrical reflectors

3.3.4 Designing layers

In order to make position measurement more manageable, even in larger industrial plants, the entire course over which the AGV is to be used is sub-divided into separate layers. So a layer represents a permanently defined area on the course of the AGV. The memory of the NAV200 can record a maximum of 40 different layers. A minimum of 3 and a maximum of 32 fixed reflectors are fitted within a layer.

Absolute and local co-ordinate system of the layer

When designing the reflector positions, a **common** co-ordinate system for all layers is defined on a site plan. This **absolute co-ordinate system** corresponds to the co-ordinate system of the industrial plant. The zero point and axes of the absolute co-ordinate system are determined in this way. In this co-ordinate system, the NAV200 determines its current absolute position in the X and Y direction including the angular position α of its **local co-ordinate system** relative to the absolute co-ordinate system. Angular position here is taken as the angle that the x-axis of the sensor makes to the x-axis of the absolute co-ordinate system. Angles measured counter-clockwise are mathematically positive.

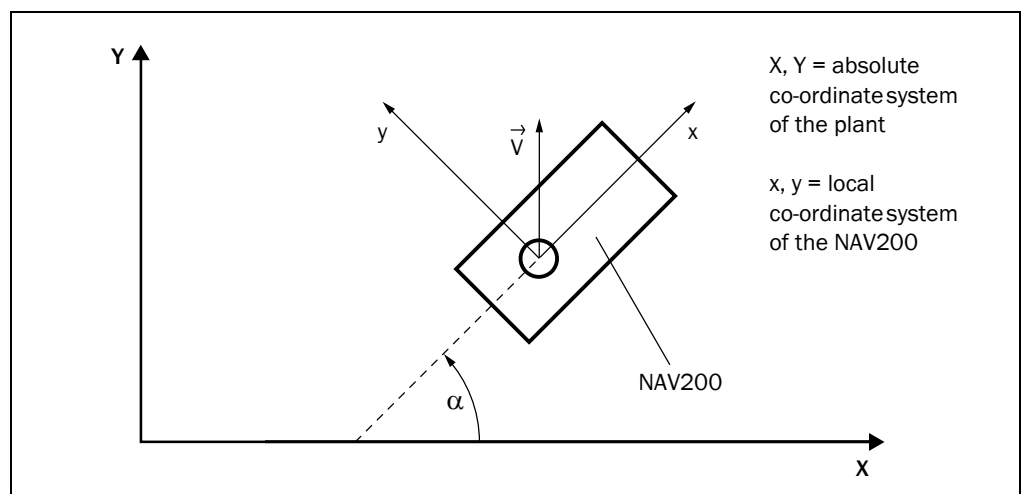


Fig. 3-8: Absolute and local co-ordinate system with angular position of the NAV200

The co-ordinates origin of the NAV200 lies on the central axis of the scanner head.

Definition of layers

All the reflectors needed for operation of the automated guided vehicle are distributed over the layers.

Recommendations

All layers have a common, absolute co-ordinate system and hence a common zero point. Physically separate areas should be implemented in different layers. A layer should be set up so that the NAV200 can detect as many reflectors of this layer as possible, but as few as possible from other layers. Ideally, the transition points between layers should be selected so that they lie on straight areas of the route. The required changeover of the NAV200 from the stored reflector data of one layer to the data of the adjoining layer should take place in the middle of a route section roughly 1 m (3.28 ft) long.

The same reflector can be assigned to different layers. So layers can overlap, and this is actually recommended for a smooth transition of the AGV between two layers. Exceptions to this recommendation are transitions between layers with cylindrical reflectors and layers with flat reflectors, and transitions between layers with different radius cylindrical reflectors. Common reflectors must be avoided in such cases.

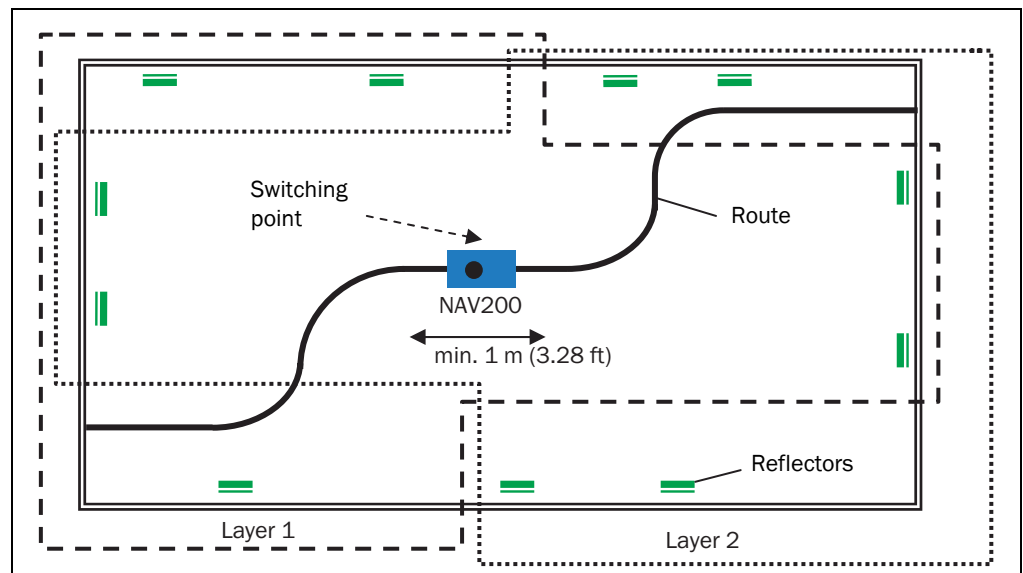


Fig. 3-9: Common use of reflectors of two adjoining layers

3.3.5 Reflector arrangements within a layer

The NAV200 identifies a reflector arrangement by assigning the stored reflector coordinates to the individual reflector measurements. The NAV200 needs a recognizable, i.e. an asymmetrical pattern, so that it can identify a reflector arrangement unambiguously. In such an asymmetrical pattern, all the distances from the reflectors to one another differ by at least 500 mm (19.7 in).

[Fig. 3-10](#) and [Fig. 3-11](#) show two examples of a correct and an incorrect reflector arrangement:

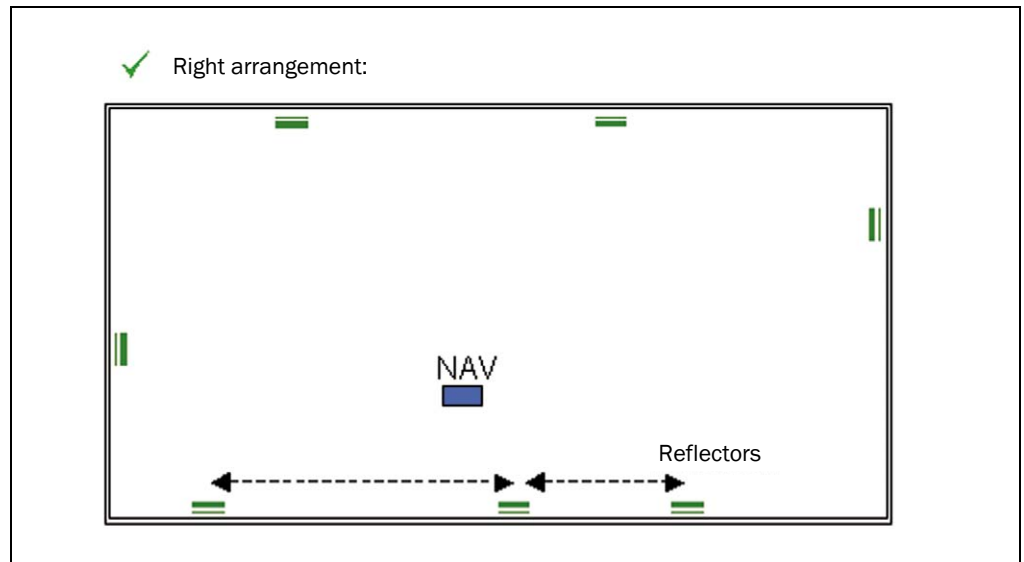


Fig. 3-10: Correct, asymmetrical arrangement of reflectors in the layer

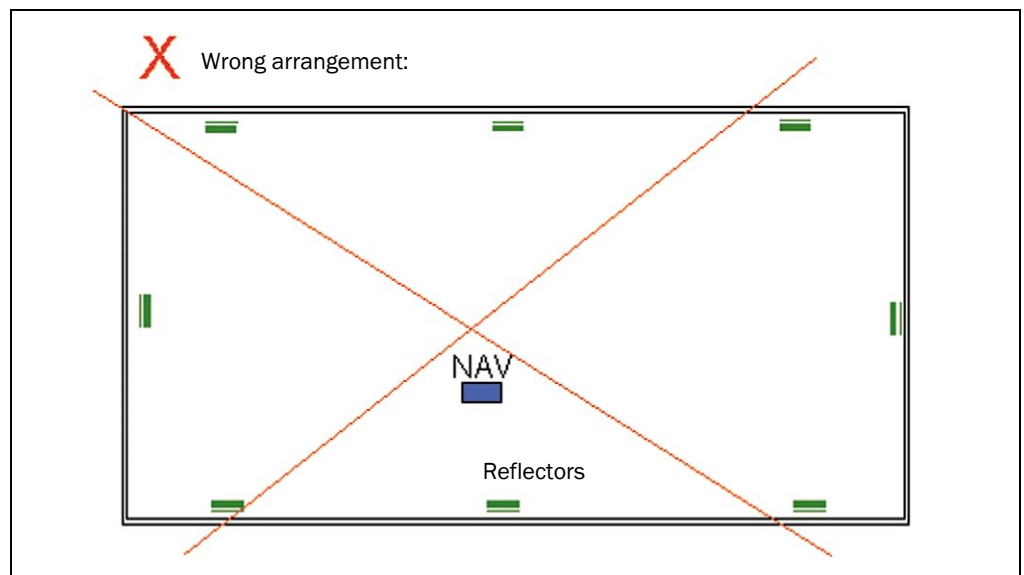


Fig. 3-11: Incorrect, symmetrical arrangement of reflectors in the layer

3.4 Measurement accuracy

The measured reflector positions in the layer depend on the required accuracy of the position measurement. Positions in a restricted radius of action of the NAV200 are measured more precisely and improve the positioning accuracy (see [Section 9 Technical data, Page 77](#)).

Recommendations At docking stations (e.g. pallet transfer points) and on curved routes, fit reflectors within the defined, restricted radius of action of the NAV200 or for the route.

If distant reflectors are detected and measured at the same time as close-up reflectors, we recommend that the distant reflectors are excluded. There are two ways of doing this:

- Sending the software telegram "N closest" from the vehicle computer to the NAV200. With this software telegram, the vehicle computer informs the NAV200 how many (N) of the nearest reflectors are to be used for the measurement (e.g. 4). The advantage of this is that, in this case, the system only includes the near reflectors in the position measurement, and the overall result is not corrupted by more distant reflectors.
- Reducing the radius of action of the NAV200 by means of a vehicle computer software telegram (radii of action). While doing so, it must be ensured that at least 3 reflectors are visible within the restricted radius of action from every position of the NAV200. If, for example, only 2 reflectors are visible, the NAV200 automatically changes over to the full 28.5 m (93.5 ft) radius of action.

This relationship is explained by way of example in [Fig. 3-12](#) and [Fig. 3-13](#). If the "N closest" function is used with the parameter "5" or the "Radius of action" function is used with the parameters "MINIMUM RADIUS = 500 mm" and "MAXIMUM RADIUS = 8,500 mm", the NAV200 detects 5 reflectors in the defined, restricted radius of action (radius less than 8.50 m (27.9 ft)), which results in a higher positioning accuracy.

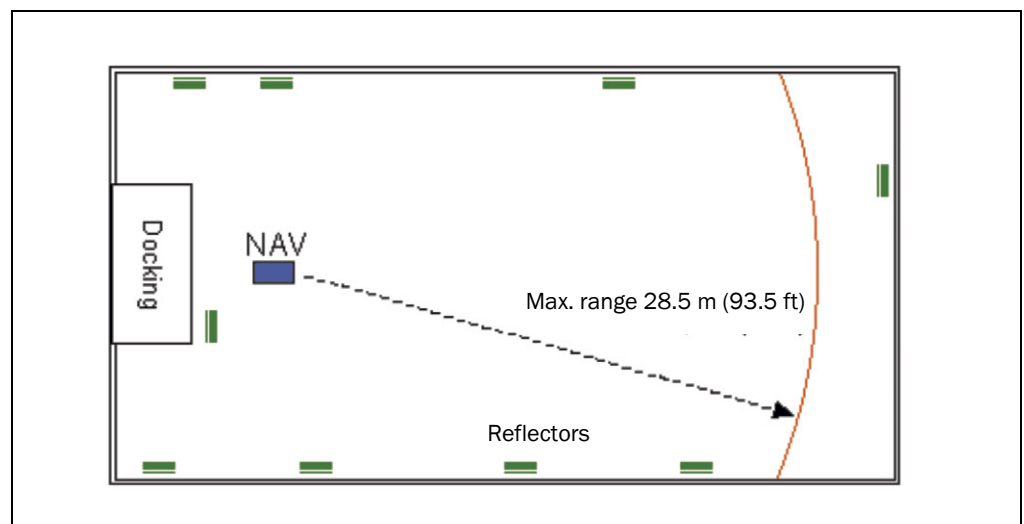


Fig. 3-12: Example; low positioning accuracy without the "N closest" function and without the "Radii of action" function

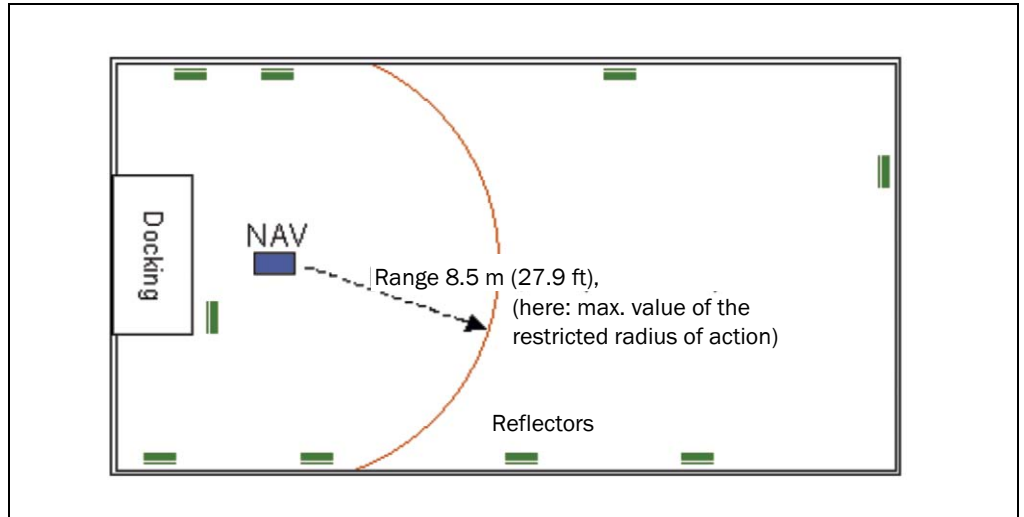


Fig. 3-13: Example: higher positioning accuracy with the "N closest" function and with the "Radius of action" function

- Recommendations**
- In principle, since not all reflectors are detected during travel or are partially obscured, more than 3 reflectors per layer should be used. We recommend a total of 5 to 15 reflectors. The route of the vehicle should be walked along to check that at least 3 reflectors can always be detected at the same time.
 - Fit the same number of reflectors at each side of the route wherever possible. If the reflectors as seen from the NAV200 are all positioned on one side, the positioning accuracy can be reduced due to adverse geometry.
 - If possible, at positions where very high accuracy is required and in curved areas, there should be 4 or more reflectors within the restricted radius of action of the NAV200. In addition, the angle between 2 reflectors must not be more than 120° .
 - At positions where the NAV200 is brought on to the route, at least 4 to 6 reflectors must fall within the range of the NAV200. In addition, the angle between 2 reflectors must not be more than 120° .

The above recommendations cannot always be implemented in practice. Consequently, the reflector positions must be designed as closely in line with these recommendations as possible

3.4.1 How the NAV200 deals with sources of error

Partially obscured reflectors

To determine a measured reflector position, the NAV200 works out the position of the middle of the reflector based on the visible reflector width. Consequently, the full width of the reflectors must be visible from the NAV200. Partial obscuration of reflectors corrupts the determination of middle of the reflector and leads to a corresponding error in the position measurement.

If a reflector belonging to the current layer is partially obscured by parts of the building, machinery or the like, the following measures can be taken:

- By using the "N closest" software telegram.
Select the number and distribution of reflectors in the area around the obscured reflector so that the obscured reflector is not used for the position measurement until its full width is visible from the NAV200.
- By using the "Radii of action" software telegram.
Set the restricted radius of action so that the obscured reflector does not come into this range until its full width is visible from the NAV200.
- Do not program the obscured reflector in the current layer. Do not change over to another layer that includes the reflector concerned until the full width of the reflector is visible from the NAV200.



For more detailed information on the "N closest" and "Radii of action" software telegrams, see also the *NAV200 Telegram Listing* (No. 8009595)

Overlapping reflectors

Repeatedly, when travelling round curves or along aisles, two reflectors positioned behind one another when viewed from the NAV200 can completely or partially overlap. As a result, the positions of these reflectors can no longer be measured unambiguously and would corrupt the position calculation of the NAV200. Assuming that the reflectors are at least 300 mm (11.8 in) apart viewed in the direction of the beam, the NAV200 detects such a situation and automatically suppresses the use of overlapping reflectors.

The situation of an overlapping reflector occurs when the angle between two reflectors, viewed from the NAV200, is less than 1.26° . The reflector arrangement for this case should be chosen so that at least 3 more reflectors are still present in the visible range of the NAV200.

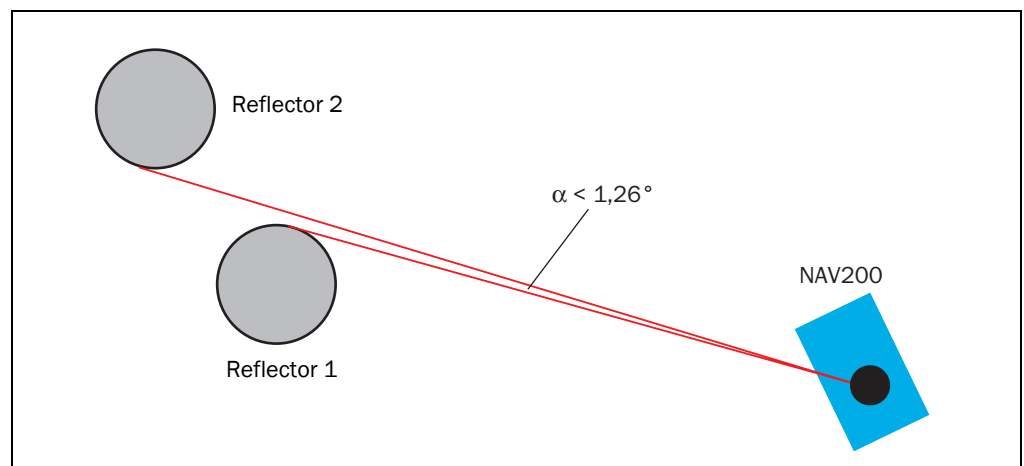


Fig. 3-14: Overlapping of two reflectors with an angle of less than 1.26°

Spurious reflections

Highly reflective objects can give rise to spurious reflections. Examples of highly reflective objects are windows, stainless steel cladding and metal pipes. The spurious reflections occur when the measurement beam of the NAV200 hits these objects at right angles.

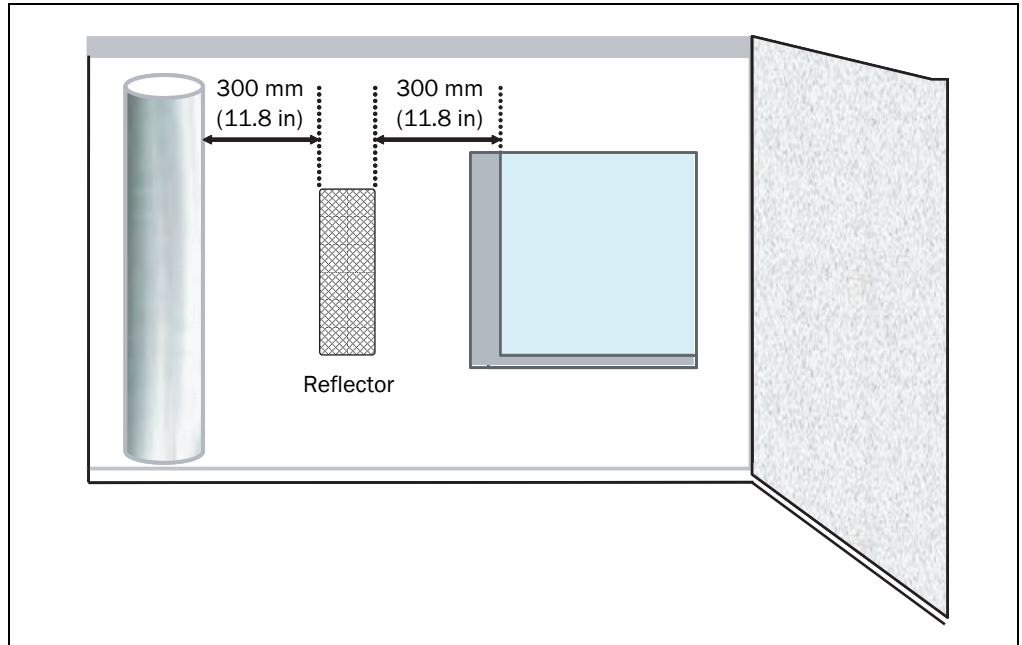


Fig. 3-15: Minimum distance from reflectors to other reflective objects

So that these spurious reflections are not interpreted as reflectors, it must be ensured that there is always a minimum distance of 300 mm (11.8 in) from the fitted reflectors to these objects. Where this minimum distance cannot be maintained with certain objects, these objects should be covered with a material with less reflective properties.

Subsequent movement of reflectors

Movement of reflectors that still lie within the measuring range of the NAV200 even after being moved will corrupt the measurement result and must be corrected. To correct this situation, the reflector must be put back in its original position or the co-ordinates of the new reflector position must be re-measured with the function „mapping“ and transferred to the NAV200 with the NAV200 Setup configuration software.

Subsequent removal or obscuration of reflectors

When reflectors are obscured or removed, the NAV200 carries on its position measurement without interruption, based on the remaining reflectors, provided that at least 3 reflectors are visible from the scanner head position.

3.5 Measurement and entry of the reflector co-ordinates

After design and installation of the reflectors, the reflector co-ordinates must be precisely measured. The NAV200 needs these co-ordinates for position measurement in actual operation. There are two ways of measuring and entering the reflector co-ordinates:

- A (land) surveyor measures the position of all reflectors manually, with reference to a common co-ordinate system. All these co-ordinates are acquired in a structured ASCII file in the PC and transferred to the NAV200 Setup using the NAV200 configuration software. This transfer can also take place from the vehicle computer with the "Download" software telegram.
- The reflector positions can be taught into the NAV200 automatically with the "Mapping" function followed by "Download". To do this, the NAV200 needs an accurately measured initial position in order to successively measure the co-ordinates of all the reflectors on the course.

Recommendations Using a land surveyor to determine the reflector positions is more precise and ensures a higher system accuracy.

The "Mapping" function of the NAV200 is suitable

- for measuring new reflectors after the initial installation
- for correcting for positional changes of reflectors
- when only low positioning accuracy is required in the layer/system

For more information on measurement and transfer of reflector co-ordinates see [Section 6.6 Performing and testing the configuration, Page 63](#).

3.6 Integration of the NAV200 in a navigation system

The navigation system in an AGV consists of two linked positioning systems, a relative positioning system and an absolute positioning system.

The relative positioning system draws its data from the odometry (shaft encoder). The odometry provides new data with a high update rate, from which the vehicle computer can calculate the position of the vehicle and then use this data to control the drive. The relative position calculation is prone to error. The error increases continuously with distance covered.

The NAV200, on the other hand, provides absolute positional data on the course. Based on these absolute positions, the vehicle computer of the AGV can minimize the error from the odometry.

[Fig. 3-16](#) is a schematic illustration of the integration of the NAV200 laser positioning system in a complete navigation system:

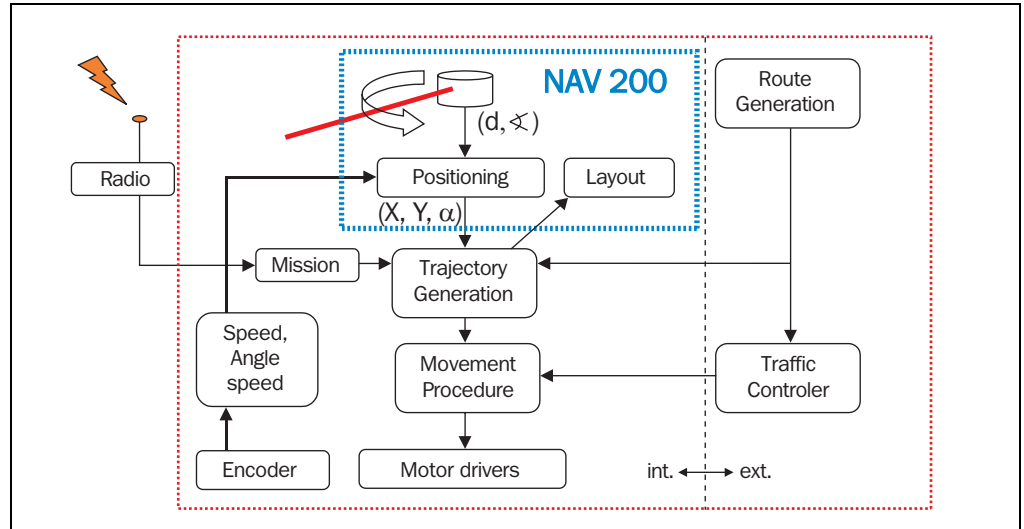


Fig. 3-16: Integration of the NAV200 in a navigation system

3.6.1 Data interface

The NAV200 communicates with the vehicle computer of the AGV via an RS 232 data interface. Data transfer takes place with a software telegram **at the request** of the vehicle computer. Depending on the frequency at which the vehicle computer requests data, the NAV200 transfers the following data to the vehicle computer up to 8 times per second:

- X-position (referred to the zero point of the absolute co-ordinate system)
- Y-position (referred to the zero point of the absolute co-ordinate system)
- Angular position α
(Orientation of the x-axis of the NAV200 in the absolute co-ordinate system)
- Measurement quality on a scale of 1 to 100
(values less than or equal to 0 are used as identification)
- Number of reflectors used for position measurement

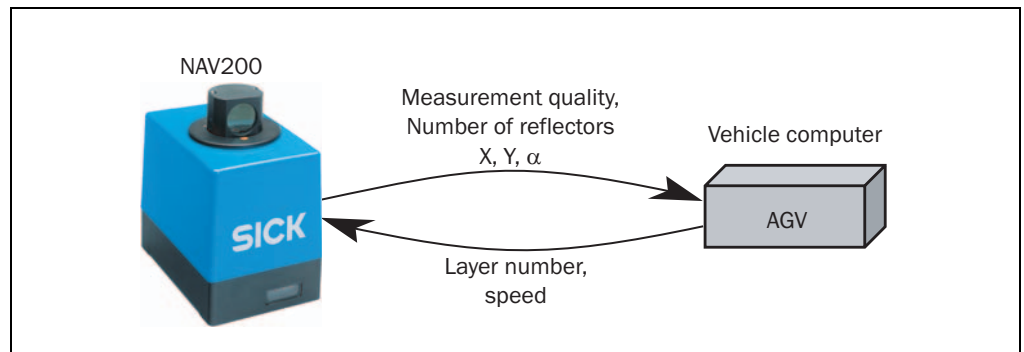


Fig. 3-17: Data communication between NAV200 and vehicle computer of the AGV

The vehicle computer uses the odometry data to calculate the speed and turning speed of the AGV. It transmits this speed data in the position request to the NAV200. The NAV200 extrapolates its measured positional data at the time of the data transfer, based on this speed data.

Depending on the position on the route, the vehicle computer informs the NAV200 which layer it should use to measure the position. Changeover to another layer occurs during travel on the order of the vehicle computer. Information and recommendations on changing layers is provided in [Section 3.3.4 Designing layers, Page 25](#).

Data exchange between vehicle computer and NAV200 takes place in the form of software telegrams. The NAV200 does not become active of its own accord here, but always responds to the request of the vehicle computer. An example of a software telegram is the activation of the "Mapping" mode:

Mode: **M** (Mapping)

Function: **A** (activate)

Data transfer from vehicle computer to the NAV200:

STX	5	M	A	BCC
-----	---	----------	----------	-----

The NAV200 acknowledges the vehicle computer's telegram with the following telegram:

STX	5	M	A	BCC
-----	---	----------	----------	-----

The Mapping operation is activated.



For more details on the software telegrams that the vehicle computer can use in communication with the NAV200, see the *NAV200 telegram listing* (No. 8009595).

3.6.2 Measurement quality as an indicator of the reliability of the positional data

Along with the positional data, the NAV200 also transmits the measurement quality **G** to the vehicle computer. The measurement quality assesses the agreement between the stored reflector arrangement and the reflector measurement. It is a relative measure of the reliability of the positional data on a scale between 1 and 100.

Note Values for the measurement quality less than or equal to zero are used as identification. For more information on the quality see the *NAV200 Telegram Listing*.

Typical values for the measurement quality are:

- at a standstill and with unaccelerated motion, between 60 and 100
- with accelerated motion, especially on bends, between 40 and 80

Should poorer qualities occur, we recommend checking the reflector arrangement and the speed settings and, where possible, limiting the acceleration rates of the AGV.

The measurement quality is incorporated into the control loop in the vehicle computer. The system integrator can use it to specify the extent to which the positional data of the odometry is to be corrected by the positional data of the NAV200. The influence of the positional data of the NAV200 on the correction is application-specific and depends on the quality of the odometry and the permissible positioning tolerances in the plant.

3.6.3 Position measurement ("Positioning operation" mode)

The NAV200 has two operating conditions in this mode:

- initial position measurement, "Fullmap" operating condition
- continuous position measurement, "Quickmap" operating condition

With a change to "Positioning operation" mode from another mode, the NAV200 activates the "Fullmap" operating condition. Here the NAV200 calculates and identifies the reflector positions by a pattern comparison between the measured reflectors and the known reflector positions in the current layer. Preconditions for a successful Fullmap are:

- The vehicle is not moving
- The vehicle computer has activated the associated layer for the current area in the NAV200.
- There are at least 3 reflectors of the current layer in the visible range of the NAV200.

Depending on the number of measured reflectors and reflectors in the current layer, a Fullmap can take several seconds.

After a successful Fullmap, the NAV200 automatically changes to the "Quickmap" operating condition. With Quickmap, the Fullmap's pattern comparison involving complex computation is omitted. In Quickmap the NAV200 has an expectation for the approximate position of the reflectors. As shown in Fig. 3-18, the NAV200 puts a 300 mm (11.8 in) radius detection window round each reflector co-ordinate of the current layer. If a reflector is measured within this detection window, this reflector is assigned to the expected position and used for the next position calculation. In Quickmap, the NAV200 can provide new positional data with a repetition rate of approx. 7.3 Hz.

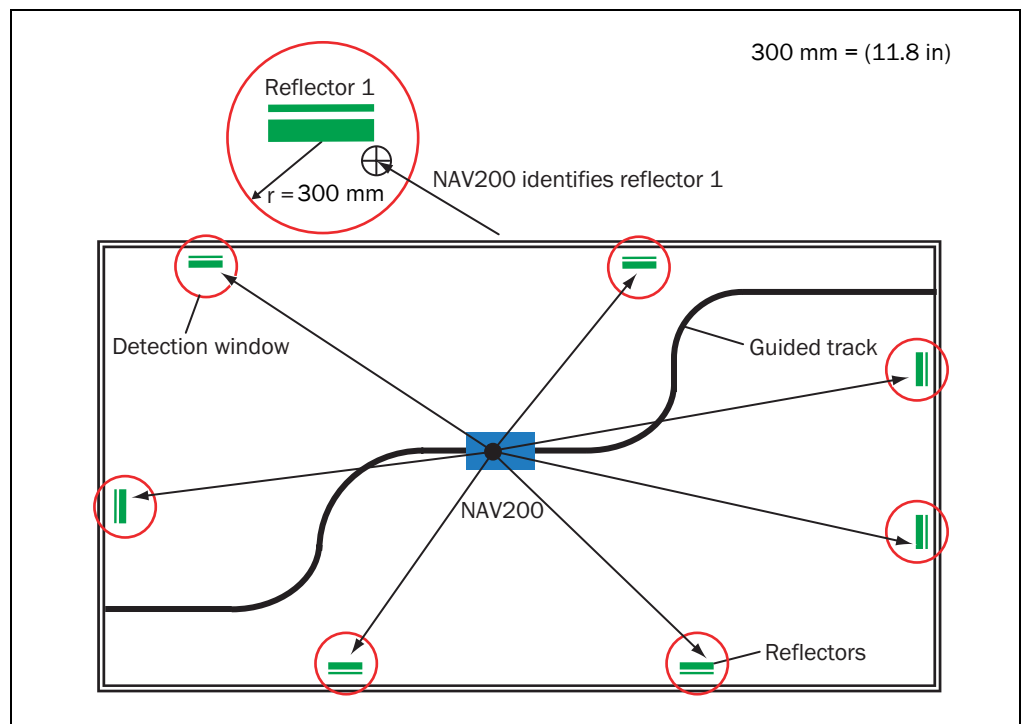


Fig. 3-18: Identification of reflectors in "Quickmap" operating condition

If contact with the layer is lost due to interference factors (e.g. several reflectors obscured at the same time) the vehicle computer can initiate a Fullmap to re-establish contact. If the last position is still known in the vehicle computer, it can activate the Quickmap directly via the "PM" software telegram with position entry, and so re-establish contact with the layer.

3.6.4 Reflector co-ordinates" mode

In this mode, the NAV200 generates an image of its current reflector environment within one revolution of the scanner head. The NAV200 measures a maximum of 32 visible reflectors at this time and determines the reflector co-ordinates relative to its own position (local co-ordinate system, see [Fig. 3-8, Page 25](#)).

In actual operation, this enables the vehicle computer of the AGV to directly access the co-ordinates measured by the NAV200. The vehicle computer can evaluate the data from this direct access using its own algorithms. The "Reflector co-ordinates" mode is not required for position measurement.

One possible application of this mode is, for example, temporary orientation on only two visible reflectors on a route ([Fig. 3-19](#)), when all other reflectors are obscured by stacks of objects such as pallets or boxes (Deep Stacking) and reliable positioning with at least 3 reflectors is no longer possible.

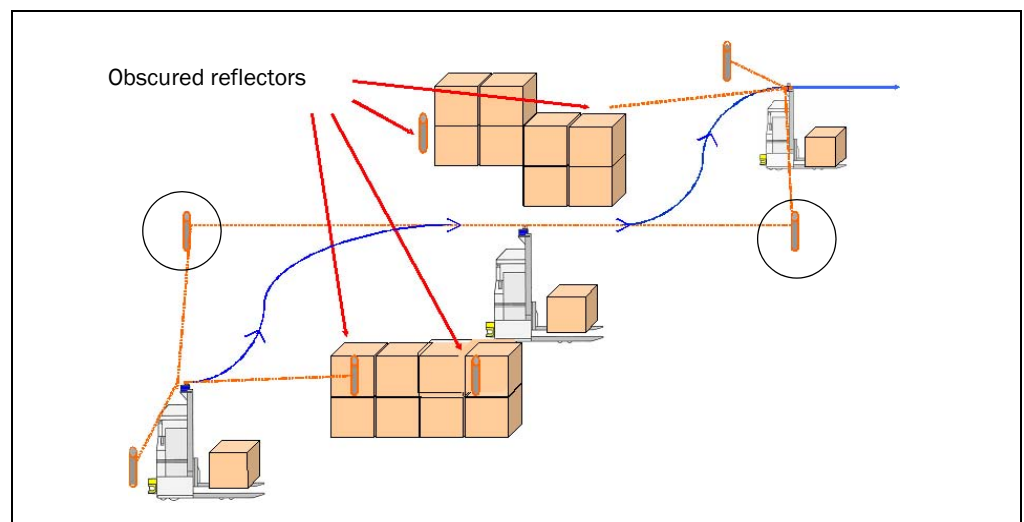


Fig. 3-19: Travel along a route with loss of all other reflectors

This mode is also useful with straight-line travel along a narrow aisle ([Fig. 3-20](#)), which only allows two reflectors to be fitted — at the start and end — as, for example, the distance to the reflectors would otherwise fall below the minimum lateral distance (1.2 m (3.93 ft)) to the NAV200.

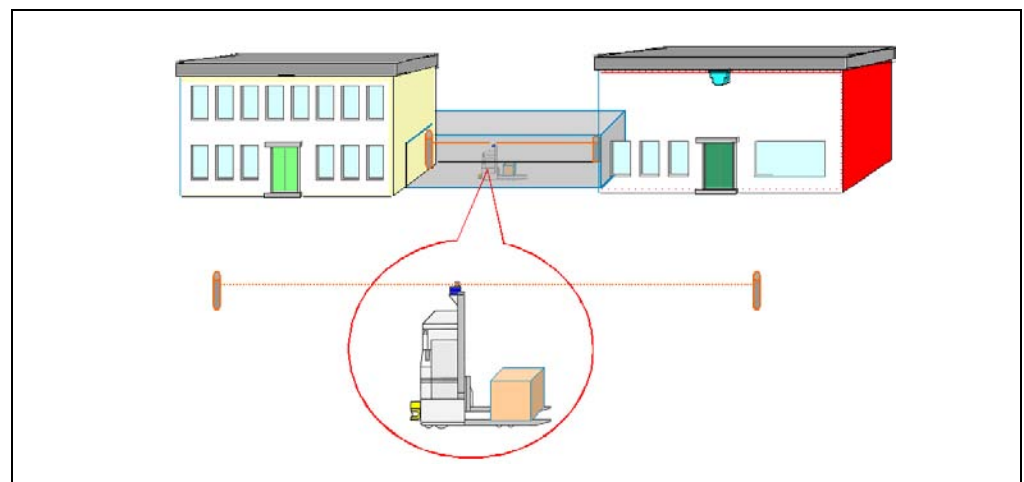


Fig. 3-20: Travel along a narrow aisle by means of the "Reflector co-ordinates" mode

See also [Section 6.5.6 Reflector co-ordinates, Page 62](#).

3.7 Displays and controls

3.7.1 Controls

The parameters of the NAV200 are set once only via the RS 232 data interface, using the NAV200 Setup configuration software. The supply voltage is applied with a main switch (supplied by the client). The system starts automatically in Standby operation.

3.7.2 Function of the LEDs on the NAV200

Four LEDs give a visual indication of the operating condition of the NAV200. The LEDs are located on the front of the NAV200 (Fig. 3-21). Tab. 3-1 lists the meanings of the LEDs.

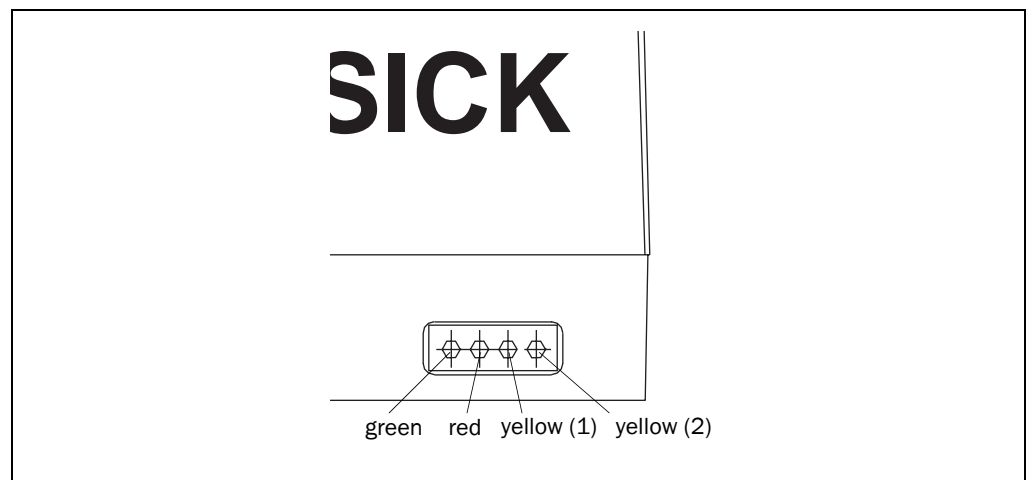


Fig. 3-21: NAV200: Position of the LEDs on the NAV200

Operating condition	LED green	LED red	LED yellow (1)	LED yellow (2)
Start (Initializing)	flashes	flashes	off	flashes
Standby operation (no communication)	on	on	off	off
Data transfer to the NAV200 in "Positioning operation", "Mapping" and "Reflector co-ordinates"	on	flashes	on	off
Data transfer from the NAV200 in "Positioning operation", "Mapping" and "Reflector co-ordinates" modes	on	flashes	off	off
Reflector data transfer from nonvolatile reflector memory to the internal working memory of the NAV200 (can take several seconds)	on	on	off	on
Error in telegram communication	any	any	on	on
Error	off	off	any	any

Tab. 3-1: NAV200: Meaning of the LEDs

Notes:

4 Installation

4.1 Overview of the installation steps

- Mount the reflectors
- Establish mounting position and installation location for the NAV200
- Mount the NAV200; observe the screening concept when mounting it

Note Do not open the NAV200. Opening the device will invalidate the manufacturer's warranty.

4.2 Preparation for installation of the NAV200

4.2.1 Ensure that you have all the required components

- NAV200

4.2.2 Preparing the accessories

- Screw kit (No. 2026277, included in scope of delivery)
 - 4 x hexagon socket (Allen) screws M4 x 10 mm (0.39 in) - A2
 - 4 x washers 4.3 - A2
 - 4 x spring lock washers B4
- Tool

4.2.3 Selecting mounting position and installation location for the NAV200

The mounting position of the NAV200 should be chosen such that the scanning plane formed by the rotating optical axis runs parallel to the area travelled. The rotating scanner head can be positioned above or below (overhead mounting) the scanner housing here. A clear view over the entire 360° scanning width must be ensured from the mounting position of the NAV200. With overhead mounting, the mounting bracket should be selected so that the restriction of vision occurs in or against the direction of travel. This will ensure an adequate view of the reflectors along the guided track.

The reference point (co-ordinates origin) on the NAV200 lies on the central axis of the scanner head. In an ideal case, the central axis of the scanner head would be in the navigational point of the vehicle. If the mounting position of the NAV200 in the longitudinal axis of the vehicle is offset either in front of or behind the turning point, this deviation must be taken account of mathematically in the programming of the vehicle computer.

Note The functional earth of the NAV200 must be electrically connected to the chassis of the AGV!

The NAV200 is mounted on a substantial, level support that is solidly fixed to the AGV. The support, when aligned parallel to the area travelled, determines the correct alignment of the NAV200. The way the support is fitted on the AGV varies with the type of construction of the vehicle. The NAV200 has four tapped fixing holes in the baseplate. Four matching holes are required in the support for the NAV200 in order to mount the NAV200.

4.3 Mounting the device

The supply must be switched off for safety when mounting the device.



Risk of injury due to the device falling!

The NAV200 weighs approx. 3.3 kg (7.26 lb).

- Exercise caution when mounting the device above head height, secure the device to prevent it falling and wear suitable safety headgear.
-

4.3.1 Mounting

1. Prepare for mounting the device as described in [Section 4.2 Preparation for installation of the NAV200, Page 39](#).



Risk of damage to the equipment!

The four tapped holes of the NAV200 have a maximum screw-in depth of 10 mm (0.39 in). Longer screws will damage the equipment.

- Use the right length screws.
-
2. Using the screw kit No. 2026277 (included in scope of delivery), fix the baseplate of the NAV200 to the support (aligned parallel to the area travelled).
If other screws are used, depending on the wall thickness of the support, bear this maximum screw-in depth in mind.
 3. The scanner head of the NAV200 must be able to turn freely.

4.4 Mounting additional components

4.4.1 Assembly and mounting of the reflectors

- Mount the reflectors at the planned positions for each defined layer.
When mounting the reflectors, take note of the information on the types, reflector dimensions and on the reflective film given in [Section 3.3.3 Reflectors, Page 22](#).

4.5 Disassembling the system

1. Switch off the power supply for NAV200.
2. Unscrew the power supply cable and the RS232 data interface cable.
3. Unscrew the fixing screws on the underside of the device and remove the device.

After final removal from service, dispose of the device in an environmentally-responsible manner, in accordance with [Section 7.3, Page 74](#).

5 Electrical installation

5.1 Overview of the installation steps

- Connect the functional earth of the NAV200.
- Connect the RS 232 data cable to the NAV200 and PC (configuration) or vehicle computer (operation)
- Connect the power supply cable (24 V DC supply)

5.2 Electrical connections and cables

The electrical connections of the NAV200 consist of the terminal for the functional earth, and the two chassis-mount plugs for the power supply and data interface.

Note IP 65 protection of the NAV200 is only achieved when the RS 232 data cable and the power supply cable are securely screwed on.

5.2.1 Conductor cross-sections

- Use copper cables for all connections!
Conductor cross-sections required:
 - Power supply cable, minimum 0.25 mm² (24 AWG)

5.2.2 Cables

- Use screened cables for both power supply and RS 232 cables.

5.2.3 Screening concept

- Electrically connect the screen of the power supply of the NAV200 to the vehicle chassis in accordance with [Fig. 5-1!](#)
- Connect the power supply to a DC/DC converter that provides galvanic isolation between the supply of the NAV200 and the battery voltage.

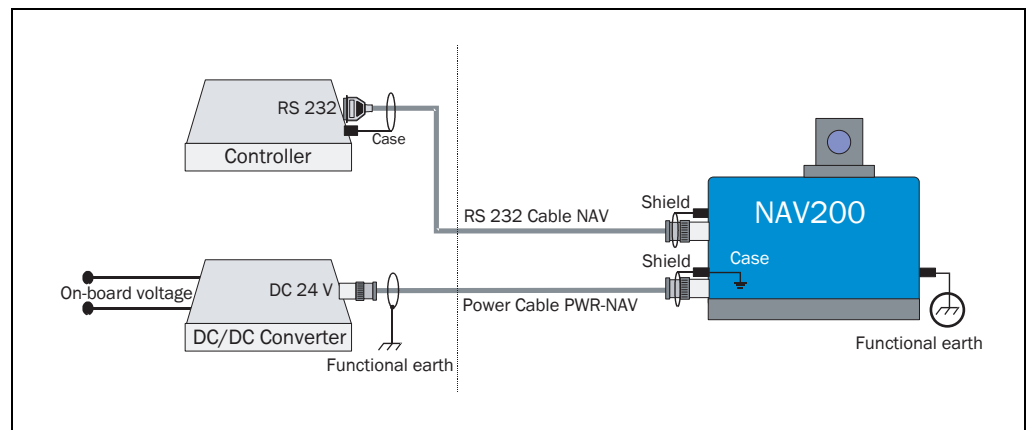
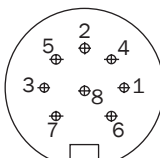


Fig. 5-1: Screening concept of the NAV200

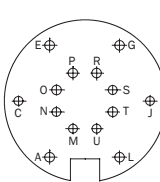
5.3 Pin assignment of the connections

5.3.1 “Power supply” device plug

	Pin	Signal	Function
	1	24 V DC	Supply
	2	0 V	0 V
	3	n. c.	–
	4	n. c.	–
	5	n. c.	–
	6	n. c.	–
	7	n. c.	–
	8	n. c.	–
	Case	–	Shield

Tab. 5-1: Pin assignment of the 8-pin chassis-mount plug for connecting the power supply

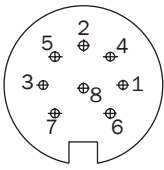
5.3.2 “RS 232 data interface” device plug

	Pin	Signal	Function
	A	GND	GND
	C	n. c.	–
	E	n. c.	–
	G	TxD	Transmitter (NAV200)
	J	RxD	Receiver (NAV200)
	L	n. c.	–
	M	n. c.	–
	N	n. c.	–
	O	n. c.	–
	P	n. c.	–
	R	n. c.	–
	S	n. c.	–
	T	n. c.	–
	U	n. c.	–
	Case	–	Shield

Tab. 5-2: Pin assignment of the 14-pin chassis-mount plug for connecting the RS 232 data cable

5.3.3 Power cord

[Tab. 5-3](#) shows the pin assignment of the cable socket for connecting the power supply. The metal socket provides the connection to the NAV200 case.

	Pin	Signal	Function
	1	24 V DC	Supply
	2	0 V	0 V
	3	n. c.	–
	4	n. c.	–
	5	n. c.	–
	6	n. c.	–
	7	n. c.	–
	8	n. c.	–
	Case	–	Shield

Tab. 5-3: Pin assignment of the 8-pin cable socket for connecting the power supply, view of the soldered connections

5.3.4 RS 232 data cable

[Fig. 5-2](#) shows the arrangement of the RS 232 data cables No. 6024723 (5 m (16.4 ft))/No. 2030334 (6.5 m (21.3 ft)):

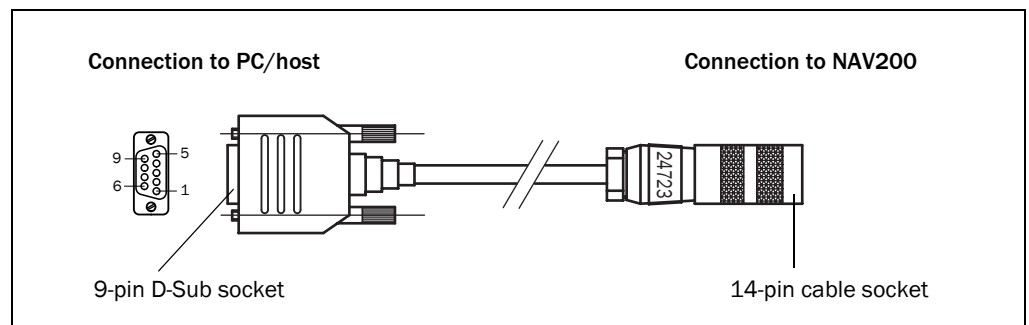
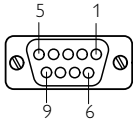


Fig. 5-2: Assembled RS 232 data cable No. 6024723/No. 2030334

[Tab. 5-4](#) shows the pin assignment of the data cable D-Sub socket:

	Pin	Signal	Function
	1	n. c.	–
	2	RxD	Receiver (host)
	3	TxD	Transmitter (host)
	4	n. c.	–
	5	GND	GND
	6	n. c.	–
	7	n. c.	–
	8	n. c.	–
	9	n. c.	–

Tab. 5-4: Pin assignment of the RS 232 data cable 9-pin D-Sub socket

5.4 Preparations for electrical installation

5.4.1 Conditions for the data interface

[Tab. 5-5](#) shows the maximum recommended cable length of the RS 232 data cable.

Interface type	Transmission rate	Length of the data cable
RS 232	19.2 kbaud	15 m (49.2 in)

Tab. 5-5: Maximum cable length between NAV200 and vehicle computer

- Use screened cable to prevent interference.

5.4.2 Power supply

The NAV200 needs a 24 V DC \pm 25 % supply (functional extra low voltage in accordance with IEC standard 364-4-41) for operation. Observe the permissible cable lengths in [Section 5.2.1 Conductor cross-sections, Page 41](#) here.

The maximum power consumption of the NAV200 in operation is 24 W. The power supply/ external power supply unit supplying the device must have a continuous rating of at least 24 W.

Note To ensure adequate short-circuit/overload protection of the incoming supply cable, the cable must be fused according to the conductor cross-sections used. The valid standards must be observed.

5.5 Carrying out the electrical installation

5.5.1 Tools and equipment

- Tool
- Digital multimeter (current/voltage measurement)

5.5.2 Connecting the NAV200 to the PC and vehicle computer

The NAV200 is configured from a PC with the NAV200 Setup configuration software. In operation, the NAV200 is linked to a vehicle computer (host) via an RS 232 data cable. The RS 232 serial data interface of the PC (COM 1, COM 2, ...) is selected after the NAV200 Setup configuration software is started. No other PC application must access this port at the same time.

Wiring the RS 232 data interface

[Fig. 5-3](#) shows the wiring of the RS 232 data interface.

The RS 232 data cables No. 6024723 (5 m (16.4 ft))/No. 2030334 (6.5 m (21.3 ft)) for connecting to a 9-pin D-Sub socket (PC/host) is available for this.

- Take account of maximum cable lengths, see [Section 5.4.1 Conditions for the data interface, Page 44](#).

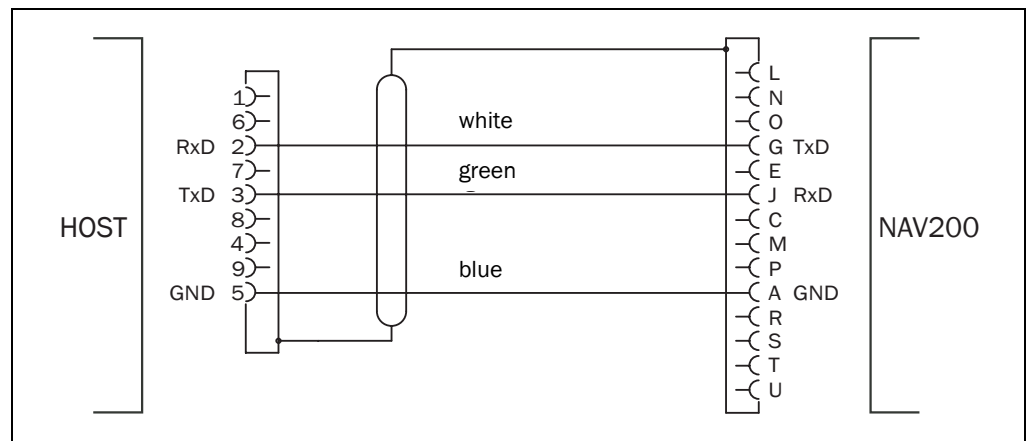


Fig. 5-3: Wiring of the RS 232 data cable

5.5.3 Connecting the power supply

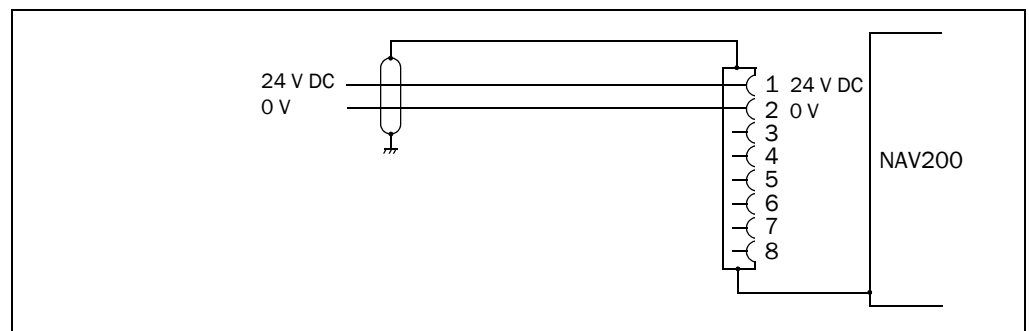


Fig. 5-4: Wiring of the cable socket for the power supply

Notes:

6 Operation



Damage to the NAV200!

Blocking the scanner head abruptly when it is operating can damage the device.

- Ensure that the scanner head can turn freely at all times.

6.1 Overview of the commissioning steps

1. Install the NAV200 Setup configuration software on the PC and start it.
2. Connect the NAV200 to an RS 232 data interface of the PC, possibly via a USB serial converter if the PC does not have a built-in serial data interface.
3. Establish data communication to the NAV200.
4. Configure the NAV200 for position measurement.
5. Connect the NAV200 to the vehicle computer and start positioning operation.

6.2 Default settings of the NAV200 Setup configuration software

Parameter	Value
User interface language	English
PC data interface	COM 1 (alternatively COM 2 to COM 8)
Data display	Cartesian
RS 232 serial communication ^{*)}	19.2 kbaud, even parity, 8 data bits, 1 stop bit
Generate log file of the data communication	yes
Download immediately	no
Units	mm ^{*)}
Direction of rotation of the scanner head taken into account with the display	clockwise
Current detection threshold	50
^{*)} The serial communication parameters and the units (mm) are fixed default settings and cannot be changed from the configuration software.	

Tab. 6-1: Default settings of the NAV200 Setup configuration software

Note The NAV200 has no variable default settings. The factory default settings of all reflector co-ordinates is zero. To restore the factory default settings, open a new project with the NAV200 Setup configuration software (all reflector co-ordinates equal to zero) and transfer this data to the NAV200 (Download).

6.3 Quick Start

1. Mount the NAV200 on an automated guided vehicle (AGV) and align the scanning plane parallel to the travelled area, see [Section 4.2 Preparation for installation of the NAV200, Page 39](#).
 2. Connect the NAV200 to the PC via the RS 232 data cable.
 3. Assemble the supply cable using the cable socket supplied, see [Section 5.5 Carrying out the electrical installation, Page 45](#).
 4. Connect the NAV200 to the 24 V DC power supply, switch on the supply. The NAV200 initializes and changes to "Standby" mode. The scanner head starts to turn.
 5. Install the CD-ROM-based NAV200 Setup configuration software (supplied) on the PC (minimum requirement Windows 98™) (see [Section 6.4.2 Installation of the NAV200 Setup configuration software, Page 50](#)).
 6. Start the NAV200 Setup configuration software.
 7. Choose the required language for the user interface (Menu LANGUAGE).
 8. Establish data communication between NAV200 and PC.
(OPEN SERIAL INTERFACE TO NAV).
The NAV200 Setup configuration software is connected to the NAV200 online.
 9. Configure the NAV200 with the NAV200 Setup configuration software. To do this, determine the positions (co-ordinates) of the used reflectors in NAV200 Setup as follows:
 - more exact method: measure the reflector positions manually on site and acquire them as structured data in an ASCII text file and load them into NAV200 Setup. Alternatively, acquire the data manually in "Standby" mode in NAV200 Setup.
 - quicker but less exact method: read in reflector data using the NAV200 "Mapping" mode (automatic transfer to NAV200 Setup)
 10. Transfer the reflector data permanently to the NAV200 ("Download" mode)
(LOAD ALL DATA TO NAV).
 11. Save the reflector data as a project on the PC (SAVE PROJECT UNDER...).
 12. Test the successful detection of the reflector positions entered.
For this, move the AGV with NAV200 in one of the defined layers.
 13. Start "Position measurement" (START/STOP POSITIONING OPERATION)
 14. Select the appropriate layer and the "All seen reflectors measured" option in the DATA ENTRY FOR MAPPING dialog box. Confirm with OK.
 15. Check the detected reflectors in the NAV200 Setup display.
 16. Change to the next layer etc. with the AGV and repeat steps 14 and 15 each time.
 17. Terminate data communication between NAV200 and PC.
(CLOSE SERIAL LINK TO NAV).
 18. Close the NAV200 Setup configuration software
 19. Switch off the power supply for NAV200.
 20. Disconnect the RS 232 data cable from the PC and connect it to the vehicle computer.
 21. Switch on the power supply for NAV200 again.
The NAV200 initializes and changes to "Standby" mode.
- The NAV200 is ready for operation with the **application-specific** settings.

The NAV200 is configured with a PC, connected to the NAV200 via an RS 232 serial data interface. (see [Section 5.5 Carrying out the electrical installation, Page 45](#)). After configuration, the NAV200 is commissioned by connecting it to the vehicle computer and starting positioning operation by the vehicle computer.

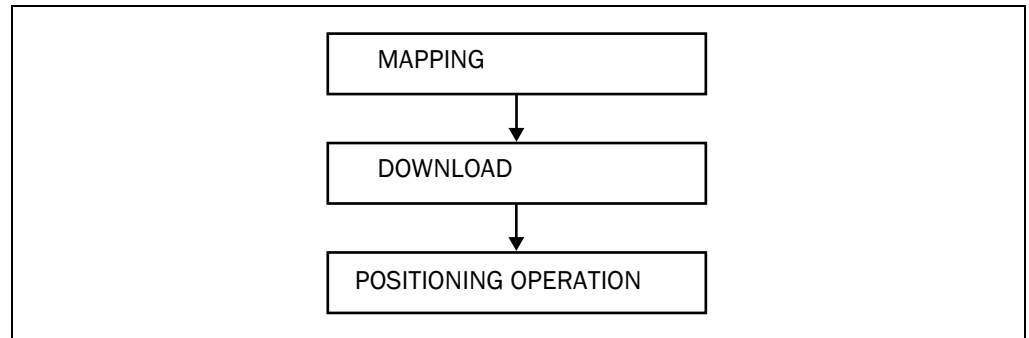


Fig. 6-1: Quick start with Mapping operation

For test and demonstration purposes, or if exact positioning is not required, measuring the position of the reflectors by the NAV200 in "Mapping" mode is quite adequate. This method is less exact compared with a transfer of accurately measured, manually entered reflector positions (see [Section 6.6.1 Measuring, entering and transferring the exact reflector co-ordinates manually and testing positioning operation, Page 63](#)). After the Mapping operation the positional data is transferred from the PC to the NAV200 by download. Positioning operation (position measurement) can now begin.

- **Mapping**

The NAV200 measures the current position of the reflectors and stores the reflector data in NAV200 Setup on the PC.

Preconditions:

- All reflectors are in position.
- The initial position of the NAV200 has been measured.

- **Download**

NAV200 Setup transfers the reflector co-ordinates measured during Mapping from the PC to the NAV200 as a layer. Up to 40 layers, each with a maximum of 32 reflectors, are possible.

- **Positioning operation**

The NAV200 continuously measures its position and orientation in the current layer. The positional data is simultaneously displayed on screen graphically and numerically, in tabular form.

6.4 NAV200 Setup Configuration Software

The NAV200 can be configured with the NAV200 Setup configuration software. For this, the NAV200 Setup uses the software telegrams listed in the *NAV200 Telegram listing*. The configuration software is also used for test and analysis purposes. In normal operation, the NAV200 is totally controlled by the AGV vehicle computer.

6.4.1 Configuring the NAV200 with the NAV200 Setup software

To configure the NAV200, the NAV200 Setup configuration software must be installed on a PC. The PC is then connected to the NAV200 via the serial data cable. Connection of the PC to the NAV200 is described in [Section 5.5 Carrying out the electrical installation, Page 45](#). Installation of the NAV200 Setup configuration software and operation of the user interface is described in the following section.

6.4.2 Installation of the NAV200 Setup configuration software

The scope of delivery of the NAV200 includes the NAV200 Setup configuration software on CD-ROM. A PC with a Pentium III processor or better, 400 MHz clock frequency, 32 MB working memory (RAM), CD-ROM drive, RS 232 data interface and mouse and with a Windows 98™, Windows ME™, Windows 2000™ or Windows XP™ operating system is required for the installation. The NAV200 Setup configuration software requires approx. 5 MB of free hard disk space, plus space for any log files required.

The latest version of the software can be downloaded at www.sick.com.

Note Installation and configuration under Windows XP™ is described in the course of the following sections.

Performing initial installation:

1. Turn the PC on and start Windows.
2. Insert the CD-ROM in the CD drive.
3. Start the "NAV200Install.exe" program.
4. Various prompts appear during the installation. We recommend keeping to the standard settings
5. After the installation is complete the NAV200 Setup program starts automatically by default. It opens a new project file. After the installation, the PC is not linked to the NAV200, it is offline.

Performing new installation (update):

1. Turn the PC on and start Windows.
2. Back up stored project files.
3. Uninstall the old software version with the Windows command
START > PROGRAM > NAV200 SETUP > REMOVE NAV200 SETUP.
4. Install the new software version of the NAV200 Setup on the PC as described under "Performing initial installation".
5. Copy the backed-up project files into a sub-directory of the NAV200 installation directory and open them with the new software version.

Uninstallation

Use the following Windows menu command to uninstall the software:

START > PROGRAM > NAV200 SETUP > REMOVE NAV200 SETUP.

6.4.3 Software functions (overview)

- Establishing communication with the NAV200 via the RS 232 data interface
- Direct entry of the reflector co-ordinates in groups, organised in layers, or acquisition in ASCII file and transfer to NAV200 Setup.
Alternatively, scanning in the reflector environments, maximum of 40 layers each with 32 reflectors ("Mapping" mode)
- Saving reflector data (layer data) and projects to data medium
- Reading reflector data (layer data) and projects from data medium
- Downloading reflector data of selected layers to the NAV200 ("Download" mode)
- Uploading reflector data of selected layers to the NAV200 ("Upload" mode)
- Displaying the position of the NAV200 in a defined layer environment, with and without display of the reflectors ("Positioning operation" mode). Used to test the entered reflector data on detection and use of the reflectors in the position measurement of the NAV200.
- Measuring the reflector positions of a current environment
("Reflector co-ordinates" mode)

6.4.4 Overview of the configuration steps

1. Select the menu language of the user interface.
2. Establish communication with the NAV200.
3. In "Standby" mode, manually create a list of reflectors with exact reflector co-ordinates, or measure the reflector positions of an environment ("Mapping" mode).
4. Transfer reflector co-ordinates to the NAV200.
5. Test position measurement of the NAV200 with the entered reflector data.
6. Save the reflector positions in a project file.

6.4.5 Starting the NAV200 Setup software



The program is started by double-clicking the program icon in the desktop or by the start command START > PROGRAM > SICK > NAV200 SETUP > NAV200 SETUP.

When NAV200 Setup starts, a new, blank project file with no layer or reflector data opens at the same time. There is no link to the NAV200 (offline state).

Offline state and online state

In the offline state, project files with reflector data can be opened, changed and saved. To configure the NAV200 for position measurement, to change between modes, or to transfer reflector data, the user must establish data communication between NAV200 and PC. As soon as a link exists from the PC to the NAV200, the NAV200 Setup configuration software is in the online state.

Establish and monitor data communication between NAV200 and PC

NAV200 Setup automatically detects all serial data interfaces available on the PC and only offers these for selection. The required RS 232 data interface, e.g. COM 1, can be selected with the menu command OPTIONS > SETTINGS.

The other communication parameters for the serial link are permanently set in the NAV200 Setup software and cannot be changed. On the menu command COMMUNICATION > OPEN SERIAL INTERFACE TO NAV, the configuration software establishes communication to the NAV200. Appropriate error messages appear if the NAV200 device is not correctly linked to the PC or is not switched on.

As soon as there is a link to the NAV200, the user interface shows the parameters of the RS 232 data interface in the status bar at the bottom:

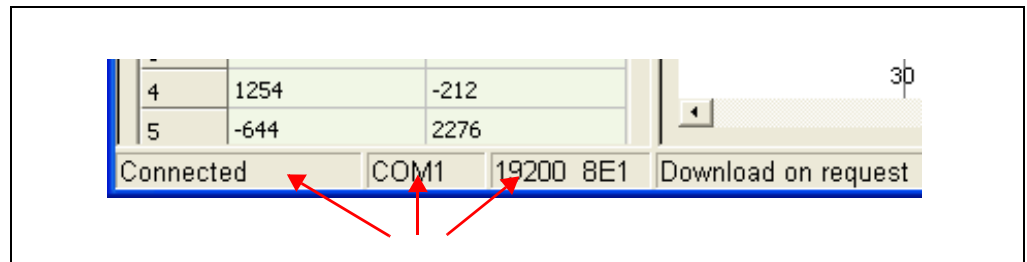


Fig. 6-2: Interface parameters in the status bar of NAV200 Setup

The following menu commands are active in the online state and inactive in the offline state:

- NAV > ACTIVATE STANDBY
- NAV > CREATE ENVIRONMENT MAPPING
- NAV > START / STOP POSITIONING MODE
- NAV > REFLECTOR COORDINATE MODE
- COMMUNICATION > CLOSE SERIAL INTERFACE TO NAV
- COMMUNICATION > LOAD ALL DATA TO NAV
- COMMUNICATION > LOAD ALL DATA TO NAV
- OPTIONS > FLASH BOOT FILE

NAV200

6.4.6 User interface of the NAV200 Setup configuration software

The diagram below shows the user interface of the NAV200 Setup:

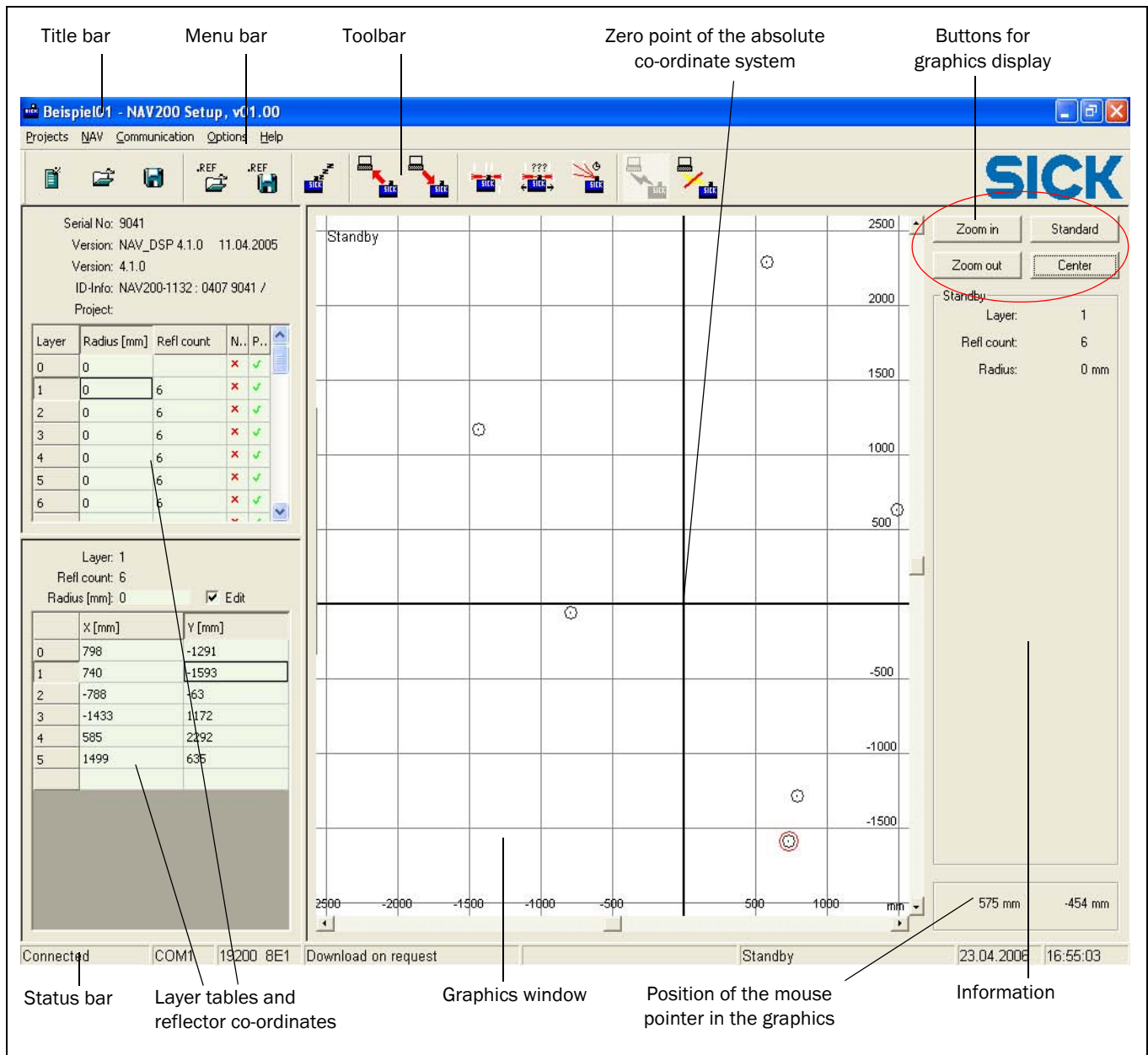


Fig. 6-3: Program window of the NAV200 Setup configuration software

The user interface of the NAV200 Setup is orientated towards the usual Windows standard and consists of the following elements:

- Title bar showing the current configuration file (project file), the name of the program and the software version
- Menu bar with pull-down menus
- Toolbar with the most important functions from the menu bar (see [Section 6.4.7 Toolbar commands, Page 56](#))
- Status bar along the bottom edge of the window with data interface and program parameters
- Working and information area in the middle

The working area is made up of three separate areas arranged side by side.

- **Left-hand area:** project data, layer table and table of the reflector co-ordinates
Display of layer data and reflector co-ordinates of the selected layer; possibility of editing the reflector co-ordinates in Standby mode
- **Central area:** graphics window
Two-dimensional graphical display of the reflector positions **of the selected layer** in the absolute co-ordinate system of the actual environment;
Display in three variants via the menu item **OPTIONS > DATA VIEW**:
 - Cartesian
 - Polar co-ordinates
 - Distance-Angle graph
- **Right-hand area:** control and information field
Buttons for the graphics display, display of different measurement data, dependent on the selected program function

The three display variants in the graphics window can be selected with the command **OPTIONS > DATA VIEW**:

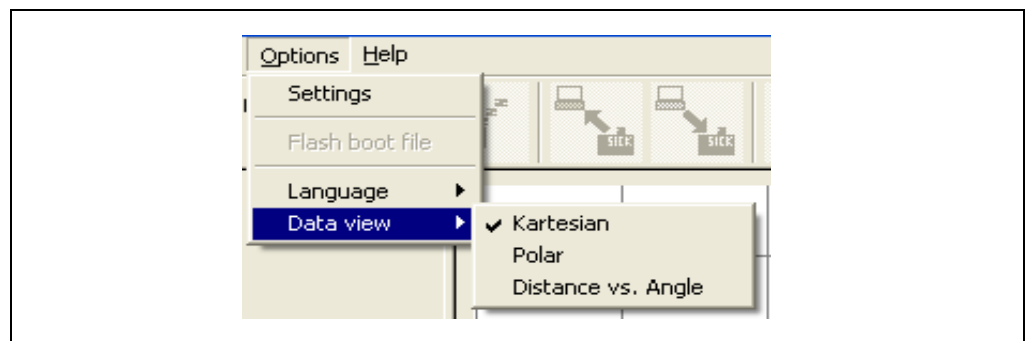


Fig. 6-4: Selecting the three types of display of the graphics window

- **Cartesian**
The graphics window shows the reflectors two-dimensionally in the absolute X-Y co-ordinate system of the course. This is the default setting and is the most suitable for the configuration as it exactly and graphically mirrors the actual position of the reflectors.
- **Polar**
The position of the NAV200 is given by polar co-ordinates:
 - The distance to the zero point of the absolute co-ordinate system
 - The angle between the connecting line from the NAV200 zero point to the X-axis of the absolute co-ordinate system

The reflector positions appear at the same positions in the graphics window as with the Cartesian display. The range rings indicate the distance to the zero point. The X and Y axes are marked with the 0°, 90°, 180° and 90° bearings. Positions that the graphics window shows below the X-axis of the absolute co-ordinate system are denoted by negative angles.

The layer table in the left-hand area displays the polar co-ordinates instead of the X-Y co-ordinates: distance (mm) and angle (°).

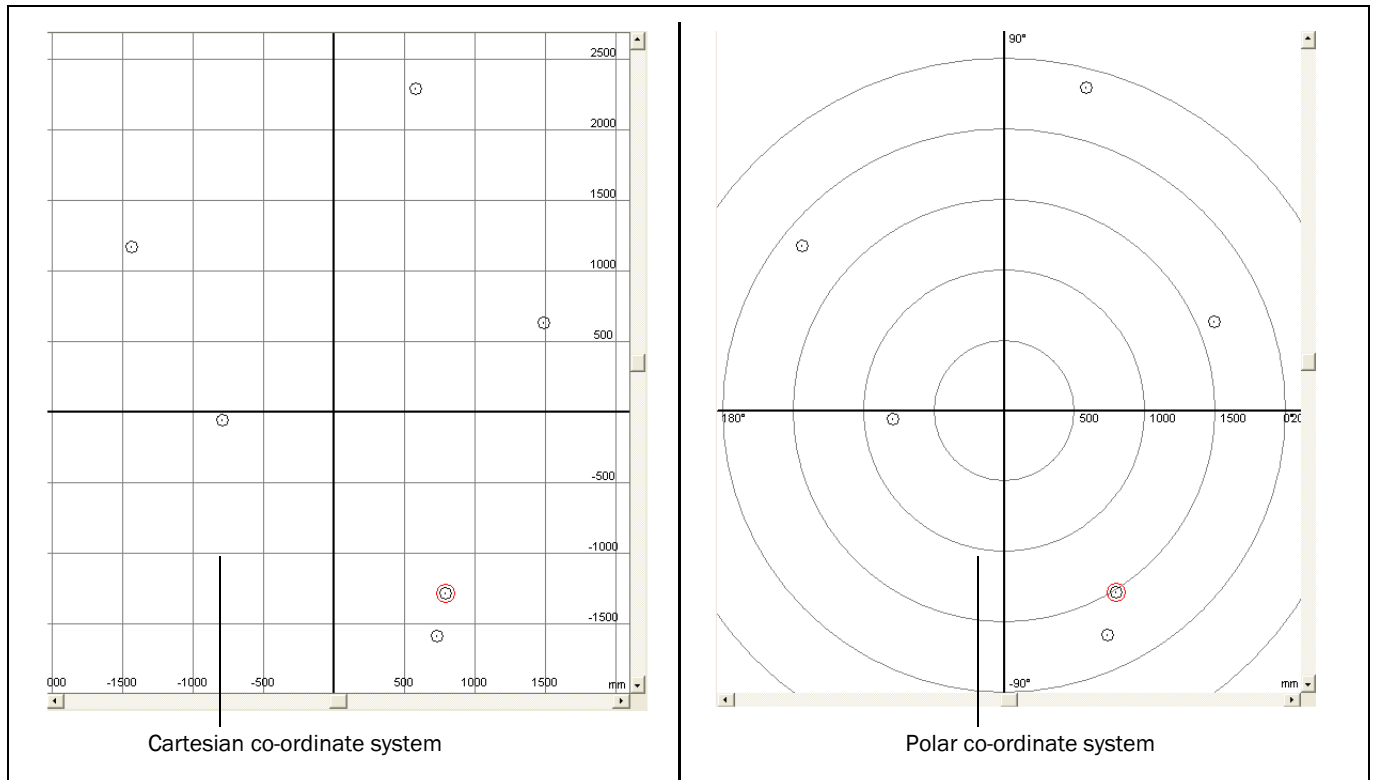


Fig. 6-5: The same reflector arrangement displayed in the Cartesian co-ordinate system and in the polar co-ordinate system

- **Distance against angle**

The horizontal axis shows the angle, the vertical axis shows the distance to the zero point. This is an abstract representation: the positional representation of the reflectors is not really a true reflection of the actual arrangement. The data in the layer table is identical to that of the polar representation.

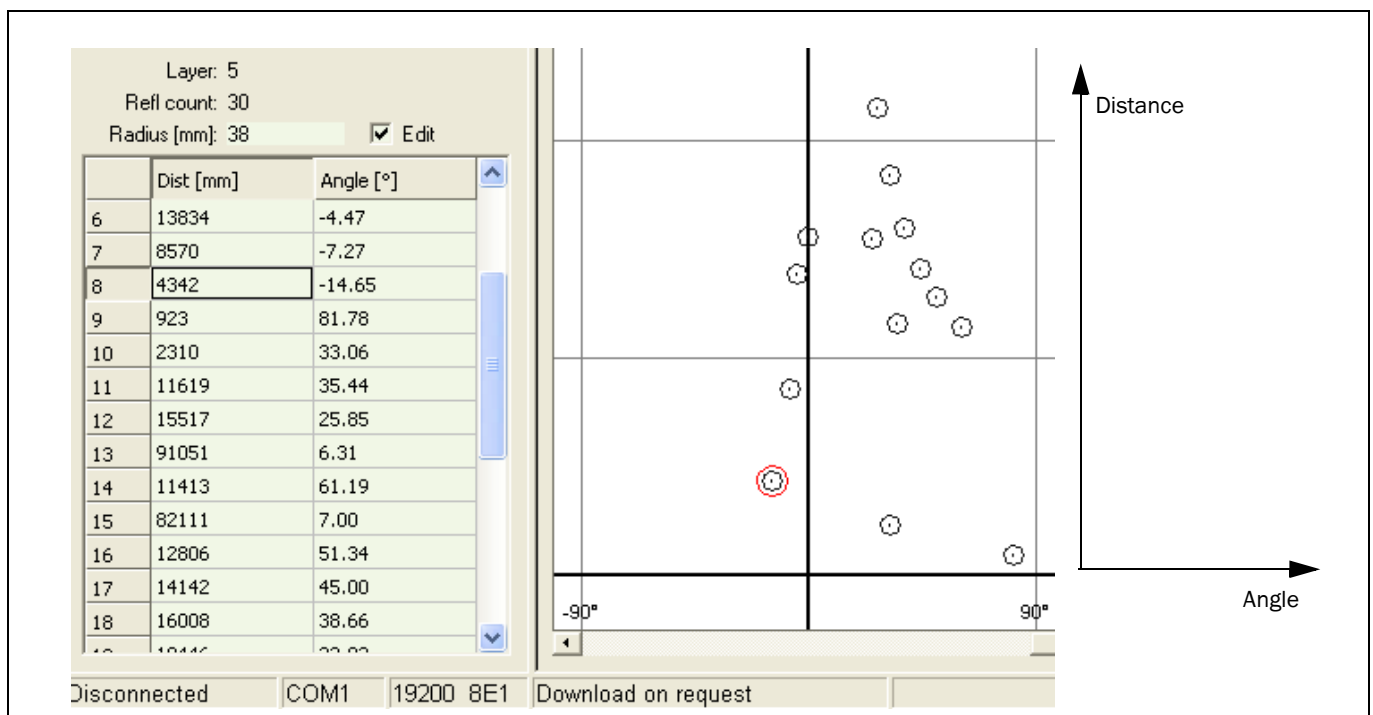















Fig. 6-6: Data display: "Distance against angle" (extract from the layer table and part of the graphics window)

6.4.7 Toolbar commands

The toolbar contains the most important and most frequently used commands of the menu bar. The menu items and their function are explained in the table below:

Icon	Menu item	Function
	CREATE NEW PROJECT	Opens a new, blank project
	OPEN PROJECT	Reads an existing project from a data medium
	SAVE PROJECT	Saves all project data in a project file on a data medium
	LOAD REFLECTOR DATA	Reads reflector data from a file on a data medium
	SAVE REFLECTOR DATA	Saves reflector data in a file on a data medium
	ACTIVATE STANDBY	Changes to "Standby" mode, to close positioning operation, for example
	LOAD ALL DATA FROM NAV	Transfers the layer data of all or selected layers from the NAV200 to the NAV200 Setup configuration software ("Upload" mode)
	LOAD ALL DATA TO NAV	Transfers the layer data of all or selected layers from the configuration software to the NAV200 ("Download" mode)
	CREATE ENVIRONMENT MAPPING	Generates a Mapping of the reflector environment; to do this, the NAV200 measures the co-ordinates of all reflectors that are visible from the current position of the NAV200.
	START / STOP POSITIONING MODE	Starts and stops the positioning operation of the NAV200 ("Positioning operation" mode)
	REFLECTOR COORDINATES MODE	Starts "Reflector co-ordinates" mode for checking and display of the reflector positions of an environment in the local co-ordinate system of the NAV200
	OPEN SERIAL INTERFACE TO NAV	Establishes communication between NAV200 Setup and the NAV200 via an RS 232 data interface
	CLOSE SERIAL INTERFACE TO NAV	Terminates communication between the NAV200 and NAV200 Setup

Tab. 6-2: NAV200 Setup: Function of the buttons in the toolbar

6.4.8 Project files and reflector data

The reflector data assigned to the individual layers can be saved in a project file and/or a "Reflector data" text file. By default, NAV200 Setup offers the "Data" sub-directory of the Installation directory for saving these files.

Project files

Project files contain all necessary and known data for positioning within an overall environment: settings, description and information on the NAV200 in use, together with all data on the installed layers and their reflectors.

Projects are read in and stored using the menu commands in the PROJECTS menu. Project files have the .nav file name extension.

The settings of a project can be specified and documented with the PROJECTS > PROJECT SETTINGS menu command:

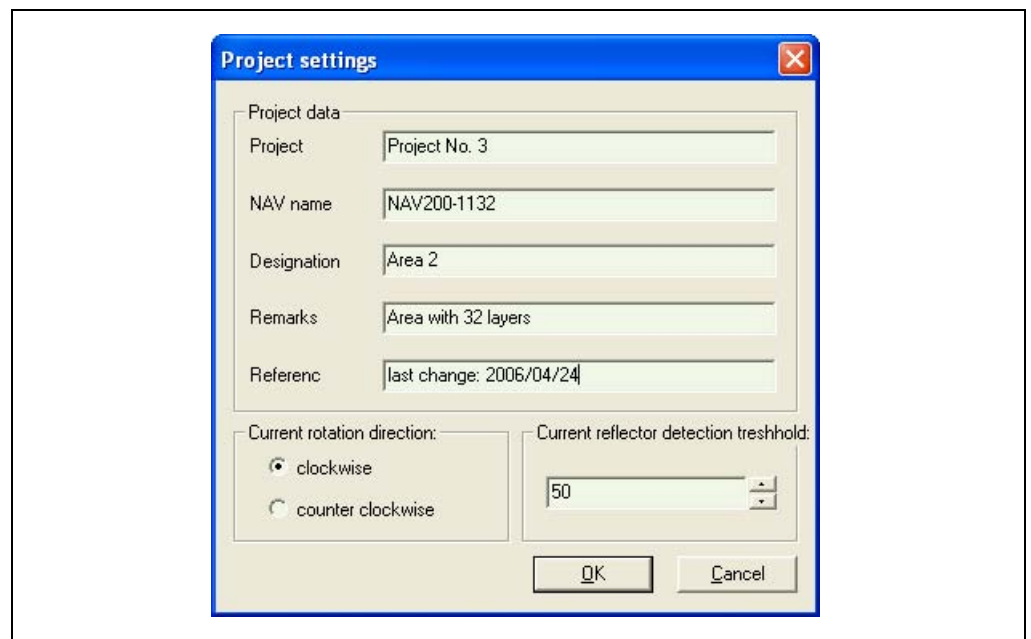


Fig. 6-7: "Project settings" dialog box

Note Entries in the project settings dialog box relate to additional information on the project that is saved with the other data in the project file. So, for example, the CURRENT ROTATION DIRECTION: entry does not control the actual direction of rotation of scanner head. CLOCKWISE means that the NAV200 is mounted with the scanner head at the top. COUNTER CLOCKWISE means that the NAV200 is mounted with the scanner head down (overhead mounting), which reverses the direction of rotation as seen from the reflectors. This information is required so that the NAV200 Setup displays the reflector arrangement the right way round in the graphics window of the user interface.

The entry in the CURRENT REFLECTOR DETECTION THRESHOLD field is not saved with the other data in the project file.

"Reflector data" text file

This type of file contains all the information for one or more layers: X and Y co-ordinates and the reflector radius, which is identical for all reflectors within a layer. So this data is part of a project. In the same way as the project files, the reflector data can be read in from or saved to a corresponding text file on a data medium with the PROJECTS > LOAD REFLECTOR DATA and PROJECTS > SAVE REFLECTOR DATA menu commands. Any combinations can be selected from the list of all available layers here.

Files with reflector data have the **.ref** file name extension.

```

NAV Reflector data
C NAVConfigwin 00.10    06.06.2005
C
C SICK AG
C NAV Data: TEST003.REF
C
C   Layer   Reflectors   Radius [mm]
C   0       6           0
C E   Nr.    X [m]      Y [m]
C -----
C   0   0      2.618    -0.919
C   0   1      1.321    -1.636
C   0   2      0.412    -1.611
C   0   3     -0.544    -0.037
C   0   4     -0.785     0.784
C   0   5      1.308     0.129
C   Layer   Reflectors   Radius [mm]
C   1       5           9
C E   Nr.    X [m]      Y [m]
C -----
C   1   0      1.311    -1.623
C   1   1      0.408    -1.596
C   1   2     -0.528    -0.036
C   1   3     -0.774     0.773
C   1   4      1.293     0.127

```

Fig. 6-8: "Reflector data" text file

The reflector data stored in the text file is available in ASCII format and can be changed with any Text Editor. The project files, on the other hand, cannot be edited.

The file is sub-divided into the following elements (from the top downwards)

- The first line is used to identify the type of file.
- Comments lines are marked with a C at the beginning of the line
- The numbers mean:
layer number, number of reflectors and reflector radius of the layer
- The XY data lines with the co-ordinates contain 4 columns:
Layer number, number of the reflector, X-co-ordinate [mm], Y-co-ordinate [mm]

Note When the text file is created manually, like the example above, at least **one blank space** must be used as a separator in the data lines. Tab spaces are not permitted here. NAV200 Setup ignores data lines with tab spaces when the data is transferred.

Data alignment of NAV200 with configuration software

The COMMUNICATION > LOAD ALL DATA TO NAV menu command can be used to download the reflector data to the NAV200, or the COMMUNICATION > LOAD ALL DATA FROM NAV menu command used to upload from the NAV200 into the configuration software. The user can specify the required layers for the data transfer in both these processes.

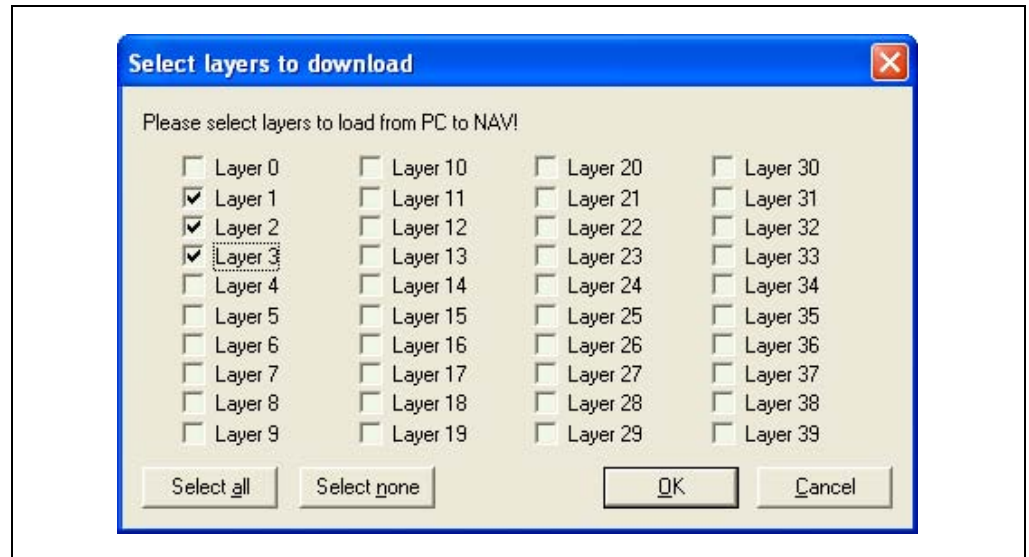


Fig. 6-9: Layer selection for data transfer

Note When data is transferred from the NAV200 to the PC, the reflector data of the layers to be transferred held in the current project file is overwritten with no advance warning. We recommend backing up the project file and making a copy if necessary before the data transfer.

When data is transferred from the PC to the NAV200, the reflector data of the corresponding layers that are active in the NAV200 is overwritten with no advance warning.

The layer and reflector data can be located in three different places:

- temporarily in the NAV200 Setup configuration software
(the data is lost when the program is closed unless it was saved beforehand or transferred to the NAV200!),
- in a project file or "Reflector data" text file on a data medium of the PC,
- in the reflector memory of the NAV200.

NAV200 Setup provides information on whether the data in these three places is identical or different. For this, the layer table includes the two columns NAV and PROJECT on the right. The data comparison between NAV200 and the NAV200 Setup configuration software takes place after each upload or download process.

Note With the standard screen setting, the NAV and PROJECT column headings are not completely legible, but only appear as N.. and P.., for example. They become completely visible if the left-hand area is made bigger by dragging the column separator to the right. If the left-hand area is set too narrow, the icons are no longer displayed!

Layer	Radius [mm]	Refl count	N..	P..	
0	0	6	✓	💾	
1	9	5	✓	✓	
2	50	6	✗	💾	
3	0	6	✗	✓	
4	0	6	✗	✓	
5	38	32	✗	✓	
6	38	32	✗	✓	

Data in the program, on the data medium and in the NAV200 is identical
 Data in the program, and on the data medium is different
 Data in the program, and in the NAV200 is different

Fig. 6-10: Icons in the NAV and PROJECT columns of the layer table

A **green check mark** means that the data in the NAV200 Setup configuration software and in the project file and in the NAV200 device is identical.

A **red cross** in the NAV column means that the data in the configuration software and in the device is different. Data can be aligned by an upload (see [Section 6.5.4 Upload, Page 61](#)) or download (see [Section 6.5.3 Download, Page 61](#)).

A **disk icon** in the Project column means that the data in the configuration software and in the project file is different. The data is identical again after the project is saved; the NAV200 Setup indicates this with a green check mark.

Note The diskette symbol is still displayed when the layer and reflector data is saved in a "Reflector data" text file. It is not replaced by the green check mark until the entire project is saved.

6.4.9 Closing the NAV200 Setup configuration software

Click on the cross at the top right-hand corner of the user interface or choose the PROJECT > CLOSE APPLICATION menu command.

Before shutting down, the configuration software asks whether the user wants to save any changes made to the project. If this is confirmed, NAV200 Setup saves the changes.

6.5 NAV200 operating modes

The following NAV200 modes are possible:

6.5.1 Standby

When this function is selected, the NAV200 changes to "Standby" mode. This is also the operating condition that the NAV200 adopts after it is switched on or after a reset. The NAV200 layer and reflector data can be edited manually in "Standby" mode using the NAV200 Setup configuration software.

6.5.2 Mapping

"Mapping" mode is used for quick commissioning for test or demonstration purposes, or even for normal operation, when exact positioning is not required. On the other hand, to achieve exact positioning, the precise reflector positions must be transferred to the NAV200 in a "Reflector data" text file (extension .ref) via the configuration software, or manually entered in the NAV200 Setup configuration software.

In "Mapping" mode, the NAV200 measures all the reflectors visible in its environment. The NAV200 initially transfers the results temporarily into NAV200 Setup (working memory of the PC). Data held in the reflector memory of the NAV200 remains unchanged.

NAV200 Setup displays the transferred data on screen in tabular and graphical form. The data can then be saved in a file and/or transferred to the NAV200 as reflector data sets.

The buttons in the right-hand area of the screen can be used to zoom in and out of the graphical display in the middle area of the screen. Saving the data means that the acquired information can be transferred to other NAV200 devices later, or even that the results can be analysed outside this application. By loading the information on to the NAV200 it can be used for its future navigation tasks. On the PROJECTS > PRINT ACTIVE PROJECT menu command, NAV200 Setup sends the contents of the graphics window and the layer tables data to a printer.

6.5.3 Download

In "Download" mode, the NAV200 Setup configuration software transfers reflector data sets to the NAV200. The NAV200 files the data in its reflector memory. The source for the data can be a file with reflector data, the results of a Mapping, or a manual entry in NAV200 Setup. The Download function can transfer all or just individually selected layers, see [Fig. 6-9, Page 59](#).

6.5.4 Upload

In "Upload" mode, the NAV200 transfers the reflector co-ordinates of all or only selected layers to the NAV200 Setup configuration software. This data can then be used in various ways in the configuration software:

- display in a two-dimensional graphic and in tabular form
- saved in a file
- printout of the graphic and table

6.5.5 Position measurement

In "Positioning operation" mode, the NAV200 continuously measures its own current position on the basis of the reflector environment and forwards the positional data to the PC or to the AGV vehicle computer. The software reproduces the results of this

measurement continuously in the graphics window and in tabular form in the information area of the user interface.

6.5.6 Reflector co-ordinates

In "Reflector co-ordinates" mode, the NAV200 generates an up-to-date image of its current reflector environment within one turn of the scanner head. No comparative measurement with stored reflector data takes place at this time, nor does any measurement of the NAV200's own position. The NAV200 measures a maximum of 32 reflectors visible at this time and determines the reflector co-ordinates relative to its own position (local co-ordinate system, see [Fig. 3-8, Page 25](#)). The NAV200 transfers these co-ordinates to the NAV200 Setup configuration software. As in "Positioning operation" mode, the graphical and tabular displays occur continuously, but without any display of the position of the NAV200 itself. The NAV > REFLECTOR CO-ORDINATE MODE menu command is selected to change to "Reflector co-ordinates" mode.

In actual operation, "Reflector co-ordinates" mode enables the AGV vehicle computer to directly access the co-ordinates measured by the NAV200. The vehicle computer can then use its own algorithms to analyse the data from this direct access (see also [Section 3.6.4, Page 36](#)). "Reflector co-ordinates" mode is not required for positioning operation.

6.6 Performing and testing the configuration

The object of the configuration is to pass the co-ordinates of all reflectors on the course to the NAV200. Basically, there are two possible ways of doing this:

- Measuring, entering and transferring the exact reflector co-ordinates (accurate method)
- Measuring and reading the reflector co-ordinates using the NAV200 Mapping (less accurate but quicker method)

The following instructions assume that NAV200 Setup has been started on the PC and that communication is available to the NAV200 (online state).

6.6.1 Measuring, entering and transferring the exact reflector co-ordinates manually and testing positioning operation

This method should be selected to achieve the highest possible positioning accuracy in actual operation. But this does require as accurate as possible measurement of the reflector positions by surveying. Any inaccuracy in the measurement will become noticeable later on through variations in the positioning accuracy of the AGV.

When the reflector data is available, there are two possible ways - described below - of transferring it to the NAV200 Setup:

- Creating a "Reflector data" text file, editing it and opening it in NAV200 Setup
- Entering reflector co-ordinates directly in NAV200 Setup

a) Creating a "Reflector data" text file, editing it and opening it in NAV200 Setup

1. Create a blank text file with an ASCII text editor and save the file in a directory on the data medium under a suitable name, with the extension ".ref".
2. Enter the layer and reflector data in the text file in accordance with the requirements for structure and content given in [Section 6.4.8 Project files and reflector data, Page 57](#), especially [Fig. 6-8, Page 58](#).
3. Save and close the file.
4. Load the file in NAV200 Setup with the PROJECTS > LOAD REFLECTOR DATA menu command. Select the required reflector file in the dialog box and click on OPEN.

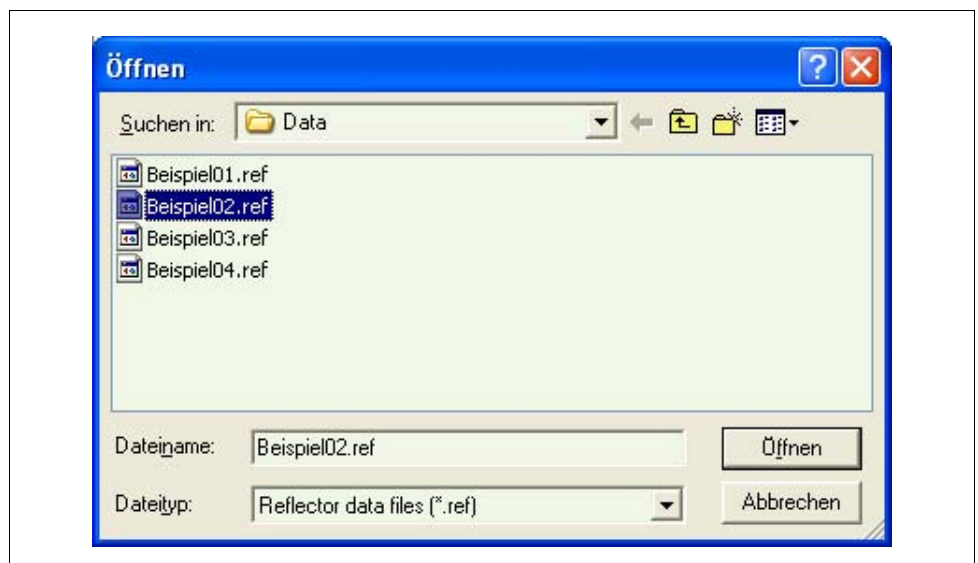


Fig. 6-11: Dialog box for loading data "Reflector data" text file in NAV200 Setup

The "Reflector data" text file is now loaded in NAV200 Setup and ready for transfer to the NAV200.

5. If necessary, enter any additional project data for the new project (see [Fig. 6-7, Page 57](#)) and save the project file under a suitable name with the extension ".nav".

b) Entering reflector co-ordinates directly in NAV200 Setup

1. Open NAV200 Setup
2. Choose the CREATE NEW PROJECT menu command
3. Select the EDIT check box above the table with the reflector co-ordinates. Edit mode is now active, editing of reflector data is now permissible.

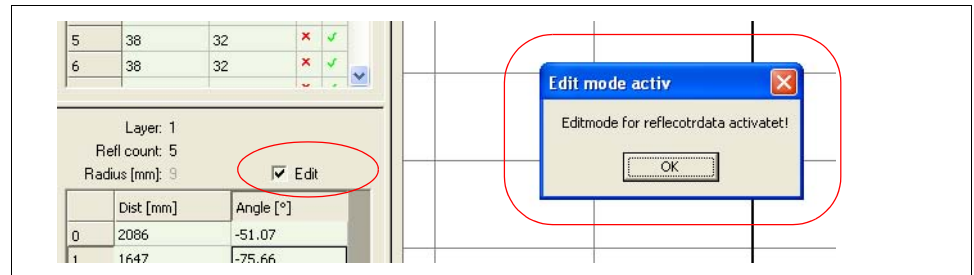


Fig. 6-12: Activating edit mode for reflector data

4. Using the mouse, click the required layer in the layer table.
5. Select and enter or change the required co-ordinates each time by double-clicking in the cells of the table with the reflector co-ordinates.
6. Individual reflectors are deleted by right-clicking the reflector field.
7. Using this method, manually enter the reflector positions separately for each layer in the list of reflector co-ordinates.
8. When the entries are complete, if necessary, enter any additional project data for the new project (see [Fig. 6-7, Page 57](#)) and save the project file under a suitable name with the extension ".nav". The reflector data is now loaded in NAV200 Setup and ready for transfer to the NAV200.

Transferring reflector data to the NAV200 and saving data

Reflector data held in NAV200 Setup can be transferred to the NAV200:

1. If NAV200 Setup is not on line, choose the COMMUNICATION > OPEN SERIAL INTERFACE TO NAV menu command. NAV200 Setup establishes communication with the NAV200.
2. Choose the COMMUNICATION > LOAD ALL DATA TO NAV menu command. Transfer the reflector data sets from the PC to the NAV200 to store them there permanently. They are now available for the position measurement (positioning operation).
3. Choose the PROJECTS > SAVE PROJECT menu command. Finally, save the project with all layers and reflector data on a data medium

Note The COMMUNICATION > LOAD ALL DATA FROM NAV menu command can be used to transfer the layer data held on file in the NAV200 to the PC, to check the current configuration of the NAV200, for example.

Testing position measurement (positioning operation) with read-in reflectors

1. Choose the NAV > START / STOP POSITIONING MODE menu command.

This command activates the position measurement. As a result, it is now possible to test the positioning operation on the basis of the previously transferred reflector coordinates. A precondition for this is that the PC is on online and linked to the NAV200. Positioning operation requires data entry as shown in [Fig. 6-13](#):

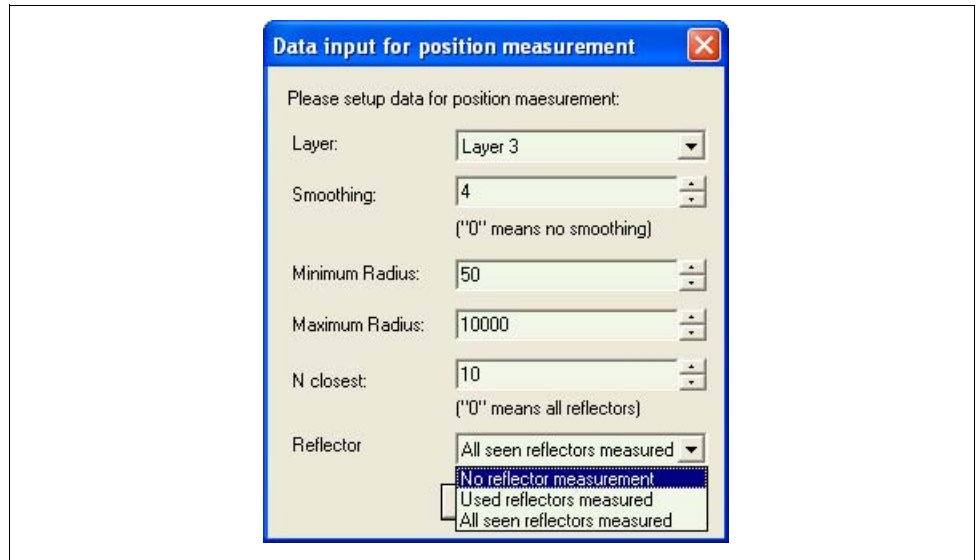


Fig. 6-13: Dialog box: data entry for positioning operation

2. Make the following entries:
 - LAYER: The number of the layer to be used
 - SMOOTHING: Specifies how many of the readings should be used for a smooth calculation of mean value.
 - MINIMUM RADIUS and MAXIMUM RADIUS: Specifying the two radii determines the restricted radius of action for the NAV200. During position measurement, the NAV200 only considers reflectors that fall within the specified effective range. The measurement result can be improved by restricting the radius of action, see [Section 3.4 Measurement accuracy, Page 28](#). Radius of action values are expressed in mm units. The lowest valid value in the MINIMUM RADIUS field is 500, the highest valid value in the MAXIMUM RADIUS field is 30000.
 - N CLOSEST: From all the detected reflectors, the NAV200 only considers the number N of reflectors for position measurement that are the shortest distance away from the NAV200. Entry of the value "0" means that all reflectors are included in the measurement. The N CLOSEST function can improve the measurement result under certain conditions, see [Section 3.4 Measurement accuracy, Page 28](#).
 - REFLECTOR:

With position measurement, the NAV200 can transfer the results of the reflector measurements to the PC. NAV200 Setup shows the results of these measurements in the graphical display. The entry in the REFLECTOR field specifies the type of display:

 - NO REFLECTOR MEASUREMENT: no transfer of reflector measurements,
 - USED REFLECTORS MEASURED: only the reflectors used (stored) and re-detected for position measurement in the NAV200 are displayed (if required, the number of reflectors used must be reduced by means of the restricted radius of action function or the N CLOSEST function),

- ALL SEEN REFLECTORS MEASURED: all the reflectors visible during the reflector measurement are displayed.

3. Confirm with OK.

Positioning operation starts and NAV200 Setup displays the position of the NAV200 in the selected layer:

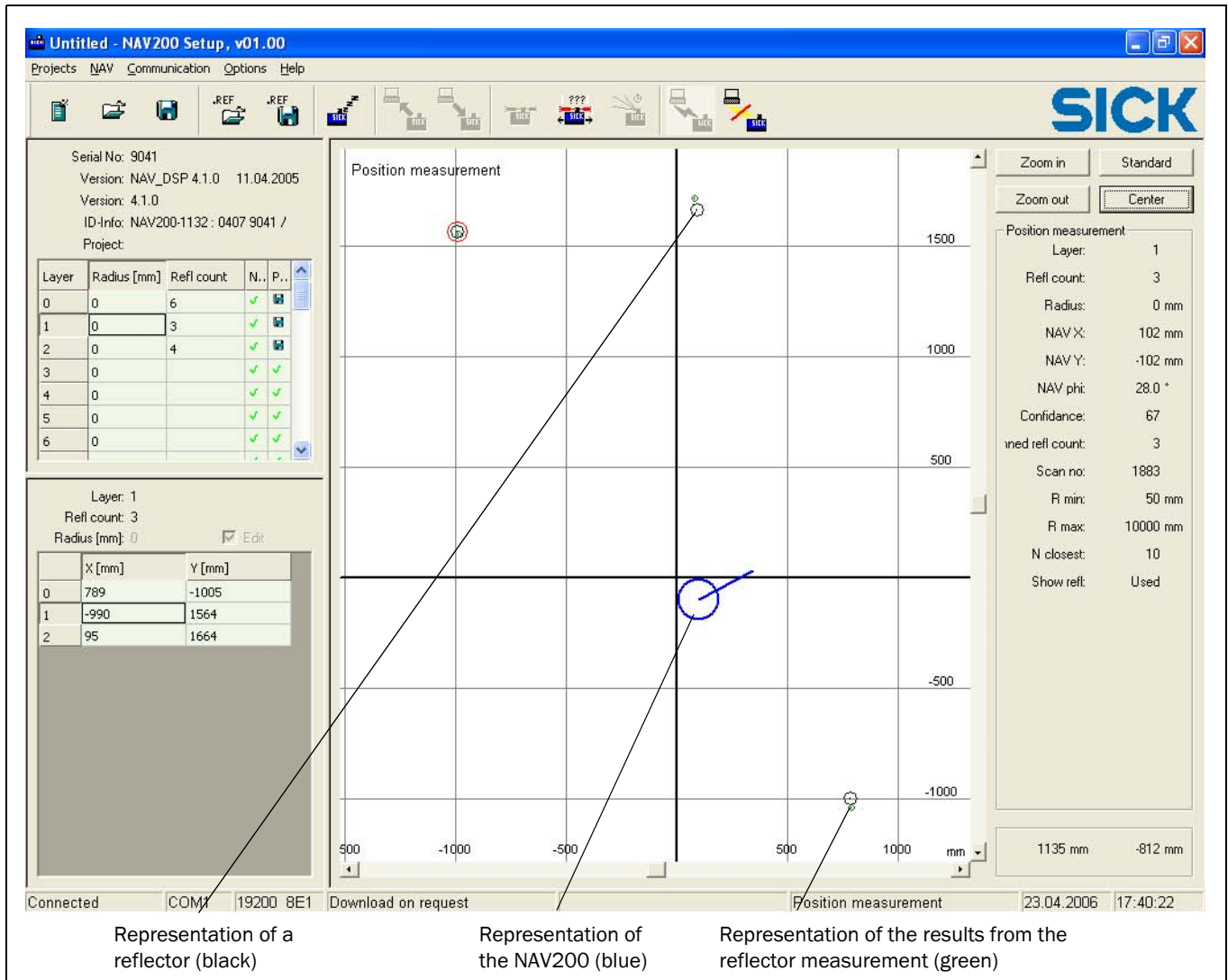


Fig. 6-14: Program window during positioning operation ("Positioning operation" mode)

This is an online display, i.e. the table values of the reflector co-ordinates in the left-hand area, the graphical display in the centre, and the information in the right-hand area are continuously updated. The blue circular symbol with the radial line in the graphics window marks the position and orientation of the NAV200. The radial line here points in the direction of the X-axis of the local co-ordinate system of the NAV200. The black circles mark the reflector positions saved in the NAV200. The small green circles display the measurement results from the type of reflector measurement and transfer that can be chosen as an option.

4. Choose the NAV > START / STOP POSITIONING OPERATION menu command.

The NAV200 closes positioning operation and changes to "Standby" mode.

6.6.2 Measuring and reading the reflector co-ordinates automatically using the NAV200's Mapping

The teach-in of a new reflector environment using Mapping (see [Section 6.5.2 Mapping, Page 61](#)) is quicker than measurement by a land surveyor, but not as exact.

1. Position the NAV200 - mounted on an AGV - at a suitable initial position. As many reflectors as possible, but with a minimum of three, must be visible at this position. Measure the initial position of the NAV200 accurately, determine the co-ordinates of the centre of the scanner head relative to the absolute co-ordinate system. The reference point (co-ordinates origin) on the NAV200 lies on the central axis of the scanner head.
2. Choose the PROJECTS > CREATE NEW PROJECT menu command.
NAV200 Setup generates a new project file. If a project is already open, NAV200 Setup asks whether the changes to the previous project should be saved.
3. Use the PROJECTS > PROJECT SETTINGS menu command to open the PROJECT SETTINGS dialog box and enter settings and information for the project (see [Fig. 6-7, Page 57](#)).
4. Choose the NAV > CREATE ENVIRONMENT MAPPING menu command.
The dialog box opens for entry of the Mapping parameters:

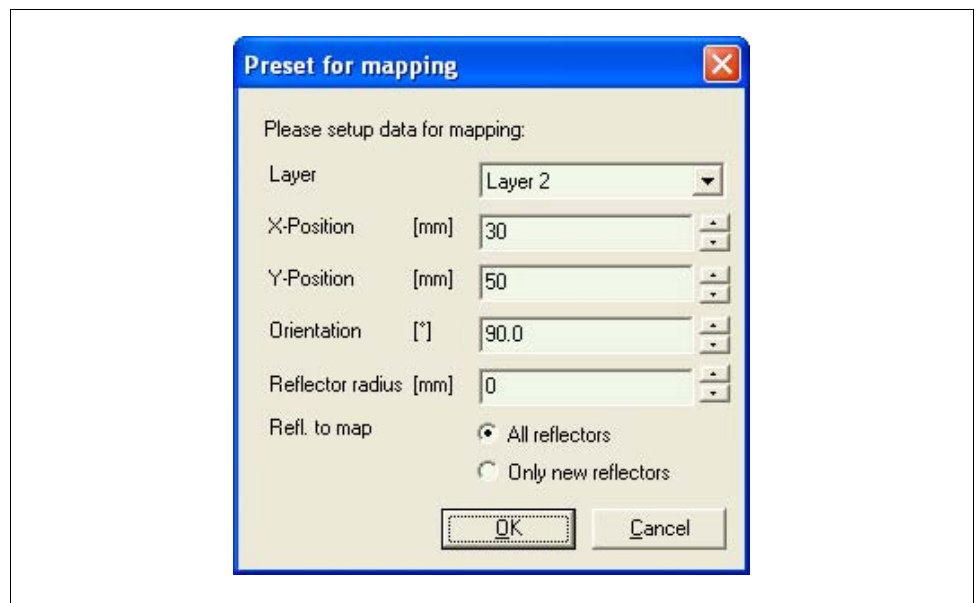


Fig. 6-15: Dialog box for the Mapping parameters after data entry

Make the following entries:

- Number of the layer that the reflectors to be measured are assigned to.
- X and Y co-ordinates of the initial position of the NAV200 in the absolute co-ordinate system of the actual environment. These co-ordinates must be specified exactly.
- The orientation of the NAV200 in the absolute co-ordinate system, see [Fig. 3-8, Page 25](#). The value 0° here means that the X-axis of the NAV200 is aligned parallel to the X-axis of the absolute co-ordinate system. The LEDs of the NAV200 are then pointing in the negative X-direction.

A positive angle means counter-clockwise rotation of the NAV200 viewed from above. The highest positive angle to be entered is 180°. Conversely, a negative angle means clockwise rotation of the NAV200. The highest negative angle to be entered is -180°.

- The reflector radius of the reflectors for this layer. As only uniform reflectors must be used within a layer, this value applies to all reflectors of the layer.
 - for flat reflectors, enter the value "0" here
 - for cylindrical reflectors, enter the radius of the cylinder
 - Use the REFL. TO MAP option to specify whether all, or just newly detected reflectors should be measured and transferred.
5. Confirm the dialog box with OK.
The NAV200 starts Mapping and shows the progress of the Mapping in a NAV200 Setup information box.

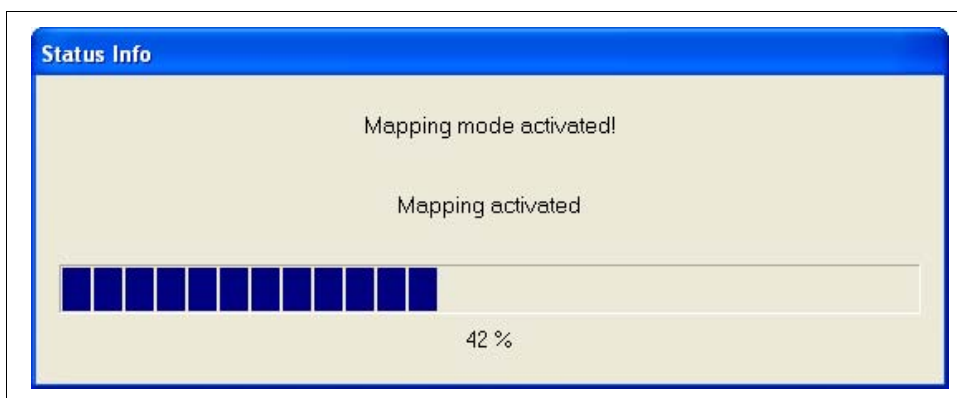


Fig. 6-16: Information box during Mapping

6. After successful completion of the Mapping, a dialog box opens that allows the Mapping results to be used in various ways:

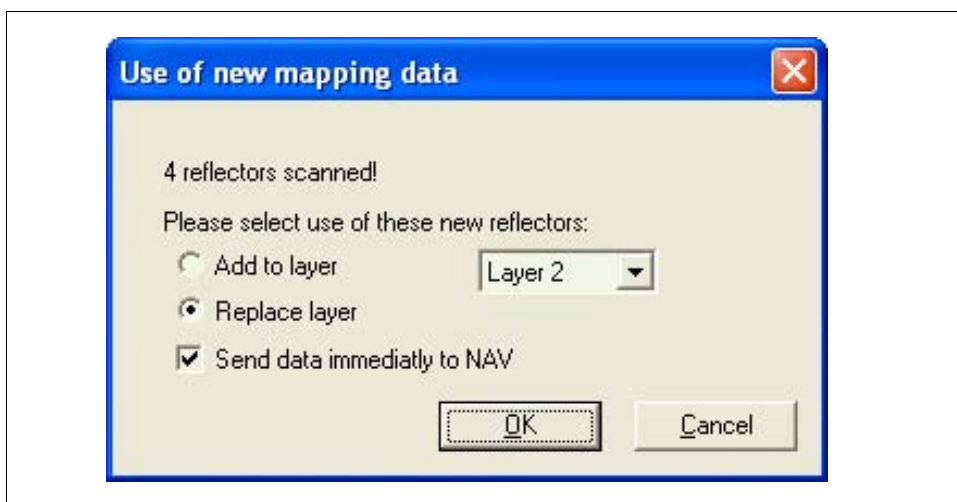


Fig. 6-17: NAV200 Setup feedback and processing of Mapping results

The following options are available:

- ADD TO LAYER option and selection of a required layer:
the NAV200 adds the co-ordinates of the detected reflectors to the selected layer as new reflectors.
- REPLACE LAYER option:
replaces the old reflector co-ordinates in the mapped layer completely with the new reflector co-ordinates.

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- SEND DATA IMMEDIATELY TO NAV:

NAV200 Setup simultaneously transfers all the data of the affected layer to the NAV200 (immediate download). This is particularly useful if the NAV200 has to teach-in additional reflectors using Mapping.

7. Confirm the dialog box with OK.

NAV200 Setup updates the reflector data sets according to the set options and changes to “Standby” mode.

NAV200 Setup displays the mapping results for the selected layer in the graphics window.

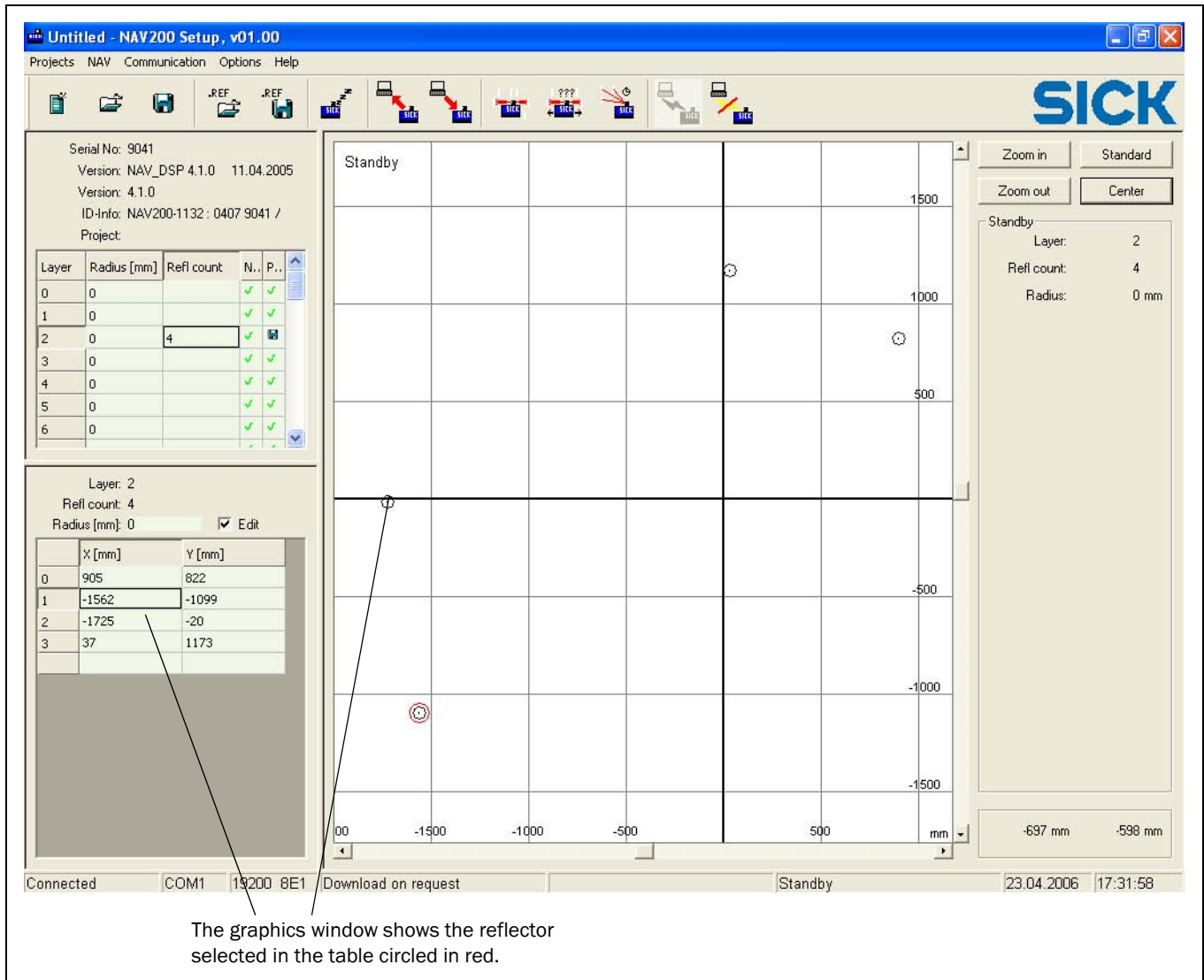


Fig. 6-18: Program window after completion of Mapping

The table of reflector co-ordinates in the left-hand area displays the co-ordinates of the detected reflectors. In the central area, the graphics window shows the reflectors as small circles. In addition, the reflector selected (mouse-click) in the table on the left is circled in red.

- Use the graphic display adjustment buttons (top right) to zoom in and out or to centre the view, to make all reflectors visible at the highest possible resolution.

Measuring additional reflectors using Mapping

8. To measure additional reflectors using Mapping, the NAV200 must know the co-ordinates of the most recently mapped reflectors. There are two ways of doing this:
 - If the SEND DATA IMMEDIATELY TO NAV check box (immediate download) was selected when the last Mapping result was used. As a result, the positional data of the mapped reflectors is already available in the NAV200.
 - Choose the COMMUNICATION > LOAD ALL DATA TO NAV menu command
NAV200 Setup transfers the reflector data sets from the PC to the NAV200. They are then available for further Mapping sweeps.
9. Move the NAV200 to a new position in the same layer. The NAV200 must be able to see at least 3 already mapped reflectors from its new position.
10. Choose the START / STOP POSITIONING OPERATION menu command to test the position measurement using the mapped reflectors.
11. The NAV200 starts the position measurement and determines its own position. Further information on data entry, options and displays for the "Positioning operation" mode is provided in *"Testing position measurement (positioning operation) with read-in reflectors"* in [Section 6.6.1, Page 63](#).
12. After a few seconds measuring time, deactivate "Positioning operation" mode again with the START / STOP POSITIONING MODE menu command. The NAV200 goes into "Standby" mode.
13. Select the NAV > CREATE ENVIRONMENT MAPPING menu command once again. The previously measured own position is automatically adopted in the data entry for the Mapping. Carry out Mapping as previously described in steps 4 to 6 to acquire all the reflectors of a layer to be used.
14. Position the NAV200 in the next layer. From its new position the NAV200 must be able to see at least 3 previously mapped reflectors of the last layer.
After Mapping, delete these reflectors again in the new layer to be saved.
15. Repeat steps 4 to 7 as many times as necessary, until all reflectors on the course have been measured - on a layer-related basis - successively in this way using Mapping.
16. Test the newly taught-in reflector environment as described in *"Testing position measurement (positioning operation) with read-in reflectors"* in [Section 6.6.1, Page 63](#).

6.7 Logging the data communication (log file)

When the CREATE COMMUNICATION LOG FILE option is activated in the GENERAL SETTINGS window (menu command OPTIONS > SETTINGS), the NAV200 Setup creates log files. NAV200 Setup saves these log files in the C:\Programme\NAV200Setup\LOGFILES folder as standard. The file names automatically generated include, amongst other details, the date the file was created.

6.8 Updating the firmware

When the OPTIONS > FLASH BOOT FILE menu command is chosen, NAV200 Setup transfers new firmware to the NAV200. The NAV200 Setup must be in the online state for this. After choosing this menu command, the user selects the file to be transferred. A check takes place before the file is transferred, to protect the NAV200 from being overwritten with an incorrect file.

6.9 Switching the NAV200 off

1. Terminate data communication to the NAV200 with the COMMUNICATION > CLOSE SERIAL INTERFACE TO NAV menu command. NAV200 Setup changes to the offline state.
2. If necessary, save the current project and close it.
3. Close NAV200 Setup with the PROJECTS > CLOSE APPLICATION menu command.
4. Switch off the power supply for NAV200.

The NAV200 retains the permanently stored configuration in its memory. Current measurement data on the RS 232 data interface is lost if the NAV200 is switched off during data transfer, or NAV200 Setup is closed during data transfer.

Notes:

7 Maintenance

7.1 Maintenance during operation

To maintain optimum measuring performance, the front pane in the scanner head of the NAV200 must be kept clean.

We recommend that the scanner head is checked for dirt on a regular basis (e.g. weekly), particularly in a harsh operating environment (dust, abrasives, humidity); more frequent checks may be appropriate, depending on the environment.

No regular maintenance is required to ensure that the Class 1 laser classification is maintained.

Note Do not open the housing of the NAV200. Opening the device will invalidate the manufacturer's warranty.

7.1.1 Cleaning the front pane of the NAV200



Laser radiation!

The NAV200 uses a Class 1 laser.

The entire window area is used as the laser outlet aperture.

The invisible infra-red radiation emitted is safe to eyes.

Caution — use for other than the intended purpose can lead to exposure to dangerous radiation.

- Do not open the housing (opening does not stop the laser switching on)
- Use for other than the intended purpose can lead to the laser class being exceeded.
- Observe the latest version of the laser protection regulations.



Damage to the NAV200!

The NAV200 provides IP 65 protection and is only protected against the ingress of liquids in that respect.

- Do not immerse the device in liquids.
- If necessary, clean the housing with a moist, soft cloth (lint-free)
- Do not use aggressive chemicals!



Damage to the front pane!

The front pane is made of glass. Scratches and smears on the front pane can adversely affect the measuring performance.

- Always moisten the front pane when cleaning it.
- Use a mild cleaner that does not contain abrasive powder.
Never use strong cleaners or solvents such as acetone etc.
- Avoid scratching and scouring movements on the front pane.

1. Switch the NAV200 off for cleaning, as otherwise the scanner head rotates.
2. Clean the front pane at regular intervals using a damp cloth (lint-free) and a proprietary window cleaner, or with a special soft brush for lenses (camera/optical accessory).
3. Also clean the LED cover if necessary.



Fig. 7-1: Cleaning the front pane on the NAV200

Note If the front pane is scratched or damaged (crack, break) the glass must be replaced. Contact Sick Service for this.

7.2 Maintenance

Apart from the routine cleaning described above, the NAV200 is maintenance free. The NAV200 outputs device and functional errors as they occur in the form of a special error telegram, in the reply to any vehicle computer software telegram, see [Section 8 Troubleshooting, Page 75](#).

7.3 Disposal

Dispose of any unusable/irreparable NAV200 devices that are taken out of service in an environmentally-responsible manner:

1. Observe the applicable country-specific waste disposal regulations.
2. Disassemble the housing of the NAV200.
3. Disassemble the electronics modules of the NAV200.
4. Remove the front pane of the NAV200 and send it for glass recycling.
5. Send the die-cast aluminium frame and cover of the NAV200 for non-ferrous metals recycling.
6. Dispose of the electronics modules as special waste.
7. Send the cables for metal recycling

SICK AG does not currently take back devices that have become unusable or irreparable.

8 Troubleshooting

The NAV200 reports all error conditions to the AGV vehicle computer in the form of error messages via the RS 232 data interface. They can be interpreted by the supervisory control software there.



The structure of the error telegrams and the possible types of error are described in the “NAV200 Telegram Listing” (No. 8009595).

8.1 Overview of possible errors and malfunctions

8.1.1 Mounting errors

- Rotating optical axis of the NAV200 is not aligned parallel with the travelled plane.

8.1.2 Electrical installation errors

- Faulty link between PC and NAV200
- Faulty link between vehicle computer and NAV200
- Wrong conductor cross-section selected for the supply

8.1.3 Parameter setting error

- Parameter values not adjusted to local conditions
- Device-related limits (range) not taken into account

8.1.4 Operational malfunctions

- Device errors (hardware/software)

8.2 Monitoring errors and fault signs

The NAV200 signals device errors and functional errors on the basis of software telegrams that it sends to the vehicle computer via the serial data line. In addition, the NAV200 switches off all four LEDs in an error state.

8.3 SICK support

If a fault cannot be cleared with the measures described earlier, the NAV200 itself may be faulty. The system has no components that the user can repair himself to restore their functionality after a failure.

Please contact your local Sick office or subsidiary:

- The telephone numbers and email addresses are listed on the *back page* of these operating instructions.
For postal addresses see also **www.sick.com**.
- Please consult SICK Service before returning the device.

Notes:

NAV200

9 Technical data

9.1 NAV200 data sheet

Type	NAV200				
Range	Reflector distance 1.20 m to 28.5 m (3.94 ft to 93.5 ft)				
Aperture angle	360°				
Motor speed/scanning frequency	8 Hz ± 10 %				
Laser diode (wavelength)	Infrared light (λ = 855 nm)				
Device laser protection class	1 (safe to eyes), to EN/IEC 60825-1 and 21 CFR 1040				
Light emission	Via rotating scanner head				
Front window	Glass, circular				
Mean reflector distance	3 m (9.84 ft)	5 m (16.4 ft)	10 m (32.8 ft)	20 m (65.6 ft)	28,5 m (93.5 ft)
Typical positioning accuracy *)	±4 mm (±0.155 in)	±8 mm (±0.31 in)	±12 mm (±0.47 in)	±15 mm (±0.58 in)	±25 mm (±0.97 in)
Angular accuracy	±0.1°				
Beam divergence	15 mrad (0.88°), approx. 16 mm (0.63 in) per metre of measuring distance				
Required reflector marks	Strips: width > 100 mm (3.9 in); height > 500 mm (19.4 in) Cylindrical: diameter > 80 mm (3.1 in); height > 500 mm (19.4 in) (with all reflectors, the height depends on the AGV tilt)				
Reflector memory	Max. 40 layers each with 32 reflectors (at least 3 reflectors per layer).				
Visual indicators	4 x LEDs (green, red, yellow 1, yellow 2)				
Data interface	RS 232 serial, 19.2 kbaud, 8 data bits, even parity, 1 stop bit				
Electrical connections	1 x chassis-mount plug, 8-pin for 24 V DC power supply 1 x chassis-mount plug, 14-pin for RS 232 serial data interface				
Operating voltage	24 V DC ± 25 %				
Current consumption	1 A at 24 V DC				
Power consumption	Typical 12 W, max. 24 W				
Fuse	3.15 A, slow-blow				
Housing	Die-cast aluminium				
Protection class	Class 1				
Enclosure rating	IP 65 (to EN 60529)				
EMC tests	EN 61000-6-2, EN 61000-6-4				
Vibration / shock test	To IEC 68-2-6/IEC 68-2-29				
Weight	Approx. 3.3 kg (7.2 lb)				
Dimensions W x H x D (without plugs)	176 mm x 178 mm x 115 mm (6.83 in x 6.91 in x 4.47 in)				
Mounting provision	4 x M4 tapped holes, 10 mm (0.39 in) deep, in baseplate				
Operating/storage temperature	0 °C to 50 °C (+32 °F to +122 °F) / -20 °C to +70 °C (-4 °F to +158 °F)				
Max. relative humidity	5 % to 90 %, non-condensing				
Colour	SICK blue (RAL 5012)/black				
*) Positioning accuracy after minimum 30 minute run up, 6 reflectors, smoothing depth 4, requirements for the reflector arrangement in accordance with Section 3.3 Operating conditions taken into account.					

Tab. 9-1: NAV200 technical specifications

9.2 NAV200 dimensional drawing

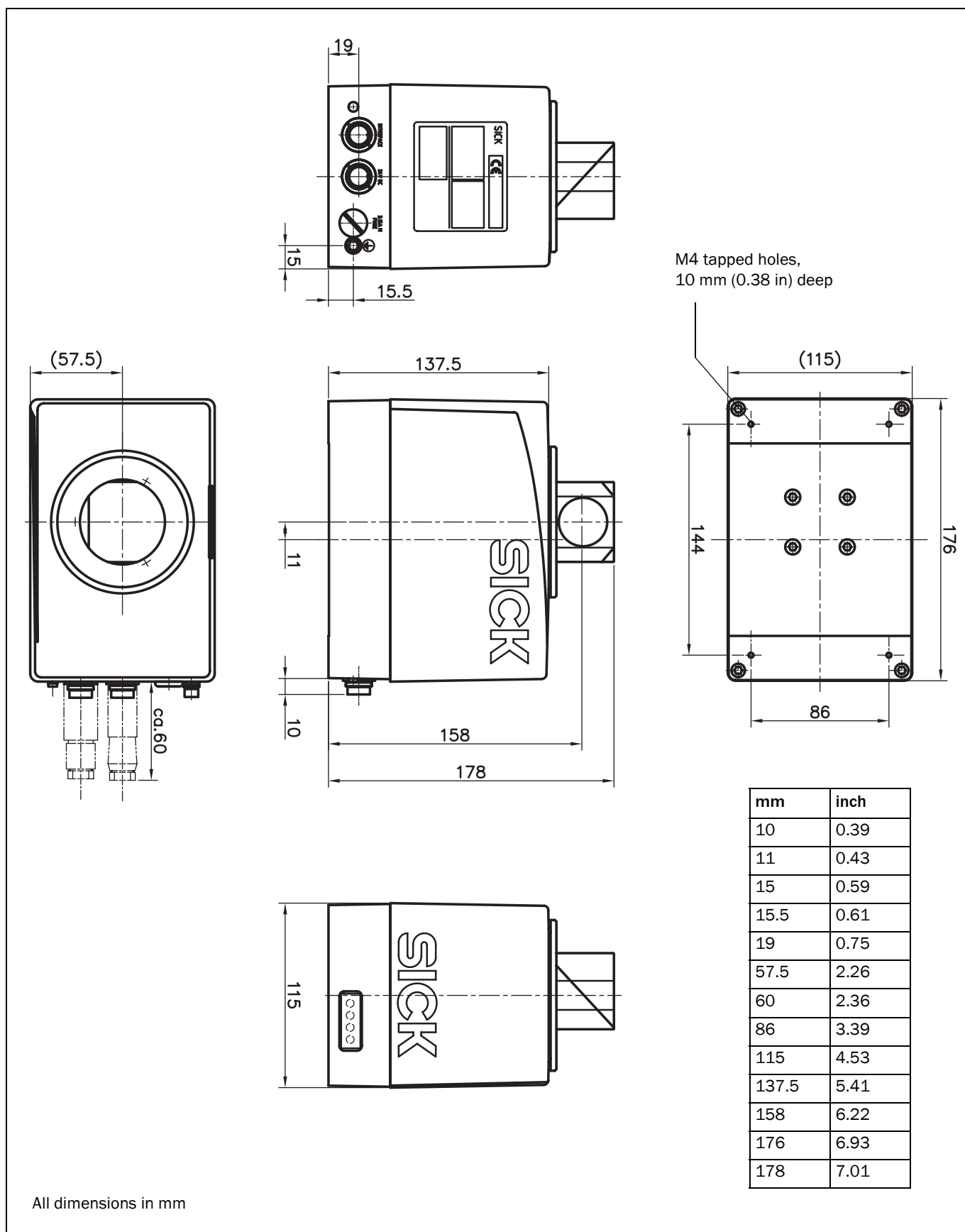


Fig. 9-1: Dimensional drawing of the NAV200

10 Appendix

10.1 Overview of the appendices

The appendix includes the following additional information:

- Available accessories
- Supplementary documentation
- Replacing a NAV200
- Reproduction of the EC Declaration of Conformity

10.2 Available accessories

10.2.1 Mounting accessories

Order No.	Description
2026277	Screw kit, consisting of 4 x hexagon socket (Allen) screws M4 x 10 mm (0.39 in) - A2 4 x washers 4.3 - A2 4 x spring lock washers B4

Tab. 10-1: Mounting accessories available

10.2.2 Accessories for reflectors

Order No.	Description
5304334	Diamond Grade 3000x reflective film, sheet 914 mm x 749 mm (35.5 in x 29.1 in)

Tab. 10-2: Accessories available for reflectors

10.2.3 Cables and connectors

Order No.	Description	Length	Connection
6024723	RS 232 data cable, Ø 5 mm (0.19 in), shielded, with 14-pin cable socket and 9-pin D-Sub socket	5 m (16.4 ft)	NAV200 to vehicle computer
2030334	As no. 6024723, but longer	6.5 m (21.3 ft)	
6024722	8-pin cable socket for power supply		to NAV200

Tab. 10-3: Available accessories Cables and connectors

NAV200

10.3 Supplementary documentation

Order No.	Title	Language	Contents
8009594	Telegrammlisting Positioniersystem NAV200	German	Description of the command strings for the functions of the NAV200, together with an overview of possible error messages
8009595	Telegram Listing NAV200 Positioning System	English	Description of the command strings for the functions of the NAV200, together with an overview of possible error messages

Tab. 10-4: Supplementary documentation for the NAV200

10.4 Replacing a NAV200

The procedure for replacing a NAV200 depends on whether the latest current configuration settings are stored in NAV200 Setup on the PC or not. The following three variants are conceivable:

- The configuration data is backed up on the PC
 - Replace and configure NAV200 as described in [Section 10.4.1](#) below.
- The configuration data is not backed up on the PC, but the latest current configuration can still be transferred from the NAV200 to NAV200 Setup on the PC using "Upload" mode.
 - After transferring the data from the NAV200 to the PC, replace and configure the NAV200 as described in [Section 10.4.1](#) below.
Make sure that the configuration data is not incorrect.
- The configuration data is not backed up on the PC and can no longer be transferred from the NAV200 to the PC.
 - Install the replacement device as described in [Section 10.4.1](#) below and set the parameters of the NAV200 again as described in [Section 6.6 Performing and testing the configuration, Page 63](#).

10.4.1 Replacing a NAV200 with backed-up configuration data

Mounting the replacement device

1. Switch off the power supply of the NAV200.
2. Unscrew the two cables at the NAV200.
3. Unscrew the fixing screws at the NAV200 and remove the device.
4. Install the replacement device in the reverse sequence and screw the two cables back on to the chassis-mount plugs.
5. Switch on the power supply of the NAV200 again.

Configuring the replacement device

1. Disconnect the NAV200 RS 232 data cable from the vehicle computer and connect it to the PC instead. This step is omitted if the vehicle computer is being used as a PC for the configuration at the same time.
2. Start NAV200 Setup configuration software on the PC and open the required configuration (project).
3. Establish communication with the NAV200 (communication parameters: data transmission rate 19.2 kbaud, stop bit 1, data bits 8, parity even).
4. Transfer the current configuration to the NAV200 ("Download" mode).
5. Close the NAV200 Setup configuration software
6. If necessary, disconnect the NAV200 RS 232 data cable from the PC and connect it to the vehicle computer again.

The replacement device is now ready for operation. Position measurement ("Positioning operation" mode) can be resumed.

10.5 Reproduction of the EC Declarations of Conformity

10.5.1 EC Declaration of Conformity for NAV200

[Fig. 10-1](#) shows a reduced-size reproduction of the EC Declaration of Conformity (Page 1).

- Full version of the EC Declaration of Conformity available on request.

SICK

EC Declaration of conformity

en

Ident-No. : 9092977

The undersigned, representing the following manufacturer

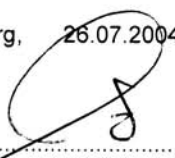
SICK IBEO GmbH
Fahrenkrön 125
22179 Hamburg
Deutschland

herewith declares that the product

NAV200-....

is in conformity with the provisions of the following EC directive(s) (including all applicable amendments), and that the standards and/or technical specifications referenced overleaf have been applied.

Hamburg, 26.07.2004


Joachim Leins
(Geschäftsführer SICK IBEO GmbH)

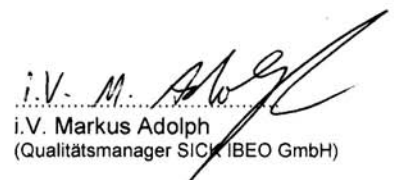

i.V. Markus Adolph
(Qualitätsmanager SICK IBEO GmbH)

Fig. 10-1: Reproduction of the EC Declaration of Conformity for NAV200 (Page 1, reduced)

Australia

Phone +61 3 9497 4100
1800 33 48 02 – tollfree
E-Mail sales@sick.com.au

Belgium/Luxembourg

Phone +32 (0)2 466 55 66
E-Mail info@sick.be

Brasil

Phone +55 11 5091-4900
E-Mail sac@sick.com.br

Ceská Republika

Phone +420 2 57 91 18 50
E-Mail sick@sick.cz

China

Phone +852-2763 6966
E-Mail ghk@sick.com.hk

Danmark

Phone +45 45 82 64 00
E-Mail sick@sick.dk

Deutschland

Phone +49 211 5301-270
E-Mail info@sick.de

España

Phone +34 93 480 31 00
E-Mail info@sick.es

France

Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Great Britain

Phone +44 (0)1727 831121
E-Mail info@sick.co.uk

India

Phone +91-22-2822 7084
E-Mail info@sick-india.com

Italia

Phone +39 02 27 43 41
E-Mail info@sick.it

Japan

Phone +81 (0)3 3358 1341
E-Mail support@sick.jp

Nederlands

Phone +31 (0)30 229 25 44
E-Mail info@sick.nl

Norge

Phone +47 67 81 50 00
E-Mail austefjord@sick.no

Österreich

Phone +43 (0)22 36 62 28 8-0
E-Mail office@sick.at

Polska

Phone +48 22 837 40 50
E-Mail info@sick.pl

Republic of Korea

Phone +82-2 786 6321/4
E-Mail kang@sickkorea.net

Republika Slovenija

Phone +386 (0)1-47 69 990
E-Mail office@sick.si

Russia

Phone +7 495 775 05 34
E-Mail denis.kesaev@sick-
automation.ru

Schweiz

Phone +41 41 619 29 39
E-Mail contact@sick.ch

Singapore

Phone +65 6744 3732
E-Mail admin@sicksgp.com.sg

Suomi

Phone +358-9-25 15 800
E-Mail sick@sick.fi

Sverige

Phone +46 10 110 10 00
E-Mail info@sick.se

Taiwan

Phone +886 2 2365-6292
E-Mail sickgrc@ms6.hinet.net

Türkiye

Phone +90 216 587 74 00
E-Mail info@sick.com.tr

USA/Canada/México

Phone +1(952) 941-6780
1 800-325-7425 – tollfree
E-Mail info@sickusa.com

More representatives and agencies
in all major industrial nations at
www.sick.com