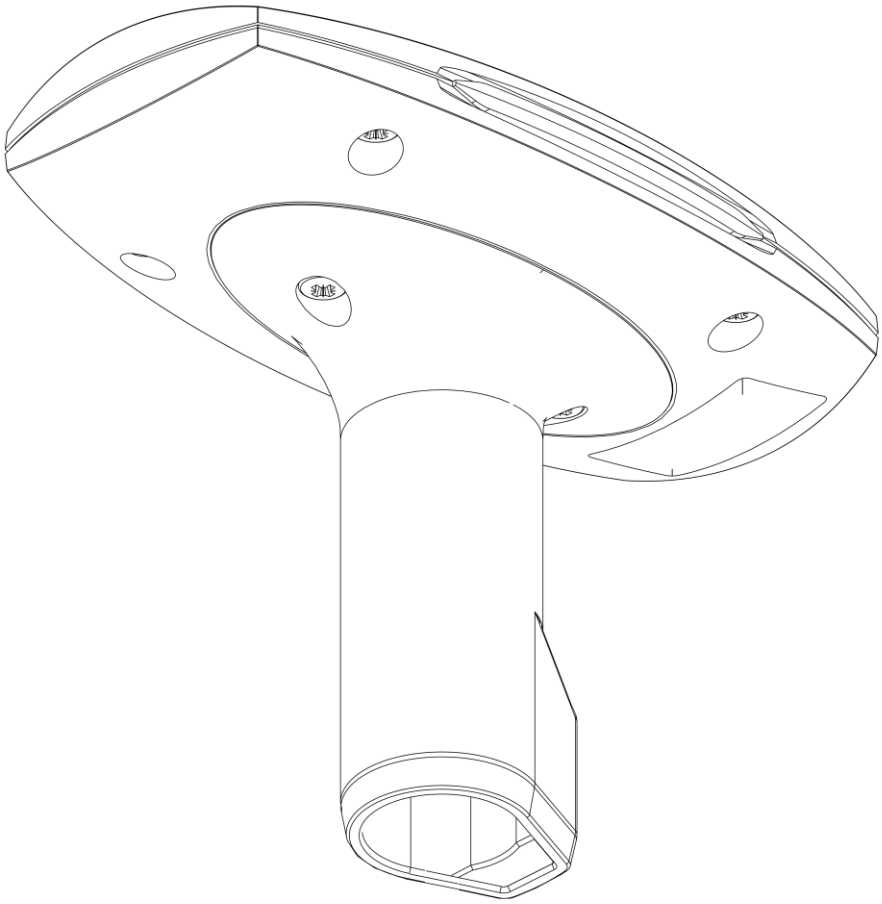
User & Installation Manual

LT-1000 NRU



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Disclaimer

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Disposal

Old electrical and electronic equipment marked with this symbol can contain substances hazardous to human beings and the environment. Never dispose these items together with unsorted municipal waste (household waste). In order to protect the environment and ensure the correct recycling of old equipment as well as the re-utilization of individual components, use either public collection or private collection by the local distributor of old electrical and electronic equipment marked with this symbol. Contact the local distributor or dealer for information about what type of return system to use.

IMO and SOLAS

The equipment described in this manual is intended for use on leisure and commercial marine boats not covered by the International Maritime Organization (IMO) and Safety of Life at Sea (SOLAS) regulations.

⚠ Safety Instructions for Installer & Operator

The following safety instructions must be observed during all phases of operation, installation, service and repair of this equipment. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture and intended use of the equipment.

Lars Thrane A/S assumes no liability for the customer's failure to comply with these requirements.

Instructions for the Installer

⚠ WARNING - Product installation

To ensure correct performance of this equipment, it is strongly recommended that professionals, with expertise, properly trained, and likewise authorized within the industry is completing the installation.

⚠ WARNING – Turn off power switch

Turn off the main power switch before installing the equipment described in this manual. Do not connect or disconnect equipment when the main power switch is on.

⚠ WARNING – Use only the supplied cable

Use only the supplied power and communication cable for connecting the equipment.

⚠ WARNING – Input Power

The input voltage range is: 9-40 VDC.

⚠ WARNING – Power supply protection

Make sure that the power supply is adequately protected by a fuse or an automatic circuit breaker when installing the equipment.

⚠ WARNING - Explosive atmosphere

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical equipment in such an environment constitutes a definite hazard.

⚠ WARNING - Compass safe distance

The compass safe distance for standard and steering compasses is 0.3 m (1 ft). Observe this distance to prevent interference to a magnetic compass.

Instructions for the Operator

⚠ WARNING – Do not disassemble

Do not disassemble or modify this equipment. Fire, electrical shock, or serious injury can result.

⚠ WARNING – Keep away from live circuits

Operational personnel must not remove product enclosure. Do not service the equipment, with the communication cable connected. Always disconnect and discharge unit, cable and circuits before touching them.

⚠ WARNING - Permanent watch

In case of smoke or water leaks into the equipment, immediately turn off the power. Continued use of the equipment can cause fire or electrical shock. Keep access and permanent watch of the equipment in order to prevent any unwanted escalation.

⚠ WARNING - Safe navigation

This product is intended only as an aid to navigation and must never be used instead of sound navigation judgement.

No one navigation device should ever be solely replied upon for the navigation of a vessel. Always confirm position against all available aids to navigation, for safety of vessel and crew.

⚠ WARNING - Turn off the autopilot

During deviation calibration and offset adjustment of the product, it is strongly recommended to turn off the autopilot in order to avoid rapid changes in the heading of the boat.

If the safety precautions and warnings above are not followed, warranty will be void.

Required information for the reader

Throughout this document, essential information will be presented to the reader. The following text (emphasized) has the following meaning and/or implication:

WARNING: A 'Warning' is an Operation or Service procedure that, if not avoided, may cause a hazard situation, which could result in personnel death or serious injury.

IMPORTANT: Text marked 'Important' provides essential information to the reader, and is key information to the user in order for the equipment to work properly. Damage to the equipment can occur if instructions are not followed.

NOTE: A 'Note' provides essential information to the reader.

About this manual

Intended readers

This is a User & Installation Manual for LT-1000 Navigation Reference Unit, LT-1000 NRU. The manual is primarily intended for installers and service personnel.

Personnel installing or servicing the system should be professionals, with technical expertise, properly trained, and likewise authorized.

All safety instructions and guidelines in this manual must be observed. The safety instructions are listed in the beginning of the manual. The guidelines are to be found in the separate chapters, where it is needed.

Manual overview

This manual has the following chapters:

- **Introduction** – *provides a high-level description of the product, technology, performance, installation options, and installation steps to be completed.*
- **Quick Installation Guide** – *a short guide providing a minimum of information to complete an installation.*
- **Pre-Installation** - *provides a short description of mounting and installation considerations.*
- **Installation Procedure** - *provides a short description of the installation procedure, which is required to complete.*
- **Mounting** – *mounting of the unit, with a step-by-step instruction for both pole and roof mount installations.*
- **Connecting** – *a description of the connector, 8-pin multi cable, connecting to NMEA 0183, connecting to NMEA 2000, connecting to power, and connecting the LT-Service Tool.*
- **Deviation Calibration** – *a description of the deviation calibration procedure (figure 8-pattern and adaptive), which needs to be completed to provide reliable heading output.*
- **MMI Description** - *a complete description of the LEDs and dip-switch.*
- **LT-Service Tool** – *a short description of the LT-Service Tool. A PC-program, communicating over NMEA 0183, which is supporting configuration and maintenance functions.*
- **Troubleshooting** – *if the unit is not working as expected, please check this guide to help resolve the problem.*
- **Service and Repair** – *a short description of what to do in case of a defective unit.*

This manual has the following appendixes:

- Outline Drawings
- Performance
- Specifications
- NMEA 0183 Sentences
- NMEA 2000 PGNs
- LT-Service Tool (commands)
- Declaration of Conformity

Software versions

This manual is applicable to the following software:

Software Versions	
Description	**Version**
LT-1000 NRU	1.04
LT-Service Tool	1.05

TABLE 1: SOFTWARE VERSIONS

Record of Revisions

Rev.	Description	Release Date	Initials
1.00	Original document	January 19, 2016	PT

1.01	The document is restructured and updated with the following new features:
	• Configuration of deviation calibration mode:
	  ○ Standard (figure 8-pattern)
	  ○ Adaptive
	• Configuration of deviation calibration options
	• Configuration of attitude filter
	• Configuration of NMEA 0183 sentences
		December 20, 2016	PT

Table of Contents

Introduction

Congratulations on your purchase of the LT-1000 Navigational Reference Unit (NRU)!

The LT-1000 Navigation Reference Unit (NRU) is a maritime navigation product from Lars Thrane A/S. The LT-1000 NRU is designed for the leisure as well as the professional maritime markets. The LT-1000 unit meets all standards and certification requirements needed for worldwide maritime navigation equipment.

Performance

The LT-1000 NRU is a small, compact, and very advanced unit with 12 precision sensors (magnetometers, gyros, accelerometers, GNSS, barometer, and thermometer). With the use of sensor fusion and Kalman filtering, the LT-1000 NRU outputs: true heading, magnetic heading, deviation, variation, roll, pitch, position, satellite information, ground speed, course over ground, time and date, air pressure, and temperature in real-time, with high precision and resolution. The LT-1000 NRU includes advanced technologies such as:

- Kalman filtering & sensor fusion
- Calculation of magnetic variation based on the World Magnetic Model (WMM)
- Compensation for soft and hard iron (deviation)
- Built-in magnetometer calibration algorithm
- Receive and track multiple satellite systems (GPS, SBAS, GLONASS, and BeiDou)
- Support for Satellite-Based Augmentation System (SBAS): EGNOS, WAAS and MSAS

The LT-1000 NRU makes use of the latest technology within GNSS receivers, with market leading acquisition and tracking performance.

The LT-1000 NRU is designed and built for the demanding and rough environment at sea and with an operational ambient temperature range from -40°C to +55°C (-40°F to +131°F).

Installation & Navigation

The LT-1000 Navigation Reference Unit is easy to mount on a 1” pole or roof mount with a single cable supporting NMEA 0183, NMEA 2000, and power. Two deviation calibration options are available:

- Standard deviation calibration (figure 8-pattern). Default configuration
- Adaptive deviation calibration

The adaptive deviation calibration algorithm is an alternative to the standard deviation calibration algorithm (figure-8 pattern), intended for vessels that are too large to perform the standard deviation calibration figure-8 pattern. The new adaptive deviation calibration algorithm will improve performance over time as the vessel navigates on different courses. The adaptive deviation calibration algorithm must be activated using the LT-Service Tool. Use the LT-Service Tool for optional configuration and offset adjustment of the LT-1000 NRU. The LT-Service Tool is a PC program, which may run on any Windows PC.

More than 40 years of experience have been put into the design and construction of the advanced LT-1000 NRU, with an exceptional performance and specification level.

Installation Guide

The following steps, with reference to relevant chapters, will provide you with information, considerations, and guidance on how to complete a successful installation:

Step 1:	Pre-installation and considerations	See *Pre-Installation* on page 5.
Step 2:	Mounting the unit:	See *Mounting* on page 8.
Step 3:	Connecting the unit:	See *Connecting* on page 21.
Step 4:	Configuring the unit:	See *Configuration* on page 27.
Step 5:	Calibrating the unit:	See *Deviation Calibration* on page 32.
Step 6:	Configuring the unit (optional):	See *Configuration* on page 27.

NOTE: A quick installation overview is presented in the *Quick Installation Guide* on page 3. Here most of the necessary information is provided to perform a fast installation and take the product in use. It is recommended to use the entire LT-1000 User & Installation Manual as guidance for the best possible and complete installation.

NOTE: A more detailed installation procedure is available in *Installation Procedure* on page 7.

Quick Installation Guide

LT-1000 Navigation Reference Unit

Congratulations on your purchase of the LT-1000 Navigational Reference Unit (NRU)!

The LT-1000 NRU is a small, compact and very advanced unit with 12 precision sensors: Magnetometers, Gyros, Accelerometers, Barometer, Thermometer, and GNSS receiver.

NOTE: Refer to the 95-100178 LT-1000 User & Installation Manual for detailed information on installation requirements and guidance.

Unpacking (in-the-box)

Unpack the LT-1000 NRU and check that the following items are present:

- LT-1000 NRU (incl. pole mount and cable plug)
- LT-1000 NRU Roof Mount (incl. screws for installation)
- 10m Cable Multi 8-pin Simple-Cut (M)
- Screw-in Conn. NMEA 2000 Micro-C (M)
- Quick Installation Guide
- Unit Test Sheet

WARNING

Refer to the 95-100178 LT-1000 User & Installation Manual for Safety Instructions.

Installation

The LT-1000 NRU DIP-switch is configured to 4800 baud (NMEA 0183) and 'Open' (NMEA 2000) from the factory. Alternative DIP-switch settings are 38400 baud (NMEA 0183) and 'Terminated' (NMEA 2000).

Mounting considerations:

- Mount the unit on a rigid structure with a minimum of exposure to vibration and shock
- Mount the unit in an area with an ambient temperature between -40°C and +55°C (-40°F to +131°F)
- Mount the unit far away from possible magnetic interference and power cables
- Mount the unit so that direct spray from seawater is avoided
- Mount the unit so that ventilation through the pole mount is possible

IMPORTANT: The pinol screw used for fastening the pole mount shall not exceed 0.8 NM (0.6 lbs/ft).

Connecting:

The LT-1000 NRU 8-pin female connector and the multi cable (simple-cut) interconnect details are listed in Table 2 and Figure 1.

LT-1000 NRU Interconnect Details		
Pin No.	**Wire Color**	**Wire Designation**
1	Brown	TxD-
2	Yellow	TxD+
3	Black	GND
4	White	CAN_H
5	Blue	CAN_L
6	Orange	RxD+
7	Green	RxD-
8	Red	Vsupply

TABLE 2: LT-1000 NRU MULTI CABLE WIRE COLOR AND DESIGNATION.

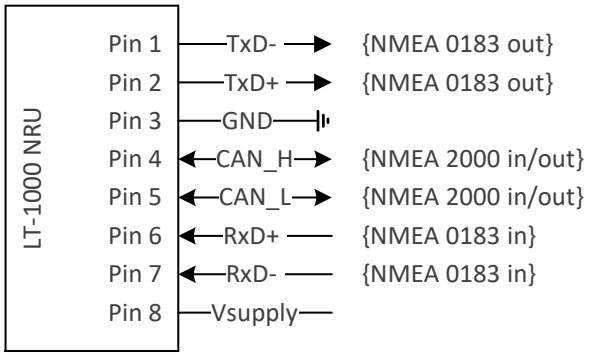


FIGURE 1: LT-1000 NRU TRANSMIT AND RECEIVE DIRECTIONS.

Deviation calibration (figure 8-pattern)

After completed installation, and before configurating the LT-1000 NRU heading offset, it is required to perform a deviation calibration. The calibration must be performed in open and calm waters, and will determine the ship's influence on the magnetic sensors.

The LT-1000 NRU will indicate absence of a valid calibration by outputting heading (true and magnetic) with a 5 degrees resolution. When a calibration has been successful, the heading will be output with full resolution.

The LT-1000 NRU will automatically perform a calibration when it detects the vessel is sailing a specific pattern. To trigger a calibration, guide the vessel through the following pattern. The best result is achieved at low speed (SOG), low rate of turn (ROT) and in calm waters.

Step 1
Keep a steady course (± 5°) for min. 10 s.
SOG: 2–12 knots

Step 2
Make a full circle (360-450°) clockwise or counterclockwise
ROT: 2-6°/s (1-3 min.)
SOG: 2-12 knots

Step 3
Make a full circle (360-450°) in opposite direction
ROT: 2-6°/s (1-3 min.)
SOG: 2-12 knots

Step 4
Keep a steady course (± 5°) for min. 10 s.
SOG: 2–12 knots

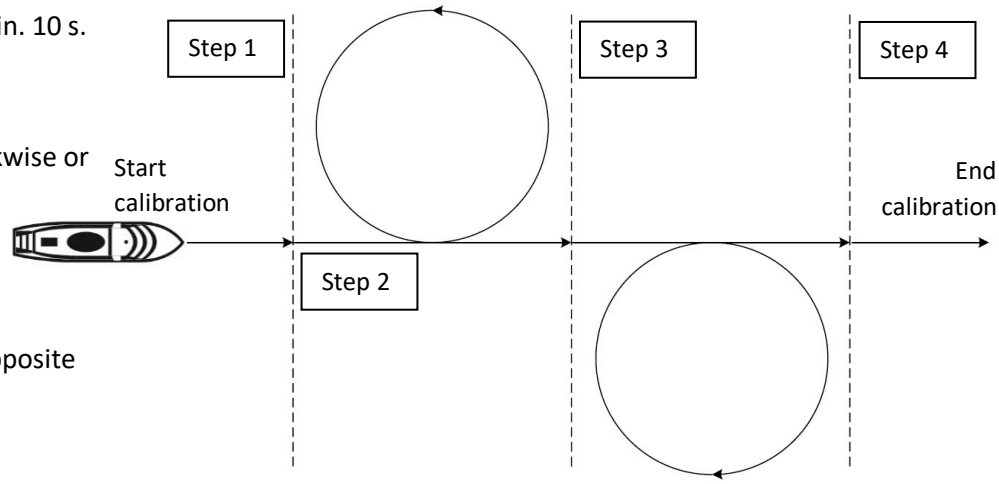


FIGURE 2: DEVIATION CALIBRATION (FIGURE 8-PATTERN) FOR THE LT-1000 NRU.

IMPORTANT: If the LT-1000 NRU is physically moved or rotated, it is required to perform a new calibration. Refer to the LT-1000 User & Installation Manual on how to use the LT-Service Tool to verify a subsequent calibration.

Configuration (optional)

Use the LT-Service Tool for optional configuration and offset adjustment of the LT-1000 NRU. The LT-Service Tool is a PC program (LT-Service_vX.XX.exe) which may run on any Windows PC. The LT-Service Tool is connected to the LT-1000 NRU via the NMEA 0183 interface, see Figure 3.

LT-Service Tool functionality:

- Configuration of deviation calibration mode (Standard or Adaptive)
- Configuration of NMEA 0183 sentences
- Configuration of Heading, Pitch, Roll offset
- Configuration of Vertical offset
- Configuration of GNSS receiver (GPS, SBAS, GLONASS, and BeiDou)
- Status of unit (POST, CM, etc.)
- Generation of a Diagnostic Report
- Upload of new Application Software

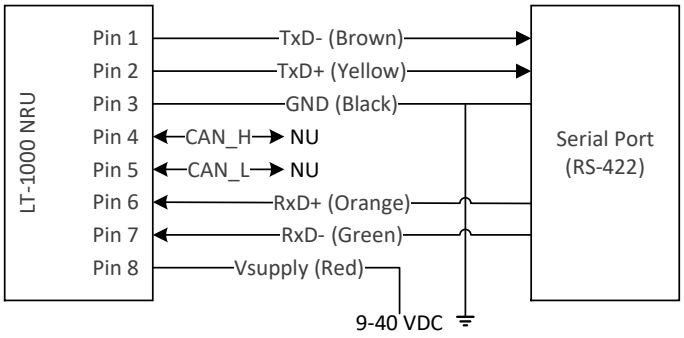


FIGURE 3: WIRING OF THE LT-1000 NRU TO A SERIAL PORT (RS-422).

Pre-Installation

Unpacking (in-the-box)

Unpack your LT-1000 NRU and check that the following items are present:

- LT-1000 NRU (incl. pole mount and cable plug)
- LT-1000 NRU Roof Mount (incl. screws for installation)
- 10m Cable Multi 8-pin Simple-Cut (M)
- Screw-in Conn. NMEA 2000 Micro-C (M)
- Quick Installation Guide
- Safety Instructions Sheet
- Unit Test Sheet

Inspection

Inspect the shipping cartons and/or wooden box immediately upon receipt for evidence of damage during transport. If the shipping material is severely damaged or water stained, request that the carrier's agent be present when opening the cartons and/or wooden box. Save all box packing material for future use.

After unpacking the system and opening the cartons, inspect it thoroughly for hidden damage and loose components or fittings. If the contents are incomplete, if there is mechanical damage or defect, or if the system does not work properly, notify your dealer.

WARNING: To avoid electric shock, do not apply power to the LT-1000 NRU if there is any sign of shipping damage to any part of the unit or the outer cover. Read the Safety Instructions at the front of this manual before installing or operating the unit.

Mounting and installation considerations

For optimum system performance, some guidelines on where to install or mount the LT-1000 NRU must be followed. It is recommended to mount the unit in a location, with as much free line of sight as possible, while making sure that the support structure fulfills the requirements for pole or roof mount installation:

- Mount the unit horizontally
- Mount the unit with free line of sight to GNSS satellites. If the Roof Mount is used for below deck installation, make sure that the unit is capable of receiving signals from the GNSS satellites
- Mount the unit on a rigid structure with a minimum of exposure to vibration and shock
- Mount the unit so that direct spray from seawater is avoided
- Mount the unit so that ventilation through the pole mount is possible
- Mount the unit in an area with an ambient temperature between -40°C and +55°C (-40°F to +131°F)
- Mount the unit away from possible magnetic disturbances (e.g. loudspeakers) and power cables
- Mount the unit at least 1 m. (3 ft.) away from radio transmitting antennas (VHF, UHF, MF-HF, Inmarsat, Iridium, Transmitting VSAT, etc.)
- Mount the unit with a minimum angle of 20 degrees towards a radar antenna (above or below).
- Mount the unit at least 50 cm. (20”) away from the following: Engines, generators, steel fuel and water tanks, bilge pump, anchor, anchor chain, and iron mast support
- Mount the unit as close as possible to the ship’s center of gravity and center line

IMPORTANT: The pinol screw used for fastening the pole mount shall not exceed 0.8 NM (0.6 lbf-ft).

Condensation and water intrusion

If possible, install the LT-1000 NRU such that direct spray of seawater is avoided.

In some weather conditions there may occur condensation inside the LT-1000 NRU. The bottom part of the LT-1000 NRU is designed to lead water away from inside of the device.

Make sure not to cover the ventilation holes around the connector at the bottom side of the LT-1000 NRU. These holes are used for ventilation of the construction and for the pressure sensor. Also, make sure that there is free space around the communication cable through the pole mount.

It is recommended not to use pneumatic tools for cleaning the LT-1000 NRU, especially at a short distance, and directly at the split between the top and bottom part of the enclosure.

Pole or Roof Mount installation

It is possible to use either a pole or roof mount, when installing the LT-1000 NRU, see Figure 4 (roof mount) and Figure 5 (pole mount).

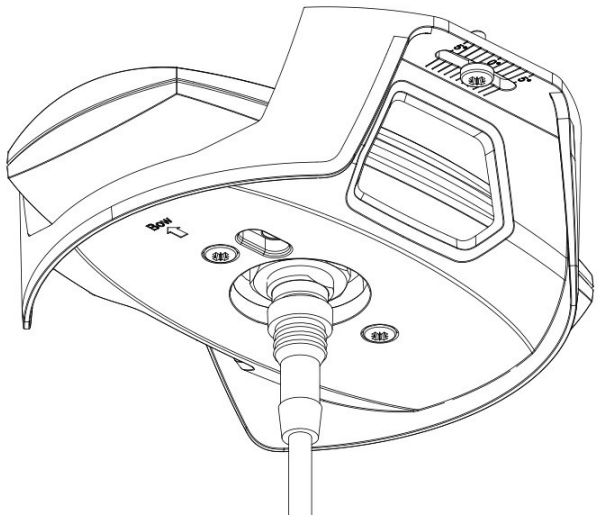


FIGURE 4: LT-1000 NRU WITH ROOF MOUNT.

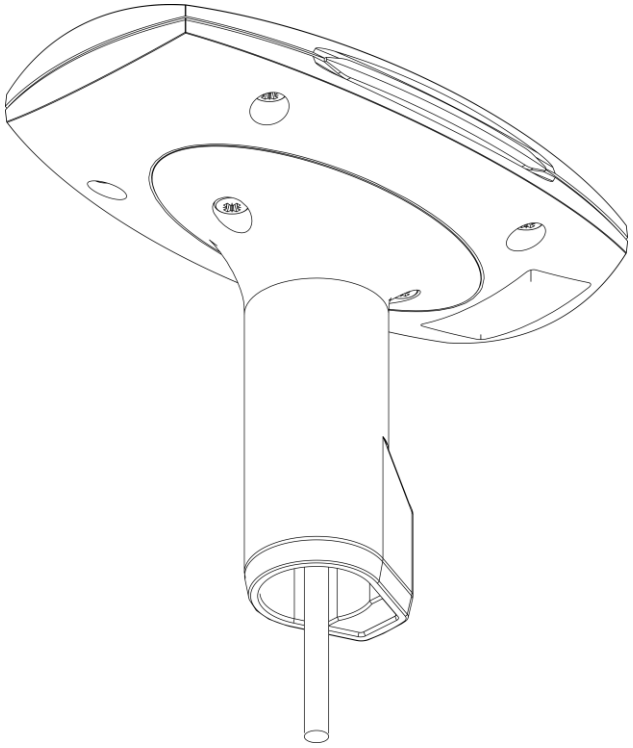


FIGURE 5: LT-1000 NRU WITH POLE MOUNT.

The following two sub-chapters will in details, step-by-step, describe how to complete an installation with either a pole or roof mount

- Pole mount installation: See *Pole mount installation* on page 8
- Roof mount installation: See *Roof mount installation* on page 16

NOTE: The LT-1000 NRU is delivered with both a Pole Mount and a Roof Mount. For further details on what is in-the-box, see *Unpacking* on page 5.

Installation Procedure

The LT-1000 NRU has to be installed and configured according to the procedure described in this chapter. The LT-1000 NRU installation procedure is illustrated in Figure 6.

Mounting on page 8

The LT-1000 NRU has to be mounted horizontally, with free line of sight to GNSS satellites, on a rigid structure, and away from any external magnetic disturbances (see *Mounting and installation considerations* on page 5).

Connecting on page 21

The LT-1000 NRU is connected to NMEA 0183, NMEA 2000, and power via the proprietary 8-pin multi cable, which is included in the box. This chapter describes how to connect the 8-pin multi cable to NMEA 0183, NMEA 2000, and power.

Configuration on page 27

The LT-1000 NRU has to be configured with respect to the specific installation requirements. The following configurations shall be considered during installation:

- NMEA 0183 baud rate
- NMEA 2000 termination
- Deviation calibration & options
- Auto level
- Heading, Roll & Pitch offset
- Vertical offset
- Attitude filter
- GNSS receiver

The NMEA 00183 baud rate and NMEA 2000 termination settings can be set via the DIP-switch, see *DIP-switch* on page 37. Other configuration options must be configured via the LT-Service Tool. A complete description of configuration options are available in *Configuration* on page 27.

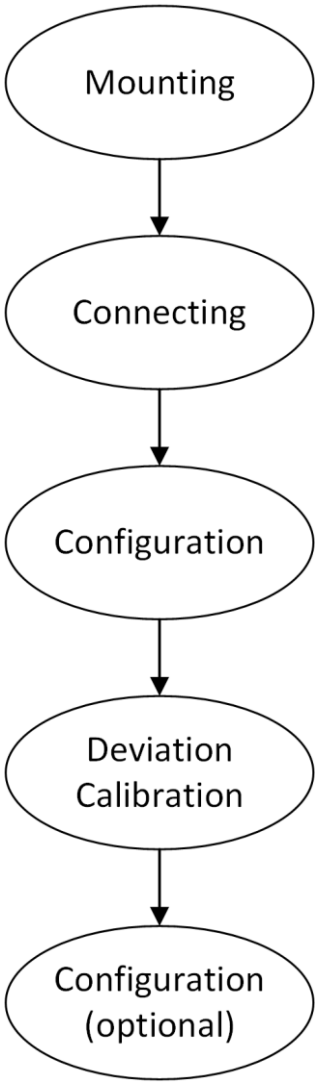


FIGURE 6: LT-1000 NRU INSTALLATION PROCEDURE TO BE COMPLETED FOR OPTIMAL PERFORMANCE.

Deviation Calibration on page 32

The LT-1000 NRU requires a deviation calibration before outputting heading in full resolution. The LT-1000 NRU will output heading data in 5 degrees resolution; until the deviation calibration is completed (deactivation of the 5 degrees heading resolution is an option). Two modes are supported:

- Standard (figure 8-pattern) default — See *Standard (figure 8-pattern)* on page 33
- Adaptive — See *Adaptive* on page 35

Configuration on page 27

LT-1000 NRU need an optional heading offset adjustment after the unit has successfully passed the deviation calibration.

Mounting

Pole mount installation

Step 1: Unpack the LT-1000 NRU and make a record of the unit serial number for support or warranty issues that could occur in the future.

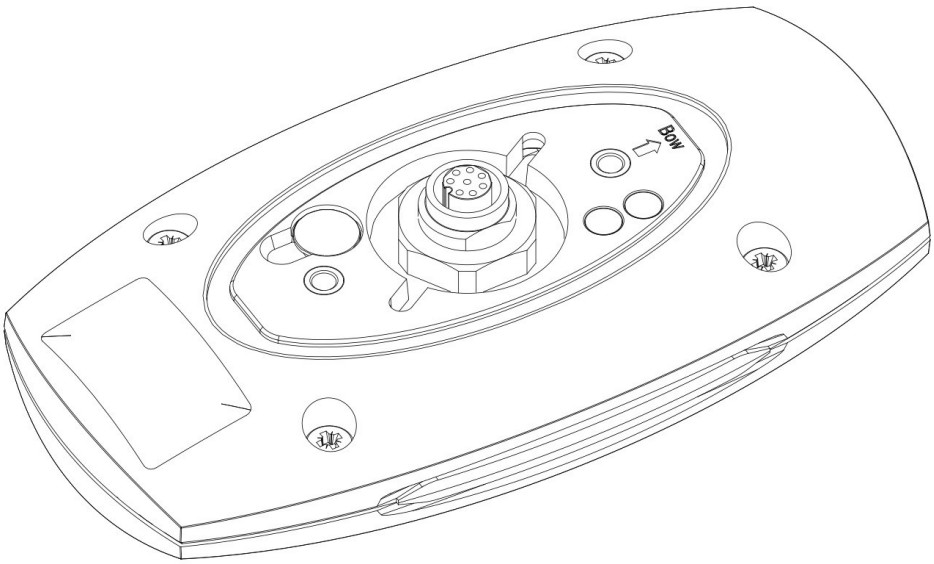


FIGURE 7: POLE MOUNT INSTALLATION STEP 1 (BOTTOM SIDE OF LT-1000 NRU)

Step 2: Remove cap for DIP-switch settings. Remember to re-insert the cap after configuration of the DIP-switch.

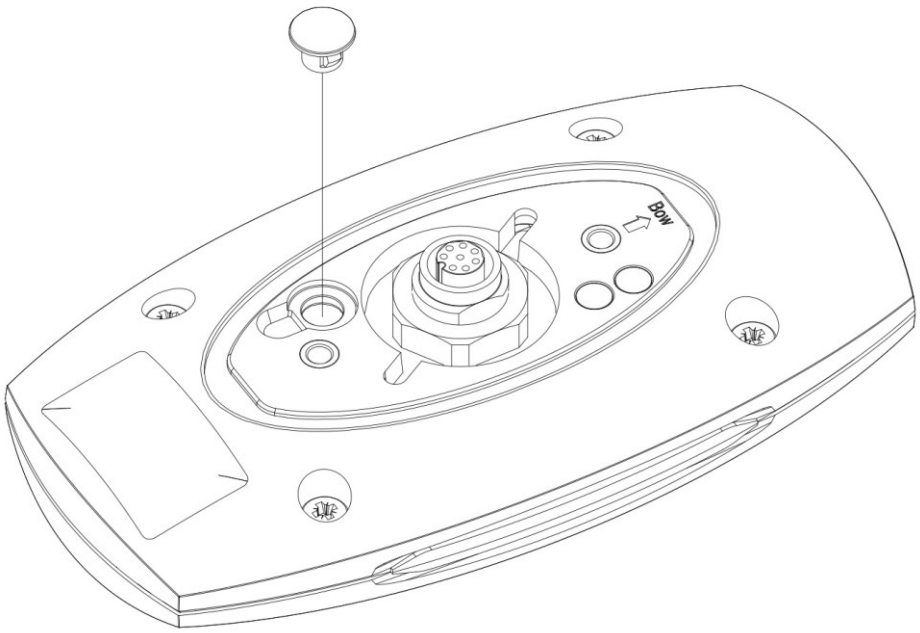


FIGURE 8: POLE MOUNT INSTALLATION STEP 2 (REMOVE CAP FOR DIP-SWITCH SETTINGS)

Step 3: Please refer to *DIP-switch* on page 37 for correct DIP-switch settings.

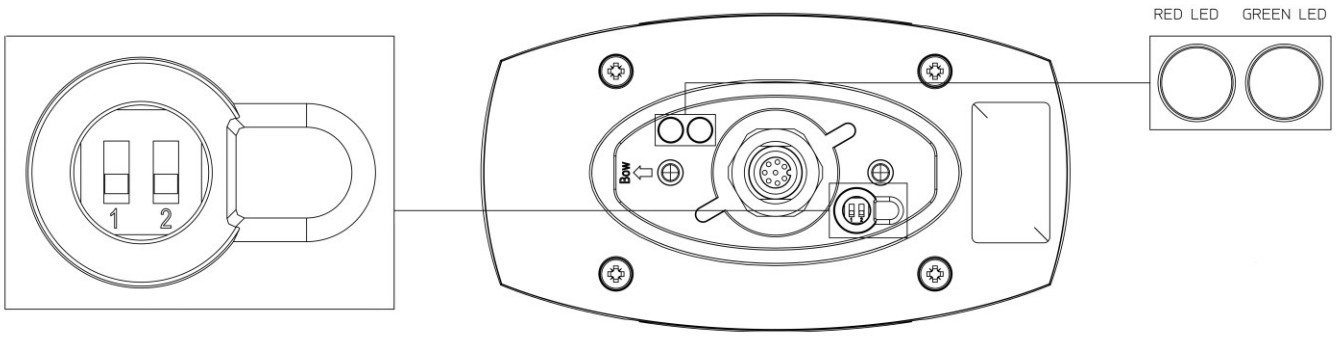


FIGURE 9: POLE MOUNT INSTALLATION STEP 3 (DIP-SWITCH AND LEDS)

Step 4: Locate an appropriate location for the pole mount installation. See drawings under step 4 with respect to pole mount installation.

IMPORTANT: Make sure that there are no magnetic disturbances (see *Mounting and installation considerations* on page 5 for details) or compass within 0.3 m. (1 ft.) of the LT-1000 NRU. Mount the LT-1000 NRU at least 1 m. away from VHF, UHF, MF-HF, Inmarsat, Iridium, etc. radio transmitting equipment. Make sure that the LT-1000 NRU minimum has a 20 degree angle towards a radar antenna (above or below).

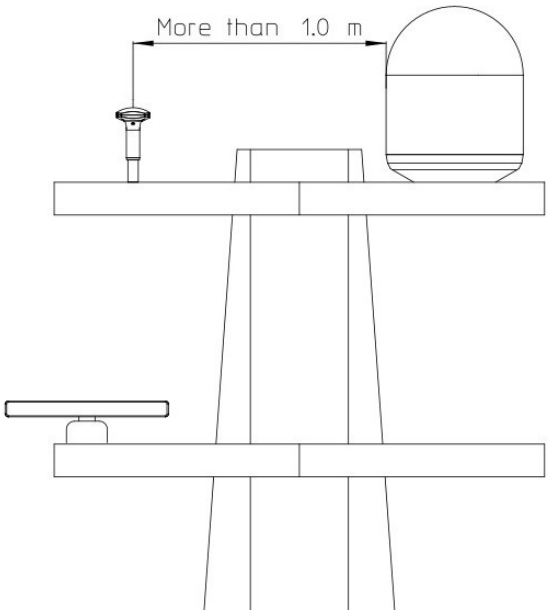


FIGURE 11: POLE MOUNT INSTALLATION STEP 4 (LOCATE AN APPROPRIATE LOCATION)

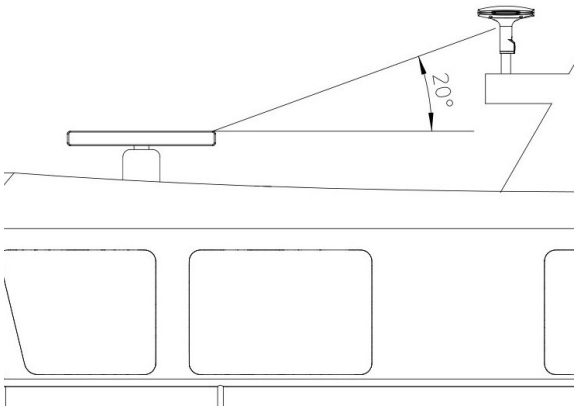


FIGURE 10: POLE MOUNT INSTALLATION STEP 4 (LOCATE AN APPROPRIATE LOCATION)

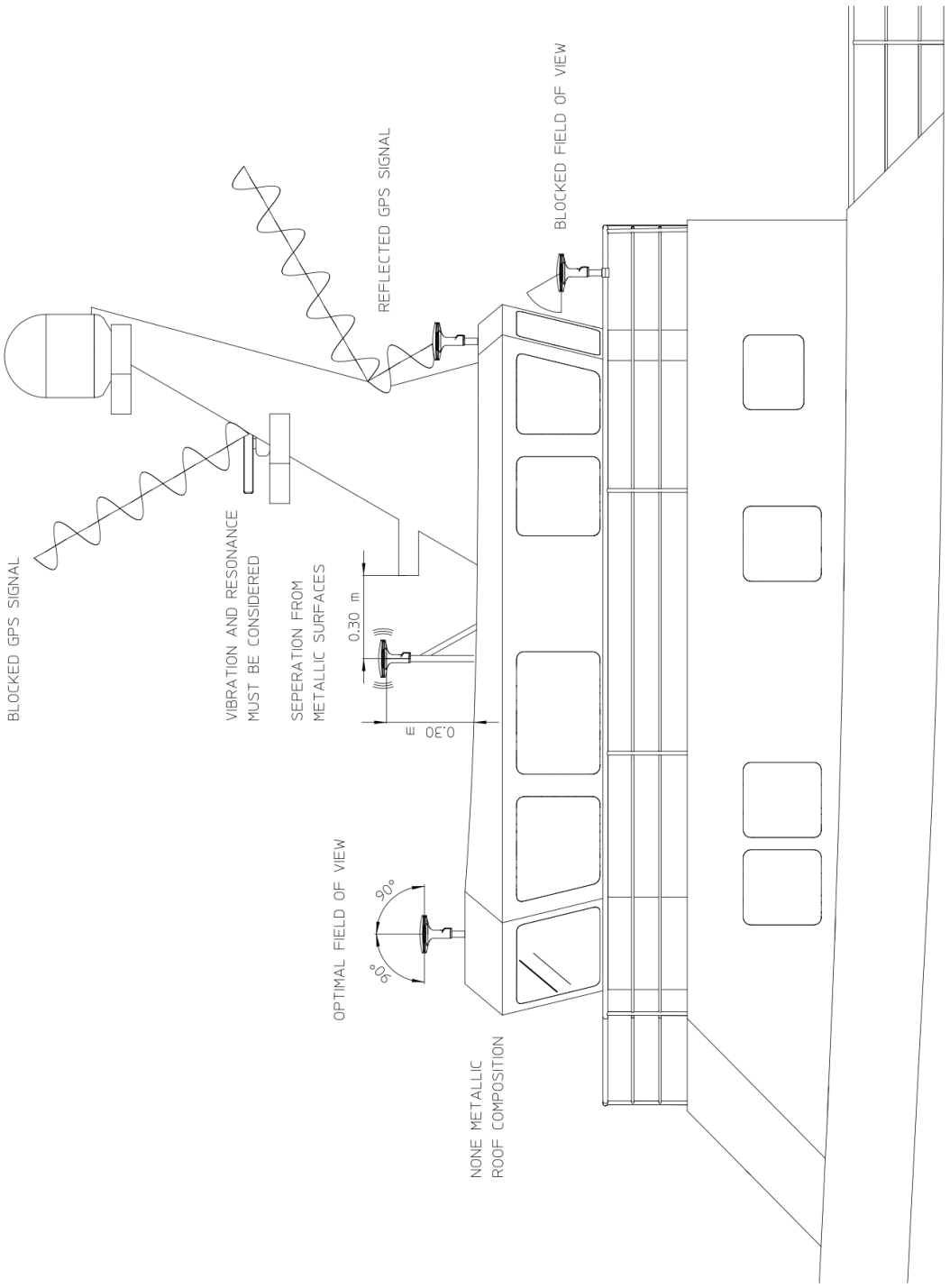


FIGURE 12: POLE MOUNT INSTALLATION STEP 4 (LOCATE AN APPROPRIATE LOCATION)

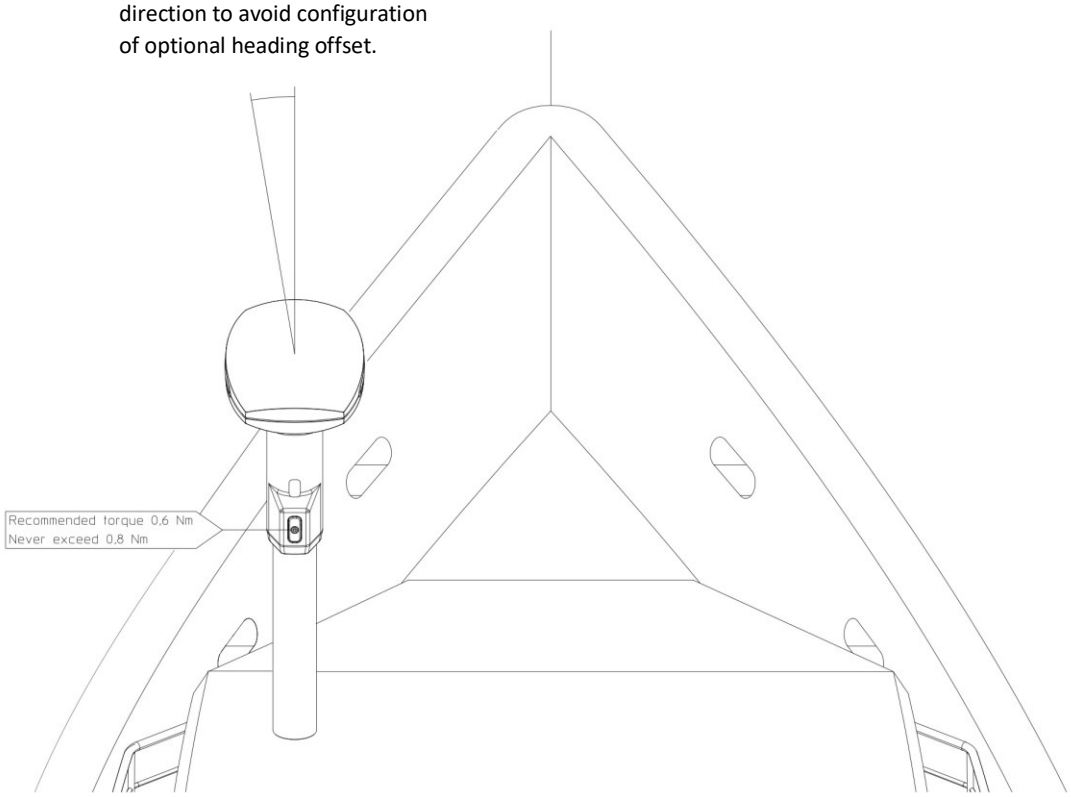


FIGURE 13: POLE MOUNT INSTALLATION STEP 4 (ALIGN UNIT)

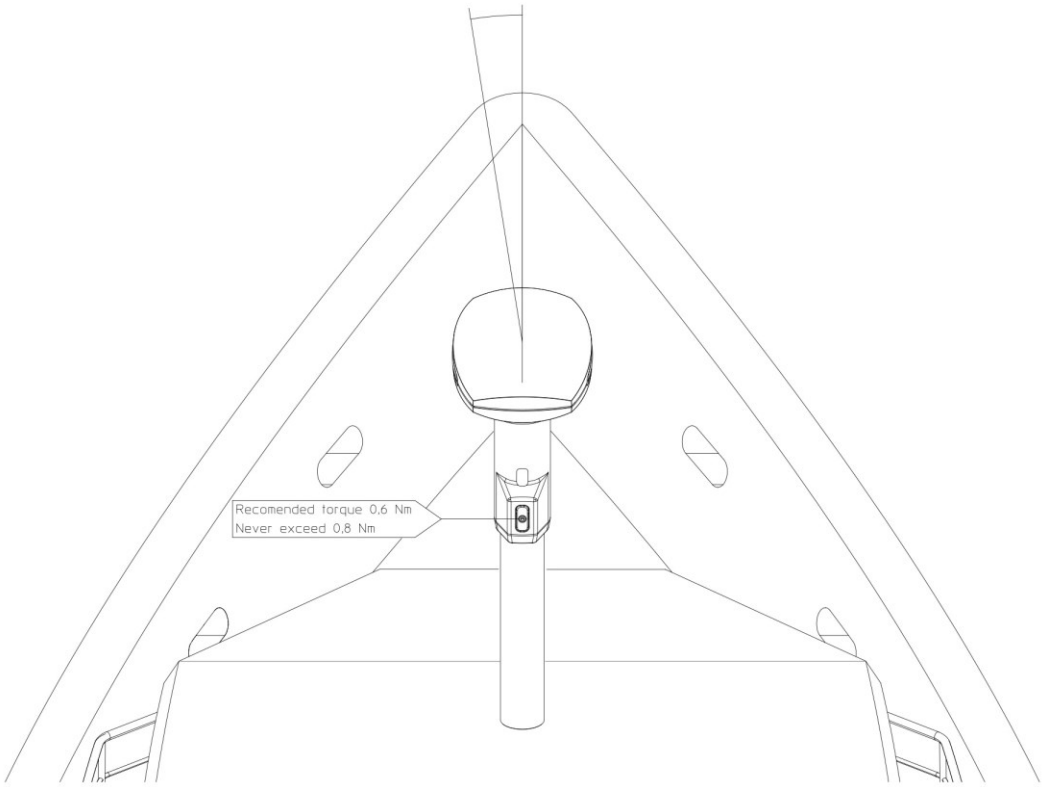


FIGURE 14: POLE MOUNT INSTALLATION STEP 4 (ALIGN UNIT)

Step 5: Complete the internal or external cable routing. Feed the communication cable through the pole mount and install the cable plug.

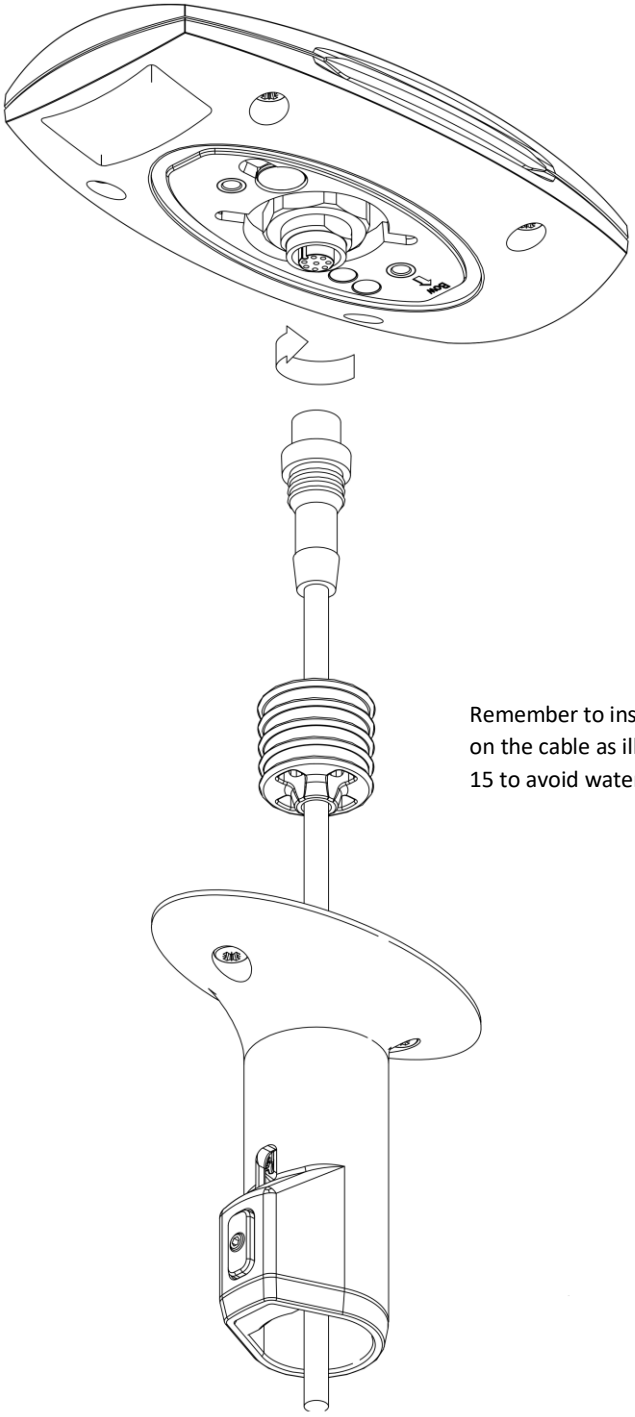


FIGURE 15: POLE MOUNT INSTALLATION STEP 5 (INTERNAL ROUTING OF THE COMMUNICATION CABLE)

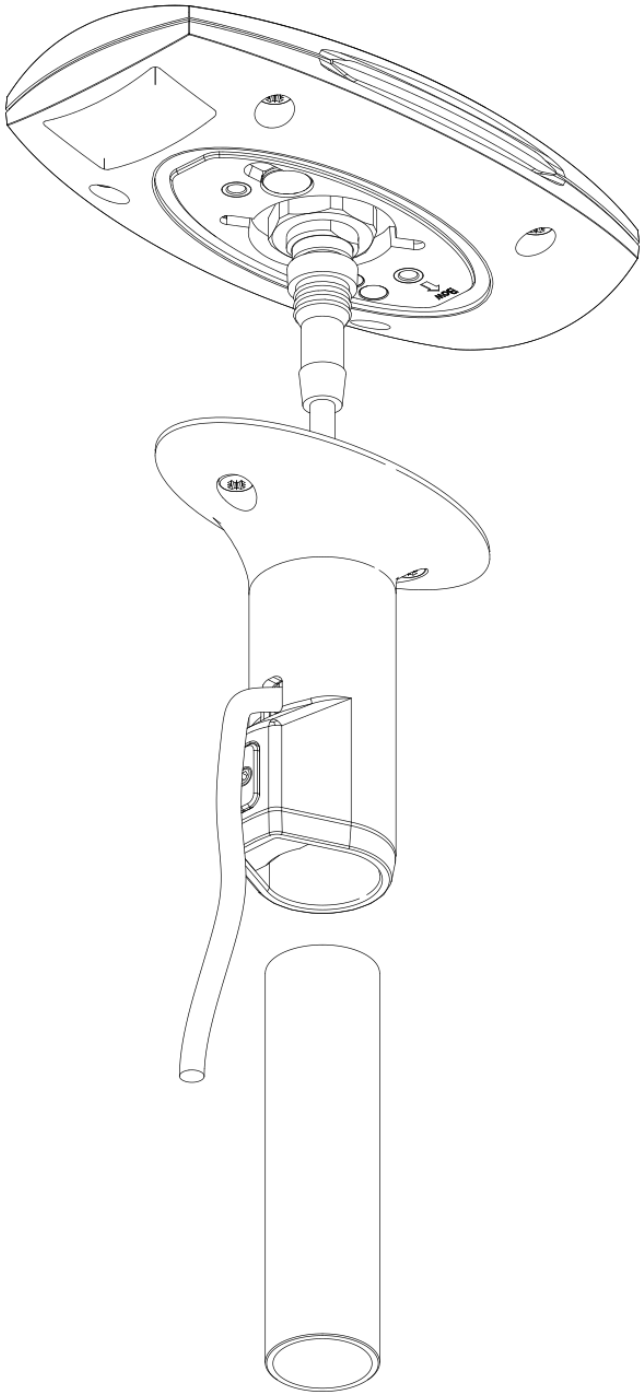


FIGURE 16: POLE MOUNT INSTALLATION STEP 5 (EXTERNAL ROUTING OF THE COMMUNICATION CABLE)

Step 6: Fasten the pole mount by securing the two stainless A4 screws onto the LT-1000 NRU as illustrated in Figure 17.

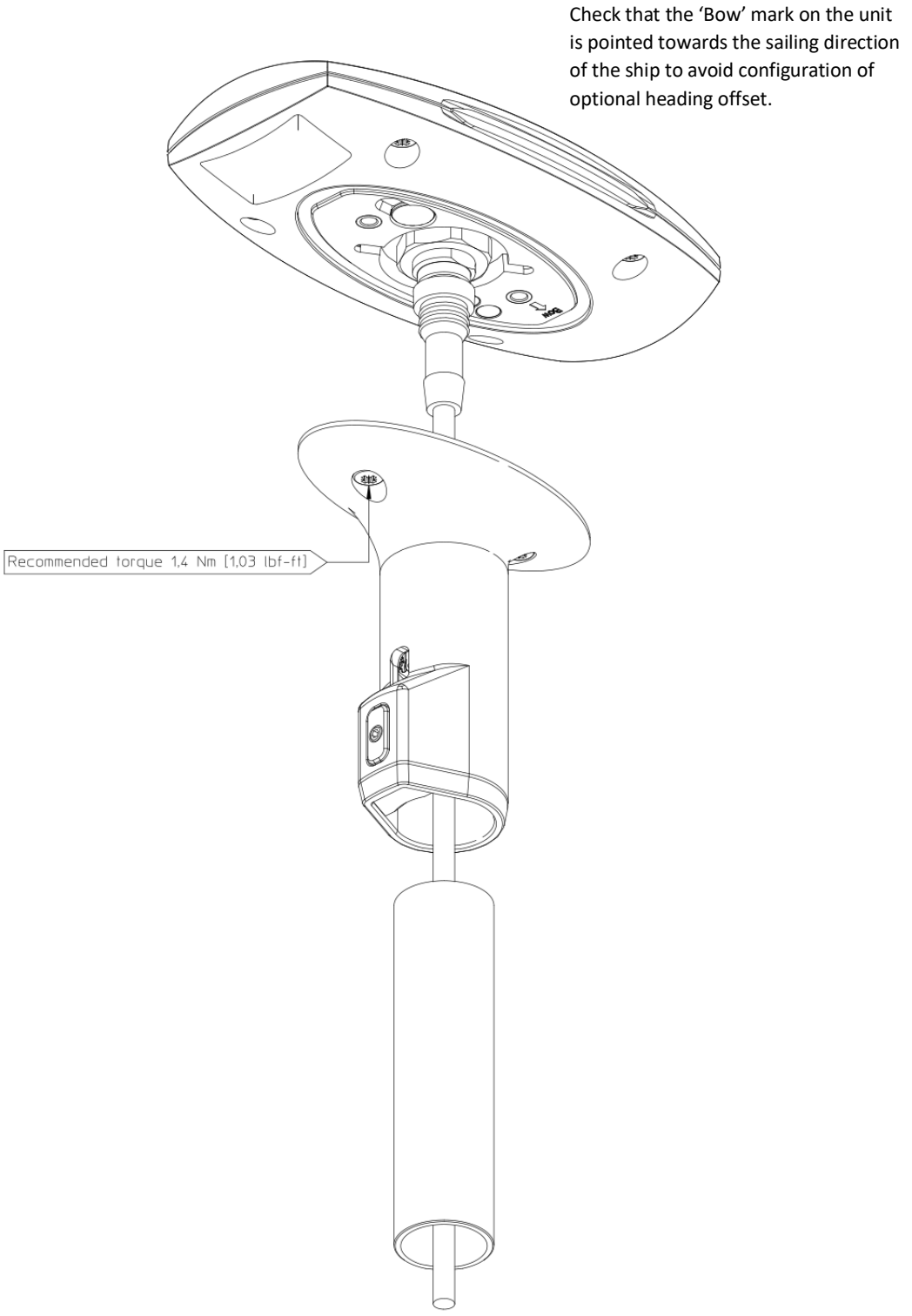


FIGURE 17: POLE MOUNT INSTALLATION STEP 6 (SECURING THE TWO STAINLESS A4 SCREWS)

Step 7: Adjust the heading direction of LT-1000 NRU before fastening the pinol screw in the pole mount.

NOTE: Final precision tuning of the Heading offset can be configured using the LT-service tool, see *Configuration* on page 27.

IMPORTANT: The pinol screw used for fastening the pole mount shall not exceed 0.8 NM (0.6 lbs/ft).

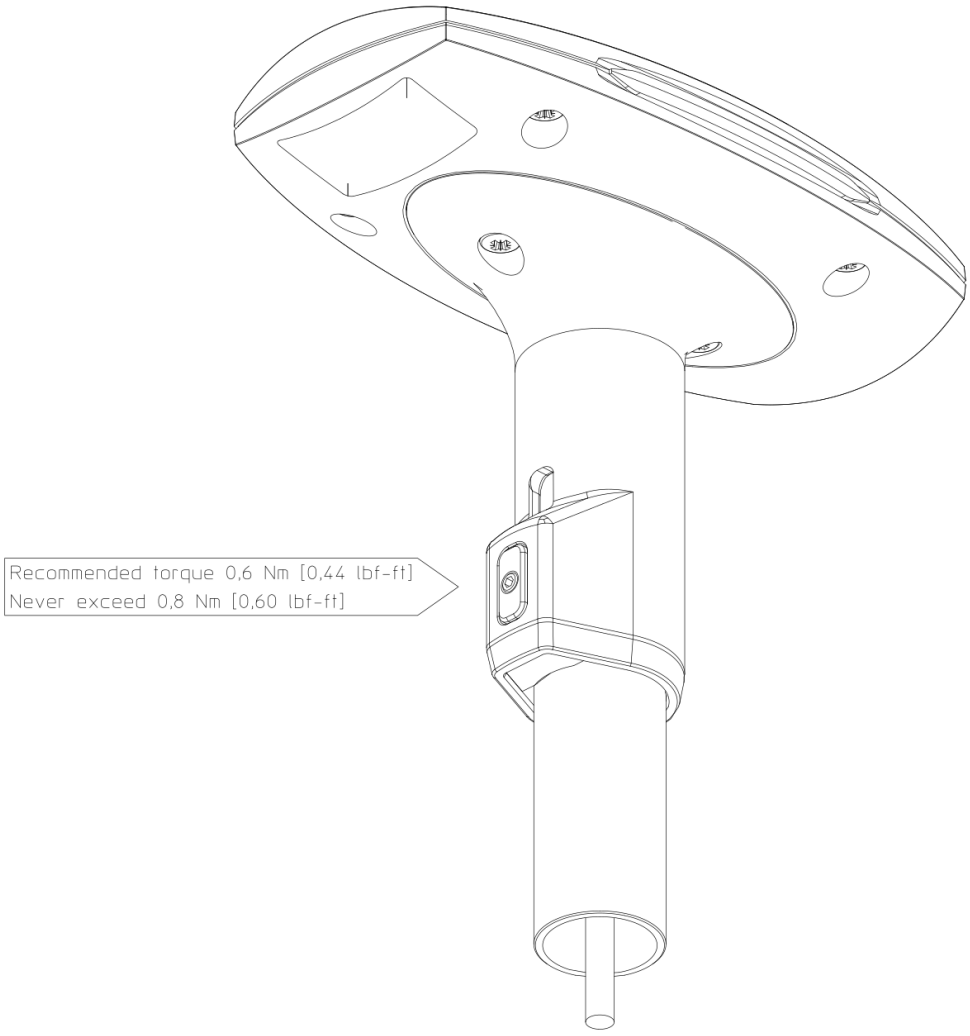


FIGURE 18: POLE MOUNT INSTALLATION STEP 7 (FASTENING THE PINOL SCREW IN THE POLE MOUNT)

Roof mount installation

Step 1: Locate an appropriate location for the roof mount installation.

IMPORTANT: Make sure that there are no magnetic disturbances (see *Mounting and installation considerations* on page 5 for details) or compass within 0.3 m. / 1 ft. of the LT-1000 NRU.

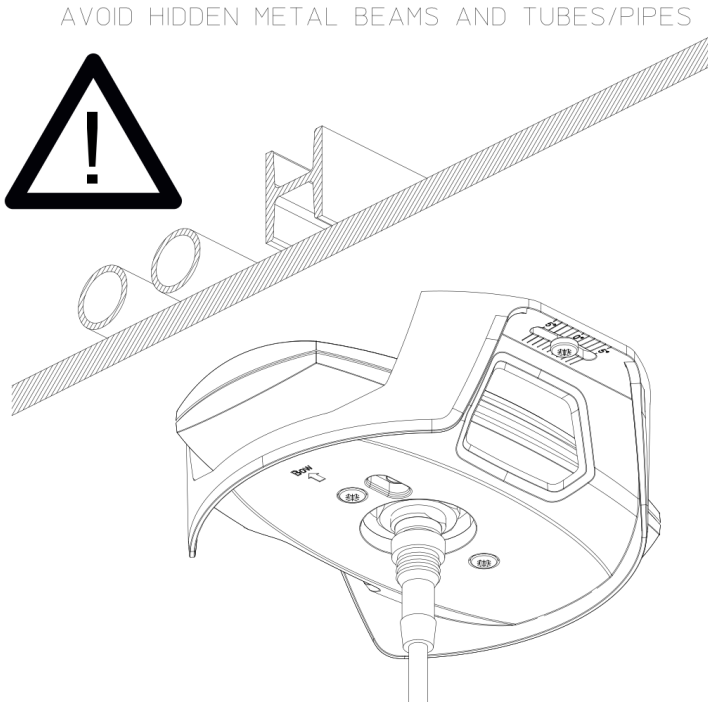


FIGURE 19: ROOF MOUNT INSTALLATION STEP 1 (LOCATE AN APPROPRIATE LOCATION)

Step 2: Measure and mark the installation holes in accordance with the drawing. Use the enclosed two stainless A4 screws for mounting. It is possible to adjust heading with ± 5 degree before final clamping of the roof mount.

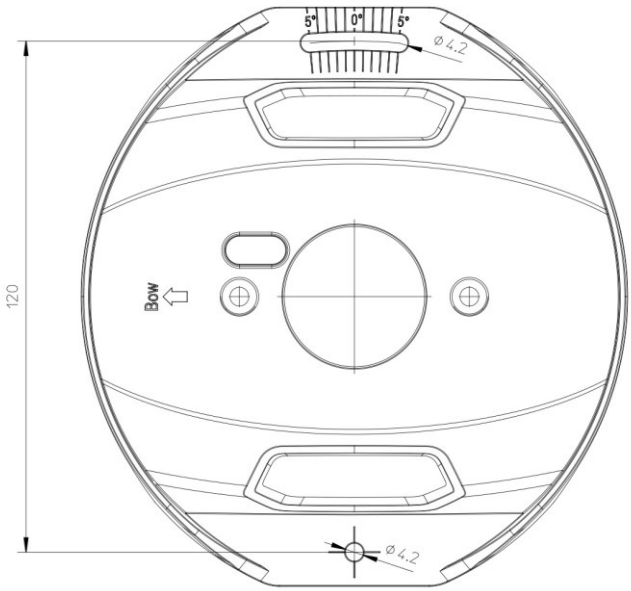


FIGURE 20: ROOF MOUNT INSTALLATION STEP 2 (MEASURE AND MARK THE INSTALLATION HOLES)

Step 3: Unpack the LT-1000 NRU and make a record of the unit serial number for support or warranty issues that could occur in the future.

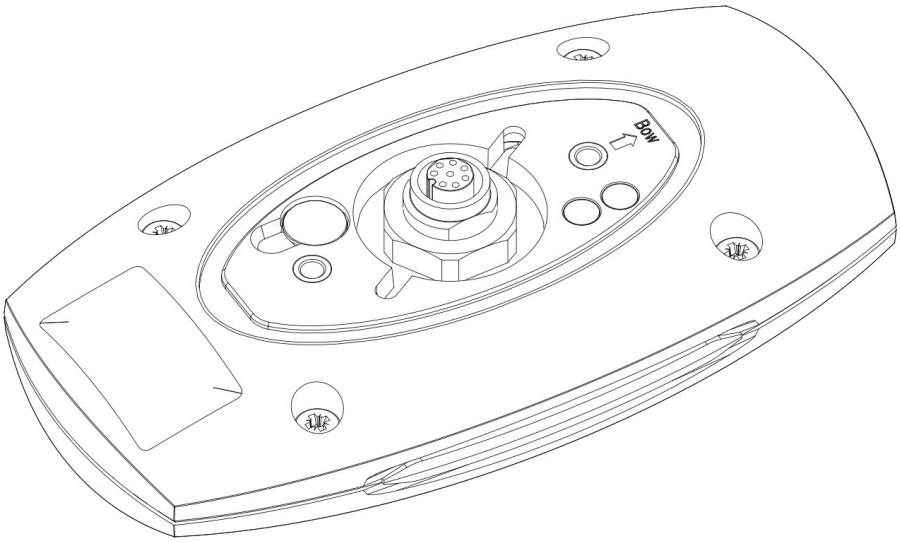


FIGURE 21: ROOF MOUNT INSTALLATION STEP 3 (BOTTOM SIDE OF THE LT-1000 NRU)

Step 4: Remove cap for DIP-switch setting. Remember to re-insert the cap after configuration of the DIP-switch.

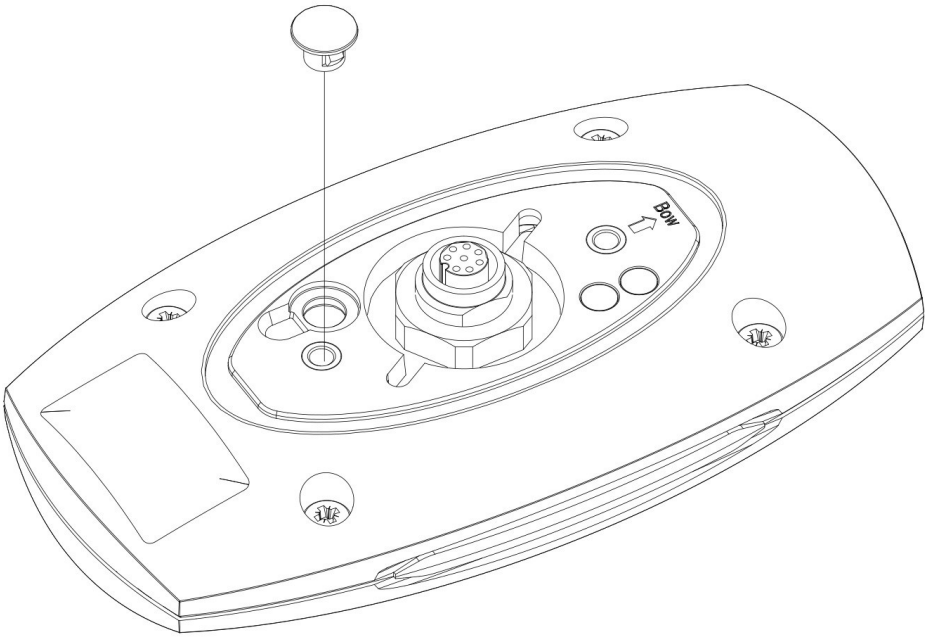


FIGURE 22: ROOF MOUNT INSTALLATION STEP 4 (REMOVE CAP FOR DIP-SWITCH SETTING)

Step 5: Please refer to *DIP-switch* on page 37 for correct DIP-switch settings.

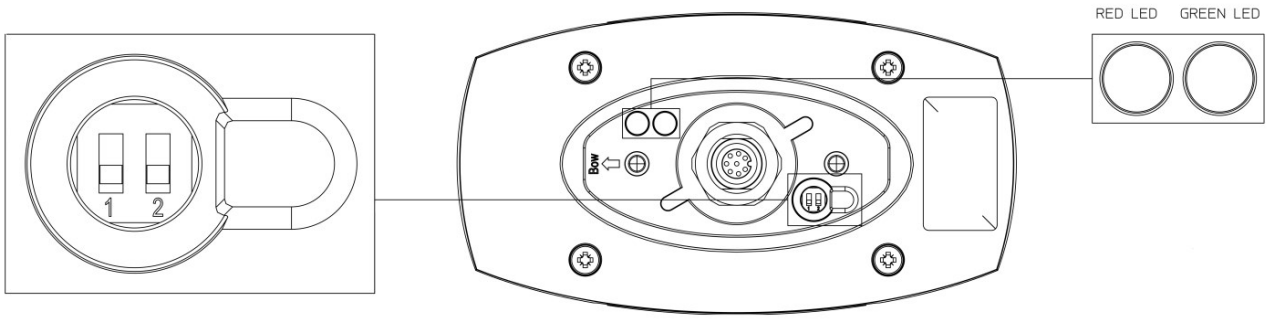


FIGURE 23: ROOF MOUNT INSTALLATION STEP 5 (DIP-SWITCH AND LEDS)

Step 6: Mount and secure the two stainless A4 screws (with securing disc) from the pole mount.

Check that the 'Bow' mark on the unit is pointed towards the sailing direction of the vessel to avoid configuration of an optional heading offset.

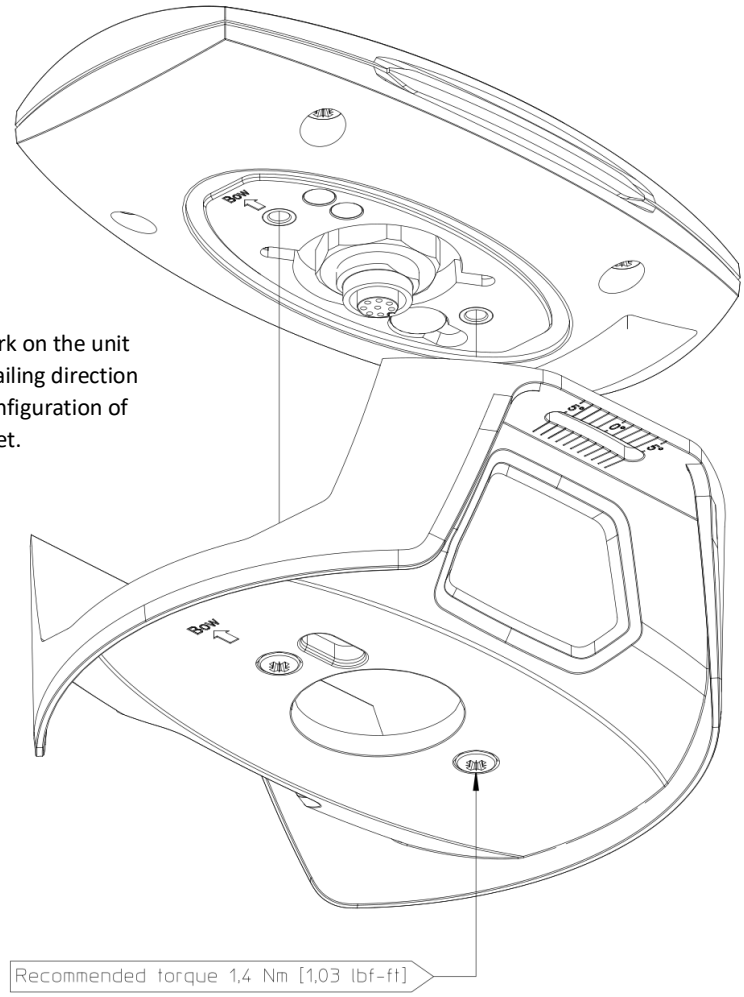


FIGURE 24: ROOF MOUNT INSTALLATION STEP 6 (SECURE THE TWO STAINLESS A4 SCREWS)

Step 7: Adjust the heading before final clamping of the two self-cutting stainless screws.

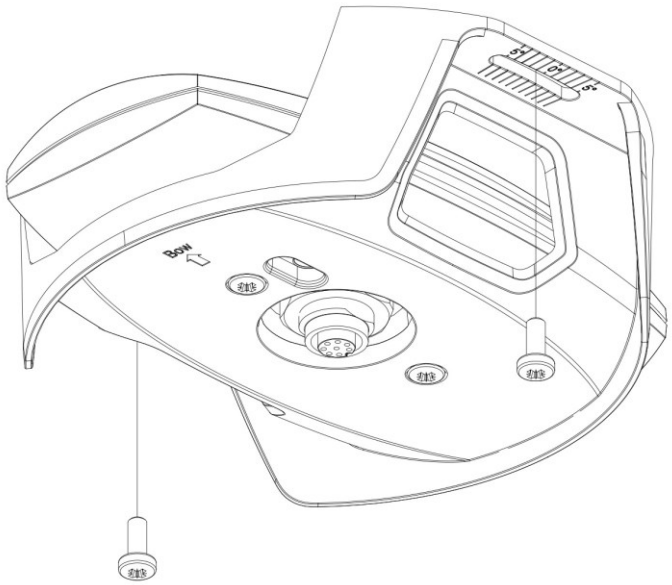


FIGURE 25: ROOF MOUNT INSTALLATION STEP 7 (FINAL CLAMPING OF THE TWO SELF-CUTTING STAINLESS SCREWS)

Step 8: Connect the communication cable.

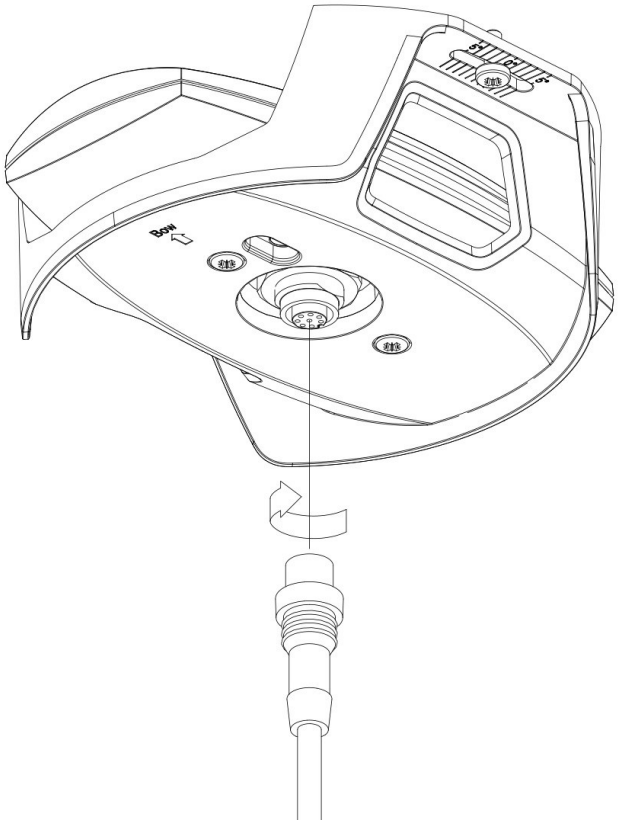


FIGURE 26: ROOF MOUNT INSTALLATION STEP 8 (CONNECT THE COMMUNICATION CABLE)

Step 9: Install the simple-cut end of the communication cable according to the details provided in *Connecting* on page 21.

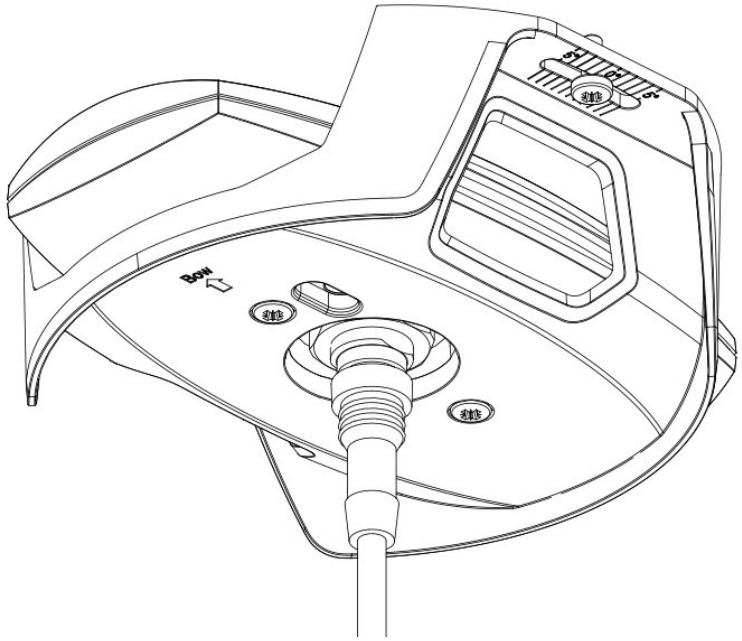


FIGURE 27: ROOF MOUNT INSTALLATION STEP 9 (INSTALL THE SIMPLE-CUT END OF THE COMMUNICATION CABLE)

Connecting

This section provides relevant information for connecting the LT-1000 NRU to NMEA 0183, NMEA 2000, power, and the LT-Service Tool.

Connector and cable definition

The LT-1000 NRU has an 8-pin connector, which is supporting simultaneously data on NMEA 0183, NMEA 2000, and power. The placement of the LT-1000 NRU connector is illustrated on Figure 28. A detailed connector pin out with pin numbering is illustrated in Figure 29.

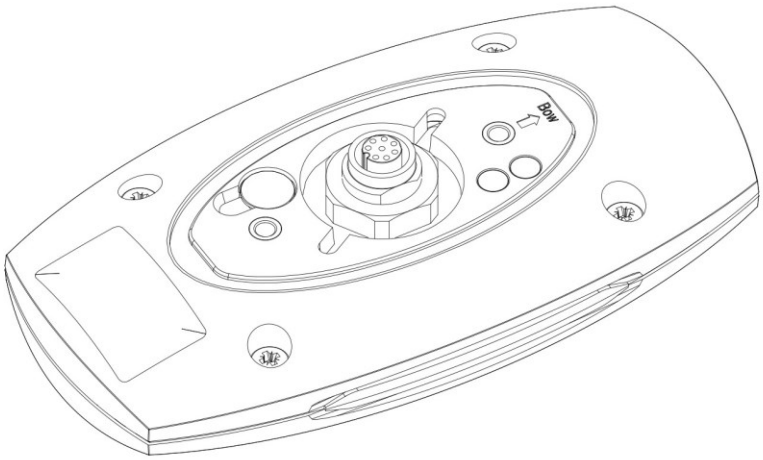


FIGURE 28: LT-1000 NRU (BOTTOM VIEW). 8-PIN CONNECTOR USED FOR CONNECTING THE LT-1000 NRU TO NMEA 0183, NMEA 2000, AND POWER.

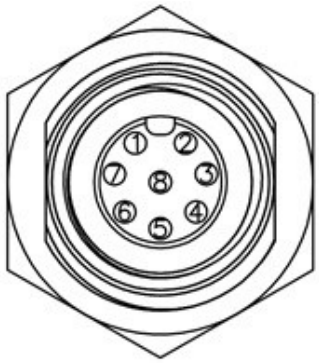


FIGURE 29: LT-1000 NRU CONNECTOR PIN NUMBERING.

The LT-1000 NRU connector has a proprietary pin out and therefore a communication cable is always included in-the-box, see *Unpacking (in-the-box)* on page 5. The communication cable is available in two lengths: 10 or 30 meters. The LT-1000 NRU is delivered including a 10 meter cable (simple-cut). The communication cable, wire color and designation, is illustrated in Table 3.

LT-1000 NRU Interconnect Details		
Pin No.	**Wire Color**	**Wire Designation**
1	Brown	TxD-
2	Yellow	TxD+
3	Black	GND
4	White	CAN_H
5	Blue	CAN_L
6	Orange	RxD+
7	Green	RxD-
8	Red	Vsupply

TABLE 3: LT-1000 NRU MULTI CABLE WIRE COLOR AND DESIGNATION.

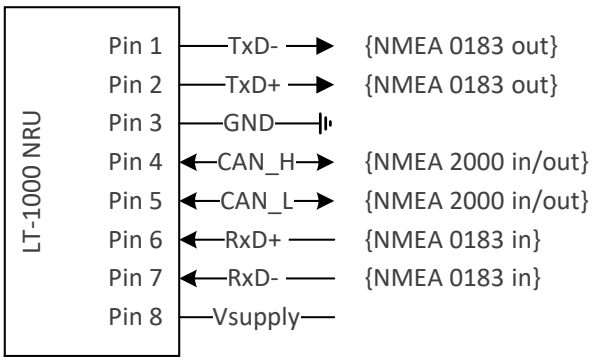


FIGURE 30: TRANSMIT AND RECEIVE DIRECTIONS FOR THE LT-1000 NRU.

NOTE: To avoid any misinterpretation, the transmit (Tx) and receive (Rx) directions are illustrated in Figure 30, relative to the LT-1000 NRU.

Connecting to NMEA 0183

If connecting the LT-1000 NRU to a NMEA 0183 device, it is only required to connect the transmit part of the NMEA 0183 wires TxD- (Brown) and TxD+ (Yellow) from the communication cable.

IMPORTANT: It is recommended to connect the LT-1000 NRU with a balanced NMEA 0183 connection (RS-422) as illustrated in Figure 31. An unbalanced connection (RS-232), as illustrated in Figure 32, is less robust and should only be considered, when using a short communication cable.

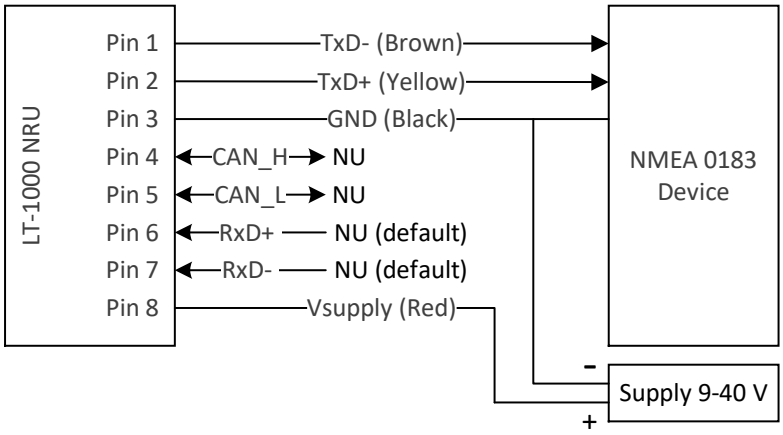


FIGURE 31: CONNECTING THE LT-1000 NRU TO A BALANCED NMEA 0183 DEVICE.

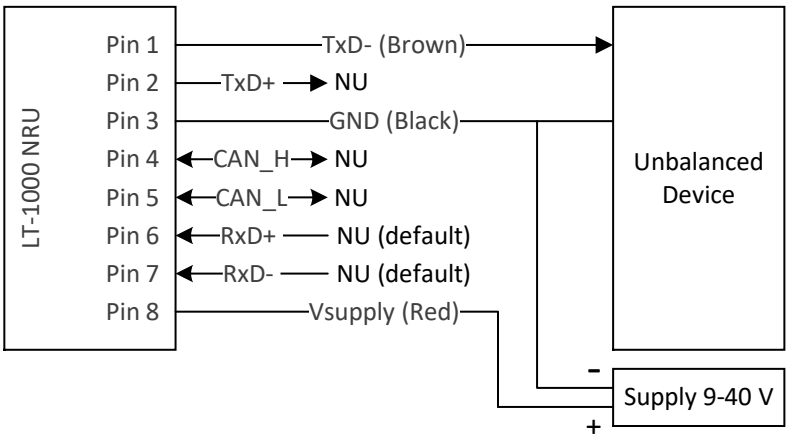


FIGURE 32: CONNECTING THE LT-1000 NRU TO AN UNBALANCED DEVICE.

NOTE: Make sure that the LT-1000 NRU is configured for the desired baud rate (4800 or 38400 baud); see *DIP-switch* on page 37. Check that both the NMEA 0183 receive device and the LT-1000 NRU have the same GND reference, as illustrated in Figure 31 and Figure 32.

Connecting to NMEA 2000

If connecting the LT-1000 NRU to a NMEA 2000 network (i.e. backbone) then it is required to use a screw-in connector as illustrated in Figure 33. The screw-in connector is in-the-box together with the LT-1000 NRU.

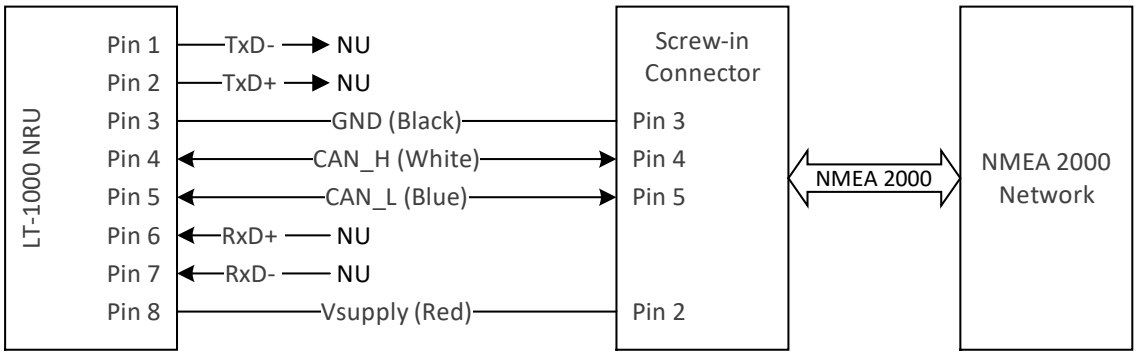


FIGURE 33: CONNECTING THE LT-1000 NRU TO A NMEA 2000 BACKBONE. A SCREW-IN CONNECTOR IS REQUIRED FOR CONNECTING THE LT-1000 NRU TO A NMEA 2000 NETWORK.

NOTE: The screw-in connector is connected to the communication cable by cutting the cable in the right length, stripping the wires, screwing the specific wires to the connector, and then re-assemble the connector again.

The screw-in connector outline is illustrated in Figure 34. The pin-out and numbering of the screw-in connector is illustrated on Figure 35, while the wiring details for interconnection with the communication cable is shown in Table 4.

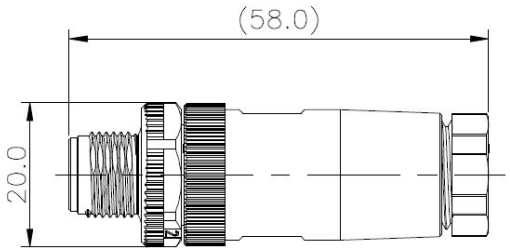


FIGURE 34: NMEA 2000 SCREW-IN CONNECTOR (M) OUTLINE

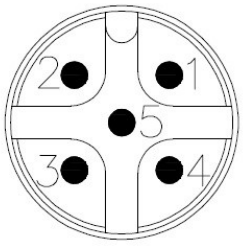


FIGURE 35: NMEA 2000 SCREW-IN CONNECTOR PIN NO.

NMEA 2000 Screw-in Conn. Wiring		
Cable Wire Color	**Cable Wire Designation**	**Screw-in Conn. Pin No.**
-	-	1
Red	Vsupply	2
Black	GND	3
White	CAN_H	4
Blue	CAN_L	5

TABLE 4: ILLUSTRATES HOW THE LT-1000 NRU 8-PIN MULTI CABLE IS CONNECTED TO A NMEA 2000 SCREW-IN CONNECTOR.

NOTE: The LT-1000 does not require a connection on Pin No. 1: drain/shield. The unit is designed to work with open cable shield.

NOTE: There are two possibilities for the LT-1000 NRU to be connected to an NMEA 2000 network: drop cable or backbone. A DIP-switch in the LT-1000 NRU shall be configured depending on the installation. The default setting for the DIP-switch is 'Open', but shall always be verified prior to an installation. The DIP-switch settings are described in *DIP-switch* on page 37.

The remaining figures in this sub-chapter does not show the screw-in connector for simplicity.

NMEA 2000 Installation

The LT-1000 NRU is delivered together with a NMEA 2000 screw-in connector, which is used to connect the communication cable with the NMEA 2000 backbone. The LT-1000 NRU DIP-switch can be configured to either 'Open' or 'Terminated', see *DIP-switch* on page 37 (factory default: 'Open'). Figure 36 and Figure 37 are illustrating two options for connecting the LT-1000 NRU to a NMEA 2000 network (backbone).

NMEA 2000 ('Open')

If the LT-1000 NRU is installed as illustrated in Figure 36, no internal NMEA 2000 bus termination is required (default 'Open'). The LT-1000 NRU is connected to the NMEA 2000 backbone using a drop cable.

NOTE: Make sure that the communication cable, delivered together with the LT-1000 NRU, is shortened to a maximum length of 6 meters as defined in the NMEA 2000 standard for a drop cable.

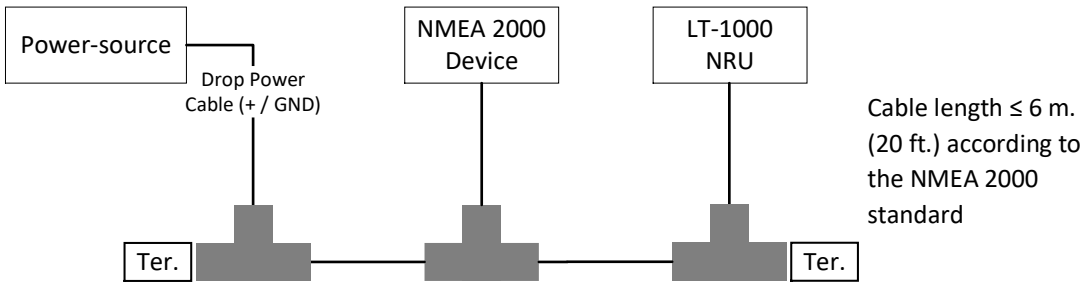


FIGURE 36: LT-1000 NRU CONNECTED TO A NMEA 2000 BACKBONE WITH THE DIP-SWITCH CONFIGURED TO 'OPEN'. THE NMEA 2000 SCREW-IN CONNECTOR IS NOT ILLUSTRATED IN THIS FIGURE.

NMEA 2000 ('Terminated')

If the LT-1000 NRU is installed as illustrated in Figure 37, then the DIP-switch must be configured to 'Terminated'. For configuration of the DIP-switch, see *DIP-switch* on page 37 (factory default: 'Open'). The LT-1000 NRU is connected to the NMEA 2000 using a standard backbone cable.

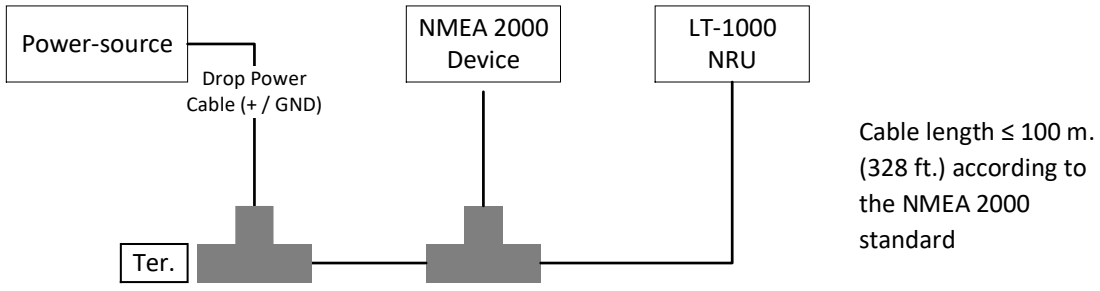


FIGURE 37: LT-1000 NRU CONNECTED TO A NMEA 2000 BACKBONE WITH THE DIP-SWITCH CONFIGURED TO 'TERMINATED'. THE NMEA 2000 SCREW-IN CONNECTOR IS NOT ILLUSTRATED IN THIS FIGURE.

For details on how to connect the communication cable with the NMEA 2000 screw-in connector, see *Connecting to NMEA 2000* on page 23.

Connecting LT-Service Tool

The LT-Service Tool is a PC program made for configuration, maintenance, and service of the LT-1000 NRU. Use of the LT-Service Tool is optional. For details and functionality, see *LT-Service Tool* on page 39. This sub-chapter is describing how to physically connect a PC (with the LT-Service Tool), to a LT-1000 NRU. The LT-Service Tool is using the NMEA 0183 interface for communicating with the LT-1000 NRU (both Tx and Rx directions).

Use either a 'USB to RS-422 converter' or connect a serial port directly to the LT-1000 NRU as described in the following sub-sections. The LT-1000 NRU requires an input voltage of 9-40 VDC. Most of the USB to RS-422 converter's and serial interfaces are only providing 5 VDC. Make sure that GND on both devices (PC and LT-1000 NRU) are connected to the same GND reference.

NOTE: The LT-Service Tool will automatically detect all LT-Navigation devices, which are connected to the PC's peripheral interfaces (USB and serial). Make sure that Tx and Rx wires are connected correctly. The LT-Service Tool will automatically try both 4800 and 38400 baud to search for possible LT-Navigation devices. If the LT-Service Tool does not automatically detects any LT-1000 NRU, check automatically and manual connection modes, described in *LT-Service Tool* on page 39.

USB to RS-422 converter

A standard USB to RS-422 converter, as illustrated in Figure 38, is perfect for providing a communication link in between the LT-Service Tool and the LT-1000 NRU. The PC is connected to the 'USB to RS-422 converter' through a standard USB cable.

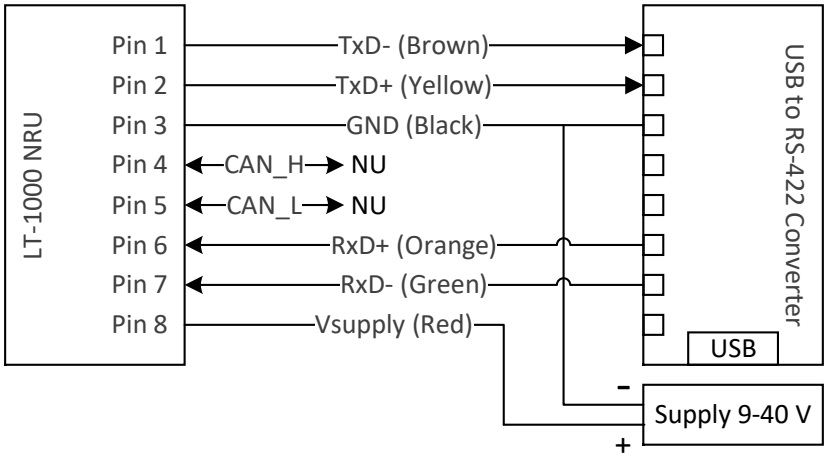


FIGURE 38: USB TO RS-422 CONVERTER PROVIDING THE COMMUNICATION LINK BETWEEN THE PC (LT-SERVICE TOOL) AND THE LT-1000 NRU.

NOTE: Windows may wrongfully recognize an USB to Serial device, as a mouse, if the device is transmitting when being plugged into the PC. Avoid this by giving Windows time to recognize the USB to Serial device before powering up the LT-1000 NRU.

Serial Port (RS-422)

The LT-Service Tool can be connected to the LT-1000 NRU via a RS-422 interface as illustrated in Figure 39.

NOTE: The RS-422 interface is using both Tx and Rx transmission lines (balanced/differential) and is therefore a more robust communication link than the RS-232 interface. The LT-1000 NRU is supporting both RS-422 and RS-232 communicating link to the LT-Service Tool.

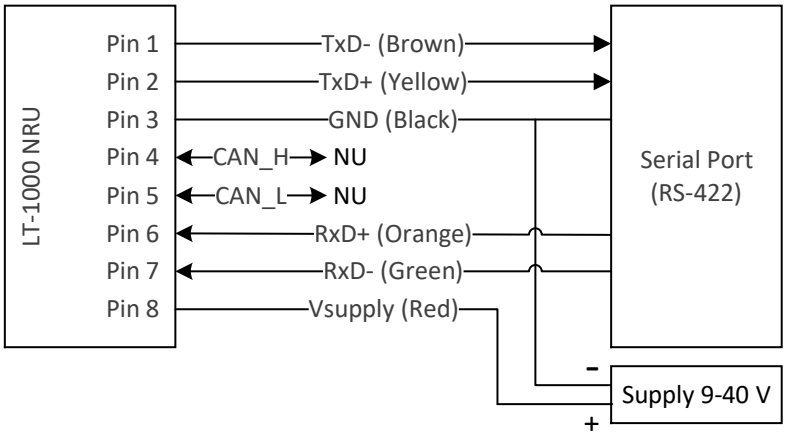


FIGURE 39: RS-422 (BALANCED) SERIAL INTERFACE PROVIDING THE COMMUNICATION LINK BETWEEN THE LT-SERVICE TOOL AND THE LT-1000 NRU.

Serial port (RS-232)

The LT-Service Tool can be connected to the LT-1000 NRU via a RS-232 interface as illustrated in Figure 40.

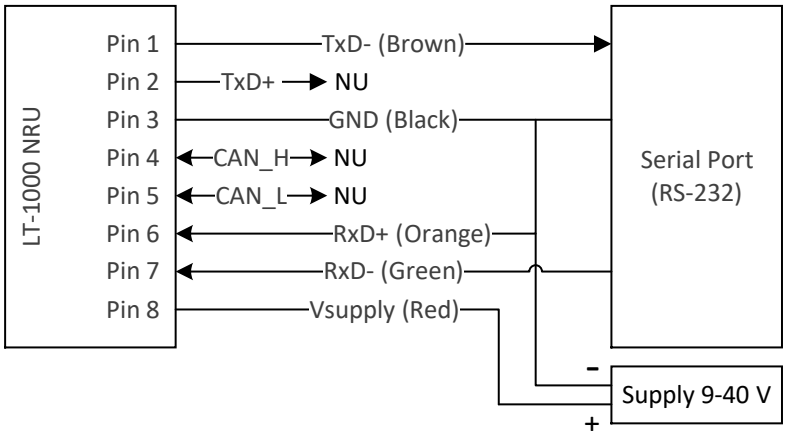


FIGURE 40: RS-232 (UNBALANCED) SERIAL INTERFACE PROVIDING THE COMMUNICATION LINK BETWEEN THE LT-SERVICE TOOL AND THE LT-1000 NRU

NOTE: When using the RS-232 (unbalanced) serial communication link, it is important that the RxD-signal level from the serial port is > 5 VDC for proper operation.

Configuration

This chapter lists configuration options for the LT-1000 NRU. The LT-1000 NRU can be configured via DIP-switch (see *DIP-switch* on page 37) or via the LT-Service Tool (see *LT-Service Tool* on page 39).

The following configurations are described in this chapter:

- NMEA 0183 baud rate (via DIP-switch)
- NMEA 0183 sentences
- NMEA 2000 termination (via DIP-switch)
- Attitude filter
- Deviation calibration & options
- Auto level
- Heading offset
- Roll offset
- Pitch offset
- Vertical offset
- GNSS receiver
- Factory default

NMEA 0183 Baud rate

The NMEA 0183 baud rate can be configured to 4800 or 38400 baud.

NMEA 0183 Baud rate			
Configuration	**Options**	**Default**	**Comments**
Baud rate	4800 or 38400	4800	configuration via DIP-switch

TABLE 5: LT-1000 NRU CONFIGURATION OF NMEA 0183 BAUD RATE.

The DIP-switch configuration is illustrated in *DIP-switch* on page 37.

NMEA 0183 sentences

From factory, the LT-1000 NRU has a default NMEA 0183 sentence configuration that determines which sentences are output at a given baud rate (4800 and 38400), their rate, and talker ID. Using the LT-Service Tool, sentences can be enabled/disabled, and their rate and talker ID configured (see note regarding GNSS).

NMEA 0183 Sentences			
Configuration	**Options**	**Default**	**Comments**
Sentence	Enable or disable	See *App. D – NMEA 0183 Sentences*	Configuration via LT-Service Tool
Talker ID	See comments		User defined (e.g. HC, HE, HN, etc.)
Output rate	0.1 to 40 Hz		Configuration via LT-Service Tool

TABLE 6: LT-1000 NRU NMEA 0183 SENTENCES.

The default configuration of the NMEA 0183 sentences for respectively 4800 and 38400 baud is illustrated in *App. D – NMEA 0183 Sentences* on page 48.

NOTE: If changing the NMEA 0183 baud rate, the NMEA 0183 sentences configuration will be reset to factory default.

NOTE: GNSS sentences can only be enabled/disabled. Configuration of output rate is currently not supported. All enabled GNSS sentences are output with 1 Hz. Configuration of GNSS receiver, see *GNSS receiver* on page 31.

The LT-Service Tool is providing support and guidance when configuring the NMEA 0183 sentences. The LT-Service Tool is providing some functions to verify the correct configuration of the NMEA 0183 sentences:

- stat: analyzing function showing statistics, including utilization of bandwidth
- mon: dumping the NMEA 0183 data, to visualize data stream

Example on the LT-Service Tool NMEA 0183 sentences configuration (syntax):

lt>nmea0183 sentences HCHDT:100 HCROT:100

NOTE: Write 'help' in front of the commands in the LT-Service Tool to get detailed information about the specific command and configuration.

NMEA 2000 termination

The NMEA 2000 can be configured to 'Open' or 'Terminated'. See *NMEA 2000 Installation* on page 24 for further details on whether the LT-1000 NRU shall be connected with a drop cable ('Open') or directly to the backbone ('Terminated').

NMEA 2000 termination			
Configuration	**Options**	**Default**	**Comments**
Termination	Open or Terminated	Open	Configuration via DIP-switch

TABLE 7: LT-1000 NRU CONFIGURATION OF NMEA 2000 TERMINATION.

The DIP-switch configuration is illustrated in *DIP-switch* on page 37.

Attitude filter

The attitude data from the LT-1000 NRU (heading, roll, and pitch) can be low-pass filtered. The same attitude filter configuration will be applied respectively on the NMEA 0183 and NMEA 2000 interface. The time constant can be varied from 0.0 to 9.9 seconds.

Attitude Filter			
Configuration	**Options**	**Default**	**Comments**
Attitude filter	0.0 to 9.9 s.	0.0 s.	Configuration via LT-Service Tool

TABLE 8: LT-1000 NRU CONFIGURATION OF ATTITUDE FILTER.

Deviation calibration

The deviation calibration can be configured to Standard (figure 8-pattern), Adaptive, or Off.

Deviation Calibration			
Configuration	**Options**	**Default**	**Comments**
Deviation Calibration	Standard, Adaptive, Off, or Reset	Standard	Configuration via LT-Service Tool

TABLE 9: LT-1000 NRU CONFIGURATION OF DEVIATION CALIBRATION.

Deviation calibration is per default Standard. After a successful deviation calibration, the deviation calibration can be switched Off, and hereafter the deviation calibration will not be overwritten. It is also possible to Reset the deviation calibration (remove the calibration). Deviation calibration is described in details in *Deviation Calibration* on page 32.

Deviation options

Per default, the LT-1000 NRU will output heading with a resolution of 5 degrees, when the unit has no valid calibration (e.g. initially or after reset of deviation calibration).

Deviation Options (5deg)			
Configuration	**Options**	**Default**	**Comments**
Deviation Options	5deg or none	5deg	Configuration via LT-Service Tool

TABLE 10: LT-1000 NRU CONFIGURATION OF DEVIATION OPTIONS 5DEG.

To suppress the 5 degrees heading resolution, the deviation options can be configured to 'none'.

Completion of a successful deviation calibration is indicated by pausing the heading output for 15 seconds.

Deviation Options (Pause)			
Configuration	**Options**	**Default**	**Comments**
Deviation Options	Pause or none	Pause	Configuration via LT-Service Tool

TABLE 11: LT-1000 NRU CONFIGURATION OF DEVIATION OPTIONS PAUSE.

The 15 seconds heading pause can be disabled by changing the deviation options to 'none'. LT-Service Tool command syntax:

lt>deviation options [5deg pause | none]

NOTE: The deviation options 'pause' configuration is only valid for the standard figure 8-pattern calibration. The adaptive calibration will never pause heading output after a successful deviation calibration is available.

Auto level

The auto level function has the following modes: Run or Reset.

Auto level			
Configuration	**Options**	**Default**	**Comments**
Auto level	Run or Reset	NA	Configuration via LT-Service Tool

TABLE 12: LT-1000 NRU AUTO LEVEL FUNCTION.

IMPORTANT: The auto level function should always be applied for best performance (only little performance improvement on horizontal installations). Make sure that pitch and roll output is stabilized (vessel is not moving) and constant before applying the auto level function.

NOTE: After applying the auto level function, it is always required to perform a new deviation calibration.

Heading offset

The LT-1000 NRU support a heading offset configuration.

Heading offset			
Configuration	**Options**	**Default**	**Comments**
Heading offset	±180.0°	+000.0°	Configuration via LT-Service Tool

TABLE 13: LT-1000 NRU CONFIGURATION OF HEADING OFFSET.

Heading offset can be applied after (or before) the deviation calibration has been completed. The heading offset compensate for a possible installation offset in the heading direction. A heading offset adjustment will not require a new deviation calibration.

Roll offset

The LT-1000 NRU support a roll offset configuration.

Roll offset			
Configuration	**Options**	**Default**	**Comments**
Roll offset	±10.0°	+00.0°	Configuration via LT-Service Tool

TABLE 14: LT-1000 NRU CONFIGURATION OF ROLL OFFSET.

Roll offset can be applied after the 'auto level' function. A roll offset adjustment will not require a new deviation calibration.

Pitch offset

The LT-1000 NRU support a pitch offset configuration.

Roll offset			
Configuration	**Options**	**Default**	**Comments**
Pitch offset	±10.0°	+00.0°	Configuration via LT-Service Tool

TABLE 15: LT-1000 NRU CONFIGURATION OF PITCH OFFSET.

Pitch offset can be applied after the 'auto level' function. A pitch offset adjustment will not require a new deviation calibration.

Vertical offset

The LT-1000 NRU support a vertical offset configuration.

Vertical offset			
Configuration	**Options**	**Default**	**Comments**
Vertical offset	±99 m.	+00.0 m.	Configuration via LT-Service Tool

TABLE 16: LT-1000 NRU CONFIGURATION OF VERTICAL OFFSET.

Vertical offset can be applied anytime. The vertical offset compensates the pressure output. If the LT-1000 NRU is installed, e.g. +5 meters above sea level, then a vertical offset of +5 meters shall be applied for the pressure output to be adjusted to sea level.

GNSS receiver

The LT-1000 GNSS Receiver is by default configured to the following GNSS satellite reception:

GPS, SBAS, and GLONASS

For a complete list of possible configurations, see Table 17.

GNSS Satellite Receiver Configuration	
Configuration	**GNSS Satellites**
Default	GPS, SBAS, GLONASS
Option 1	GPS, SBAS, BeiDou
Option 2	GPS, SBAS
Option 3	GPS
Option 4	GLONASS
Option 5	BeiDou

TABLE 17: GNSS SATELLITE RECEIVER CONFIGURATION

Example on the LT-Service Tool GNSS Receiver configuration (syntax):

lt>gnss receiver GPS SBAS GLONASS

Factory default

The factory default configuration can always be used to reset the LT-1000 NRU back to the default configuration and originally starting point.

Factory Default			
Configuration	**Options**	**Default**	**Comments**
Factory default	Yes or No	See *Configuration* on page 27	Configuration via LT-Service Tool

TABLE 18: LT-1000 NRU FACTORY DEFAULT.

After the factory default configuration has been activated, the user configurations will be deleted and default configuration will be restored.

NOTE: Make sure to reboot or power cycle the LT-1000 NRU after factory default configuration of the unit.

Deviation Calibration

The magnetometer sensors in the LT-1000 NRU may be affected by magnetic disturbances from the vessel, which needs to be corrected in order to deliver magnetic heading (and thus true heading). The source of these magnetic disturbances could be, but not limited to; engines, power cables, etc. This discrepancy between magnetic and compass heading is called the “deviation”.

Deviation will cause incorrect heading data if not corrected. To compensate for deviation, it is necessary to complete a deviation calibration of the magnetometers, after installation of the LT-1000 NRU.

NOTE: Default, the LT-1000 NRU will indicate absence of a valid calibration by outputting heading (true and magnetic) with a 5 degrees resolution. This indication can be disabled. When a calibration has been successful, the heading will be output with full resolution (0.1° degrees).

The user can choose between two methods for performing a deviation calibration:

- Standard (figure 8-pattern)
- Adaptive

The Standard deviation calibration algorithm is default configured. The Standard deviation calibration algorithm provides good performance for all vessels, which can perform the figure 8-pattern maneuver.

The Adaptive deviation calibration is an alternative to the Standard deviation calibration algorithm, intended for vessels that are too large to perform the figure 8-pattern. The performance of the Adaptive deviation calibration algorithm will converge to that of the Standard deviation calibration algorithm over time.

IMPORTANT: If the LT-1000 NRU is physically moved or rotated, it is required to perform a new deviation calibration. The deviation calibration will not be valid, if the LT-1000 NRU has been moved after completed deviation calibration.

IMPORTANT: The auto level of pitch and roll must be completed prior to the deviation calibration.

NOTE: In order to get the best possible heading accuracy on the LT-1000 NRU, it is required to compensate for the heading mounting offset after the deviation calibration is completed. The heading offset can be configured from the LT-Service Tool, see *Heading offset* on page 30.

NOTE: In order to verify that a subsequent deviation calibration has succeeded, see *Verify a subsequent deviation calibration* on page 36

NOTE: The LT-Service Tool can be used to remove the deviation calibration, see *Deviation calibration* on page 28.

The two deviation calibration methods are described in the following sub-chapters.

Standard (figure 8-pattern)

The LT-1000 NRU will automatically perform a calibration when it detects the vessel is sailing a specific pattern. To trigger a calibration, guide the vessel through the patterns (option 1 or 2), which are illustrated in Figure 41.

NOTE: The calibration should be performed in open and calm waters, and will determine the ship's influence on the magnetic sensors. The best result is achieved at low speed (SOG) and low rate of turn (ROT).

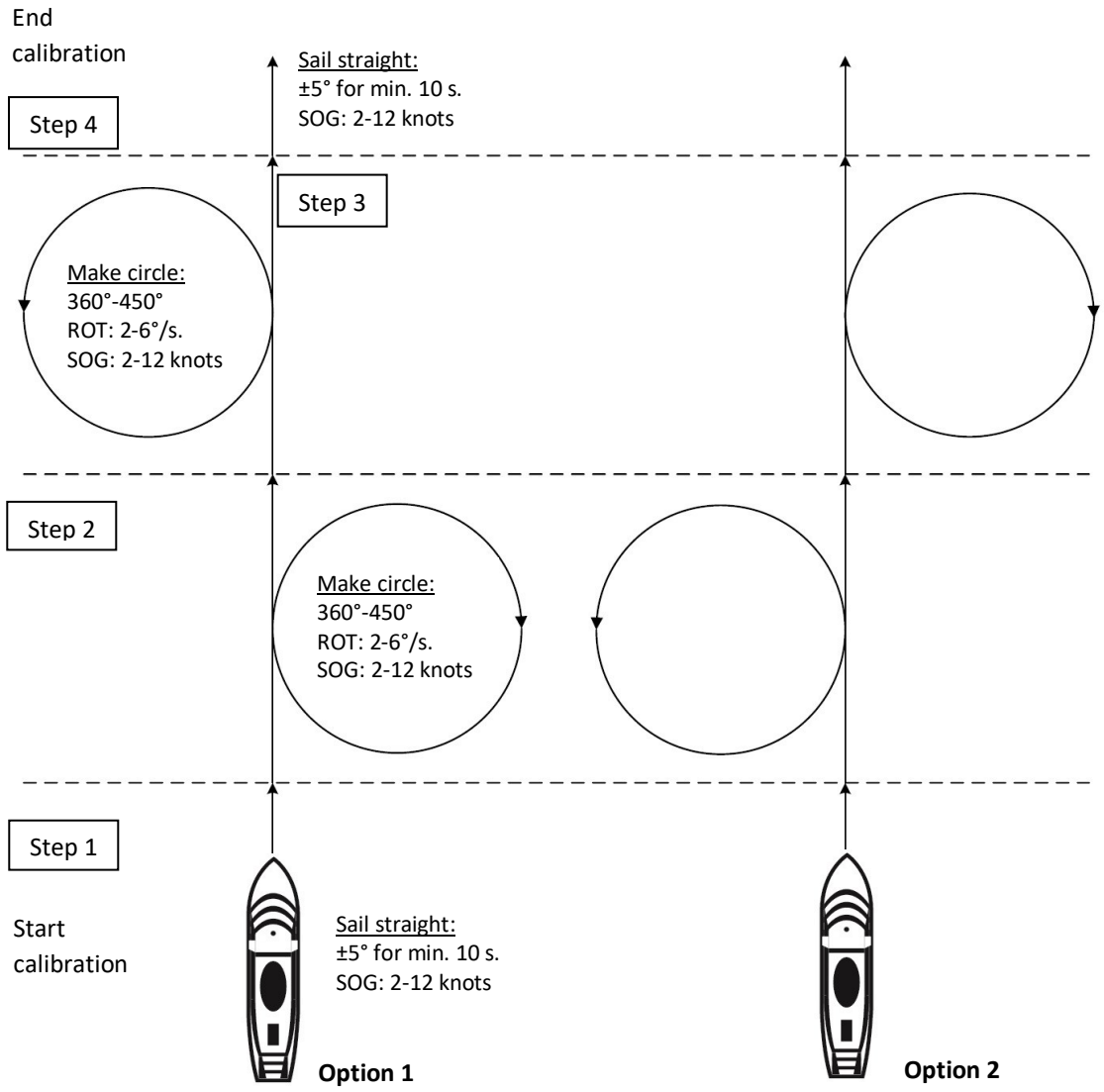


FIGURE 41: STANDARD DEVIATION CALIBRATION (FIGURE 8-PATTERN)

Step 1: Keep a steady course (± 5 degrees) for minimum 10 seconds
SOG: 2–12 knots

Step 2: Make a full circle (360-450°) clockwise or counterclockwise
ROT: 2-6 degrees/second (1-3 minutes pr. circle)
SOG: 2-12 knots

Step 3: Make a full circle (360-450°) in opposite direction
ROT: 2-6 degrees/second (1-3 minutes pr. circle)
SOG: 2-12 knots

Step 4: Keep a steady course (± 5 degrees) for minimum 10 seconds
SOG: 2–12 knots

If the calibration fails, please repeat step 1 to 4 again.

Adaptive

The adaptive deviation calibration algorithm will improve performance over time as the vessel navigates on different courses. The adaptive deviation calibration algorithm must be activated using the LT-Service Tool (see *LT-Service Tool* on page 39), using the following command:

lt>deviation calibration adaptive

NOTE: Make sure to reboot or power cycle the LT-1000 NRU after configuration of the adaptive deviation calibration. The deviation calibration command is described in *Deviation calibration* on page 28.

The adaptive deviation calibration algorithm will continuously collect data and improve the deviation calibration. When doing so, only data collected within a radius of 25 NM are taken into account. Updates to the deviation calibration will be applied seamlessly without abruptions in the heading (or other) output.

NOTE: If continuous improvement is not wanted, the adaptive deviation calibration can be disabled by setting deviation calibration to 'Off'.

Forcing the initial calibration

An initial adaptive deviation calibration can be forced by keeping a minimum speed of 3 KTS for at least 0.5 NM and then completing a 360° circle at low speed (3 to 20 KTS) and low rate-of-turn (< 2°/s).

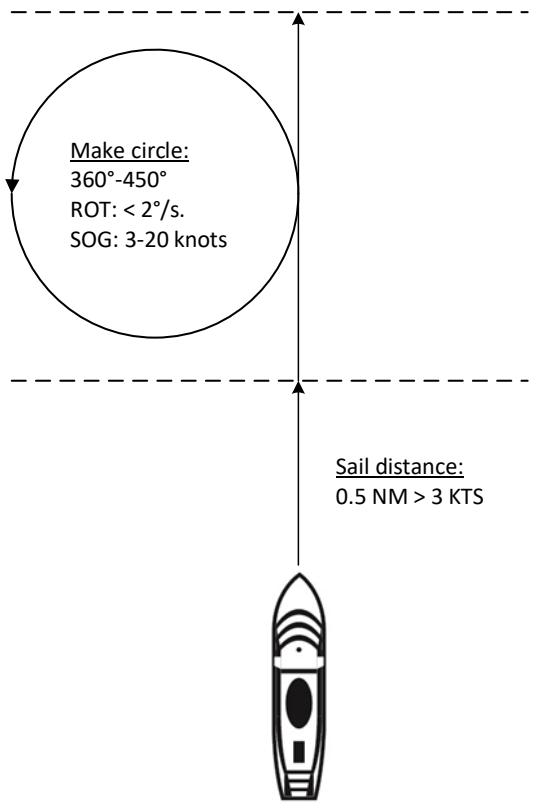


FIGURE 42: FORCE AN INITIAL ADAPTIVE DEVIATION CALIBRATION

NOTE: When in adaptive calibration mode, data is only collected if the vessel has maintained a speed of minimum 3 KTS for the last 0.5 NM. If the speed drops below 3 KTS, data collection is paused until the vessel has maintained a speed of minimum 3 KTS for the last 0.5 NM.

Verify a subsequent deviation calibration

The deviation calibration can be updated (standard and adaptive deviation calibration).

In the standard deviation calibration mode, the user has to guide the vessel through the pattern.

In the Adaptive mode, the LT-1000 NRU will collect heading sensor data over time and compare the data set with an already calculated deviation calibration. If the new deviation calibration has a better score than what is currently available, the deviation calibration will be updated.

There are two ways to verify an update has occurred:

- In standard deviation calibration mode, and unless disabled, output of heading (true and magnetic) is suspended for 15 seconds upon a deviation calibration update (including the initial deviation calibration).

- Use the LT-Service Tool command: 'status'. The status command will display the latest deviation calibration with a timestamp.

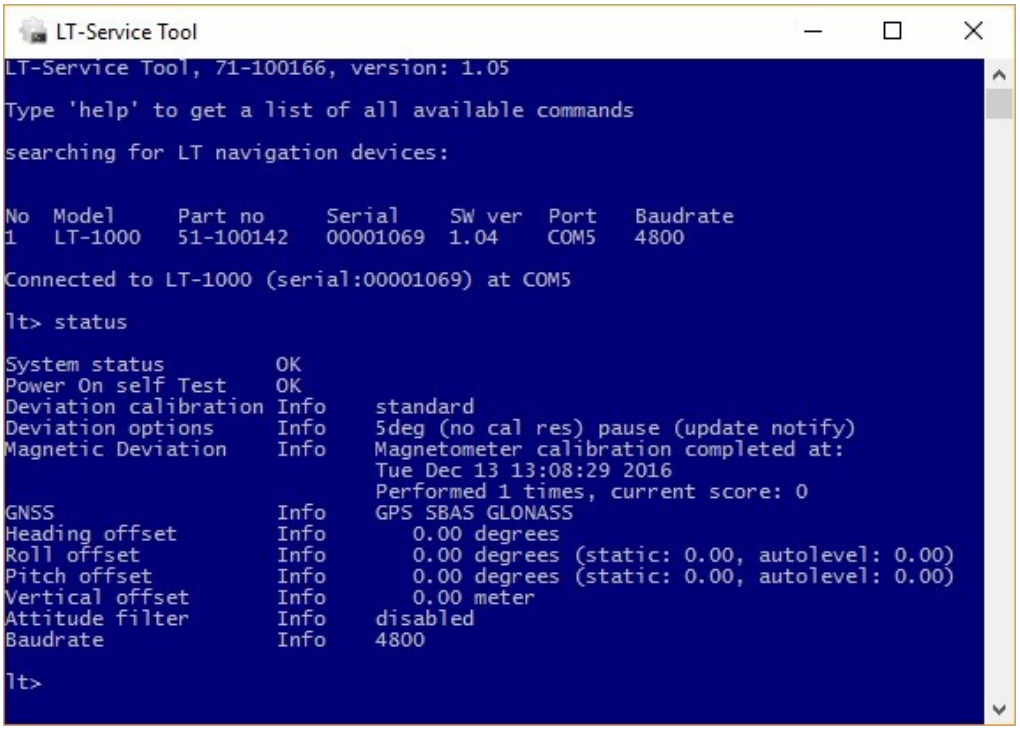


FIGURE 43: THE LT-SERVICE TOOL COMMAND 'STATUS' SHOWING THE NUMBER OF DEVIATION CALIBRATIONS (SEE MAGNETIC DEVIATION, PERFORMED 'X' TIMES).

NOTE: To avoid an update to an existing deviation calibration, the deviation calibration can be configured to 'Off' via the LT-Service Tool.

MMI Description

The LT-1000 NRU has a built-in DIP-switch, which is accessible from the bottom of the unit, before the pole or roof mount is mounted. To access the DIP-switch, the cap plug has to be removed; hereafter the installer will have direct access to configuration of the DIP-switch. Furthermore, two LEDs are visible on the bottom of the LT-1000 NRU. The placement of the DIP-switch and LEDs are illustrated in Figure 44.

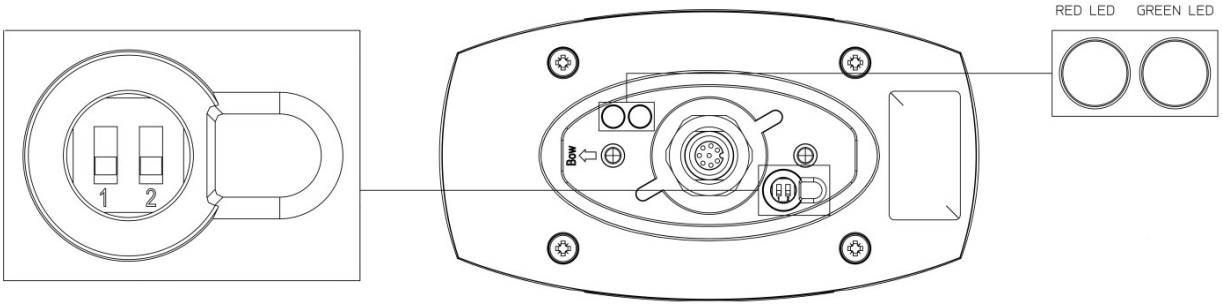


FIGURE 44: LT-1000 NRU DIP-SWITCH AND LEDS (BOTTOM SIDE OF LT-1000 NRU).

DIP-switch

The configuration of the DIP-switch is illustrated in Figure 45. The two switches can individually be configured.

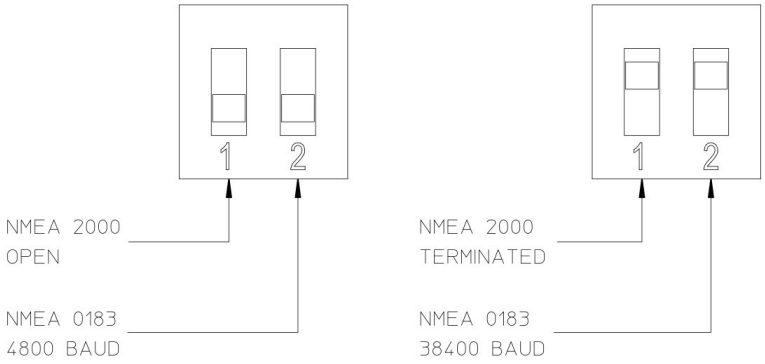


FIGURE 45: DIP-SWITCH CONFIGURATION (NMEA 0183 BAUD RATE AND NMEA 2000 OPEN OR TERMINATED)

IMPORTANT: The DIP-switch is configured to 4800 baud (NMEA 0183) and 'Open' (NMEA 2000) when leaving the factory. However, the installer should always check the settings of the DIP-switch prior to an installation. Make sure to hold the LT-1000 NRU as illustrated in Figure 44, when reading and configuring the DIP-switch, to avoid wrong settings.

LEDs

The color code and description of the LEDs are illustrated in Table 19.

LT-1000 NRU LEDs Color Description		
Power LED (Green)	**Status LED (Red)**	**Description**
On	Off	Power on unit. Unit is ready for navigation.
On	On	Power on Unit. Error or warnings present. Check installation setup and *Troubleshooting* on page 41 to resolve the problem. Connect the LT-Service Tool to read-out details from the LT-1000 NRU.
Off	NA	No power on unit.

TABLE 19: LT-1000 NRU LED COLOR CODE AND DESCRIPTION

LT-Service Tool

The LT-Service Tool is a PC program interfacing and communicating with LT-Navigation devices. The LT-Service Tool is communicating via the NMEA 0183 serial interface. The newest available LT-Service Tool will be available from the local distributor & dealer, and from our website: www.thrane.eu

File name: LT-Service_vX.XX.exe

NOTE: The LT-Service Tool is an optional PC program, which can be used together with the LT-1000 NRU. It is possible to install the LT-1000 NRU and use it for navigational purposes, without configuration by the LT-Service Tool. The LT-Service Tool is intended for installation and service by trained personnel.

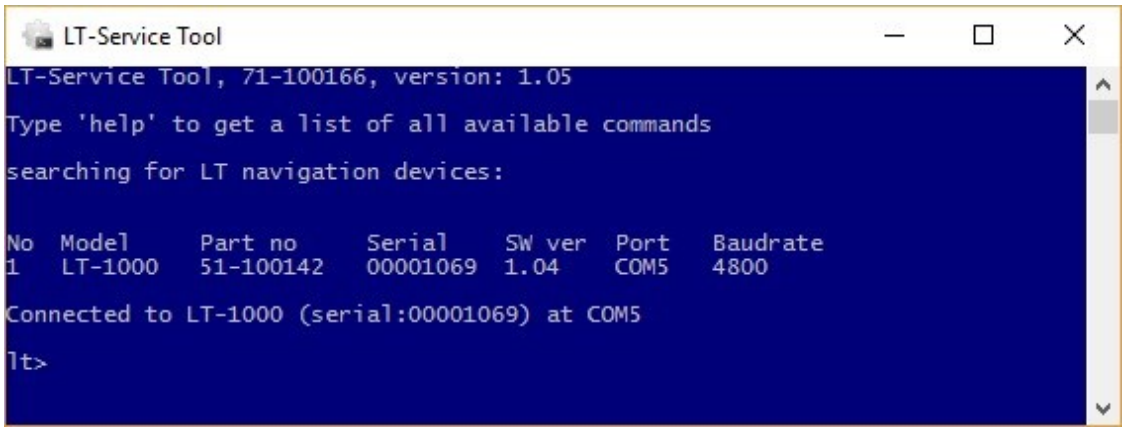


FIGURE 46: THE LT-SERVICE TOOL WILL AUTOMATICALLY SEARCH FOR LT-NAVIGATION DEVICES, WHICH ARE CONNECTED TO THE PC. A MANUAL CONNECTION MODE IS ALSO AVAILABLE.

Identify a LT-Navigation device

The LT-Service Tool requires a bi-directional RS-422 balanced or RS-232 unbalanced serial interface in order to communicate with the LT-Navigation devices. The baud-rate is either: 4800 or 38400 baud (configured on the LT-1000 NRU DIP-switch, see *DIP-switch* on page 37).

NOTE: It is recommended to use a 'USB to RS-422 converter' for easy interfacing in-between the PC (LT-Service Tool) and the LT-1000 NRU. Interconnection diagrams are illustrated in *Connecting LT-Service Tool* on page 25.

Automatic mode:

Step 1: Double click on the LT-Service_vX.XX.exe file to start the program

Step 2: The LT-Service Tool will automatically search all COM ports on the PC to identify potential LT-Navigation devices connected to the PC. Devices found, will be shown in a list, as illustrated in Figure 46.

Step 3: If the LT-Service Tool finds more than one LT-Navigation device, then type the number of the device in the list to connect to, e.g. "1" and "Return". If only one device is found, then the LT-Service Tool will automatically connect.

Manual mode:

Step 1: Start cmd.exe (Windows command prompt).

Step 2: Navigate to the directory where the LT-Service Tool is stored.

Step 3: In the cmd prompt write: "LT-Service_vX.XX.exe –p COM5 –b 4800" to launch the program (depends on the version of the LT-Service Tool (X.XX = 1.01), PC COM port, and the baud rate for which the LT-1000 NRU is configured).

LT-Service Tool functions

The LT-Service Tool functions and commands are divided into three main groups:

- SETUP — The setup commands can be used for configuration of installation parameters. The configurations are described in *Configuration* on page 27.
- UTILITIES — The utilities commands are related to the navigation status of the unit, especially verification of NMEA 0183 sentences.
- SYSTEM — The system commands are supporting general support related issues e.g. upload of firmware, configuration status, health status of unit, etc.

List of commands

All available commands in the LT-Service Tool are listed when using the "help" command, see *App. F – LT-Service Tool (commands)* on page 51.

Some of the most used commands are listed here:

"help"	Lists all commands supported by the LT-Service Tool and the LT-1000 NRU
"deviation calibration"	set mode to Standard, Adaptive, Off, or Reset
"autolevel"	Levelling pitch and roll to zero (auto level function)
"heading <actual heading>"	Calculates heading offset and compensate
"vertical offset <offset>"	Compensate barometer to sea level
"nmea0183 sentences"	Configuration of NMEA 0183 sentences (enable/disable, talker ID, output rate)
"gnss receiver"	Select the following type of satellites: GPS, SBAS, GLONASS or BeiDou
"diag"	Generate a Diagnostic Report
"upload <filename>"	Upload a new application image (absolute or relative file path)
"reboot"	Reboot device (for configuration to take affect)
"post", "event" & "status"	Prints Power On Self-Tests (POST), events (CM) and status

Troubleshooting

Before contacting the distributor or dealer for support, please check the following troubleshooting guide.

Troubleshooting guide:

1) Power cycle the unit to verify that the problem still exists

2) Is the communication cable properly connected?
   For more information on connecting cables, see *Connecting* on page 21.

3) Check the status of the LEDs.
   If everything is correct, the Power LED (green) shall lit and the Status LED (red) shall non-lit. For further details on the LEDs, see *LEDs* on page 38.

4) If using NMEA 0183:
   a. Check configuration of the NMEA 0183 baud rate.
      NMEA 0183: 4800 or 38400 baud (factory default: 4800 baud)
      For further details on the baud rate, see *DIP-switch* on page 37.

   b. Check your navigation equipment for correct baud rate. Check that the LT-1000 NRU is supporting the expected NMEA 0183 Sentences; see *App. D – NMEA 0183 Sentences* on page 48.

   c. Verify the NMEA 0183 sentences configuration (enable/disable, talker ID, output rate). The configuration of NMEA 0183 sentences are described in *NMEA 0183 sentences* on page 27.

5) If using NMEA 2000:
   a. Check the configuration of the NMEA 2000 termination.
      NMEA 2000: 'Open' or 'Terminated' (factory default: 'Open')
      For further details on the NMEA 2000 termination, see *DIP-switch* on page 37.

   b. Check your navigational equipment for correct selection of the LT-1000 NRU as preferred source (Heading, GPS, Environmental). Check that the LT-1000 NRU is supporting the expected NMEA 2000 PGNs; see *App. E - NMEA 2000 PGNs* on page 50.

6) If using the LT-Service Tool:
   If any configuration has been applied in the LT-Service Tool, make sure that you have used the "reboot" command and check that the new configuration is properly configured after the LT-1000 NRU has power up again.

7) Connect the LT-Service Tool, see *Connecting LT-Service Tool* on page 25 and *LT-Service Tool* on page 39. Check the following commands in the LT-Service Tool:
   a. Write "status" and check for errors and warnings
   b. Write "nav" and verify navigation data is as expected
   c. Write "mon" to monitor NMEA 0183 output
   d. Write "stat" to evaluate the NMEA 0183 output

8) Use the “factory default” command, to reset any configurations back to default. This command can be activated from the LT-Service Tool, see *Factory default* on page 31.

If none of these troubleshooting steps have re-solved the problem, please contact your local distributor or dealer for further action and support.

NOTE: It is recommended, that the end-user makes contact to the local distributor or dealer for technical support on the product, as they have information and experience with the product.

Service and repair

This section describes what the end-user must do in case of required service or repair.

NOTE: The LT-1000 NRU does not require any scheduled maintenance or service. Make sure that the product is installed, as described in this manual, before making contact to the distributor or dealer for further assistance.

For troubleshooting the LT-1000 NRU, see *Troubleshooting* on page 41.

If the LT-1000 NRU for some reason does not work as described in this manual, make contact with the distributor or dealer, from where the product was originally bought. The distributor or dealer will have experience and know-how to assist with further technical support and troubleshooting.

Contacting the distributor/dealer:

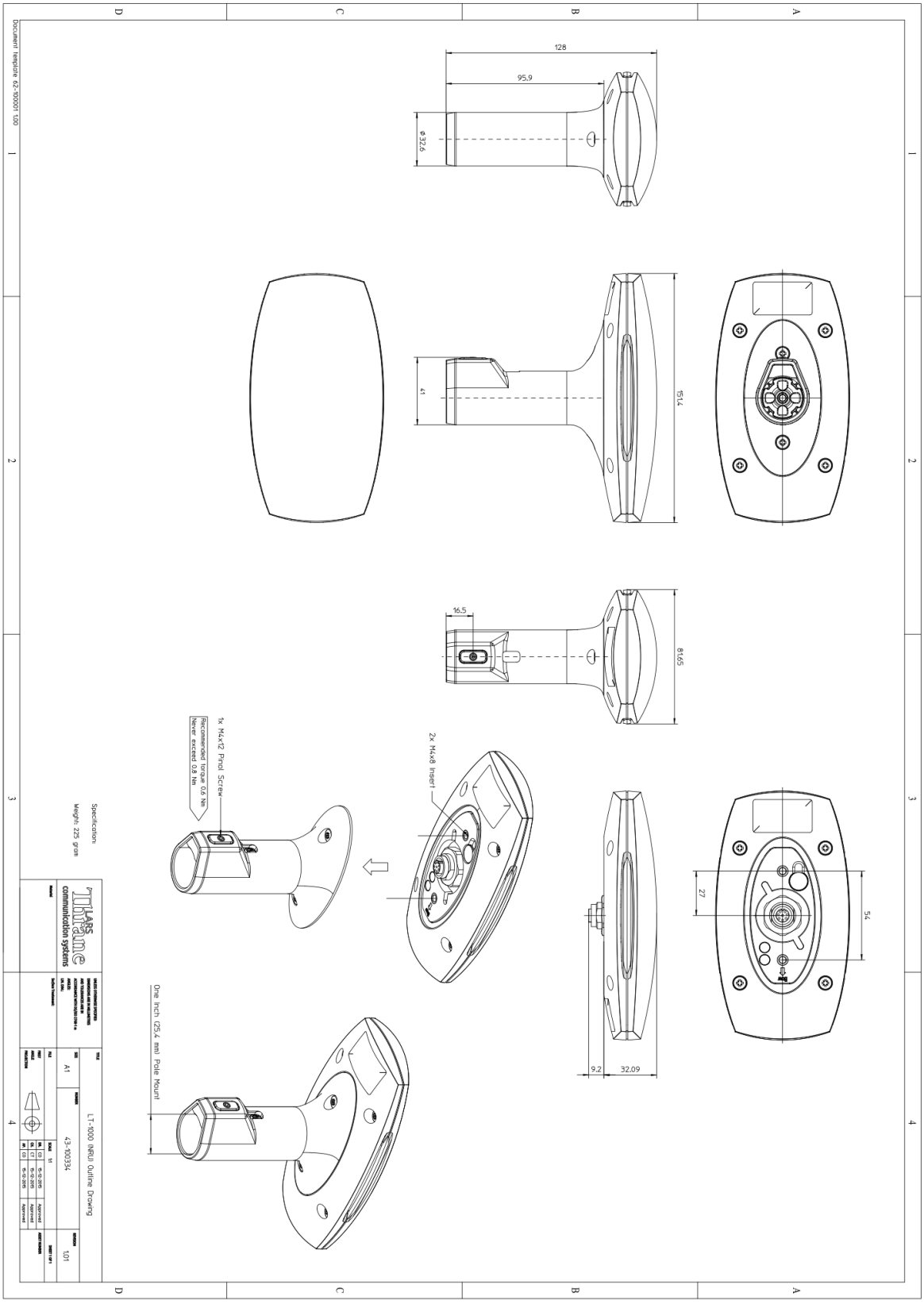
1) Make sure to have the product name (LT-1000 NRU), Part Number (P/N: 51-100142), and the unit serial number (S/N: XXXXXXXX) identified. The unit serial number is mounted on the bottom of the device. Alternatively, use the LT-Service Tool to read-out the S/N.
2) Write a technical report about the observation or error. If possible, attach a picture of the installed product and include a wiring diagram. If possible, make a diagnostic report with the LT-Service Tool (see *LT-Service Tool* on page 39).
3) Send all information to the local distributor or dealer.

IMPORTANT: Unless otherwise agreed, the end-user shall always coordinate service and repair issues directly with the distributor or dealer. This practice also applies for returning of products for service and repair.

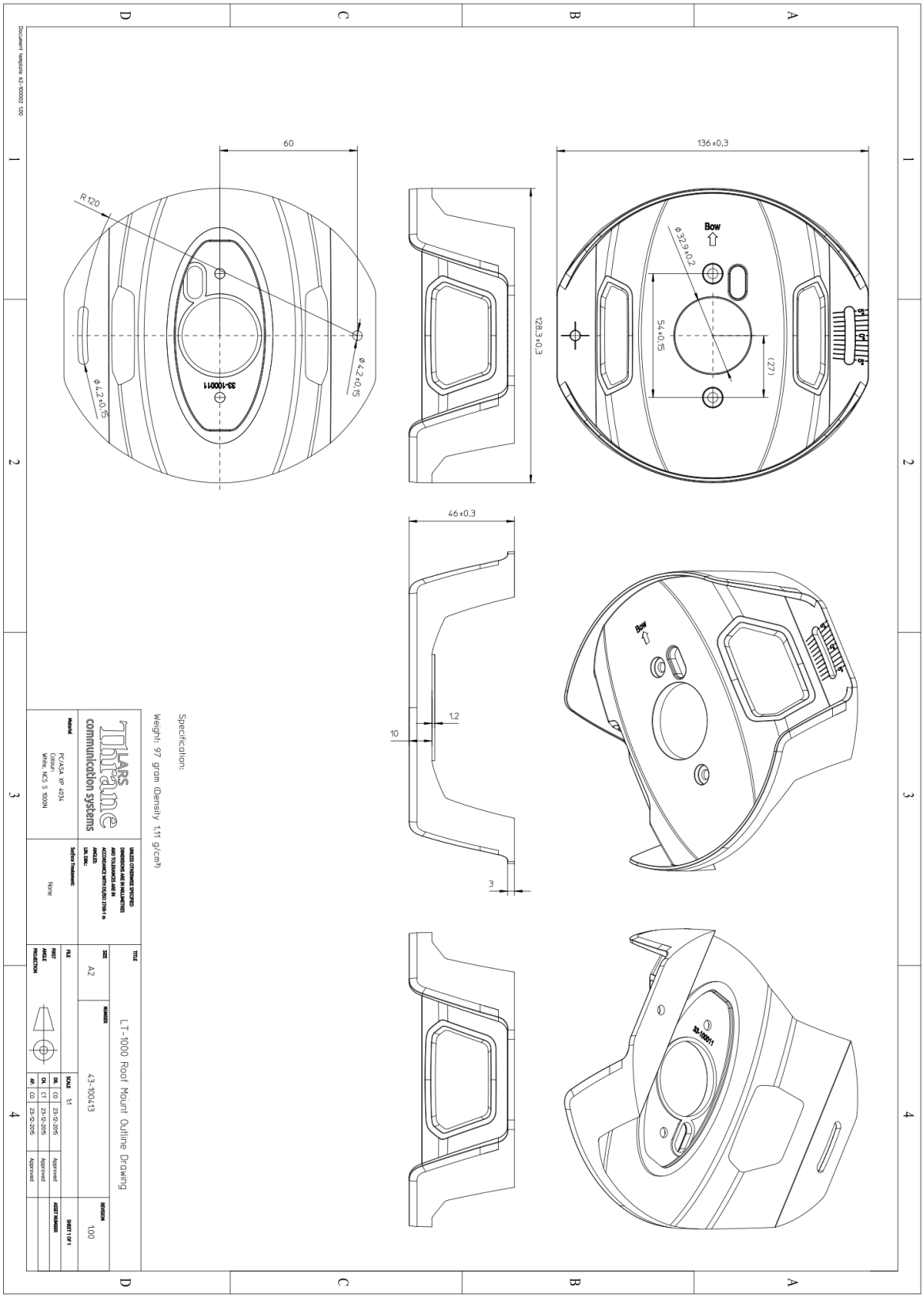
All information that will get back to Lars Thrane A/S, either directly or indirectly, will be handled with confidentiality. End-user sensitive data will not be shared with any third party without prior written acceptance from the involved parties.

App. A - Outline Drawings

LT-1000 with Pole Mount



LT-1000 Roof Mount



App. B - Performance

LT-1000 NRU Performance[1]			
Data	**Accuracy**	**Resolution**	**Range/Comments**
Heading[2]	Static: < 0.5° (rms) Dynamic: < 1.5° (rms)	0.1°	Heading is calculated with input from Sensor-fusion technology and Kalman filtering
Position[3]	GNSS: < 2.5 m SBAS: < 2 m	0.1 m	CEP, 50%, 24 hours static, -130 dBm, > 6 SVs By default the GNSS receiver is configured for GPS/GLONASS & SBAS reception Time-To-First-Fix (cold acquisition): 26 s.
Speed	0.1 knot	0.1 knot	0 to 195 knots
Roll	Static: < 0.5° (rms)	0.1°	± 180°
Pitch	Static: < 0.5° (rms)	0.1°	± 90°
Rate of turn	< 1°/s	0.1°/s	0 to 45°/s
Air Pressure	1 hPa	0.1 hPa	800 to 1100 hPa
Air Tempera-ture[4]	1°C (1.8°F) 2°C (3.6°F)	0.1°C (0.1°F)	0°C to +55°C (32°F to +131°F) -40°C to 0°C (-40°F to +32°F)

1: The LT-1000 NRU performance may be subject to degradation caused by an improper installation.
2: The dynamic heading accuracy is specified with roll/pitch less than ± 45° and ROT ≤ 45°/s.
3: The LT-1000 NRU has an immunity filter against Iridium and Inmarsat transceivers
4: Solar radiation and environmental conditions will affect the measured air temperature (accuracy is specified as on-board sensor performance)

App. C – Specifications

LT-1000 NRU Specifications	
Certification and standards[1]	CE, IEC 60945, IEC 60950-1/-22, EN 300 440, EN 301 389, FCC, IC, RCM (C-Tick), RoHS NMEA 0183, NMEA 2000
Equipment class	Protected, according to IEC 60945
Weight, with pole mount	240 g (0.53 lbs)
Weight, with roof mount	281 g (0.62 lbs)
Dimensions, with pole mount	151.4 x 81.6 x 128.0 mm (5.96 x 3.21 x 5.04 in)
Dimensions, with roof mount	151.4 x 136.0 x 46.0 mm (5.96 x 5.35 x 1.81 in)
Temperature, operational (ambient)	-40°C to +55°C (-40°F to +131°F)
Temperature, storage (ambient)	-40°C to +85°C (-40°F to +185°F)
Vibration, operational	IEC 60945 (sine) & Proprietary Maritime Random profile (240 h)
Vibration, survival	Proprietary Maritime Random profile (100 h)
Vibration, shock	Proprietary Maritime profile (60 g pk, 11 ms)
Waterproof rating	IP46
Humidity	95% non-condensing @ 40°C
Wind, operational	80 knots (93 MPH)
Wind, survival	110 knots (127 MPH)
Ice, survival	25 mm (1 in)
Solar radiation	1120 W/m2
Communication interface	8-pin female connector for NMEA 0183, NMEA 2000, and power
Input voltage	9-40 VDC
Power consumption	< 1 W (@ 12 VDC)
Load Equivalent Number (LEN)	2
Compass safe distance standard	0.3 m (1 ft)
Compass safe distance steering	0.3 m (1 ft)
Mounting, pole mount	25.4 mm (1 in)
Warranty	2 year
Maintenance	None

App. D – NMEA 0183 Sentences

The LT-1000 NRU is compliant with version 4.00 of the NMEA 0183 standard. The following table lists the supported sentences.

NMEA 0183 Sentences		
Sentence	**Description**	**Rate**
4800 baud		
GNRMC	Recommended Minimum Specific GNSS Data	1 Hz
HCHDG	Heading and Magnetic Heading Variation	1 Hz
HCHDM	Magnetic Heading	1 Hz
HCHDT	True Heading	10 Hz
HCROT	Rate of Turn	1 Hz
PFEC,GPatt	Attitude	1 Hz
WIMDA[1]	Meteorological Composite	0.5 Hz
38400 baud		
GNDTM	Datum Reference	1 Hz
GNGGA	GPS Fix Data	1 Hz
GNGLL	Position Latitude/Longitude WGS84	1 Hz
GNGSA	GNSS DOP and Active Satellite	1 Hz
GNRMC	Recommended Minimum Specific GNSS Data	1 Hz
GNVTG	Course Over Ground and Ground Speed	1 Hz
GNZDA	Time and Date	1 Hz
GPGSV[2]	GNSS Satellites in View	1 Hz
HCHDG	Heading and Magnetic Heading Variation	10 Hz
HCHDM	Magnetic Heading	10 Hz
HCHDT	True Heading	10 Hz
HCROT	Rate of Turn	10 Hz
HCTHS	True Heading and Status	10 Hz
PFEC,GPatt	Attitude	10 Hz
WIMDA[1]	Meteorological Composite	2 Hz
WIXDR[3]	Transducer Measurements	2 Hz

NMEA 0183 sentences are configurable (enable/disable, talker ID, output rate). For all GNSS sentences, talker ID "GN" can be configured to "GP".

1: Pressure (inHg, Bar) and Air Temperature (°C) only

2: Talker ID (GP, GL, GB) depends on satellite system (GPS/SBAS, GLONASS, BeiDou)

3: Pressure (Pa) and Temperature (°C)

GNSS Talker Identifier

The first two characters in the address field of an NMEA 0183 sentence is the Talker Identifier (e.g. "HC" in the address field "HCHDG"). The Talker Identifier may be used to determine the source of a sentence, when it can have multiple sources. In case of the GNSS related sentences (DTM, GGA, GLL, GSA, GSV, RMC, VTG, ZDA), the Talker Identifier can be used to determine from which specific GNSS system the data originates:

GNSS Talker Identifier	
Talker Identifier	**GNSS Type**
GB	BeiDou
GL	GLONASS
GN	Multiple GNSS'
GP	GPS, SBAS, or QZSS

TABLE 20: GNSS TALKER IDENTIFIER

GN Talker Identifier is a special case that indicates the sentence data originates from multiple GNSS systems. This is the case when the LT-1000 is configured (see *GNSS receiver* on page 31) to use multiple GNSS systems: GPS + GLONASS or GPS + BeiDou.

The GSV sentence will never be sent with Talker Identifier GN as it will ever only contain data from one GNSS system. If the LT-1000 NRU is configured to use multiple GNSS systems, the GSV sentence will be repeated for each GNSS system and the Talker Identifier of each GSV sentence will indicate the specific GNSS system to which it applies.

MDA sentence

The Meteorological Composite (MDA) sentence can convey more information about the environment than the LT-1000 NRU supports. In compliance with the NMEA 0183 standard, data fields for which LT-1000 NRU has no data will be null fields.

Here is an example of an MDA sentence outputted from an LT-1000 NRU containing air pressure and air temperature:

$WIMDA,29.29,I,0.9918,B,19.8,C,,C,,,,C,,T,,M,,N,,M*23

XDR sentence

The XDR sentence Transducer ID field is not standardized by the NMEA 0183 standard and is thus proprietary. Lars Thrane A/S has defined the following proprietary Transducer IDs:

XDR Proprietary Transducer ID's		
Transducer ID	**Transducer**	**Unit**
ATMO	Pressure (P)	Pascal (P)
TEMP	Temperature (C)	Celcius (C)

TABLE 21: XDR TRANSDUCER ID'S

Here is an example of an XDR sentence outputted from an LT-1000 NRU containing air pressure and air temperature:

$WIXDR,P,99178,P,ATMO,C,19.8,C,TEMP*6B

App. E - NMEA 2000 PGNs

The LT-1000 NRU is compliant with version 2.000 of the NMEA 2000 standard and version 2.000 of the NMEA Network Database. The following table lists the supported PGNs.

NMEA 2000 PGNs		
PGN	**Description**	**Rate**
Periodic PGNs		
126992	System Time	1 Hz
126993	Heartbeat	< 0.1 Hz
127250	Vessel Heading	10 Hz
127251	Rate of Turn	10 Hz
127257	Attitude	10 Hz
127258	Magnetic Variation	1 Hz
129025	Position, Rapid Update	10 Hz
129026	COG & SOG, Rapid Update	4 Hz
129029	GNSS Position Data	1 Hz
129044	Datum	0.1 Hz
129539	GNSS DOPs	1 Hz
129540	GNSS Sats in View	1 Hz
130311	Environmental Parameters	2 Hz
130312	Temperature	0.5 Hz
130314	Actual Pressure	0.5 Hz
130316	Temperature, Extended range	0.5 Hz
Requestable PGNs		
126464	PGN List (Transmit and Receive)	-
126996	Product Information	-
129538	GNSS Control Status	-
Oher PGNs		
059392	ISO Acknowledgement	-
059904	ISO Request	-
060928	ISO Address Claim	-
126208	NMEA Request/Command/Acknowledge	-

App. F – LT-Service Tool (commands)

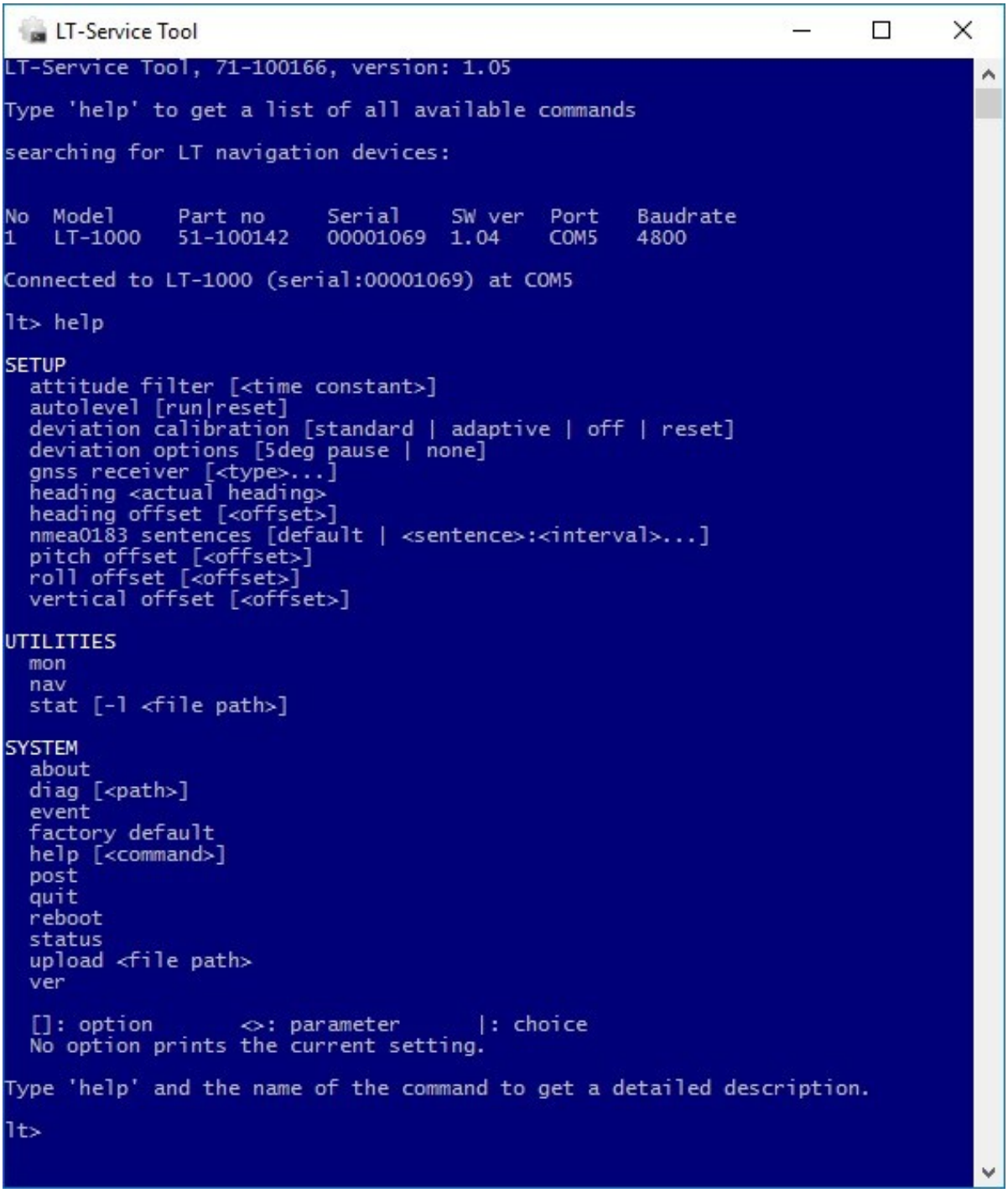


FIGURE 47: LT-SERVICE TOOL SCREEN DUMP (HELP COMMAND OUTPUT)

App. G - Declaration of Conformity

68-100335 Rev. 1.01

LARS Thrane communication systems

Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer

Manufacturer: Lars Thrane A/S

Address: Stubbeled 2, 2950 Vedbæk, Denmark

Product Identification: LT-1000 Navigation Reference Unit (NRU) PN = 51-100142

Product Description

The LT-1000 NRU is a small, compact, and very advanced unit with 12 precision sensors (magnetometers, gyros, accelerometers, barometer, thermometer, and GNSS). With the use of sensor-fusion and Kalman filtering, the LT-1000 NRU outputs: true-heading, roll, pitch, position, speed, air pressure, and temperature real-time, with high precision and resolution. The LT-1000 NRU makes use of the latest technology within GNSS receivers, with market leading acquisition and tracking performance. The LT-1000 NRU is designed and built for the demanding and rough environment at sea and with an operational temperature (ambient) range from -40°C to +55°C (-40°F and +131°F).

Declaration

We as manufacturer declare that the above listed product complies with the specification of the EC directive 1999/5/EC. The conformity has been assessed according to the procedure detailed in Annex IV of the R&TTE Directive. The following harmonized standards were applied:

RF Spectrum: EN 300 440-2, v1.4.1

EMC: EN 301 489-1, v1.9.2 / EN 301 489-3, v1.6.1

Safety: EN 60950-1:2006+AC:2011+A11:2009+A1:2010+A12:2011+A2:2013 / EN 60945:2002

Confirmed by Cetecom, Notified Body No. 0682

Year of affixing the CE mark: 2015

Place and Date

Vedbæk, 26. October 2015

Peter Thrane, CEO

Lars Thrane A/S

CE

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