Lars Thrane A/S

LT-500 AHRS - Technical Presentation Rev. 1.01

January 2017
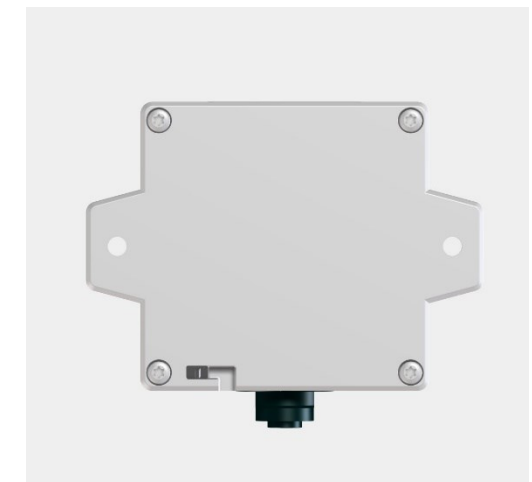
LT-500 AHRS

Market:

- Yachting, fishery, and workboats

Product technology and key features:

- Electronic compass

- Built-in User MMI (5 push buttons and display) for quick installation

- The LT-500 AHRS can be mounted in any orientation – auto level function to zero pitch and roll

- The LT-500 AHRS has performance and functionality matching more expensive products

- Providing heading input to chart plotters, autopilots, and radars

- *Note*: Deviation calibration required to output reliable heading

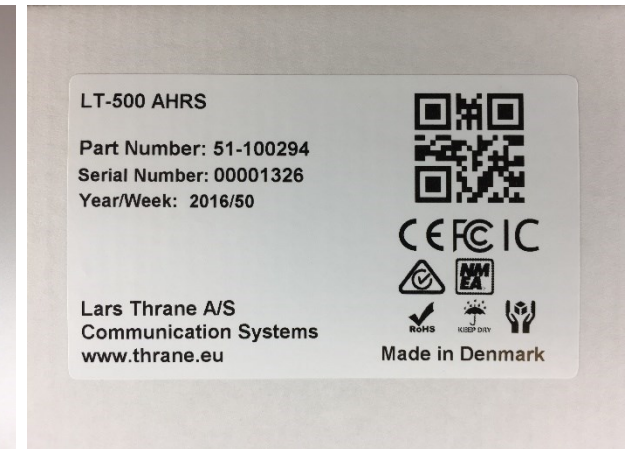- *Note*: The LT-500 AHRS is not IMO approved

LT-500 AHRS - In-The-Box

In-The-Box:

- LT-500 AHRS
- A4 self-cutting screws
- 10m cable 8-pin multi-cut
- Screw-in connector (NMEA 2000)
- Quick installation guide
- Safety instructions sheet
- Unit test sheet

Box dimensions (LxWxH): 25 x 24 x 10 cm
Box weight: 1.0 kg

LT-500 AHRS – Installation Procedure
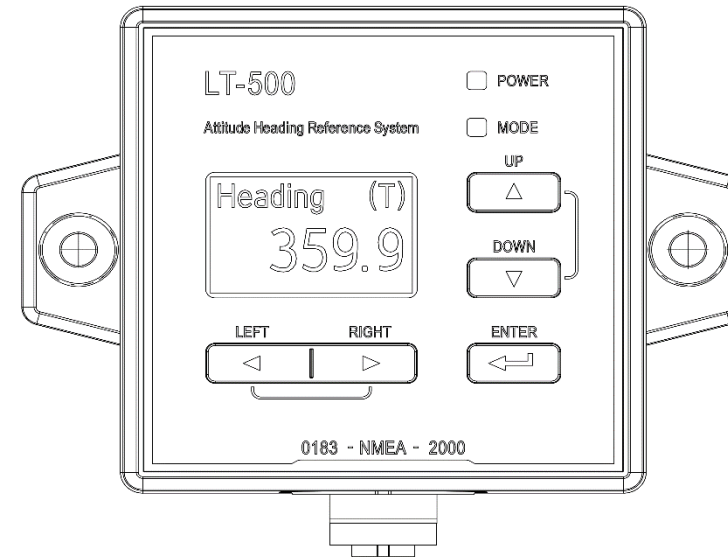
- **Mounting**

  Fasten the LT-500 AHRS

- **Connecting**

  NMEA 0183, NMEA 2000, and power

- **Configuration (optional)**

  MMI (5 push buttons & display) or

  LT-Service Tool (e.g. enable/disable NMEA 0183 sentences)

- **Deviation calibration**

  Perform Standard (figure 8-pattern) deviation calibration

- **Configuration - Heading offset (optional)**

  MMI (5 push buttons & display)

Mounting

↓

Connecting

↓

Configuration

↓

Deviation
Calibration

↓

Configuration
(optional)
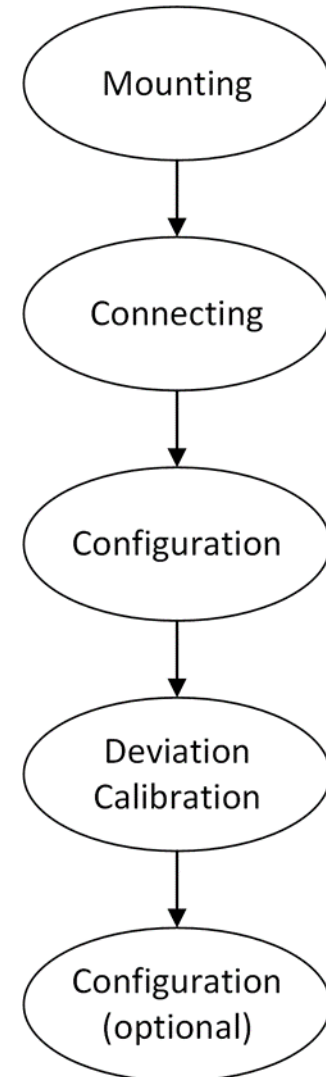
LT-500 MMI (5 push buttons & display)
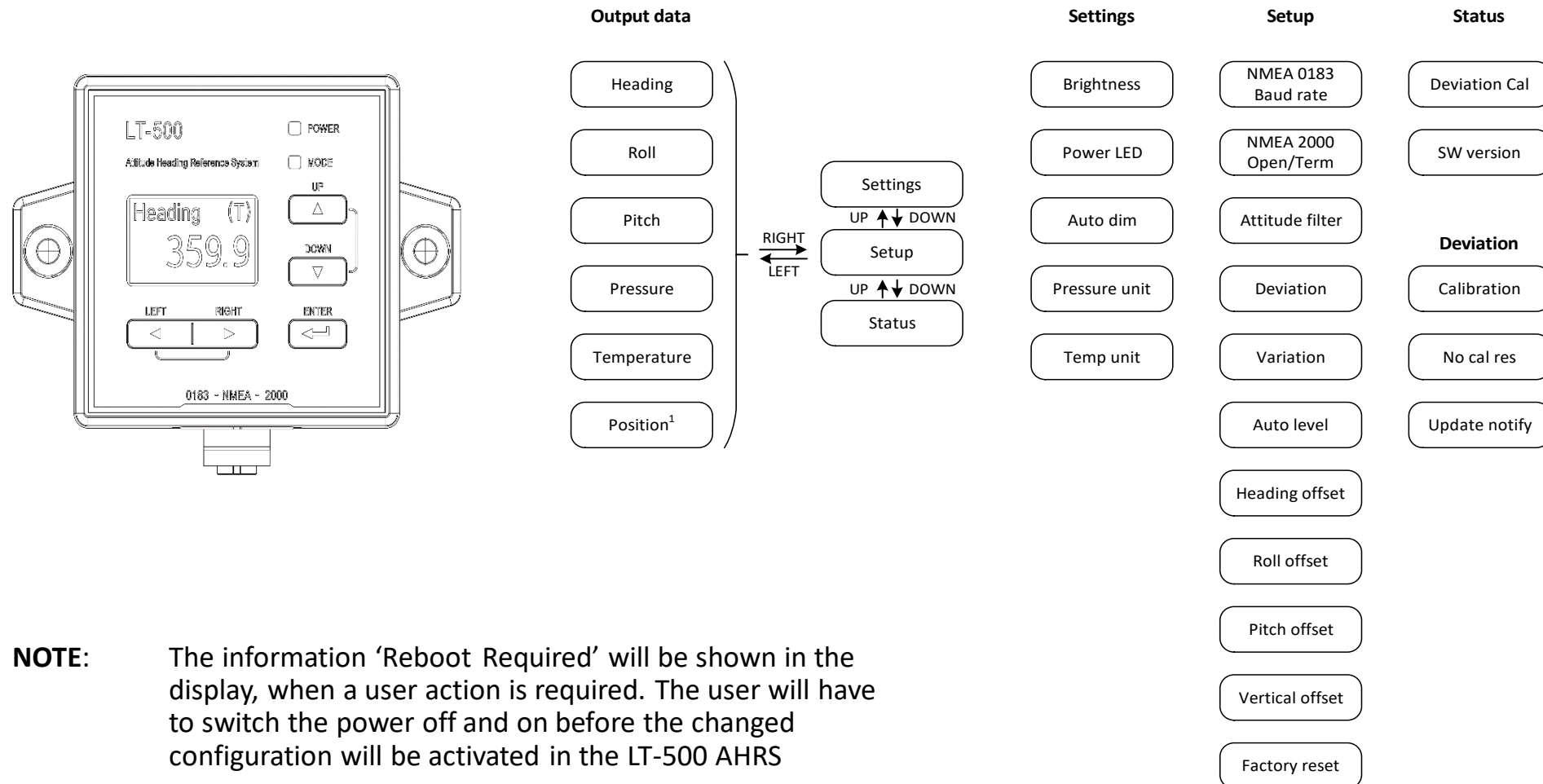
MMI Description:

- The MMI interface consists of LEDs, five push buttons, and a display.

- All relevant functions to be used under installation, calibration, and operation can be accessed and controlled via this MMI interface

- Auto dim is per default enabled and the backlight will be removed after 60 seconds of inactivity in the MMI

- If the light from the green LED (power) is distracting, then it is possible to turn it off

- The red LED (mode) cannot be switched off

- Brightness of the display and LEDs can manually be adjusted in the settings menu

| LT-500 AHRS LEDs Color Description		
Power LED	**Mode LED**	**Description**
On	Off	Power on unit.
On	On	Power on Unit. Error present. Check Troubleshooting to resolve the problem. Connect the LT-Service Tool to retrieve details from the LT-500 AHRS.
Off	NA	No power on unit (check whether the Green LED has been turned off)

LT-500 AHRS – Menu Layout

LT-500 AHRS Menu Layout

Output data		Settings	Setup	Status
Heading		Brightness	NMEA 0183 Baud rate	Deviation Cal
Roll		Power LED	NMEA 2000 Open/Term	SW version
Pitch	Settings	Auto dim	Attitude filter	**Deviation**
Pressure	UP ↑↓ DOWN Setup UP ↑↓ DOWN	Pressure unit	Deviation	Calibration
Temperature	Status	Temp unit	Variation	No cal res
Position[1]			Auto level	Update notify
			Heading offset	
			Roll offset	
			Pitch offset	
			Vertical offset	
			Factory reset	

RIGHT → ← LEFT

NOTE: The information 'Reboot Required' will be shown in the display, when a user action is required. The user will have to switch the power off and on before the changed configuration will be activated in the LT-500 AHRS

LT-500 AHRS – Installation Considerations

- Mount the unit indoor (ventilation hole shall be free and not exposed to direct water)

- Mount the unit in any position

- 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 -25°C to +55°C (-13°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 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
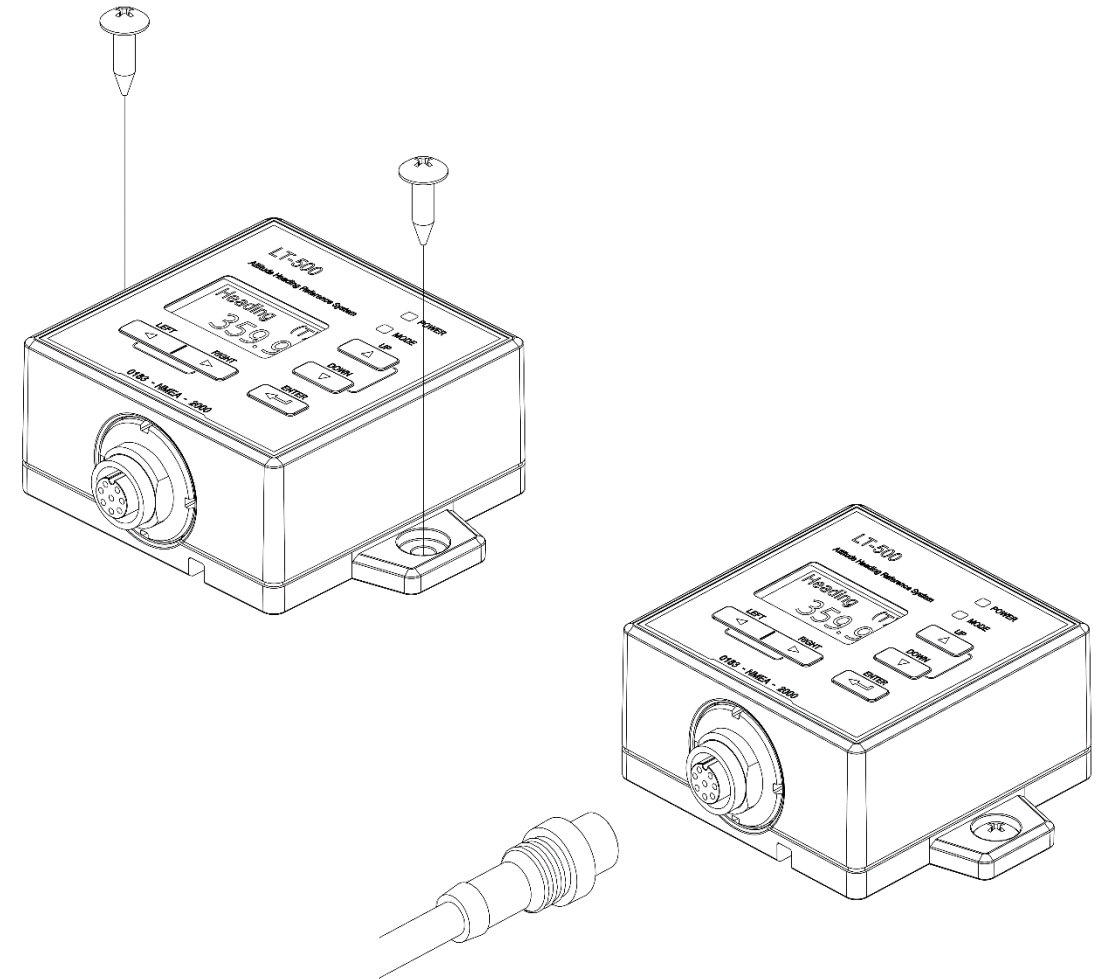
# LT-500 AHRS – Installation Considerations

- The LT-500 AHRS can be mounted in any position/orientation and thus, no additional bracket is required

- It is mandatory to 'run' the auto level function after the LT-500 AHRS has been fastened. By applying the auto level function, the LT-500 AHRS horizontal plane is adjusted to the surface orientation (output of pitch and roll becomes zero)

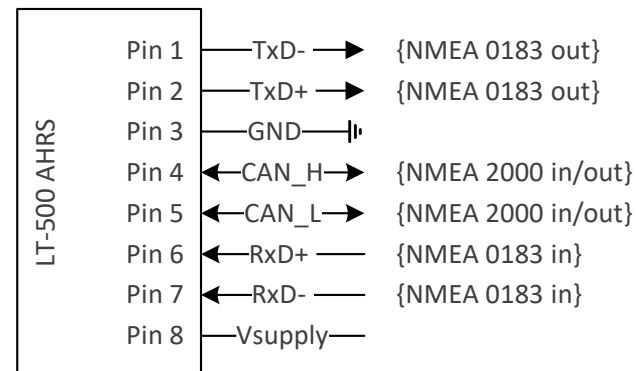- For further details on the auto level function, see the LT-500 AHRS User & Installation Manual
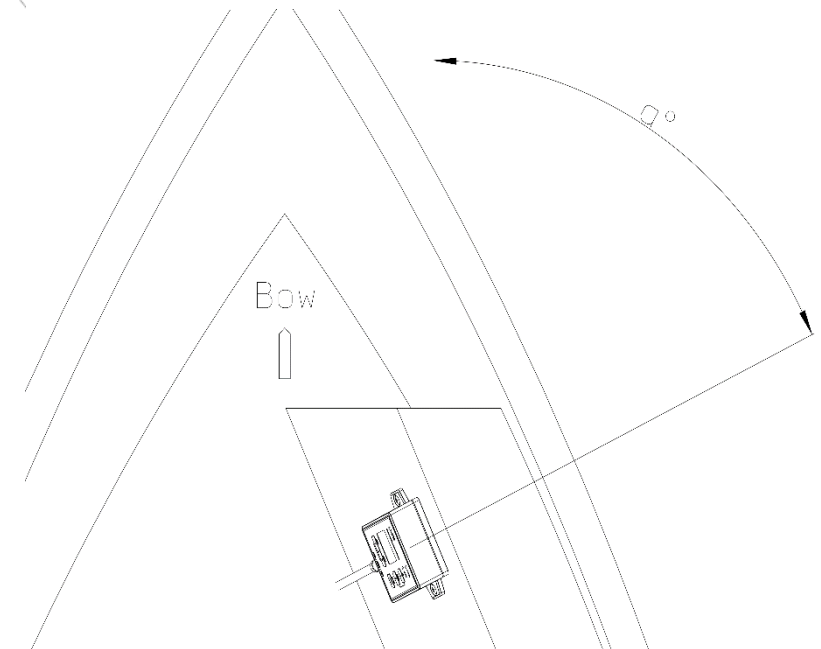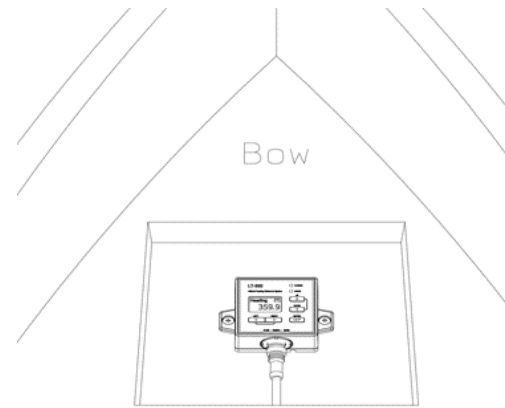
LT-500 AHRS - Connecting

- 10m cable 8-pin multi-cut is always in-the-box

- 30m cable 8-pin multi-cut is available as sales option

- NMEA 0183, NMEA 2000, and power

- Power: 9-40 VDC
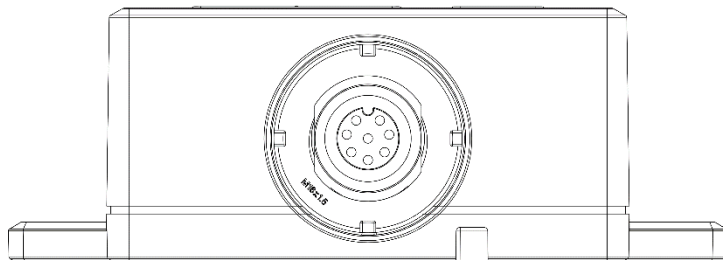
LT-500 AHRS Interconnect Details		
Pin No.	**Wire Color**	**Wire Designation**
1	Brown	TxD-
2	Yellow	TxD+
3	Black	GND
4	White	CAN_H
5	Blue	CAN_L
6	Orange	RxD+
7	Green	RxD-
8	Red	Vsupply

LT-500 AHRS

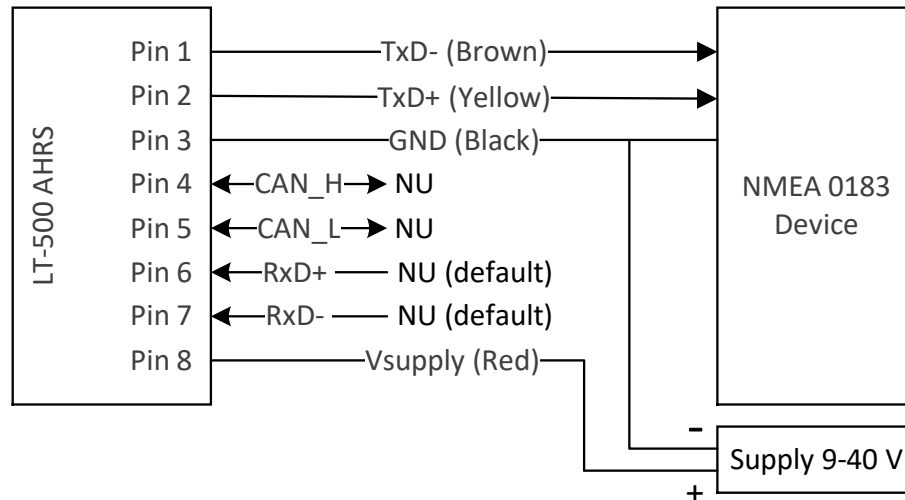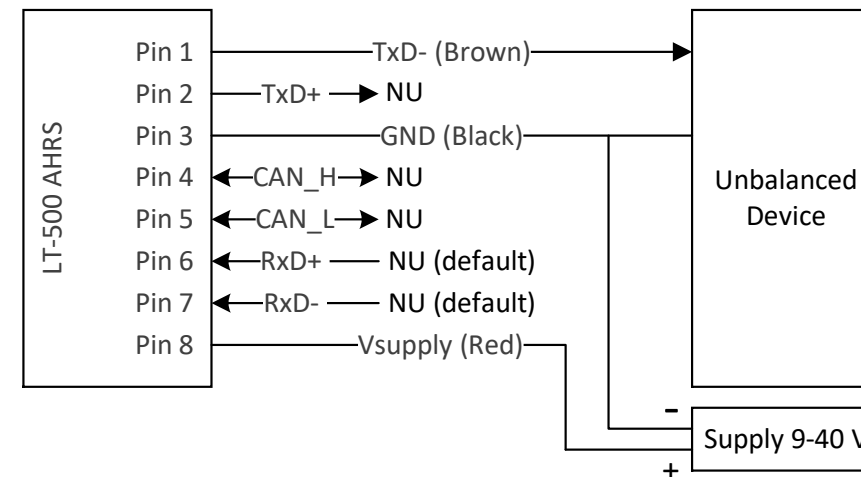|		
Pin 1	TxD- →	{NMEA 0183 out}
Pin 2	TxD+ →	{NMEA 0183 out}
Pin 3	GND	
Pin 4	← CAN_H →	{NMEA 2000 in/out}
Pin 5	← CAN_L →	{NMEA 2000 in/out}
Pin 6	← RxD+	{NMEA 0183 in}
Pin 7	← RxD-	{NMEA 0183 in}
Pin 8	Vsupply	

10m cable:

30m cable:

LT-500 AHRS – Connecting to NMEA 0183

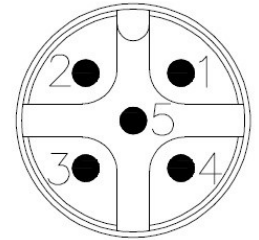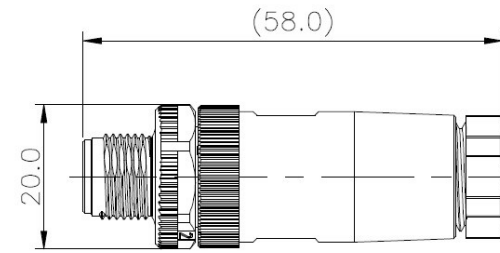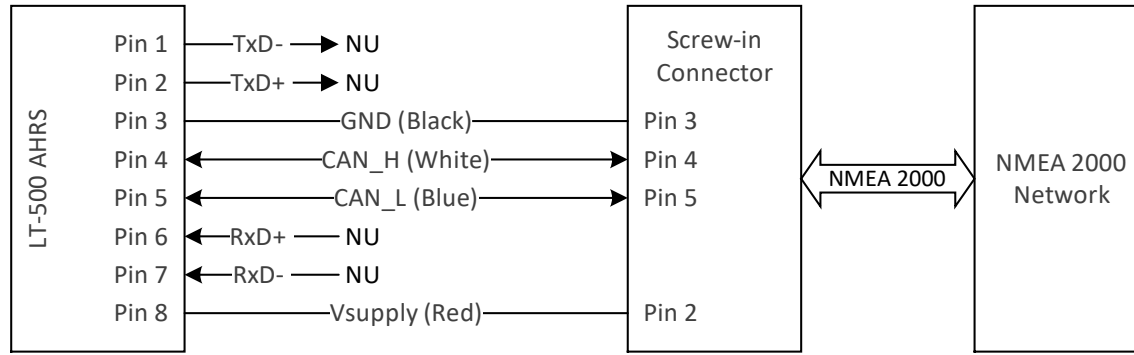Connecting the LT-500 AHRS to a balanced NMEA 0183 device:

Connecting the LT-500 AHRS to an unbalanced device:

NOTE: It is recommended to connect the LT-500 AHRS with a balanced NMEA 0183 connection (RS-422). An unbalanced connection (RS-232) is less robust and should only be considered, when using a short communication cable.
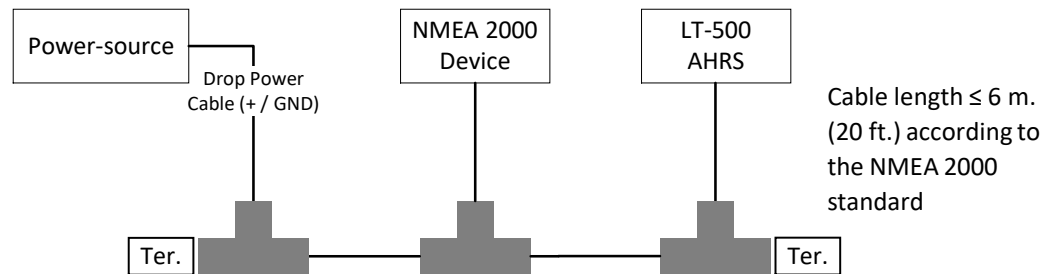
LT-500 AHRS – Connecting to NMEA 2000

NOTE: The LT-500 does not require a connection on Pin No. 1: drain/shield. The unit is designed to work with open cable shield.

- It is required to use a screw-in connector if connecting the LT-500 AHRS to a NMEA 2000 network. The screw-in connector is in-the-box

- The screw-in connector outline and pin-out is illustrated in the figures above
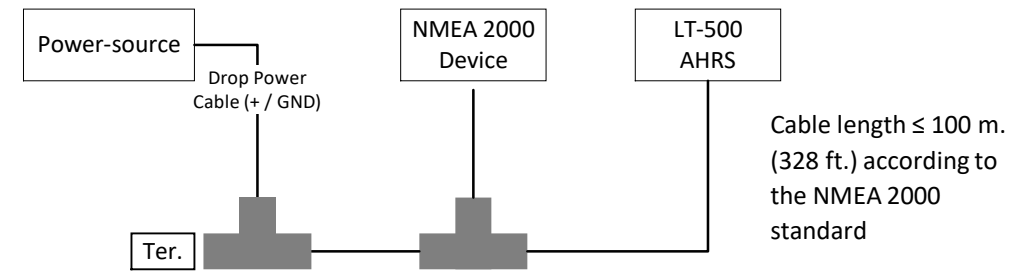
NMEA 2000 Screw-in Conn. Wiring		
Cable Wire Color	**Cable Wire Designation**	**Screw-in Conn. Pin No.**
-	-	1
Red	Vsupply	2
Black	GND	3
White	CAN_H	4
Blue	CAN_L	5

LT-500 AHRS – Connecting to NMEA 2000

NMEA 2000 ('Open')

Cable length ≤ 6 m. (20 ft.) according to the NMEA 2000 standard

NMEA 2000 ('Terminated')

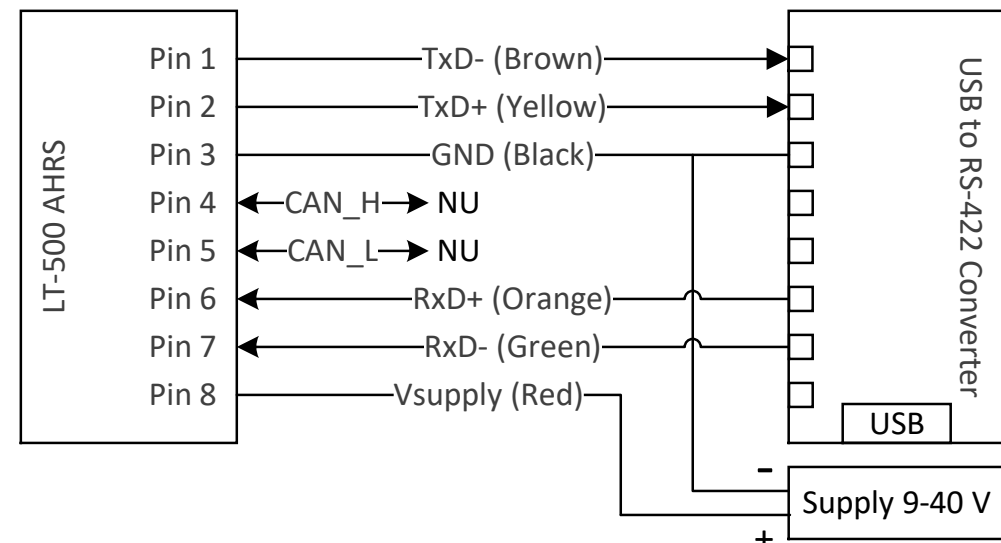Cable length ≤ 100 m. (328 ft.) according to the NMEA 2000 standard

NOTE: The LT-500 AHRS can be configured to either 'Open' or 'Terminated' from the MMI. The two figures above illustrates two options for connecting the LT-500 AHRS to a NMEA 2000 network (backbone).

LT-500 AHRS – Connecting to LT-Service Tool

- The LT-Service Tool is a PC program, which may run on any Windows PC.

- The LT-Service Tool is a PC program made for configuration, maintenance, and service of the LT-500 AHRS

- The LT-Service Tool is using the NMEA 0183 interface for communicating with the LT-500 AHRS (both Tx and Rx directions)

- Connection to the LT-Service Tool on a PC may be obtained using either:
  - USB to RS-422 Converter
  - Serial Port (RS-422)
  - Serial Port (RS-232)

USB to RS-422 converter providing the communication link between the PC (LT-Service Tool) and the LT-500 AHRS:

LT-500 AHRS		USB to RS-422 Converter
Pin 1	TxD- (Brown)	
Pin 2	TxD+ (Yellow)	
Pin 3	GND (Black)	
Pin 4	←CAN_H→ NU	
Pin 5	←CAN_L→ NU	
Pin 6	RxD+ (Orange)	
Pin 7	RxD- (Green)	
Pin 8	Vsupply (Red)	

USB

Supply 9-40 V

LT-500 AHRS – Configuration Options

Configuration options:

- NMEA 0183 baud rate

- NMEA 2000 termination

- Attitude filter

- Deviation calibration & options

- Variation

- Auto level

- Heading offset

- Roll offset

- Pitch offset

- Vertical offset

- NMEA 0183 sentences (not available in the MMI)   **NOTE**:   The details of these configurations are explained and
- Factory default   listed in the LT-500 AHRS User & Installation Manual
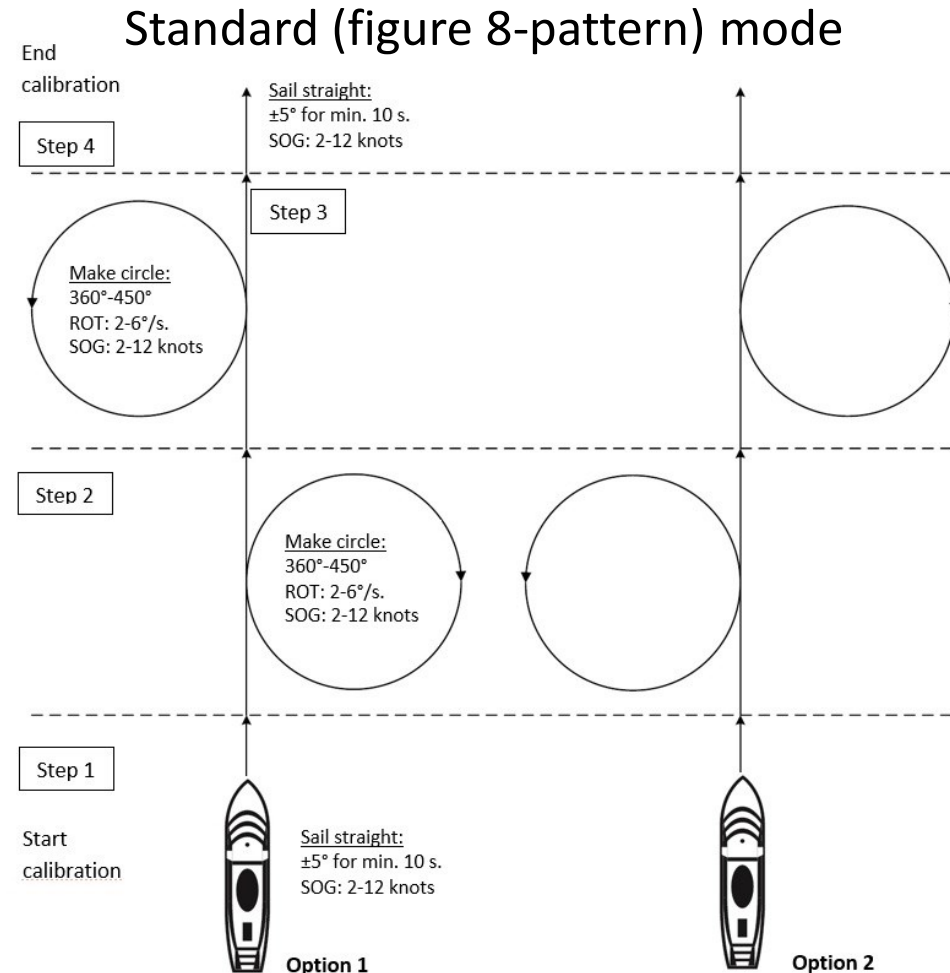
LT-500 AHRS - Deviation Calibration

Deviation calibration method:

- Standard (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

NOTE: Default, the LT-500 AHRS 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).

Standard (figure 8-pattern) mode

End calibration

Step 4

Sail straight:
±5° for min. 10 s.
SOG: 2-12 knots

Step 3

Make circle:
360°-450°
ROT: 2-6°/s.
SOG: 2-12 knots

Step 2

Make circle:
360°-450°
ROT: 2-6°/s.
SOG: 2-12 knots

Step 1

Start calibration

Sail straight:
±5° for min. 10 s.
SOG: 2-12 knots

Option 1

Option 2

LT-500 AHRS – 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 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

- It is recommended to use a 'USB to RS-422 converter' for easy interfacing in-between the PC (LT-Service Tool) and the LT-500 AHRS

LT-500 AHRS – LT-Service Tool

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

- UTILITIES   The utilities commands are related to the navigation status of the unit

- SYSTEM   The system commands are supporting general support related issues

List of commands
All available commands in the LT-Service Tool are listed when using the "help" command

```
LT-Service Tool                                    —    □    ×

lt> help

SETUP
  attitude filter [<time constant>]
  autolevel [run|reset]
  deviation calibration [on | off | reset]
  deviation options [5deg pause | none]
  heading <actual heading>
  heading offset [<offset>]
  nmea0183 baudrate [4800 | 38400]
  nmea0183 sentences [default | <sentence>:<interval>...]
  nmea2000 bus [term | open]
  pitch offset [<offset>]
  roll offset [<offset>]
  variation source [auto | off | user <variation>]
  vertical offset [<offset>]

UTILITIES
  mon
  nav
  stat [-l <file path>]

SYSTEM
  about
  diag [<path>]
  event
  factory default
  help [<command>]
  post
  quit
  reboot
  status
  upload <file path>
  ver

  []: option        <>: parameter      |: choice
  No option prints the current setting.

Type 'help' and the name of the command to get a detailed description.

lt> _
```

LT-500 AHRS – NMEA 0183 Sentences

- The dip-switch is by default configured to 4800 baud

- From factory, the LT-500 AHRS 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

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

- The LT-500 AHRS is compliant with version 4.00 of the NMEA 0183 standard

NMEA 0183 Sentences		
Sentence	**Description**	**Rate**
4800 baud		
HCHDG[1]	Heading and Magnetic Heading Variation	1 Hz
HCHDM[1]	Magnetic Heading	1 Hz
HCHDT[1]	True Heading	10 Hz
HCROT	Rate of Turn	1 Hz
PFEC,GPatt[1]	Attitude	1 Hz
WIMDA[2]	Metrological Composite	0.5 Hz
38400 baud		
HCHDG[1]	Heading and Magnetic Heading Variation	10 Hz
HCHDM[1]	Magnetic Heading	10 Hz
HCHDT[1]	True Heading	10 Hz
HCROT	Rate of Turn	10 Hz
HCTHS[1]	True Heading and Status	10 Hz
PFEC,GPatt[1]	Attitude	10 Hz
WIMDA[2]	Meteorological Composite	2 Hz
WIXDR[3]	Transducer Measurements	2 Hz

LT-500 AHRS – NMEA 2000 PGN's

- The LT-500 AHRS is compliant with version 2.000 of the NMEA 2000 standard and version 2.000 of the NMEA Network Database

- The NMEA 2000 PGN's can not be configured

PGN	Description	Rate
NMEA 2000 PGNs		
Periodic PGNs		
126993	Heartbeat	< 0.1 Hz
127250[1]	Vessel Heading	10 Hz
127251	Rate of Turn	10 Hz
127257	Attitude	10 Hz
127258[1]	Magnetic Variation	1 Hz
130311[2]	Environmental Parameters	2 Hz
130312[2]	Temperature	0.5 Hz
130314	Actual Pressure	0.5 Hz
130316[2]	Temperature, Extended range	0.5 Hz
Requestable PGNs		
126464	PGN List (Transmit and Receive)	-
126996	Product Information	-
Oher PGNs		
059392	ISO Acknowledgement	-
059904	ISO Request	-
060928	ISO Address Claim	-
126208	NMEA Request/Command/Acknowledge	-

LT-500 AHRS - Performance

- The LT-500 AHRS is a small, compact, and very advanced unit with 11 precision sensors (magnetometers, gyros, accelerometers, barometer, and thermometer)

- With the use of sensor fusion and Kalman filtering, the LT-500 AHRS outputs:
  - true heading, magnetic heading, roll, pitch, air pressure, and temperature

- The LT-500 AHRS 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

LT-500 AHRS 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
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
Temperature[3]	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) -25°C to 0°C (-13°F to +32°F)

1: The LT-500 AHRS performance may be subject to degradation caused by an improper installation. For best performance, the LT-500 AHRS shall be mounted in the horizontal plane (if the LT-500 AHRS is not mounted in the horizontal plane, a little degradation can be seen in the temperature min and max areas).
2: The dynamic heading accuracy is specified with roll/pitch less than ± 45° and ROT ≤ 45°/s.
3: Environmental conditions will affect the measured air temperature (accuracy is specified as on-board sensor performance)

LT-500 AHRS – Specifications

LT-500 AHRS Specifications	
Certification and standards	CE, IEC 60945, IEC 60950-1, FCC, IC, RCM (C-Tick), RoHS, NMEA 0183, NMEA 2000
Equipment class	Protected, according to IEC 60945
Weight	104 g (0.23 lbs)
Dimensions	91.6 x 75.3 x 32.7 mm (3.61 x 2.96 x 1.29 in)
Temperature, operational (ambient)	-25°C to +55°C (-13°F to +131°F)
Temperature, storage (ambient)	-30°C to +85°C (-22°F to +185°F)
Vibration, operational	IEC 60945 (sine) & Proprietary Maritime Random profile (240 h)
Vibration, survival	Properitary Maritime Random profile (100 h)
Vibration, shock	Proprietary Maritime profile (100 g pk, 11 ms)
Waterproof rating	IP42
Humidity	95% non-condensing @ 40°C
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)
Warranty	2 year
Maintenence	None
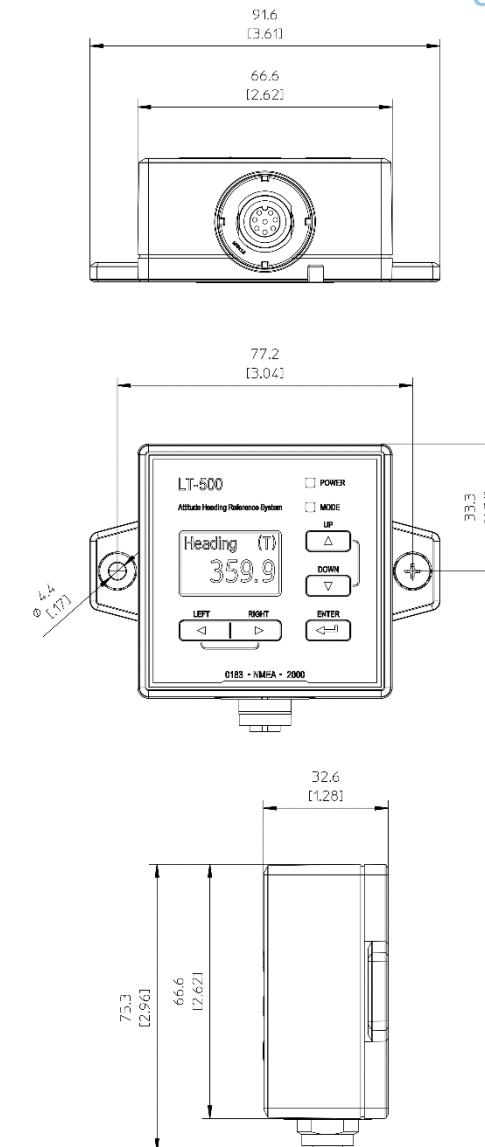
LT-500 AHRS - Test Boat

- Sargo 36
  - Ship yacht: SARGO - Sarins Båtar Oy
  - Length Overall: 11.8 m/ 38.7 ft
  - Beam: 3.6 m / 11.8 ft
  - Draft: 1.1 m / 3.6 ft
  - Dry weight: 8800 kg / 19400 lb
  - Top speed: 40 knots

LT-500 AHRS – Test Boat Installation (deck)

- Products:
  - LT-1000 NRU
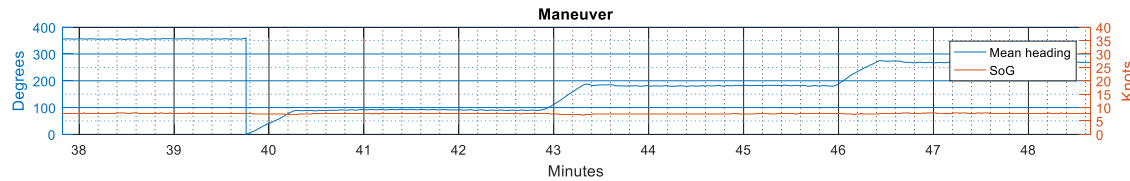 - Furuno SC-30

LT-500 AHRS – Test Boat (below deck)

- Products:
  - LT-500 AHRS
  - Furuno PG-700 (EC1)
 - Maretron SSC300 (EC2)
  - KVH GyroTrac (EC3)

LT-500 AHRS – Heading Accuracy (example)
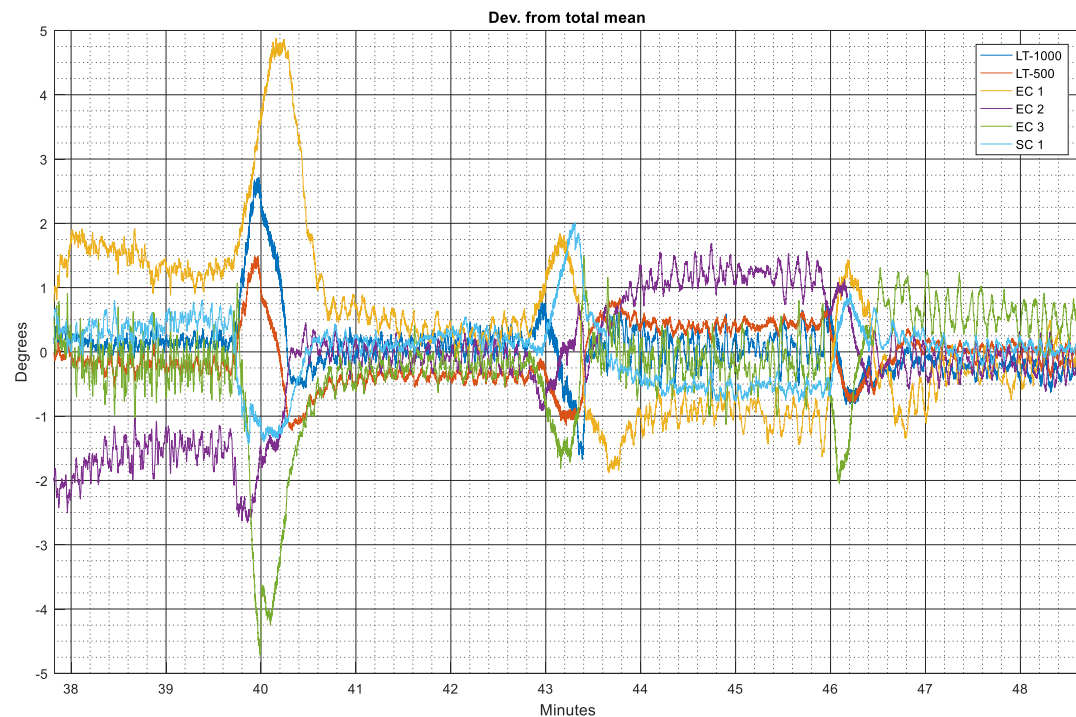
Device	RMS	Peak to Peak
Static		
LT-1000	0.22	1.39
LT-500	0.35	1.94
GyroTrac (EC 1)	0.96	5.04
PG-700 (EC 2)	0.99	4.19
SSC300 (EC 3)	0.44	2.59
SC-30 (SC 1)	0.36	1.58
Dynamic		
LT-1000	0.48	4.39
LT-500	0.44	2.71
GyroTrac (EC 1)	1.33	6.76
PG-700 (EC 2)	1.00	4.34
SSC300 (EC 3)	0.91	6.22
SC-30 (SC 1)	0.51	3.44

LT-500 AHRS – Test Installation (example)

- SIMRAD equipment
  - AP44 autopilot display
  - NAC-3 autopilot computer

- LT-500 AHRS
  - Verified on NAC-3 NMEA 0183 interface
  - Verified on NMEA 2000 back-bone (drop cable)
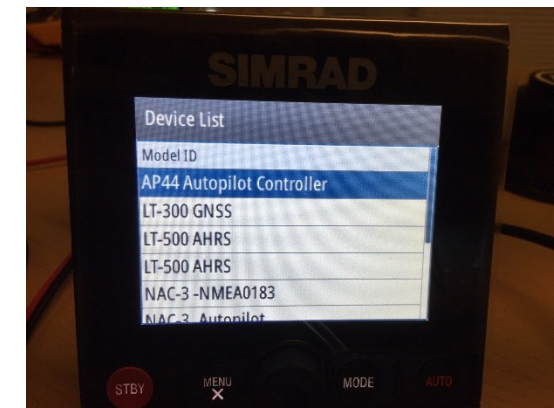
LT-500 AHRS – Installation Pictures

- Leisure

- Fishing

- Work

LT-500 AHRS Documentation

- LT-500 AHRS documentation and software can be downloaded from the website (free):

  http://thrane.eu/wdpress/index.php/lt-500-ahrs/

- Website (download):
  - Product Sheet
  - Quick Installation Guide
  - User & Installation Manual
  - Outline Drawings
  - Declaration of Conformity (DoC)
  - LT-500 Application SW
  - LT-Service Tool SW
  - Release Notes

- Access Partner Area or request additional information

END