# Rudder indicators

4189350103-A

Systems using DEIF angle transmitters and indicators

## Application notes

DEIF Marine Instruments

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# 1. General information

## 1.1 About the Application notes

### 1.1.1 General purpose

This document includes application notes about DEIF rudder indicator systems. The system provides continuous indication of the actual rudder position of the steering gear. The system shown is for one steering gear. You can duplicate it for a double-rudder installation.

### 1.1.2 Intended users

The application notes are for the indicator system designer, typically a panel designer or integrator. Other users may also find them useful.

### 1.1.3 List of technical documentation

See all the available DEIF Marine Instruments documentation at https://www.deifmarineinstruments.com/documentation/. On the documentation page for each product, you can also find the latest approvals.

| Products | Documentation |
|---|---|
| XL, BW, and BRW | • Illuminated indicators Data sheet<br>• Illuminated indicators, Standard scale designs<br>• Illuminated indicators CAN specification<br>• Illuminated indicators User manual |
| TRI-2 | • TRI-2 Data sheet<br>• TRI-2 Packing instructions<br>• TRI-2 User's manual<br>• TRI-2 Quick start guide |
| XDi indicators | • XDi Data sheet<br>• XDi Standard virtual indicator library<br>• XDi Upgrade Tool Installation and User manual<br>• XDi Designer's handbook<br>• XDi-net CANopen reference manual |
| TDG-210 | • TDG-210DG Data sheet<br>• TDG-210DG-2 Installation instructions<br>• Adjustments and tightening torques for switchboard instruments |
| RTA and RTC | • RTA 800 and RTC 800 Data sheet<br>• RTA 800 and RTC 800 Installation instructions<br>• Rudder indicators Application notes |

## 1.2 Warnings, safety, and legal information

### 1.2.1 Symbols for hazard statements

**DANGER!**

**This shows dangerous situations.**

If the guidelines are not followed, these situations will result in death, serious personal injury, and equipment damage or destruction.

**WARNING**

**This shows potentially dangerous situations.**

If the guidelines are not followed, these situations could result in death, serious personal injury, and equipment damage or destruction.

**CAUTION**

**This shows low level risk situation.**

If the guidelines are not followed, these situations could result in minor or moderate injury.

**NOTICE**

**This shows an important notice**

Make sure to read this information.

### 1.2.2 Symbols for general notes

**NOTE** This shows general information.

**More information**
This shows where you can find more information.

**Example**

This shows an example.

**How to ...**
This shows a link to a video for help and guidance.

### 1.2.3 Safety during installation and operation

When you install and operate the equipment, you may have to work with dangerous currents and voltages. The installation must only be carried out by authorised personnel who understand the risks involved in working with electrical equipment.

**DANGER!**

**Hazardous live currents and voltages**

Do not touch any terminals, especially the AC measurement inputs or any relay terminals, as this could lead to injury or death.

### 1.2.4 Electrostatic discharge

Protect the equipment terminals from electrostatic discharge during installation. Electrostatic discharge could damage the equipment. Once the equipment is installed and connected, these precautions are no longer necessary.

### 1.2.5 Legal information and disclaimer

DEIF takes no responsibility for installation or operation of the equipment. If there is any doubt about how to install or operate the equipment, the company responsible for installation or operation of the equipment must be contacted.

The controller is not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

**Disclaimer**

DEIF A/S reserves the right to change any of the contents of this document without prior notice.

The English version of this document always contains the most recent and up-to-date information about the product. DEIF does not take responsibility for the accuracy of translations, and translations might not be updated at the same time as the English document. If there is a discrepancy, the English version prevails.

# 2. Installation

## 2.1 XL, BW, and BRW indicators (analogue and CAN)

XL is an analogue indicator with a mechanical pointer. The pointer is controlled by a microprocessor using x-coil technology which gives a high accuracy (class 0.5). To obtain good visibility in all lighting conditions, the XL scale is illuminated by a dimmable LED backlight. In designs where the scale base colour is black, the pointer is also illuminated.

Dimming is controlled by a potentiometer and requires that the XL is supplied with a dimming voltage up to 30 V DC.

The XL interface is available with a wide range of input options. The analogue interface is available with both single and dual inputs. Use the dual input function to take input from a SIN/COS angle sensor.

The analogue input covers a large input range and supports current and voltage. This includes 4 to 20 mA or voltage of ±10 V inputs.

**More information**
See the Illuminated indicators Data sheet for a full list of available input ranges.

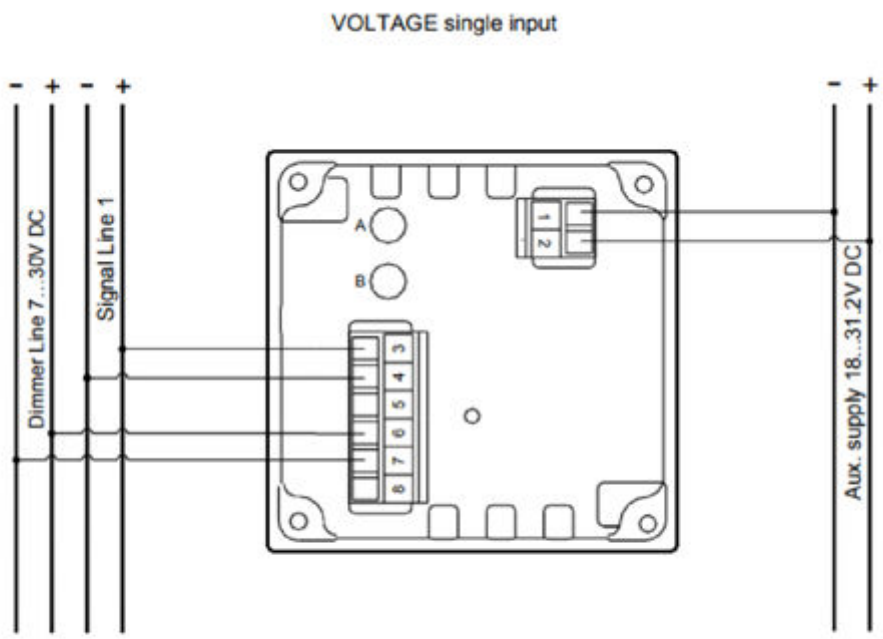
### 2.1.1 CAN interface

The XL is available with a CAN bus interface, which comes in two versions: sCAN and Dual CAN.

sCAN is a single CAN line connected directly to a CAN transmitter. The receiving node ID must be known when ordering an XL with an sCAN interface.

Dual CAN has full redundancy from two galvanic separated CAN lines. This version is typically used in systems where a CAN master controls different indicators.

### 2.1.2 Analogue input connections



**NOTICE**

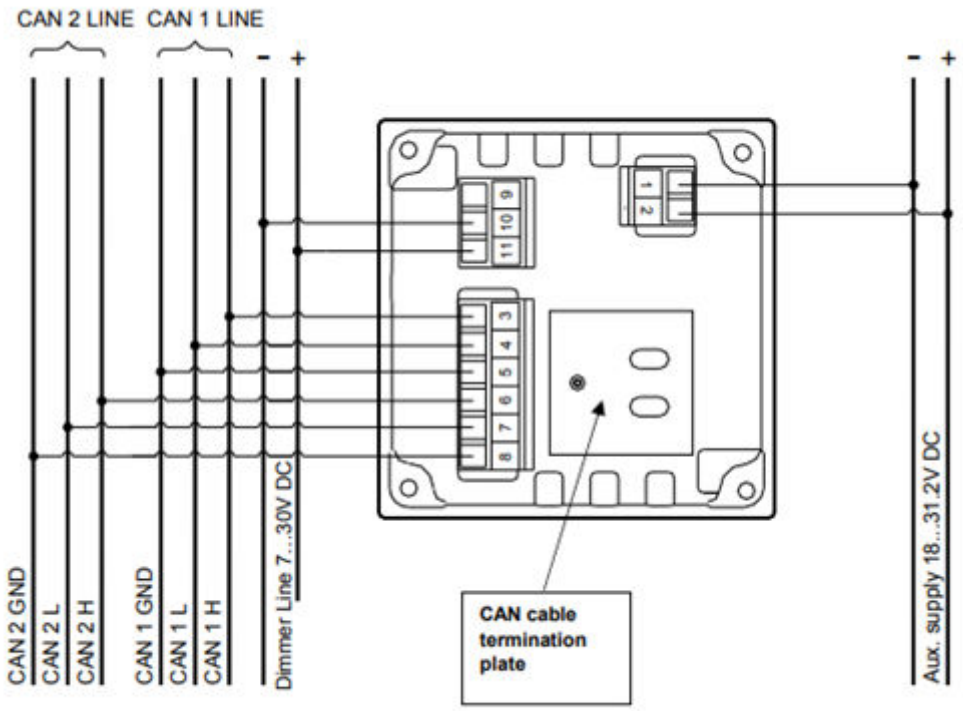
**Avoid incorrect wiring**

Pay attention to the order of the terminal numbering.

| Pin number | Function | | Notes |
|---|---|---|---|
| 1 | Supply voltage | 0 V | Maximum consumption: 150 mA |
| 2 | | 24 V | |
| 3 | Analogue input | Input 1 (SIN) | • Input 1 and input common are used for single input*<br>• 4 to 20 mA: input 1 is CW and input 2 is CCW |
| 4 | | Input common | |
| 5 | | Input 2 (COS) | |
| 6 | Illumination | Illumination positive | Dimmer input<br>Dimmer range: 7 to 30 V DC<br>Consumption: maximum 30 mA |
| 7 | | GND | |
| 8 | | NC | Not connected |
| A | Analogue adjustment | Maximum adjustment | Maximum and zero adjustment, sealed by label |
| B | | Zero adjustment | On the 360 degree versions, A is EM selection and B is zero adjustment. |

**NOTE** * Input common is used for both input 1 and input 2.

### 2.1.3 CAN input connections



| Pin number | Function | | Notes |
|---|---|---|---|
| 1 | Supply voltage | 0 V DC | Maximum consumption: 150 mA |
| 2 | | 24 V DC | |
| 3 | CAN connection | CAN 1 H input | CAN 1 line |
| 4 | | CAN 1 L input | |
| 5 | | CAN 1 GND | |
| 6 | | CAN 2 H input | CAN 2 line |
| 7 | | CAN 2 L input | |
| 8 | | CAN 2 GND | |
| 9 | No connection | | |
| 10 | Illumination analogue dimmer | Illumination GND | Dimmer input<br>Dimmer range: 7 to 30 V DC<br>Consumption: maximum 30 mA |
| 11 | | Illumination positive | |

### 2.1.4 Outdoor version

We recommend using BRW-2 for outdoor use with the white scale. You can easily control the dimming with the built-in dimmer on the front. BRW-2 has three large PG21 glands for cable mounting.

The BW with a pivot foot is ideal for indoor mounting, but can also be used outdoor. BW144 uses PG9 cable glands for 5 to 8 mm cables, and BW192 uses PG16 cable glands for 8 to 14 mm cables.

When you place the BW outside, we recommend you use the white scale base for the indicators.

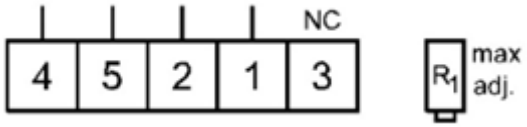
## 2.2 TRI-2 Panorama indicator (analogue and CAN)

The TRI-2 are designed for ceiling mounting. Place the TRI-2 so it can be seen from all positions on the bridge. The three large, curved scales of the TRI-2 are made so the rudder position is visible from a 250 degree angle and from a distance of up to 5 metres.

You can order the analogue TRI-2 with either current or voltage input. The CAN TRI-2 is available with either sCAN or Dual CAN.

The sCAN version is used for the rudder applications in this application note.

### 2.2.1 Analogue input connections



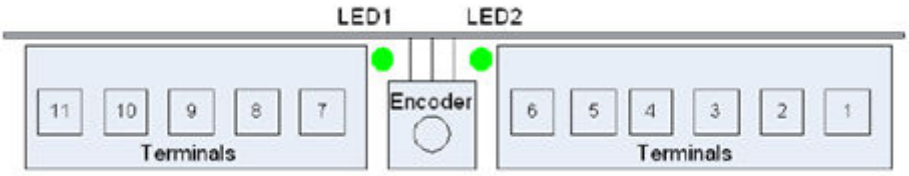

**NOTICE**

**Avoid incorrect wiring**

Pay attention to the order of the terminal numbering.

| Terminal number | Function | | Notes |
|---|---|---|---|
| 1 | Analogue input | Input - | Voltage or mA input, often ordered as: ±10 V or 4 to 20 mA |
| 2 | | Input + | |
| 3 | | No connection | |
| 4 | Illumination | + 24 V DC | Consumption: Maximum 150 mA |
| 5 | | 0 V DC | |

### 2.2.2 CAN input connections



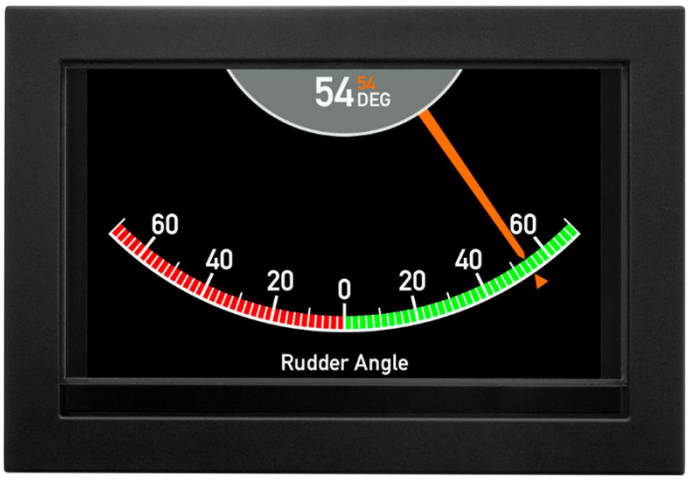

| Terminal number | Function | | Notes |
|---|---|---|---|
| 1 | Supply voltage | +24 V DC | Consumption: Maximum 150 mA |
| 2 | | 0 V DC | |
| 3 | CAN connection | CAN 2 H input | CAN 2 line |
| 4 | | CAN 2 L input | |
| 5 | | CAN 2 GND | |
| 6 | | No connection | |
| 7 | | CAN 1 H input | CAN 1 line* |
| 8 | | CAN 1 L input | |
| 9 | | CAN 1 GND | |
| 10 | Illumination analogue dimmer | Dimmer wiper | Dimmer controlled via 1 kΩ 2 W potentiometer |
| 11 | | Dimmer ref | |

**NOTE** * Only CAN 1 has a switch to activate the internal termination resistor.

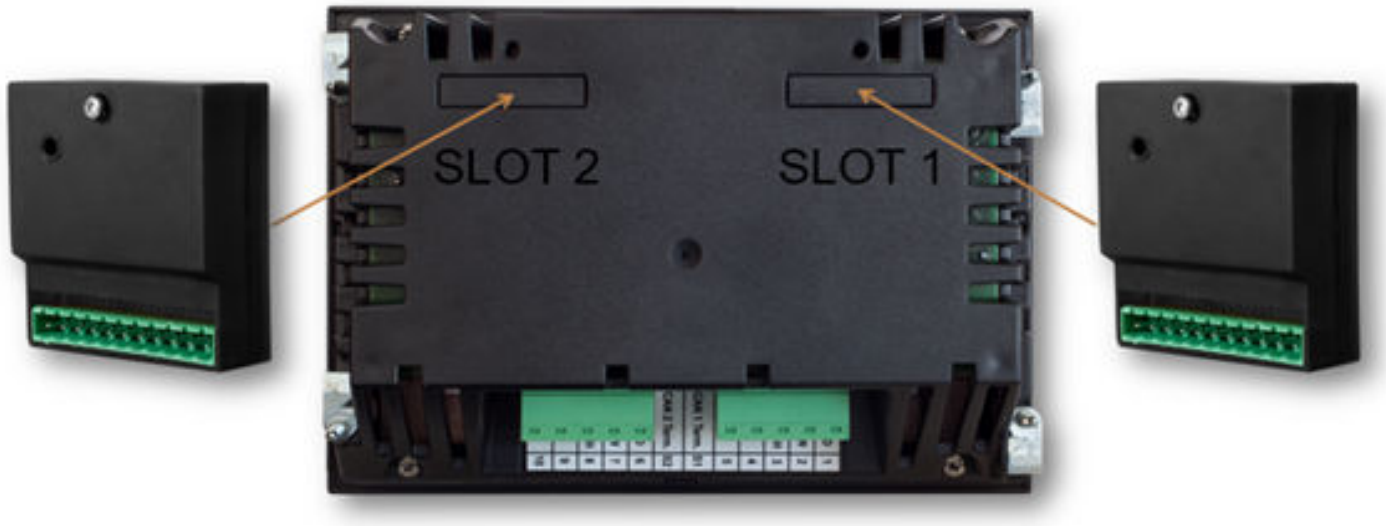
## 2.3 XDi digital display indicator (analogue and CAN)

In the following sections, XDi refers to any of the three XDi sizes: XDi 96, XDi 144, or XDi 192.

XDi with the pre-installed DEIF standard rudder indicator library has performance class Dual.




All the XDi rudder indicators can show both the actual rudder angle and the commanded rudder position (or the rudder set point). If commanded data is not available, the commanded rudder value must be disabled from the XDi installation menu.




The XDi unit has two CAN bus interfaces. Therefore, the actual rudder angle and commanded rudder angle can be received directly through one of the CAN bus interfaces.

This means that the rudder angle value can be received directly as serial data via CANopen. The angle value can be sent in a standard CANopen TPDO or RPDO or using the XDi-net data format.

XDi-net is an extension on top of CANopen, making it easy to use the CAN bus for high accuracy data sharing in a hybrid analogue/CAN system. Examples of a hybrid analogue/CAN systems are shown in some of the application examples.

To receive inputs from an analogue rudder transmitter, the XDi rudder indicator must have an AX1 analogue extension module installed. The AX1 module has two configurable analogue input ports. Each configurable port can be configured as a current input or a voltage input. There is also a third analogue voltage input that is often used as a dimmer input.

The input current or voltage is scaled to the actual rudder angle value controlling the pointer on the XDi display. This value can be shared through CAN bus.

The virtual rudder indicators in the standard rudder library supports CAN data sharing using the XDi-net plug and play protocol and/or transmitting the angle value in a standard CANopen TPDO.

The use of CAN bus can increase the overall system accuracy and make system calibration easier.

**More information**
See Appendix 1 for more information about setting up the XDi during installation. This appendix contains detailed descriptions about how to select the right setup for dimmer, the selection of the virtual indicator and input setup.

### 2.3.1 XDi connections on main unit

| Type | Terminal number | Signal | Marking | Notes |
|---|---|---|---|---|
| Connector 1 | 1 | CAN 1 | CAN 1 GND | Common (do not connect) |
| | 2 | | CAN 1 LOW | |
| | 3 | | CAN 1 HIGH | |
| | 4 | Supply voltage | + 24 V DC | Standard power input 1 |
| | 5 | | 0 V | |
| DIL switch 1 | - | ON/OFF | CAN 1 Terminal | 120 Ω termination |
| DIL switch 2 | - | ON/OFF | CAN 2 Terminal | 120 Ω termination |
| Connector 2 | 6 | CAN 2 | CAN 2 GND | Common (do not connect) |
| | 7 | | CAN 2 LOW | |
| | 8 | | CAN 2 HIGH | |
| | 9 | Supply voltage | +24 V DC | Standard power input 2 |
| | 10 | | 0 V | |

By default, the CAN bus termination switch is set to OFF.

## 2.4 AX1 Analogue extension module connections

AX1 is the extension module enabling the XDi to measure analogue input signals and scale them to absolute data.
When AX1 module is mounted in the extension slot, several inputs and one reference voltage output are available.
The standard rudder libraries require the AX1 module to be mounted in slot 1 on the rear of either XDi 144 or XDi 192. (XDi 96 only has one extension slot.)
The different input and output ports and terminal connections are shown in the table below.

| Voltage and current connection | | | |
|---|---|---|---|
| Terminal number | | Signal | Input |
| + | - | | |
| 11 | 1 | High voltage (HV1) input range, maximum ±30 V | Analogue port 1 |
| 9 | 10 | Low voltage (LIV1) input range, maximum ±2 V | |
| | | Low current (LIV1) input range, maximum ±2 mA | |
| 9 | 8 | High current (HI1) input range, maximum ±20 mA | |
| | | | |

| Voltage and current connection | | | |
|---|---|---|---|
| 7 | 1 | High voltage (HV2) input range, maximum ±30 V | Analogue port 2 |
| 5 | 6 | Low voltage (LIV2) input range, maximum ±2 V | |
| | | Low current (LIV2) input range, maximum ±2 mA | |
| 5 | 4 | High current (HI2) input range, maximum ±20 mA | |
| | | | |
| 2 | 1 | Dimmer input/high voltage 3 (DIM/HV3), maximum ±30 V | Analogue port 3 |
| 3 | 1 | REF out voltage | Voltage output/reference input |

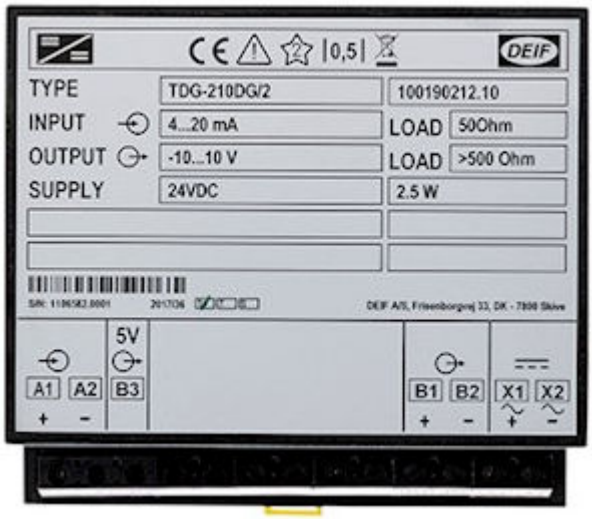
## 2.5 NX1 NMEA output module connections

NX1 is the extension module enabling the XDi to transmit the rudder angle in a NMEA0183 sentence. This option is useful in systems where the rudder angle must be made available for other systems. The NMEA output on NX1 is galvanically separated from supply voltage, analogue inputs and the CAN bus ports.
Any XDi indicator with a free NX1 slot can act as the NMEA output source.
The NX1 module has two contact inputs that can be used as button inputs for dimmer control. Ensure the product profile supports front-button dimmer control. Then activate the button inputs in the installation menu.

| Terminal number | Signal | NX2 label | Notes |
|---|---|---|---|
| 1 | Do not use | DO NOT CONNECT (DNC) | Do not connect anything to terminals 1 to 4. |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | Contact input 1 | C-IN-1 | Button input 1 with internal pull-up +5 V |
| 6 | Contact input 2 | C-IN-2 | Button input 2 with internal pull-up +5 V |
| 7 | COM 1 output NMEA 0183 | TX1-A | RS-422 Differential output (IEC 61162-1) |
| 8 | | TX1-B | |
| 9 | Common GND | COMMON | Used for COM 1 output and the contact inputs |
| 10 | Do not use | DNC | Do not connect anything to terminals 10 and 11. |
| 11 | | | |

XDi follows the NMEA 0183/IEC 61162-1 convention for the marking of NMEA output terminals.

## 2.6 TDG-210DG Analogue insulation amplifier and signal converter



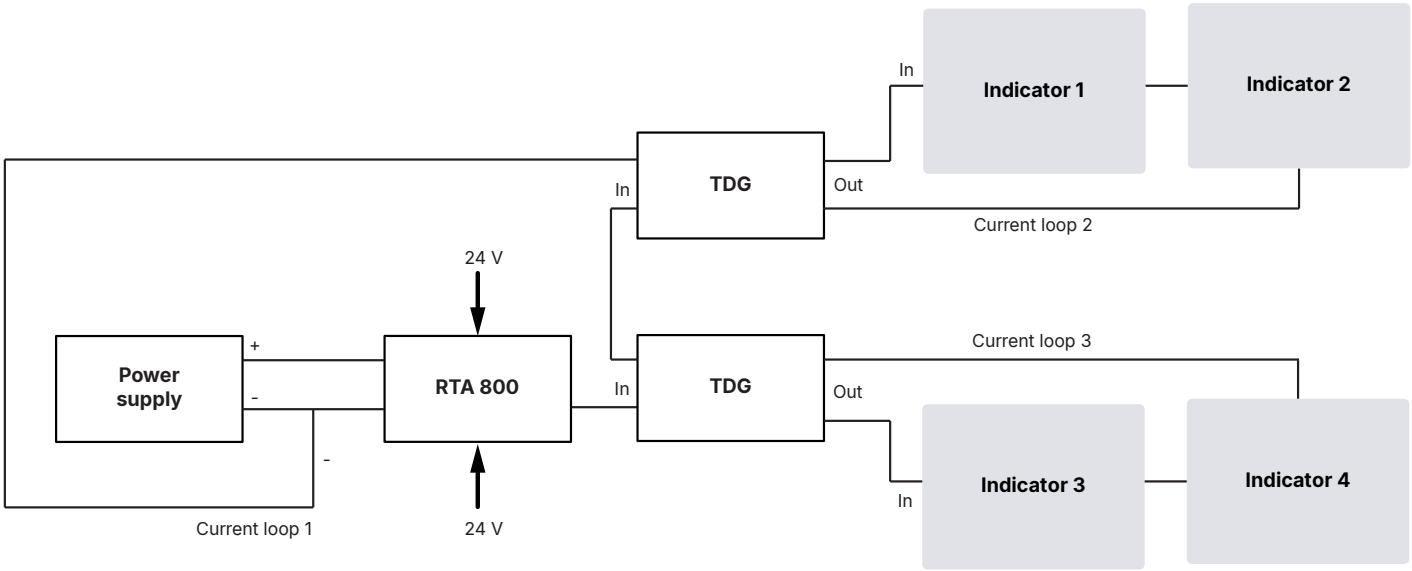

The TDG-210DG can convert a 4 to 20 mA current input into a current or voltage output. The input and output are galvanically separated.

The unit converts the RTA 800 4 to 20 mA signal to a ±10 V output. This voltage is then distributed to multiple indicators.

The unit can also be configured to have 4 to 20 mA input and galvanic separated 4 to 20 mA output. This configuration can be used to buffer a 4 to 20 mA input signal. It allows more indicators to be connected to the angle sensor.

In a current-to-current configuration, the unit can divide the rudder indicator system into separate current loop branches. This separation of the system makes it more robust to single faults in the installation. For example, if one indicator has a broken wire, only indicators on that current loop branch are affected.

**Example 1: Angle transmitter with two galvanically separated current loops drive the indicators**

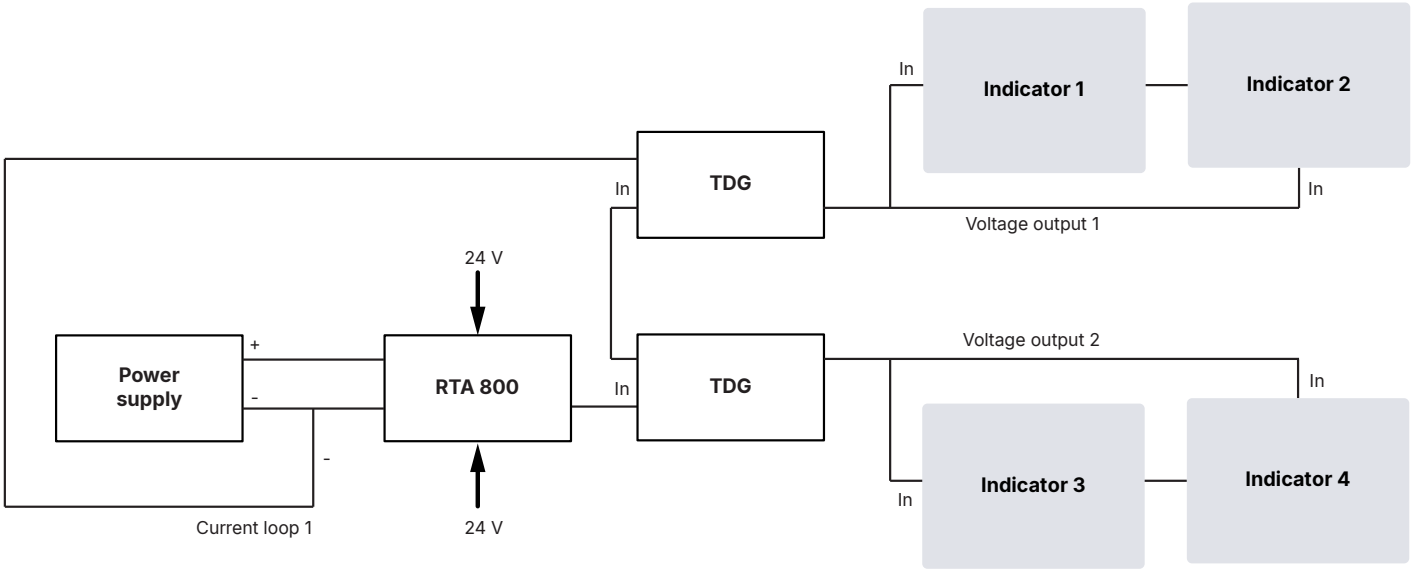



If indicator 1 loses connection, indicators 1 and 2 stop working. Indicators 3 and 4 are not affected.

A lost connection in current loop 1 shuts down the system. The cabling in loop 1 must be short and robust.

A short circuit between the input terminals of indicator 1 will only affect indicator 1. Consider using a redundant power supply or power supply with battery backup (UPS). The same goes for the routing of power cabling to the system component.

**Example 2: Angle transmitter with two galvanically separated voltage outputs drive the indicators**




The indicators must be connected directly to the voltage output terminals to obtain the most robust system (star coupled).

A lost connection to indicator 1 only affects indicator 1. A short circuit on indicator 1 input stops indicator 1 and 2. Indicators 3 and 4 continue to operate. The TDG output is short-circuit-protected.

A lost connection in current loop 1 shuts down the system. Use robust cabling and the required cable reliefs.

Consider using a redundant power supply or power supply with battery backup (UPS). This increases system and component redundancy.

### 2.6.1 Ordering TDG-210DG

The TDG-210DG made according to the conversion specified during ordering. Input and output configuration cannot be changed during installation. Make sure you know the correct configuration when you order the system.

## 2.7 RTA 800 and RTC 800 rudder angle transmitters

You can use these rudder transmitters in a DEIF rudder indicator system:

- RTA 800: Analogue transmitter with 4 to 20 mA output
- RTC 800: Transmitter with CANopen interface

### 2.7.1 RTA 800 analogue rudder transmitter

The RTA 800 analogue transmitter measures angles from 5 ° to 360 °. It provides a high resolution 4 to 20 mA output.

You need to calibrate the RTA 800 during installation. The rudder transmitter has a teach input and a data output, which are used for calibration.

See the RTA 800 and RTC 800 Installation instructions for how to calibrate the RTA 800.

You need an external power supply for the RTA 800, and the supply must be 14 to 30 V DC.

| Terminal number | Wire | Type | Signal | Notes |
|---|---|---|---|---|
| 1 | White | - V | Supply voltage | 14 to 30 V DC |
| 2 | Brown | + V | | |
| 3 | Green | $U_{out}/I_{out}$ | Analogue output | Current output<br>Load: Less than 500 Ω |
| | | | | Voltage output<br>Current output: Maximum 10 mA |
| 4 | Yellow | DV | Data valid output | This output is used for calibration. |
| 5 | Grey | Teach | Teach input used for calibration | This input is used for calibration. |

For more information, see:

- RTA 800 and RTC 800 Data sheet
- RTA 800 and RTC 800 Installation instructions

### 2.7.2 RTC 800 rudder transmitters

The RTC 800 is a single-turn transmitter that measures positions within 360 ° rotation with a 16-bit data resolution. There are 65536 steps per revolution, which means that 1 ° has a resolution of 182 steps.

You need to calibrate the indicator for use with the RTC 800. See System application 4 for how to calibrate the XDi for use with the RTC 800.

You can find more information on how to calibrate the RTC in the Installation instructions.

| Terminal number | Wire | Type | Signal | Notes |
|---|---|---|---|---|
| 1 | Grey | CAN GND | Common for CAN inputs | Common for CAN inputs |
| 2 | Brown | + V | Supply voltage | 14 to 30 V DC |
| 3 | White | - V | | |
| 4 | Green | CAN High | CAN input | |
| 5 | Yellow | CAN Low | CAN input | |

For more information, see:

- RTA 800 and RTC 800 Data sheet
- RTA 800 and RTC 800 Installation instructions

### 2.7.3 RTA 800 & RTC 800 Order information

| Type | Product name | Order number |
|---|---|---|
| RTA 800 | RTA 800 rudder transmitter<br>Analogue 4 to 20 mA output | 2951860010-06 |
| | 90 ° mounting bracket | 2195350001 |
| | Adjustable lever<br>Maximum length: 1127 mm | 291299009-01 |
| | Position linkage with a length of 317 mm | 291299009-02 |
| RTC 800 | RTC 800 rudder transmitter<br>CANopen interface | 2951860010-07 |
| | 90 ° mounting bracket | 2195350001 |
| | Adjustable lever<br>Maximum length: 1127 mm | 291299009-01 |
| | Position linkage with a length of 317 mm | 291299009-02 |

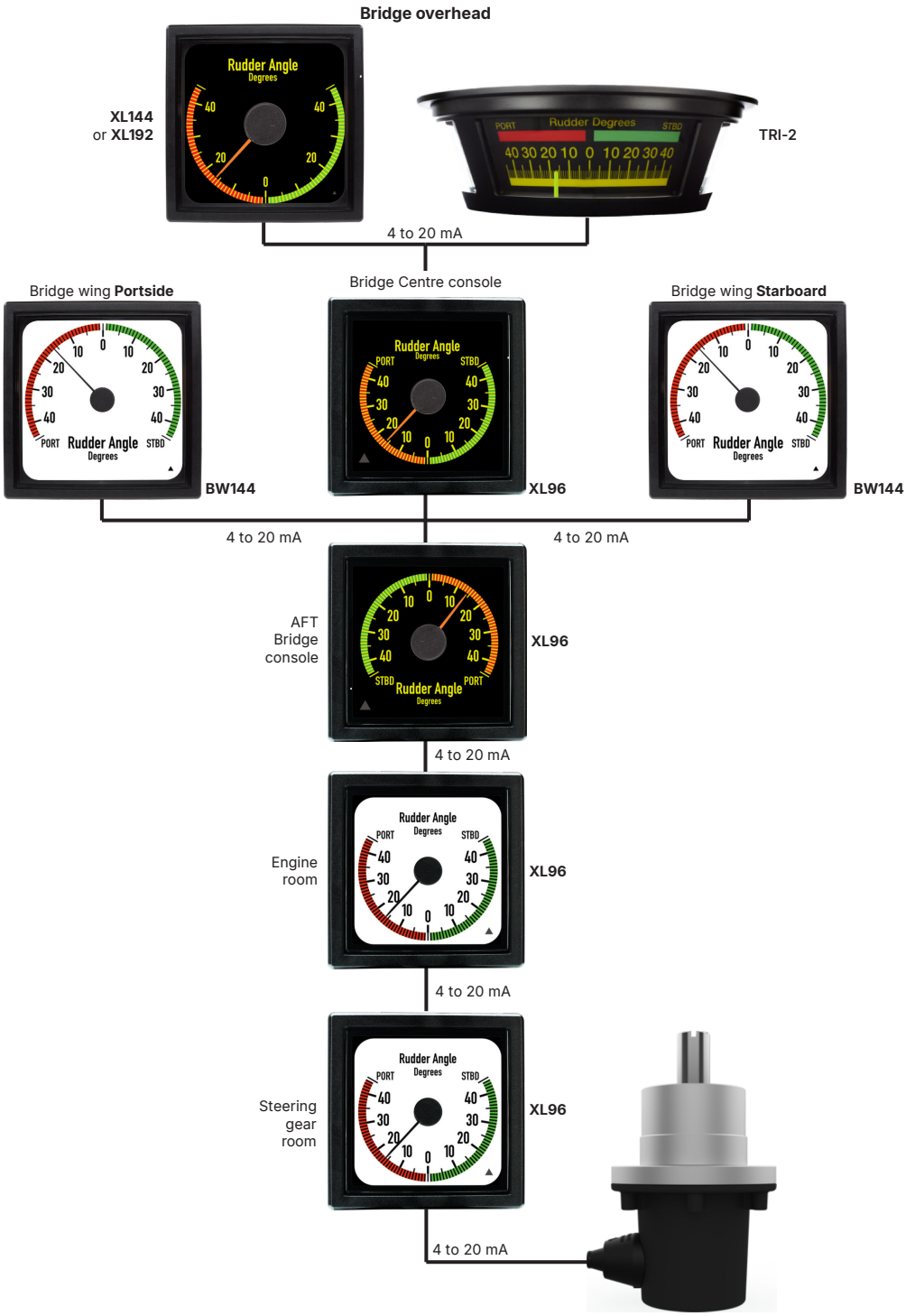
# 3. System applications

## 3.1 System application 1: Traditional current loop 4 to 20 mA

The 4 to 20 mA current loop is easy to install. It only needs one signal wire. Connect the analogue output from the RTA 800 to the first XL and make a current loop through all the remaining indicators in the system.

The current loop is not sensitive to fluctuations in the supply voltage. The voltage source must supply enough voltage for all indicators and the RTA 800 electronics, including the voltage drop in the signal wire loop at a maximum current of 20 mA.

The TRI-2 indicator uses a 24 V DC supply for the backlight. XL, BW, and BRW indicators require 24 V DC auxiliary power to operate.



In systems with many rudder indicators, make a load calculation. This ensures sufficient margin under all operating conditions.

**More information**
For a description of how to make load calculations to secure stable operation in all working conditions, see Appendix 2.

**More information**
If more than 8 to 10 indicators are needed in a system, see System Application 2.

### 3.1.1 Fault situations

A short circuit of the input terminals on one of the indicators will only affect indication on the short-circuited indicator. The other indicators will not be affected.

A single disconnection in the current loop will interrupt operation of the entire indicator system. This is shown when the pointer on all indicators moves outside the scale. For an indicator with clockwise deflection, the pointer is on the left side of the scale to indicate a 0 mA input current.

### 3.1.2 Dimming

Each XL indicator can be dimmed. The backlight dimming requires 7 to 30 V DC between terminal 6 (illumination positive) and 7 (illumination GND). The voltage can either be from an external supply voltage or a connected potentiometer.

### 3.1.3 Adjustment

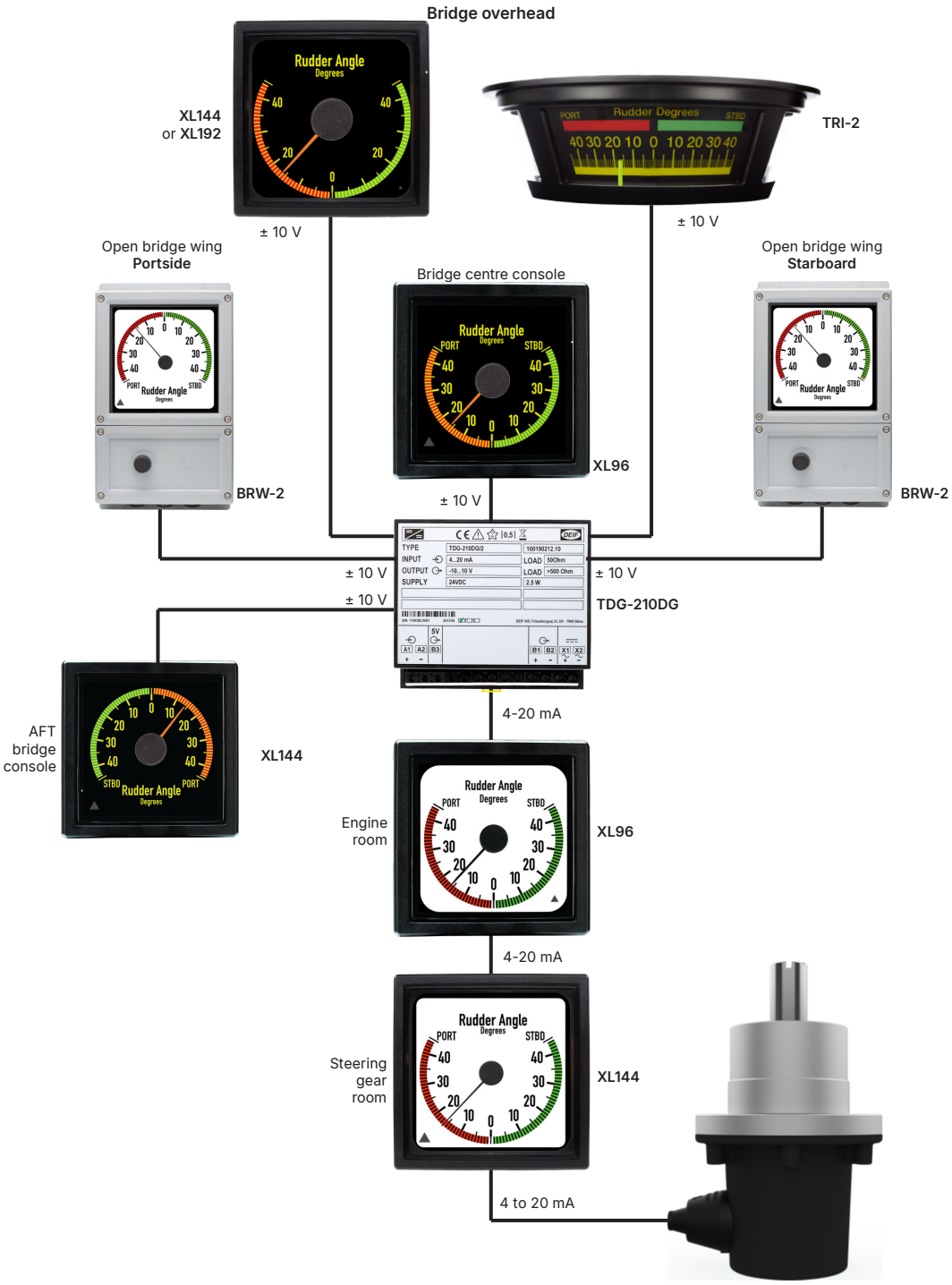
The RTA 800 has no physical zero markings and is therefore mounted without making any physical zero alignment. To calibrate the RTA 800, see the RTA 800 and RTC 800 Installation instructions.

## 3.2 System application 2: Traditional ±10 V system

In a ±10 V system, the output signal is routed to each indicator in a star configuration. Unlike a 4 to 20 mA current loop, one lost input does not affect the remaining indicators.

The RTA 800 supplies a 4 to 20 mA signal to the TDG-210DG. The TDG-210DG converts the signal to ±10 V. The voltage signal is routed to each indicator in the system. The RTA 800, TDG-210DG, and XL indicators require a 24 V DC auxiliary supply. TRI-2 does not require an auxiliary supply voltage.

The ± 10 V output from the TDG-210DG is not sensitive to fluctuations in the supply voltage. The connected indicators must not draw more than 20 mA in total from the TDG-210DG output.




## 3.2.1 Fault situations

In the 4 to 20 mA current loop part, see the fault description in System application 1. Faults in the system after TDG-210DG (the star-coupled indicators):

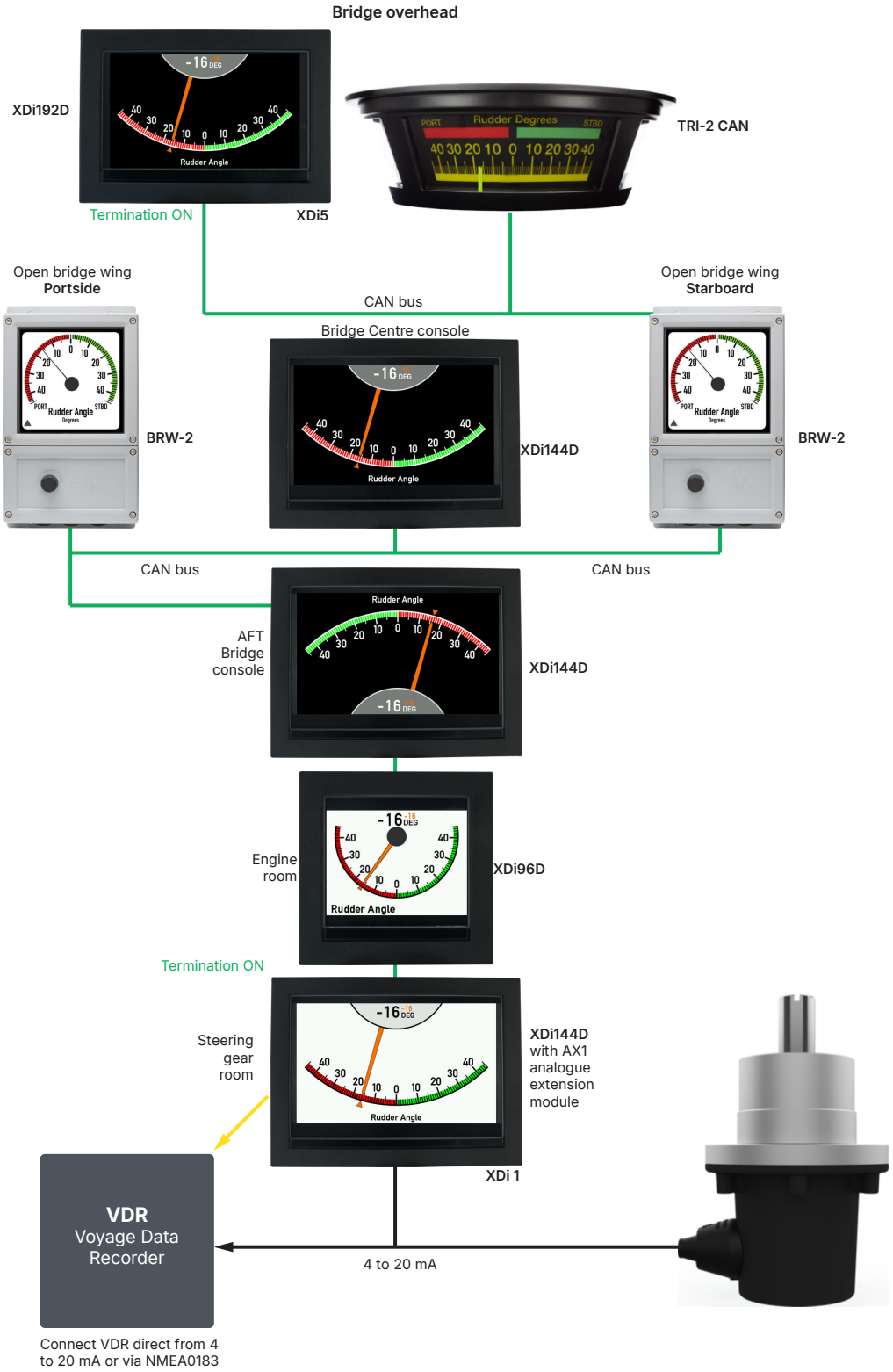
- A short circuit of the input terminals affects all indicators connected to the TDG-210DG.
- Losing an input connection to one of the voltage-driven indicators only affects that specific indicator. The rest of the system is not affected.

**More information**
To make load calculations to secure a stable operation in all working conditions, see Appendix 2.

## 3.3 System application 3: Combined 4 to 20 mA and CANopen system

This system solution combines the use of an analogue rudder angle transmitter with high accuracy data distribution via CAN bus.

The system example shows how different DEIF indicators can work together in a rudder indicator system.




XDi 1 in the steering gear room has an AX1 module for the 4 to 20 mA signal from the RTA 800. It shows the rudder angle and sends the angle on CAN to the other indicators. The XDi with the AX1 module works as a converter from 4 to 20 mA to CAN, similar to the TDG-210DG in System Application 2.

The standard virtual rudder indicator transmits the rudder angle in XDi-net and sCAN formats by default. The sCAN has an sID = 10 (TPDO1 from NodeID 10, COB-ID 0x18A).

The XDi indicators in the system use the XDi-net plug and play format. The XL, BW, BRW and TRI-2 indicators use the sCAN format.

### Rudder system as a separate system

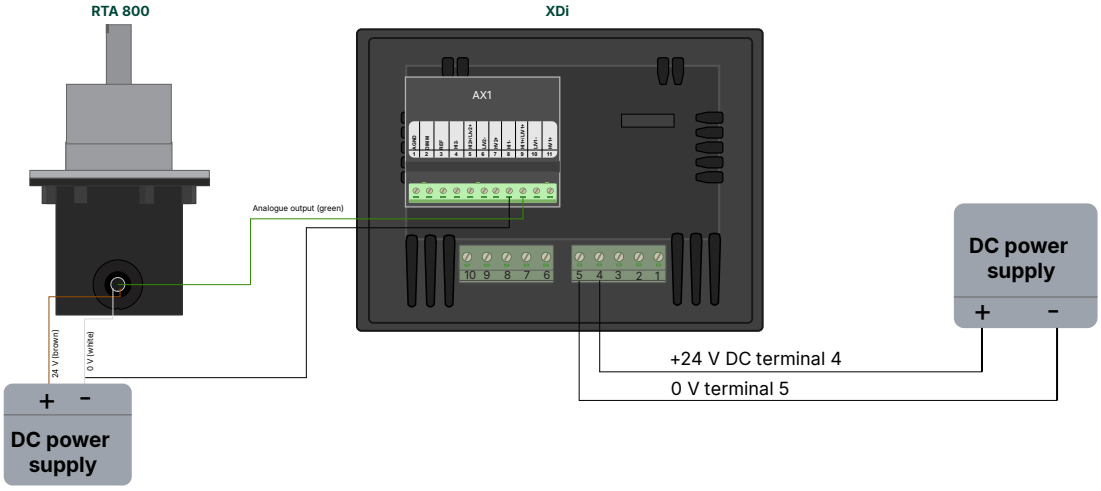
According to MED, the rudder indicator system must be a separate system. There must only be one XDi rudder indicator with an analogue input in this system. Contact DEIF support for more information about running two or more rudder systems on the same CAN bus.

### Change DEIF indicator to another DEIF indicator

Almost all indicators* can be changed to another DEIF indicator with CAN, or they can be removed from the system. The XDi with analogue rudder input can be located anywhere in the system, as long as there is only one.

**NOTE** * The XDi indicator in the steering room cannot be changed or removed.

## 3.3.1 Connecting the analogue part




## 3.3.2 Analogue input connections

| RTA 800 | Function | XDi terminal | AX1 terminal |
|---|---|---|---|
| Green wire | Current HI+ | - | 9 |
| Yellow wire | Setup wires | No connection | |
| Grey wire | | | |
| Shield | Electrical shielding of data signal cable | No connection | |

Connect terminal 8 on the AX1 module to the 0 V DC input on the power supply for the RTA 800.

**NOTE** The XDi and RTA 800 need external power supplies.

### 3.3.3 CAN system connections

| Function | | XDi 1 terminal | XDi 2 terminal | XDi 3 terminal | BRW-2 terminal | XDi-4 terminal | BRW-2 terminal | TRI-2 terminal | XDI-5 terminal | Power supply |
|---|---|---|---|---|---|---|---|---|---|---|
| Supply voltage | - | 5 | 5 | 5 | - | 5 | - | 2 | 5 | 0 V |
| | + | 4 | 4 | 4 | + | 4 | + | 1 | 4 | + 24 V DC |
| CAN 1 Low | | 2 | 2 | 2 | 84 | 2 | 84 | 8 | 2 | |
| CAN 1 High | | 3 | 3 | 3 | 83 | 3 | 83 | 7 | 3 | |
| CAN cable shield | | Connected between cables, but no connection to the indicators | | | | | | | | |
| CAN 1 termination | | ON | OFF | OFF | OFF | OFF | OFF | OFF | ON | |

#### Replacing a rudder indicator with an XL CAN

All CAN indicators can be replaced with an XL sCAN indicator. XDi 1 cannot, because it also converts the analogue signal to a CAN signal.

Replace the relevant indicator connections in the table above with the content of the table below:

| Function | | XL CAN terminal |
|---|---|---|
| Supply voltage | - | 1 |
| | + | 2 |
| CAN 1 Low | | 4 |
| CAN 1 High | | 3 |
| CAN cable shield | | NC |
| CAN 1 termination | | Not available* |

**More information**
* See CAN bus termination.

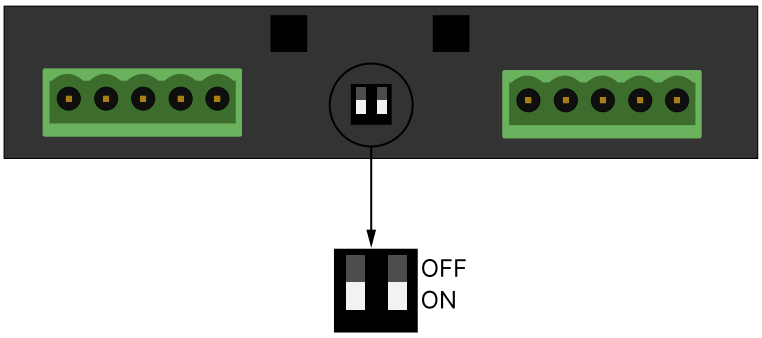
### 3.3.4 CAN bus termination

**NOTICE**

**Terminate both CAN ends**

It is important to terminate the CAN bus in both ends. Failing to do so will result in an unreliable CAN bus operation.

In this example the XDi is located in both endpoints of the CAN bus, and the CAN bus can be terminated by activating the internal CAN bus termination resistor in the XDi.




You can activate the built-in termination resistor if a BRW-2 and TRI-2 CAN is at a CAN bus endpoint.

XL CAN does not have built in termination resistor. If the XL is at a CAN bus endpoint, add a 120 Ω external resistor. Connect it between terminals 3 and 4.

### 3.3.5 Dimming

Dimming is difficult because traditional indicators need no backlight in daylight, while display indicators need maximum backlight.

In this example system the TRI-2 CAN and BRW-2 are dimmed locally via the built-in potentiometer. In both cases it is possible to replace the potentiometer with an external dimming control. It can be beneficial to have an external dimmer control in the panel for the ceiling-mounted TRI-2 CAN.

The XDi indicators offer a wide range of dimmer control options:

- CAN bus
- External voltage dimmer input
- External potentiometer connection
- External buttons
- Buttons in the XDi front

All external dimming functions, except dimming via CAN bus, require the use of an extension module.

The front button dimmer control on XDi requires the four-button front frame kit, available as an option or accessory. The XDi library version must be version 2000 or higher. The standard rudder indicator libraries support this function.

An XDi with front dimmer control can share its dimmer level on XDi-net for other XDi units on the CAN bus.

With several XDi indicator systems in the installation, CAN bus 2 can be used as a dimmer control bus. In this way the separated indicator systems can be interconnected without jeopardising the system separation. This is possible due to the galvanic separation of the two CAN busses.

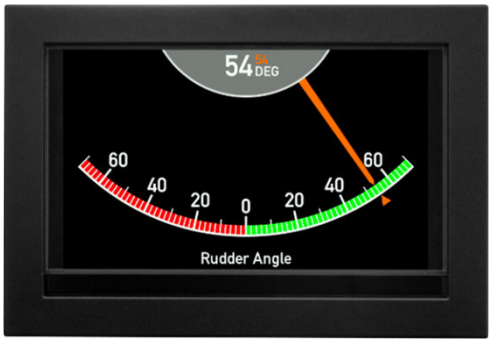
Dimming from the front buttons is selected in this system application example for both indicators. Since they are connected via XDi-net (CAN), the dimmer level will be synchronised between the two indicators. By default, the indicators are assigned to dimmer group 1.

**More information**
See Appendix 3 for other dimmer alternatives.

### 3.3.6 XDi Installation setting

Order the XDi unit with the DEIF standard rudder library 031. This library contains a selection of virtual rudder indicators.

The library contains indicators with standard scales for ±40 °, ±45 °, ±50 °, and ±70 °. These are available for forward and aft bridge layouts.

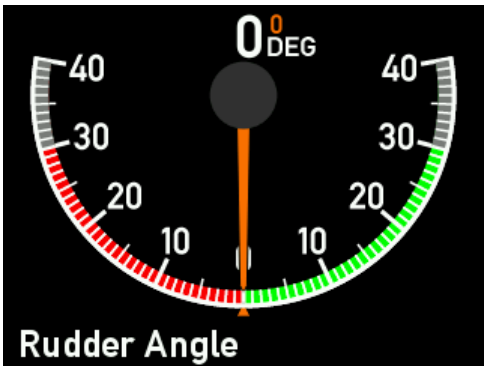



Rudder angle indicator ±70 ° forward (VI007)

Rudder angle indicator ±45 ° aft (VI004)

Additionally, there is a special MED compliant rudder indicator for systems where the rudder angle is less than 40 degrees. This indicator has a ±40 ° scale (minimum scale required by ISO 20673) and with a configurable grey scale.

### Example: XDi 96 D scale configured to ±30 °




Contact DEIF if the rudder scale you need is not in the standard library.

### Customised indicator design

You can have a unique customised indicator design if required. XDi is made for easy customisation of indicators.

### Installation wizard

When the XDi has not yet been set up, it will automatically start the start-up wizard.

You can find the correct XDi setup for the system example in the table below.

### Select the CAN NodeID

In this application XDi-net (on CAN bus) is used to share data with other indicators in the system. All the XDi indicators must have a different CAN NodeID. It is not important which ID you select for the XDi indicators as long as they are different. The suggested CAN node IDs are found in the tables below.

The example system uses the DEIF standard rudder indicator library number 031. The rudder indicator selected is ±45 °.

| XDi indicator number 1: Steering gear room (including analogue to CAN bus conversion ) * | | |
|---|---|---|
| Node ID: 30 (default) | | |
| Product profile | Virtual indicator | VI setup |
| PP06: ECR fixed dimmer<br>Group: Local | VI003 ±45 ° forward bridge indicator | VS04 Analogue system<br>4 to 20 mA input |

**NOTE** *AX1 module is required.

| XDi indicator number 2: Engine room | | | |
|---|---|---|---|
| Node ID: 31 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP06: ECR fixed dimmer Group: Local | VI003 ±45 ° forward bridge indicator | VS01 XDi-net | This XDi will receive accurately calibrated data from XDi 1 via CAN bus. |

| XDi indicator number 3: AFT bridge | | | |
|---|---|---|---|
| Node ID: 32 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: front dimmer / XDi-net Dimmer group 1* | VI004 ±45 ° aft bridge indicator | VS01 XDi-net | This XDi will receive accurately calibrated data from XDi 1 via CAN bus. |

| XDi indicator number 4: Centre console (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 33 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS01 XDi-net | This XDi will receive accurately calibrated data from XDi 1 via CAN bus. |

| XDi indicator number 5: Overhead panel (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 34 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI003 ±45 ° forward bridge indicator | VS01 XDi-net | This XDi will receive accurately calibrated data from XDi 1 via CAN bus. |

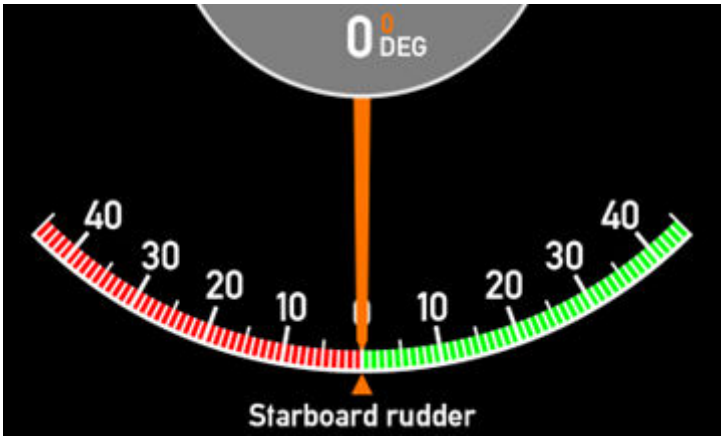
**NOTE** * Select another product profile (PP) if you want to use a different type of dimmer input.

**More information**
See Appendix 3 for details about external dimming options.

**More information**
See Appendix 1 for details about the XDi first-time setup procedure.

### 3.3.7 Commanded rudder presentation on XDi

All standard XDi rudder indicators use a small triangle pointer and an orange digital readout for the commanded angle.



In this example, XDi 1 receives the commanded rudder angle as a 4 to 20 mA signal on its AX1 module. XDi 1 scales the signal and shares it automatically on XDi-net to the other XDi units.

### Disabling commanded rudder indication

If you do not want to use commanded rudder indication, it can be disabled. The commanded rudder indication must be disabled on all XDi indicators if you do not want to use this feature. If it is not disabled on all indicators, it will be presented with a fixed value out of range. If it is set up with CAN data, it will be presented as a data lost indication.

**More information**
See Appendix 5 for more information about disabling the commanded rudder indication.

## 3.3.8 XL, BRW-2, or BW144/192

The traditional indicators (XL, BRW-2, or BW) used in this rudder system, must be ordered with single CAN input (sCAN). XL with sCAN is a listen only device on the CAN bus.

The XL type indicators in the example system have the following configuration:

| Item | Configuration |
|---|---|
| Input | Single CAN |
| Source NodeID | 10 (Data is sent from XDi in CAN TPDO1 with COB-ID: 0x18A) |
| Application type | General |
| Input type | Absolute (16-bit signed, rudder angle value x 10 (Resolution 0.1)) |
| Input minimum | -450 (equal to -45.0 ° PS, this must match the minimum scale value) |
| Input centre | 0 |
| Input maximum | +450 (equal to +45.0 ° SB, this must match the max. scale value) |

### Determining the EM and pointer turning direction

EM is the pointer position at the electrical midpoint of the input.

| Input values on CAN1 | Pointer position | FWD design<br>EM = 6 o'clock<br>Pointer CCW | AFT design<br>EM = 12 o'clock<br>Pointer CCW |
|---|---|---|---|
| -450 | PS (red)<br>-45.0 º | | |
| 0 | PS (red)<br>0.0 º | | |
| +450 | SB (green)<br>+45.0 º | | |

**NOTE** The standard rudder scales shown in the table above are available for XL, BRW-2, and BW indicators.

**More information**
See Illuminated indicators, standard scale designs for more examples of standard scales.

### Other available scales

Apart from the standard scales, DEIF provides a wide range of alternative scale designs. Contact DEIF customer care for more information.

### Customised scales

DEIF can make a customised rudder scale for your specific needs. Contact DEIF customer care for more information.

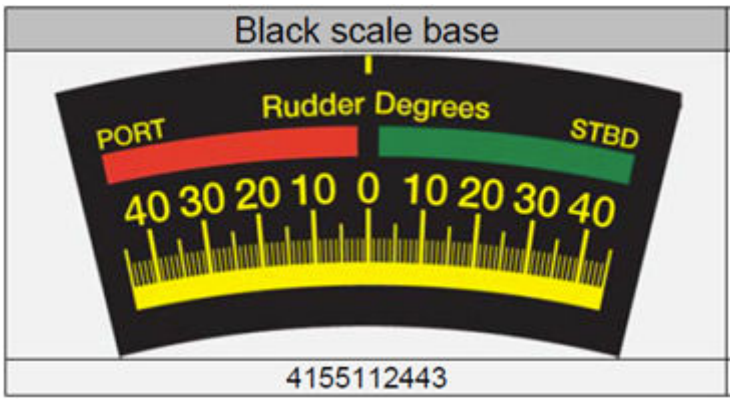
## 3.3.9 TRI-2 CAN configuration

TRI-2 is available in a special CAN bus version in addition to the traditional analogue input version. For this system the TRI-2 CAN version must be ordered.

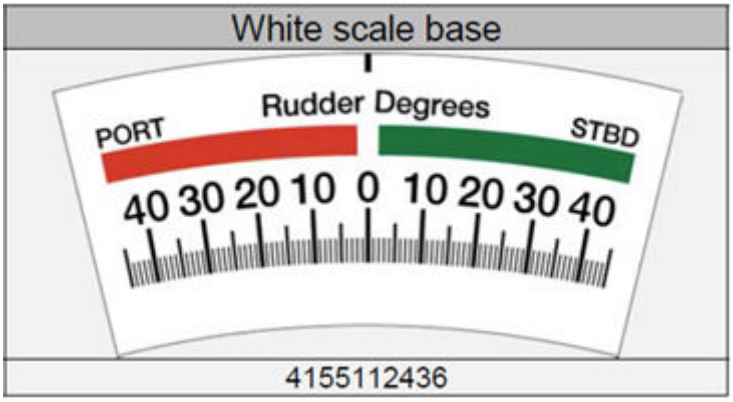
Order number: 2951460020 variant 02.

The TRI-2 CAN in the example system has the following configuration:

| Item | Configuration |
|---|---|
| Input type | Single CAN from XDi as transmitter |
| Source NodeID | 10 (Data is sent in byte 0 & 1 of CAN TPDO1 with COB-ID 0x18A) |
| Selected standard scale | ±45 red/green |




| Standard black scales with yellow pointer | |
|---|---|
| FWD | ±45 red/green scale number 4155112443 |
| AFT | ±45 green/red scale number 4155112444 |
| FWD | ±45 red/green scale number 4155110872 |
| FWD | ±50 red/green scale number 4155112445 |
| AFT | ±50 red/green scale number 4155112439 |
| FWD | ±70 red/green scale number 4155112440 |
| AFT | ±70 red/green scale number 4155111433 |
| FWD | ±180 red/green scale number 4155112595 |




| Standard white scales with black pointer | |
|---|---|
| FWD | ±45 red/green scale number 4155112436 |
| AFT | ±45 green/red scale number 4155112437 |
| FWD | ±50 red/green scale number 4155112438 |
| AFT | ±50 red/green scale number 4155112439 |
| FWD | ±70 red/green scale number 4155112440 |
| AFT | ±70 red/green scale number 4155112441 |

### Many more scales available

DEIF offers a wide range of other scales that may suit your requirements. If you do not see the scale you need, contact DEIF customer care for more information.

## 3.3.10 Installation and calibration of the rudder system

The system can be calibrated after it is installed on board. The XDi indicators are set up according to the previous chapters.

When XDi is used as an analogue to CAN converter it is easy to set up the system. It also works when the physical rudder movement cannot reach the minimum or maximum points on the rudder scale.

### Example

In this example, the maximum rudder movement is 41.0° to portside from zero and 39.5 ° to starboard. The full 4 to 20 mA signal is used to reflect the maximum rudder span.

### Calibrate the angle transmitter

The angle transmitter is delivered with a ±180 ° range. In the actual installation, you must calibrate the sensor to match your rudder movement.

You can use the XDi or the XL to calibrate the RTA 800 with the calibration wires on the rudder transmitter. See the RTA 800 and RTC 800 Installation instructions for how to calibrate the rudder transmitter.

### Calibration steps

1. Portside (PS) minimum
   - Position the rudder in the utmost portside. Note the physical rudder angle in degrees (in the example 41.0° PS). Perform the calibration procedure as described in the RTA and RTC 800 Installation instructions.

     The rudder angle is now set to either 4 or 20 mA. The value depends on the direction the sensor is rotated when the rudder is positioned in utmost portside.

     The XDi will now show either +45 ° (SB) or -45 ° (PS).
2. Starboard (SB) maximum
   - Position the rudder in the utmost starboard position. Note the physical rudder angle in degrees (in the example 39.5 ° starboard). Perform the calibration procedure as described in the RTA and RTC 800 Installation instructions.

     The RTA 800 is now calibrated. It uses the full 4 to 20 mA resolution to present the rudder angle range.

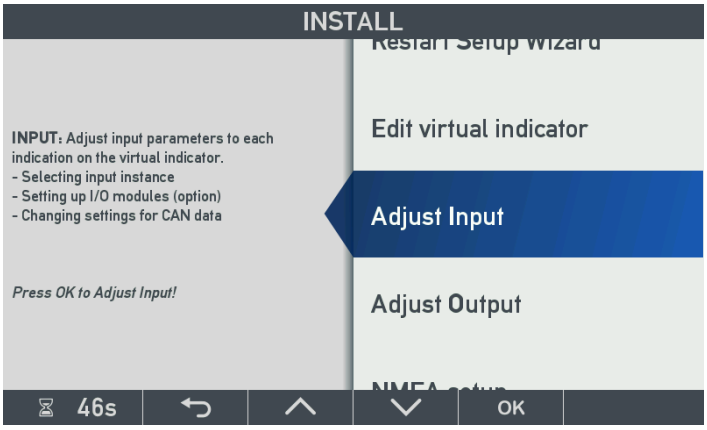
     All the rudder indicators in the system now show a value between -45.0 ° and +45.0 °. This corresponds to when the rudder moves between -41.0 ° (portside) and +39.5 ° (starboard).

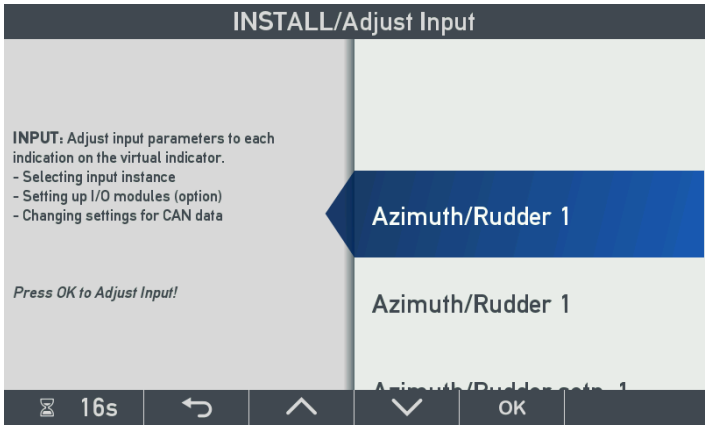
     This can easily be re-scaled via the installation menu on XDi 1 (the XDi connected to the RTA).

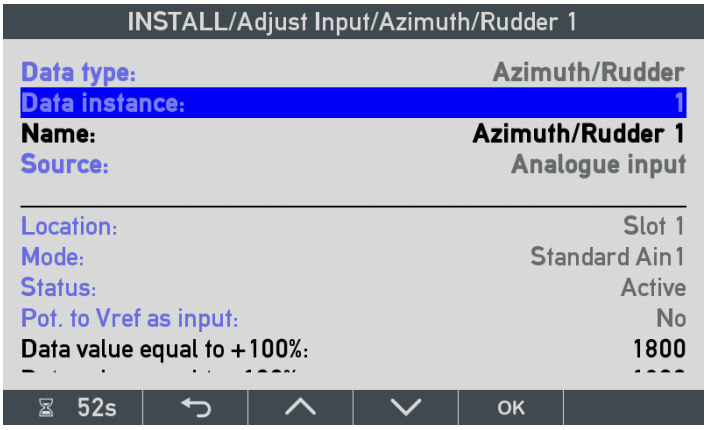
### Rescale the rudder angle input

Press button 1 and 4 at the same time for 5 seconds to open the user menu.

Press button 2 and 3 at the same time for 5 seconds to open the installation menu.



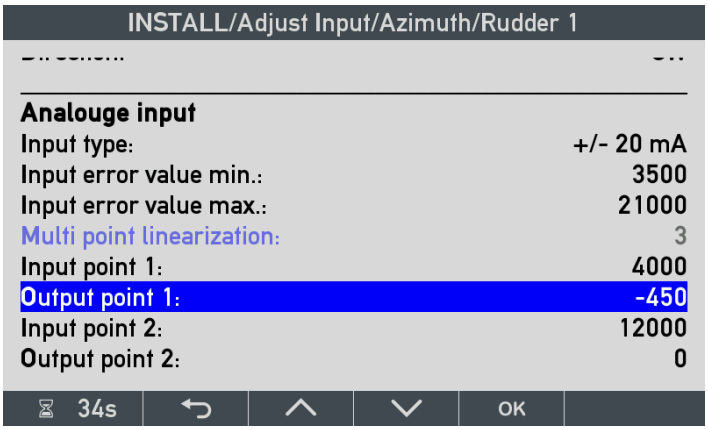




Make the above selections to enter the Azimuth/Rudder input adjust menu.

Scroll down to the analogue input part of the menu.

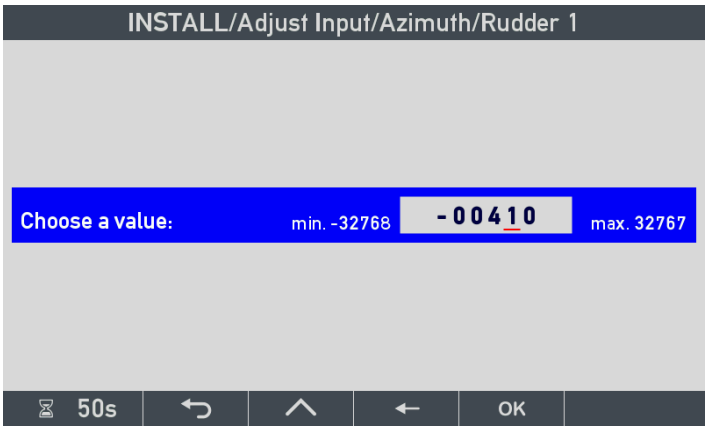
The rudder input is setup for 3-point linearisation. This means that there is an input/output pair for minimum rudder (PS), zero rudder, and maximum rudder (SB). The input is setup as a 4 to 20 mA input.

Input point 1 is 4000 µA, input point 2 is 12000 µA, and input point 3 is 20000 µA.

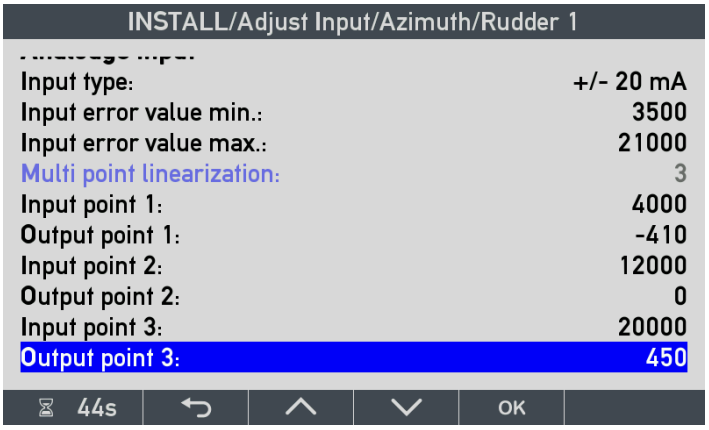



Scale the output to match the actual rudder angles.

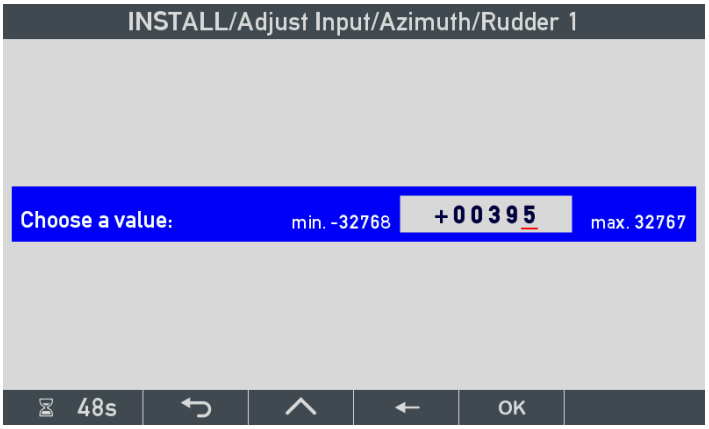
Output point 1 (PS) shall be changed to -41.0 °. This means that we will enter the value -410 since XDi is using an internal 0.1 ° resolution of the angle.



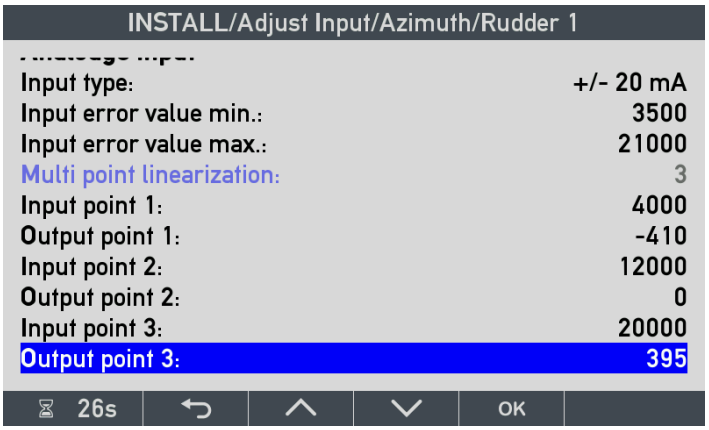

Press *OK* to save the new value.




Next, the output point 3 value must be changed to +39.5 ° or 395 with resolution 0.1 °.

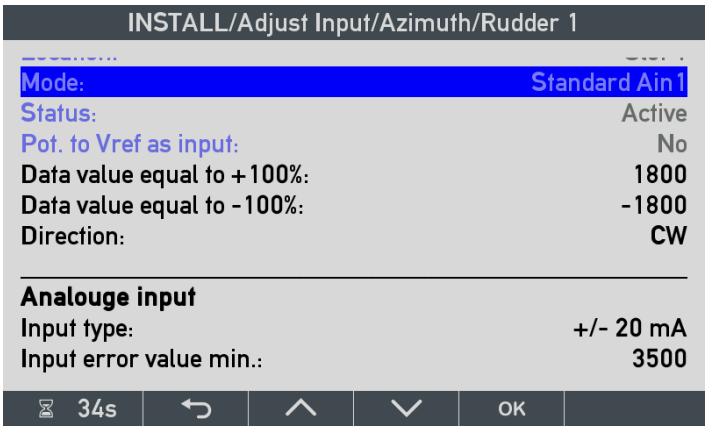



Press *OK* to save the new value.




Now the calibration is complete, and the total system is showing the correct rudder angle with a very high accuracy.

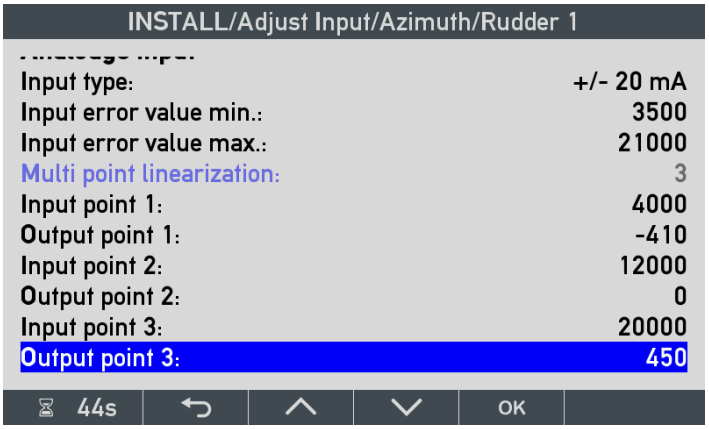
It is possible to fine-tune output point 2. If there is a small zero fault, adjust either input point 2 (12000 µA) or the output point 2 value. It depends on what is the easiest to do in the actual case. XDi will just scale the parameters accordingly.




### If the pointer turns the wrong way

If XDi 1 turns to port when the rudder moves to starboard, change the RTA 800 rotation from CW to CCW. In this case you must recalibrate the sensor following step 1 to 2.

Alternatively, you can make the change in the XDi installation menu, under *Adjust input:*




Change *Output point 1* from -450 to +450 and *Output point 3* from 450 to -450. The movement of the pointer will change direction, and the sign of the digital readout will change accordingly.

### Note the following

The ±100 % values are not used in this indicator type and shall not be changed.

| | |
|---|---|
| Data value equal to +100%: | 1800 |
| Data value equal to -100%: | -1800 |
| Direction: | CW |

**NOTICE**

**Do not change the *Direction* parameter from CW to CCW for a 4 to 20 mA signal**

If you change the Direction parameter from CW to CCW, it will reverse the signal input.

Changing the directions means that a 4 to 20 mA (CW) will be measured as -4 to -20 mA (CCW). This does not give the desired result.

If you reconfigure the input, for example to ±10 V, you can change the direction with the CW/CCW function. You can also swap the input wires to get the same result.

### New input lost function

The new input lost function was implemented in March 2020. The function defines the valid measuring range for the analogue input.

| | |
|---|---|
| Input error value min.: | 3500 |
| Input error value max.: | 21000 |

If the measured µA current or mV voltage is outside the range above, the XDi detects an input error. The XDi then gives an input signal warning pop up stating: *AX1 S1 input error*.

For a 4 to 20 mA input and the above settings, the XDi monitors the input wires. It shows a data lost or input signal error if one wire is broken.

When the input is lost, the XDi will also stop transmitting CAN data. Data loss will also be detected in all other devices connected via the CAN bus.

## 3.4 System application 4: Full CANopen system 1

The CAN systems are based on CANopen data distribution from the RTC 800 to all indicators in the system.

The CAN bus based rudder indicator system offers the absolute best possible rudder angle accuracy.

CAN system 4.1 is the fully digital XDi rudder system. It measures the rudder angle with 16-bit data resolution, giving 1/182 ° angle resolution. The digital data distribution and full digital signal processing in the XDi gives practically no degradation in accuracy. The calibration of the rudder system during installation is also easy. Calibrate on one XDi unit. When you leave the installation menu, let the XDi synchronise calibration settings to XDi rudder indicators on the CAN bus.

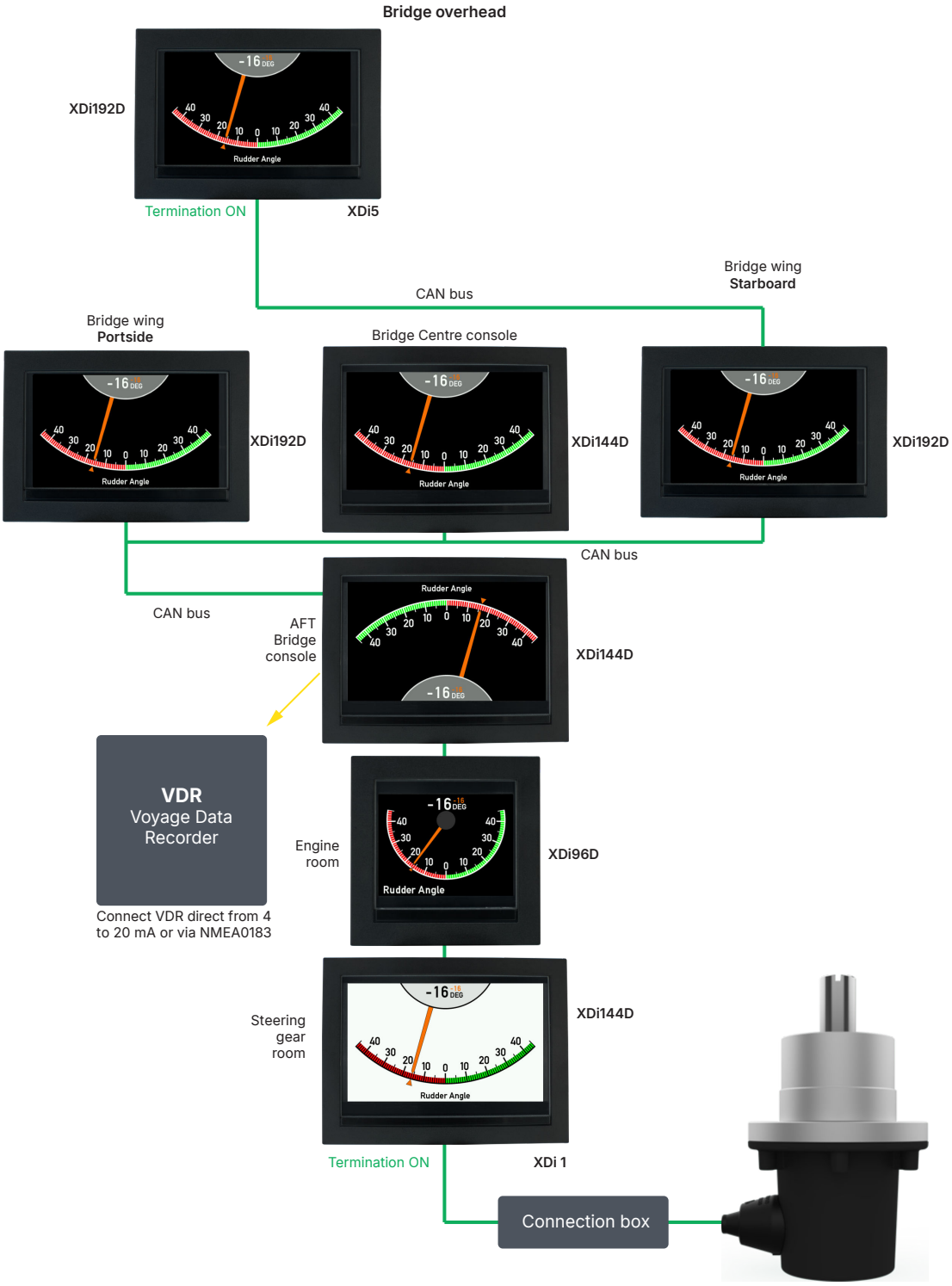
A CAN based system with traditional XL, BRW-2, BW and/or TRI-2 CAN indicators is still an accurate system. The conversion of the digital angle value to a mechanical pointer position on a scale degrades the accuracy slightly. This is in comparison to the fully XDi-based system. Calibration of minimum, zero, and maximum in this system is also relatively simple. The calibration can be performed on one XL (BRW-2 or BW) indicator. It will then automatically be shared with other XL, BRW-2, or BW rudder indicators on the CAN bus. TRI-2 CAN requires separate calibration.

You can combine XDi with traditional CAN indicators (XL, BW, and so on) to form an accurate rudder indicator system, as shown in CAN system 4.2. This system type is easy to calibrate via the menu in one XDi. Additional calibration of the traditional indicators will normally not be necessary.

In the following there will be application examples of 2 different CAN based systems.

## 3.4.1 CAN system 4.1: All indicators are type XDi

All indicators receive raw CAN data directly from the angle transmitter. Calibration can be made from the menu on any XDi indicator. The result is synchronised with all other XDi indicators for fast and easy setup.

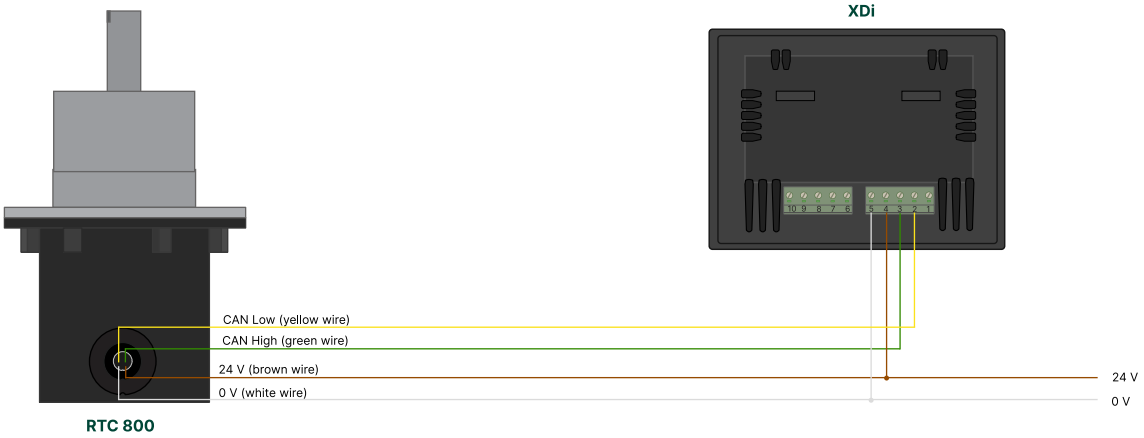



### CAN bus termination

If the CAN cable between XDi 1 and the RTC rudder transmitter is longer than 10 m, you must:

1. Switch OFF the termination resistor in the XDi.
2. Use a 120 Ohm resistor and connect it across CAN high and CAN low in the connection box betweem RTC 800 and XDi 1.

### Connecting the RTC CAN angle transmitter to the indicators




| Wire | Function | XDi 1 terminal |
|---|---|---|
| White | 0 V DC | 5 |
| Brown | 24 V DC | 4 |
| Green | CAN High | 3 |
| Yellow | CAN Low | 2 |
| Shield | Electrical shielding of data signal cable | No connection |

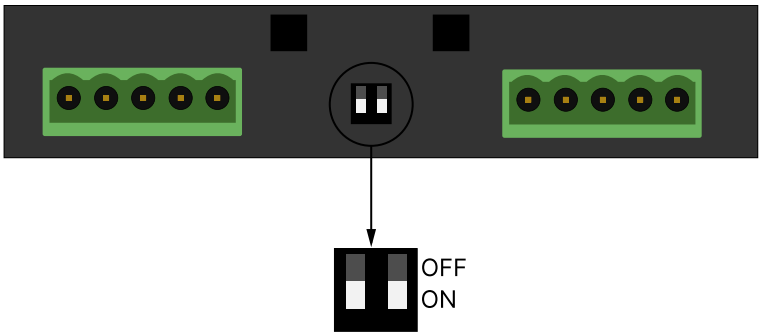
### CAN system connections

| Function | | XDi 1 terminal | XDI 2 terminal | XDI 3 terminal | XDI 4 terminal | XDI 5 terminal | XDI 6 terminal | XDI 7 terminal | Power supply |
|---|---|---|---|---|---|---|---|---|---|
| Supply voltage | - | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 0 V |
| | + | | 4 | 4 | 4 | 4 | 4 | 4 | 24 V DC |
| CAN 1 Low | | | 2 | 2 | 2 | 2 | 2 | 2 | |
| CAN 1 High | | | 3 | 3 | 3 | 3 | 3 | 3 | |
| CAN cable shield | | No connection | Connected between cables, but no connection to the indicators | | | | | | |
| CAN 1 termination | | ON | OFF | OFF | OFF | ON | OFF | OFF | 0 V |

### CAN bus termination

It is very important to terminate the CAN bus in both ends, failing to do so will result in unreliable CAN bus operation.

In this example an XDi is located in both endpoints of the CAN bus. Activate the internal CAN bus termination resistor in the XDi units located in both ends of the CAN bus to terminate the CAN bus.



### Dimming of an XDi system

The XDi indicators offer a wide range of dimmer control options:

- CAN bus
- External voltage dimmer input
- External potentiometer connection
- External buttons
- Buttons on the XDi front (optional)

All external dimming functions, except dimming via CAN bus, requires the use of an extension module.

The front button dimmer control on XDi requires the four-button front frame kit (available as an accessory). The XDi library version must be version 2000 or higher. The standard rudder indicator libraries support this function.

An XDi with external or front dimmer control can share its dimmer level via XDi-net. All XDi indicators on the same CAN bus can use this shared level.

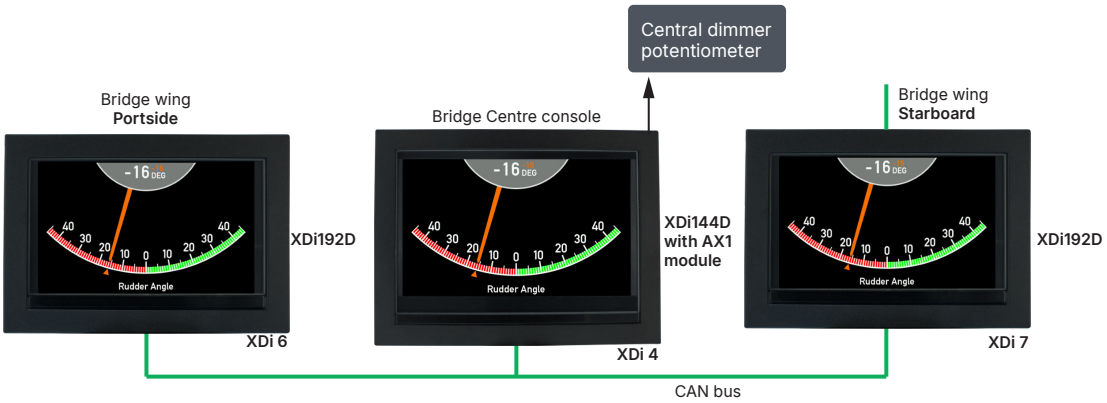
In installations with several separate XDi indicator systems, it can be beneficial to use CAN bus 2 for dimmer control. In this way the separated indicator systems can be interconnected without jeopardising the system separation. This is possible due to the galvanic separation of the two CAN busses.

Dimming can be controlled via CAN, and the system can use up to nine dimmer groups regardless of input type. XDi 3 to XDi 7 can for example be controlled as one group. The default is dimmer group 1.

One indicator with a dimmer potentiometer (AX1 module required) can control the dimmer level for all indicators in the group. Front button dimming is also possible on one or more XDi indicators that have the front button option or kit.

### Example

In this example we will control dimmer group 1 via a potentiometer connected to an AX1 module on XDi 4.



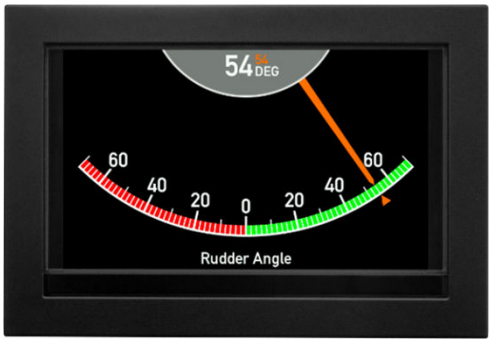

XDi units in the steering gear room and the engine control room often use a fixed dimmer level and also Local dimmer group. *Local* means that dimming is not controlled via the CAN bus.

Most product profiles use dimmer group 1. The ECR profile uses a fixed *Local* dimmer level.

**More information**
See Appendix 3 for other dimmer alternatives.

Order the XDi unit with the DEIF standard rudder library 031. This library contains a selection of virtual rudder indicators.

The library has indicators with standard scales (±40 °, ±45° , ±50 °, ±70 °). Use them for forward or aft bridges.




Rudder angle indicator ±70 ° forward (VI007).

Rudder angle indicator ±45 ° aft (VI004).

Additionally, there is a special MED compliant rudder indicator for systems where the rudder angle is less than 40 degrees. This indicator has a ±40 ° scale (minimum scale required by ISO 20673) with a configurable grey scale.

Example of XDi 96 D scale configured to ±30 °

Contact DEIF if the rudder scale you need is not in the standard library. The scale could already be added or is in the process of being added. It is also possible to have a unique customised indicator design if required. XDi is made for easy customisation of indicators.

### Installation wizard

When the XDi has not yet been set up, it will automatically start the start-up wizard.

In the tables below, you will find the correct XDi setup for the system example.

### Select the CAN NodeID

In this application example all XDi units receive the angle value directly from the RTC 800 CAN angle transmitter. By default, the unit uses *NodeID 1*. It sends a 16-bit angle value in TPDO1 (COB-ID 0x181).

All devices on the CAN bus must have different CAN NodeIDs. It is not important which ID you select for the XDi indicators as long as they are different. The suggested CAN Node IDs are found in the tables below.

The example system uses the DEIF standard rudder indicator library no. 031 and the rudder indicator selected should be ±45 °.

| XDi indicator number 1: Steering gear room (including analogue to CAN bus conversion) | | | |
|---|---|---|---|
| Node ID: 31 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP06: ECR fixed dimmer Group: Local | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1. |

| XDi indicator number 2: Engine room | | | |
|---|---|---|---|
| Node ID: 31 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP06: ECR fixed dimmer Group: Local | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| XDi indicator number 3: AFT bridge | | | |
|---|---|---|---|
| Node ID: 32 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI004 ±45 degrees aft bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1. |

| XDi indicator number 4: Centre console (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 33 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP02: Analogue dimmer. Dimmer level is shared on CAN 1 and CAN 2 dimmer group 1.* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| XDi indicator number 5: Overhead panel (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 34 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| XDi indicator number 6: Bridge wing Portside (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 34 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| XDi indicator number 7: Bridge wing Starboard (Forward bridge) | | | |
|---|---|---|---|
| Node ID: 34 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

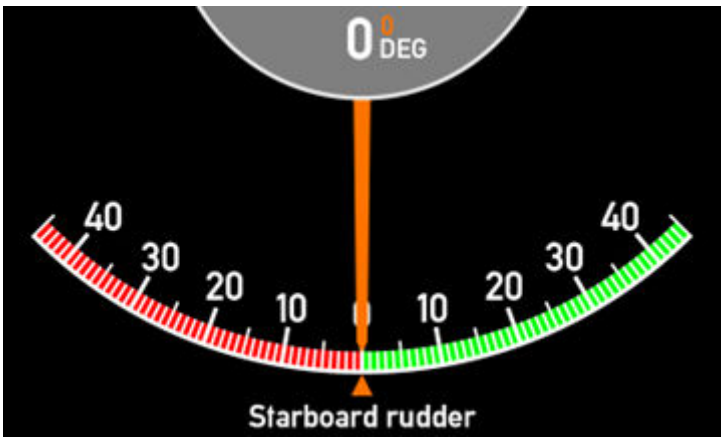
**NOTE** * Select another product profile (PP) if you want to use another type of dimmer input.

**NOTE** ** The RTC angle transmitter can be connected to either CAN 1 or CAN 2. Adjustment of the minimum and maximum angle can be made from any of the XDi units in the system and can be synchronised with all other XDi indicators in the system.

**More information**
See Appendix 3 for details on external dimming control..

### Commanded rudder presentation on XDi

All the standard XDi rudder indicators have a small triangle pointer and an orange digital readout showing the commanded rudder angle.




In this example the XDi system can receive the commanded rudder angle via CAN either in a TPDO with COB-ID 0x1A1 (Byte 0 and 1: value ±1800) or via XDi-net format.

If the VI-setup profile VS03 is used instead of VS02, then an analogue 4 to 20 mA signal connected to an AX1 module on the XDi, for example, in the steering gear room (XDi 1) can be received and shared on CAN using XDi-net. The other indicators use profile VS02 as before. XDi 1 scales the input and distributes it automatically via XDi-net (CAN) to the other XDi units in the system.

### Disabling commanded rudder indication

If you do not want to use the commanded rudder indication, it can be disabled.

**More information**
See Appendix 5 on how to disable commanded rudder indication.

### Installation and calibration of the rudder system

The system can be calibrated after it is installed on-board and the XDi indicators are setup according to the previous chapters.

### Example

In this example, the maximum rudder movement is 41.0 ° to portside from zero and 39.5 ° to starboard.

### Calibration steps

1. Zero set

   Position the rudder in its zero position. To set this as the zero value, push buttons 1 and 4 at the same time for five seconds to open the User menu. From the User menu, push buttons 2 and 3 at the same time to open the Installation menu.

   In the Installation menu, go to Adjust input, and select Azimuth/Rudder 1. Select Zero ref and then Use actual input value to set the current rudder position as your zero value.

If the RTC angle transmitter is connected to the rudder 1:1, so that 20 ° rudder angle equals a 20 ° rotation of the RTC shaft, the XDi default input scaling parameters will be correct and no further adjustment is needed.

2. Starboard angle verification (maximum)

   Position the rudder in the utmost starboard (SB) position. Check that the rudder angle indication on the XDi display is showing the correct SB rudder angle.

   If the angle is not correct, change it as shown in step 4. In this example, the actual physical rudder angle is 39.5 ° SB and the angle value presented on XDi is 41.5 ° SB.

3. Portside angle verification (minimum)

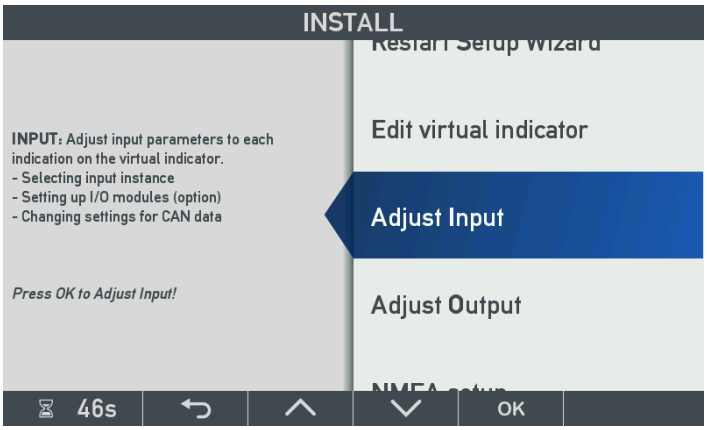
   Position the rudder in the utmost portside (PS) position. Check that the rudder angle indication on the XDi display is showing the correct PS rudder angle.

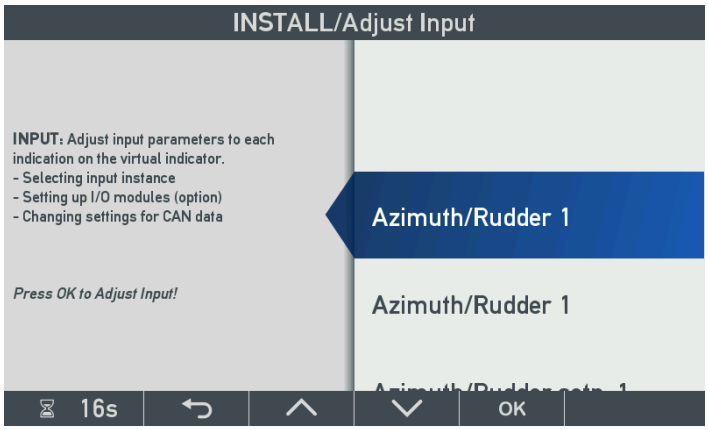
   If the angle is not correct, change it as shown in step 4. In this example, the actual physical rudder angle is 41.0 ° PS and the angle value presented on XDi is 43 ° PS.

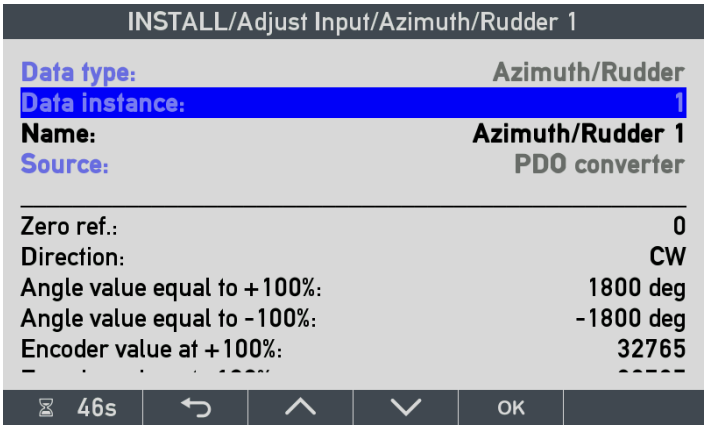
4. Rescale the rudder angle input

   Press button 1 and 4 at the same time for 5 seconds to open the user menu.

   Press button 2 and 3 at the same time for 5 seconds to open the installation menu.



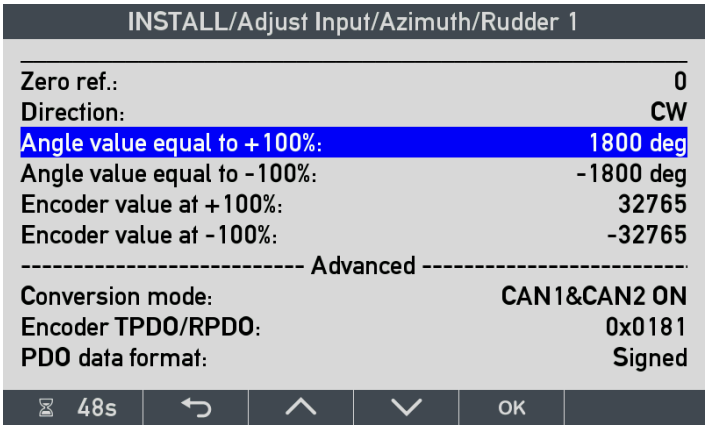



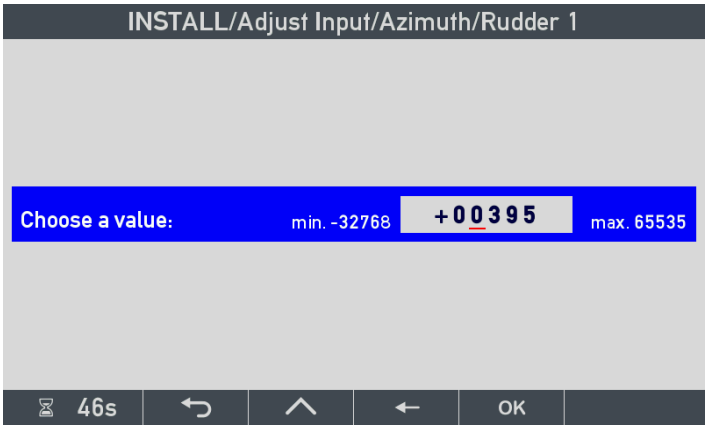

Make the above selections to enter the Azimuth/Rudder input adjust menu.

The relative angle value from the RTC is equal to 182.04 per degree. This is equal to what XDi was showing 41.5 ° when the rudder was in outmost SB position. In that position, the actual rudder angle is determined to be only 39.5 °, so the SB position must be calibrated. The easiest is to make a new set of input scaling parameters. Angle value +100% must be changed to 39.5 °, and with an internal resolution of 0.1, this is equal to 395. The Encoder value from RTC must be changed to the value received in the SB rudder end point. It is the value 7555 (7555/182.04 = 41.5).

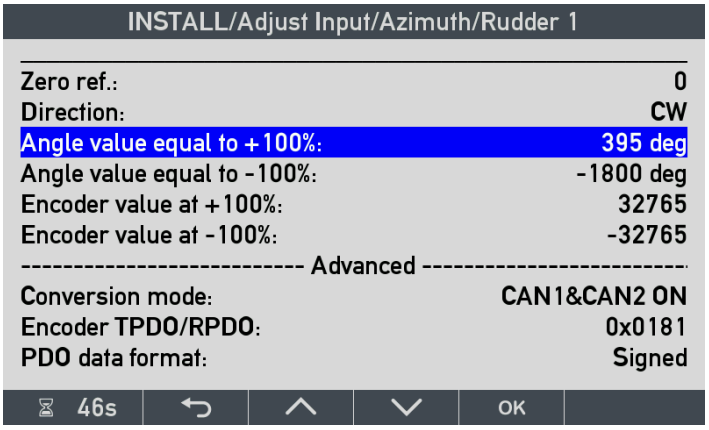
Scroll down to *Angle value equal to +100%* in the menu. Push the *OK* button to change this value to the new maximum rudder angle.



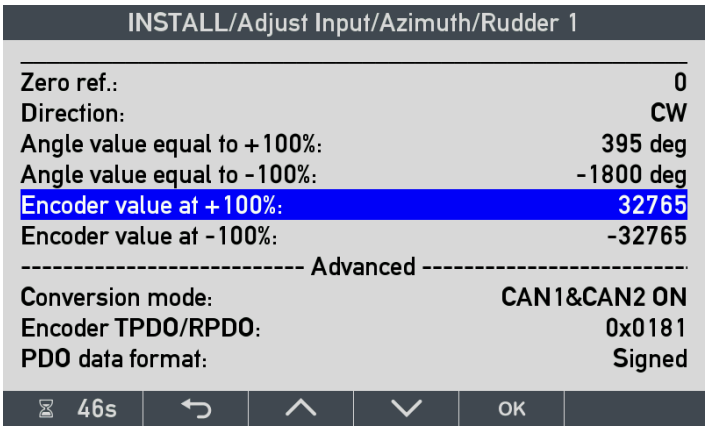

**NOTE** XDi is able to calculate both a percentage and an actual angle value. The rudder indicator only uses an actual angle value.




Press *OK* to save the new value.

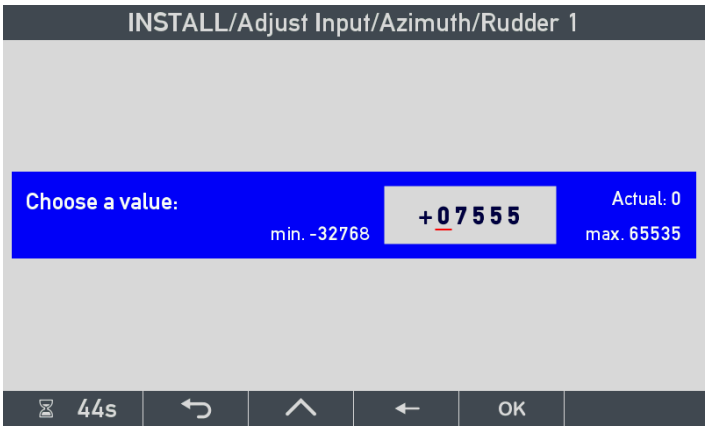



Next the step is to set the Encoder value at 100%.



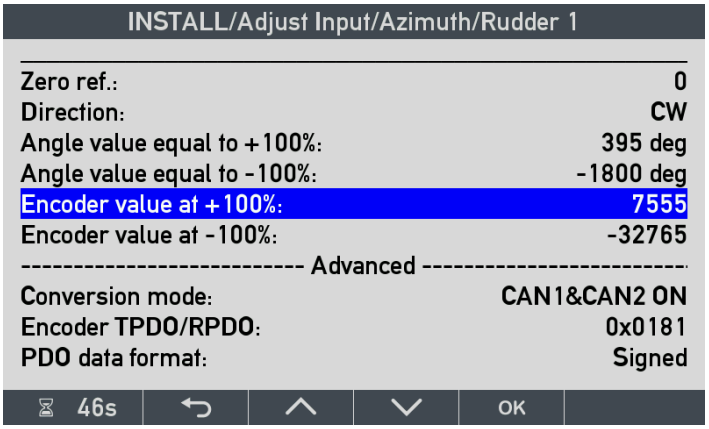

Press *OK* to edit.

The rudder is still in the maximum SB position, and the actual RTC angle transmitter value is to the left of the parameter value. In this case, the value is 7555. Enter this value into the parameter window.




**NOTE** Due to the limited number of buttons, there is not a single push function to enter the actual encoder value. You must enter the value manually.

Press *OK* to save the new value.

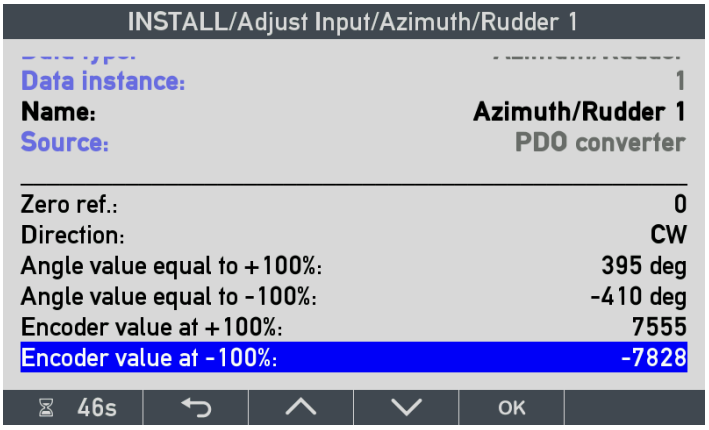



You have now calibrated the SB side.

The portside rudder is also slightly misaligned, so you must calibrate it. The maximum portside angle is -41.0 °, but with the default setup, XDi shows -43.0 °. This means that the value from the RTC angle transmitter is -43.0 x 182.04 = -7828

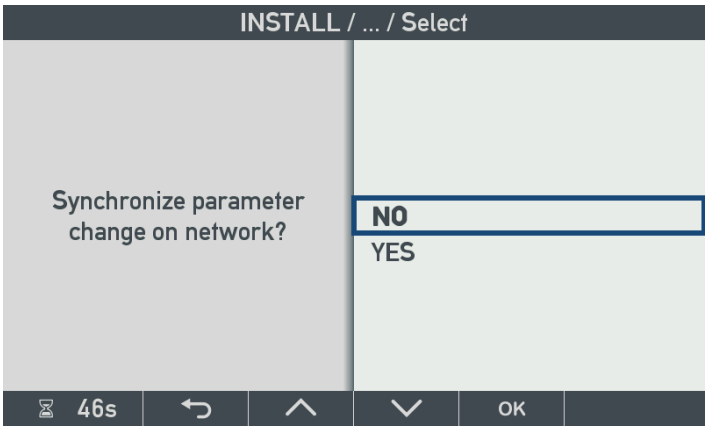
Now change *Angle value equal to -100%* to -410 (=41.0°) and change the encoder value at -100% to -7828.

The actual value from the RTC angle transmitter for the rudder in its maximum SB position. Press *OK* to save the new value.




Now the calibration is completed for this XDi unit.

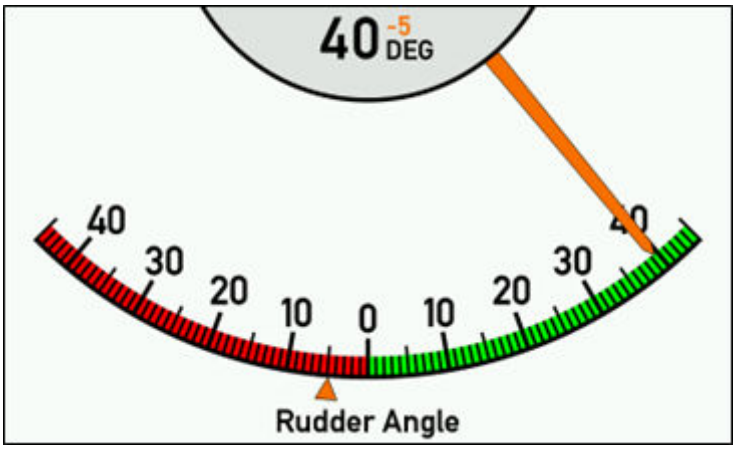
When you select , a new menu will be shown:



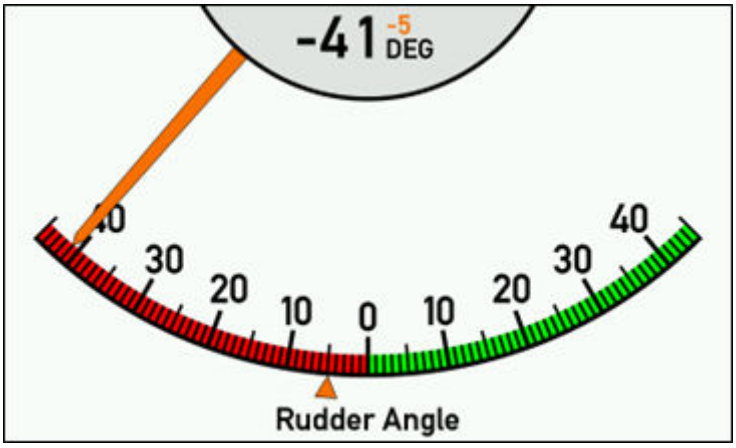

Make sure that all XDi indicators in the rudder system are powered up and then select *YES* to synchronise parameters on the network. All the other XDi indicators in the system now receive the new parameter settings for the scaling of the RTC angle transmitter CAN data.

The system now reads data directly from the RTC angle transmitter and scales it to display the correct rudder angle with very high accuracy.

Outmost starboard rudder 39.5 °.

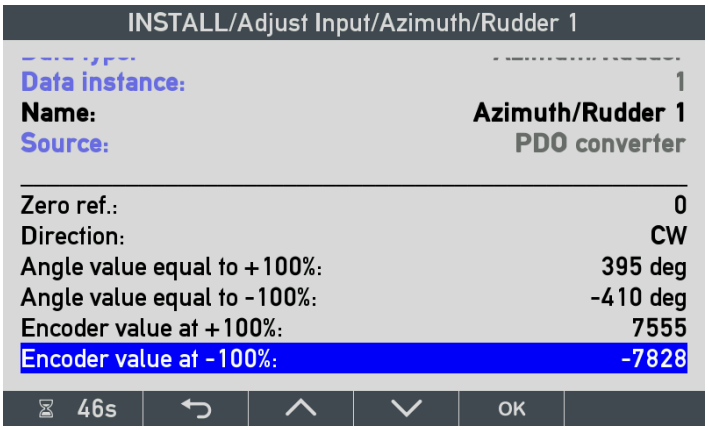



Outmost portside rudder position 41.0 °




### If the pointer moves in the wrong direction

Before you start the calibration process, you should check if the pointer is moving in the right direction. If it is moving in the wrong direction, you should change *Direction* from the default CW to CCW.

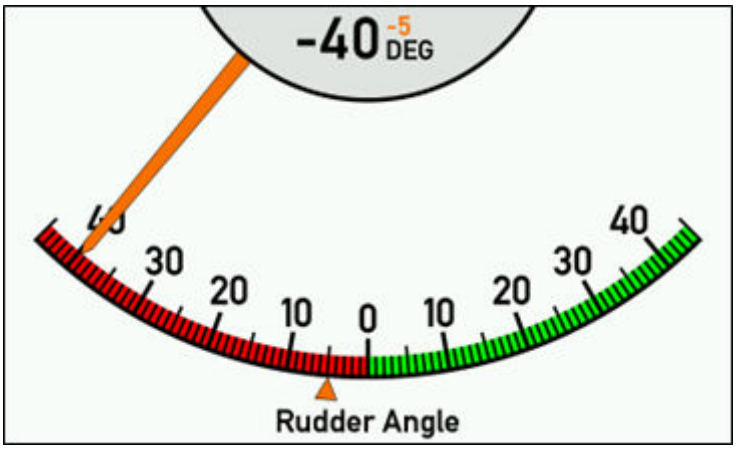



It is important that you check the pointer before making the calibration. The scaling parameters will be overwritten by the default values.

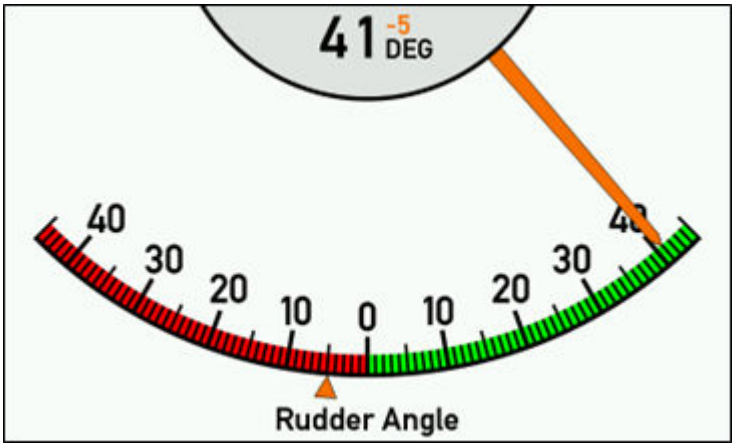
Be aware that in CCW mode the -100% scaling parameters now scales the starboard angle values. +100% scaling parameters now scales the portside angle values.

**NOTE** CCW equals a multiplication of the output value by -1 before it is used or shared on CAN.

With the CCW setup using input value +7555, the pointer now shows 39.5 ° to PS.




With the CCW setup using input value -7828, the pointer now shows 41.0 ° to PS.



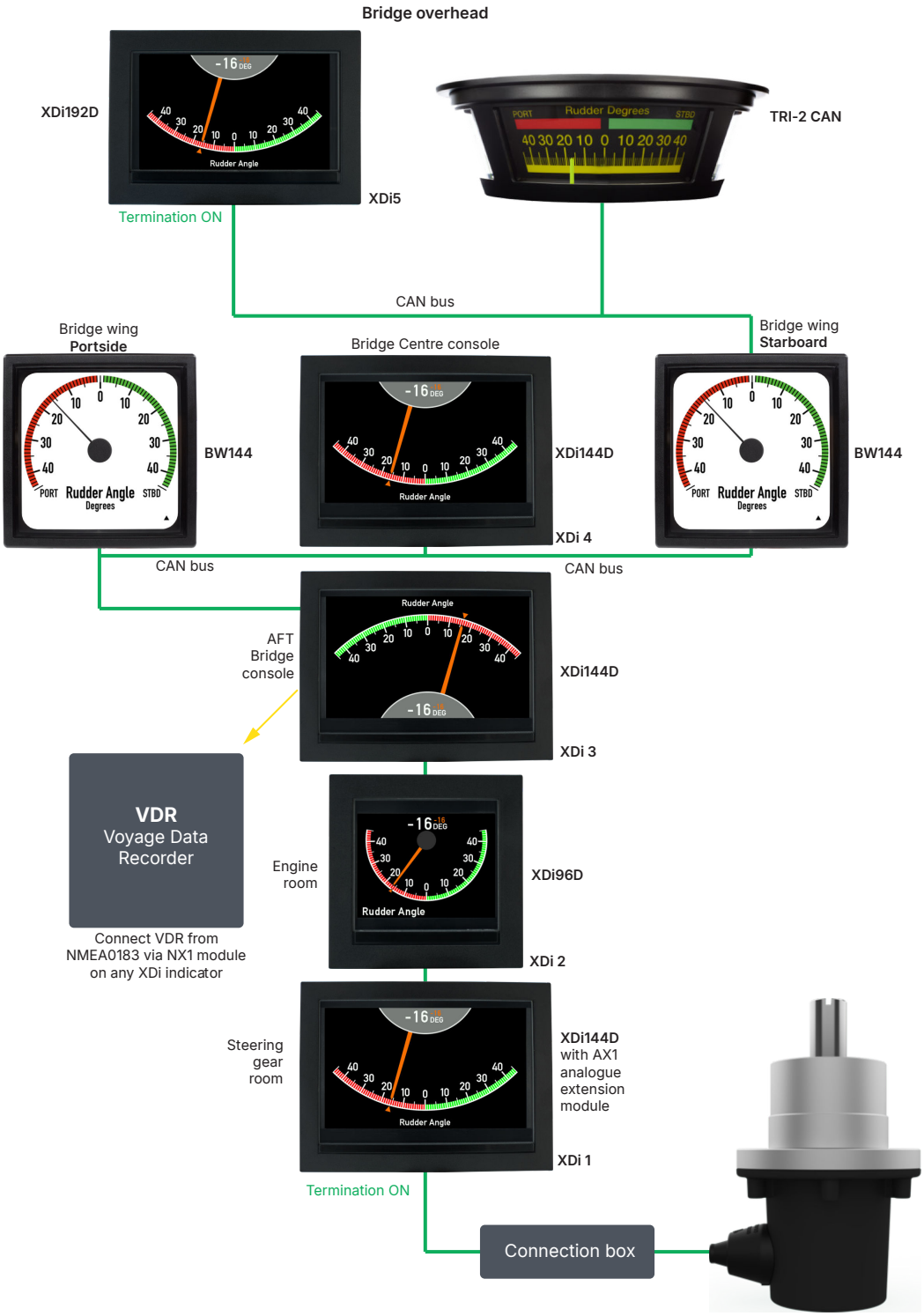

In this case, you must select *YES* to synchronise the parameters in the system. All XDi indicators will then be aligned and use CCW when the system scales the angle data from the RTC.

### 3.4.2 CAN system 4.2: Combined XDi and XL indicators with sCAN interface

It is possible to make a full CAN bus rudder indicator system where XDi and traditional mechanical indicators are mixed. This fully digital system offers very high accuracy and reliability. It is even possible to build some degree of redundancy into the system.

This solution can for example be used in applications where very robust BRW-2 or BW outdoor indicators are needed. BRW-2 and BW provide superior viewing ability in bright sunlight conditions, where display-based indicators are challenged. The solution can also be used where there is a need for a large panorama type indicator mounted on the ceiling.

The menu system in the XDi units makes it easy to setup and calibrate the complete system. All calibration can be done from any one of the XDi units.




All the XDi indicators receive CAN data directly from the angle transmitter.

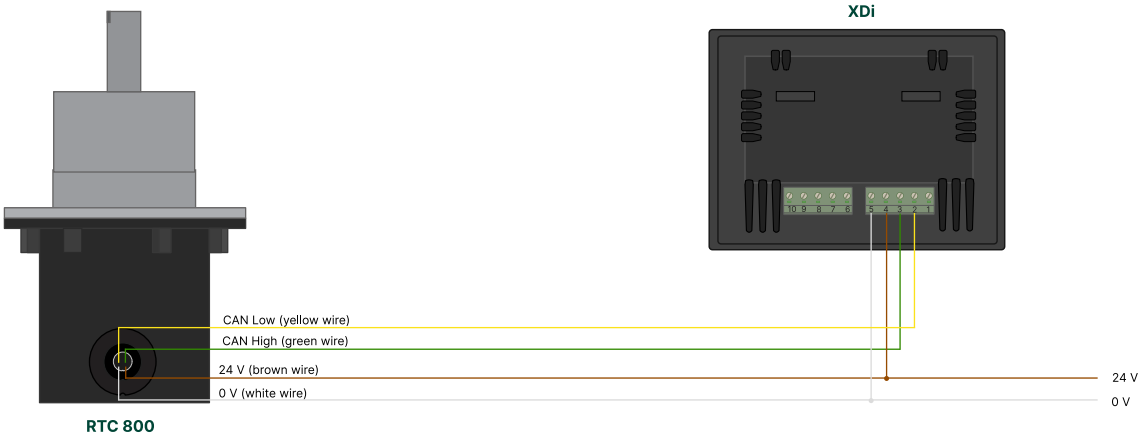
One XDi indicator is set up to transmit the correct scaled rudder angle values via CAN bus to all the traditional indicators in the system. This indicator is both a rudder indicator and a converter box. Using an XDi as converter box is just a digital converter solution, similar to using the TDG-210 amplifier to convert a 4 to 20 mA to a ±10 V signal in System application 2.

The actual rudder angle value is sent in TPDO1 (Default 0x18A) as a signed 16-bit value to all the traditional indicators, such as XL, BRW-2, BW and/or TRI-2 CAN. Note that the indicator must be ordered preconfigured with sCAN ID = 10 (this means that data is received in TPDO1, COBID0x18A).

The installation menu system in any of the XDi units in this system can be used to calibrate the rudder system and synchronise the calibration data with all other XDi units.

Using XDi in this way makes calibration of the complete system very easy.

### Connecting the RTC CAN angle transmitter to the indicators




### Connecting RTC to XDi via CAN bus 1

| Wire | Function | XDi 1 terminal |
|---|---|---|
| White | 0 V DC | 5 |
| Brown | 24 V DC | 4 |
| Green | CAN High | 3 |
| Yellow | CAN Low | 2 |
| Shield | Electrical shielding of data signal cable | No connection |

### CAN system connections

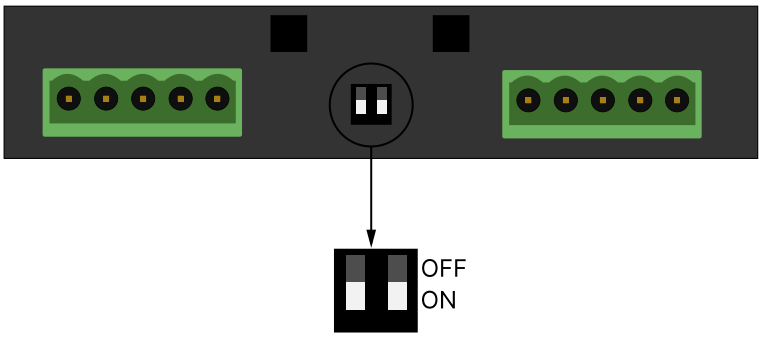
| Function | | XDi 1 terminal | XDi 2 terminal | XDi 3 terminal | BRW-2 terminal | XDi 4 terminal | BRW-2 terminal | TRI-2 terminal | XDi 5 terminal | Power supply |
|---|---|---|---|---|---|---|---|---|---|---|
| Supply voltage | - | 5 | 5 | 5 | - | 5 | - | 2 | 5 | 0 V |
| | + | 4 | 4 | 4 | + | 4 | + | 1 | 4 | +24 V DC |
| CAN 1 Low | | 2 | 2 | 2 | 84 | 2 | 84 | 8 | 2 | |
| CAN 1 High | | 3 | 3 | 3 | 83 | 3 | 83 | 7 | 3 | |
| CAN cable shield | | Connected between cables, but no connection to the indicators | | | | | | | | |
| CAN 1 termination | | ON* | OFF | OFF | OFF | OFF | OFF | OFF | ON | |

**NOTE** * CAN bus termination: If the CAN bus cable between the RTC 800 and XDi 1 is more than 10 metres, it is recommended to mount a 120 Ω termination resistor closer to RTC 800. The resistor must be mounted between CAN 1 High and CAN 1 Low. A good location for this resistor is the installation box where the RTC 800 pigtail meets the CAN backbone. In this case, do not activate the termination resistor in XDi 1.

### CAN bus termination

It is very important to terminate the CAN bus in both ends, failing to do so will result in unreliable CAN bus operation.

In this example an XDi is located in both endpoints of the CAN bus. Activate the internal CAN bus termination resistor in the XDi units located in both ends of the CAN bus to terminate the CAN bus. See the table above.




## Dimming of an XDi system

The XDi indicators offer a wide range of dimmer control options:

- CAN bus
- External voltage dimmer input
- External potentiometer connection
- External buttons
- Buttons on the XDi front (optional)

All external dimming functions, except dimming via CAN bus, requires the use of an extension module.

The front button dimmer control on XDi requires the four-button front-frame kit (available as an accessory), and the XDi library version must be version 2000 or higher. The standard rudder indicator libraries support this function.

An XDi unit with external or front dimmer control can share the dimmer level via XDi-net (CAN bus) for a group of XDi indicators connected to the same CAN bus.

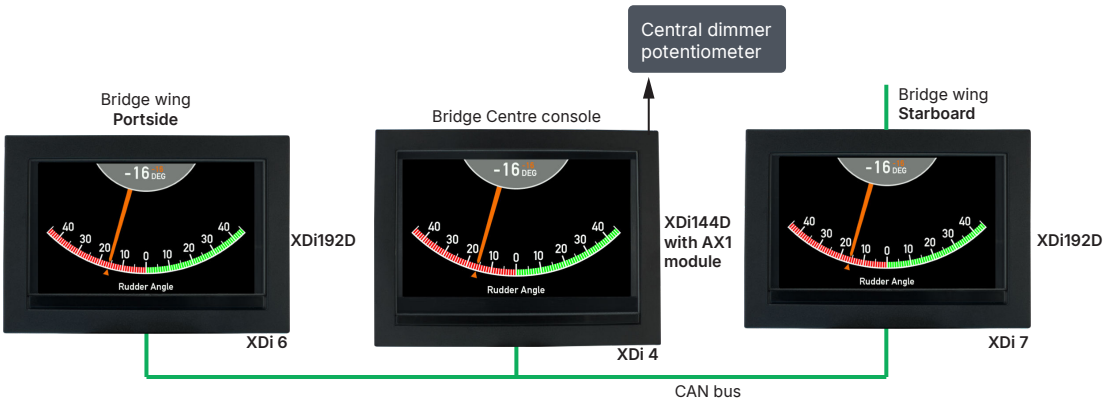
In installations with a number of separate indicator systems using XDi, it can be beneficial to use CAN bus 2 as a dimmer control bus. In this way the separated indicator systems can be interconnected without jeopardising the system separation. This is possible due to the galvanic separation of the two CAN busses.

It is possible to control dimming via CAN and divide the system into dimmer groups (maximum 9 groups) independent of the selected dimming input type. XDi 3 to XDi 7 can for example be controlled as one group. The default is dimmer group 1.

One of the indicators controlled by a dimmer potentiometer (AX1 module required) controls all units in the group. Dimming can also be controlled via the front button on one or more XDi indicators in the group (front button option or kit is required).

## Example

In this example we will control dimmer group 1 via a potentiometer connected to an AX1 module on XDi 4.




For the XDi units located in the steering gear room and engine control room, a fixed dimmer level and dimmer group *Local* is often used. Local means that dimming is not controlled via the CAN bus.

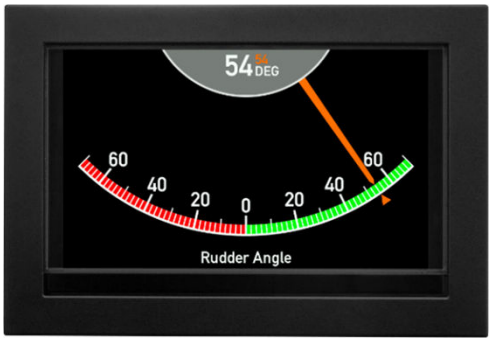
Note that the default dimmer group is 1 for most of the product profiles, except for the ECR profile that has a fixed dimmer level and is pre-set to *Local*.

**More information**
See Appendix 3 for other dimmer alternatives.

### Installation setting

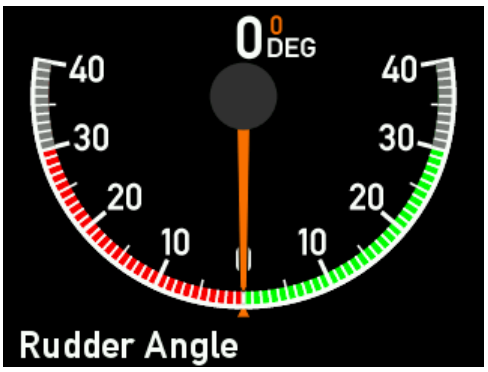
Order the XDi unit with the DEIF standard rudder library 031. This library contains a selection of virtual rudder indicators.

The library contains indicators with standard scales for ±40 °, ±45 °, ±50 °, ±70 ° and for use on a forward or aft pointing bridge respectively.




Rudder angle indicator ±70 ° forward (VI007).

Rudder angle indicator ±45 ° aft (VI004).




Example of XDi 96 D scale configured to ±30 °.

Contact DEIF if the rudder scale you need is not in the standard library. The scale could already be added or is in the process of being added.

It is also possible to have a unique customised indicator design if required. XDi is made for easy customisation of indicators.

### Installation wizard

When the XDi has not yet been set up, it will automatically start the start-up wizard.

In the tables below, you find the correct XDi setup for the system example.

### Select the CAN NodeID

In this application all XDi units receive the angle value directly from the RTC 800 CAN angle transmitter that by default has NodeID 1. The transmitter transmits angle data as a 16-bit value in byte 0 and 1 in TPDO1 with COB-ID 0x181.

All XDi units on the CAN bus must have a unique ID. The suggested CAN node IDs are found in the tables below.

The XL, BRW-2, BW and TRI-2 indicators are all single CAN (sCAN) indicators and are listen only devices. This means that they do not have a NodeID on the CAN bus. The sCAN ID for the indicator refers to the source of the CAN data this unit will read, not the node ID for the unit. The TPDO that such an indicator is listening for is a TPDO1, COB-ID 0x180 + sCAN ID.

The example system uses the DEIF standard rudder indicator library no. 031 and the rudder indicator selected should be ±45 °.

| **XDi indicator number 1: Steering gear room (including analogue to CAN bus conversion)** | | | |
|---|---|---|---|
| Node ID: 31 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP06: ECR fixed dimmer Group: Local | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| **XDi indicator number 2: Engine room** | | | |
|---|---|---|---|
| Node ID: 31 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP06: ECR fixed dimmer Group: Local | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| **XDi indicator number 3: AFT bridge** | | | |
|---|---|---|---|
| Node ID: 32 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net Dimmer group 1* | VI004 ±45 degrees aft bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| **XDi indicator number 4: Centre console (Forward bridge)** | | | |
|---|---|---|---|
| Node ID: 33 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP02: Analogue dimmer.Dimmer level is shared on CAN 1 and CAN 2 for dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

| **XDi indicator number 5: Overhead panel (Forward bridge)** | | | |
|---|---|---|---|
| Node ID: 34 | | | |
| Product Profile | Virtual indicator | VI setup | Notes |
| PP01: Front dimmer / XDi-net.<br>Dimmer group 1* | VI003 ±45 degrees forward bridge indicator | VS02 RTC / TPDO | This XDi will receive data directly from RTC 800 via CAN bus 1.** |

**NOTE** * Select another product profile (PP) if you want to use another type of dimmer input.

**NOTE** ** The RTC angle transmitter can be connected to either CAN 1 or CAN 2. Adjustment of the minimum and maximum angle can be made from any of the XDi units in the system and can be synchronised with all other XDi indicators in the system (see detailed description later in this section).

**More information**
See Appendix 3 for details about external dimming control.

**More information**
See Appendix 1 for details about the first-time setup procedure.

No setup is required for:

| BW 144 indicator: Bridge wing Portside (Forward bridge) |
|---|
| sCAN ID: 10 |

| BW 144 indicator: Bridge wing Starboard (Forward bridge) |
|---|
| sCAN ID: 10 |

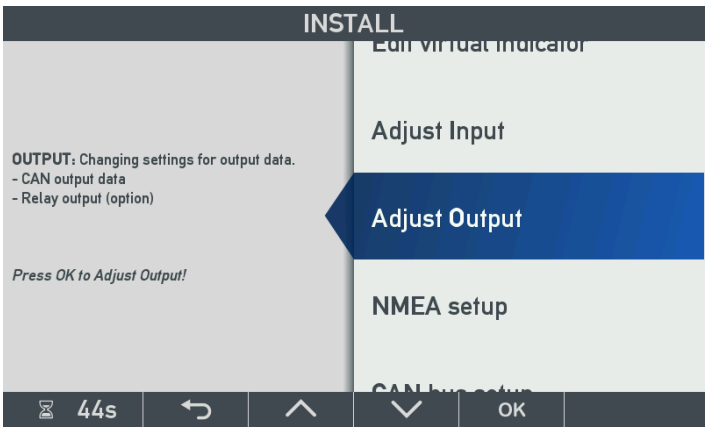
| TRI-2 CAN Panorama indicator: Ceiling (Forward bridge) |
|---|
| sCAN ID: 10 |

### Activation of the CAN signal to the traditional indicators

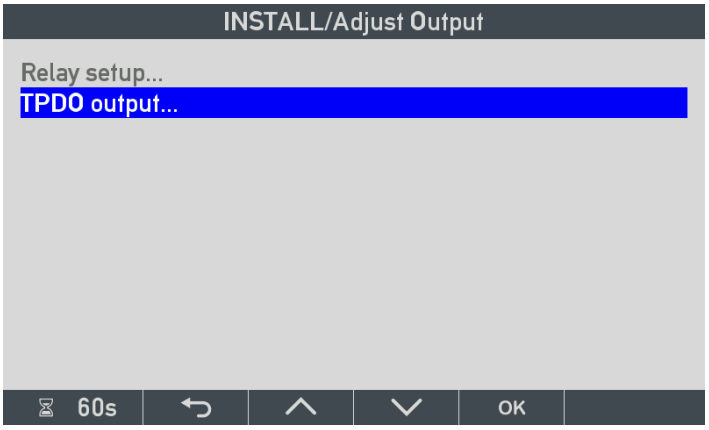
The traditional XL, BW, BRW and TRI indicators receive angle data from one of the XDi indicators.

XDi 1 is used as the CAN converter unit. It receives the relative 16-bit value and scales it to an absolute angle value before it is retransmitted to the traditional indicators.

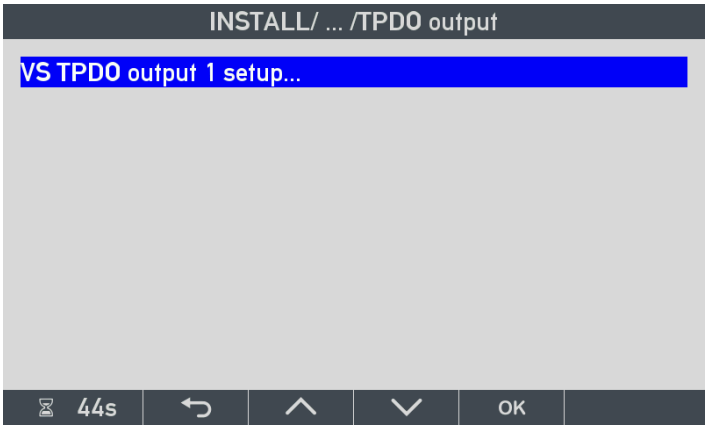
To activate the transmission of CAN data, enter the installation menu on XDi 1 (Steering gear room) by pushing button 1 and 4 at the same time for 5 s to enter the user menu. Then push button 2 and 3 at the same time for 5 s to enter the installation menu:



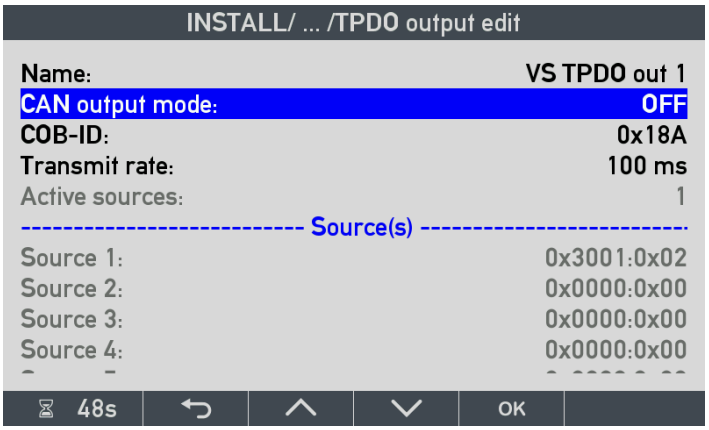

Go to *Adjust output* and press *OK*.



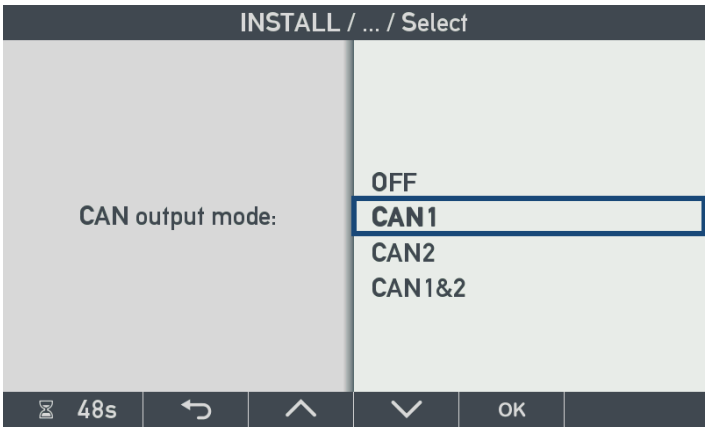
Because the rudder angle is transmitted in a TPDO, highlight *TPDO output...* and press *OK*.



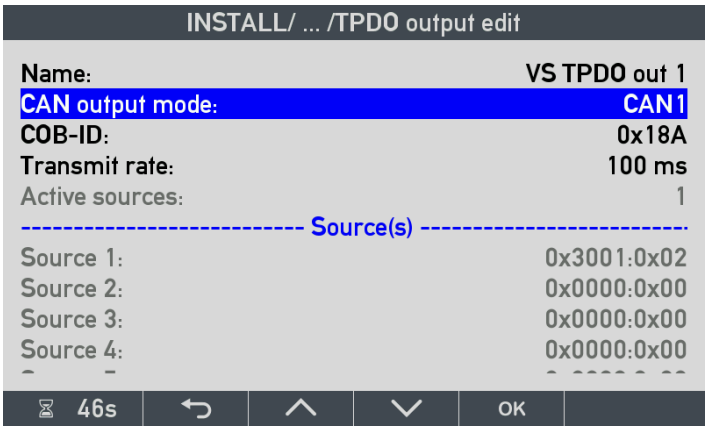

All rudder angle indicators in the standard rudder library has a VS02 profile that is prepared for transmission of the actual rudder angle value. In this case there is only one TPDO output defined. Press *OK*.




The TPDO output is disabled by default. The CAN output mode is OFF. Highlight *CAN output mode* and press *OK*.




Select *CAN1* and press *OK*.




It is possible to change the transmit rate of the TPDO. In this example the 100 ms default is used.

The rudder angle is sent in TPDO with COBID 0x18A (0x180 + sCAN ID 10, (Decimal 10 = Hex0xA)) by default. It is possible to change the TPDO that is used for the transmission.

### Fault handling in the system

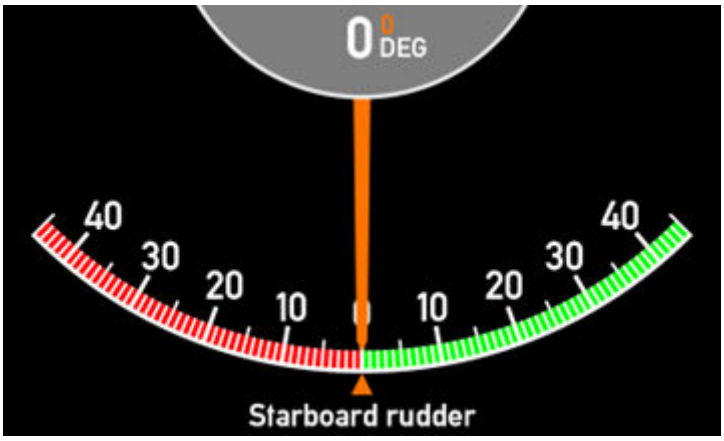
In all rudder indicator systems, there is a fault scenario that makes the entire system fail.

For example, if the angle transmitter fails or the cable from the transmitter is damaged, then the entire system fails. In this system one XDi is acting like a CAN converter between the sensor and the traditional indicators, so if this indicator fails all the traditional indicators are without a signal.

If this happens it is possible for a skilled person on-board to disconnect the faulty XDi unit from the system and then change the Output setup on any other XDi in the system to take over transmitting the TPDO with actual rudder angle data. Follow the above procedure to activate the TPDO on CAN1.

### Commanded rudder presentation on XDi

All the standard XDi rudder indicators have a small triangle pointer and an orange digital readout showing the commanded rudder angle.




**More information**
See **Commanded rudder presentation** on XDi in System application 3 for details about using this function and how to disable it.

### XL, BRW, or BW144/192 configuration

The traditional indicators (XL, BRW, or BW144/192) used in this rudder system, must be ordered with single CAN input (sCAN). XL sCAN is a listen only device on the CAN bus.

The XL type indicators in the example system have the following configuration:

| Configuration | |
|---|---|
| Input | Single CAN |
| Source NodeID | 10 (Data is sent from XDi in CAN TPDO1 with COB-ID: 0x18A) |
| Application type | General |
| Input type | Absolute (16-bit signed, rudder angle value x 10 (Resolution 0.1)) |
| Input minimum | -450 (equal to -45.0 ° PS, this must match the minimum scale value) |
| Input centre | 0 |
| Input maximum | +450 (equal to +45.0 ° SB, this must match the max. scale value) |

**More information**
See **XL, BRW, or BW144/192 configuration** in System application 3 for more information about the traditional indicator configuration.

### TRI-2 CAN configuration

TRI-2 is available in a special CAN version, TRI-2 CAN.

Order number: 2951460020 variant 02.

The TRI-2 CAN in the system application example has the following configuration:

| Configuration | |
|---|---|
| Input type | Single CAN from XDi as transmitter |
| Source NodeID | 10 (CAN data is sourced in CAN TPDO1 with COB-ID 0x18A) |
| Select standard scale | ±45 red/green |

**More information**
See **TRI-2 CAN configuration** in System application 3 for more information about the traditional indicator configuration.

### Installation and calibration of the rudder system

The system can be calibrated after it is installed on board and the XDi indicators are set up according to the previous chapters.

### Calibration procedure

To calibrate the entire system, calibrate one XDi and synchronise the calibration date with the rest of the system. All the traditional indicators are setup and calibrated from factory to show the actual rudder angle, and require no further calibration.

**More information**
See the example in CAN system 4.1 for more information about how to calibrate the rudder system. The calibration procedure of this system application is the same as the calibration procedure for system application 4.1.

## 3.5 System application 5: 3-wire rudder indicator system (not MED)

XDi Dual with DEIF standard rudder library number 031 (library owner 1) contains an indicator setup profile specifically for 3-wire rudder system applications. For XDi 144 and XDi 192 D, it is VS09.

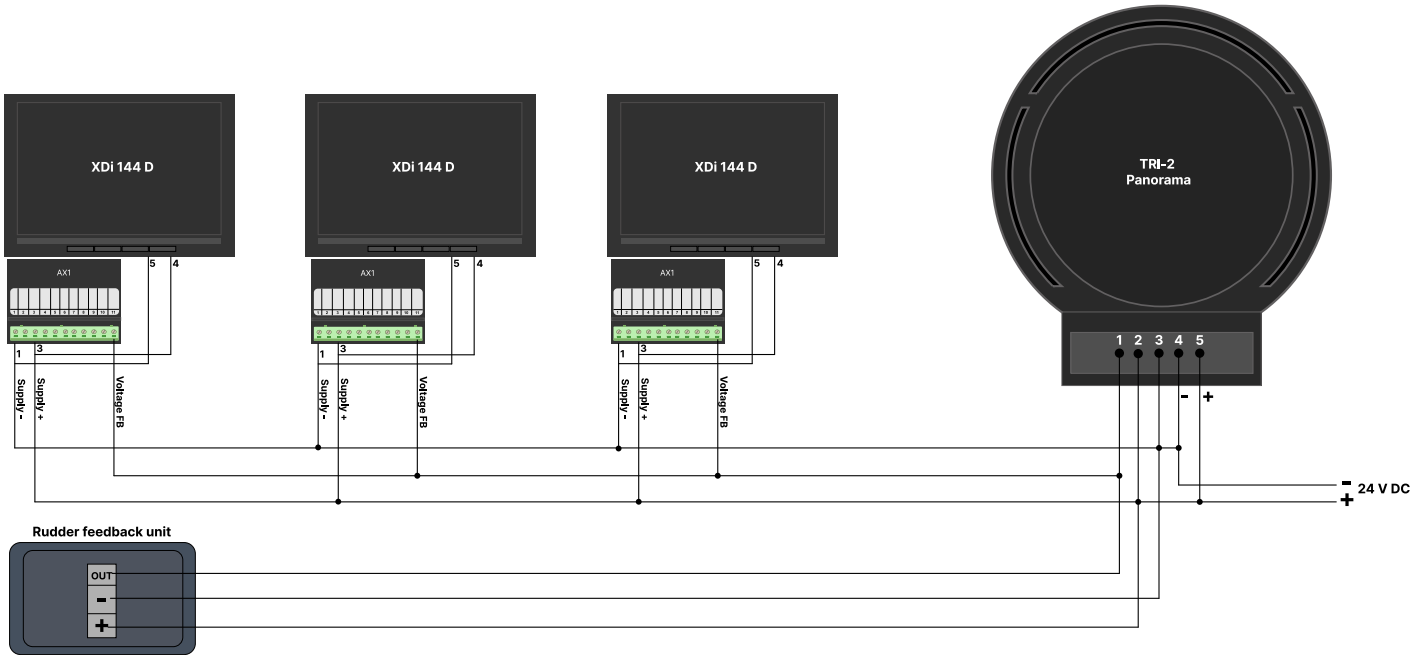
Due to the flexibility of the XDi this solution is attractive for retrofit and service projects.

**NOTICE**

**No 3-wire feedback unit in MED certificate**

DEIF does not have a 3-wire feedback unit and therefore this solution is not included on the MED certificate.

## 3.5.1 Analogue 3-wire system




For outdoor installations, using a BRW-2 with a white scale is recommended. The BRW-2 is available with a 3-wire input.

### XDi 144 D unit

The power supply input is on terminal 4 (+24 V) and terminal 5 (0 V). The typical current consumption at 24 V and 100 % backlight is 160 mA, with an absolute maximum of 200 mA.

### AX1 module

| Terminal | Notes |
|---|---|
| 1 | Analogue ground. |
| 3 | $V_{ref}$ output that in this system is overwritten by the 24 V supply voltage. ($V_{ref}$ is approximately 7.3 V DC. This means that the external voltage must be more than 7.3 V and maximum 30 V). |
| 11 | + high voltage input 1 (maximum ±30 V DC). |

### XDi 144 D setup

For a 45 ° rudder indicator (FWD type) select VI03 and VS09 (3-wire input profile).

### Calibration of the rudder input

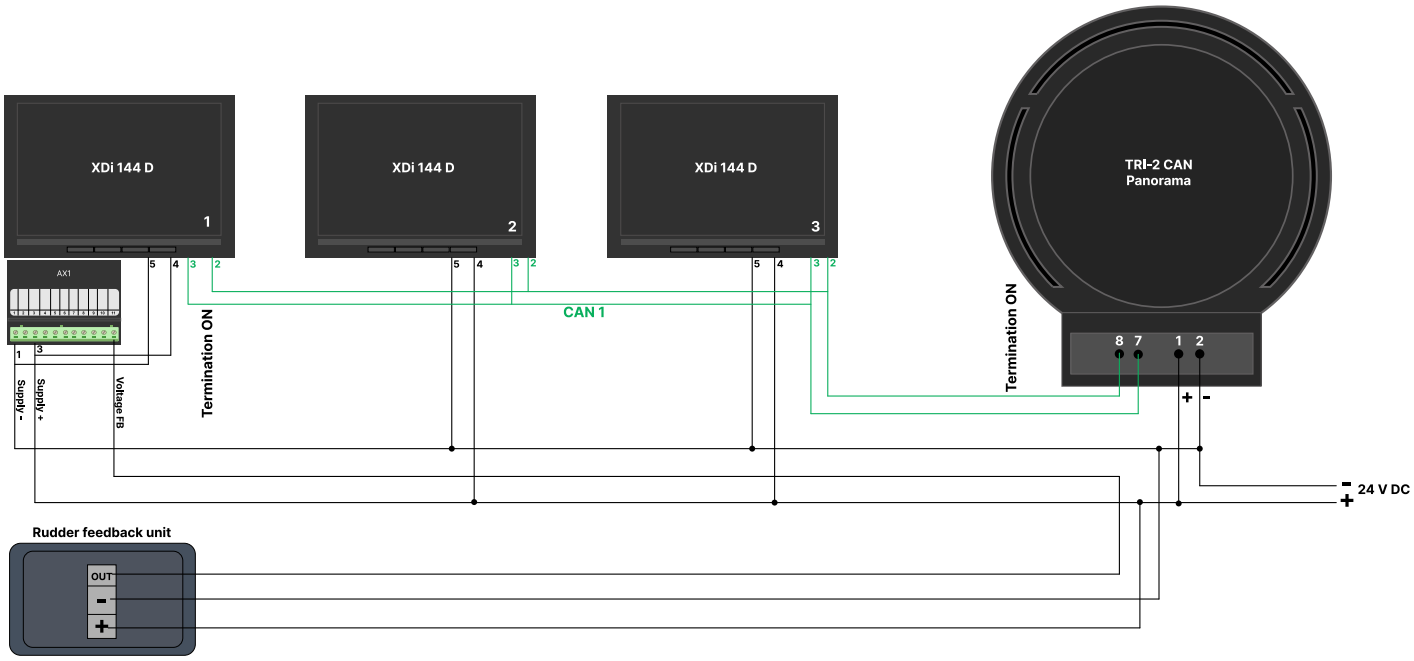
The selected VS profile is set up to match a system with a 24 V supply and ±9 V voltage range centered at half the supply voltage. In this system it may be necessary to calibrate each indicator separately to get an accurate zero, minimum and maximum rudder angle setting. This is done with the XDi installation menu.

Due to the high accuracy of the inputs on the AX1 analogue extension module, the calibration parameters can be used to calibrate the remaining units. Calibrate the first XDi to match the rudder angle in three positions. Then use the same calibration parameters for the remaining XDi indicators in the system.

**More information**
See Calibrating the rudder input via XDi menu in a 3-wire system for more information about the calibration process.

### 3.5.2 CAN and analogue 3-wire input

The configuration in this example uses CAN bus and the XDi-net Plug and Play protocol to reduce the system calibration effort. A TRI-2 CAN is added to the system for this example. Alternatively, replace the TRI-2 CAN with an XL, BW or BRW-2 with sCAN.




Remember to terminate the bus in both ends with a 120 Ω resistor when using CAN bus. The built-in termination resistor can be activated by a switch located between the Power/CAN connectors.

If the TRI-2 CAN is connected as the last unit on the bus, the internal termination on CAN1 must be activated.

#### TRI-2 configuration

TRI-2 CAN with the input type *Single CAN from XDi as transmitter* with CAN ID 10.

The CAN input is pre-configured to the selected scale angle. This means that no other setup or calibration is required.

#### XDi 144 D setup

XDi Dual with DEIF standard rudder library number 31 (owner 1).

After the unit is installed a setup wizard starts when the unit is powered up. Follow the steps in the wizard to finish the setup and calibration.

**More information**
See Appendix 1 for how to set up the XDi.

For a 45° rudder indicator (FWD type):

- Select VI03 and VS09 (3-wire input profile) for XDi 1.
- Select VI03 and VS01 (XDi-net) for XDi 2.

**Calibration of the rudder input**

The selected VS09 profile is setup to match a system with 24 V supply and ±9 V voltage range centered at half the supply voltage. Only XDi 1 needs to be calibrated to the accurate zero and minimum and maximum rudder angle setting in this system.

**More information**
See Calibrating the rudder input via XDi menu in a 3-wire system for more information about the calibration process.

The XDi 2, XDi 3, and TRI-2 CAN automatically receive the angle data via XDi-net. No additional setup is required. You can add up to 50 indicators on the CAN bus.

| NOTICE |
| --- |
| **Calibration process failure**<br>If previous calibration attempts were unsuccessful, a master reset of the unit can be made to start a new calibration process. |

### 3.5.3 Disabling the commanded rudder presentation

If you do not want to use the commanded rudder indication, it can be disabled.

**More information**
See Appendix 5 for how to disable the commanded rudder indication.

### 3.5.4 XDi dimming

The dimmer signals are not shown on the system application diagram.

The XDi can be dimmed using the following methods:

- Using the front buttons
  - Select PP01 and order XDi with the front button option.
- Using external buttons
  - Requires an NX1 input.
- Using an analogue dimmer potentiometer
  - Select PP02 for dimmer group 1 control via CAN or PP05 for local dimmer.
  - The potentiometer can be connected to terminal 1 (AGND), 2 (Wiper), and 3 ($V_{ref}$) (in this case 24 V from the 3-wire supply).

**More information**
See Appendix 3 for more information on external dimming.

### 3.5.5 XDi first-time setup

When the XDi is new and has not yet been set up for the first time it will automatically start a setup wizard. You will have to complete the four basic selections on each indicator to make it enter normal operation.

**More information**
See Appendix 1 for how to set up the XDi.

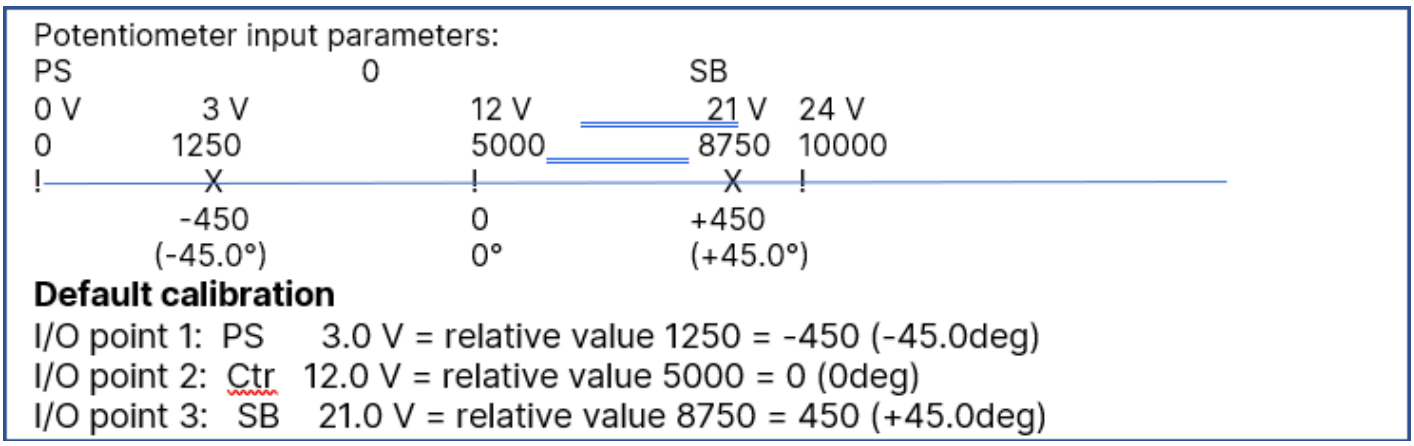
### 3.5.6 Calibrating the rudder input via XDi menu in a 3-wire system

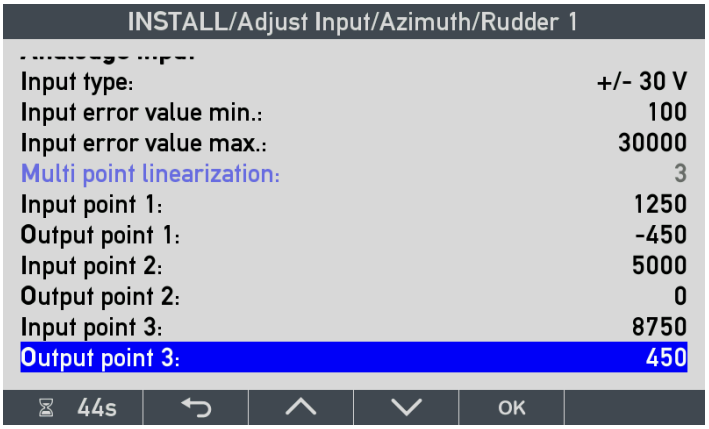
The following description is for an analogue input calibration in a 3-wire configuration where $V_{ref}$ is overwritten by 24 V DC. The default input range is ±9 V centered at half the supply voltage (12 V). The input voltage ranges between 3 and 21 V.

#### Calibration of the rudder input

When potentiometer input mode (3-wire) is used, the input signal on $+HV_{in}$ is scaled to a relative value between 0 and the measured $V_{ref}$. The relative input value ranges from 0 (in=0 V) to 10000 (in = 24 V).

Default 3-point rudder input calibration for a 45 ° indicator:



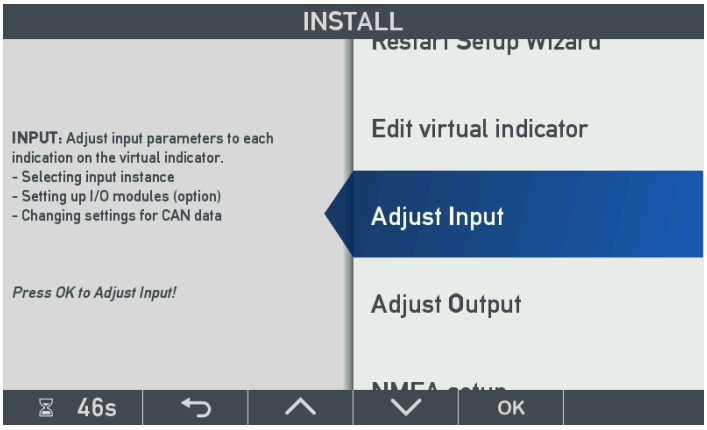



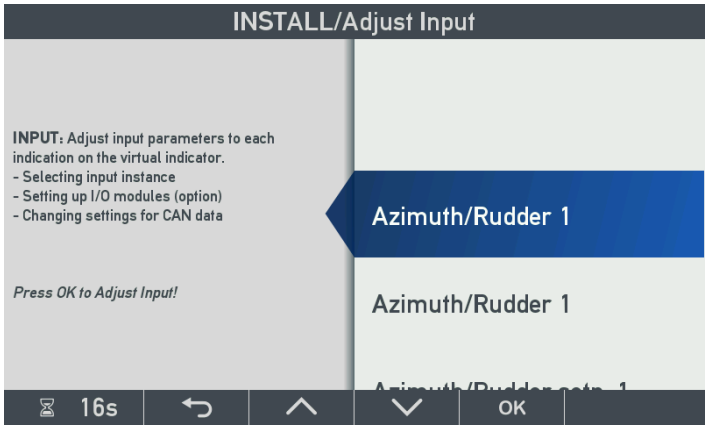

The input error band is set up to a minimum voltage of 100 mV and a maximum of 30,000 mV. For values outside this range an AX1 input error warning appears.

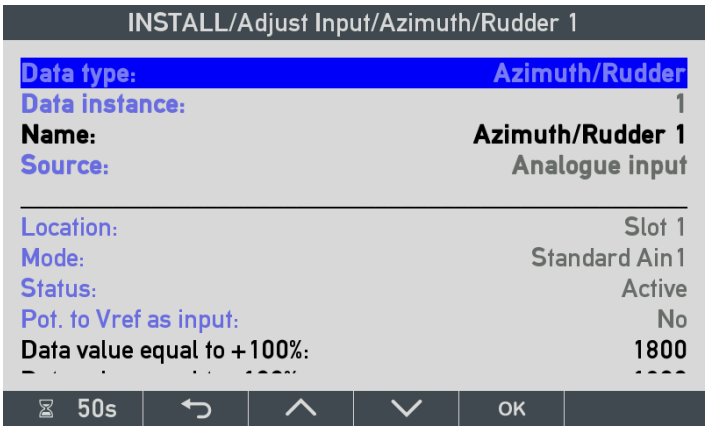
#### Enter the installation menu

Press button 1 and 4 at the same time for 5 seconds to open the User menu.

Press button 2 and 3 at the same time for 5 seconds to open the Installation menu.



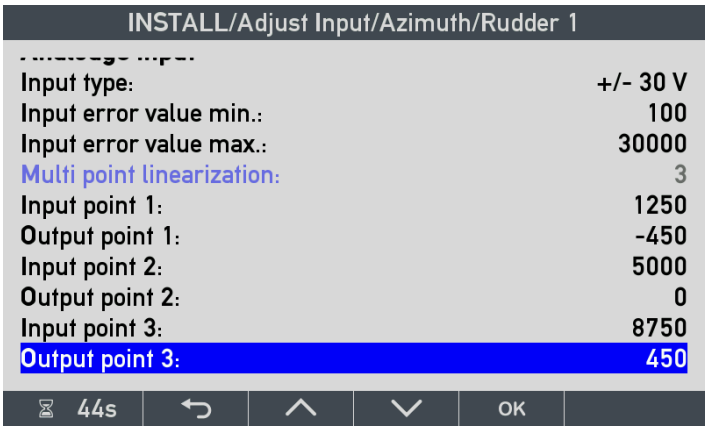

Make the above selections to enter the Azimuth/Rudder input adjust menu.

### Calibrating procedure

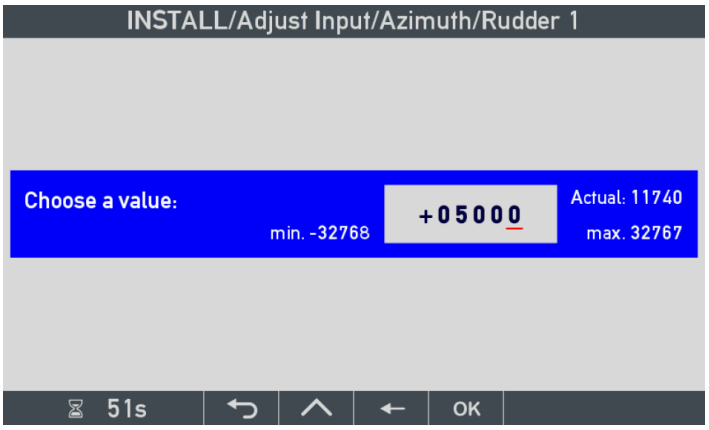
### Step 1: Adjust rudder centre (zero set)

Position the rudder physically in the centre position (0 °) and see if the rudder indication is also showing 0 ° on the XDi.

If the rudder indication is not correct change the Input point 2 value.




Highlight *Input point 2* and press *OK*.



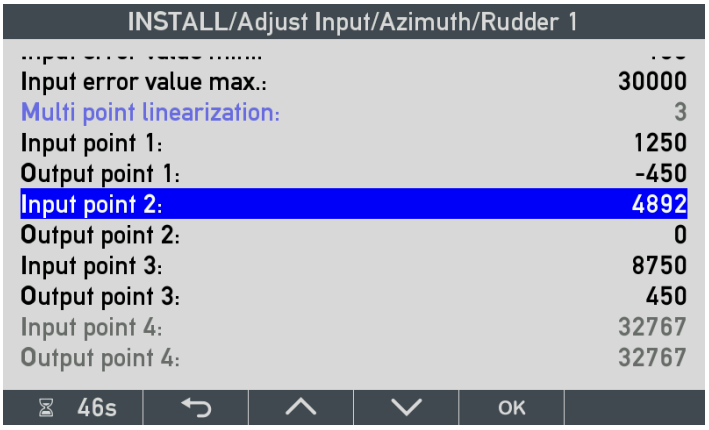

After a few seconds the actual input voltage value is shown in mV in the corner, reading 11740 mV.

This means that when the sensor is in the centre position the voltage is not 12.0 V, but 11.740 V. Change the input value, but remember it is a relative value where measured $V_{ref}$ = 10000.

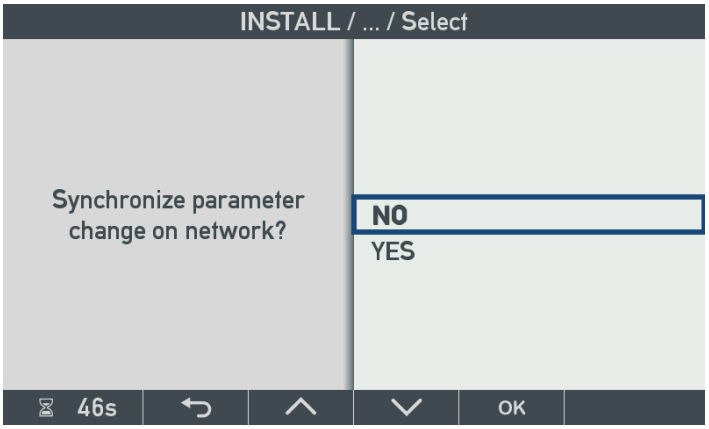
The voltage between AGND and $V_{ref}$ can be measured with a digital voltmeter to see the actual $V_{ref}$ value. Alternatively, disconnect the sensor wire from +HV input 1 (terminal 11) and connect terminal 11 shortly to terminal 3. After a short period, the actual $V_{ref}$ value is shown as a new *Actual* value on the display.

Calculate the new relative value to enter into *Input point 2* to scale the zero point.

For this example the new value is: 11740 mV x 10000/24000 mV = 4891.6666. Enter 4892 in the above menu and press *OK*.




Now the zero point is adjusted. Exit the menu by pushing the back button several times.




When you get this question select *NO* or just push the back button again.

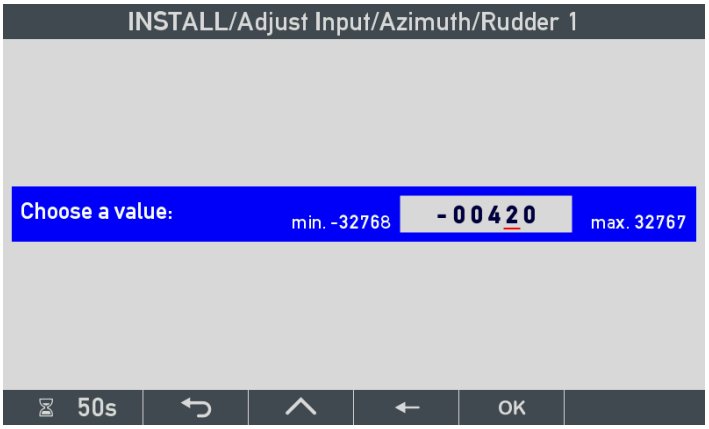
### Step 2: Adjust portside angle (minimum set)

Turn the rudder to the maximum portside position, and read the physical angle.

Position the rudder at 45.0 °, or select a value close to the maximum PS position. In this example 42.0 ° is used.

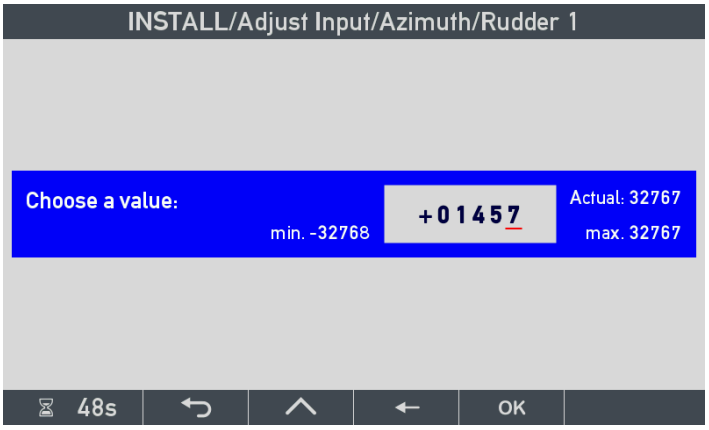
Adjust I/O pair 1:

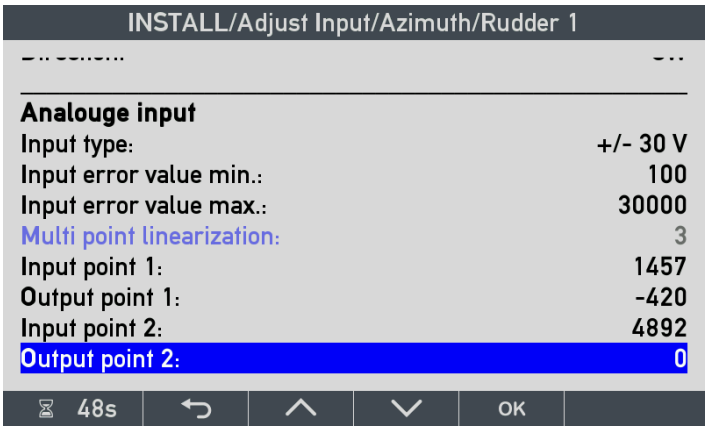
Set the value of Output point 1 to the selected PS position. For 42.0 ° PS the value is -420 (- =PS).




Highlight *Input point 1* and press *OK*. Read the voltage value for the selected PS position.

The actual voltage is 3498 mV at 42.0 ° for this example. The new relative value is: 3498 mV x 10000 / 24000 mV = 1457. Set the new relative value for *Input point 1*.






Press the back button several times to exit the menu.

### Step 3: Adjust starboard angle (maximum set)

Repeat the procedure in Step 2 to set *Input point 3* for the maximum starboard angle (+ = SB).

# 4. Appendix 1: XDi setup wizard

## 4.1 XDi setup during installation

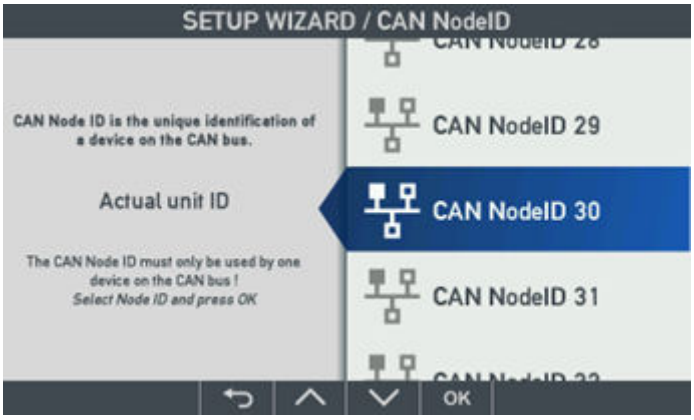
When the XDi is powered up for the first time, it automatically starts the setup wizard. This wizard will guide you through the setup process.

The library owner number, type, number and version are shown in the second line.

The library used in this example is the DEIF standard rudder indicator library no. 031.

Press *OK* to continue.

### 4.1.1 Select CAN node ID




If the CAN bus/XDi-net is not used in your installation, press *OK* on the default CAN NodeID to continue.

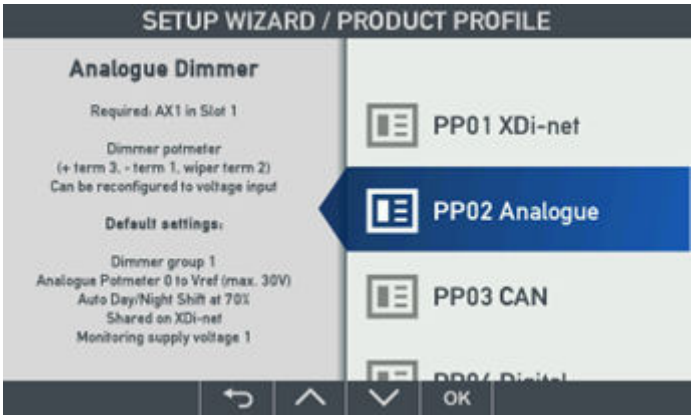
In a system with multiple XDi indicators, you can use XDi-net (on CAN) to make a cost-effective, easy installation, plug-and-play system solution. In XDi-net, the CAN NodeIDs are not important as long as they are different for each unit.

Assign the default CAN NodeID = 30 for the first XDi unit. Assign CAN NodeID = 31 to the next XDi and so on.

If the same NodeID is selected for two XDi units on the same CAN bus, the warning *CAN NodeID conflict* is displayed. The CAN port does not function until each unit on the bus has a unique NodeID.

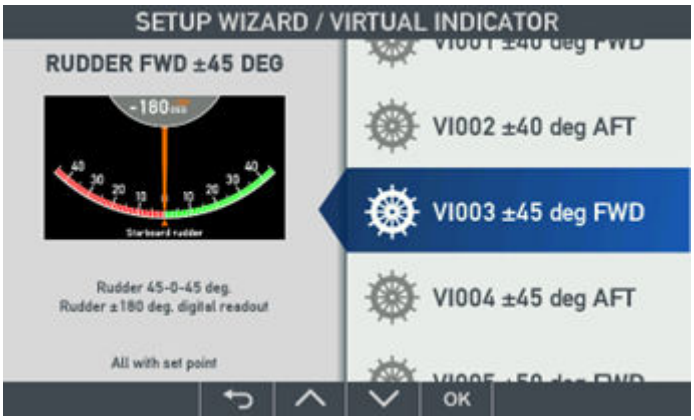
### 4.1.2 Select Product Profile (PP)

The product profile (PP) in an XDi library contains all product and system related parameters. For example, the default CAN bus setup parameters, default dimmer and day/night shift setup parameters.




For each PP in the library, there is a description in the left side of the screen to help you make the right choice. Select the product profile that fits your system and press *OK*.

### 4.1.3 Select virtual indicator (VI)




The next step is to select the rudder angle indicator (VI) that fits your system. The short description and thumbnail picture help you select the right one. Select the VI and press *OK*.

### 4.1.4 Select virtual indicator setup (VS)

The VI setup (VS) defines the actual input setup for all pointers and digital readouts for the selected virtual indicator, and the outputs from the indicator to other systems. In the example, the selected virtual indicator VI003 has six VI-setup profiles to choose from.

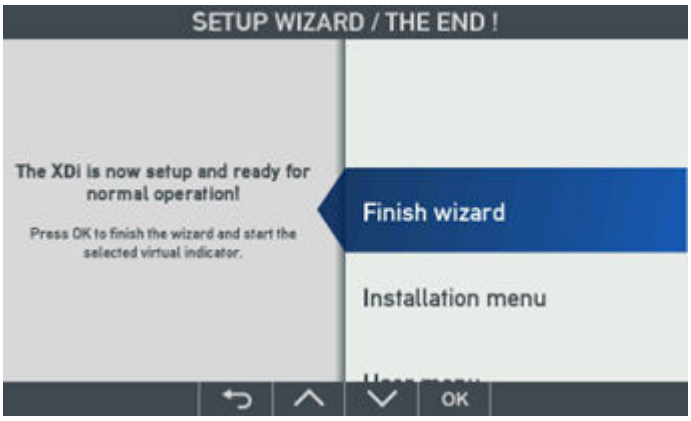
The **VS02** profile is intended for use in a CAN bus system with a CAN angle transmitter connected as data source for rudder angle and another CAN bus parameter containing the commanded rudder value. The commanded rudder indicator can be disabled from menu.

This profile is also prepared for transmission of the actual rudder angle in a TPDO for other systems to use. For example, traditional XL indicators with sCAN input.

Select the VS profile and press *OK*.

### 4.1.5 Finish

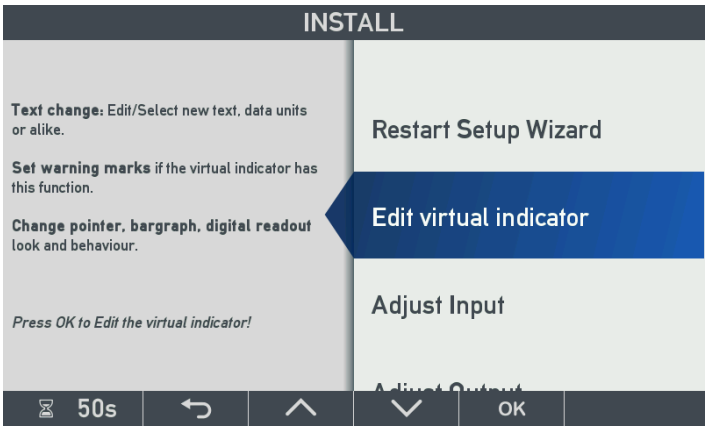
XDi is now set up. Press *OK* to finalise the setup and go to normal operational mode.



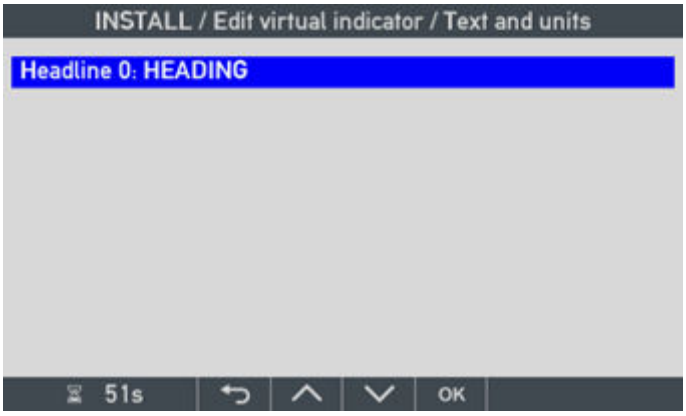

If the system has to be calibrated, the installation menu can be accessed directly. It is common to calibrate one XDi in a system and then share the calibration settings with the remaining XDis. See the application description to determine how to calibrate the XDi system.

## 4.2 Edit the indicator headline

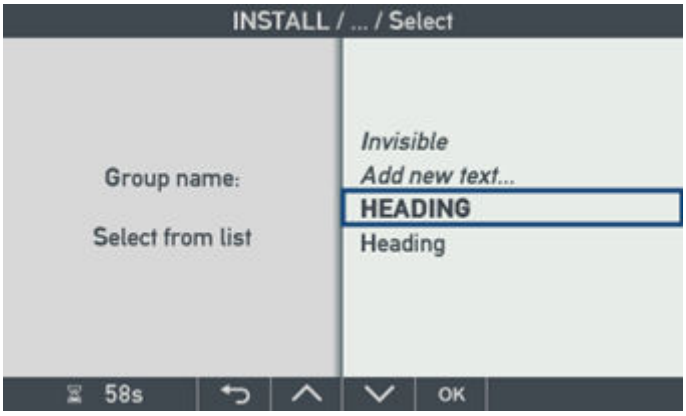
The headline of the indicator can be changed from the XDi installation menu.



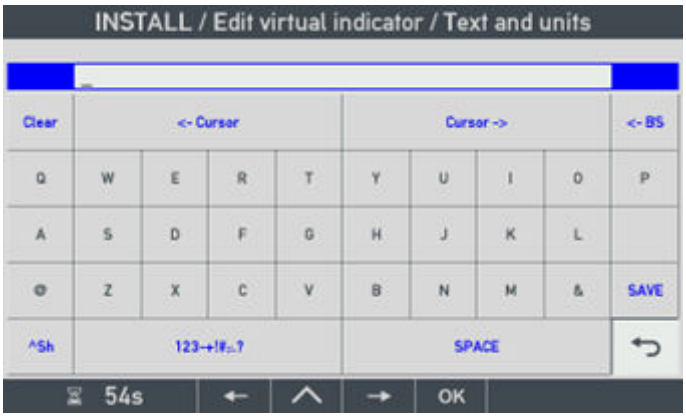

Select *Edit virtual indicator*. Select *Text and units* and then select *Headlines*.




Press *OK* to select new headline text from the list of predefined headlines:



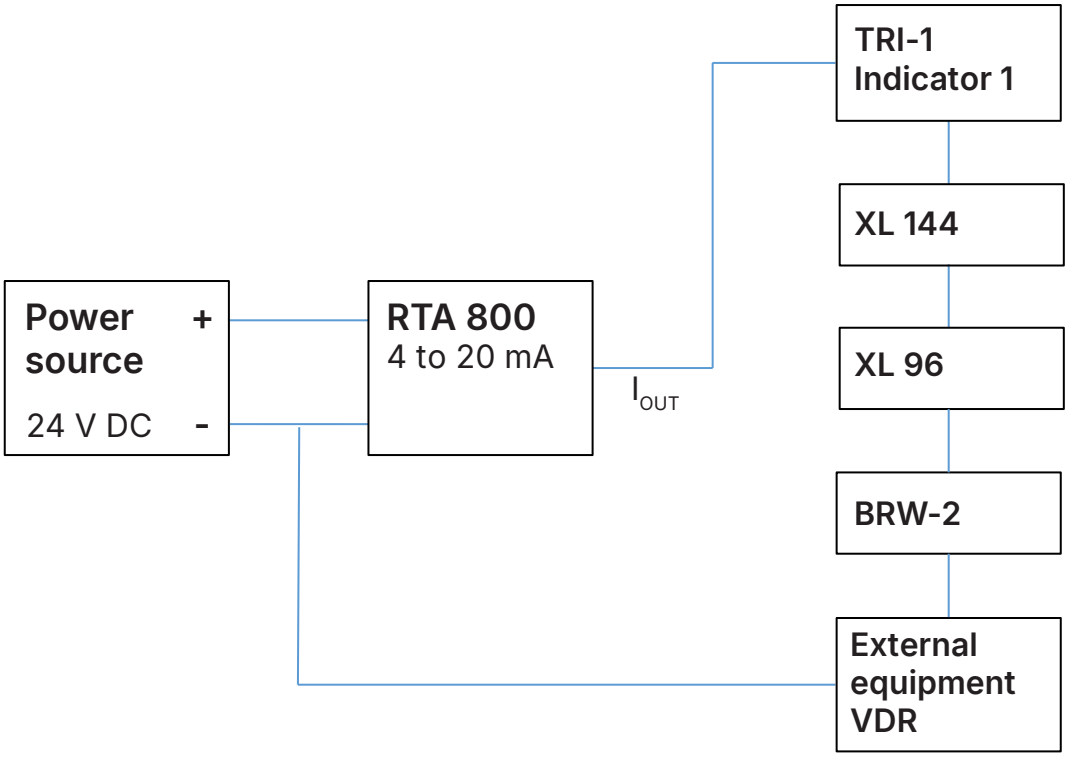

Alternatively, select *Add new text* to enter a new headline using the virtual keyboard. It is also possible to make the headline invisible.


INSTALL / Edit virtual indicator / Text and units
Clear
<- Cursor
Cursor ->
<- BS
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M &
SAVE
^Sh
123-+!#.?
SPACE
54s
OK

# 5. Appendix 2: Angle transmitter load calculations

Load calculations are made to ensure the system has a reasonable safety margin to be able to function under all conditions.

## 5.1 4 to 20 mA current loop system




The RTA 800 allows a maximum load of 500 Ω, so the total loop resistance must stay below this limit. The load resistance of each individual unit in the example system is shown in the table below.

| Connected unit | Load resistance |
|---|---|
| Indicator 1, TRI-2 | 150 Ω |
| Indicator 2, XL144 | 50 Ω |
| Indicator 3, XL96 | 50 Ω |
| Indicator 4, BRW-2 | 50 Ω |
| Equipment 1, VDR | 50 Ω |
| All cables in this example 35 Ω | 35 Ω |
| Total consumption/resistance | 385 Ω |
| Maximum available voltage/resistance | 500 Ω |

If the system changes, check the load resistance. Do this whenever indicators are added or replaced.

## 5.2 Load current calculation in a voltage driven system

In a voltage driven system all indicators and other equipment are parallel coupled to the output of the sensor system. The voltage output must be able to deliver a current which is higher than the current running through each connected indicator or other device.

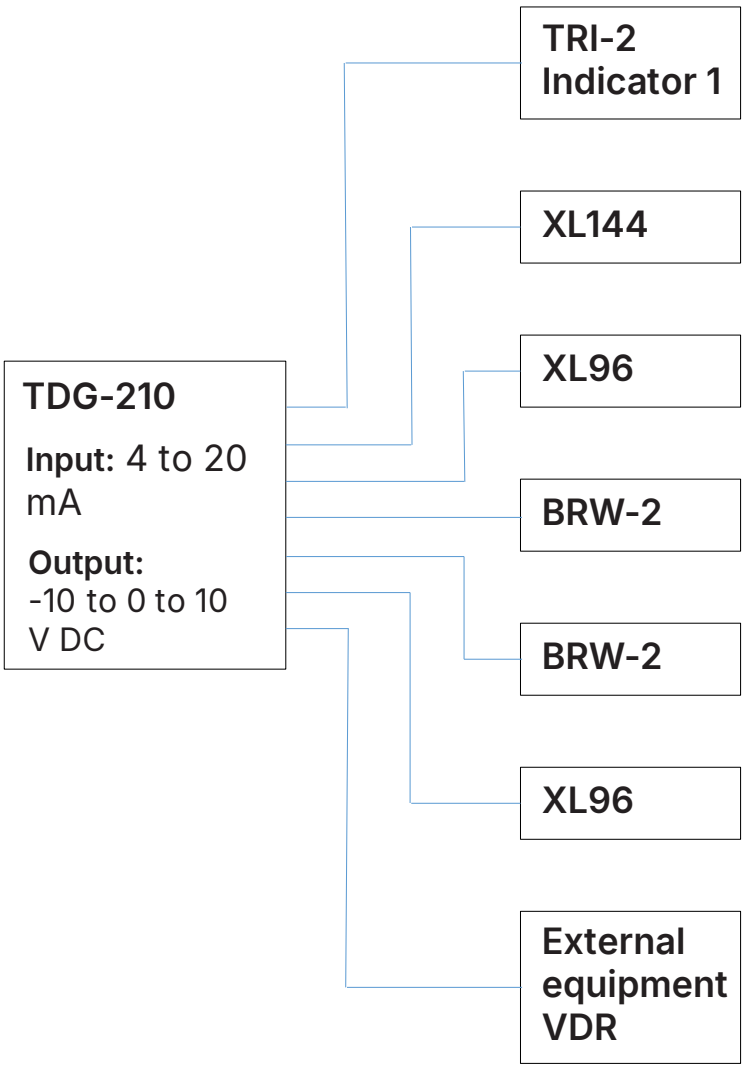
In this system the RTA 800 sensor is connected to a TDG-210 insulated amplifier that can convert the 4 to 20 mA input signal from the RTA sensor to a voltage signal.

The TDG output can output a maximum of 20 mA (source or sink). This output current limits the number of indicators that can be connected in parallel without overloading the output.

**Example**

A calculation example for a ±10 V indicator system is shown below.

The impact of the signal cable resistance is considered to be insignificant and is not included in the calculation.




### 5.2.1 Current calculation

For the above system, the total load of the TDG output is calculated by adding the current consumption at maximum voltage for each indicator (see the table below).

The maximum load occurs at the maximum positive and negative output voltage from the TDG.

| Connected unit | Current at -10 V | Current at 10 V | Load resistance |
|---|---|---|---|
| Indicator 1, TRI-2 | -0.7 mA | 0.7 mA | 14 kΩ |
| Indicator 2, XL144 | -1.0 mA | 1.0 mA | 10 kΩ |
| Indicator 3, XL96 | -1.0 mA | 1.0 mA | 10 kΩ |

| Connected unit | Current at -10 V | Current at 10 V | Load resistance |
|---|---|---|---|
| Indicator 4, BRW-2 | -1.0 mA | 1.0 mA | 10 kΩ |
| Indicator 5, BRW-2 | -1.0 mA | 1.0 mA | 10 kΩ |
| Indicator 6, XL96 | -1.0 mA | 1.0 mA | 10 kΩ |
| Equipment 1, VDR | -1.0 mA | 1.0 mA | 10 kΩ |
| | | | |
| Total consumption | -6.7 mA | 6.7 mA | |
| Available current from TDG-210DG | -20 mA | 20 mA | |
| | | | |
| Safety margin | -13.3 mA | 13.3 mA | |

The load resistance is listed in the Data sheet for the respective indicator or connected device.

In some cases, the load is specified in kΩ/V. For example, a 1 kΩ/V indicator with a 10 V input has an input resistance of 10 kΩ.

If the system changes, recheck the current consumption. Do this whenever indicators are added or replaced.

# 6. Appendix 3: External dimming

XDi offers a number of different ways to control the dimmer level and day/night colour shift.

Dimmer data from external inputs are shared on XDi-net (CAN).

See the detailed description of the available Product Profiles (PP) with different default dimmer configurations in the library description document:

- XDi144_192_D_000001_031_rxxx_v2xxx.pdf
- Di96_D_000001_031_rxxx_v2xxx.pdf

The latest version can be downloaded from DEIF FTP server.

**More information**
See XDi-Standard virtual indicator library for how to access the FTP.

## 6.1 Dimming from external buttons

Connect a push button to a contact input and the common input on the NX1 module and set them up to work similarly to front buttons 2 and 3. This is done in the installation menu: *NMEA setup...\NXbutton setup...*.

The external buttons dim the display in the same way as the two buttons on the front of the XDi. This function works with any Product Profile setup for dimming via front buttons.

The dimming buttons on the front of the XDi still work, and the dimmer setting for the active dimmer group is shared on XDi-net.

Only XDi 144 and XDi 192 have two extension slots allowing for installation of both AX1 and NX2 extension modules at the same time.

XDi 96 can have an AX1 module installed when it is receiving data via XDi-net. In this case, it can control other XDi 96 indicators in the same dimmer group via XDi-net.

## 6.2 Dimming from external potentiometer (AX1)

In the standard library, product profile PP02 supports dimming from a connected potentiometer. This requires an AX1 analogue extension module mounted on slot 1 on the XDi.

The dimmer potentiometer must be connected to the AX1 module like this:

| AX1 terminal | AX1 name | Potentiometer |
|---|---|---|
| 1 | AGND | Left (minimum) |
| 2 | HV3+/DIMM | Wiper |
| 3 | REF* | Right (maximum) |

**NOTE** * The REF terminal is a reference voltage output (+7.5 V DC). An external voltage more than +7.5 V can be connected between REF (3) and AGND (1) to overwrite the reference voltage. The dimmer level scales relative to the new, higher reference voltage.

The analogue dimmer value is shared via XDi-net to all XDi units in dimmer group 1 (default). The dimmer group can be changed to any group between 1 and 9.

**NOTICE**

**Front button dimmer disabled when using AX1**

The front button dimmer does not work when the AX1 module is controlling the dimmer level.

## 6.3 Dimming from analogue voltage input (AX1)

The product profile PP04, mentioned above, can be reconfigured from the user menu to act as a normal voltage input (range 0 to 30 V). The minimum and maximum dimmer input voltages must be set up to scale to 0 % and 100 % of the dimmer level. The voltage level specified in mV (1 V = 1000 mV).

### 6.3.1 Galvanic separation of analogue rudder angle and dimmer signals

If the measuring system (analogue rudder angle signal) has to be galvanically separated from the dimmer system, install a second AX1 module in Slot 2 of the unit (only XDi 144 or XDi 192). Select PP07 or PP08 to use the dimmer input on this module instead of the dimmer input on the AX1 module in Slot 1.

If all indicators are connected via CAN bus it is possible to run dimming control via the same CAN bus.

Dimming can be divided into dimmer groups and each group can use the front buttons of the unit or an analogue dimmer input as described above.

XDi shares dimmer data via CAN if a product profile (PP) with a dimmer group 1 control is selected. You can change to another group from the XDi user menu (group 1 to 9 is available).

If a PP with local dimmer is selected then dimming is not shared via CAN.

Dimming via CAN from an external system is also possible, but will not be described in this section.

## 6.4 XL dimming

The backlight of the XL series is controlled by LEDs. The backlight is developed to use the LEDs and illuminates the back of the scale. This construction ensures that the backlight is evenly distributed across the scale and provides optimum illumination at night.

The backlight level is controlled by a voltage from 0 to 30 V. A higher voltage creates a brighter backlight.

To use a potentiometer to dim the backlight, connect the dimming input of the XL to the regulated voltage terminal of the potentiometer.

**Dimming connection terminals for an analogue XL**

| Terminal | Function | Name | Notes |
|---|---|---|---|
| 6 | Illumination | Illumination + | Dimmer input. Dimmer range 7 to 30 V DC. Consumption maximum 30 mA. |
| 7 | | GND | |
| 8 | | NC | Not connected. Can be used freely. |

**Dimming connection terminals for a CAN XL**

| Terminal | Function | Name | Notes |
|---|---|---|---|
| 9 | Illumination analogue dimmer | NC | Dimmer input. Dimmer range 7 to 30 V DC. Consumption maximum 30 mA. |
| 10 | | Illumination GND | |
| 11 | | Illumination + | |

## 6.5 BW 144/192, BRW-2 and TRI-2 dimming

BRW, BW and TRI indicator types have a built-in potentiometer for dimming. If another type of dimmer is required, then refer to the respective data sheets for more information.

# 7. Appendix 4: Standard rudder indicators

## 7.1 XDi rudder indicator libraries

The standard indicator rudder library consists of a selection of different rudder angle indicators for both forward and aft pointing bridge applications. The range of indicators expands over time.

During setup, select the indicator and the setup profiles that suits the installation the best.

You can find the latest content of DEIF standard libraries and a detailed description of indicators and setup profiles in the XDi-Standard virtual indicator library.

The standard rudder library has library owner number 00001 and library number 031.

### 7.1.1 XDi standard rudder indicator overview

Download the standard rudder library description (pdf) to get the latest updated overview of all available virtual rudder indicators for the different XDi sizes.

You can find a description of all standard libraries here: https://www.deif.com/xdi-standard-libraries/

## 7.2 XL, BRW-2, BW, or TRI-2 standard rudder indicator scales

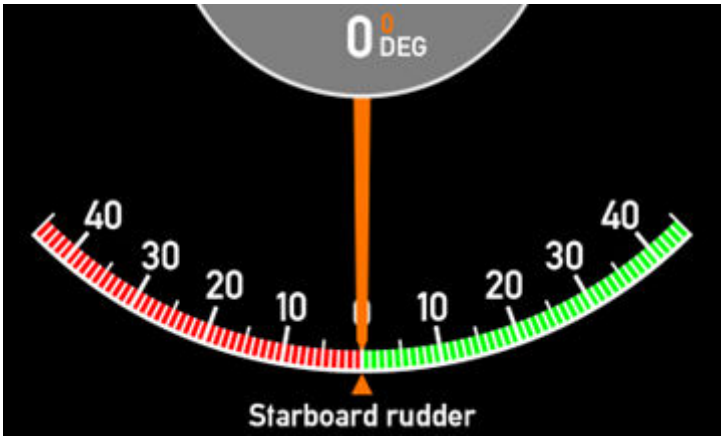
To get an overview of the most used standard rudder scales for XL, BRW-2, BW, and TRI-2, see the Illuminated indicators Standard scale designs.

Contact DEIF if the rudder indicator you want is not shown in this overview. The indicator might be available already or a customised scale can be developed for your application.

# 8. Appendix 5: XDi Disabling commanded rudder

The commanded rudder indicator can be disabled if it is not required.

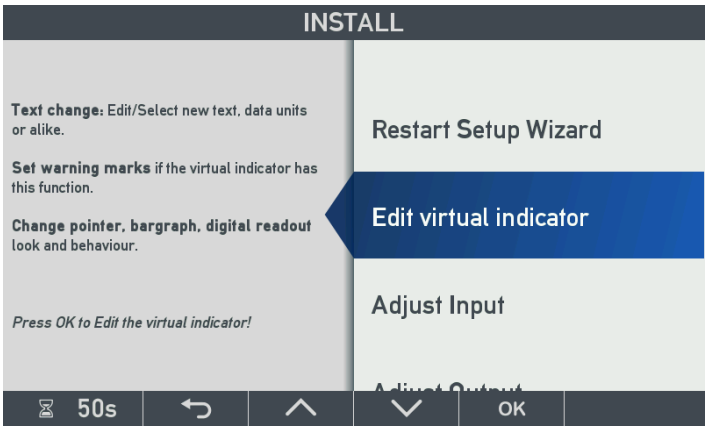
Commanded data is presented with a small orange triangle pointer and an orange digital readout.



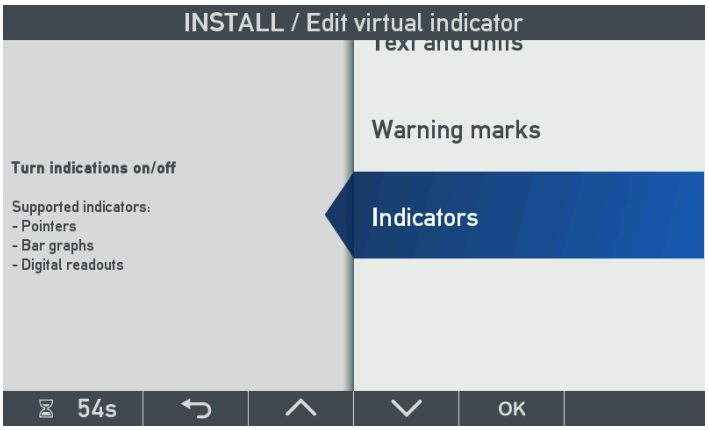

The commanded rudder presentation must be disabled on all XDi indicators where you do not want to use this feature. If it is not disabled on all units, then it is presented as an out of range fixed value, or as data loss if the unit uses a CAN bus data input.

To disable the commanded rudder indicator, enter the installation menu. Press button 1 and 4 for more than 5 seconds and when the user menu is open, press button 2 and 3 for more than 5 seconds. This opens the installation menu.

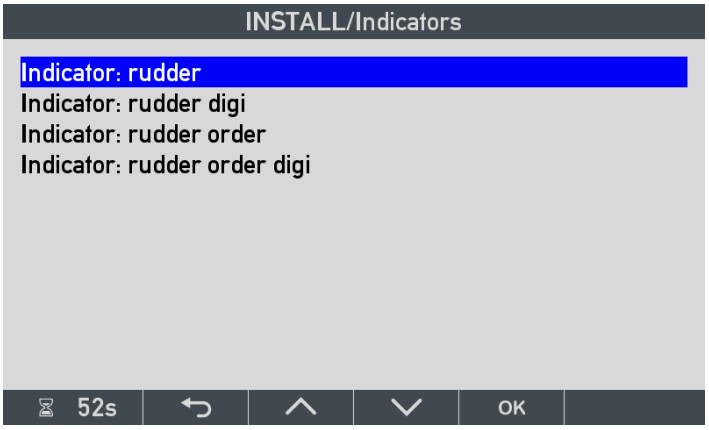
**More information**
The installation menu can be accessed directly in the last step of the setup wizard (see Appendix 1).



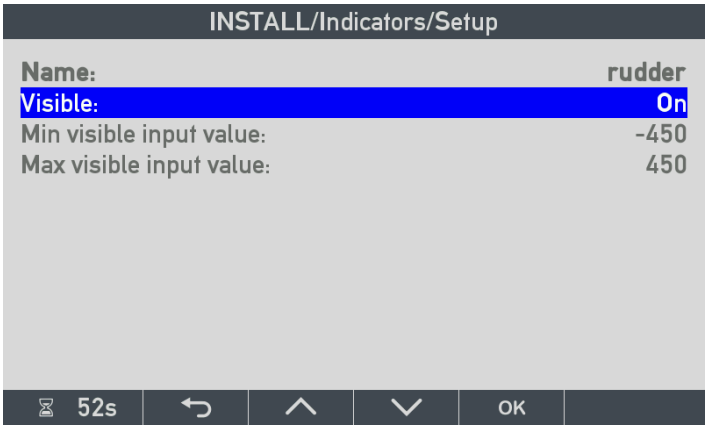

In the Install menu, go to Edit virtual indicator and push *OK*.



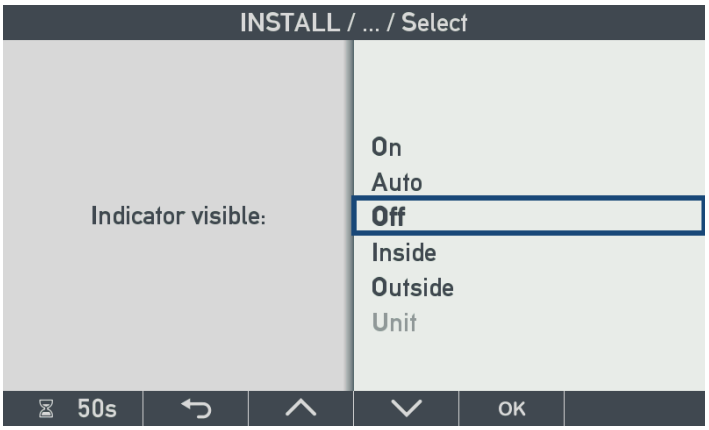

Select *Indicators* and press *OK*.




Select the first instance of *rudder order* and press *OK*.

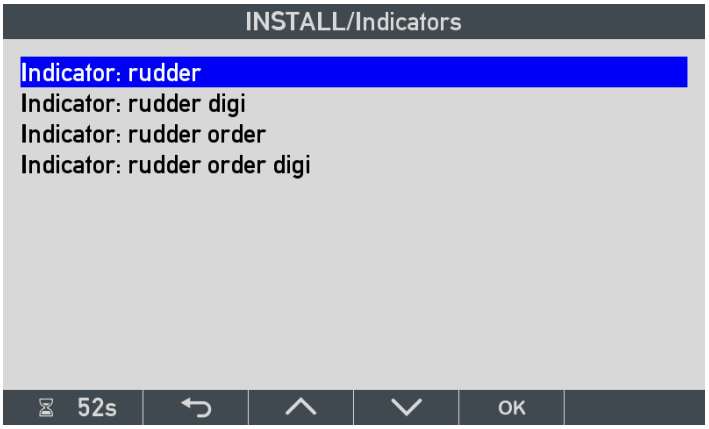



Select *Visible* and press *OK*.




Select *Off* and press *OK*.

Use the back button a few times to reach this menu again:




Follow the same procedure to disable *rudder order digi* (the orange digital readout).

Now the orange triangle pointer and the small orange digital readout are disabled.

The function has to be disabled on every unit where the commanded rudder angle is not required. The parameter is indicator specific and does not synchronise with other XDis (even if yes to synchronisation is selected when the menu is closed).

# 9. Appendix 6: Installing a CAN bus system

## 9.1 XDi CAN bus ports

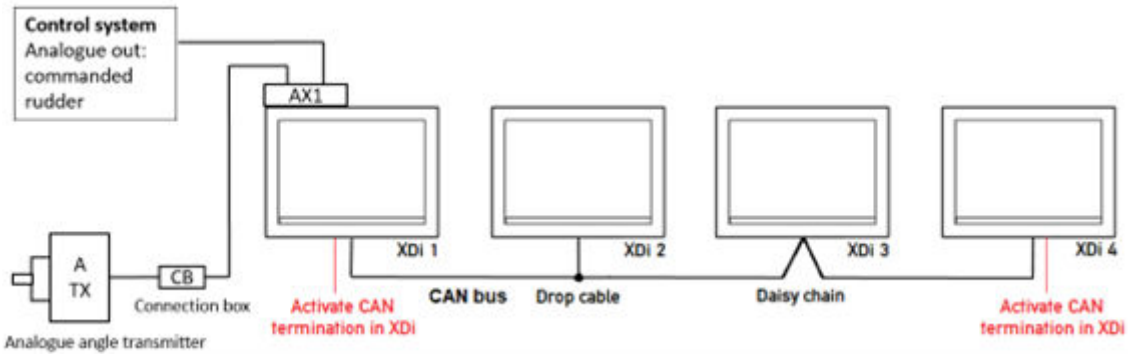
The XDi base unit is equipped with two CAN bus ports, with CANopen as the standard interface protocol. The unique DEIF XDi-net plug-and-play extension to the CANopen protocol is used in all DEIF standard libraries for easy data sharing. The XDi-net extension is also used in many custom specific libraries, to make system setup and integration easy.

This Appendix describes the basic CAN installation procedure. The example uses the DEIF standard rudder indicator system with multiple XDi indicators.

For more detailed information, consult the XDi-net CANopen reference manual.

## 9.2 CAN bus system wiring

The XDi unit can be connected to the CAN bus either by a short drop cable to the backbone or by daisy-chaining the backbone from unit to unit (see drawing).




The standard terminal block, with a single row of 5 screw terminals, is well suited for a drop cable connection. Daisy chaining requires two wires to be mounted in each terminal location.

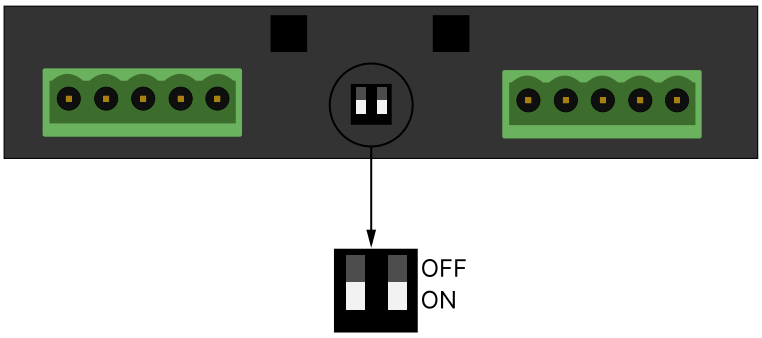
If daisy chaining is the preferred installation form, we recommend that you order the XDi unit with either the double screw terminal option or the double spring terminal option.

**More information**
See the XDi data sheet for ordering information.

## 9.3 CAN backbone and termination

### 9.3.1 Termination

To make termination easy, the XDi has a built-in 120 Ω termination resistor. Set the switch to ON (see drawing) to activate the termination. Each CAN port has a separate built-in termination resistor and ON/OFF switch.




**NOTICE**

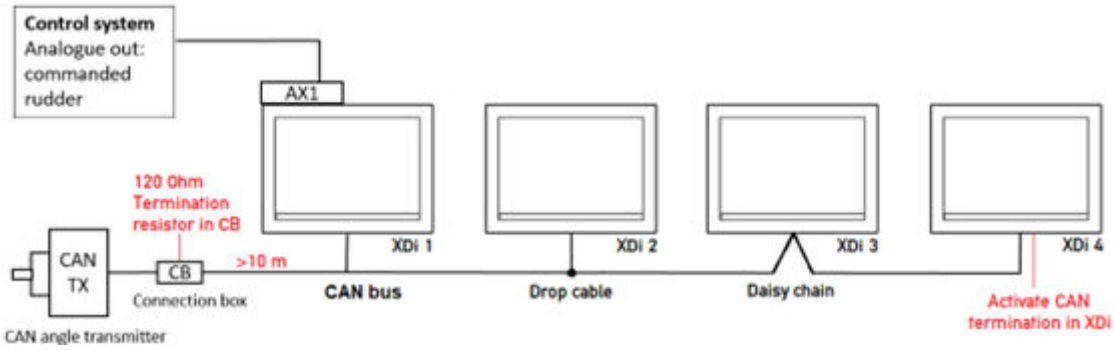
**Do not overload CAN bus drivers**

Only two termination resistors must be connected in a CAN bus network. Using more than two will overload the CAN drivers, interfering with communication and may damage the CAN driver circuit over time.

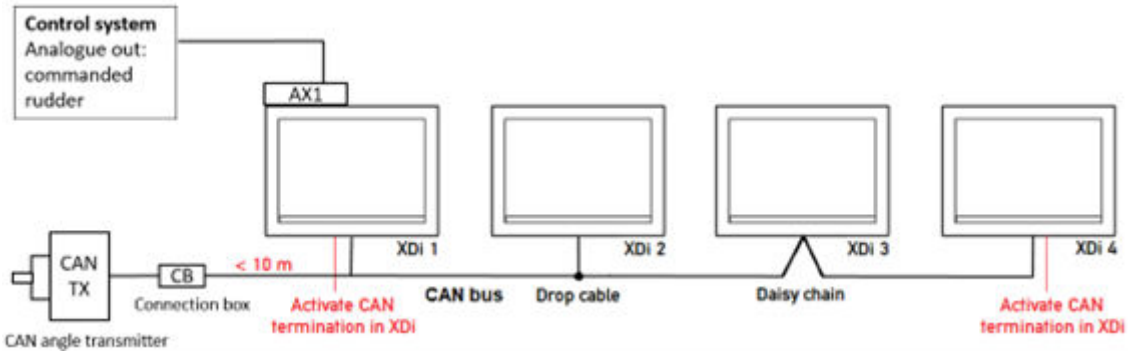
## 9.3.2 Termination example

These examples show two similar systems with two termination possibilities.

If the cable from the CAN angle transmitter exceeds the maximum allowed drop cable length (10 metres at 125 kbps), then a 120 Ω termination resistor must be installed in the connection box. The other termination can be made using the internal termination in XDi 4 (right side).




If the cable from the CAN angle transmitter is less than the maximum allowed drop cable length (10 metres at 125 kbps), then the CAN bus can be terminated using the internal terminations in XDi 1 (left side) and XDi 4 (right side).



### 9.3.3 Backbone and drop-cable

The CAN bus backbone is the CAN bus cable between the two endpoint terminations. Terminations should be inserted so that the most cable length is serially connected between the two terminations. This cable will then be defined as the backbone.

A cable section connected to the backbone in one end and to a product in the other end (without termination), is called a drop-cable. Drop-cables are not part of the backbone, but the length of all drop-cables must be included in the total allowed CAN bus cable length.

### 9.3.4 Specifications of the data wire pair (twisted pair)

| Specifications | |
|---|---|
| Gauge | Not less than AWG20/0.5 mm2 (approx. 33 mΩ/m). Where long supply cables are used, thicker wire is recommended and worst-case calculations of supply voltage drop in the cable must be performed. |
| Characteristic impedance | 120 Ω ±10 % up to at least 500 kHz. |
| Cable loss | The AC signal attenuation must be less than 24 dB/100 m up to 16 MHz. |
| Propagation delay | Maximum 5 ns/m. |

Guidelines for selecting CAN bus cable can also be found in ISO 11898-2.

If also using a redundant CAN bus, the two CAN bus cables should be routed separately and at a safe distance from each other to reduce the risk of a single event damaging both CAN bus cables.

## 9.4 Shielding and grounding of the CAN bus cables

### 9.4.1 Cable shield

Where CAN cables are connected, the cable shield must be interconnected. The cable shield must not be connected to the CAN GND terminal on the XDi. CAN GND is a common terminal that must only be used if there is an extra “common mode wire” included in the CAN cable (that is the twisted pair for data + one common wire). This extra wire reduces common mode voltage between CAN devices on the bus, but it is only rarely used in marine applications.

### 9.4.2 Grounding of the CAN bus cable

It is recommended to connect the shield, of the total CAN bus network, to the ship’s ground in one single location.

It is important that the ground connection is free from noise and transients from other devices using the same ground connection. If a good and noiseless ground connection is not available, it is normally better to leave the CAN bus cable shield ungrounded.

**NOTICE**

**Avoid electrical noise loops**

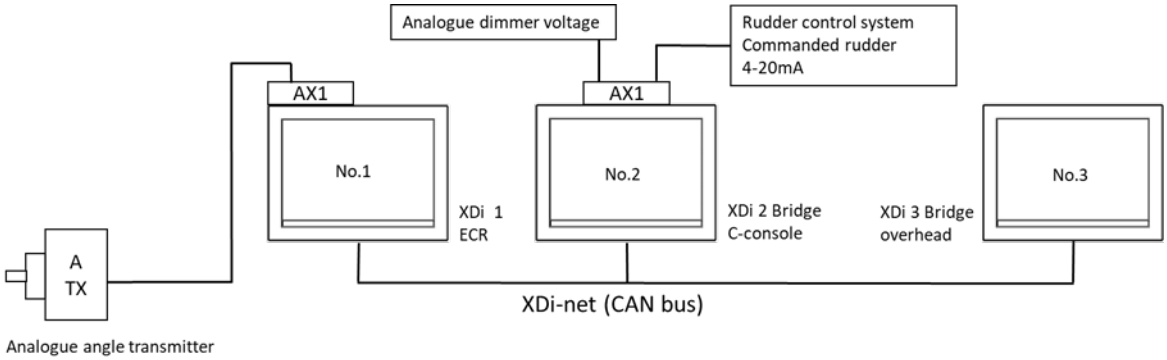
Using multiple ground connections on the CAN bus cable can create electrical noise loops that disturb the CAN bus communication.

## 9.5 Special analogue to CAN configuration

The analogue signals for commanded and actual rudder angle do not need to be connected to the same XDi.

In this example the first XDi is located in the engine control room where the analogue rudder transmitter is connected to the AX1 module. This XDi distributes the actual rudder angle via XDi-net to the other two indicators in the system.

The rudder control system is located on the bridge and has a 4 to 20 mA output that is connected to the XDi with AX1 module located in the centre console on the bridge. This unit is distributing the commanded rudder angle to the other two XDi indicators via XDi-net.




All XDi indicators are using the standard indicator library for XDi 144/192D, VI003: ±45 °.

It is important to select the correct VS profile for each indicator in this system.

| XDi | No. 1 | No. 2 | No. 3 |
|---|---|---|---|
| Type | XDi 144D | XDi 192D | XDi 192D |
| VS profile | VS07 | VS08 | VS01 |
| Actual angle input | 4 to 20 mA | XDi-net | XDi-net |
| Commanded angle in | XDi-net | 4 to 20 mA | XDi-net |