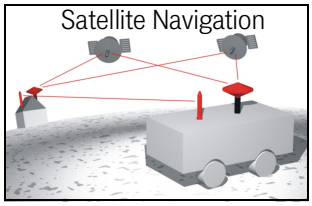
System Description HG S-57652ZD



GNSS Positioning System

HG S-57652ZD

Positioning of Cranes using RTK DGNSS with Control Unit HG G-61430YD

English, Revision 11	Date: 03.12.2019	Dev. by: LM	Author(s): RAD/LM

Innovation through Guidance

www.goetting-agv.com

Summary

Characteristics of the system HG S-57652ZD:

- RTG positioning/autosteering or container tracking with Global Navigation Satellite Systems (GNSS)
- State of the art RTK DGNSS
  - Position accuracy better ±2 cm with 20 Hz update rate
  - Heading accuracy ~ 0.1° with 2 m baseline and 20 Hz
- Up to 255 blocks for autosteering / container tracking
- User friendly and comfortable web interface via Ethernet
  - all web browsers supported
  - all operating systems
  - remote usage possible
- Interfaces to PLC/vehicle control
  - CAN interface
  - Ethernet
  - RS 232 interface (optional)
  - PROFINET interface (optional via extension module HG G-61432ZA)

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The Götting KG in D-31275 Lehrte has a certified quality management system according to ISO 9001.

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1 About this Document

The following symbols and formattings are used in Götting documentations:

Indicates technical information that should be followed when using the device.

ATTENTION!

Indicates dangers that may lead to damages or the destruction of the device.

BEWARE!

Indicates dangers that may lead to injuries or severe damage of property.

WARNING!

Indicates dangers that may lead to injuries, potentially with loss of life, or severe damage of property.

Tipp

Indicates information that makes handling of the device easier.

Indicates additional information in the internet, e.g. on our homepage www.goetting-agv.com. Those links are clickable in the PDF version of this documentation.

- Program texts and variables are indicated through the use of `a fixed width font`.
- Whenever the pressing of letter keys is required for program entries, the required [L]etter [K]eys are indicated as such (for most programs of Götting KG small and capital letters are equally valid).

2 Introduction

The purpose of the system described in this document is the position determination of moving machines, especially container cranes, with millimeter precision. Furthermore those machines can be automatically track guided with the system and the position of the load can be determined accurately.

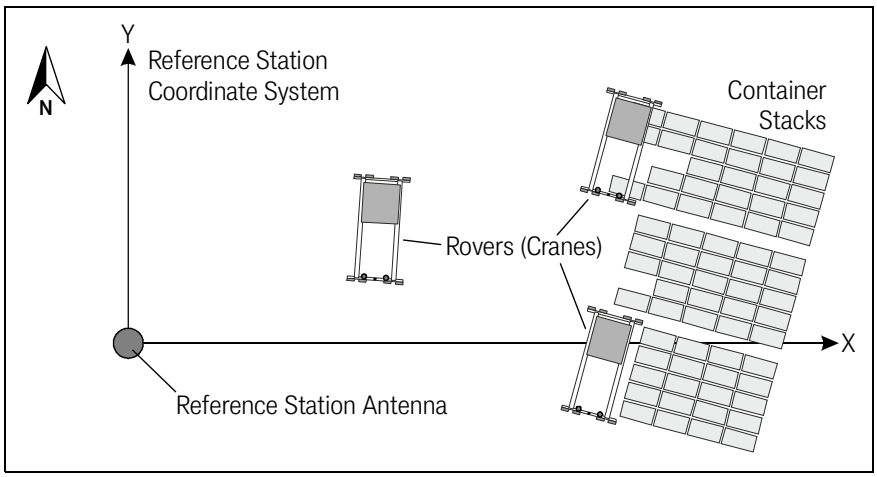
A latest generation GNSS receiver is used. Depending on its configuration the receiver can process all available satellite navigation systems. The position calculation works in real-time. With a second GNSS antenna the receiver can also determine the angle.

In addition to this 255 different straight virtual tracks (blocks) can be stored in the system by programming the start and end points of each track.

2.1 System Components

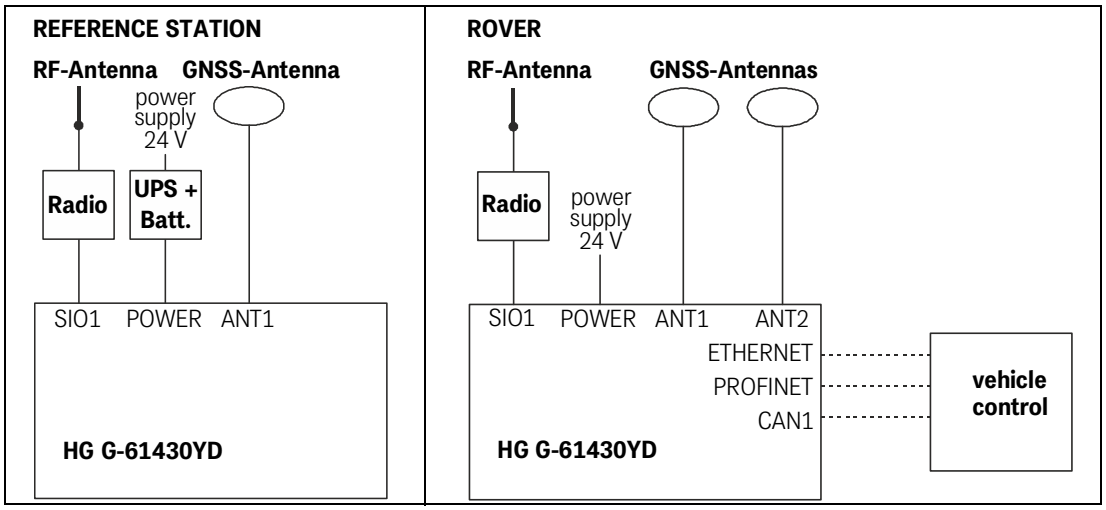
The system can either be used for a Reference Station or a Rover. There is only one Reference station per facility. It has a high precision GNSS receiver. Its GNSS antenna (e.g. placed on top of a building) is used as the zero point of a facility specific reference coordinate system.

Figure 1 *Reference Station and Rovers*



The GNSS system consists of several components. These components are partly project specific and differ between a reference station and a rover.

Figure 2 *System components: Reference Station and Rover*



For a more detailed component overview including the cabling see section 4.1 on page 18.

Table 1 *System Components*

Part	Version	Description
Control Unit HG G-61430	YD 001	GNSS Reference Station
	YD 002	GNSS Crane Positioning Rover
	YD 003	GNSS Crane Positioning Rover/Reference Station
HW ANT00044		GNSS Antenna
HW DEV00058		UPS Reference Station
HW DEV00059		UPS Battery Reference Station
HW DEV00101 *)		Radio Modem
HW ANT00007 *)		RF Antenna Reference Station
HW ANT00004 *)		RF Antenna Rover
*) Project specific, the components listed are used in most projects.		

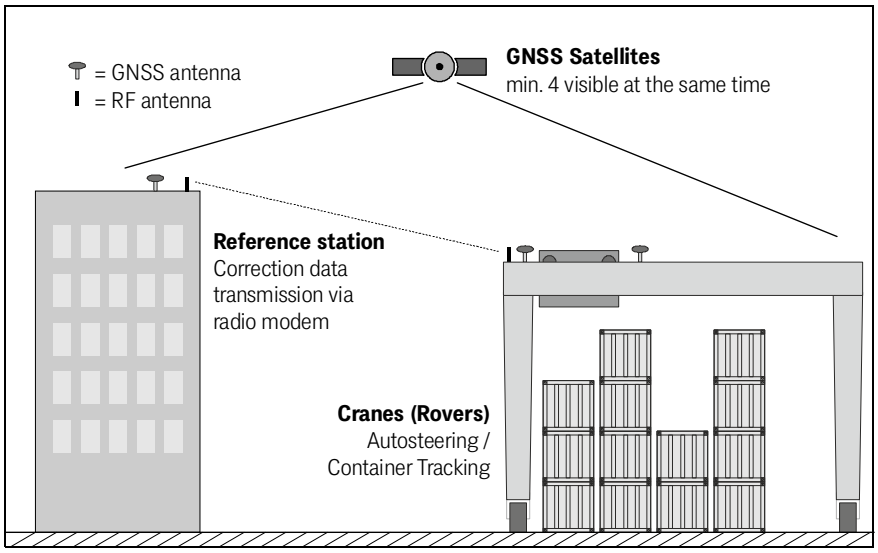
2.2 Employed Technologies

2.2.1 Standalone GNSS

With the, in general use, Global Navigation Satellite System (GNSS) it is possible to determine a geographical position. The commonly used standard GNSS provides an accuracy of approx. 10 m.

2.2.2 Differential GNSS (DGNSS)

Figure 3 *DGNSS structure*



The standard GNSS accuracy is not enough for the presented system. Therefore alongside the GNSS system fitted to the crane (mobile unit, Rover) a further stationary GNSS system (Reference Station) is set up. The position of the reference station can be exactly calculated. So it can compare its actual position with the current position given by the satellite signal and transmits the calculated error factor via a wireless data transceiver to the mobile units. These can then calculate their positions with an accuracy of up to ±1 m (differential GNSS; **DGNSS**).

2.2.2.1 Real Time Kinematic DGNSS

Through additional evaluation of the carrier phase of the satellite signal – the system needs up to approx. 60 seconds after initial start up for ruling out ambiguities – Real Time Kinematic (RTK) DGNSS receivers are capable of improving the accuracy of the output position to approx. ±2 cm (**RTK DGNSS**). Dual frequency GNSS receivers are able to use both positioning signals transmitted from the satellites, the initialization time thus is much less than for single frequency GNSS receivers.

The GNSS system seen over a long period of time offers a very stable service but can due to shadowing, or reflection become temporarily unavailable.

2.2.3 Preconditions for Operation

It is essential to pay attention to the fact that obstacles, that are higher than the horizon of the GNSS antennas, may generally have a bad influence on the satellite reception. As a result of these shadings and/or reflections, the accuracy of the GNSS may decrease. Even a total breakdown of the GNSS might be possible. Therefore it is advisable, to include the Götting KG already in the project planning phase.

2.3 System Function

2.3.1 Container Tracking

The temporary storage of containers by use of visual means with manual confirmation leads to an error rate in the storage handling which disrupts the efficient turn over time of the container ships so that therefore it is better to use GNSS to control the positioning and documentation of containers within the container port environment.

It has been possible for years for Rubber Tired Gantry Cranes (RTG), working on container transport within a seaport, to communicate with the controlling container management system, via a data Radio Transceiver, when it picks up or sets down a container at a predesignated position within the container yard. This takes some of the load off of the driver as well as reduce the error rate, which a complicated and time exhaustive container search entails.

2.3.2 RTG Autosteering

Due to the achievable positional determination of approx. ±2 cm, it is possible to track a vehicle‘s movements. Consequently by using a series of measurements together with the geographical positional data it is possible to determine the vehicle‘s direction and its velocity.

With the help of these functions it is possible to automatically steer a RTG over a predetermined route within a container yard. This means that apart from the free movability that rubber tired vehicles provide, they can also be used like rail mounted vehicles. That means they can be used within the container storage area without disrupting the driver‘s attentiveness, with unnecessary requirement to control the tracking and manually steer the crane. A special advantage of this system is that for both functions there is no need to mount equipment within the track surface of the container yard.

All these points serve to improve the operational safety and therefore remove some of the pressure placed on the driver, which in turn reduces the failure rate. A looped memory stores all relevant information so that in the event of a disruption with the system‘s function or during testing, a quick and easy error diagnoses is available. For special or emergency uses all these functions are manually operable so that a complete operational shut down can be avoided.

3 Control Unit HG G-61430YD

The device described in this chapter is the basic hardware component of two different systems. The name of the superordinate system depends on the operating software (firmware) inside the device. Also the device may come equipped with different interfaces and connectors for different system configurations.

3.1 Device Variants

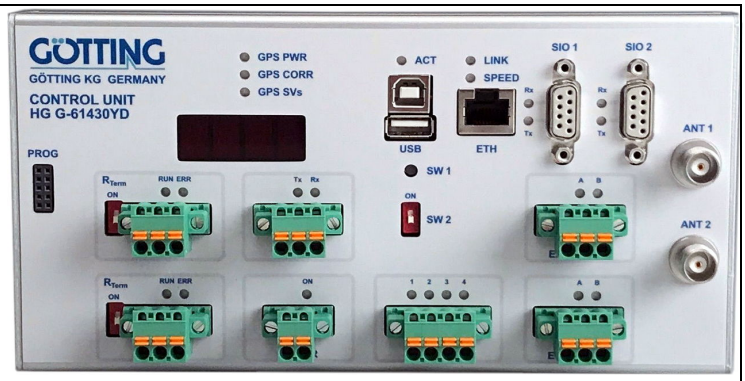
Thus the device is available in different versions.

Table 2 *Versions of the Control Unit HG G-61430YD*

System / Firmware	Device No.: HG G-61430		
	YD 001	YD 002	YD 003
HG S-57652 (this system)	GNSS Reference Station	GNSS Crane Positioning Rover	GNSS Crane Positioning Rover/Reference Station

The control unit is available in a basic configuration and in a version with a module that enables the connection of additional bus types (s. section 3.7 on page 17).

Figure 4 *Photo of the Control Unit: Basic configuration with GNSS and version including the field bus/Profinet extension module HG G-61432ZA*

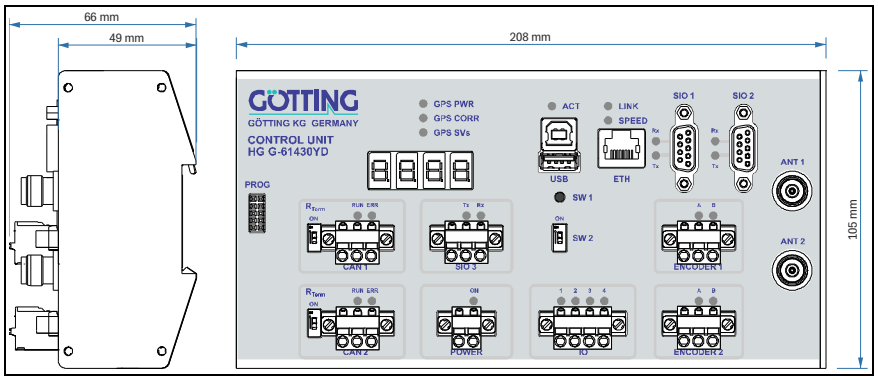


Basic configuration HG G-61430YD with integrated GNSS

With extension module HG G-61432ZA for Profinet (field bus)

3.2 Mounting

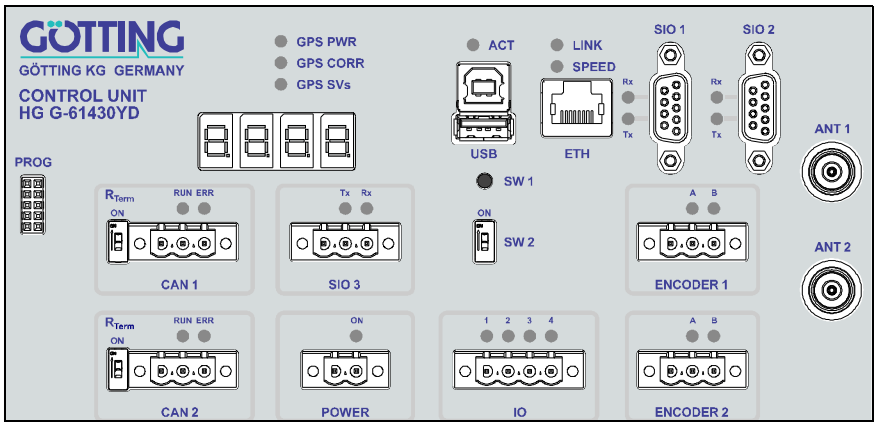
Figure 5 *Dimensions of the control unit Hardware HG G-61430YD*



The device is designed to be mounted on a 35 mm top hat rail according to EN50022. The mounting place has to be protected against humidity. Often a control cabinet is available for other components of the vehicle control.

3.3 Front Panel

Figure 6 *Control Unit: LEDs and connectors*



3.4 Control Elements on the Front Panel

Table 3 *Control elements of the control unit (part 1 of 2)*

Element	Position	Meaning
SW 1	Press button > 1 s	Stop data recording and eject the USB stick. As soon as the LED ACT stops blinking the stick may be safely detached.
	Press button > 10 s	Format USB stick **(Attention: erases all data on the stick without extra confirmation)**
SW 2	ON	Firmware Update via USB interface, see appendix section 12.2 on page 74
	OFF	Normal operation of the control unit

Table 3 *Control elements of the control unit (part 2 of 2)*

Element	Position	Meaning
R_{Term} CAN 1	ON	120 Ohm terminating resistor for CAN 1 activated
	OFF	No internal terminating resistor for CAN 1
R_{Term} CAN 2	ON	120 Ohm terminating resistor for CAN 2 activated
	OFF	No internal terminating resistor for CAN 2

3.5 Display Elements on the Front Panel

Table 4 *Display elements*

LED	Meaning when LED is lit/flashing
Display	7 segment display with 4 characters
POWER/ON	Power supply
ETH/LINK	Active data transmission via the ethernet interface
ETH/SPEED	– ON –> Ethernet transmission rate 100 Mbit/s – OFF –> Ethernet transmission rate 10 Mbit/s
USB/ACT	Data logging active
GPS PWR	Power Supply GNSS receiver ok
GPS CORR	Reception of GNSS correction data
GPS SVs	Reception of GNSS satellites
SIO 1/Rx	SIO 1 receiving data
SIO 1/Tx	SIO 1 transmitting data
SIO 2/Rx	SIO 2 receiving data
SIO 2/Tx	SIO 2 transmitting data
SIO 3/Tx	SIO 3 receiving data
SIO 3/Rx	SIO 3 transmitting data
CAN 1/RUN	CAN Bus 1 OK
CAN 1/ERR	CAN Bus 1 Error
CAN 2/RUN	CAN Bus 2 OK
CAN 2/ERR	CAN Bus 2 Error
ENCODER 1/A	Incremental encoder 1 / Channel A
ENCODER 1/B	Incremental encoder 1 / Channel B
ENCODER 2/A	Incremental encoder 2 / Channel A
ENCODER 2/B	Incremental encoder 2 / Channel B
IO/1	Input/Output 1 signal > programmed threshold
IO/2	Input/Output 2 signal > programmed threshold
IO/3	Input/Output 3 signal > programmed threshold
IO/4	Input/Output 4 signal > programmed threshold

3.6 Connectors

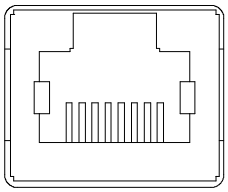
3.6.1 ETH

Figure 7 *Sketch of connector ETH*

Function: Communication with higher-level control and/or PC

Interface: Ethernet

Plug type: RJ-45



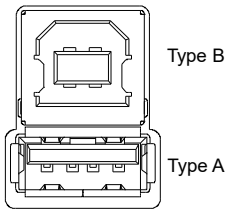
3.6.2 USB

Figure 8 *Sketch USB connectors Type A and Type B*

Function: Data logging on USB stick (Type A) or firmware update (Type B, see section 12.2 on page 74 in the appendix)

Interface: USB 1.1

Plug type: USB Type A and B (alternatively)



3.6.3 SIO 1 (GNSS Receiver)

Figure 9 *Sketch of connector SIO 1*

Function: Communication with internal GNSS receiver (optional)

Interface: RS 232 + voltage supply for external radio modem

Plug type: Sub-D 9 pins (DE9) female

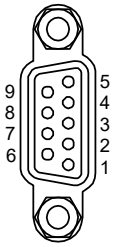


Table 5 *Pin assignment SIO 1*

Pin	Function	Direction
1		
2	TxD	O
3	RxD	I
4		
5	GND	O
6	+Ub (12-24 V)	O
7		
8		
9		

3.6.4 SIO 2

Figure 10 *Sketch of connector SIO 2*

Function: Configuration of Ethernet Interface, see section C on page 146 in the appendix

Interface: RS 232

Plug type: Sub-D 9 pin (DE9) female

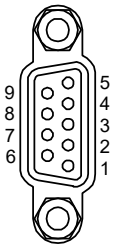


Table 6 *Pin assignment SIO 2*

Pin	Function	Direction
1		
2	TxD	O
3	RxD	I
4		
5	GND	
6		
7		
8		
9		

3.6.5 CAN 1

Figure 11 *Sketch of connector CAN 1*

Function: CAN Bus 1

Interface: CAN Spec. V2.0 part B

Plug type: Phoenix-Contact FKCT 2,5/3-STF-5,08

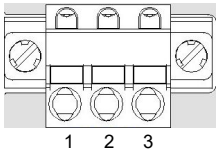


Table 7 *Pin assignment SIO 2*

Pin	Function	Direction
1	GND	
2	CAN High	I/O
3	CAN Low	I/O

3.6.6 CAN 2

Figure 12 *Sketch of connector CAN 2*

Function: CAN Bus 2

Interface: CAN Spez. V2.0 Teil B

Plug type: Phoenix-Contact FKCT 2,5/3-STF-5,08

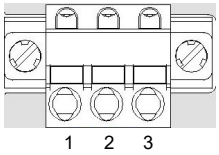
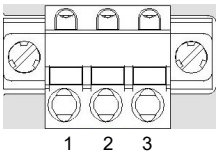


Table 8 *Pin assignment SIO 2*

Pin	Function	Direction
1	GND	
2	CAN High	I/O
3	CAN Low	I/O

3.6.7 SIO 3

Figure 13 *Sketch of connector SIO 3*



Function: Not used

Interface: RS 232

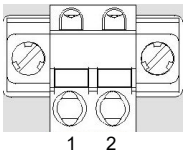
Plug type: Phoenix-Contact FKCT 2,5/3-STF-5,08

Table 9 *Pin assignment SIO 2*

Pin	Function	Direction
1	GND	
2	TxD	O
3	RxD	I

3.6.8 POWER

Figure 14 *Sketch of connector POWER*



Function: Energieversorgung 12 – 24 V

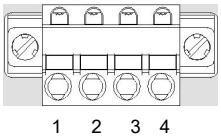
Plug type: Phoenix-Contact FKCT 2,5/2-STF-5,08

Table 10 *Pin assignment SIO 2*

Pin	Function	Direction
1	GND	
2	+Ub (12 – 24 V)	I

3.6.9 IO

Figure 15 *Sketch of connector IO*



Function: Connection of transponder antennas and emergency stop

Interface: Configurable, default three inputs (switching threshold 0 - 24 V) and one output 0 to +Ub

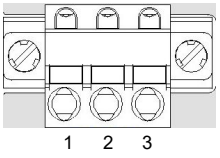
Plug type: Phoenix-Contact FKCT 2,5/4-STF-5,08

Table 11 *Pin assignment SIO 2*

Pin	Direction	Function
1	Input	Transp.-Ant.
2	Input	Transp.-Ant.
3	Input	Transp.-Ant.
4	Output	Emergency Stop

3.6.10 ENCODER 1 / ENCODER 2

Figure 16 *Sketch of connectors ENCODER 1 / ENCODER 2*



Function: Connection of incremental encoders

Interface: Switching threshold 5 - 24 Volt (configurable)

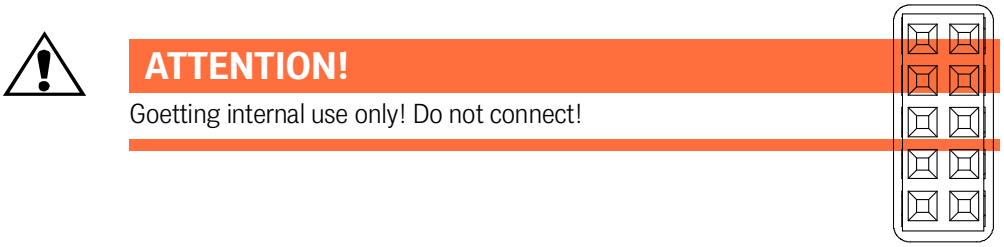
Plug type: Phoenix-Contact FKCT 2,5/3-STF-5,08

Table 12 *Pin assignment ENCODER 1 / ENCODER 2*

Pin	Function	Direction
1	GND	
2	Channel A	I
3	Channel B	I

3.6.11 PROG

Figure 17 *Sketch of connector PROG*



ATTENTION!

Goetting internal use only! Do not connect!

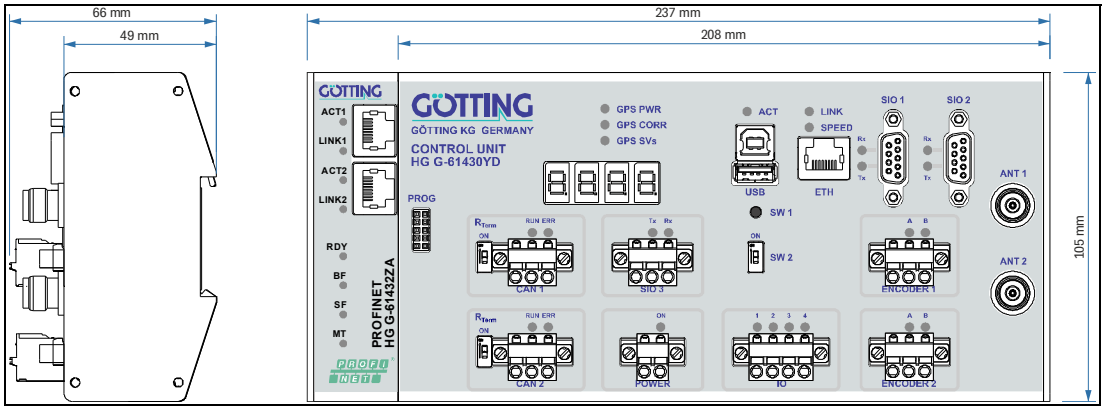
3.6.12 ANT1 / ANT2

2 X TNC plugs for the connection of GNSS antennas (s. Figure 4 on page 11)

3.7 Extension Module Field Bus

The control unit can be ordered with the extension module HG G-61432ZA, which adds a Profinet interface.

Figure 18 *Dimensions control unit incl. field bus expansion module HG G-61432ZA*



4 Mounting / Cabling

ATTENTION!

All cables and devices need to be installed carefully! Make sure that they are not damaged during the mounting process. Observe the bending radii of the cables, see section 11.4 on page 71.

4.1 System Components / Cabling

4.1.1 Reference Station

Figure 19 *Components and cabling Reference Station*

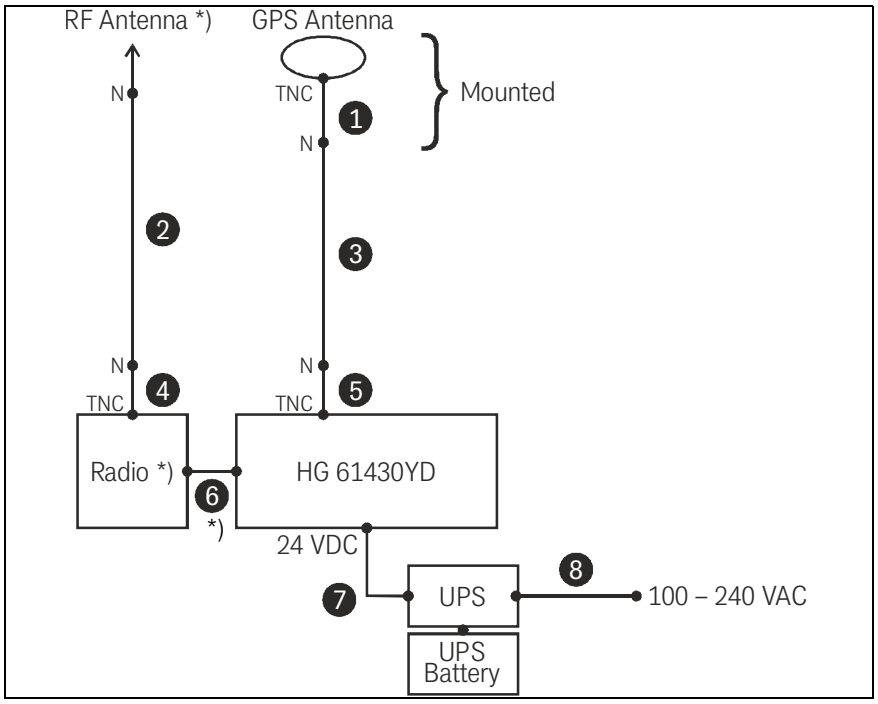


Table 13 *Components Reference Station (part 1 of 2)*

Component	Order No.	Description
Cable 1	HW CAB00042	RG58, 0.5 m, attached to the GNSS antenna and sealed with heat shrink, TNC connector (male) straight / N socket (female) straight
Cable 2	HW CAB00079	ECOFLEX10, project specific length, N connector (male) straight / N connector (male) straight
Cable 3		
Cable 4	HW CAB00042	RG58, 2 m, TNC connector (male) straight / N socket (female) straight
Cable 5		
Cable 6 *)	HW CAB00135	Project specific interface cable supplied by Götting

Table 13 *Components Reference Station (part 2 of 2)*

Component	Order No.	Description
Cable 7		1x Cable for 24 V power supply between UPS and Control Unit, not within scope of supply
Cable 8		1x Power Cable, not within scope of supply
Control Unit	HG G-61430YD	See chapter 3 on page 11
GNSS Antenna	HW ANT00044	1x, see section 4.6 on page 23
UPS	HW DEV00058	See section 4.5 on page 23
UPS Battery	HW DEV00059	
Radio *)	HW DEV00101	See section 4.4 on page 22
RF Antenna *)	HW ANT00007	See section 4.6 on page 23
*) Project specific, the components listed are used in most projects.		

4.1.2 Rover

Figure 20 *Components and cabling Rover*

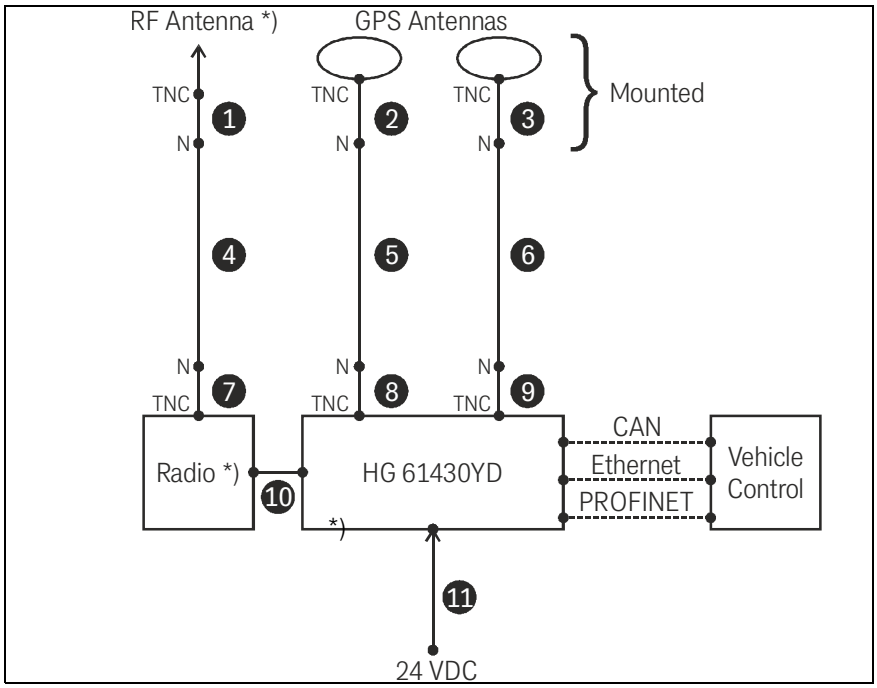


Table 14 *Components Rover (part 1 of 2)*

Component	Order No.	Description
Cable 1	HW CAB00055	RG58, 2 m, TNC assembly socket (female) straight / N socket (female) straight
Cable 2	HW CAB00042	RG58, 0.5 m, attached to the GNSS antenna and sealed with heat shrink, TNC connector (male) straight / N socket (female) straight
Cable 3		
Cable 4	HW CAB00079	ECOFLEX10, project specific length, N connector (male) straight / N connector (male) straight
Cable 5		
Cable 6		

Table 14 *Components Rover (part 2 of 2)*

Component	Order No.	Description
Cable 7	HW CAB00042	RG58, 2 m, TNC connector (male) straight / N socket (female) straight
Cable 8		
Cable 9		
Cable 10 *)	HW CAB00135	Project specific interface cable supplied by Götting
Cable 11		1x Power Cable not within scope of supply
Control Unit	HG G-61430YD	See chapter 3 on page 11
GNSS Antenna	HW ANT00044	2x, see section 4.6 on page 23
Radio *)	HW DEV00101	See section 4.4 on page 22
RF Antenna *)	HW ANT00004	See section 4.6 on page 23
*) Project specific, the components listed are used in most projects.		

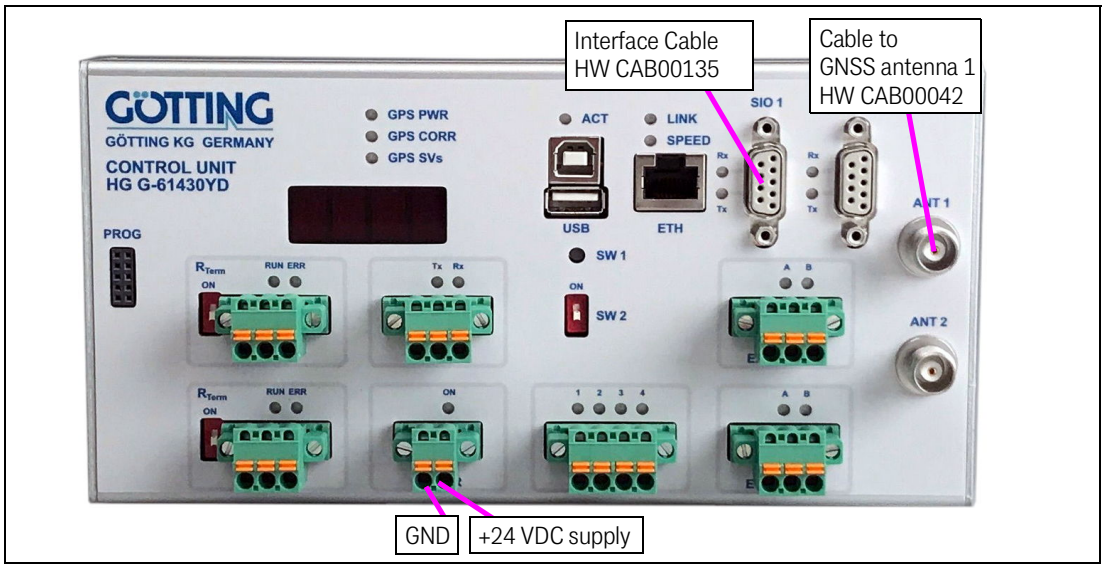
4.2 Mounting Control Unit

The control unit may be mounted onto a 35 mm top hat rail according to EN50022, see section 3.2 on page 12.

4.3 Connections to the Control Unit

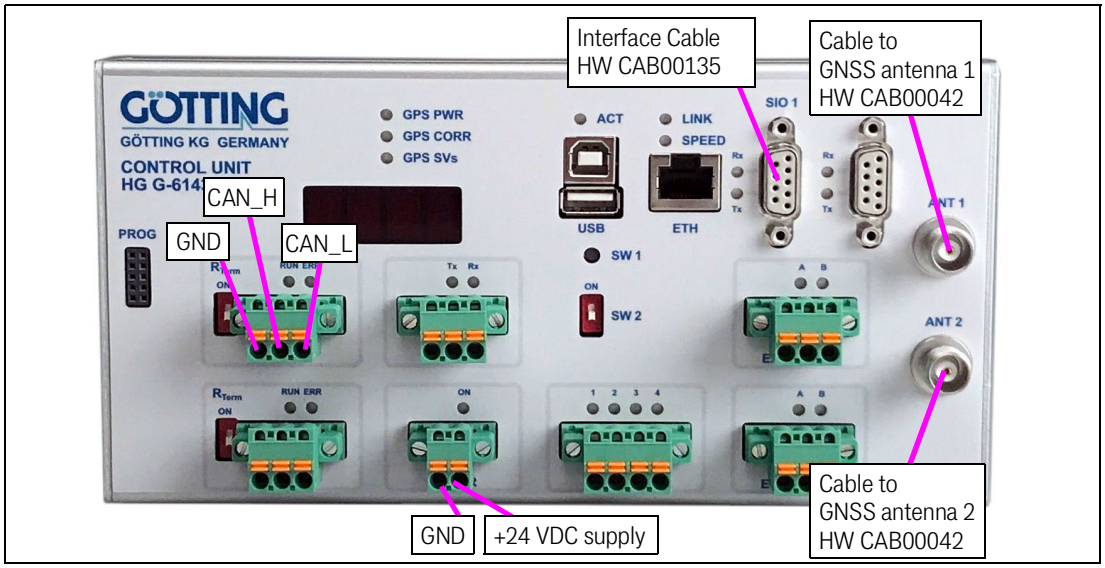
4.3.1 Reference Station

Figure 21 *Connections to the Control Unit (Reference Station)*



4.3.2 Rover

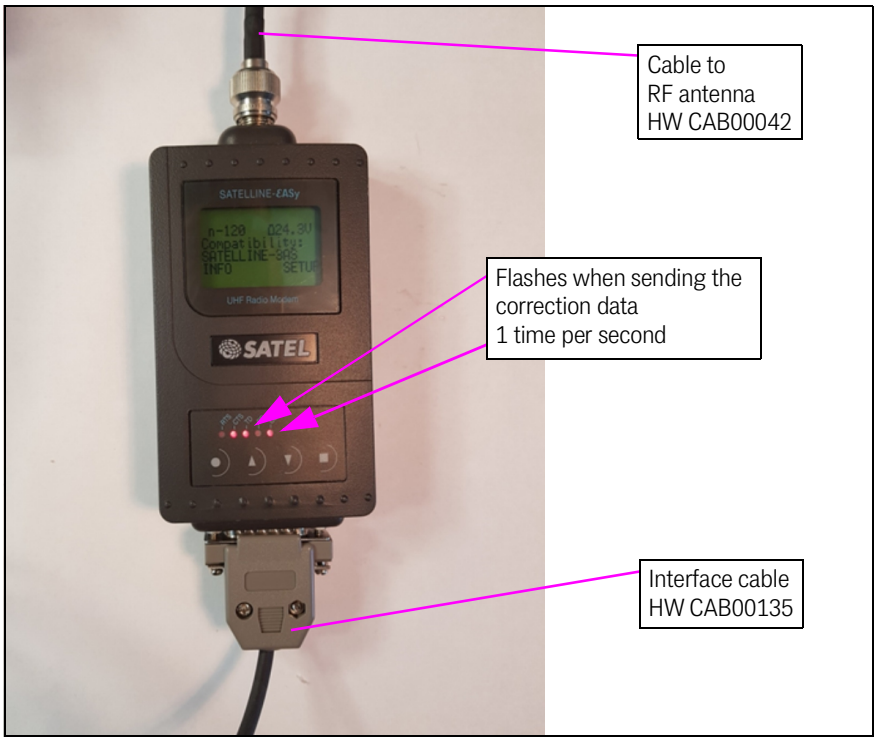
Figure 22 *Connections to the Control Unit (Rover)*



4.4 Connections to SATEL Radio Modem HW DEV00101

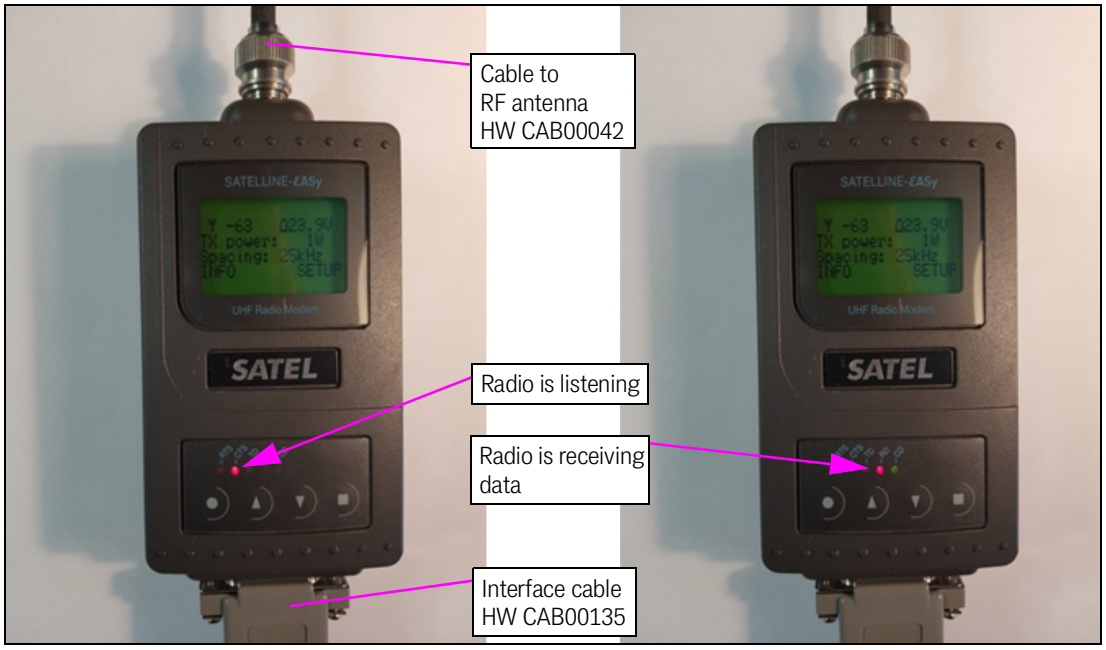
4.4.1 Reference Station

Figure 23 *Connections to SATEL radio modem (reference station)*



4.4.2 Rover

Figure 24 *Connections to SATEL radio modem (Rover)*



4.5 Connections to UPS and Battery (Reference Station only)

Figure 25 *Connections to UPS HW DEV00058 (Reference Station)*

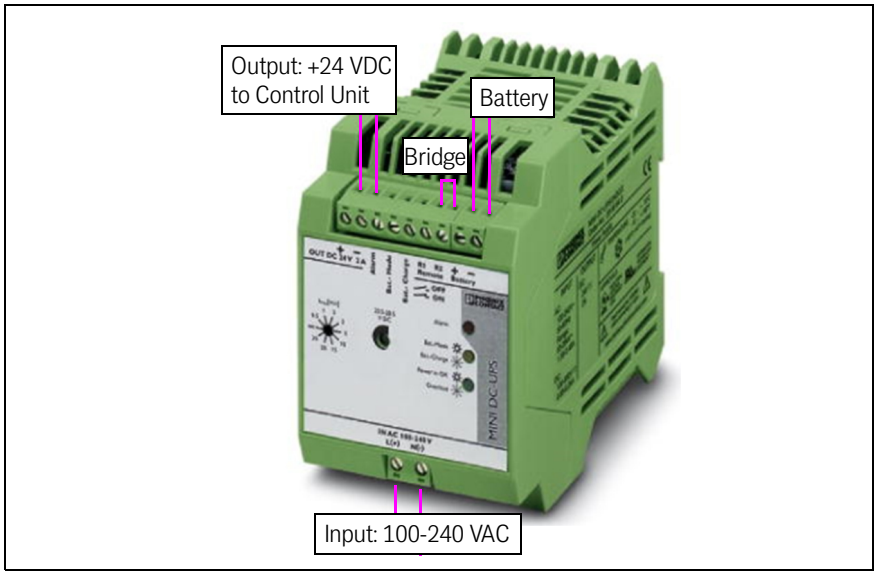
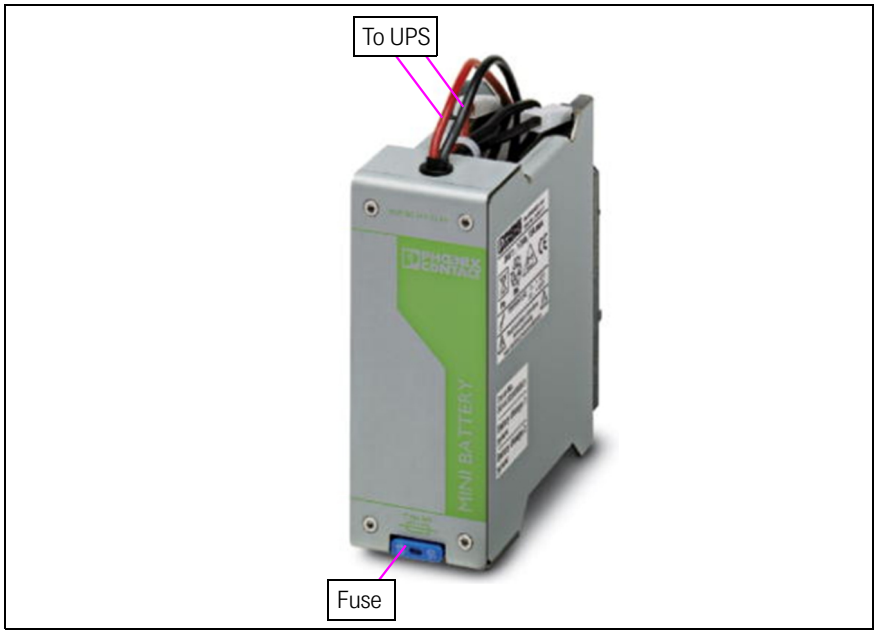


Figure 26 *Connections to Battery HW DEV00059 (Reference Station)*



4.6 Antennas

- The GNSS antennas should
  - be installed on top of the RTG
  - be mounted at the highest point of the crane, above all obstacles
  - be separated as far apart as possible, minimum 2 m

- The RF antenna
  - should be fixed at the highest possible point on the RTG

- should not tower above the GNSS antennas
- requires a free line-of-sight in all directions

Figure 27 *Mounting places for the antennas (example)*

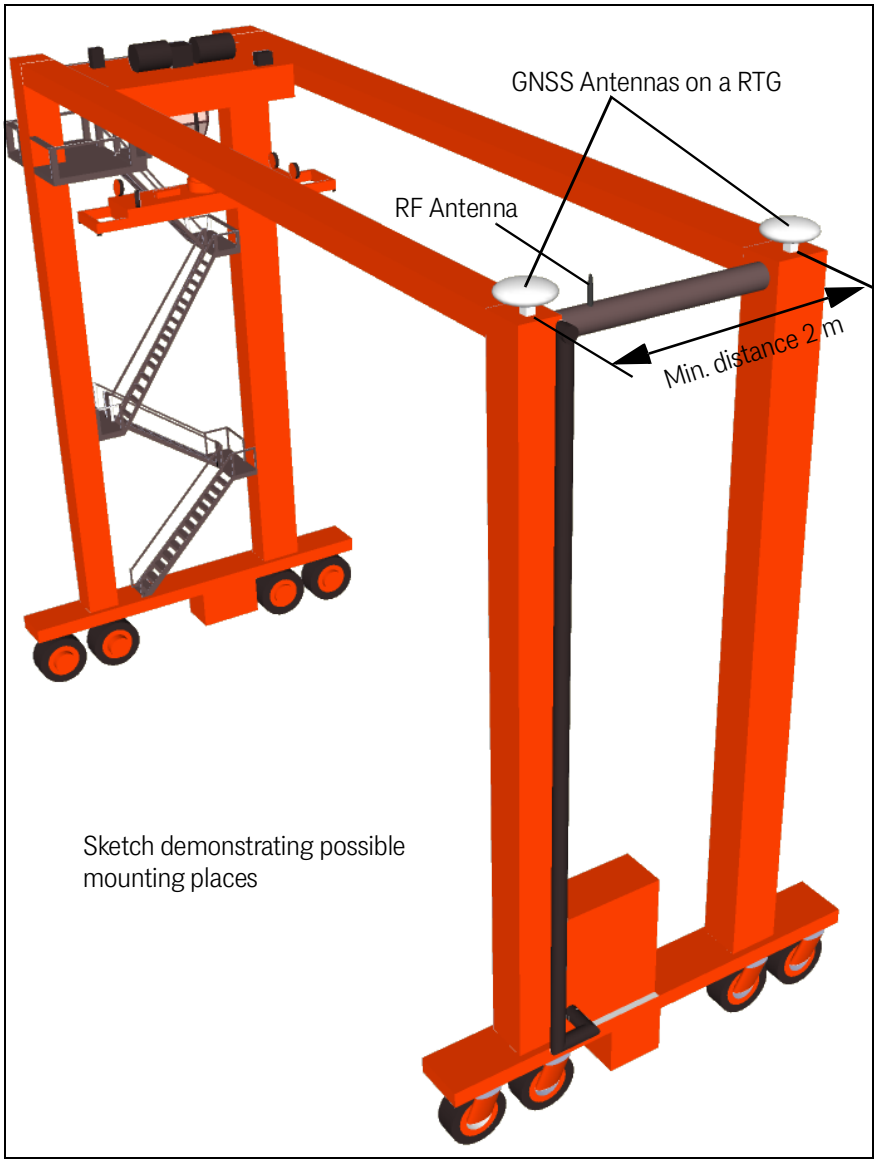


Figure 28 *Dimensions of the GNSS antenna HW ANT00044*

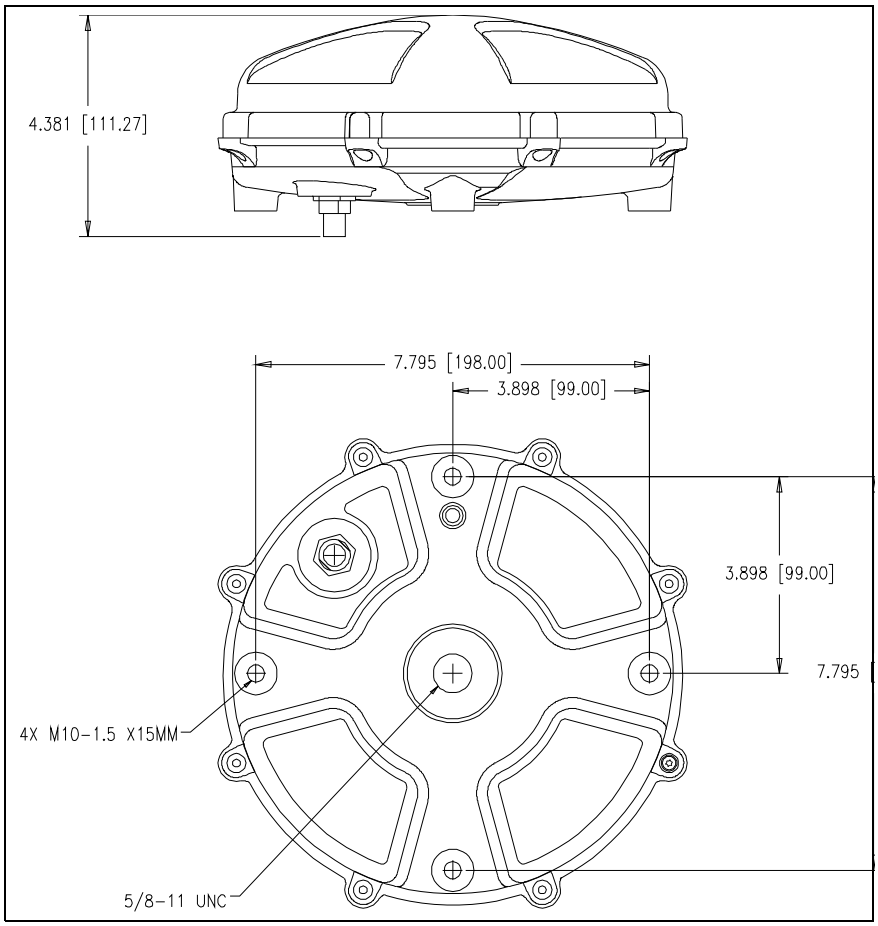
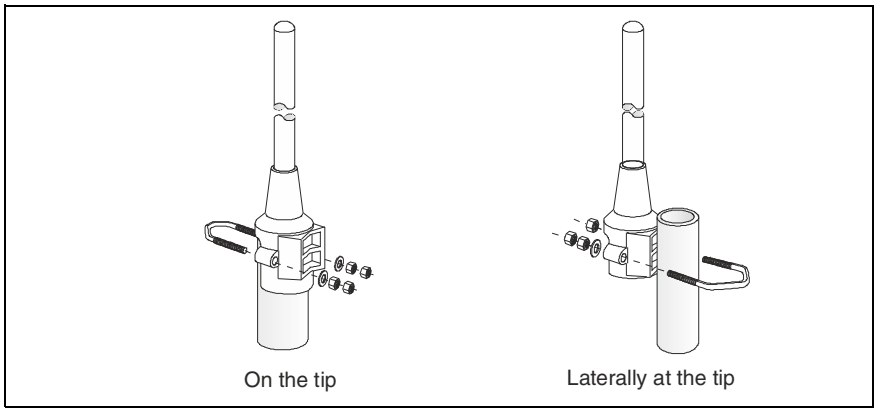


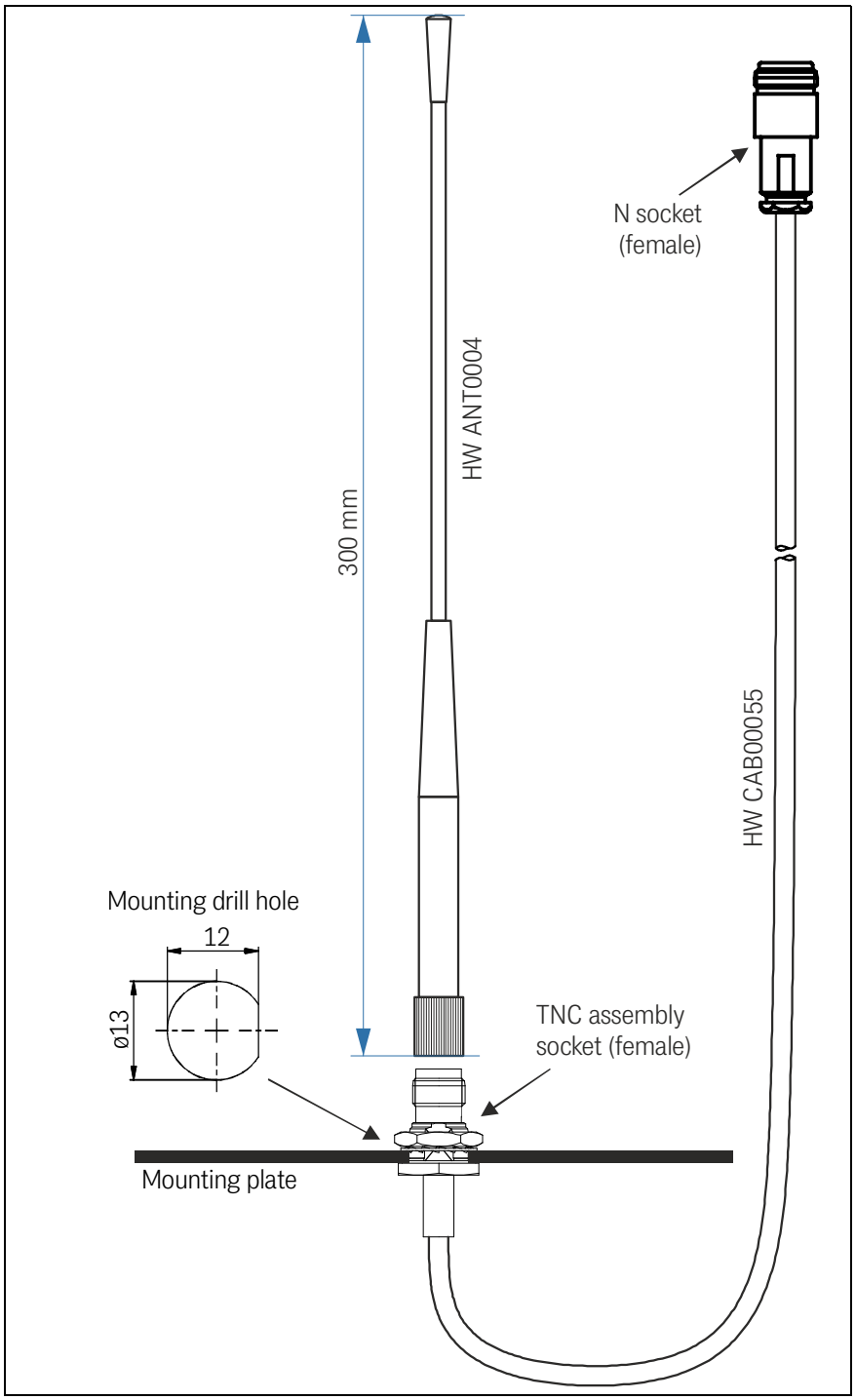
Figure 29 *Reference Station: Mounting RF antenna HW ANT00007*



The antenna can be attached in two ways with the supplied mounting kit:

1. On the tip of a tubular mast of 40 – 54 mm diameter (connecting cable runs inside the mast).
2. Laterally at the tip of a tubular mast of 20 – 54 mm diameter (connecting cable runs outside the mast).

Figure 30 *Rover: Mounting RF antenna HW ANT00004*



5 Software / Configuration

ATTENTION!

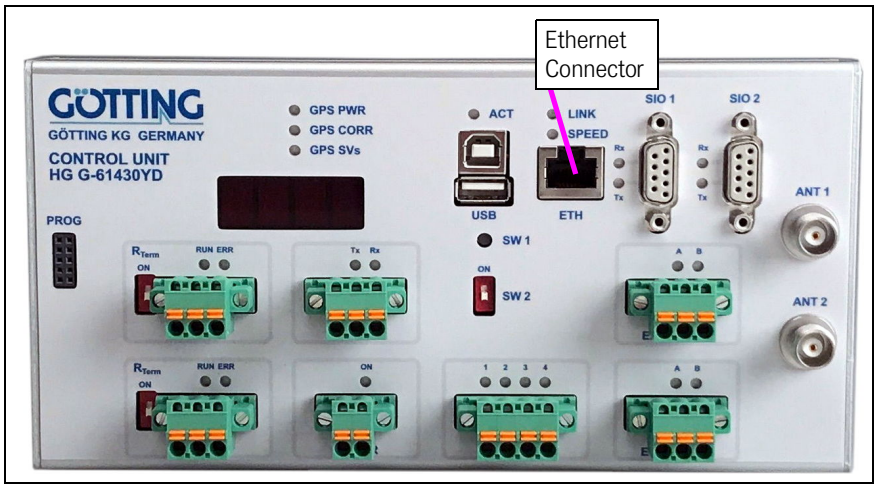
Only especially trained personnel should alter system settings since wrong values can lead to **restricted system functionality** or even **system failure**!

For each project a specific set of configuration files is assembled by Götting. These files are made available to the customer e.g. via E-Mail or on a memory stick. Several of these files are used throughout the following configuration.

5.1 Configuration of the Control Unit

A HTTP server runs in the Control Unit and it can be addressed from outside. You can use an internet browser on the PC to do so. A browser that is as up to date as possible should be used, for example Google® Chrome®, Opera®, Firefox® or Microsoft® Edge® or Internet Explorer® 10 or higher.

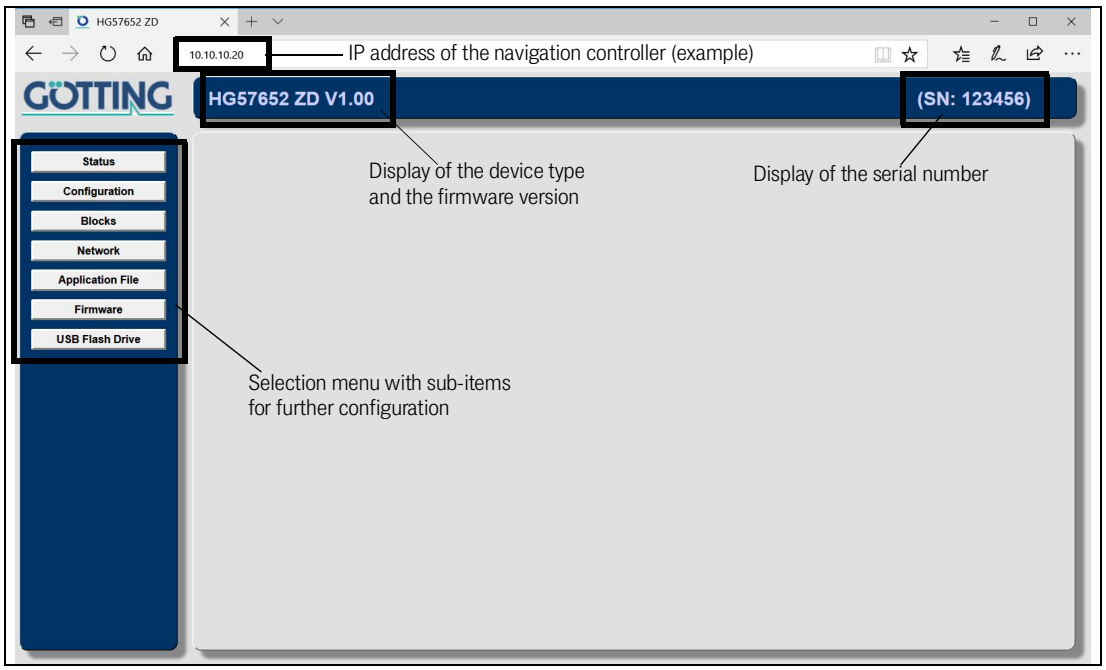
Figure 31 *Ethernet connection Control Unit*



To configure the control unit, you can connect a standard PC/laptop to the device via the Ethernet interface ETH. Make sure that the devices have compatible network settings (for example PC IP: 10.10.10.1, control unit IP: 10.10.10.20, both subnet masks 255.255.255.0). Once the PC and control unit are connected via the network cable, start the browser on the PC and enter the IP of the control unit in the address line, in the example `10.10.10.20` (this is also the default address in the navigation controller). The main menu of the control unit opens.

5.1.1 Start Screen

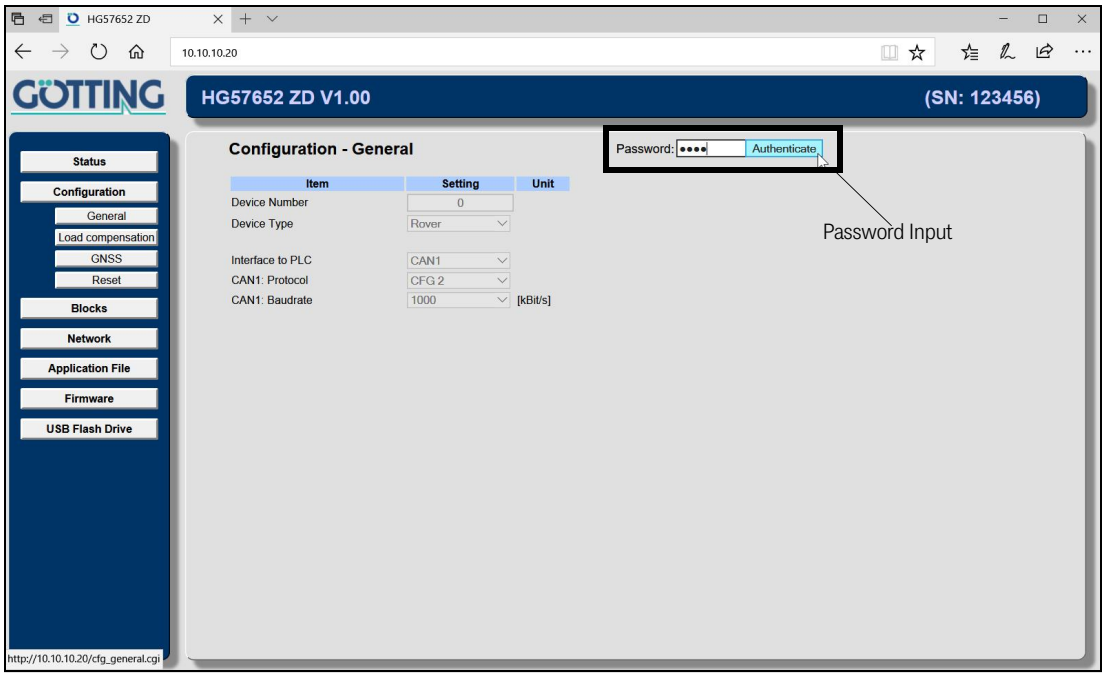
Figure 32 *Screenshot: Start screen*



5.1.2 Login / Password Input

Changing, saving or uploading a configuration as well as uploading of a block table is password protected. The password is **3141**. Viewing a configuration or block table as well as downloading them is possible without entering the password.

Figure 33 *Screenshot: Password input / Authentication*



5.1.3 Status

5.1.3.1 Status – Main

Figure 34 *Screenshot: Status – Main*

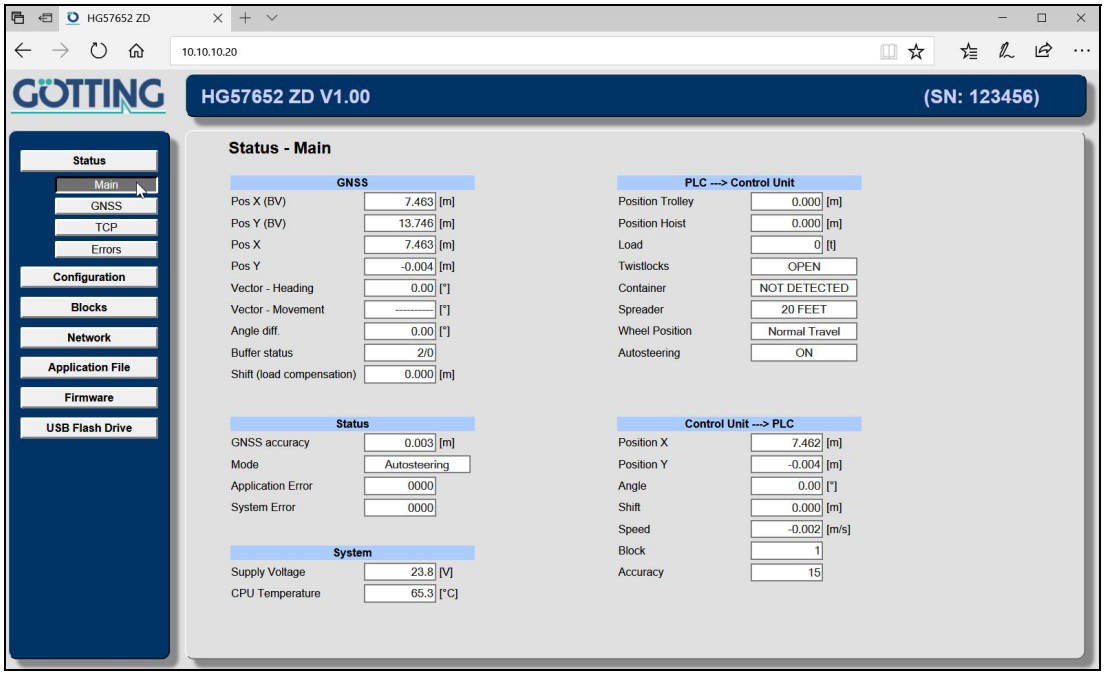


Table 15 *Status – Main: GNSS*

GNSS	
Item	**Function**
Pos X (BV)	X coordinate from the GNSS in the reference coordinate system
Pos Y (BV)	Y coordinate from the GNSS in the reference coordinate system
Pos X	X coordinate from the GNSS in the vehicle coordinate system
Pos Y	Y coordinate from the GNSS in the vehicle coordinate system
Vector-Heading	Vehicle angle from the vector formed by the two GNSS antennas
Vector-Movement	Vehicle angle calculated from the moving direction of the primary GNSS antenna
Angle diff.	Averaged difference between: Vector-Heading and Vector-Movement
Buffer status	Internal Counter
Shift (load compensation)	Lateral deviation due to movement of the trolley resp. the load

Table 16 *Status – Main: Status*

Status	
Item	**Function**
GNSS Accuracy	Accuracy of the GNSS
Mode	Init / Tracking / High Precision
Application Error	<– (see Table 23 on page 34)
System Error	<– (see Table 22 on page 33)

Table 17 *Status – Main: System*

System	
Item	**Function**
Supply Voltage	Measured supply voltage
CPU Temperature	Measured CPU internal temperature

Table 18 *Status – Main: PLC —> Control Unit*

PLC —> Control Unit	
Item	**Function**
Position Trolley	Trolley position
Load	Weight of the container
Twistlocks	Open / Closed
Container	Detected / Not Detected
Spreader	20 Feet / 40 Feet / 45 Feet
Wheel Position	Normal / Cross Travel / Spin Turn
Autosteering	State of autosteering, active = ON, inactive = OFF

Table 19 *Status – Main: Control Unit —> PLC*

Control Unit —> PLC	
Item	**Function**
Position X	X coordinate in block coordinate system
Position Y	Y coordinate in block coordinate system
Angle	Vehicle angle in block coordinate system
Shift	Lateral deviation due to movement of the trolley resp. the load
Speed	Gantry speed
Block	Current block number / 0 = no block found
Accuracy	See Table 40 on page 64

5.1.3.2 Status – GNSS

Figure 35 *Screenshot: Status – GNSS*

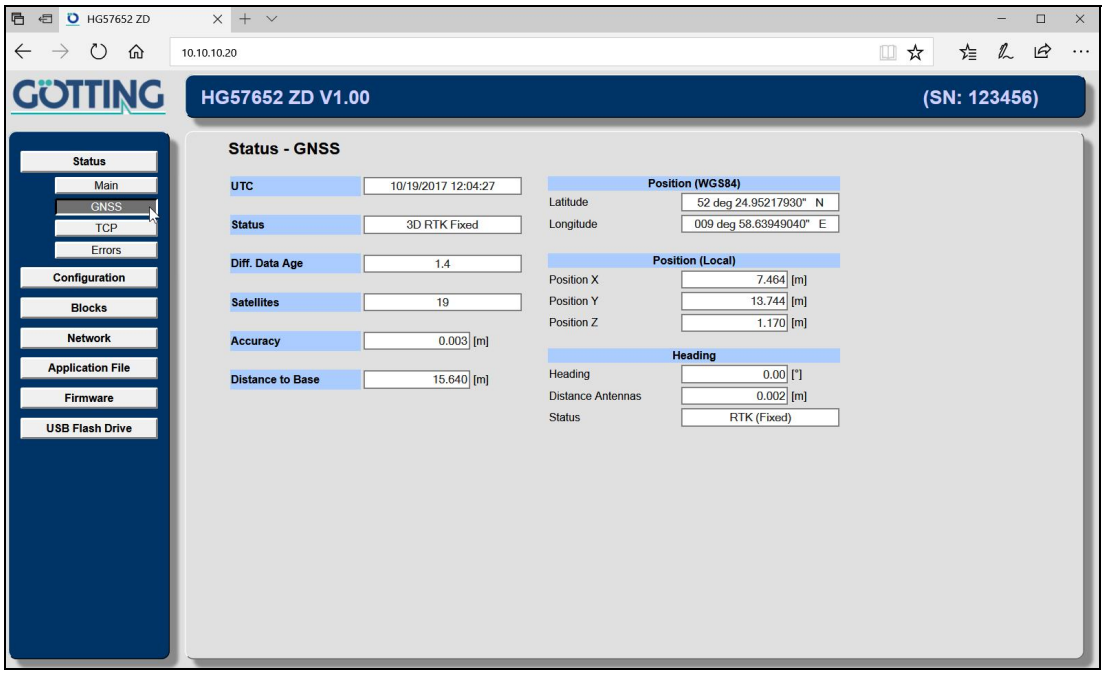


Table 20 *Status – GNSS*

GNSS	
Item	**Function**
UTC	Universal Time Coordinated
Status	Current position solution, possible states: – "3D Autonomous", "3D DGNSS", "3D RTK (Float)", "3D SBAS", "3D RTK Location", "3D RTK (Fixed)" – The status shows the actual accuracy. For autosteering the status has to be "3D RTK (Fixed)"
Diff. Data Age	Time since the last transmission of the correction data
Satellites	Number of satellites in use
Accuracy	Accuracy of the position
Distance to Base	Distance between the GNSS antenna of the reference station and GNSS antenna ANT1
Position (WGS84)	World Geodetic System 1984, geodetic reference system
Position (Local)	Display of the 3 dimensions in the Cartesian coordinate system relative to the reference station (base coordinate system)
Heading	Output of the second GNSS receiver – Heading: Display of the angle in relation to the geographic north pole – Distance Antennas: Distance between ANT1 and ANT2 – Status: Current position solution of the second receiver, possible states: "Autonomus", "RTK (Float)", "RTK (Fixed)", "DGNSS", "not available", for correct function the status has to be "RTK (Fixed)"

5.1.3.3 Status – TCP

Figure 36 *Screenshot: Status – TCP*

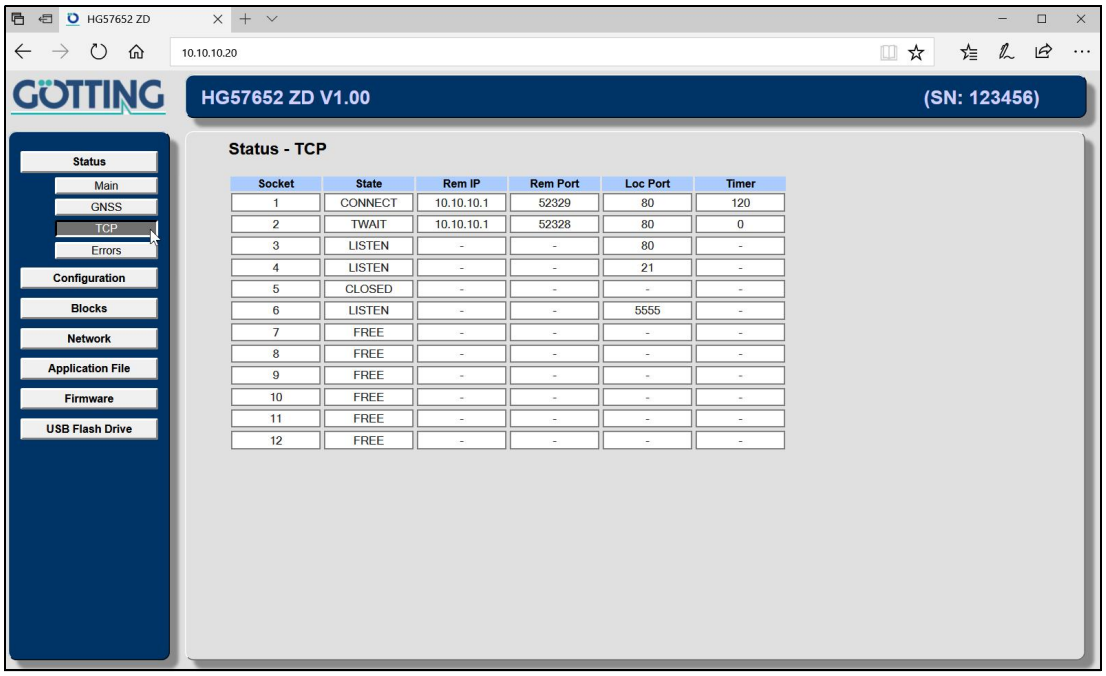
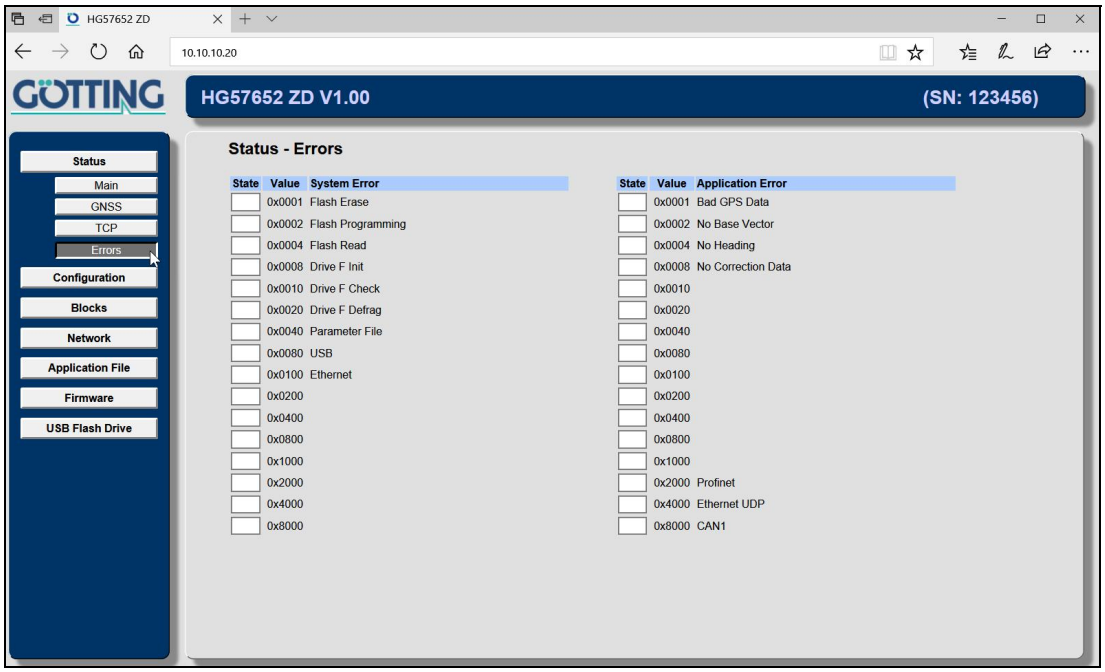


Table 21 *Status – TCP*

TCP	
Item	**Function**
Socket	Number of the TCP connection
State	Possible states: "FREE", "CLOSED", "LISTEN", "SYN_REC", "SYN_SENT", "FINW1", "FINW2", "CLOSING", "LAST_ACK", "TWAIT", "CONNECT"
Rem IP	IP address of the remote communication partner of this TCP connection
Rem Port	Port of the remote communication partner of this TCP connection
Loc Port	Local port of this TCP connection
Timer	Timeout for this TCP connection

5.1.3.4 Status – Errors

Figure 37 *Screenshot: Status – Errors*



See chapter 9 on page 68 for trouble shooting strategies.

Table 22 *Status – Errors: System Error*

System Error		
Value	**Error**	**Cause**
0x0001	Flash Erase	An error occurred during the erasure of the internal Flash memory
0x0002	Flash Programming	An error occurred during the programming of the internal Flash memory
0x0004	Flash Read	An error occurred during the reading from the internal Flash memory
0x0008	Drive F Init	Initialization of the file system failed
0x0010	Drive F Check	An error occurred during the checking of the file system
0x0020	Drive F Defrag	An error occurred during the defragmentation of the file system
0x0040	Parameter File	Parameter file faulty
0x0080	USB	Error during the execution of the USB stack
0x0100	Ethernet	Error during the execution of the Ethernet stack
0x0200		
0x0400		
0x0800		
0x1000		
0x2000		
0x4000		
0x8000		

Table 23 *Status – Errors: Application Error*

Application Error		
Value	**Error**	**Cause**
0x0001	Bad GNSS Data	Data from GNSS receiver insufficient
0x0002	No Base Vector	No base vector available
0x0004	No Heading	Heading determination via second antenna not possible
0x0008	No Correction Data	No correction data reception
0x0010		
0x0020		
0x0040		
0x0080		
0x0100		
0x0200		
0x0400		
0x0800		
0x1000		
0x2000	Profinet	Profinet communication disturbed
0x4000	Ethernet UDP	Ethernet UDP communication disturbed
0x8000	CAN1	CAN1 communication disturbed

5.1.4 Configuration

In order to change parameters you first have to authenticate yoursel.

▶ Enter the password as shown in section 5.1.2 on page 28.

Changed parameters are only saved when clicking on the **OK** button on the corresponding configuration page.

When configuring a new facility the process usually is to:

1. Configure a master crane.
2. Store the values of the master crane on a USB memory stick, see section 5.1.7 on page 42.
3. Apply these values on subsequent cranes by importing the master‘s parameter set, see section 5.1.7 on page 42.
4. Check that the subsequent cranes drive as well as the master cranes. Sometimes they behave slightly different. In those cases apply offsets to the imported settings of the master crane instead of changing master values. An example for this is the parameter *Antenna 1 reference distance Y*. Set it on the master crane, then on subsequent cranes adjust *Antenna 1 offset X* and *Antenna 1 offset Y* if necessary (see section 5.1.4.3 on page 38).

5.1.4.1 Configuration – General

Figure 38 *Screenshot: Configuration – General*

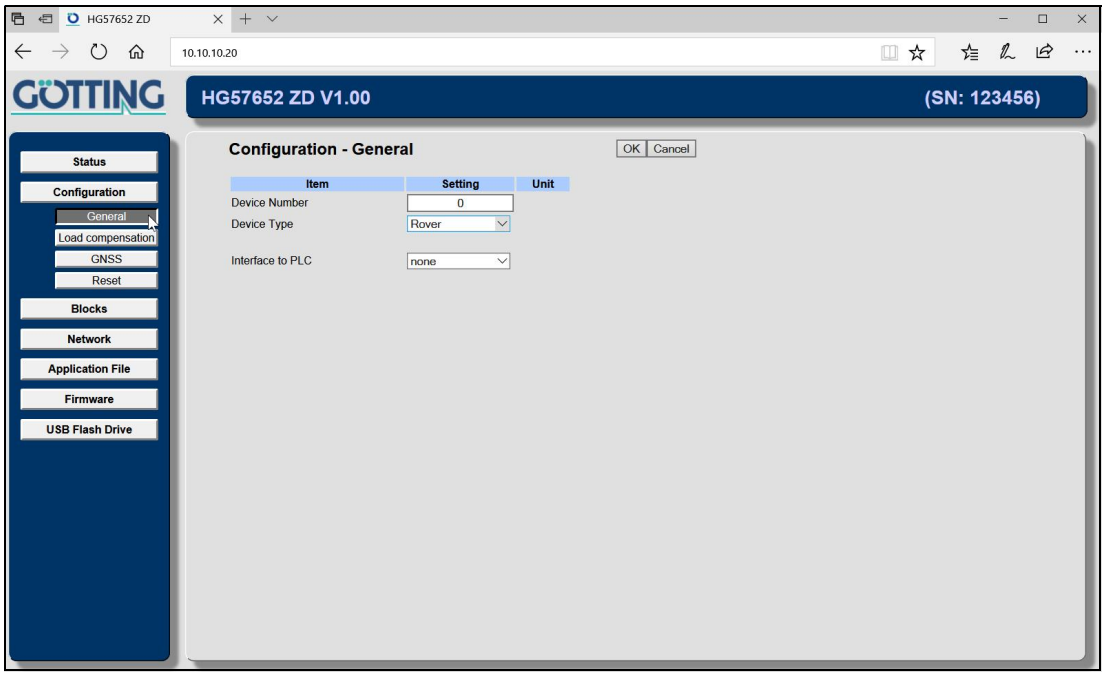


Table 24 *Configuration – General*

General	
Item	**Function**
Device Number	Freely settable vehicle number
Device Type	„Base“ (Reference station) or „Rover“
Interface to PLC	„CAN1“, „Ethernet/UDP“ or „PROFINET“ Depending on the interface the screen looks different, see below.

Figure 39 *Screenshot: Configuration – General: CAN1*

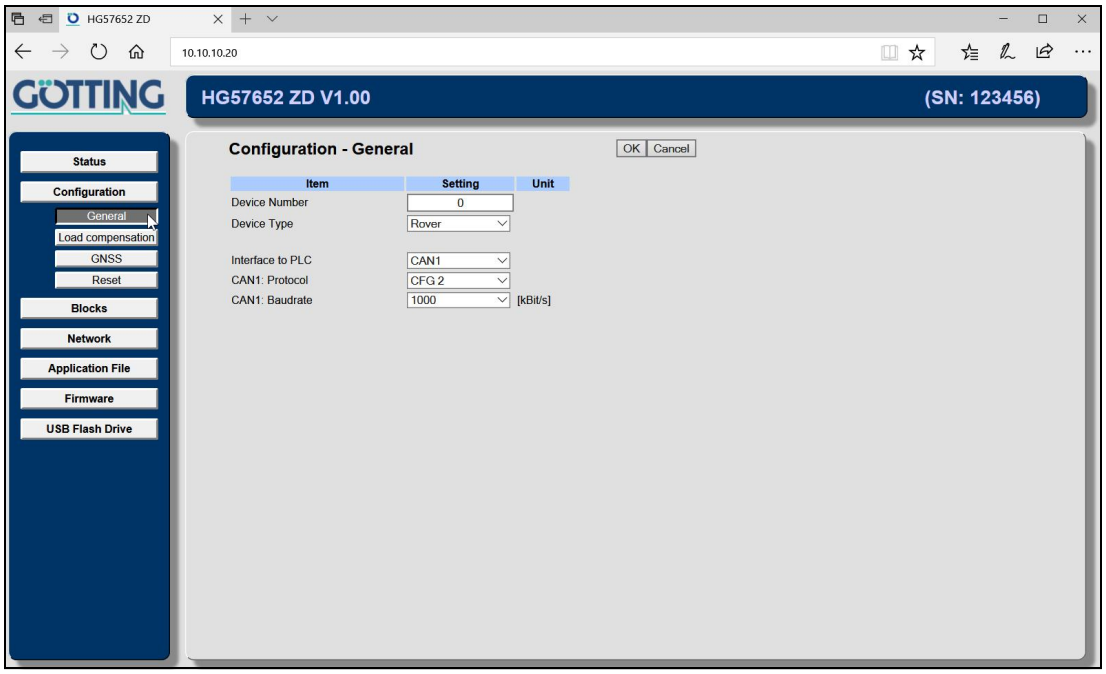


Figure 40 *Screenshot: Configuration – General: Ethernet/UDP*

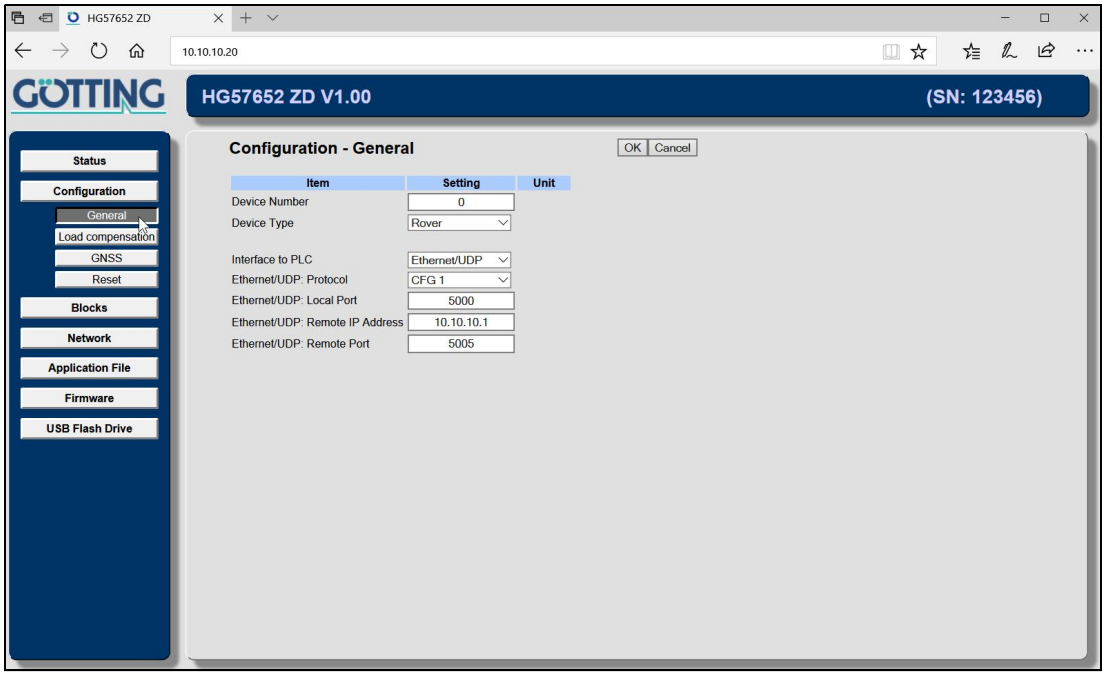
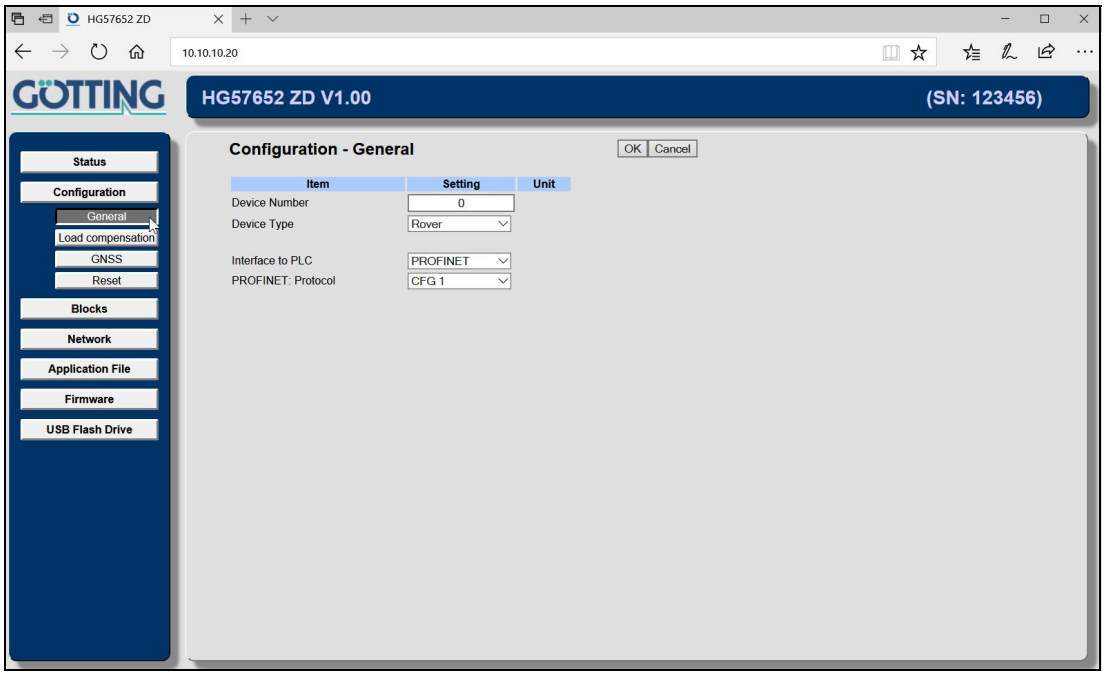
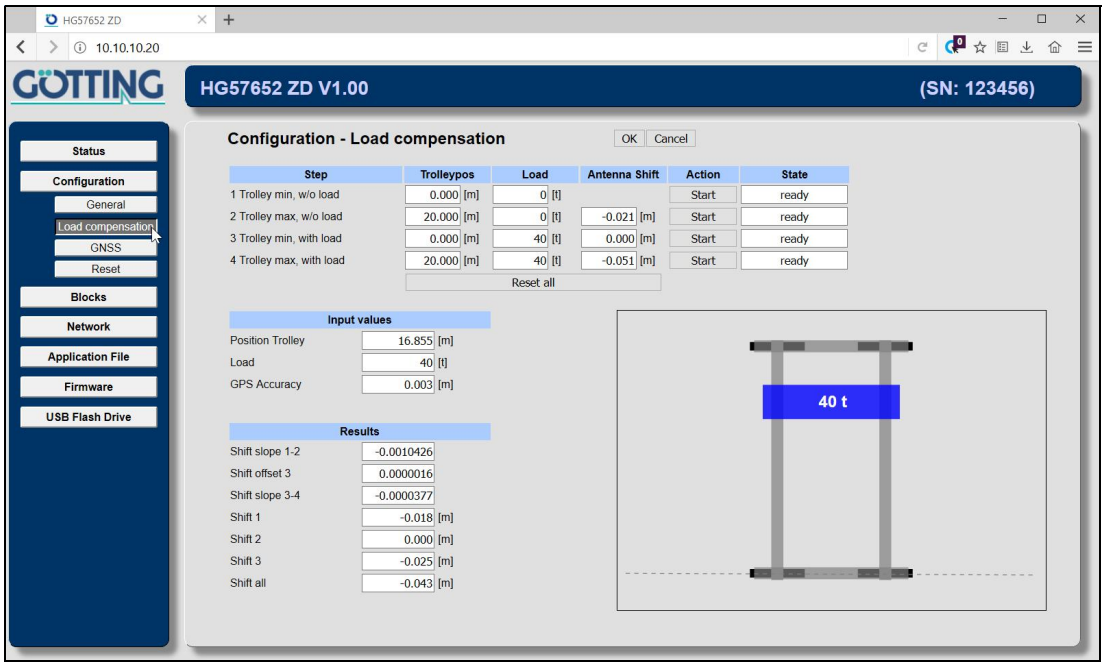


Figure 41 *Screenshot: Configuration – General: PROFINET*



5.1.4.2 Configuration – Load compensation

Figure 42 *Screenshot: Configuration – Load compensation*



The Control Unit is capable of calculating the load compensation. For this the configuration page offers 4 steps. Use the `Start` Action on each step to initiate the corresponding calculation process. While a step is currently carried out the state changes to `Running` and shows the progress. The corresponding start button switches to the `Stop` function. When the step is finished the state switches back to `ready` and the antenna shift is filled with actual data. Wait until a step is finished before starting the next step. With `Reset all` you can start all over again. The following steps are available:

1. Trolley min, w/o load: Move the trolley to its minimum position with no load attached. Then keep it there until the step is finished.
2. Trolley max, w/o load: Move the trolley to its maximum position without load. Then keep it there until the step is finished.
3. Trolley min, with load: Attach a load to the trolley. Ideally the load weighs close to the maximum load. Move the trolley to its minimum position and keep it there until the step is finished.
4. Trolley max, with load: Move the trolley with the load still attached to its maximum position. Keep it there until the step is finished.

Remember to store the calculated values with the **OK** button once all four steps are finished.

5.1.4.3 Configuration – GNSS

Figure 43 *Screenshot: Configuration – GNSS*

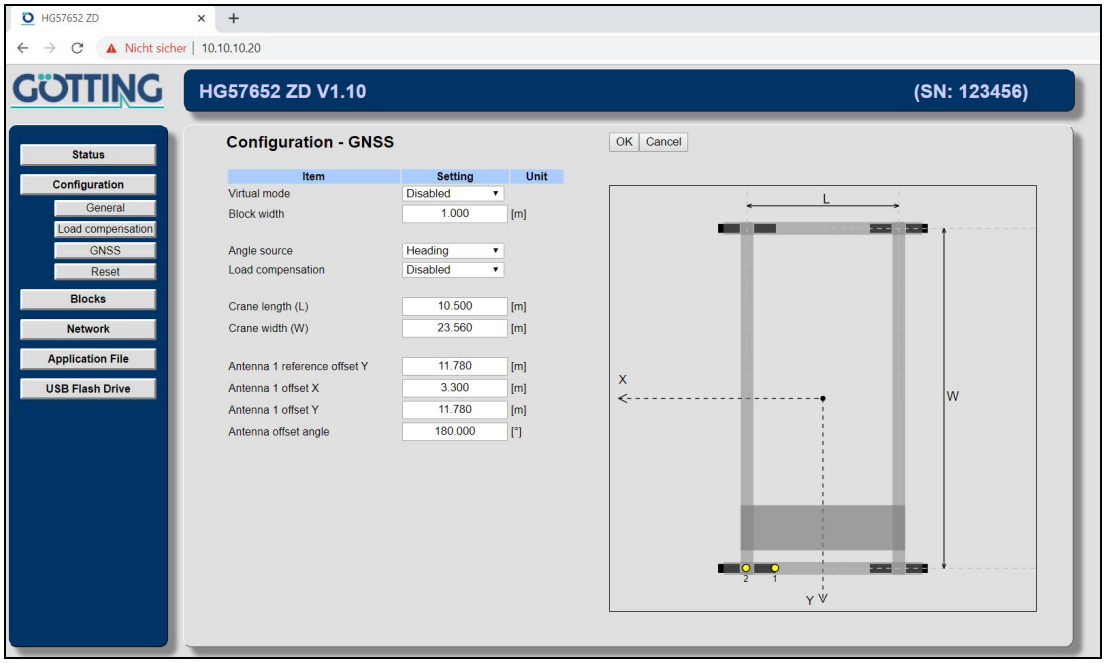


Table 25 *Configuration – GNSS (part 1 of 2)*

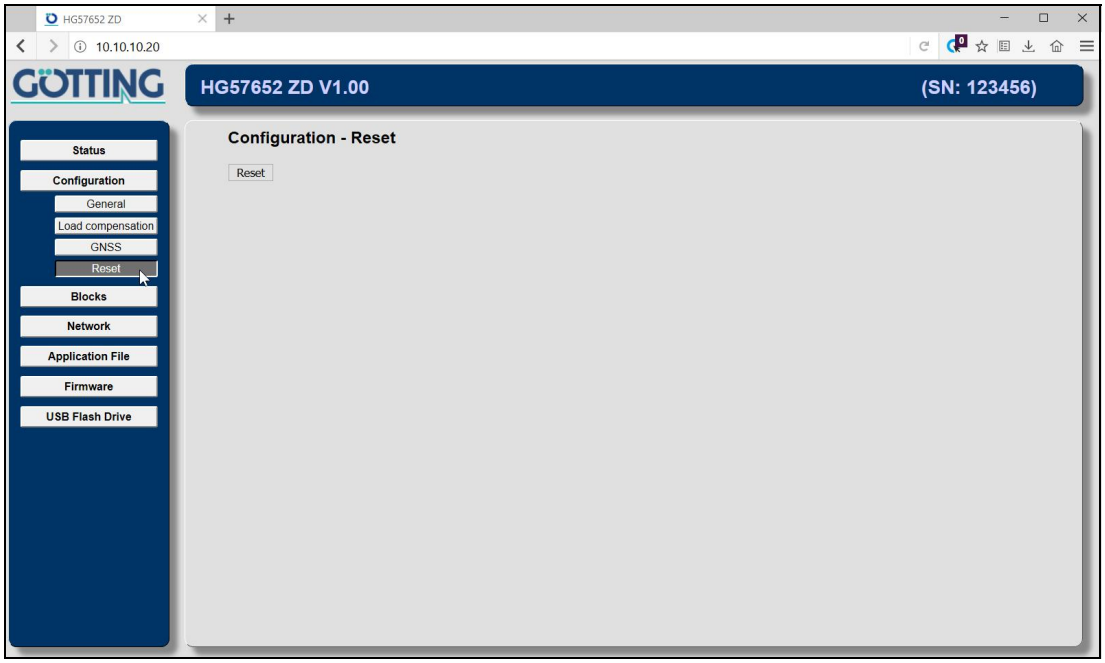
GNSS	
Item	**Function**
Virtual mode	– Enabled: The vehicle outputs the last found block until a new one is found even if it leaves the first block – Disabled: When the vehicle leaves the current block, block number 0 is shown
Block width	Width of the block (extension to the left and right, see section 5.1.5.1 on page 40)
Angle source	Heading: The heading of the vehicle is always determined using the connecting line between ANT1 and ANT2
Load compensation	– Enabled: The calculated offset of the GNSS antennas is compensated depending on trolley position and load – Disabled: The Shift value is not calculated (always 0)

Table 25 *Configuration – GNSS (part 2 of 2)*

GNSS	
Item	**Function**
Crane length (L) Crane width (W)	Length and width of the crane in [m] for the correct display of the crane proportions on the right side of this website
Antenna 1 reference offset Y	Lateral distance between vehicle center and ANT1. This value has to be the same for all vehicles. Set it on the master crane then use the offsets below if other cranes have slightly different antenna positions.
Antenna 1 offset X	Individual distance in longitudinal direction between vehicle center ANT1.
Antenna 1 offset Y	Individual distance in lateral direction between vehicle center ANT1.
Antenna offset angle	Angle offset between the GNSS antennas and the actual direction of travel.

5.1.4.4 Configuration – Reset

Figure 44 *Screenshot: Configuration – Reset*

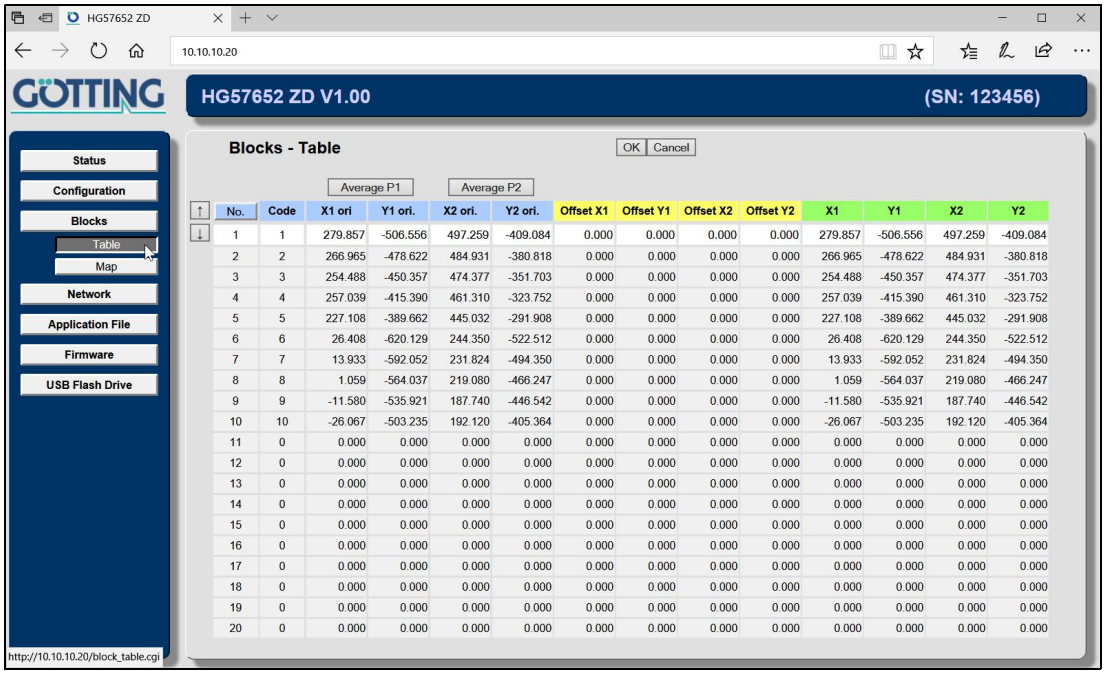


By clicking the button the Control Unit can be reset. This can e.g. be used to initiate a remote Hardware Reset. The Control Unit then performs a cold re-start that takes approx. 30 seconds. The configuration is neither changed nor reset.

5.1.5 Blocks

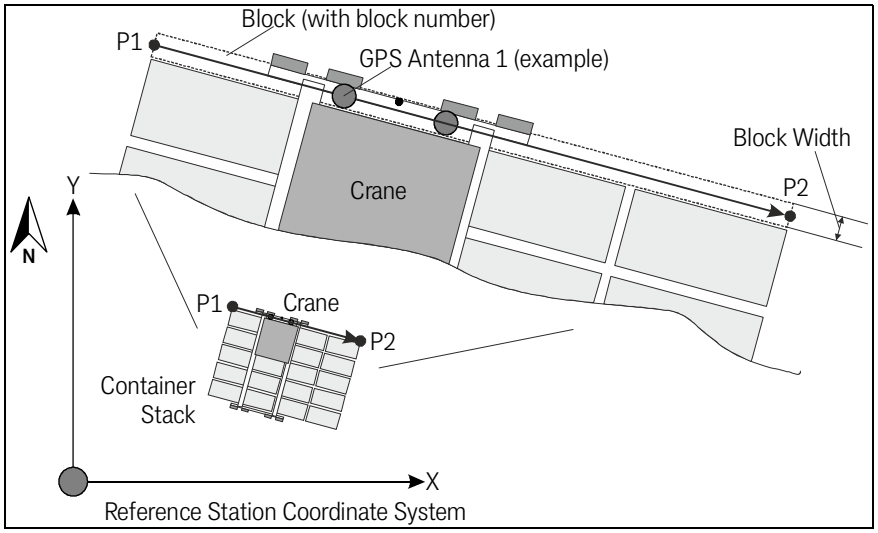
5.1.5.1 Blocks – Table

Figure 45 *Screenshot: Blocks – Table*



No.	Code	X1 ori	Y1 ori.	X2 ori.	Y2 ori.	Offset X1	Offset Y1	Offset X2	Offset Y2	X1	Y1	X2	Y2
1	1	279.857	-506.556	497.259	-409.084	0.000	0.000	0.000	0.000	279.857	-506.556	497.259	-409.084
2	2	266.965	-478.622	484.931	-380.818	0.000	0.000	0.000	0.000	266.965	-478.622	484.931	-380.818
3	3	254.488	-450.357	474.377	-351.703	0.000	0.000	0.000	0.000	254.488	-450.357	474.377	-351.703
4	4	257.039	-415.390	461.310	-323.752	0.000	0.000	0.000	0.000	257.039	-415.390	461.310	-323.752
5	5	227.108	-389.662	445.032	-291.908	0.000	0.000	0.000	0.000	227.108	-389.662	445.032	-291.908
6	6	26.408	-620.129	244.350	-522.512	0.000	0.000	0.000	0.000	26.408	-620.129	244.350	-522.512
7	7	13.933	-592.052	231.824	-494.350	0.000	0.000	0.000	0.000	13.933	-592.052	231.824	-494.350
8	8	1.059	-564.037	219.080	-466.247	0.000	0.000	0.000	0.000	1.059	-564.037	219.080	-466.247
9	9	-11.580	-535.921	187.740	-446.542	0.000	0.000	0.000	0.000	-11.580	-535.921	187.740	-446.542
10	10	-26.067	-503.235	192.120	-405.364	0.000	0.000	0.000	0.000	-26.067	-503.235	192.120	-405.364
11	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Figure 46 *Blocks and Stacks*



A block consists of two points, P1 (start) and P2 (end). It defines the coordinates of GNSS antenna 1 while a crane moves from P1 to P2. Each of these two points has a X and Y coordinate. Around the line between P1 and P2 an area is defined by setting a block width (see section 5.1.4.3 on page 38). As long as the antenna position is within this area the corresponding block is detected and output to the crane controller. When the antenna is not within a valid block, block no. 0 (no block) is output.

The blocks table has three sections: ori. (light blue headers), offset (yellow headers) and the coordinates used for the calculation (green headers). Only the sections ori. and offset can be edited, the points used for the calculation (green headers) are then calculated by applying the offsets to the ori. coordinates. Without offsets both use the same coordinates.

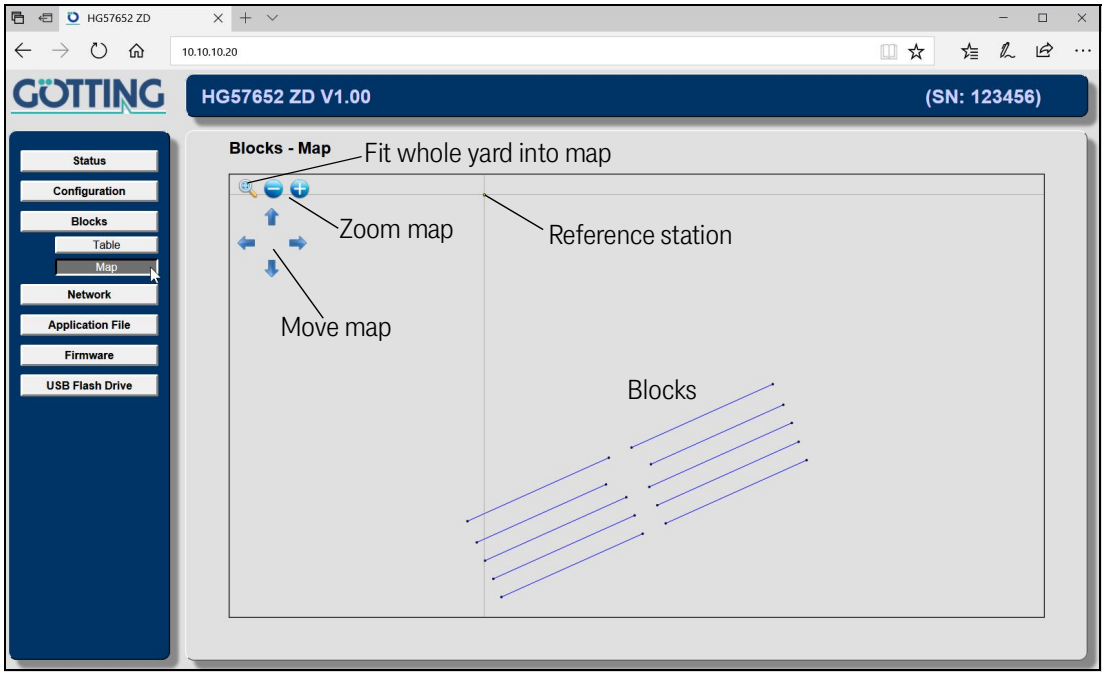
The white row at the top of the blocks table is editable. With the up and down arrows it is possible to select other rows. In order to define a block:

- Give the selected row a unique block number (code) between 1 and 255. Setting a block number to 0 deactivates the block without the need to remove the row or to delete the corresponding coordinates.
- Then define the points P1 and P2 for the selected block:
  - Manual: Enter the coordinates of P1 as X1 ori. / Y1 ori. Enter the coordinates of P2 as X2 ori. / Y2 ori.
  - Automatic (recommended): Place the crane at position P1 and click on *Average P1*. Wait until the calculation is finished. Then drive the crane to position P2 and click on *Average P2*. Wait until the calculation is finished.
- The offsets can be used to adjust the points used for calculation in case the averaged positions are not accurate enough.

Remember to store the calculated values with the **OK** button whenever a block is changed.

5.1.5.2 Blocks – Map

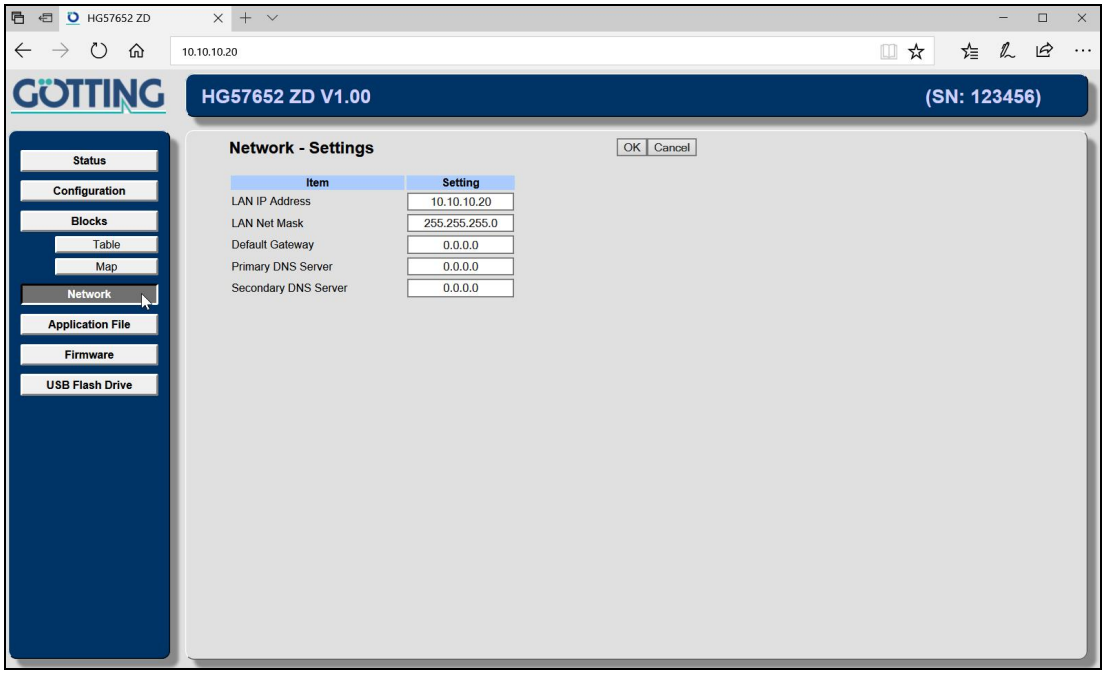
Figure 47 *Screenshot: Blocks – Map*



Graphical display of the block coordinates.

5.1.6 Network

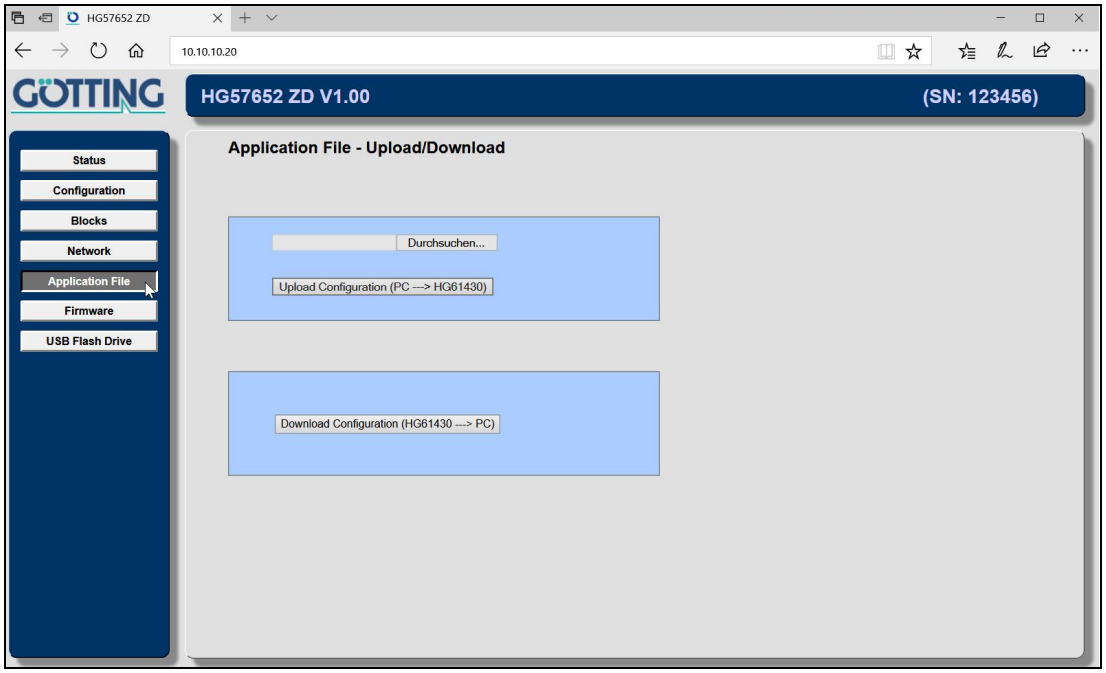
Figure 48 *Screenshot: Network – Settings*



Allows to change the settings of the Control Unit's Ethernet interface.

5.1.7 Application File

Figure 49 *Screenshot: Application File – Upload/Download*

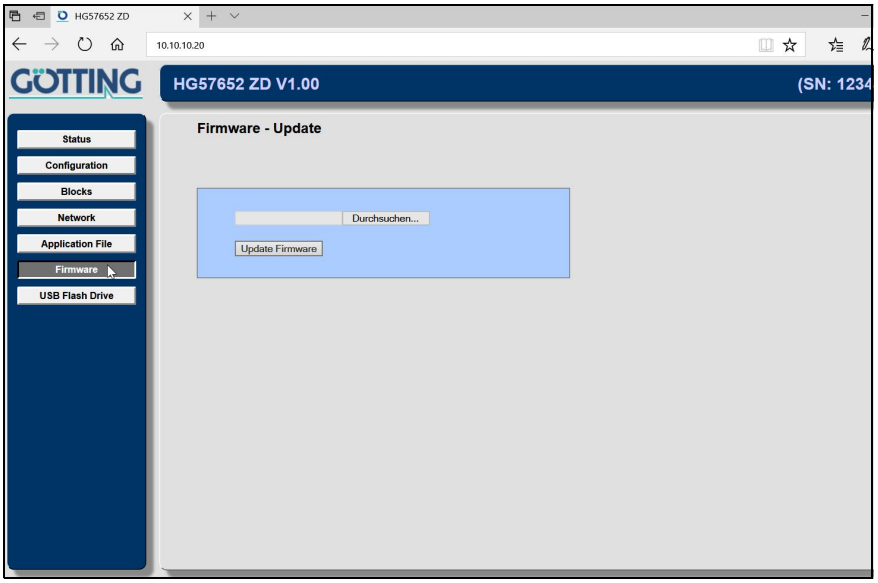


Allows to save or restore all parameters using a file. This can also be used to take the parameter set of a master crane and apply it to subsequent cranes. The file name of a parameter file has to start with *parameter* and have the extension *.txt*, e.g. *parameter01.txt*.

5.1.8 Firmware Update

There are two ways to update the firmware. Remotely via the web site described below or via an USB stick, see appendix section 12.2 on page 74.

Figure 50 *Screenshot: Firmware – Update*



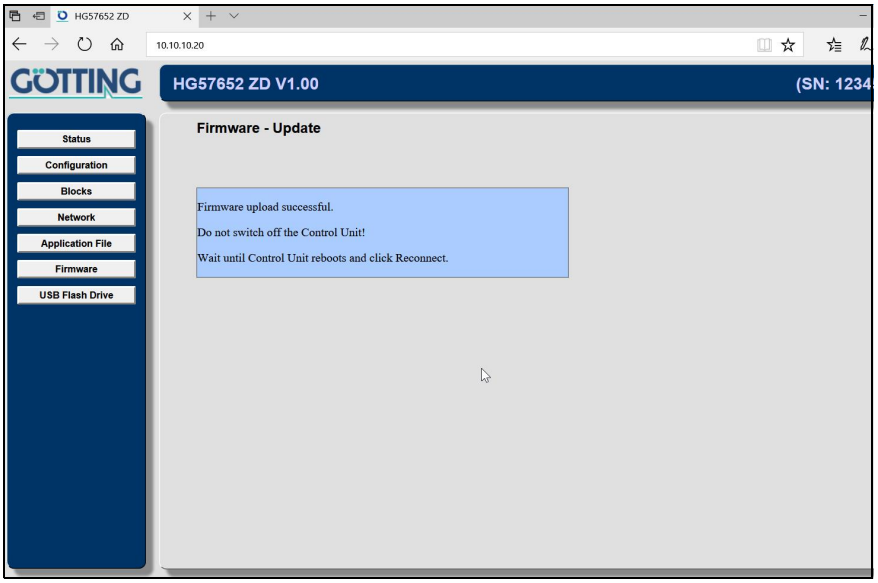
A firmware update file needs to have the extension *.hex*. You can receive the file upon request by contacting Götting. By clicking on *Update Firmware* the file upload starts.

ATTENTION!

Once the update process has started do not switch off the Control Unit until it is finished!

Once the upload is finished the following message is shown:

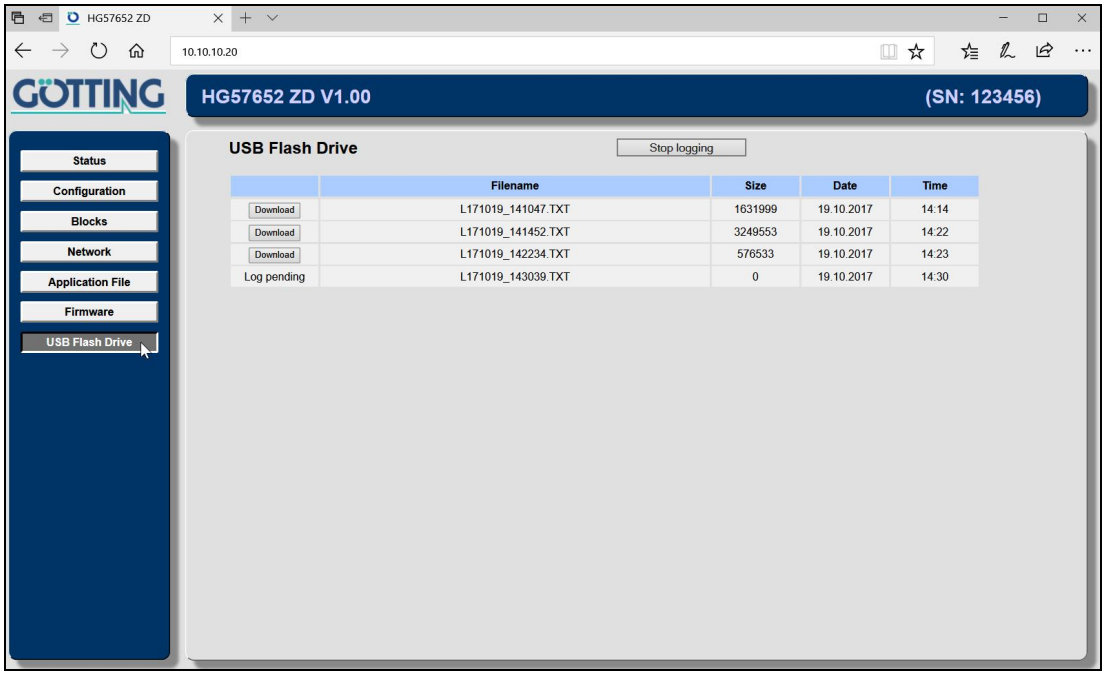
Figure 51 *Screenshot: Firmware – Update – Upload successful*



The update progress is visualized on the Control Unit's 7 segment display by counting from *fu-1* to *fu-9*. Once the update is finished successfully the Control Unit is automatically reset and you can reconnect.

5.1.9 USB Flash Drive

Figure 52 *Screenshot: USB Flash Drive*

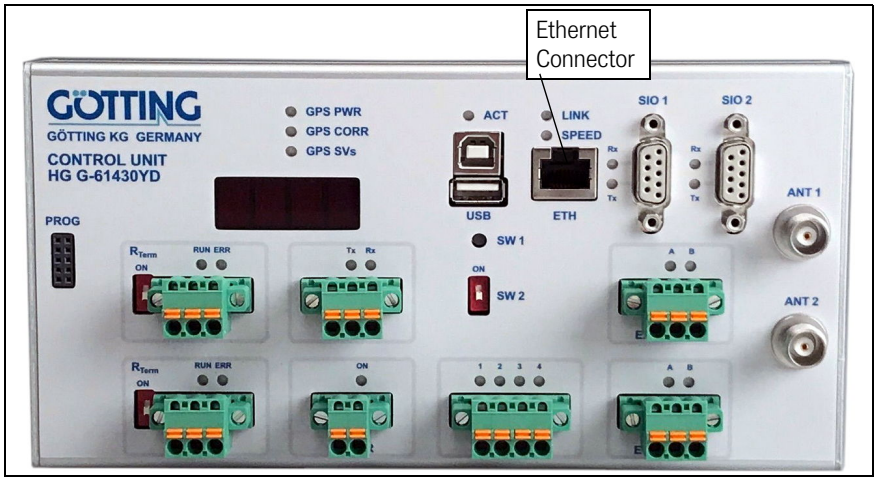


Lists all the log files on the USB drive including file size in bytes, date and time. By clicking on *Download* the respective file can be downloaded to the PC.

5.2 Configuration of the GNSS Receiver

1. Connect the Control Unit to a PC via an Ethernet cable.

Figure 53 *Ethernet connection Control Unit*



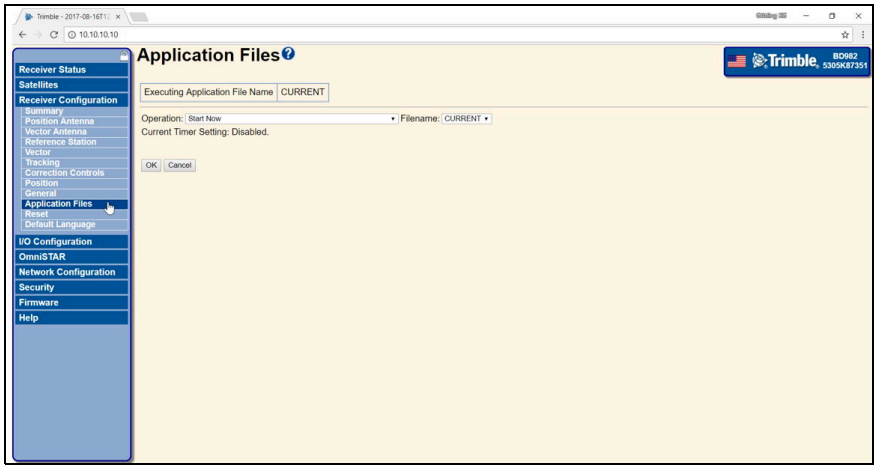
2. Start a web browser and type in the IP address of the Control Unit (default: `10.10.10.10`).

The next steps are different for a reference station or a rover.

5.2.1 Reference Station

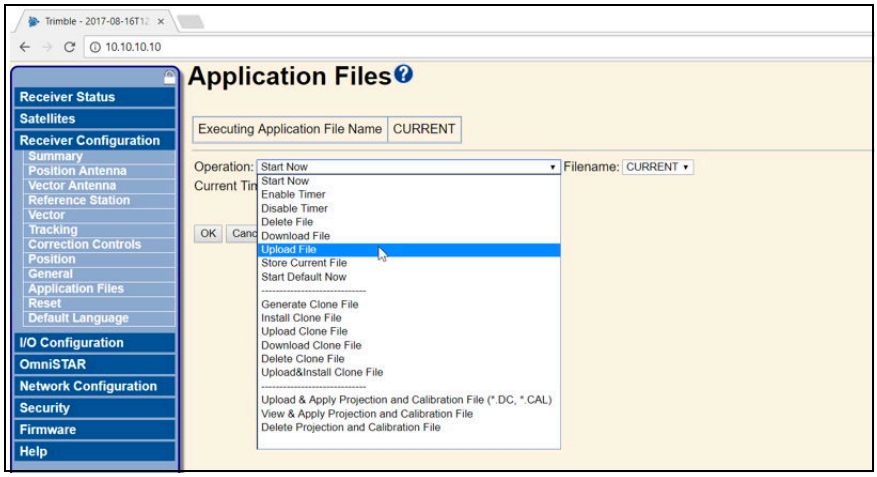
1. Go to menu *Receiver Configuration* > *Application Files*.

Figure 54 *Reference station: GNSS > Receiver Configuration > Application Files*



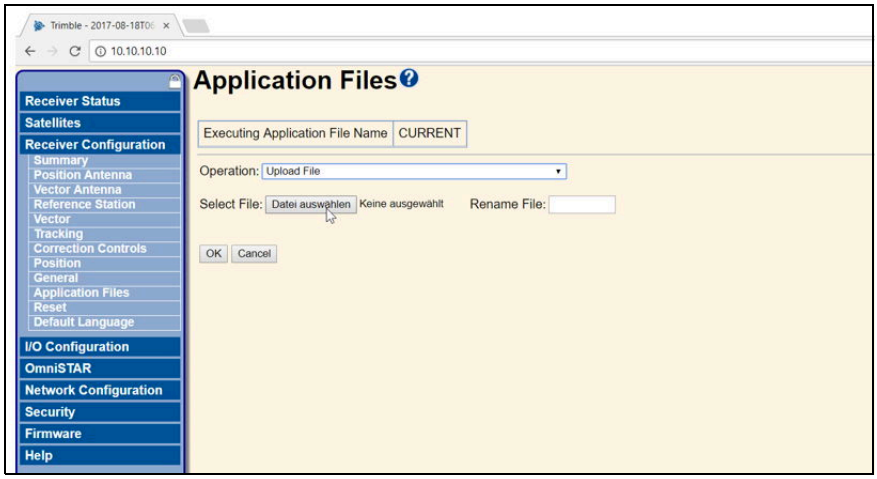
2. Select *Operation* > *Upload File*.

Figure 55 *Reference station: GNSS > Receiver Conf. > Appl. Files > Upload File*



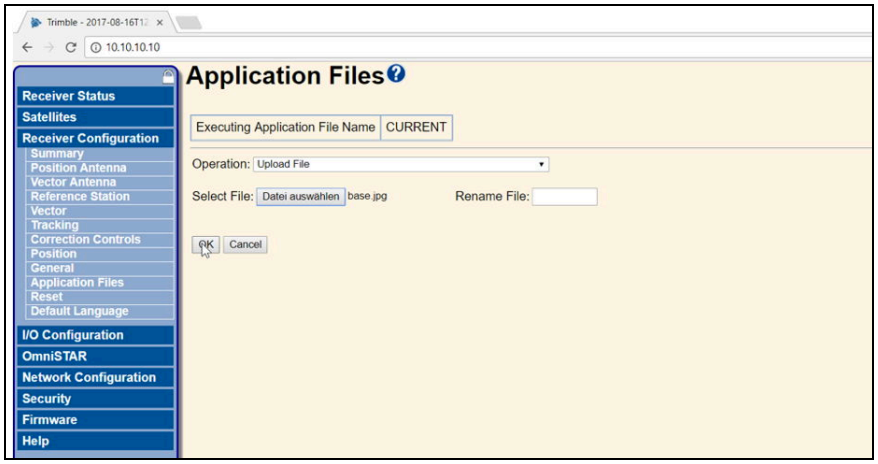
3. Select file `Base.cfg` from folder *GNSS Configuration* for upload.

Figure 56 *Reference station: GNSS > Receiver Conf. > Application Files > Upl. File > Base.cfg*



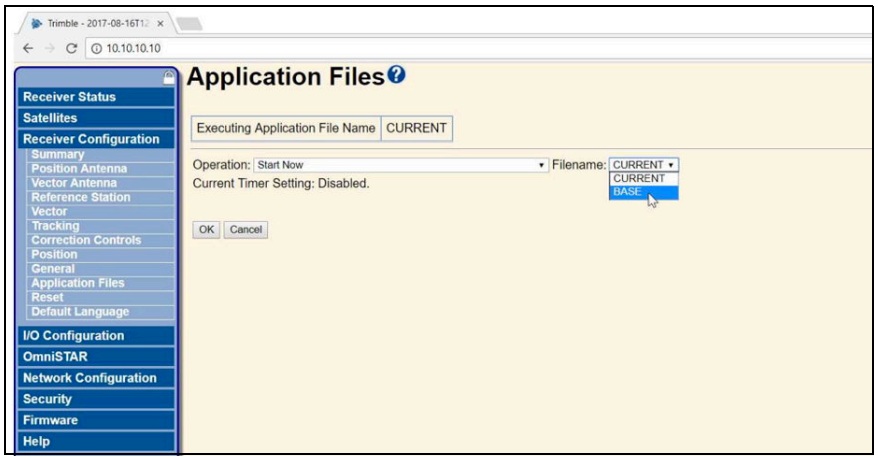
4. Press *OK* to start upload.

Figure 57 *Reference station: GNSS > Receiver Conf. > Appl. Files > Upl. File > Base.cfg > OK*



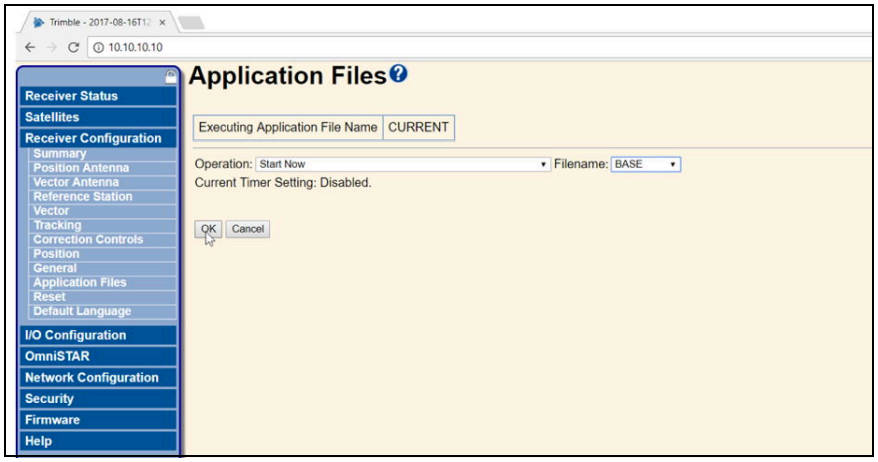
5. Select *Operation* > *Start Now* and the filename BASE.

Figure 58 *Reference station: GNSS > Receiver Conf. > Appl. Files > Start Now > BASE*



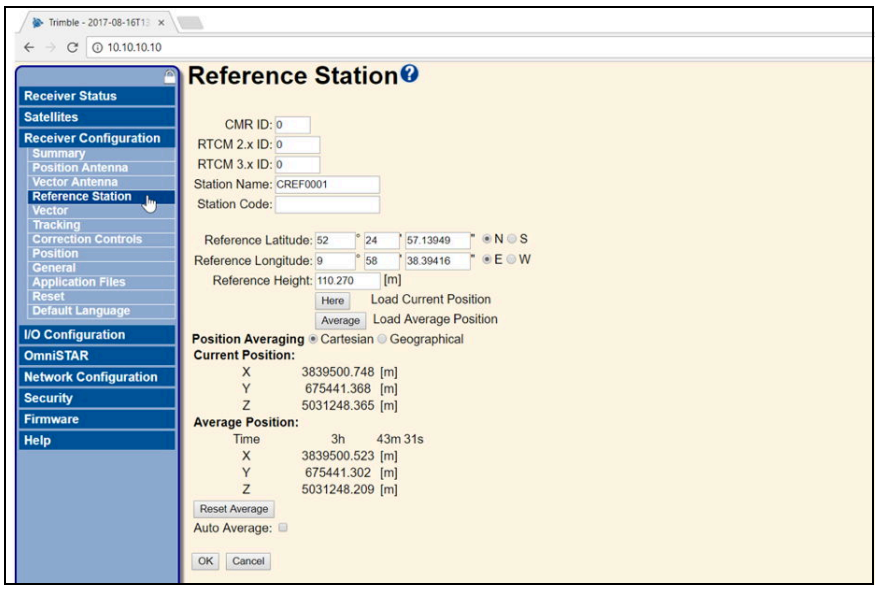
6. Confirm with *OK*.

Figure 59 *Reference station: GNSS > Receiver Conf. > Appl. Files > Start Now > BASE > OK*



7. Go to menu *Receiver Configuration > Reference Station*.

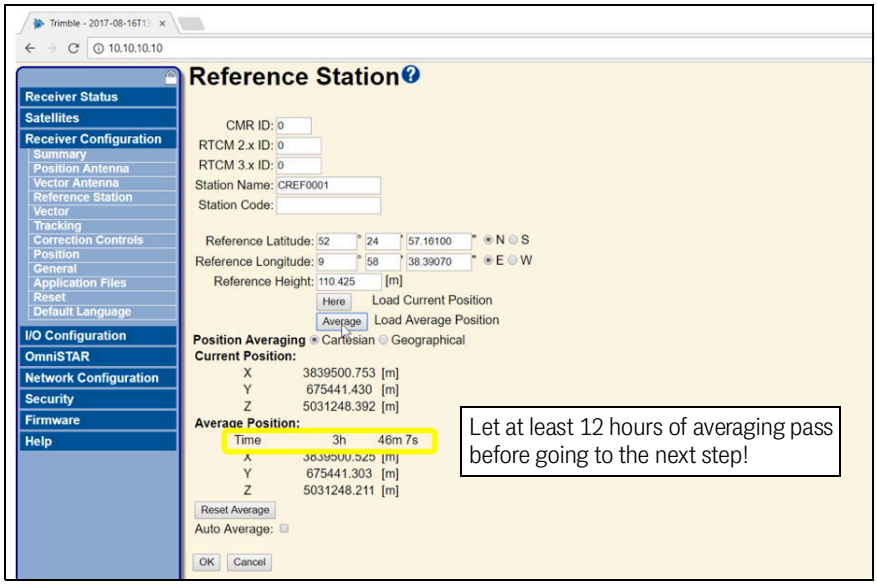
Figure 60 *Reference station: GNSS > Receiver Configuration > Reference Station*



Now let the receiver average the position for at least 12 hours before going to the next step.

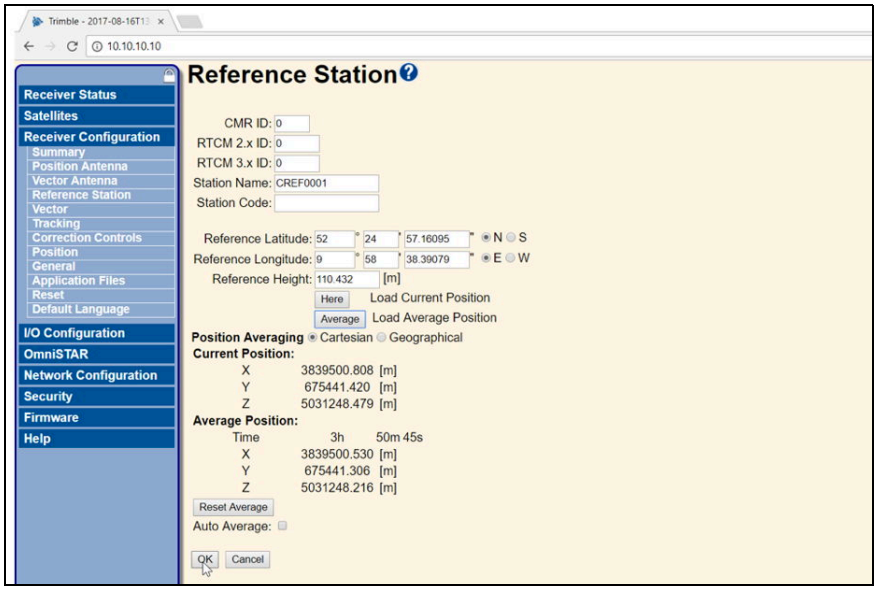
8. When at least 12 hours of averaging have passed press *Average* to take over the calculated average position.

Figure 61 *Reference station: GNSS > Receiver Configuration > Reference Station > Averaging*



9. Confirm with *OK*.

Figure 62 *Reference station: GNSS > Receiver Configuration > Reference Station > OK*



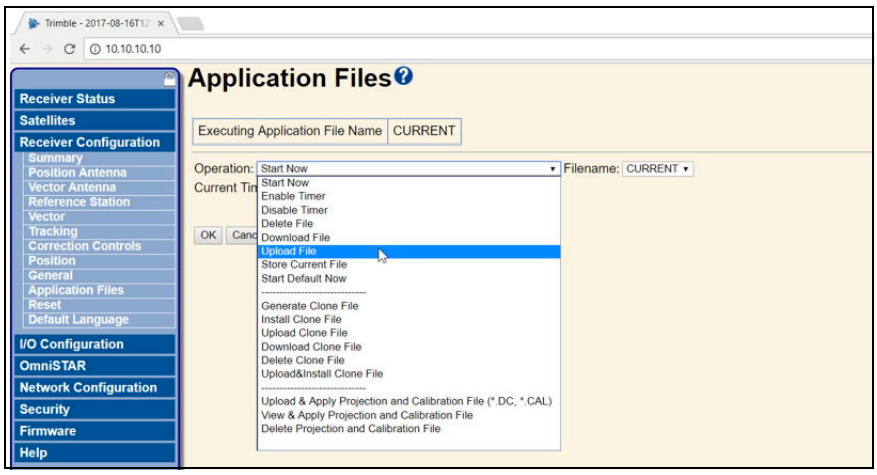
5.2.2 Rover

1. Go to menu *Receiver Configuration > Application Files.*

Figure 63 *Rover: GNSS > Receiver Configuration > Application Files*

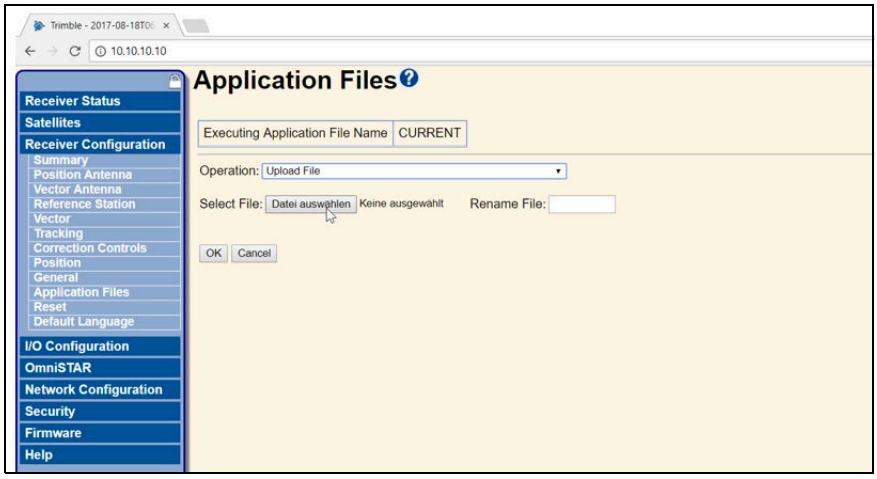
2. Select *Operation* > *Upload File*.

Figure 64 *Rover: GNSS > Receiver Configuration > Appl. Files > Upload File*



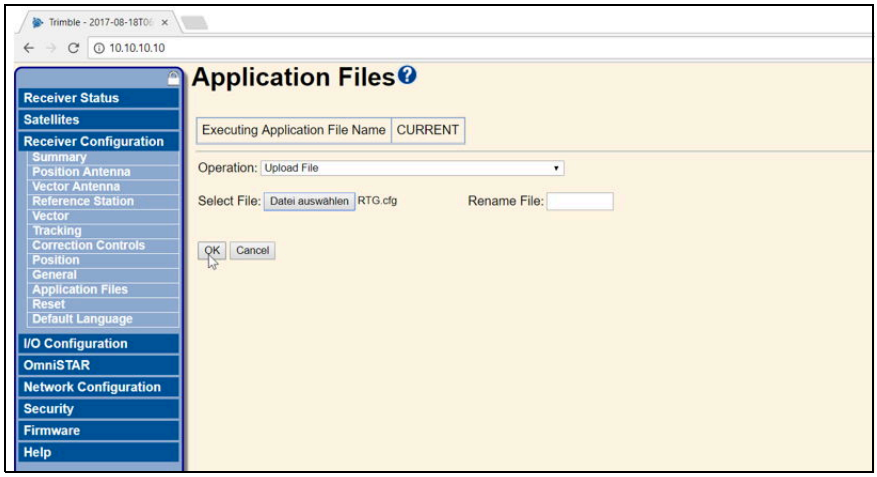
3. Select file `RTG.cfg` from folder *GNSS Configuration* for upload.

Figure 65 *Rover: GNSS > Receiver Configuration > Appl. Files > Upload File > Rtg.cfg*



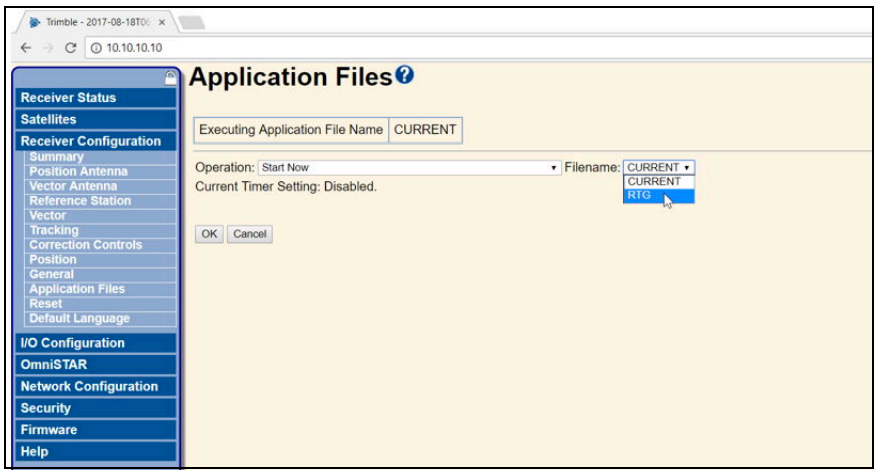
4. Press *OK* to start upload.

Figure 66 *Rover: GNSS > Receiver Configuration > Appl. Files > Upload File > Rtg.cfg > OK*



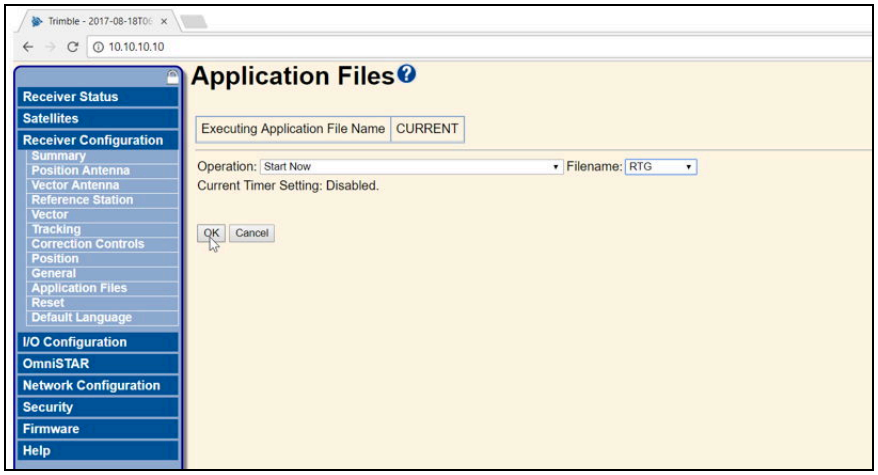
5. Select *Operation* > *Start Now* and the filename `RTG`.

Figure 67 *Rover: GNSS > Receiver Configuration > Appl. Files > Start Now > RTG*



6. Confirm with *OK*.

Figure 68 *Rover: GNSS > Receiver Configuration > Appl. Files > Start Now > RTG > OK*



5.3 Configuration of the Radio Modem (Reference Station & Rover)

The following procedure applies to the radio modem type SATELLINE-EASy.

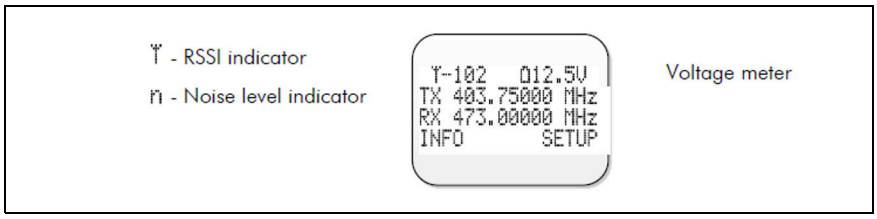
5.3.1 Power-Up Behavior

Figure 69 below shows the output of the LCD after the power-up in its top-level view. The indicator on the upper left corner has two functions:

- Antenna symbol followed by Receiver Strength Signal (RSSI) in dBm units. RSSI will be shown for about 7 seconds after the last message has been received.
- ‚n' symbol followed by the noise level whenever RSSI is not shown, i.e. there are no messages from any other compatible radio modem detected.

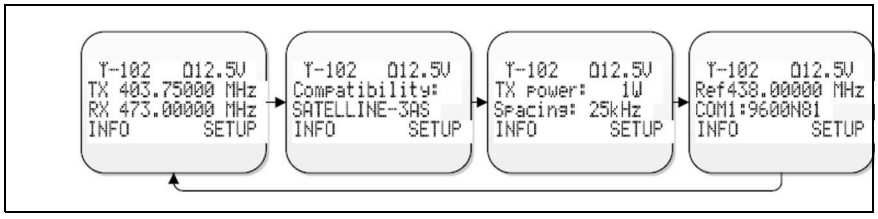
The indicator on the upper right corner indicates the supply voltage / battery level of the radio modem in Volts.

Figure 69 *Start output radio modem*



The two lines in the middle revolve automatically every 5 seconds displaying the basic settings as illustrated below.

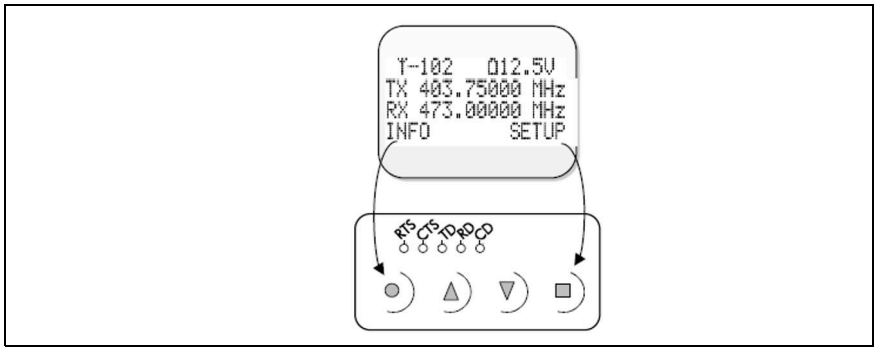
Figure 70 *Revolving output radio modem*



There ore two options to proceed from the top level view:

- Press the INFO button ● to view the info pages
- Press the SETUP button ■ to modify the settings

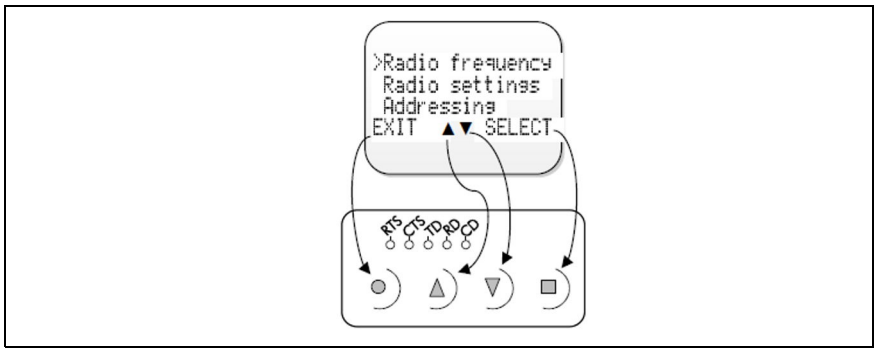
Figure 71 *Radio modem selection possibilities*



5.3.2 How to Modify the Settings

After pressing the SETUP button ■ on the top level view, the list of settings sub-menus appears. The cursor > indicates the active line or the current value of a setting.

Figure 72 *Radio modem: Settings*



Pressing the DOWN ▼ button, the cursor moves downwards. Depending on the sub-menu, the button also scrolls the digits of numerical values when changing some settings.

Pressing the UP ▲ button the cursor moves upwards. Depending on the sub-menu, the button also scrolls the digits of numerical values when changing some settings.

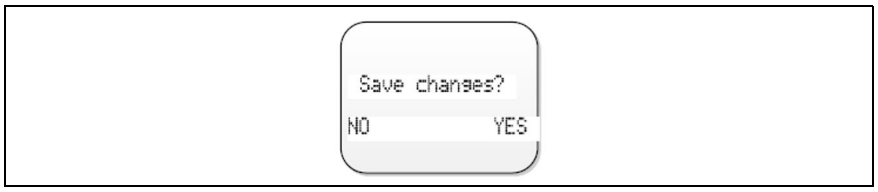
Pressing the SELECT/SET/CHANGE/NEXT/YES ■ button either confirms a selection, sets or changes a value, moves to the next digit or enters a sub-menu depending on the context.

Pressing the EXIT/CANCEL/BACK/NO ● button escapes back to the previous higher level in the menu hierarchy or cancels the modification of a setting depending on the particular sub-menu.

5.3.3 Saving the modified settings

After all the desired modifications are done, the settings need to be saved in order to make them permanent (until the next modification). This is accomplished by choosing EXIT on the top level menu of the settings. The LCD prompts a message asking a confirmation of the modified configuration.

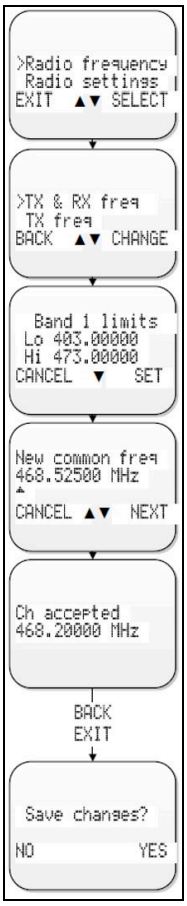
Figure 73 *Radio modem: Saving changes*



By choosing YES ■ the configuration is saved into the non-volatile memory inside the radio modem. By choosing NO ● the modified settings are canceled and the previous settings remain in the non-volatile memory.

5.3.4 Example — How to change the Radio Frequency

Figure 74 *Radio modem example: Changing the radio frequency*



Enter the settings menu first by pressing the SETUP button ■ on the top level view. Press ▲ or ▼ until the cursor > points to *Radio frequency* selection. Then press SELECT to move to the next sub-menu.

Press ▲ or ▼ until the cursor > points to your selection:

- TX & RX freq (in case both TX frequency and RX frequency are to be changed at the same time)
- TX freq (in case only TX frequency is to be changed)
- RX freq (in case only RX frequency is to be changed)

The limits of the Frequency Band I will be shown for informative purposes. Likewise the limits of Frequency Band 2 will be shown by pressing ▼. Press SET ■ to activate the window for entering the frequency.

Increase or decrease the value of each digit by pressing ▲ or ▼. Move to the next digit by pressing NEXT ■. Repeat the procedure until the frequency is fully set.

Acknowledgment or error message (in case of on invalid value) appears.

Get back to the lop level by pressing BACK ●.

On the top level of the settings press EXIT ●.

If you want to save the settings as they are now, press YES ■.

If you are not sure or want to cancel the changes, press NO ●.

5.3.5 List of Settings

Modified values (compared to the factory settings) are highlighted in red.

SETUP →
Radio frequency →TX & RX freq → SET (403 - 473 MHz) depending on project
TX freq → SET (403 - 473 MHz)
RX freq → SET (403 - 473 MHz)
Ch Spacing → 12,5 / 20 / 25 (kHz) depending on project

Radio settings →TX level: 1000 mW depending on project
Sig. threshold: -115 dBm
TX start delay: 0 ms
Compatibility: SATELLINE-3AS
Call sign: Call sign OFF

Addressing → RX addr OFF
TX addr OFF
RX addr->RS OFF
TX add auto OFF

Port 1 → ON
9600 bit/s
8 bit data
None parity
1 stop bit

Port 2 → OFF
9600 bit/s
8 bit data
None parity
1 stop bit
RS-422

Handshaking →CTS Clr to send
CD RSSI
RTS Ignored
Pause len 3

Additional → Error corr. ON
Error check ON
Repeater OFF
SL-commands ON
Priority TX
Full CRC16 OFF
Data Whiten OFF

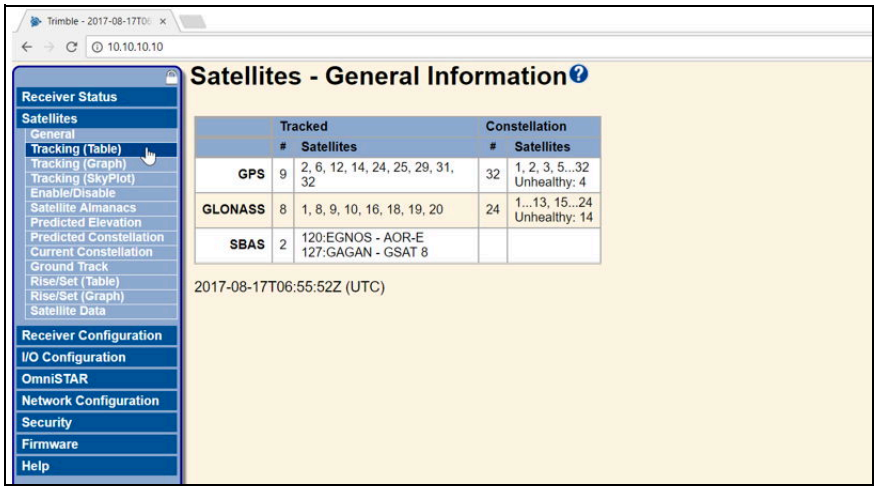
Test → Short block OFF
Long block OFF

Factory setup →NO/YES
LCD-Contrast →Display contr. 3

5.4 Verify GNSS Signal Quality (Reference Station & Rover)

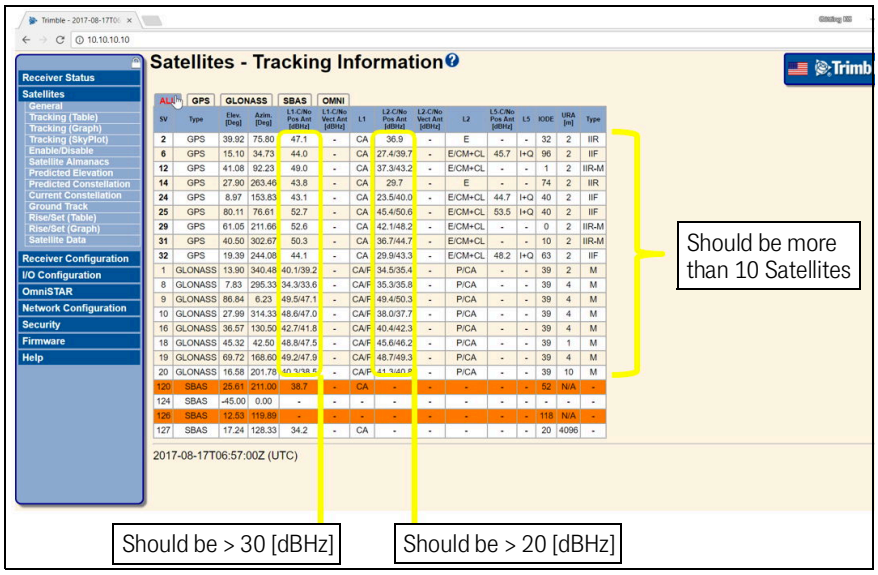
- Go to menu *Satellites*.

Figure 75 *Reference station: GNSS > Satellites*



- Go to sub-menu *Tracking (Table)*. Select tab *ALL*.

Figure 76 *Reference station: GNSS > Satellites > Tracking (Table) > All*

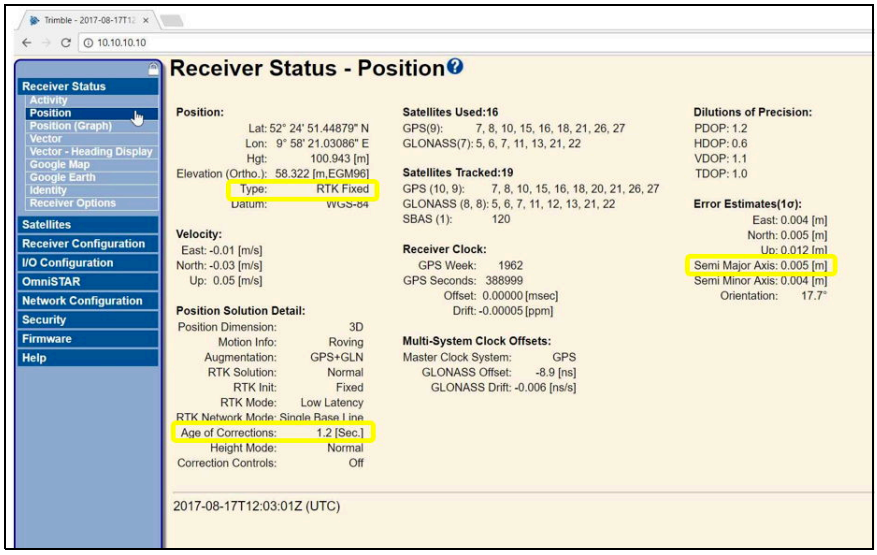


5.5 Verify GNSS Position Solution (Rover)

Go to menu *Receiver Status > Position*.

- Type must be *RTK Fixed*
- *Age of Corrections* should be around 1 sec.
- *Semi Major Axis* should be between 0 and 0.015 [m]

Figure 77 *Rover: GNSS > Receiver Status > Position*



6 USB Data Logging

When a USB flash drive (USB Type A, file system FAT32) is inserted into the Control Unit (s. section 3.4 on page 12), the Control Unit automatically starts to log data on it. Data logging being active is indicated by the flashing LED ACT. The data is logged in the CSV (MS-DOS®) format. This writes data line by line into a file and the different values in each line are separated by semicolon.

The Control Unit limits those files to have a maximum length of 6,000 lines. Afterwards the Control Unit closes the actual file and automatically starts a new one. The file names comprise the current time, the file extension is *.txt*. At a timing of 60-70 ms each file contains approx. 5 minutes of a drive.

ATTENTION!

As soon as there are more than 100 files on the stick the control unit automatically deletes the oldest files in order to prevent the stick from becoming filled up!

As the stick receives data in short intervals it is important that it is fast enough. We e.g. successfully used an USB 3.0 memory stick SanDisc Ultrafit 16GB.

Tipp

You can access the files on the stick and download them to your computer using the control unit‘s browser interface, see section 5.1.9 on page 44.

If the stick has to be removed while the Control Unit is powered on press and hold the button SW1 (below the stick) until the LED ACT turns off (approx. 5 Sek.).

ATTENTION!

Do not press SW1 longer than 10 seconds because then the stick will be formatted and all data erased!

When the LED ACT stops flashing the current file is closed safely and the stick unmounted. When switching the Control Unit off it also closes the file and the stick may be removed.

7 Communication with the Superordinate Controller

7.1 CAN Communication

7.1.1 Configuration Sets CFG_1, CFG_2, CFG_3 and CFG_4

The GNSS control unit offers four sets of configurations.

1. CFG_1: Basic data, compatible with earlier versions of the GNSS control unit
2. CFG_2: Includes everything from CFG_1 with added crane coordinates
3. CFG_3: Extended data
4. CFG_4: Includes everything from CFG_3 but adds the same data as CFG_2

Both the GNSS control unit and the crane controller must use the same configuration set.

The following sections show the structure of the configuration sets.

7.1.2 Configuration Sets CFG_1 & CFG_2

7.1.2.1 GNSS Control Unit –> Crane Controller (CFG_1 & CFG_2)

7.1.2.1.1 CAN Identifier 192 hex / 402 dec, Length: 8 Byte

Table 26 *CAN Identifier 192 hex / 402 dec, Length: 8 Byte*

Byte	Byte order	Description	Unit	Type
1	Lowbyte	X-position	[mm]	Signed long
2	Highbyte			
3	Middlebyte			
4	Topbyte			
5	Lowbyte	Direction angle	[0.01°]	Unsigned integer
6	Highbyte			
7		Block number		Unsigned char
8		Telegram counter		Unsigned char

7.1.2.1.2 CAN Identifier 193 hex / 403 dec, Length: 8 Byte

Table 27 *CAN Bus data telegr. structure CAN Identifier 193 hex / 403 dec, Length: 8 Byte*

Byte	Byte order	Description	Unit	Type
1	Lowbyte	Y-position	[mm]	Signed long
2	Highbyte			
3	Middlebyte			
4	Topbyte			
5	Lowbyte	Speed	[cm/s]	Signed integer
6	Highbyte			
7		DGPS status ♦ Bit 0: error ♦ Bit 3: normal position ♦ Bit 4-7: quality parameter (see Table 40 on page 64)		Unsigned char
8		Telegram counter		Unsigned char

7.1.2.2 GNSS Control Unit –> Crane Controller (CFG_2 only)

Includes CFG_1. Adds the following data.

Absolute Coordinates

Coordinate System: WGS84

Latitude Position: XXYY.ZZZZZZZZ ⇒ XX°YY.ZZZZZZZZ‘
Latitude Direction: N (North), S (South)

Longitude Position: XXXYY.ZZZZZZZZ ⇒ XXX°YY.ZZZZZZZZ‘
Longitude Direction: E (East), W (West)

7.1.2.2.1 CAN Identifier 194 hex / 404 dec, Length: 5 Byte

Table 28 *CAN Identifier 194 hex / 404 dec, Length: 5 Byte*

Byte-No.	Description	Type
1	“N“ / “S“ (North or South)	ASCII char
2	X (Latitude)	ASCII char
3	X (Latitude)	ASCII char
4	Y (Latitude)	ASCII char
5	Y (Latitude)	ASCII char

7.1.2.2.2 CAN Identifier 195 hex / 405 dec, Length: 8 Byte

Table 29 *CAN Identifier 195 hex / 405 dec, Length: 8 Byte*

Byte-No.	Description	Type
1	Z (Latitude)	ASCII char
2	Z (Latitude)	ASCII char
3	Z (Latitude)	ASCII char
4	Z (Latitude)	ASCII char
5	Z (Latitude)	ASCII char
6	Z (Latitude)	ASCII char
7	Z (Latitude)	ASCII char
8	Z (Latitude)	ASCII char

7.1.2.2.3 CAN Identifier 196 hex / 406 dec, Length: 6 Byte

Table 30 *CAN Identifier 194 hex / 404 dec, Length: 5 Byte*

Byte-No.	Description	Type
1	“E“ / “W“ (East or West)	ASCII char
2	X (Longitude)	ASCII char
3	X (Longitude)	ASCII char
4	X (Longitude)	ASCII char
5	Y (Longitude)	ASCII char
6	Y (Longitude)	ASCII char

7.1.2.2.4 CAN Identifier 197 hex / 407 dec, Length: 8 Byte

Table 31 *CAN Identifier 195 hex / 405 dec, Length: 8 Byte*

Byte-No.	Description	Type
1	Z (Longitude)	ASCII char
2	Z (Longitude)	ASCII char
3	Z (Longitude)	ASCII char
4	Z (Longitude)	ASCII char
5	Z (Longitude)	ASCII char
6	Z (Longitude)	ASCII char
7	Z (Longitude)	ASCII char
8	Z (Longitude)	ASCII char

7.1.2.3 Crane Controller –> GNSS Control Unit (CFG_1 & CFG_2)

7.1.2.3.1 CAN Identifier 181 hex / 385 dez, Length: 8 Byte

Table 32 *CAN Identifier 181 hex / 385 dez, Length: 8 Byte (part 1 of 2)*

Byte	Byte order	Description	Unit	Type
1	Lowbyte	X-position from the vehicle control	[mm]	Signed long
2	Highbyte			
3	Middlebyte			
4	Topbyte			

Table 32 *CAN Identifier 181 hex / 385 dez, Length: 8 Byte (part 2 of 2)*

Byte	Byte order	Description	Unit	Type
5		Container weight	[t]	Unsigned char
6	Lowbyte	Trolley position	[mm]	Signed long
7	Highbyte			
8		telegram counter		

7.1.2.3.2 CAN Identifier 182 hex / 386 dez, Length: 2 Byte

Table 33 *CAN Identifier 182 hex / 386 dez, Length: 2 Byte*

Byte	Description	Unit	Type
1	vehicle status Bit 3 2 → position: “spinturn“ 1 → position: “cross travel“ 0 → position: “normal“		Unsigned char
2	not used		

7.1.3 Configuration Sets CFG_3 & CFG_4

7.1.3.1 GNSS Control Unit –> Crane Controller (CFG_3 & CFG_4)

7.1.3.1.1 CAN Identifier 192 hex / 402 dec, Length: 8 Byte

Table 34 *CAN Identifier 192 hex / 402 dec, Length: 8 Byte*

Byte	Byte order	Description	Unit	Type
1	Topbyte	X-position	[mm]	Signed long
2	Middlebyte			
3	Highbyte			
4	Lowbyte			
5	Highbyte	Angle	[0.01°]	Unsigned integer
6	Lowbyte			
7	Highbyte	Shift	[mm]	Signed integer
8	Lowbyte			

7.1.3.1.2 CAN Identifier 193 hex / 403 dec, Length: 8 Byte

Table 35 *CAN Bus data telegr. structure CAN Identifier 193 hex / 403 dec, Length: 8 Byte*

Byte	Byte order	Description	Unit	Type
1	Topbyte	Y-position	[mm]	Signed long
2	Middlebyte			
3	Highbyte			
4	Lowbyte			
5	Highbyte	Speed	[cm/s]	Signed integer
6	Lowbyte			
7		Block Code		Unsigned char
8		Status Control Unit (s. 7.3.1 on page 63)		Unsigned char

7.1.3.2 GNSS Control Unit –> Crane Controller (CFG_4 only)

Includes CFG_3. For the additional data see section 7.1.2.2 „GNSS Control Unit –> Crane Controller (CFG_2 only)“ on page 58.

7.1.3.3 Crane Controller –> GNSS Control Unit (CFG_3 & CFG_4)

7.1.3.3.1 CAN Identifier 181 hex / 385 dez, Length: 8 Byte

Table 36 *CAN Identifier 181 hex / 385 dez, Length: 8 Byte*

Byte	Byte order	Description	Unit	Type
1	Highbyte	Trolley position	[mm]	Signed integer
2	Lowbyte			
3	Highbyte	Lifting unit position	[mm]	Signed integer
4	Lowbyte			
5		Weight of the load	[t]	Unsigned char
6		Spreader state (s. 7.3.3 on page 64)		Unsigned char
7		Status Crane Controller (s. 7.3.4 on page 65)		Unsigned char
8		unused		Unsigned char

7.2 Ethernet/UDP Communication & PROFINET Communication

7.2.1 GNSS Control Unit –> Crane Controller (CFG_1 & CFG_2)

Table 37 *Ethernet/UDP & Profinet communication: GNSS Control Unit –> Crane Controller (CFG_1 & CFG_2) (part 1 of 2)*

Byte	Byte order	Description	Unit	Byte
CFG_1				
1	Topbyte	X-position	[mm]	signed long
2	Middlebyte			
3	Highbyte			
4	Lowbyte			
5	Topbyte	Y-position	[mm]	signed long
6	Middlebyte			
7	Highbyte			
8	Lowbyte			
9	Highbyte	Angle	[0,01°]	unsigned integer
10	Lowbyte			
11	Highbyte	Shift	[mm]	signed integer
12	Lowbyte			
13	Highbyte	speed	[cm/s]	signed integer
14	Lowbyte			
15		Block Code		unsigned char
16		Status Control Unit (see 7.3.1 on page 63)		unsigned char
CFG_2 (for the format of the coordinates see section 7.1.2.2 on page 58)				
17		“N“ / “S“ (North or South)		ASCII char
18		X (Latitude)		ASCII char
19		X (Latitude)		ASCII char
20		Y (Latitude)		ASCII char
21		Y (Latitude)		ASCII char
22		Z (Latitude)		ASCII char
23		Z (Latitude)		ASCII char
24		Z (Latitude)		ASCII char
25		Z (Latitude)		ASCII char
26		Z (Latitude)		ASCII char
27		Z (Latitude)		ASCII char
28		Z (Latitude)		ASCII char
29		Z (Latitude)		ASCII char
30		“E“ / “W“ (East or West)		ASCII char
31		X (Longitude)		ASCII char
32		X (Longitude)		ASCII char

Table 37 *Ethernet/UDP & Profinet communication: GNSS Control Unit –> Crane Controller (CFG_1 & CFG_2) (part 2 of 2)*

Byte	Byte order	Description	Unit	Byte
33		X (Longitude)		ASCII char
34		Y (Longitude)		ASCII char
35		Y (Longitude)		ASCII char
36		Z (Longitude)		ASCII char
37		Z (Longitude)		ASCII char
38		Z (Longitude)		ASCII char
39		Z (Longitude)		ASCII char
40		Z (Longitude)		ASCII char
41		Z (Longitude)		ASCII char
42		Z (Longitude)		ASCII char
43		Z (Longitude)		ASCII char

7.2.2 Crane Controller –> GNSS Control Unit (CFG_1 & CFG_2)

Table 38 *Ethernet/UDP & Profinet communication: Crane Controller –> GNSS Control Unit (CFG_1 & CFG_2)*

Byte	Byte order	Description	Unit	Type
1	Highbyte	trolley position	[mm]	signed integer
2	Lowbyte			
3	Highbyte	Lifting unit position	[mm]	signed integer
4	Lowbyte			
5		Weight of the load	[t]	unsigned char
6		Spreader state (see 7.3.3 on page 64)		unsigned char
7		Status Crane Controller (see 7.3.4 on page 65)		unsigned char

7.3 Explanations

7.3.1 Status Control Unit

Table 39 *Status Control Unit*

Bit	Description
0	Quality / accuracy of the GNSS Position (see 7.3.2 on page 64)
1	
2	
3	
4	
5	
6	
7	Error

7.3.2 Quality Parameter GNSS Position

Table 40 *Quality parameter GNSS position*

Quality	Bit				Accuracy
	3	2	1	0	
15	1	1	1	1	<= 1 cm
14	1	1	1	0	<= 2 cm
13	1	1	0	1	<= 3 cm
12	1	1	0	0	<= 5 cm
11	1	0	1	1	<= 7 cm
10	1	0	1	0	<= 10 cm
9	1	0	0	1	<= 15 cm
8	1	0	0	0	<= 20 cm
7	0	1	1	1	<= 30 cm
6	0	1	1	0	<= 50 cm
5	0	1	0	1	<= 70 cm
4	0	1	0	0	<= 1 m
3	0	0	1	1	<= 1.5 m
2	0	0	1	0	<= 2 m
1	0	0	0	1	<= 3 m
0	0	0	0	0	bad GNSS

7.3.3 Spreader State

Table 41 *Spreader state*

Bit	Description
0	Twist locks closed
1	Container detected
2	
3	
4	
5	Spreader position at 20 foot
6	Spreader position at 40 foot
7	Spreader position at 45 foot

7.3.4 Status Crane Controller

Table 42 *Status Crane Controller*

Bit	Description
0	Wheels in position: Normal
1	Wheels in position: Cross Travel
2	Wheels in position: Spin Turn
3	Autosteering activated
4	
5	
6	
7	

8 Commissioning

For the commissioning the steps in the chapters prior to this chapter are important. Below you can find two check lists for the Reference Station resp. the Rovers that link to the corresponding sections.

Götting offers commissioning support on site or training for commissioning. Please contact the sales department for a quote.

8.1 Reference Station

Table 43 *Commissioning Checklist Reference Station*

Step	Description	Done
1.	Wiring according to drawing? *See section 4.1.1 on page 18*	❑
2.	UPS and battery correctly wired? *See section 4.5 on page 23*	❑
3.	GNSS receiver configured? *See section 5.2.1 on page 45*	❑
4.	Radio modem configured? *See section 5.3 on page 50*	❑
5.	Average position saved? *See Figure 61 on page 47*	❑
6.	GNSS signal quality verified? *See section 5.4 on page 54*	❑
7.	Firmware version ok? *See section 5.1.8 on page 43*	❑
8.	Parameter updated? *See section 5.1.7 on page 42*	❑

8.2 Rover

For the cranes (Rovers) the usual process is to commission a master crane, save its parameters and then import them into subsequent cranes (see section 5.1.7 on page 42). If necessary set offsets on the subsequent cranes instead of changing the master values (see section 5.1.4 on page 34).

Table 44 *Commissioning Checklist Rover*

Step	Description	Done
1.	Wiring according to drawing? *See section 4.1.2 on page 19*	❑
2.	GNSS receiver configured? *See section 5.2.2 on page 48*	❑
3.	Radio modem configured? *See section 5.3 on page 50*	❑
4.	GNSS signal quality verified? *See section 5.4 on page 54*	❑
5.	GNSS position solution ok? *See section 5.5 on page 55*	❑
6.	Firmware version ok? *See section 5.1.8 on page 43*	❑
7.	Parameter updated? *See section 5.1.7 on page 42*	❑
8.	Heading offset adjusted? *See section 5.1.4.3 on page 38*	❑
9.	Program Blocks? *See section 5.1.5 on page 40*	❑

9 Trouble Shooting

If you should not be able to correct an occurring error, please use the table to locate the source of the error as exactly as possible (nature of malfunction, at which point of time did the error occur, etc.) before contacting us.

Tipp

If you need support by Götting it helps if you collect log files and have them ready to send to us, see chapter 6 on page 56.

Table 45 *Trouble shooting*

Error	Possible cause	Diagnosis / possible correction
System Error - Parameter File	Configuration file faulty	Check the configuration and save it anew with *OK*. Then restart the control unit.
Application Error - Bad GNSS Data	Data from GNSS receiver insufficient	Check the configuration of the GNSS receiver.
Application Error - No Base Vector	Insufficient GNSS reception via ANT1	Check ANT1 and its connections/ cables.
Application Error - No Heading	Insufficient GNSS reception via ANT2	Check ANT2 and its connections/ cables.
Application Error - No Correction Data	Insufficient reception of correction data	Check radio modem (configuration), antenna cabling, antenna and data line to control unit.
Application Error - Profinet	No communication to PLC via PROFINET	– Check configuration – Check cabling
Application Error - Ethernet/ UDP	No communication to PLC via Ethernet/UDP	– Check configuration – Check cabling
Application Error - CAN1	No communication to PLC via CAN	– Check configuration – Check cabling – Check switch position for terminating resistor

10 Maintenance

The system is maintenance free.

11 Technical Data

11.1 Control Unit

Table 46 *Technical Data Control Unit HG G-61430YD*

Control Unit HG G-61430YD	
Casing	Aluminium
Dimensions	– Basic configuration: 208 mm x 105 mm x 66 mm (W x H x D, s. Figure 5 on page 12) – With PROFINET extension module: 237 mm x 105 mm x 66 mm (W x H x D, s. Figure 18 on page 17)
Weight	– Basic configuration with GNSS: 950 g – With PROFINET extension module: 1050 g
Operating temperature	-25 to 70° C
Storage temperature	-40 to 85° C
Protection class	IP20
Shock / vibration	DIN rail mount: 3.5 mm from 5-9 Hz, 1G from 9-150 Hz 10 sweeps each axis, 1 octave per minute
Relative humidity	95 % @ 25° C (not condensating)
Interfaces	See section 3.5 on page 38
Supply Voltage	Nominal: 12 – 24 Volt (Maximum range 10 – 30 Volt)
Current consumption	– Basic configuration: 350 mA @ 24 Volt – With PROFINET extension module: 400 mA @ 24 V

11.2 GNSS Antenna

Table 47 *Technical Data HW ANT00044 Zephyr 2 Rugged*

HW ANT00044 Zephyr 2 Rugged	
Dimensions	ø 25,4 cm x 11.1 cm height (s. Figure 28 on page 25)
Weight	1.8 kg
Operating temperature	-40° C to 70° C
Supply Voltage	3.5 V DC to 20 V DC
Input current	125 mA maximum

11.3 RF Antennas

Table 48 *Technical Data HW ANT00007 Reference Station*

HW ANT00007 Reference Station	
Height	515 mm
Weight	0.8 kg
Frequency range	406 – 470 MHz

Table 49 *Technical Data HW ANT00004 Rover*

HW ANT00004 Rover	
Height	300 mm
Weight	approx. 50 g
Frequency range	440 – 470 MHz

11.4 Antenna Cables

Table 50 *Technical Data ECOFLEX10 Cable*

ECOFLEX10 Cable	
Installation Temperature	-40° C to 60° C
Operating temperature	-55° C to 85° C
Storage temperature	-70° C to 85° C
Pulling strength	5 daN
Min. bending radius	80 mm

Table 51 *Technical Data RG58 Cable*

RG58 Cable	
Installation Temperature	-20° C to 60° C
Operating temperature	-25° C to 85° C
Min. bending radius	50 mm

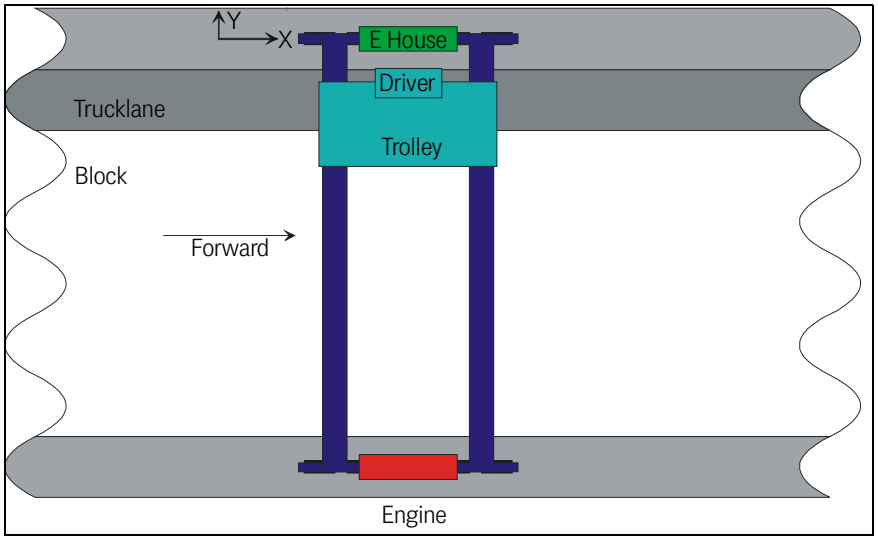
12 Appendix

12.1 Algorithm for Automatic Steering

The system provided by Götting, which enables automatically steering of RTG, outputs only a position and an angle within the local coordinate system of the currently used block. In order to achieve automatic steering of the RTG, it is essential to implement an algorithm within the crane PLC, which will convert the values of position and angle in such a way, that the velocities of the right and left hand drives are corrected accordingly.

As Götting can rely on experiences derived from transponder-based track guiding, our suggestion is an algorithm already known and proven from the use with transponder systems. The position and angle information received from the DGNSS is converted into deviations of two virtual transponder antennas. The algorithm will then calculate a corresponding correction value from these deviations. This value is then added to the nominal velocity on the E house side and subtracted from the velocity on the diesel/engine side.

Figure 78 *RTG moving in a block (example)*



For the definition of blocks see section 5.1.5 on page 40.

Figure 79 *Simplified RTG on a block*

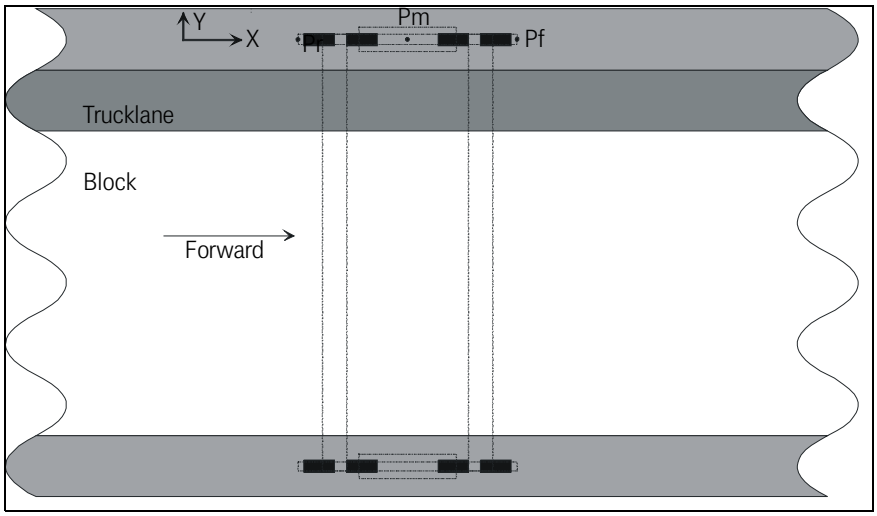


Figure 79 shows a simplified RTG on a block. In addition, the transferred position `Pm` (point between the wheels) is indicated in this figure. The other two given points `Pr` and `Pf` are the positions of the two virtual transponder antennas.

Figure 80 *Drive on the E house side*

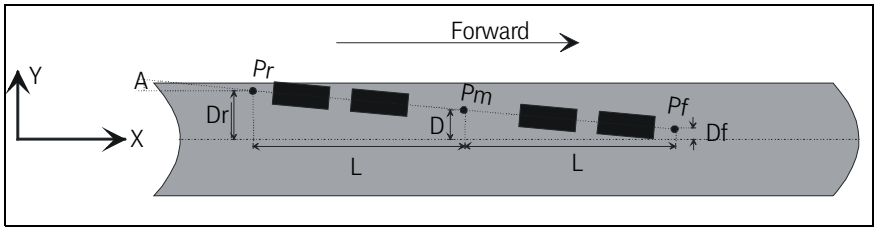


Figure 80 shows the drive on the E house side. This figure will be used to explain the suggested algorithm.

`D` is the deviation from the ideal track received from the DGNSS System. As the definition of the blocks is done in such a way that the ideal track is identical with the x axis, `D` is the `Y` value of the DGNSS system. This value should be in the geometrical center of the drive. `A` is the angle given by the DGNSS System. Using this information, it is possible to calculate the deviations `Df` and `Dr`, with `Df` being the deviation of the virtual transponder antenna in the front and `Dr` being the deviation of the virtual transponder antenna in the rear.

`D = Y` (directly from the DGNSS system)

```
Df = D + sin(A) * L
Dr = D - sin(A) * L
```

The correction value is calculated as follows:

```
K = Kp * (Ks * Df - (1-Ks) * Dr) * V   [valid for V > 0]
K = Kp * ((1-Ks) * Df - Ks * Dr) * -V  [valid for V < 0]
K = 0                                  [valid for V = 0]
```

With `Ks = 0.7` (selectable between 1 and 0.5)

and `V = set velocity`

`Kp` enables changing the amplification. This parameter depends on the crane and is set during the commissioning of the crane. It may be advisable to reduce `Kp` for higher velocities.

Ks is responsible for the behavior of the crane when returning to the ideal track. E.g. if `Ks = 0.5`, the crane will align itself quickly parallel to the ideal track, but will never return onto the ideal track itself. If `Ks = 1`, the crane would return quickly onto the ideal track. However, in this case, the system will more easily start to swing. `0.7` has proven to be a good compromise.

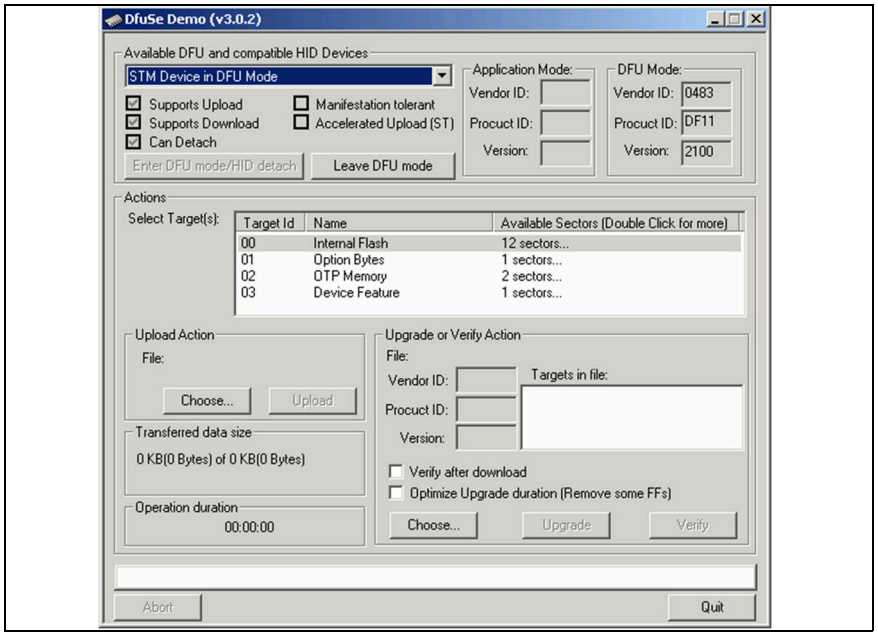
12.2 Firmware Update via the USB Interface

You can download the Firmware Update Software `DfuSe_Demo_Vx.x.x_Setup.exe` from:

http://goetting-agv.com/components/57652

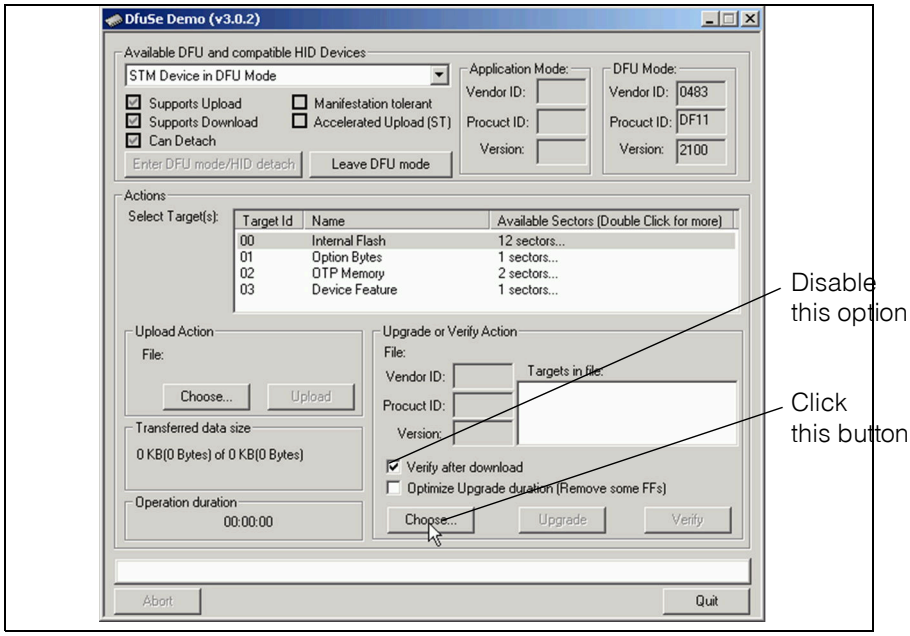
1. Preparation: Install the PC software by executing `DfuSe_Demo_Vx.x.x_Setup.exe`.
2. Power the control unit off.
3. Switch SW2 to "ON".
4. Connect the computer with the Type B USB interface of the navigation controller. Usually the device is detected and all drivers are installed automatically.
5. Use the windows start menu to start the program "DfuSe Demonstration" in Start > Programme > STMicroelectronics > DfuSe > Run DfuSe Demonstration. The following screen should be shown when a navigation controller is connected:

Figure 81 *Firmware Update Software: Start screen*



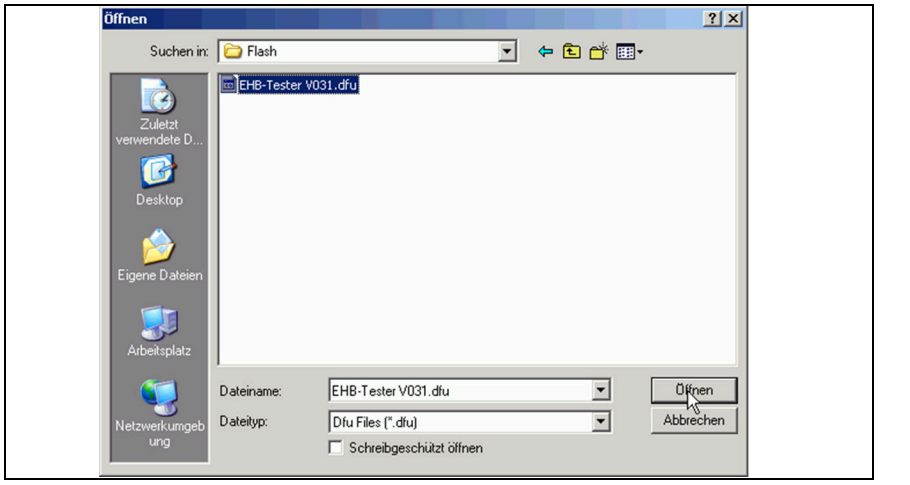
6. Disable the option "Verify after download" in the section "Upgrade or Verify Action". Click "Choose" iin the section "Upgrade or Verify Action".

Figure 82 *Firmware Update Software: Adjust options*



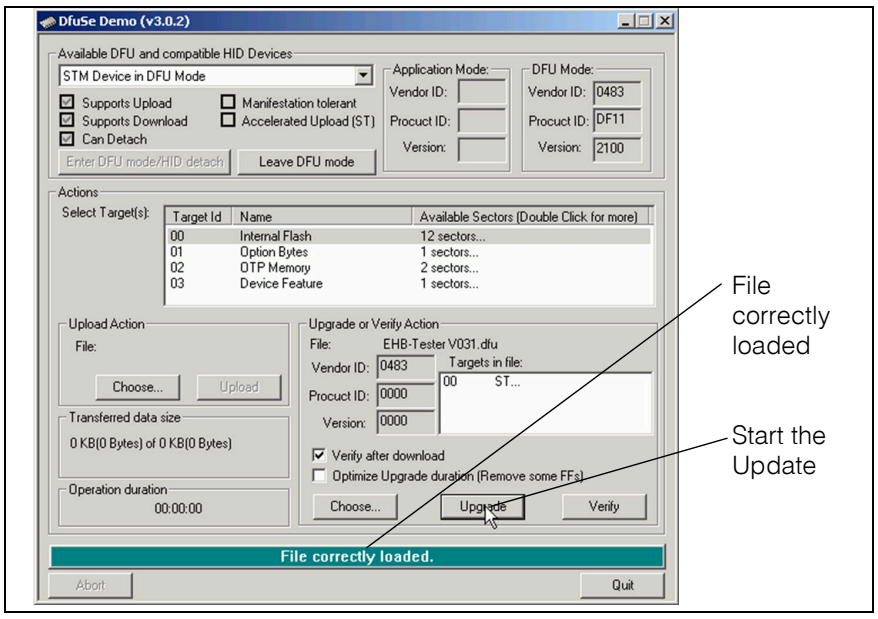
7. Choose a firmware file with the type `*.dfu`

Figure 83 *Firmware Update Software: Choose firmware file*



8. Status message: "File correctly loaded." Now click on „Upgrade“.

Figure 84 *Firmware Update Software: Start the update*

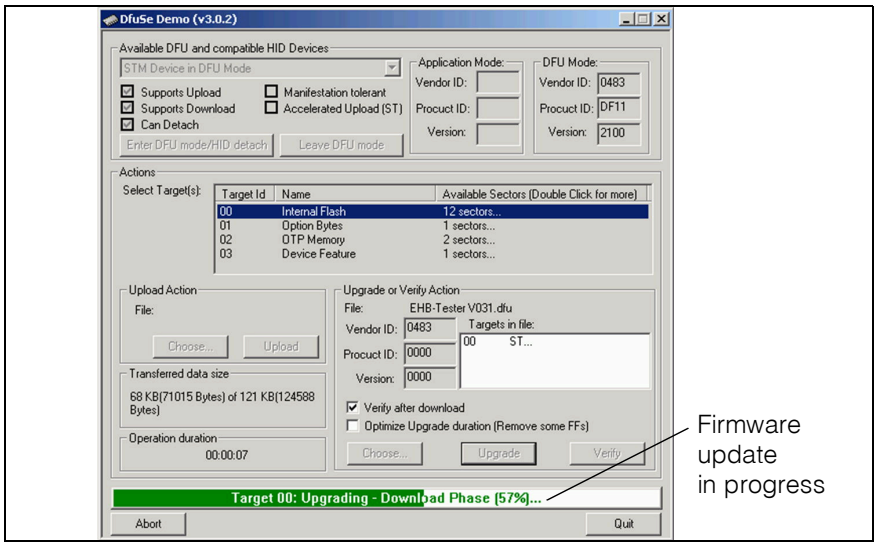


9. The following dialog appears. Confirm by clicking „Yes“.

Figure 85 *Firmware Update Software: Confirmation dialog*

10. Afterwards the deletion and programming process starts.

Figure 86 *Firmware Update Software: Update running*



11. When it is finished power the control unit off, remove the USB cable and switch SW2 to "OFF".

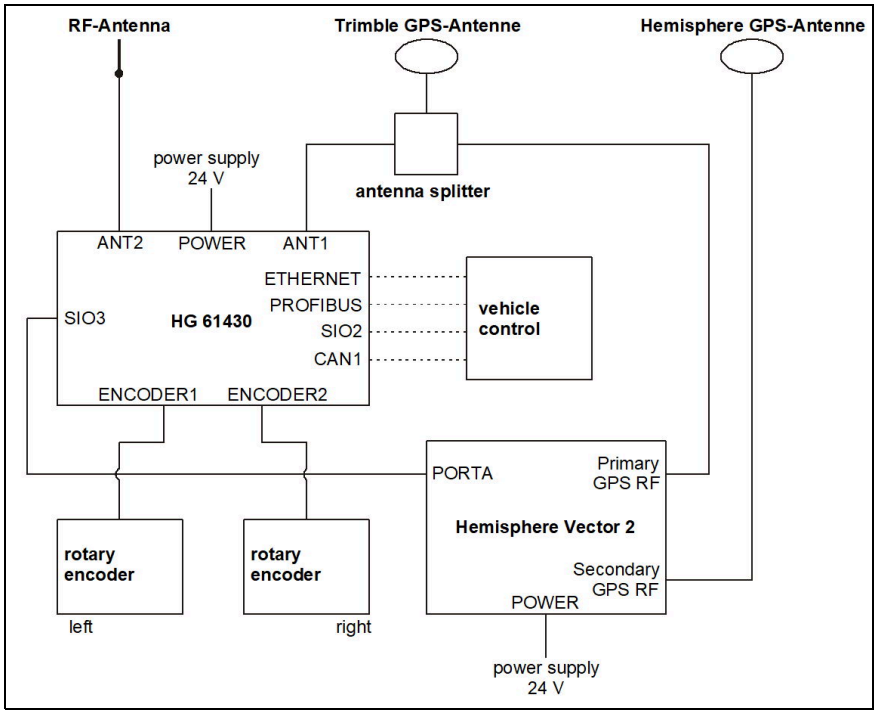
12. Wait at least 2 minutes before turning the control unit on again.

12.3 Migration HG G-61430ZA/ZB —> HG G-61430YD

This section describes the consequences of the discontinuation of the Control Unit HG G-61430ZA/ZB and the migration to HG G-61430YD for the different scenarios.

12.3.1 Existing Installation with Control Unit HG G-61430ZA

Figure 87 *System HG S-57652ZB with Control Unit HG G-61430ZA (Rover)*



12.3.2 Defective Control Unit HG G-61430ZA

The device can be repaired except for the satellite receiver for at least the next 10 years.

The BD950 satellite receiver used in this device has been discontinued and cannot be replaced in the event of a defect.

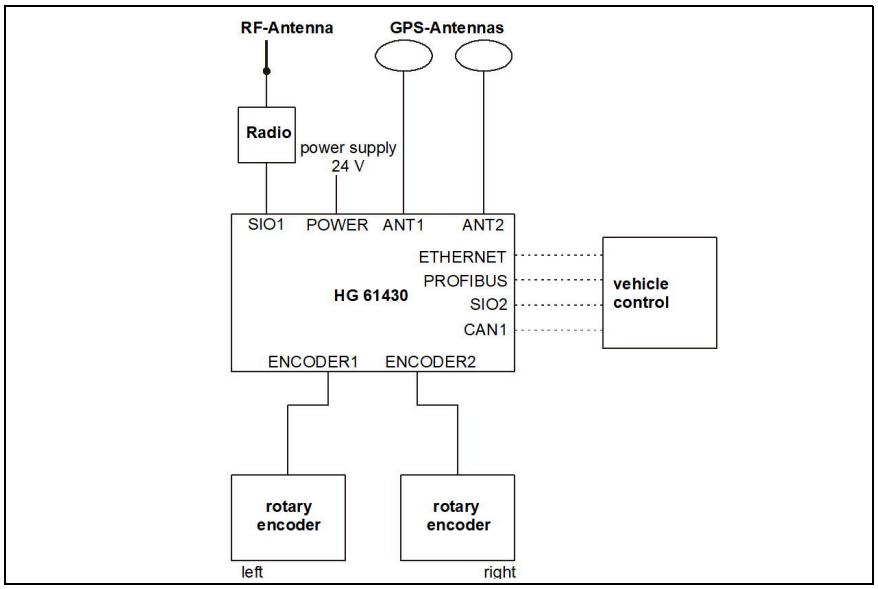
12.3.3 Control Unit HG G-61430ZA is to be replaced

Required hardware changes:

1. Secondary GNSS antenna is replaced by Trimble Zephyr Antenna.
2. Antenna splitter is dismantled.
3. Hemisphere GPS receiver is dismantled.
4. Further steps see section 12.4.2 on page 78 (Hardware changes + Parameterization) as below.

12.4 Existing Installation with Control Unit HG G-61430ZB

Figure 88 *System HG S-57652ZC with HG G-61430ZB (Rover)*



12.4.1 Defective Control Unit HG G-61430ZB

Goetting will be able to deliver repair services for this device for at least the next 10 years. As of today, Trimble has not announced any plans to discontinue the BD 982 GNSS receiver.

12.4.2 Control Unit HG G-61430ZB is to be replaced

Required hardware changes:

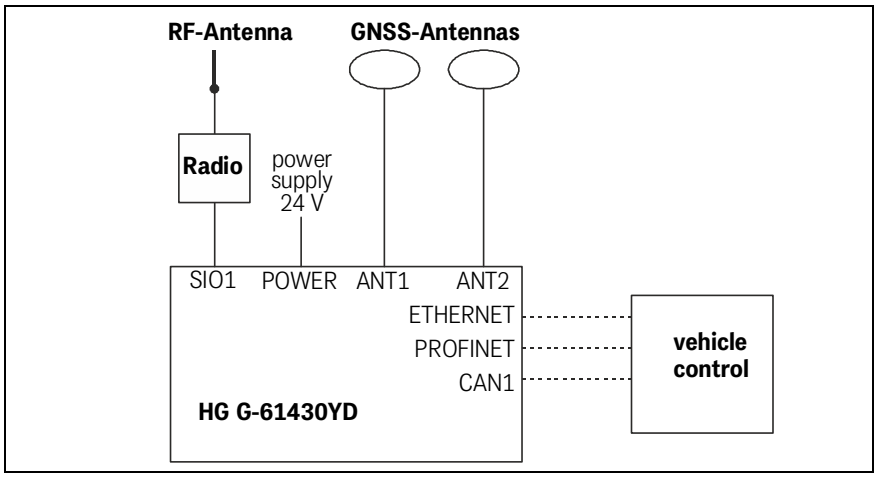
1. Connection cable between Control Unit and radio modem is exchanged.
2. The existing connectors must be replaced with new connectors. *Due to the high accuracy of the current GNSS receiver and our improved algorithms, the use of incremental encoders is no longer necessary for GNSS applications.*

Necessary changes to the parameterization:

3. The required settings can mainly be determined from the old files. This can be done by an employee of Götting KG who then provides the customer with a new configuration file.
4. The individual crane parameters are determined together with a complete system test during a short, re-commissioning. This can only be done by trained persons and is also supported by Götting KG if required.

12.5 Final Installation with Control Unit HG G-61430YD

Figure 89 *System HG S-57652ZD with HG G-61430YD (Rover)*



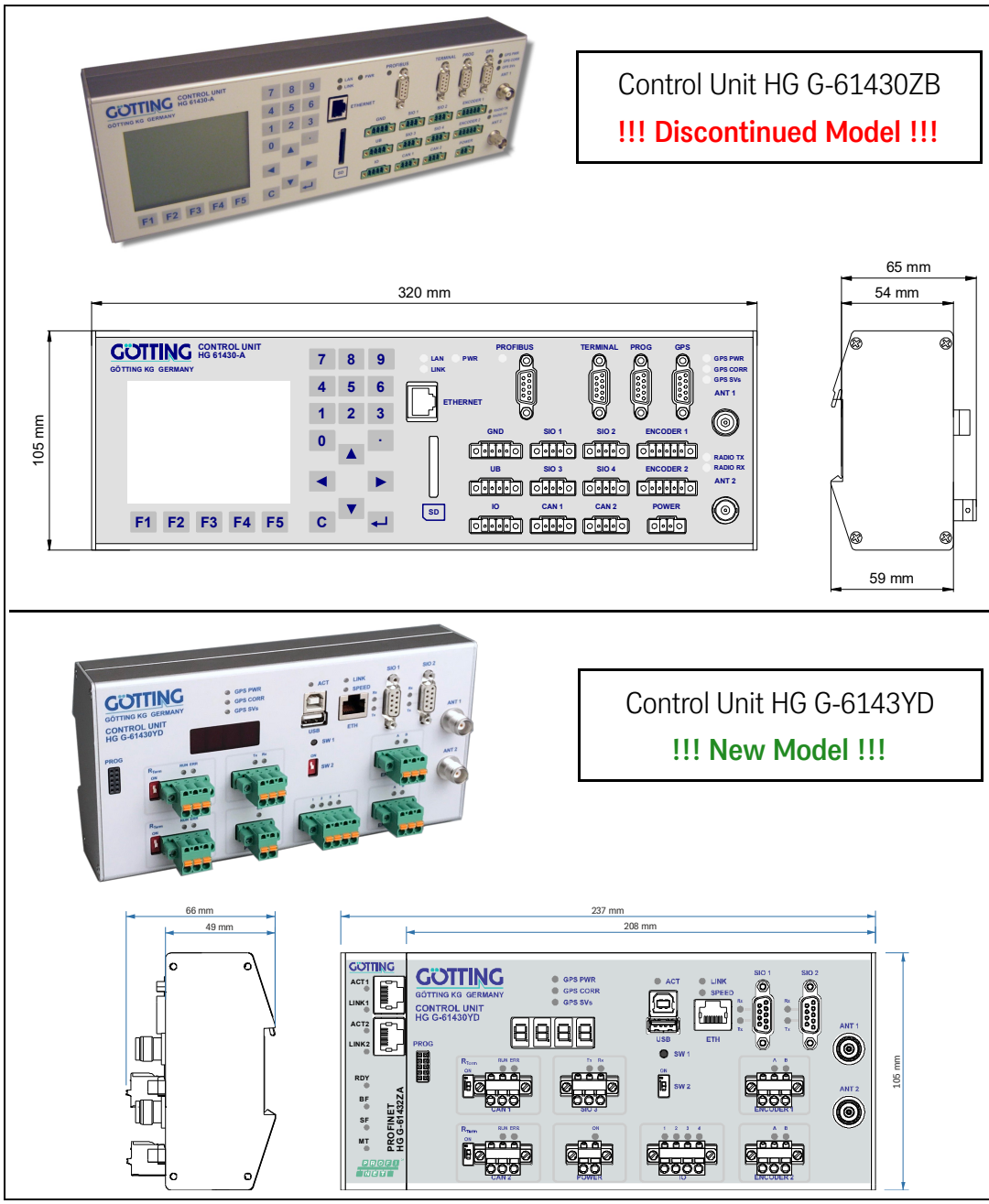
12.6 Changed Features (new model versus discontinued model)

Table 52 *Changed features*

Feature (HG G-61430YD)	Benefit / Remark
Casing dimension reduced	Less installation space needed
Larger Connectors	– Easier installation of cables – Larger cable cross-sections
Elimination of the small LC Display (simple status display on the device instead)	– Display was relatively hard to read – Operation now conveniently via a web interface with a standard web browser – Control Unit can be accessed from anywhere over the network
No incremental encoders required.	Cost savings **Remark:** *The HG G-61430YD hardware is equipped with inputs for encoders.* *Due to the high accuracy of the current GNSS receivers and improved algorithms, the connection of incremental encoders is no longer necessary for GNSS applications.* *The software of System HG S-57652ZD is designed for operation without incremental encoder signals.*
PROFINET interface available	Easier and cheaper connection to the usual programmable logic controllers
Processing speed increase by factor 30	Provides expansion reserves for future applications
Ease of use	Compared to the predecessor model, there are considerable advantages for the user due to the clear display and operation via the web interface

12.7 View and Dimension

Figure 90 *Control Unit Comparison: Discontinued and new model*



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16 Copyright and Trade Marks

16.1 Copyright

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Any information given is to be understood as system description only, but is not to be taken as guaranteed features. Any values are reference values. The product characteristics are only valid if the systems are used according to the description.

This instruction manual has been drawn up to the best of our knowledge. Installation, setup and operation of the device will be on the customer's own risk. Liability for consequential defects is excluded. We reserve the right for changes encouraging technical improvements. We also reserve the right to change the contents of this manual without having to give notice to any third party.

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Innovation through Guidance

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