

**SIMRAD**

# AP70 MK2

## Installation Manual

ENGLISH



# Preface

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## Disclaimer

As Navico is continuously improving this product, we retain the right to make changes to the product at any time which may not be reflected in this version of the manual. Please contact your nearest distributor if you require any further assistance.

It is the owner's sole responsibility to install and use the equipment in a manner that will not cause accidents, personal injury or property damage. The user of this product is solely responsible for observing safe boating practices.

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## Governing Language

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## Compliance

Navico declare under our sole responsibility that the product conforms with the requirements of:

- C - Tick
- CE under EMC Directive 2014/30/EU
- the European Council Directive 2014/90/EU on Marine Equipment modified by Commission Implementing Regulation (EU) 2018/773 (MED) - Wheelmark

→ **Note:** The AP70 MK2 system is Wheelmark approved only when installed according to the relevant AP70 MK2 MED-B certificate.

## About this manual

This manual is a reference guide for installing and commissioning the Simrad AP70 MK2 Autopilot Systems.

The manual will be continuously updated to match new software releases. The latest available manual version can be downloaded from our websites.

### Intended audience

This manual is written for professional installation and service engineers.

The manual assumes that the reader has basic knowledge about this type of equipment in regards to:

- installation work to be carried out
- nautical terminology and practices

### Important text conventions

Important text that requires special attention from the reader is emphasized as follows:

→ **Note:** Used to draw the reader's attention to a comment or some important information.

**⚠ Warning:** Used when it is necessary to warn personnel that they should proceed carefully to prevent risk of injury and/or damage to equipment/personnel.

### Change log

| Part no       | Date and description |
|---------------|----------------------|
| 988-12374-001 | 2019 January 11      |
|               | First version        |

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# 1

## Introduction

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### Wheelmark approval

The AP70 MK2 systems are produced and tested in accordance with the European Council Directive 2014/90/EU on Marine Equipment modified by Commission Implementing Regulation (EU) 2018/773 (May 2018) (HCS and HSC). This means that these systems comply with the highest level of tests for non-military marine electronic navigation equipment existing today.

While the AP70 MK2 may be installed on vessels not needing to comply with the Marine Equipment Directive, those requiring compliance must have one control unit set-up as a “master unit” in order for the installation to be approved.

Navico has no responsibility for the incorrect installation or use of the autopilots, so it is essential for the person in charge of the installation to be familiar with the relevant requirements as well as with the contents of this manual, which covers correct installation of the autopilot system.

- **Note:** AP70 MK2 systems are not wheelmark approved when used with an AC70 computer. However an AC70 board installed in an AC85 can be used in a Wheelmark approved system.
- **Note:** When a complete system (e.g. an autopilot system) is wheelmark approved, only the main unit(s) in the system identifies the wheelmark approval. This to avoid the misunderstanding that all optional units in a system retain their wheelmark approval even if they are installed in a not approved system. The type examination certificate (MED-B) for the wheelmarked system lists all optional equipment that is part of the wheelmark approval. The EC Declaration of Conformity will also show which units that are part of the approval.

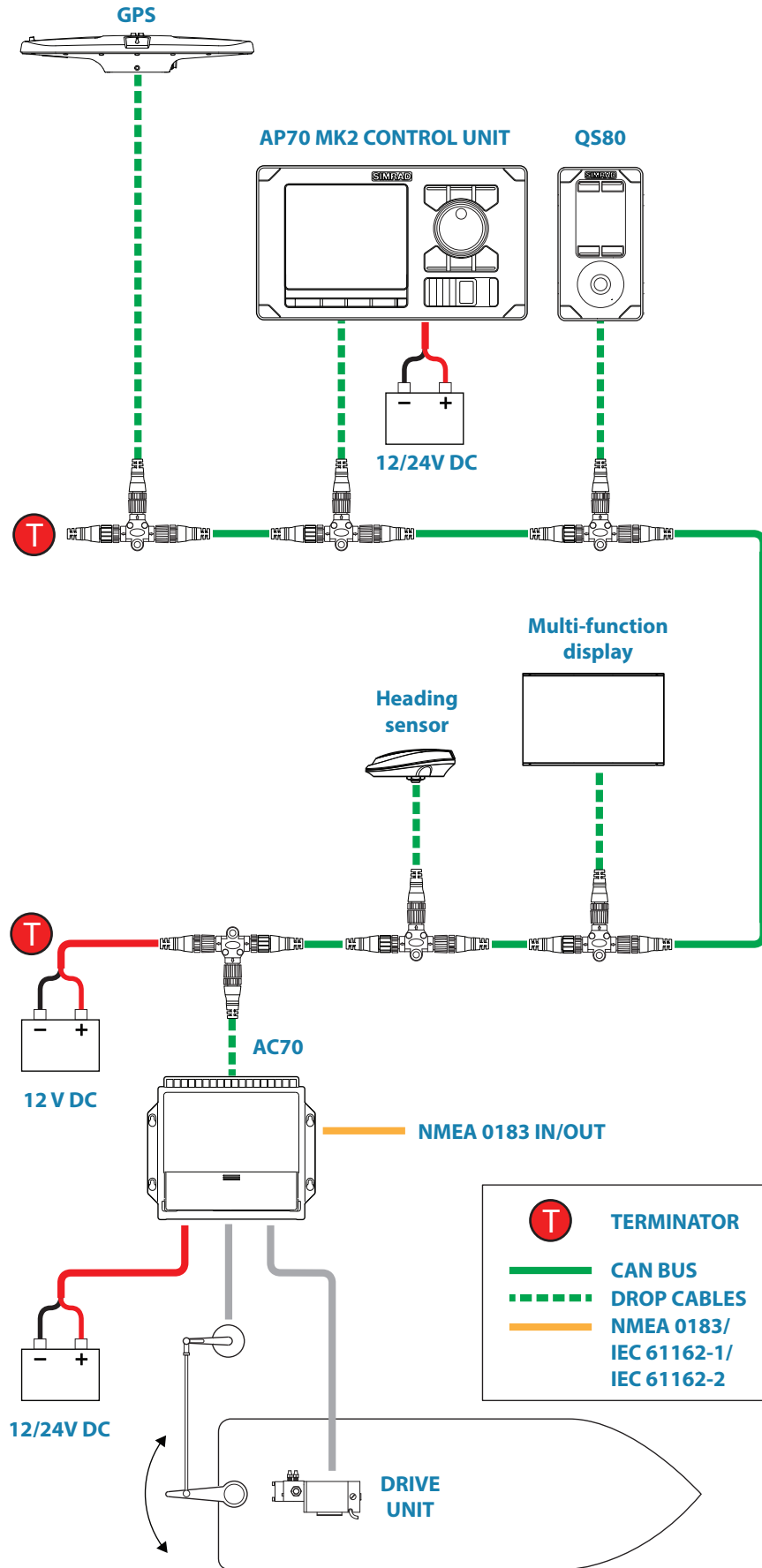
### System overview

The AP70 MK2 systems include several modules that need to be mounted in different locations on the vessel and that need to interface with at least three different systems on the boat:

- The boat’s steering system
- The boat’s electrical system (input power)
- Other equipment on board

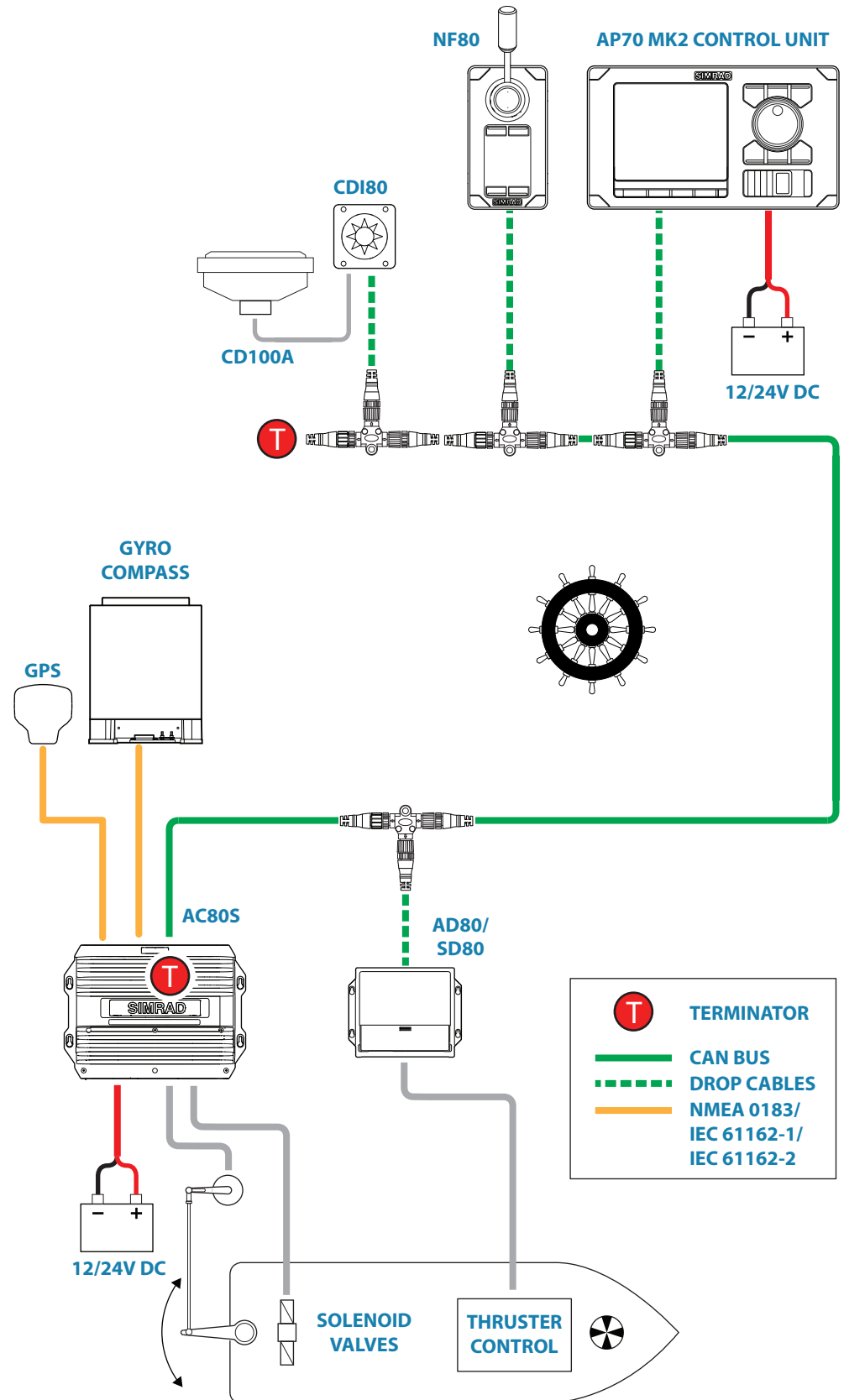
It is important to become familiar with the configuration of the system prior to beginning the installation.

### Simple system example (Not Wheelmark-approved)



### Simple system example (Wheelmark-approved)

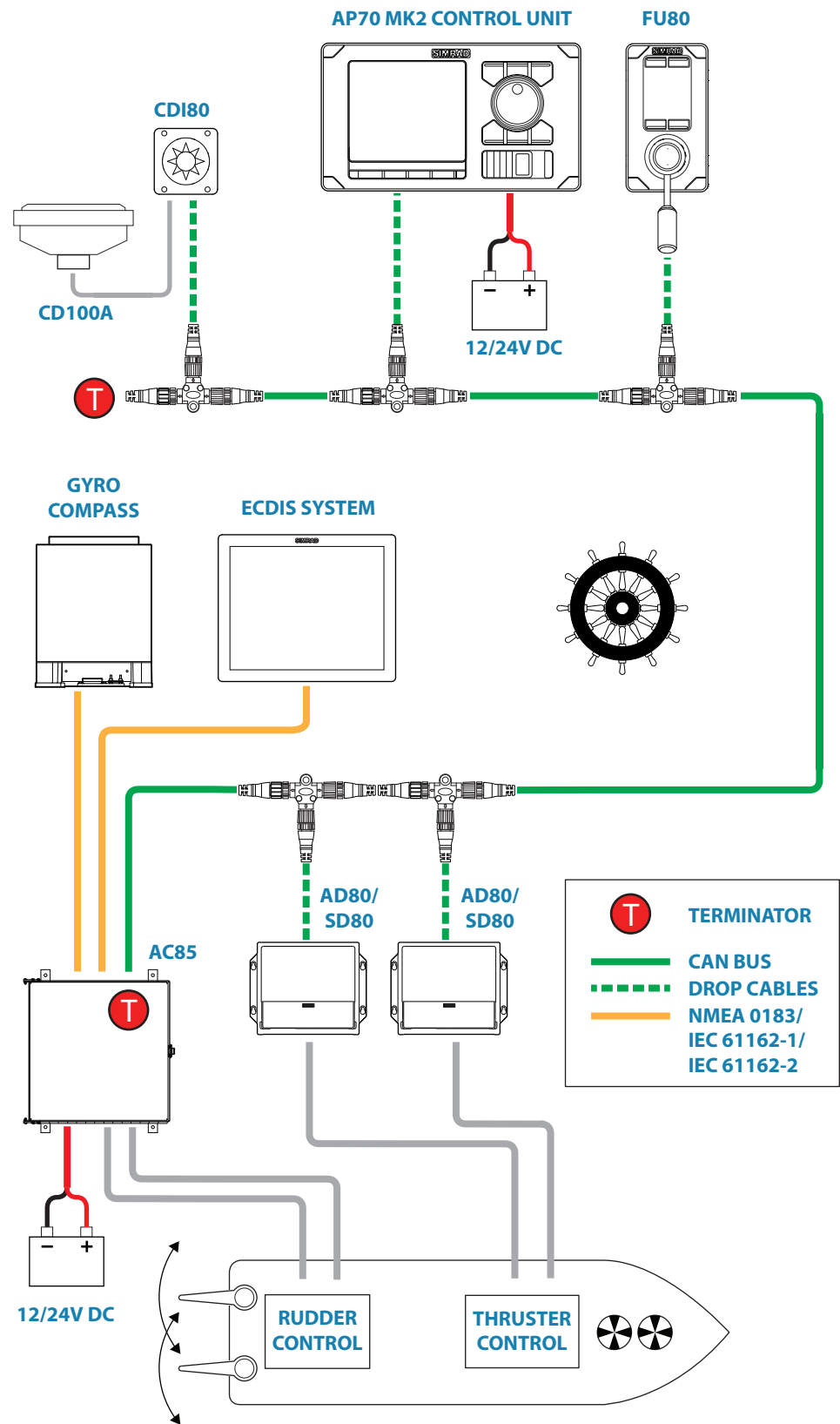
→ **Note:** In wheelmark approved installations, the CAN bus network is used for internal communication between autopilot system components. Sensors must be connected via an SI80 board located in an SI80, AC80A, AC80S or AC85 computer.





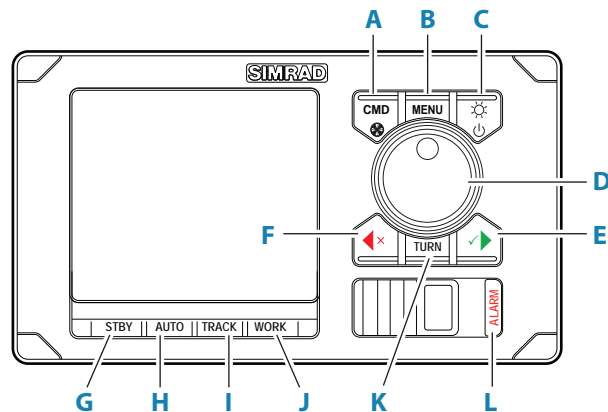
## Advanced system example (Wheelmark-approved)

→ **Note:** In wheelmark approved installations, the CAN bus network is used for internal communication between autopilot system components. Sensors must be connected via an SI80 board located in an SI80, AC80A, AC80S or AC85 computer.



# Autopilot Control unit

## Front - controls



### A Command/Thruster key

- press to take/request command
- press and hold to activate/deactivate available thrusters

### B Menu key

- press once to display the Quick menu
- press twice to show the Settings menu

### C Power/Brilliance key

- press to display the Display setup dialog
- press and hold to turn the unit to sleep mode

### D Rotary knob

Menu and dialog operation:

- turn to move up and down in menus and dialogs
- turn to adjust a value
- press to select a menu option and to enter the next menu level

In Standby and NFU mode:

- press and hold to activate Follow up (FU) mode

In FU mode:

- turn to set the rudder angle

In automatic modes:

- turn to change the set heading/set course, press to re-activate automatic mode with current heading/course as reference

### E Starboard (confirm) key

Menu and dialog operation:

- press to confirm/enter next menu level

In Standby mode:

- press to activate NFU mode

In automatic modes:

- press to change set heading/set course to starboard

**F Port (cancel) key**

Menu and dialog operation:

- press to cancel and to return previous menu level
- press and hold to close the menu

In Standby mode:

- press to activate NFU mode

In automatic modes:

- press to change set heading/set course to port

**G Standby key**

- press to turn the autopilot to Standby mode

**H Auto key**

- press once to activate Auto or NoDrift mode
- re-press to toggle between the Auto and NoDrift mode options

**I Track key**

- press to activate Nav mode

**J Work key**

- press to display the Work quick menu

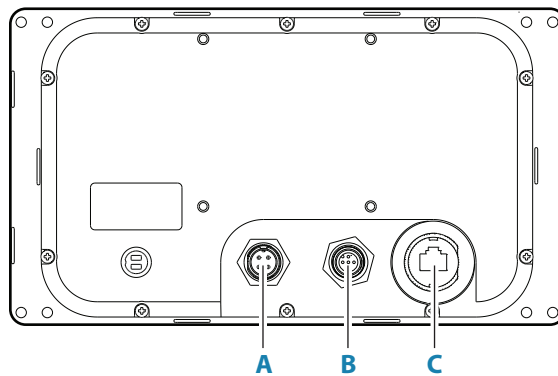
**K Turn key**

- press to display the Turn quick menu

**L Alarm key**

- press to display the list of active alerts

**Rear - connectors**



**A** 4 pin connector for 12/24 V DC local power, External alarm/Active unit OUT

**B** Micro-C connector for CAN bus

**C** Ethernet network port



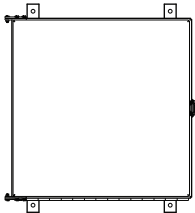
SD80  
AD80



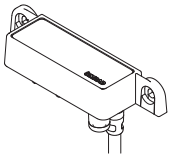
AC70  
S180



AC80A  
AC80S



AC85



SG05  
PRO

## Autopilot computers

The AP70 MK2 systems use a combination of 5 different enclosures and 4 boards to form a flexible computer and interface system.

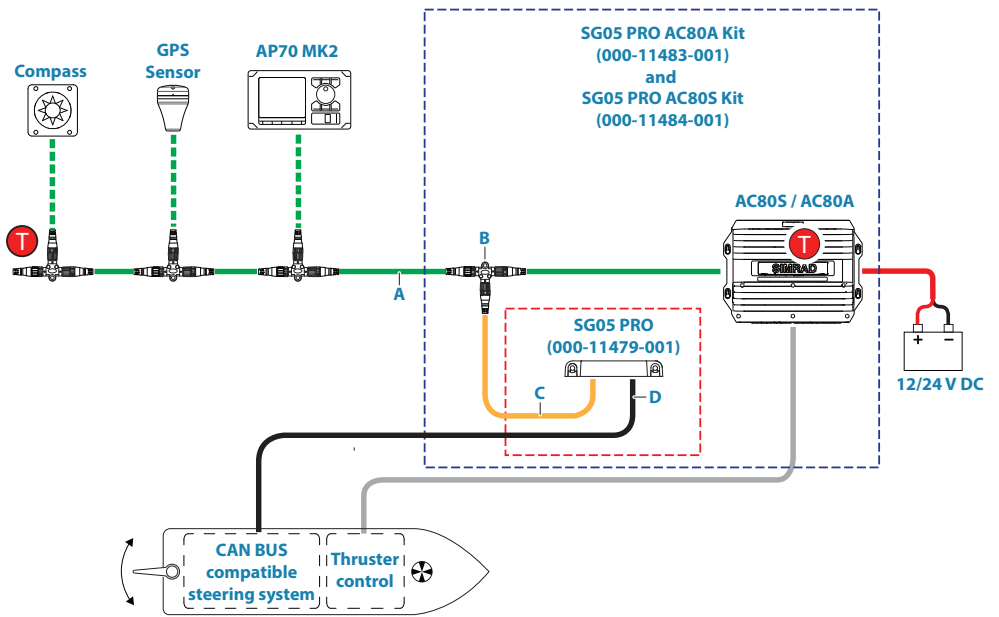
There are 7 standardized and 1 customized computers with built-in and optional boards as shown below.

Refer "Computer boards" on page 67

### SG05 PRO

The SG05 PRO Autopilot Computer provides autopilot control from AP70 MK2 control units to CAN bus/EVC steering systems.

The SG05 PRO receives sensor data (drive/rudder angle and boat speed) from the EVC, does steering calculations and sends drive/rudder commands back to the EVC system which brings drive/rudder to commanded angle.



- A** Micro-C backbone
- B** Micro-C-T-joiners
- C** SimNet to Mircor-C (male) drop cable
- D** SD05 cable, female
- T** Terminators

#### → Notes:

- For IMO approval, the system must contain an AC80S or AC80A Computer.
- A separate Installation Guide if delivered with the SG05 unit.

## Standard computers

The standardized computers have the following built-in boards:

| Computer | AC70 board                             | AD80 board | SD80 board | SI80 board |
|----------|--|------------|------------|------------|
| AC70     | x                                      |            |            |            |
| SI80     |  |            |            | x          |
| AD80     |  | x          |            |            |
| SD80     |  |            | x          |            |
| AC80A    |  | x          |            | x          |
| AC80S    |  |            | x          | x          |
| SG05 PRO | For CAN bus compatible steering system |            |            |            |

## Customized computer

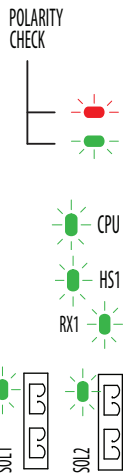
The AC85 computer is supplied with 1 SI80 board, and have space for up to 3 additional boards:

| Computer | AC70 board | AD80 board | SD80 board | SI80 board      |
|----------|------------|------------|------------|-----------------|
| AC85     | Optional   | Optional   | Optional   | x<br>1 Optional |

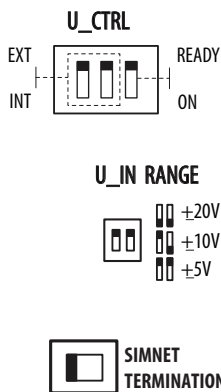
## Computer boards

### Indicator diodes and switches

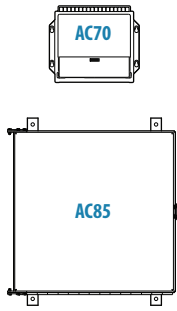
Indicator diodes and switches are available on the boards as shown in the tables below.



| LED            | Description   | AC70 | AD80 | SD80 | SI80 |
|----------------|---|------|------|------|------|
| Polarity check | Red: wrong polarity<br>Green: correct polarity  | x    |      |      | x    |
| CPU            | 1Hz alternating green: CPU is running correctly<br>Rapid flashing: Application program is missing | x    | x    | x    | x    |
| HS             | Green: Handshake output is on   |      | x    | x    |      |
| RX             | Living green: Serial data is received   | x    |      |      | x    |
| SOL            | Green: Solenoid command is given  |      |      | x    |      |



| Switch             | Description  | AC70 | AD80 | SD80 | SI80 |
|--------------------|--|------|------|------|------|
| U_CTRL             | Selection of internal ±10V or external reference voltage for analog voltage control output.<br>→ <b>Note:</b> For 4-20 mA current control, switches must be set to internal ref. voltage               |      | x    |      |      |
| U_IN RANGE         | Range setting of analog voltage input signal for rudder feedback, follow up wheel or remote DP control   |      | x    | x    |      |
| SIMNET TERMINATION | ON (to the left) or off setting of 120 ohm CAN bus termination.<br>→ <b>Note:</b> Termination must be set to ON when the board is at one end of the CAN bus backbone, otherwise it must be set to OFF. |      |      |      | x    |

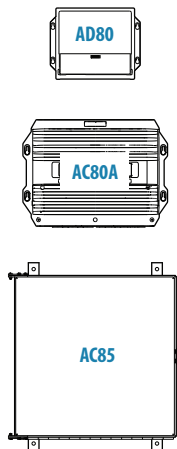
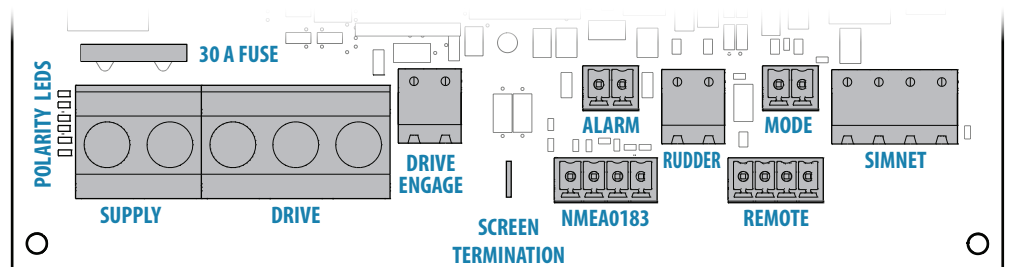


### AC70 board

Drive computer board for rudder or other steering gear i.e. Voith Schneider, reversible motor or galvanic non-isolated solenoids.

Includes:

- SUPPLY - power supply 12/24 V in
- DRIVE - output for Motor or solenoid command
- DRIVE ENGAGE - output for clutch/bypass valve or auto mode signal for oil flow valve etc
- ALARM - Output for external alarm buzzer
- NMEA 0183 - in/out for IEC 61162-1, -2 and NMEA 0183
- RUDDER - Input for frequency rudder feedback
- REMOTE - Input for NFU steering lever
- MODE - Input for external mode selector
- SIMNET - connection to CAN network

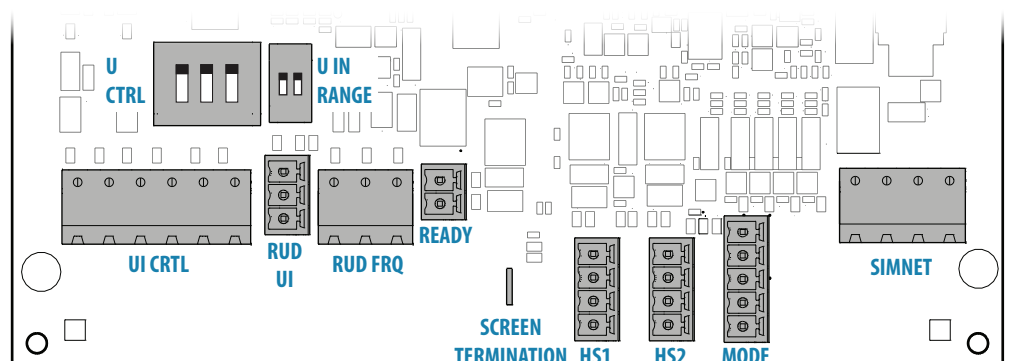


### AD80 board

Drive computer board for rudder or thruster, supporting analog voltage or low current signals for angle or proportional control.

Includes:

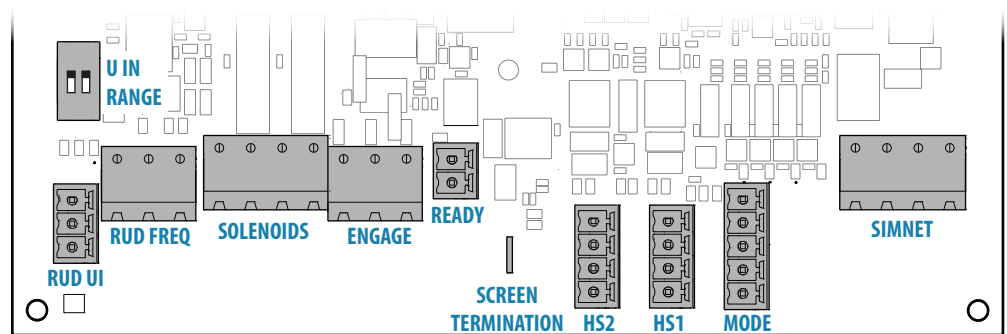
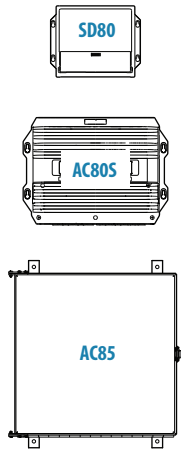
- UI CTRL - output for analog voltage low current command
- RUD UI - Input for analog (voltage or current) rudder feedback
- RUD FRQ - Input for frequency rudder feedback
- READY - output for ready contact when board is up running ready for control
- HS1 - Generic in/out handshake signal port 1
- HS2 - Generic in/out handshake signal port 2
- MODE - Input for external mode selector
- SIMNET - connection to CAN network



## SD80 board

Drive computer board for rudder or thruster, supporting galvanic isolated solenoids or high current signals for angle or proportional speed control.

- Includes:
- RUD UI - Input for analog voltage or current rudder feedback
- RUD FRQ - Input for frequency rudder feedback
- SOLENOIDS - Galvanic isolated output for solenoid command
- ENGAGE - For operating bypass or dual speed valve, clutch etc for hydraulic or mechanical drive units
- READY - output for ready contact when board is up running ready for control
- HS1 - Generic in/out handshake signal port 1
- HS2 - Generic in/out handshake signal port 2
- MODE - Input for external mode selector
- SIMNET - connection to CAN network

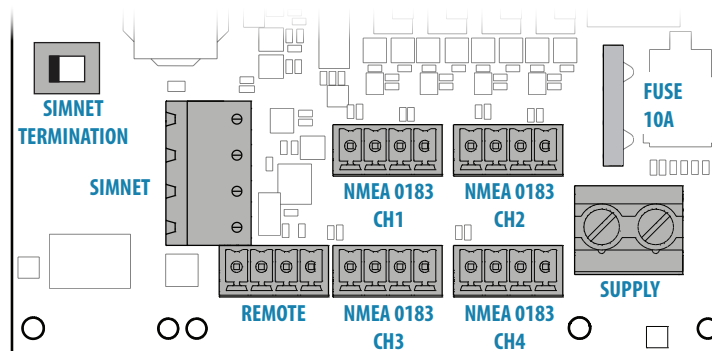
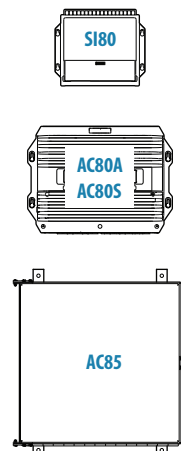


## SI80 board

A four channel NMEA 0183 interface computer board and voltage supply for CAN bus.

Includes:

- SIMNET TERMINATION - Switch for CAN bus termination ON/OFF
- SIMNET - SimNet 15 V out
- REMOTE - Input for NFU steering lever
- NMEA 0183 CH.. - 4 i/o NMEA/IEC 61162-1/IEC 61162-2 channels
- SUPPLY - power supply 12/24 V in



# 2

## Mounting

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### General

Mechanical installation of optional equipment are described in separate manuals following the units.

### Mounting location

The units should be mounted with special regard to the units' environmental protection, temperature range and cable length. Poor ventilation may cause the units to overheat. Refer "Specifications" on page 63.

The mounting location must allow for required working area when connecting the cables. Also ensure that the location for the computer units allow viewing the board's LED indicators.

The mounting surface needs to be structurally strong, with as little vibration as possible. If possible, mount the unit close to the edges of a panel to minimize vibration.

Ensure that any holes cut are in a safe position and will not weaken the boat's structure. If in doubt, consult a qualified boat builder. Ensure that there are no hidden electrical wires or other parts behind the panel.

The control unit should be mounted so that the operator can easily use the controls and clearly see the display screen. For best result, install the display away from direct sunlight and in a location with minimal glare from windows or bright objects.

When panel mounting the control unit and the remotes, the mounting surface must be flat and even to within 0.5 mm.

The units conforms to the appropriate Electromagnetic Compatibility (EMC) standards, but proper installation is required to obtain the best use and performance from this product. Ensure you have as much separation as possible between different electrical equipment.

### AP70 MK2 control unit

The nominal viewing distance for the AP70 MK2 is 0.85 m (2.79 ft).

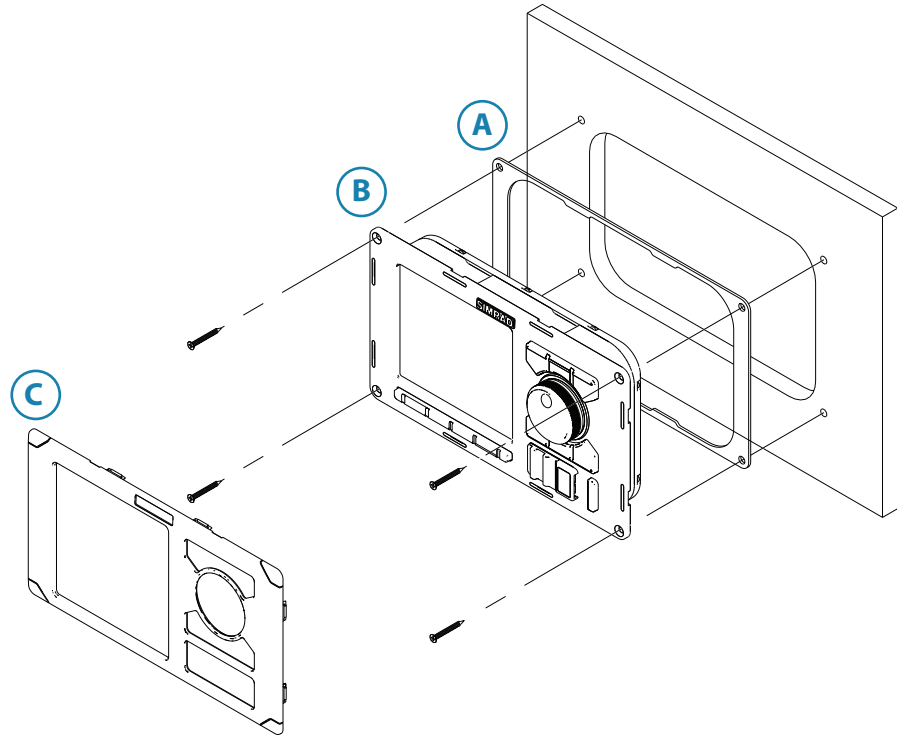
Avoid mounting a control unit where it is easily exposed to sunlight, as this will shorten the lifetime of the display. If this is not possible, make sure the unit is always covered with the optional protective cover when not in use.



### Panel (flush) mount

1. Attach the mounting template to the selected mounting position
2. Drill pilot holes for the 4 saw cut holes and for the 4 self-tapping screws used to secure the unit. If using M4 machine screws, use a 5 mm (0.20 ") drill bit
3. Use a 25 mm (1 ") hole saw to cut the four corner radius
4. Cut along the dotted line and remove waste material
5. Peel backing off the gasket and apply it to the unit (A)
6. Connect the cables to the rear of the unit before placing the unit into the console
7. Secure the display to the surface with 4 screws (B)
8. Firmly clip the bezel in place (C)

→ **Note:** The bezel may not be used for flush/low profile installations.

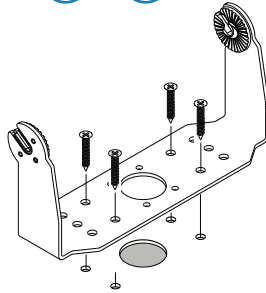


## Bracket mount (option)

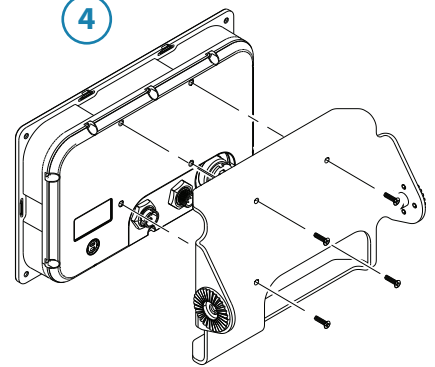
→ **Note:** When the control unit is bracket-mounted, it is not weatherproof from the back due to a breathing hole in the back cabinet. When bracket-mounted, the exposed parts of the plugs should be protected against salt corrosion.

1. Use the bracket base as a template to mark the screw hole location
2. Drill pilot holes and hole for cables if required
3. Secure the bracket base to the surface
4. Secure the bracket's adapter to the rear of the control unit using the 4 screws supplied with the bracket
5. Align the bracket base with the cradle and partially screw in the bracket knobs one at a time
6. Adjust the unit for best viewing angle, and tighten the bracket knobs

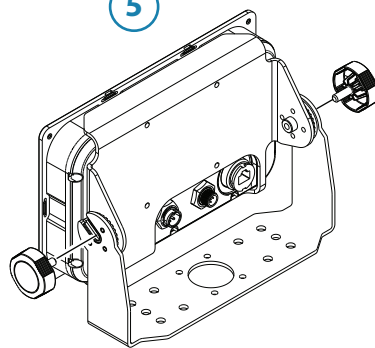
1 - 3



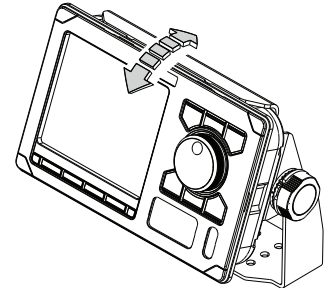
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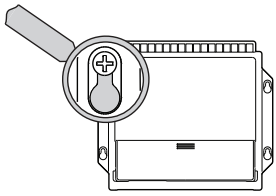


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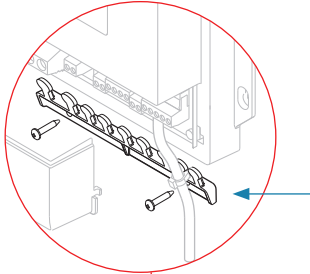




## Autopilot computers

The mounting location must allow for required working area when connecting the cables. Also ensure that the location for the computer units allow viewing the board's LED indicators. The mounting surface needs to be structurally strong, with as little vibration as possible. If possible, mount the unit close to the edges of a panel to minimize vibration. Ensure that any holes cut are in a safe position and will not weaken the boat's structure. If in doubt, consult a qualified boat builder. Ensure that there are no hidden electrical wires or other parts behind the panel.

Preferably, mount the computers with the cable entries exiting downwards.

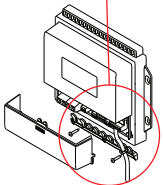


Mount the cable retainer included with the AC70, SI80, SD80 and AD80 on the wall beneath the unit.

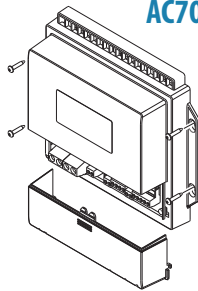
An isolating gasket is included with the AC80A/AC80S computers. This must be used as a galvanic isolator if the unit is mounted on a metal surface.

The SG05 PRO Autopilot Computer has 2 SimNet ports to connect either via a drop cable or inline as part of the network backbone.

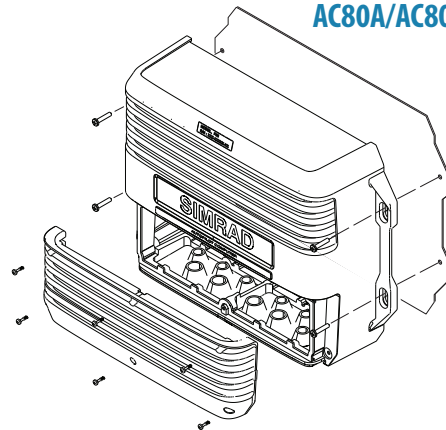
For Micro-C based networks, use the SimNet to Micro-C (male) converter cable.



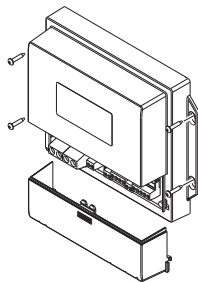
**AC70/SI80**



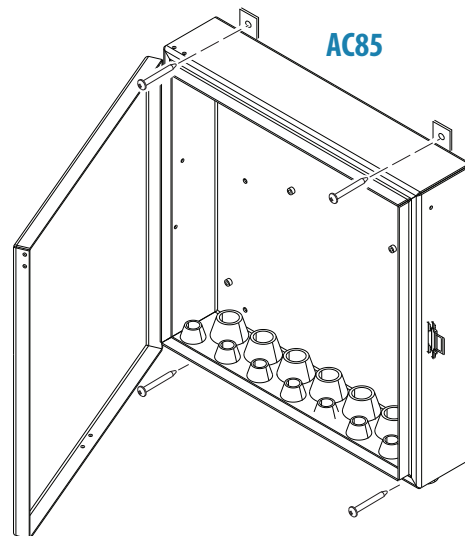
**AC80A/AC80S**



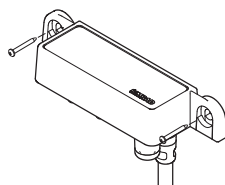
**SD80/AD80**



**AC85**



**SG05 PRO**



→ **Note:** The autopilot computers are not waterproof. Refer "Specifications" on page 63.

# 3

## Wiring

### Wiring guidelines

CAN network cables and other signal cables (i.e. compass, feedback, NMEA) should not be run in parallel with other cables carrying radio frequency or high current, such as VHF and SSB transmitters, battery chargers/generators, and winches.

Don't make sharp bends in the cables, and avoid running cables in a way that allows water to flow down into the connectors. If required, make drip and service loops.

If cables are shortened, lengthened or re-terminated, do insulate and protect all wiring connections.

Most of the units are communicating on the CAN bus with drop cables. Try mounting the units within the standard cable length supplied with each unit. Additional cables and cable extensions are available from our distributors.

**⚠ Warning:** Before starting the installation, be sure to turn electrical power off. If power is left on or turned on during the installation, fire, electrical shock, or other serious injury may occur. Be sure that the voltage of the power supply is compatible with the specification for the units.

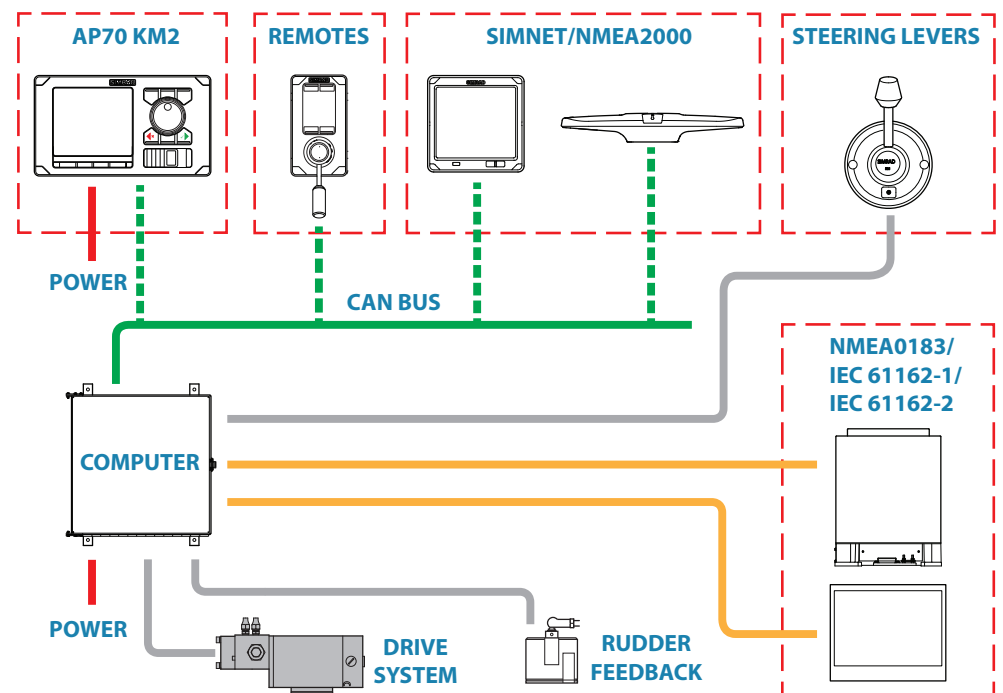
### Autopilot system, basic wiring principles

The AP70 MK2 autopilot system use a CAN bus backbone, which makes it simple to interface to SimNet and NMEA 2000 devices.

NMEA 0183 devices, rudder feedbacks and other control devices can be connected to an autopilot computer.

In a standard system the CAN bus is powered by the AC80A, AC80S, SI80 or AC85 Autopilot computer. The AP70 MK2 control unit has separate power supply.

The following sections describe installation of the components listed in the illustration below. Refer to separate manuals for detailed information about each interfacing unit.



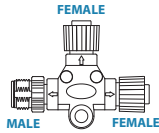
## CAN bus

The CAN bus is based on the well known SimNet plug & play concept and on the NMEA 2000 SAE J1939 protocol. Hard wiring is based on standard NMEA 2000 cables with Micro-C type connectors and joiners.

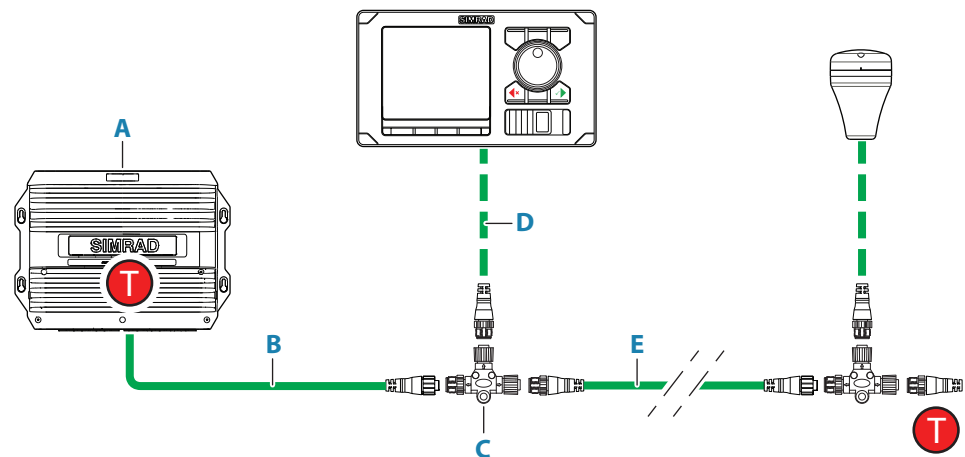
The bus consists of a linear backbone, using drop cables and Micro-C T-joiners for connecting NMEA 2000 and SimNet devices.

The bus has a maximum cable length of 150 m (500 ft), and a drop cable has a maximum length of 6 m (20 ft).

In a default autopilot system the CAN bus backbone expands from the AC80A or AC80S Autopilot computer, which supplies power to the backbone. There will always be a female connector in the expanding end of the backbone cables.



For powering the CAN bus, see “Powering the CAN bus” on page 23.



|          |  |
|----------|--|
| <b>A</b> | AC80 Autopilot computer with built-in CAN bus terminator on the SI80 board |
| <b>B</b> | 0,6 m (2 ft) pigtail cable, female connector                               |
| <b>C</b> | Micro-C T-joiner   |
| <b>D</b> | CAN bus drop cable, connectors in each end (female - male)                 |
| <b>E</b> | CAN bus backbone, various lengths available. Connectors in each end        |
| <b>T</b> | Terminator, 120 ohm, male  |

→ **Note:** If cables are not supplied by Simrad, ensure that they meet NMEA 2000/IEC61162-1/2 requirements.

### Planning and installing a network backbone

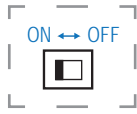
- Plan the network carefully
  - It is recommended to create a diagram of the network prior to starting the installation
- Run the backbone between the locations of all CAN devices you want to install
  - It must be less than 6 m (20 ft) cable run from a device to the backbone
- Consider the load/current draw from the devices
  - Refer “Network LEN” on page 24

For network cables and components, refer to our website.

## Terminating the CAN bus

The CAN bus must have a terminator at each end of the backbone.

In a default autopilot system the CAN bus expands from the AC80A, AC80S or AC85 Autopilot computer. This computer includes a terminator on the SI80 board, enabled by the micro switch.



- Set the switch to ON when the SI80 board is at the end of the CAN bus
- Set the switch to OFF when the SI80 board is used as additional power supply to the CAN bus

Factory default setting of SI80 terminator is OFF.

For location of the dip switch, refer to the illustrations inside the computer unit.

A terminator in the other end of the CAN bus can be of the following:

- An SI board (in SI80, AC80A, AC80S or AC85 computer) with enabled terminator
- A power cable with built-in terminator (plug marked 120 ohm)
- A single terminator plug (marked 120 ohm)

## Shield connection

It is required to use shielded cables to meet radio frequency interference requirements as defined in the NMEA 2000 specification:

- The shield shall not be electrically connected within the interface to the electronic device chassis or ground
- The shield shall be electrically continuous through the network connection
- The shield shall be connected to the DC negative of the backbone power supply

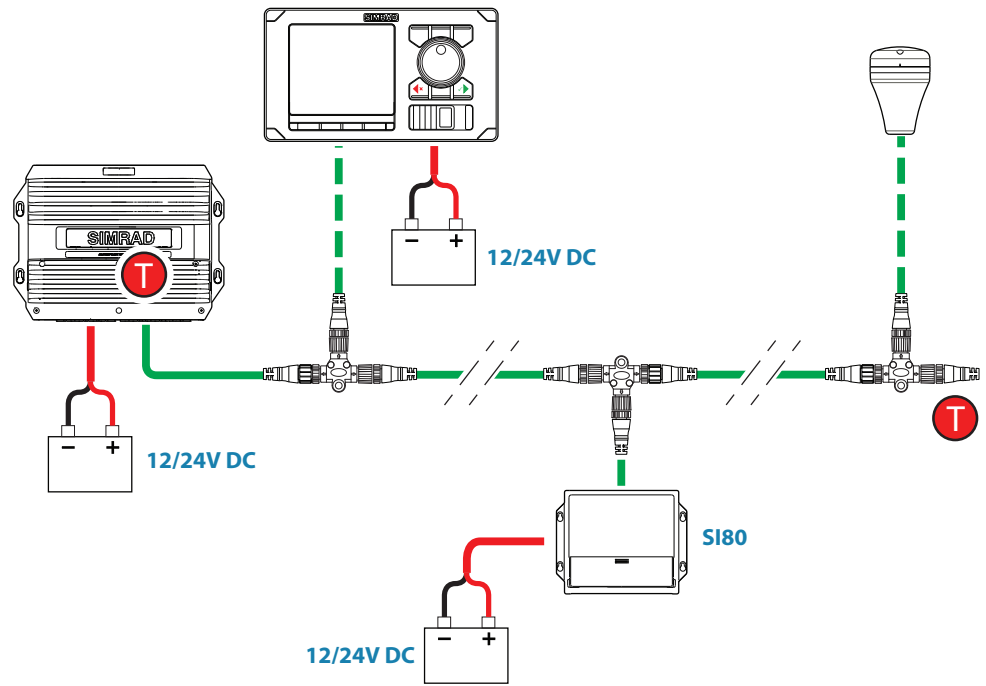
## Power supply

- **Note:** Wheelmark/US Coast Guard approved systems require a Power Failure alarm. In such installations the master station control unit and the autopilot computer with the SI80 board for CAN bus supply must be connected to different independent power supplies.
- **Note:** It is recommended to install an external on/off switch for the Autopilot Computer power supply.
- **Note:** Do not connect the power cable to the same terminals as the start batteries, drive units, thruster or other high current products.
- **Note:** If joining to an existing NMEA 2000 network or similar CAN bus network that has its own power supply, use an NMEA 2000 Gateway to isolate the two power supplies.

## Powering the CAN bus

In a default autopilot system the SI80 board (in the SI80, AC80A, AC80S or AC85 computer) is used for powering the CAN bus backbone.

For larger systems additional power should be added at a central point in the backbone to balance the voltage drop of the network. Additional power should be supplied by using an SI80 board. Refer "Network LEN" on page 24.

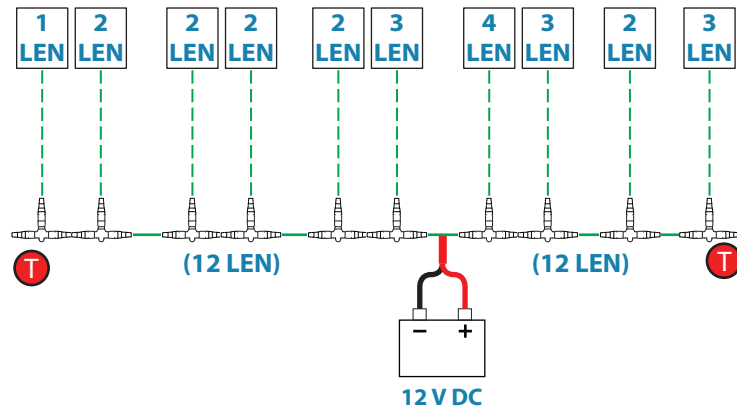


### Network LEN

When you have a larger system with network power in center of the backbone you should make the installation such that the load/current draw from the devices in each side/branch is equal.

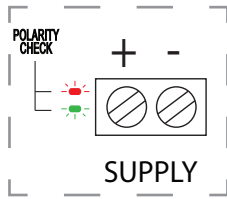
For LEN numbers, see "Specifications" on page 63.

→ **Note:** 1 LEN (Load Equivalency Number) equals 50 mA current draw.



### Powering drive units

AC70 computer requires separate power supply for drive units. Refer "Autopilot computers" on page 27.



## Polarity protection

For supply to SI80 and AC70 boards, pay special attention to polarity protection.

The main supply fuse for these units is supplied loose in the bag with the cable plugs, and it should not be put in place before polarity is checked.

1. Connect the power wires, and verify that the green diode is lit
  - A red diode indicates wrong polarity, and the wires must be swapped
2. Switch off the power supply voltage and put the fuse into correct position

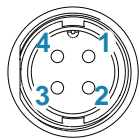
The illustration shows power terminal and diodes on the AC70 board. For location of terminals, fuse and diodes on the board, refer to the illustration inside the computer unit.

## Powering the AP70MK2 control unit

The AP70 MK2 control unit is powered directly from a 12 V DC or 24 V DC source.

The units are protected against reverse polarity, under voltage and over voltage.

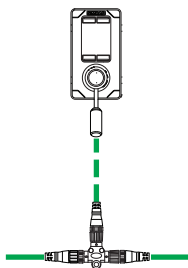
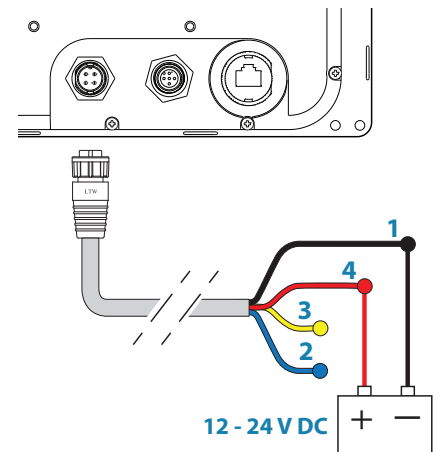
### Power cable connector (female)



| Pin | Color  | Description              |
|-----|--------|--------------------------|
| 1   | Black  | Battery (-)              |
| 2   | Blue   | Alarm/Active             |
| 3   | Yellow | External command         |
| 4   | Red    | Battery (+), 12 - 24V DC |

→ **Note:** It is recommended to install an external on/off switch for power.

→ **Note:** Do not connect the power cable to the same terminals as the start batteries, drive units, thruster or other high current products



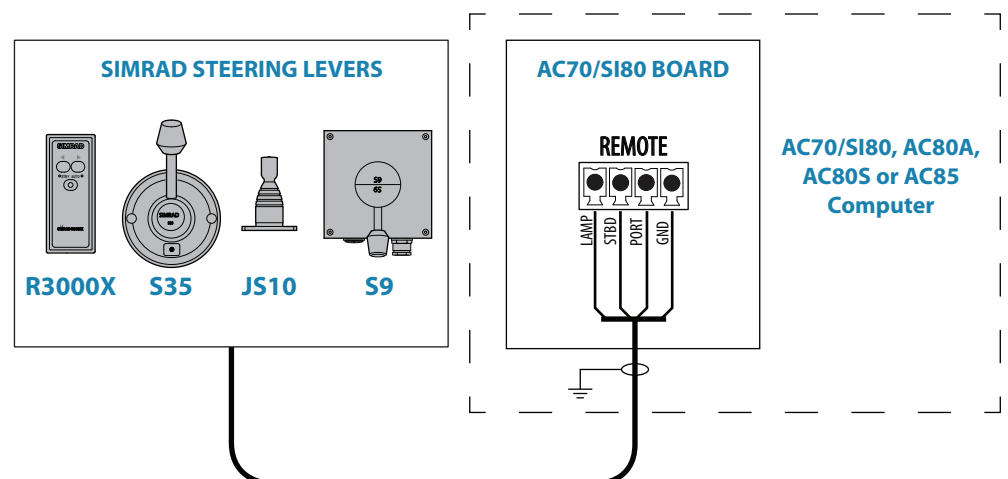
## FU80, NF80 and QS80 Remote control units

FU80, NF80 and QS80 Remote control units connect to the CAN bus by drop cables and Micro-C T-joiners. The remotes are powered from the backbone.

For details see the separate manual for these remote units.

## Steering levers

Connects to: AC70 board (in AC70 computer) or SI80 board (in SI80, AC80A, AC80S or AC85 Computer)





| Wire color/Internal remote termination |        |       |     | AC70/SI80 board termination |
|--|--------|-------|-----|-----------------------------|
| S35                                    | R3000X | JS10  | S9  |                             |
| Yellow                                 | Yellow | N/C   | N/C | Lamp                        |
| Brown/White                            | Green  | Green | B2  | STDB                        |
| Pink/Grey                              | Red    | Red   | B1  | Port                        |
| Green                                  | Blue   | Blue  | B3  | GND                         |

Interchange the Port and Starboard wires on the AC70/SI80 board if necessary to make the command from the keys/lever coincide with the direction of the rudder movement.

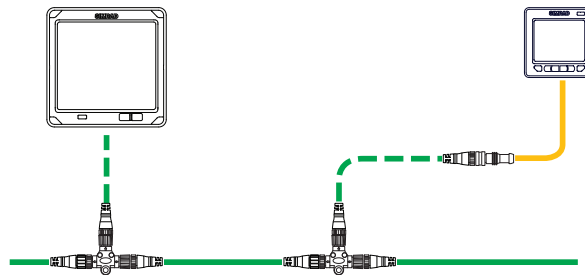
## NMEA 2000 and SimNet devices

NMEA 2000 devices can be connected to the CAN bus providing they are NMEA 2000 certified, meets the CE, FCC regulations and do not exceed the load specification.

NMEA 2000 devices and SimNet devices with Micro-C connectors will connect directly to the CAN bus backbone using drop cables and Micro-C T-joiners.

→ **Note:** It is recommended to use a gateway when connecting non-Simrad units to the CAN bus backbone.

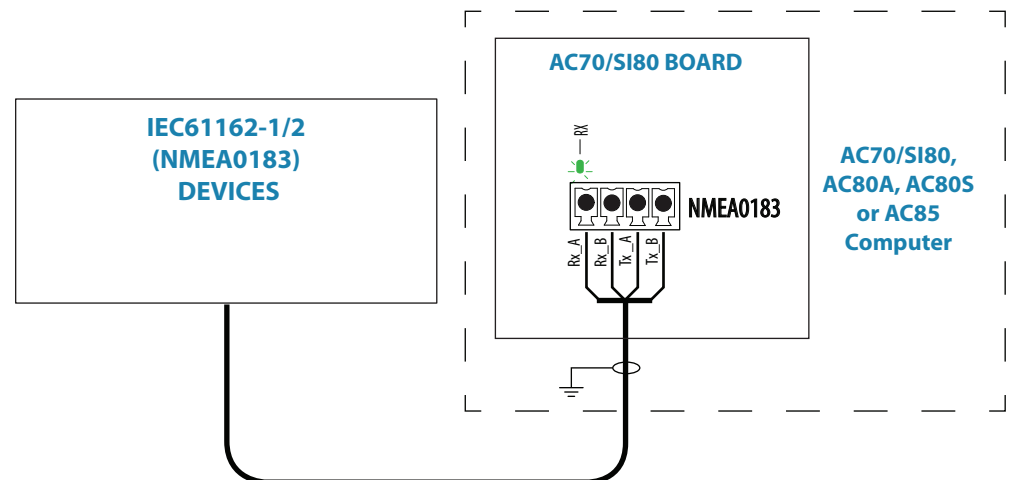
Devices with only SimNet connectors must be connected using a SimNet to Micro-C adapter cable.



## IEC61162-1/2 (NMEA 0183) devices

Connects to: AC70 (in AC70 or AC85 Computer) and SI80 board (in SI80, AC80A, AC80S or AC85 computer).

The AC70 board have 1 NMEA 0183 terminal, while the SI80 board includes 4 NMEA 0183 terminals.



The green LED at each NMEA terminal lights up when serial data is received.

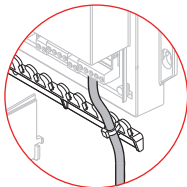
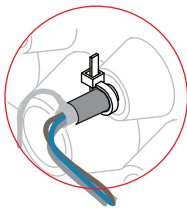
The board uses the serial RS422 (IEC 61162-1/2) standard and can be configured in the software for different baud rates, up to 38.400 baud. Sentences output by the autopilot computer are fixed for the different outputs.

Refer "Device list" on page 42 and "Supported data" on page 71

## Autopilot computers

### Grounding

The autopilot system has excellent radio frequency interference protection and all units use the autopilot computers as a common ground/shield connection. The units must therefore have a proper ground connection to the hull.



### Termination, general

Power and signal cables connect with screw terminals or terminal blocks on the board inside the computer unit. Refer connection details on the following pages.

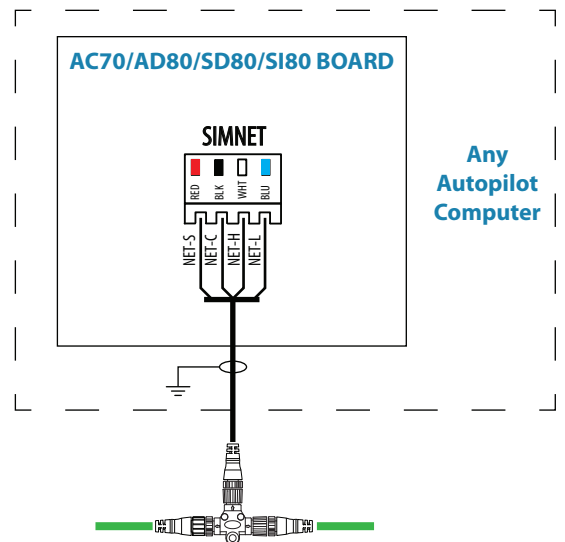
1. Insert the cable through an appropriate cable gland or slot
2. Strip off the cable insulation. Provide sufficient wire length so that the plug-in terminals can be easily connected and disconnected
3. Pull out each terminal blocks from the board before connecting the wires
4. Terminate the wires to the terminal blocks according to the terminal specification in the following pages
5. Connect the terminal blocks to the board
6. Crimp a Faston terminal to the screen and connect to the grounding plug-in terminal on the board, or on the grounding list
7. Secure the cables by using cable ties

### Connecting the computers to the CAN bus

AC70, SD80, AD80 and SI80 autopilot computers connect anywhere on the CAN bus backbone by using drop cables connected to a female connector on the Micro-C T-joiner.

AC80S, AC80A and AC85 autopilot computers includes a terminator, and should be connected at the end of the CAN bus backbone. The drop cable is connected to the male connector on the Micro-C T-joiner, and to the SimNet terminal on the computer board.

The drop cable is supplied with the autopilot computer.

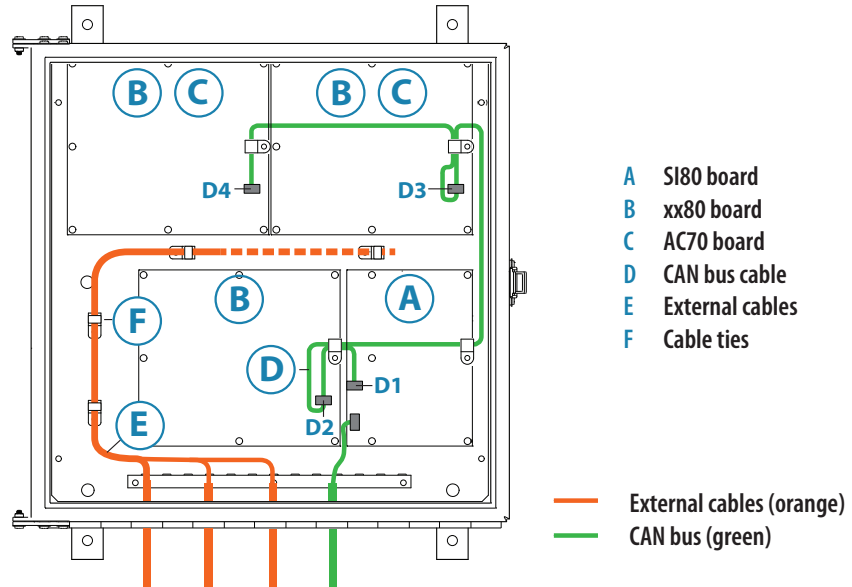


## Mounting and Interconnecting the boards in the AC85 Computer

The AC85 computer is delivered with one SI80 board. The SI80 board is not mounted from factory. Optional boards are ordered separately.

The boards should be located as shown in the illustration, and secured to the computer base with the supplied screws and washers.

A detailed mounting description is included with the AC85 computer. The document can also be downloaded from our website.



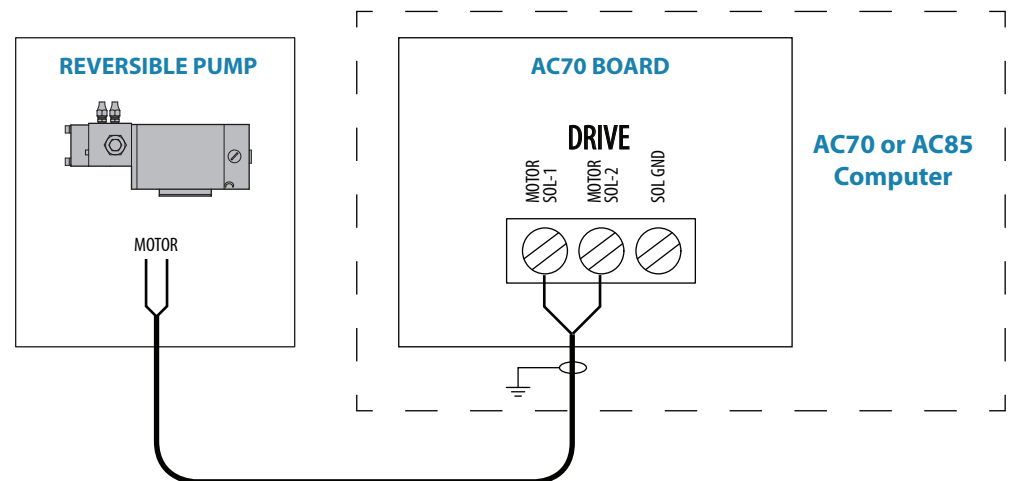
## Drive units

Connecting diagrams for the different drive units are found on the following pages.

Installation instructions for the drive units are found in the manuals for the individual units.

### Reversible pump

Connects to: AC70 board (in AC70 or AC85 Computer).

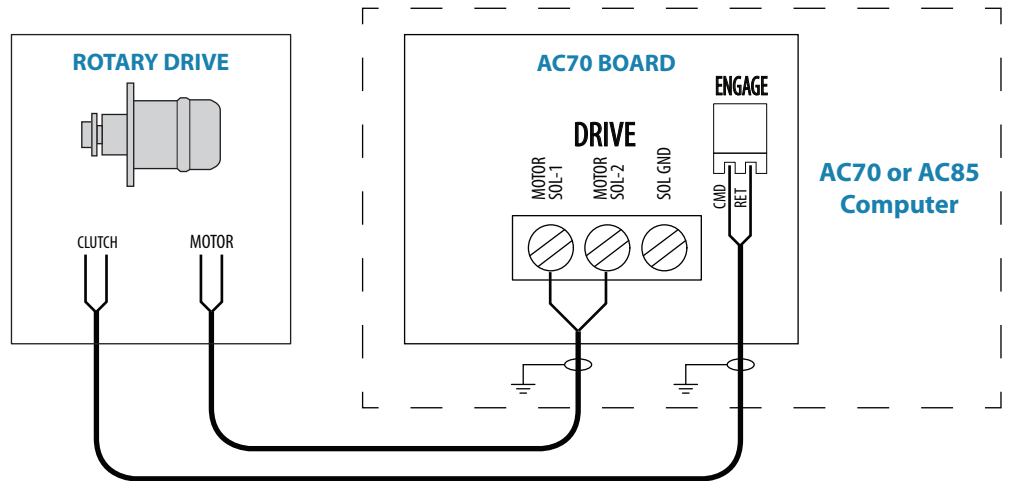


## Rotary drive

Connects to: AC70 board (in AC70 or AC85 Computer).

Rotary drive (reversible motor with clutch) is normally used for mechanical connection to Voith Schneider drive system or helm unit on sailing vessels.

The rotary drive need connection to the Engage terminal for clutch operation.



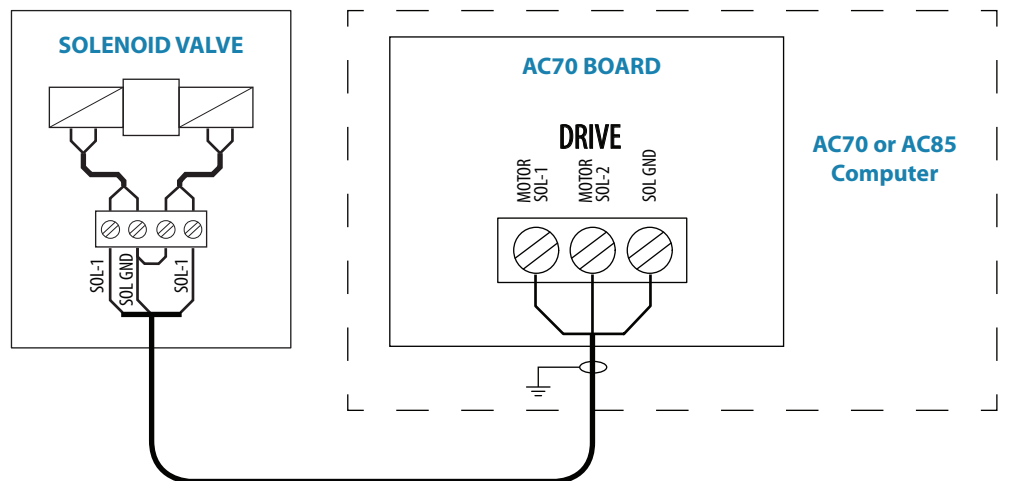
## Solenoid valves, 12 V or 24 V DC

The following figures describe operation of 12 V or 24 V solenoids.

For solenoids with higher voltage (110/220 V AC or DC), use external relays/solid state relays.

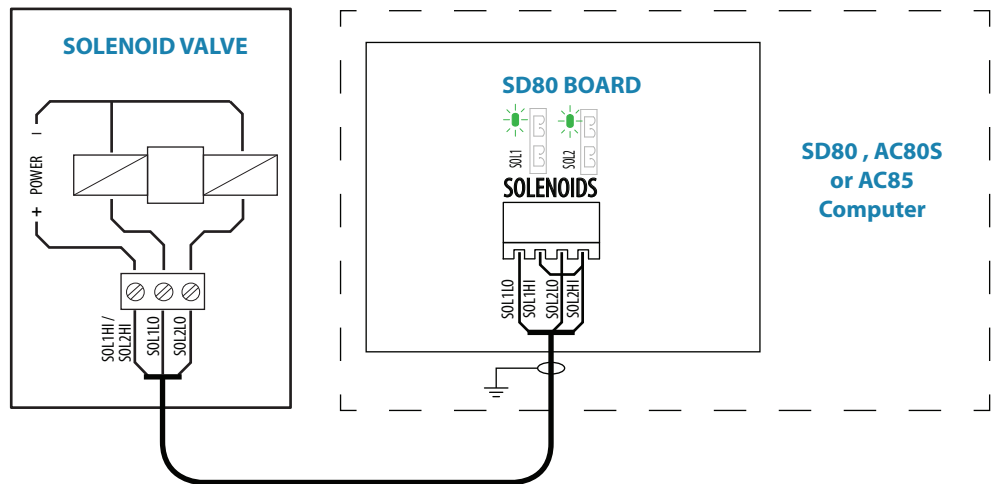
### Internally powered Solenoids

Connects to: AC70 board (in AC70 or AC85 Computer).



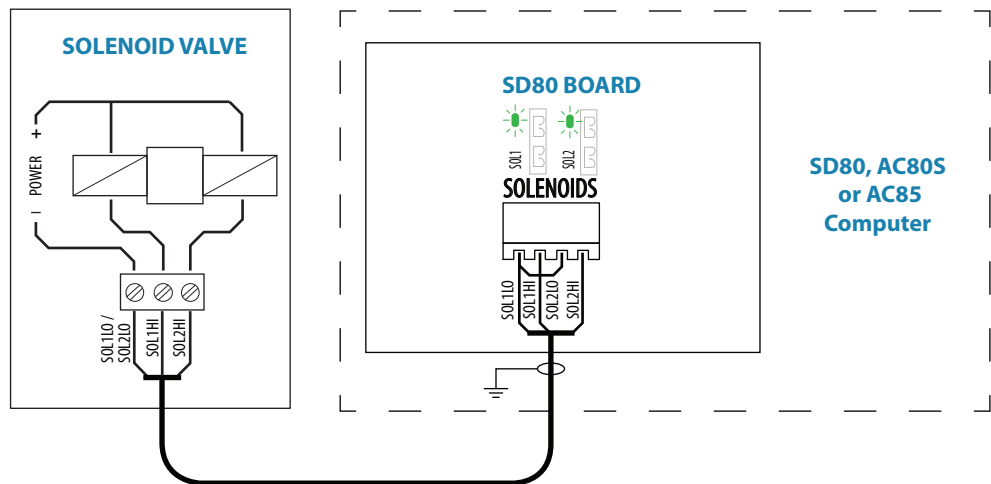
### Externally powered solenoids, common negative

Connects to: SD80 board (in SD80, AC80S or AC85 Computer).



### Externally powered solenoids, common positive

Connects to: SD80 board (in SD80, AC80S or AC85 Computer).

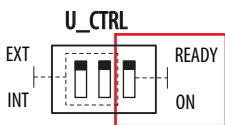


### Analog steering gear

Connects to: AC80 board (in AD80, AC80A or AC85 Computer).

The AD80 board provides analog control of rudder(s) and thrusters in an AP70 MK2 system by either continuous voltage or current signal.

The **UI\_CTRL** DIP switch is used to voltage control line.

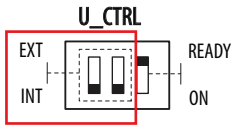


- Set to **READY**, the voltage control line will be broken by a solid state relay contact when the autopilot is not ready for steering (Power off and serious error situations)
- Set to **ON** the line will always be connected

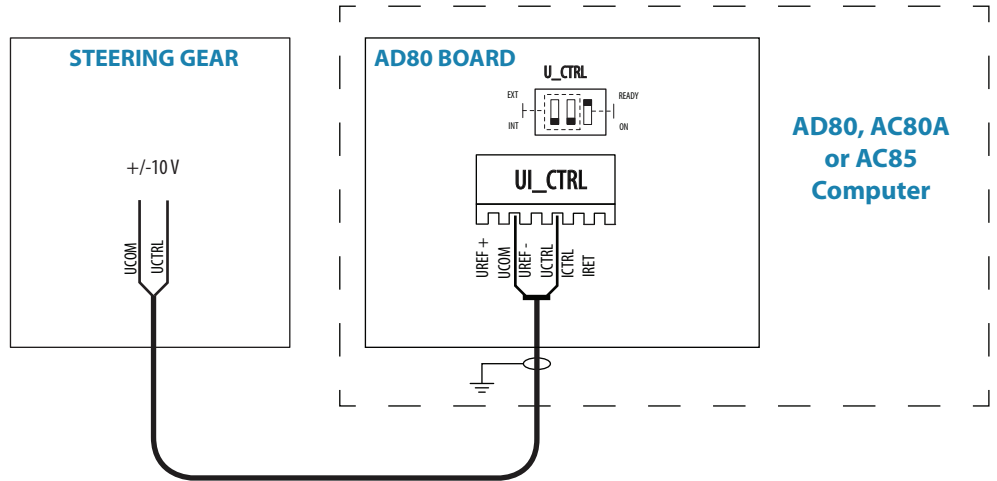
Additional switch settings for the alternative steering gear control alternatives are included in the next sections.

### Internal voltage

A nominal  $0 \pm 10$  V DC control signal is available for control. This voltage is galvanic isolated from the operating voltage for the autopilot. Rudder zero voltage and control range can be adjusted in the Dockside Drive setup. See “Rudder feedback/thruster feedback calibration” on page 51.

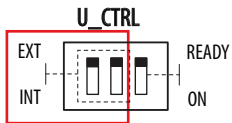


For Analog output, internal voltage, the switch must be set to **INT**.

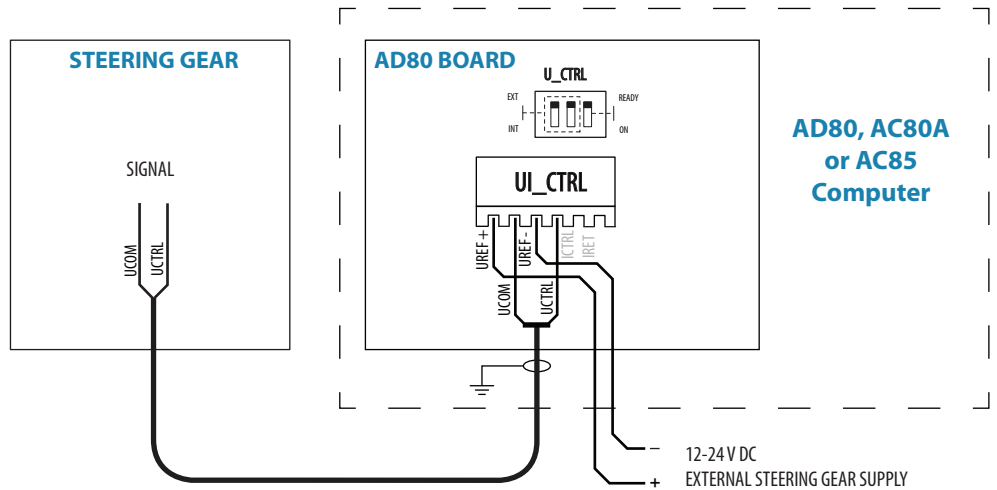


### Voltage control with external reference, +/- variable

Available control range will be +/- V signal, appr. 45% of external reference voltage. Zero setting and control range output at **U\_CTRL** can be adjusted in dockside setup.



For Analog output, external voltage, the switch must be set to **EXT**.



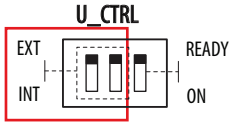
### Voltage control with external reference, positive variable

Normally used to control proportional valves with 12 V and 24 V power.

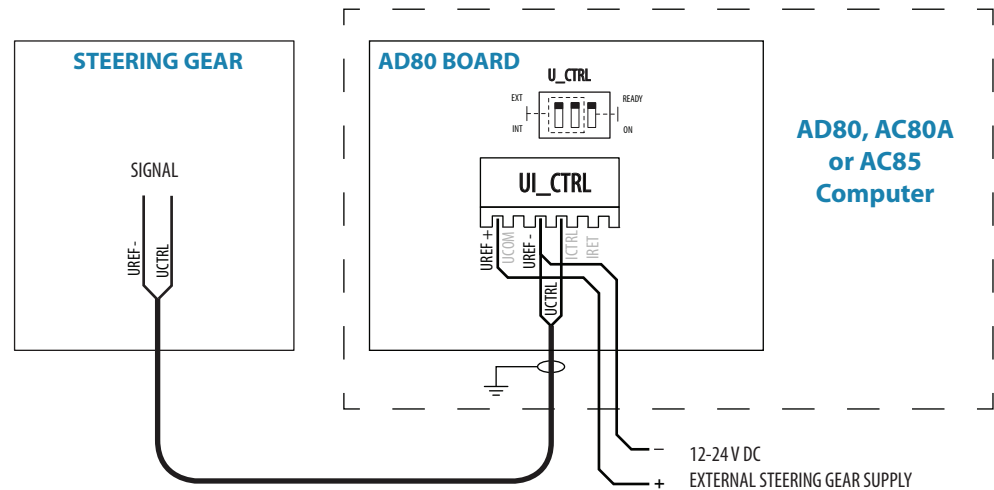
Available control range will be from 5-95% of external voltage. Control signal will be positive variable relative the external reference voltage minus.

Zero output = External power/2.

Zero setting and control range output at **U\_CTRL** can be adjusted in dockside setup. See "Rudder feedback/thruster feedback calibration" on page 51.



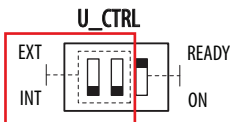
For Analog output, external voltage, the switch must be set to **EXT**.



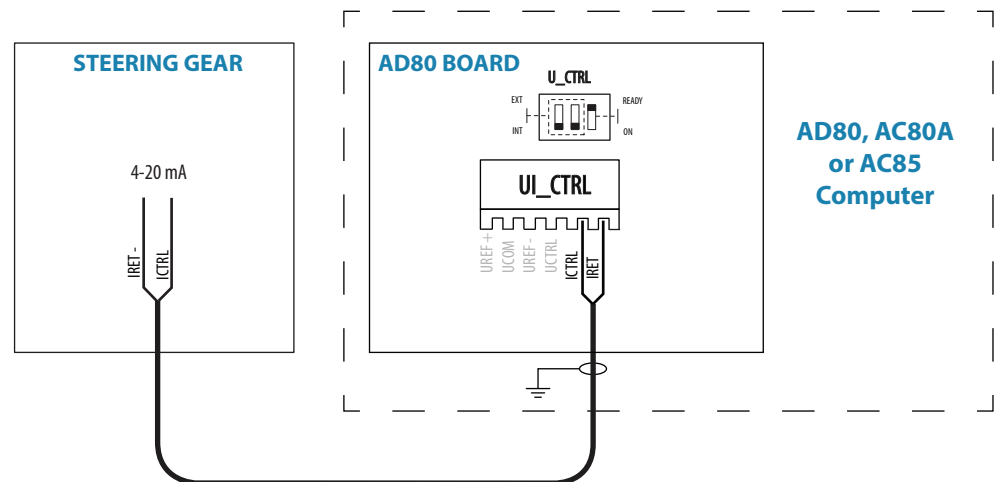
### Analog output, current

A 4-20 mA control signal is available. Rudder zero current and control range can be adjusted in the Dockside setup (ref. page 55).

Rudder zero current and control range can be adjusted in dockside setup. See "Rudder feedback/thruster feedback calibration" on page 51.



For Analog output, current, the switch must be set to **INT**.



## Rudder feedback

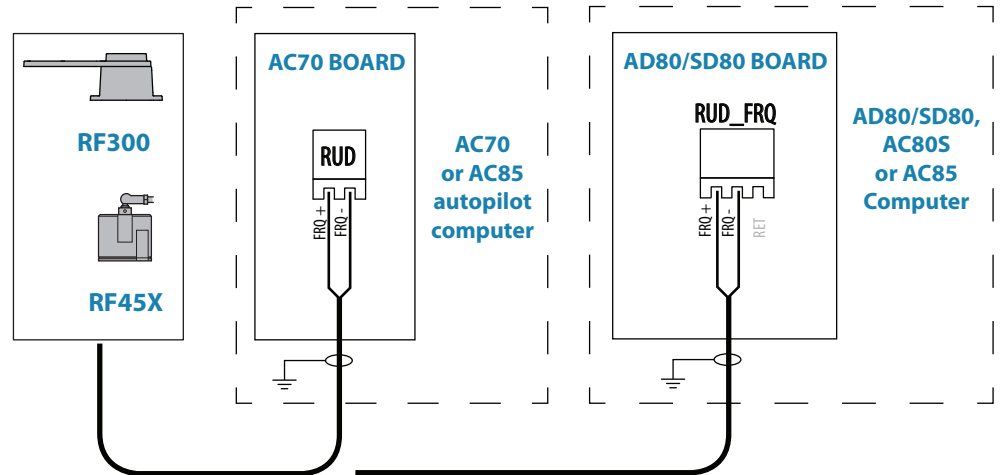
### RF300, RF45X

Connects to: AC70 board (in AC70 or AC85 Computer), SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).

RF300 = White and Brown wires

RF45X = Red and Blue wires

→ **Note:** Polarity independent.



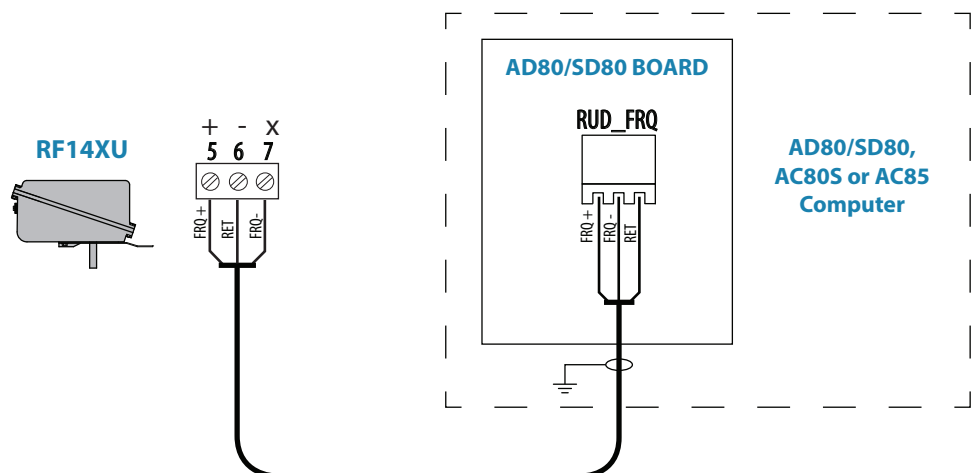
### RF14XU

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).

The cables are carried through cable glands. If required, to avoid any mechanical damage, the cables should be run in a conduit between the rudder feedback unit and the autopilot computer.

The cable screen must be connected to the internal ground terminal.

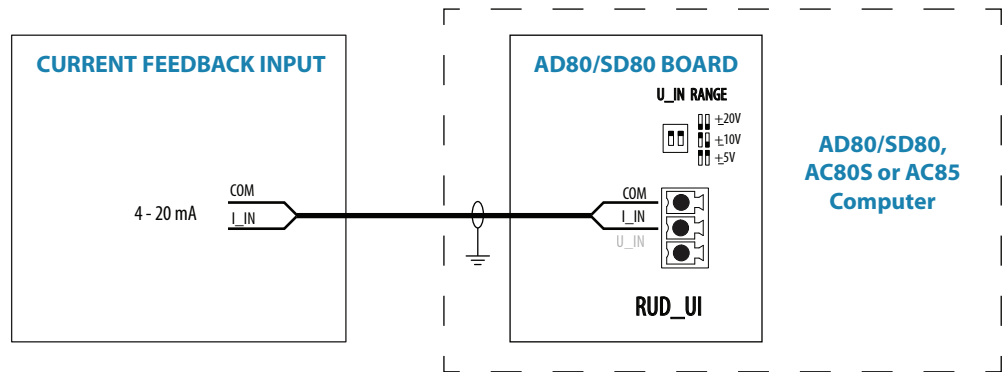
The feedback unit has an external ground terminal and must have a proper ground connection to the hull. The grounding wire should be as short as possible and at least 10 mm wide.





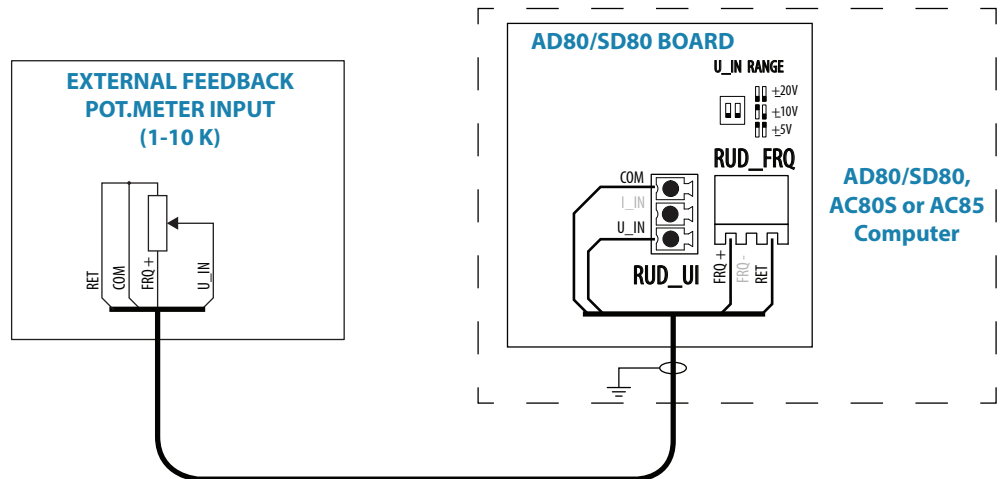
## Current feedback input

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).

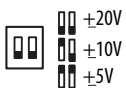


## External feedback pot.meter/external FU wheel input

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).



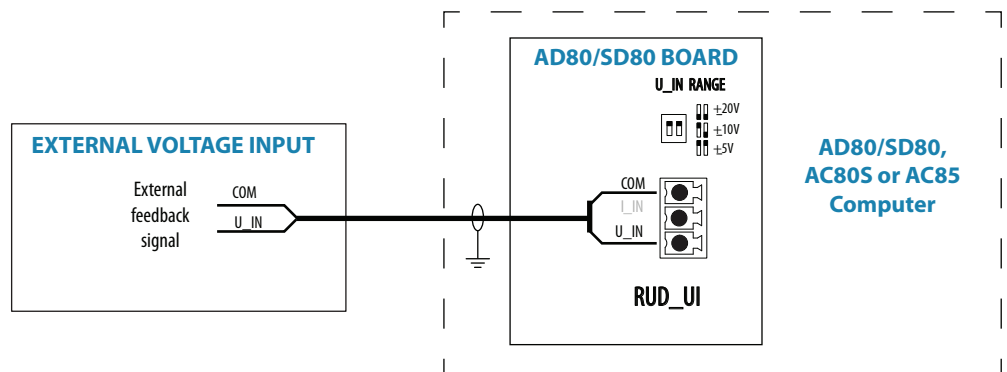
U\_IN RANGE



The DIP switch must be set to +/- 20 V.

## External voltage feedback input

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).



U\_IN RANGE



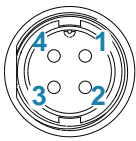
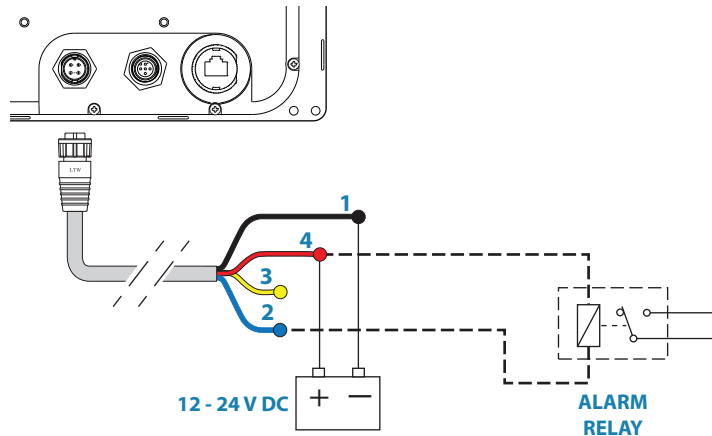
The DIP switch must be set to match range for analog voltage input signal.

## Alarm interface

### External alarm

An external alarm can be connected to the autopilot control head. The alarm signal have an open contact for an alarm buzzer or an external alarm relay as illustrated below. The alarm voltage is the same as the main supply voltage. The maximum load on the external alarm output is 0.75 Amp.

Alarms are configured globally in the system, i.e. they can be configured on one unit and seen, heard and acknowledged from all control units.



| Pin | Color  | Description               |
|-----|--------|---------------------------|
| 1   | Black  | Battery (-)               |
| 2   | Blue   | Alarm/Active              |
| 3   | Yellow | External command          |
| 4   | Red    | Battery (+), 12 - 24 V DC |

### External alarm setup

The siren must be enabled in order for the unit to drive the external alarm when an alarm condition arises.

Refer the alarm description in the separate AP70 MK2 Operator manual.

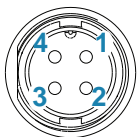
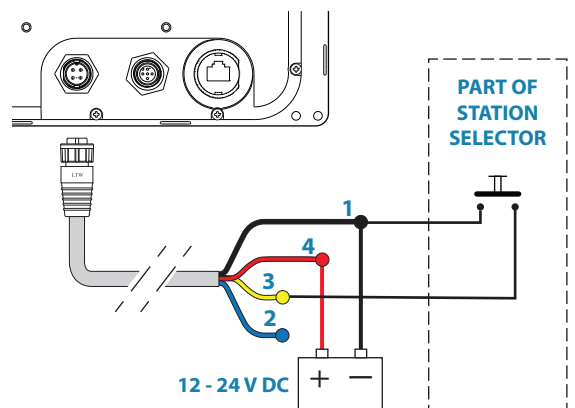
### External Take command

An external take command signal can be used to take command on a control unit.

The function is identical to a short press on the Command key on AP70 MK2 control unit.

In an open system (no command transfer restrictions) you will get immediate control from the control unit requesting command.

In a multi-station system with active lock function, the command request must be confirmed on the active control unit.



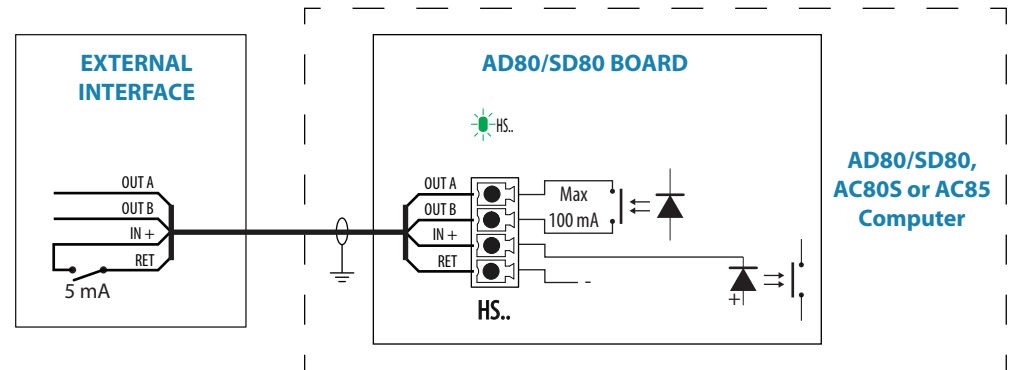
| Pin | Color  | Description               |
|-----|--------|---------------------------|
| 1   | Black  | Battery (-)               |
| 2   | Blue   | Alarm/Active              |
| 3   | Yellow | External command          |
| 4   | Red    | Battery (+), 12 - 24 V DC |

## External I/O

### Handshake

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80S or AC85 Computer).

The SD80 and AD80 boards have two identical galvanic isolated handshake digital I/O ports that can be software configured for various applications like interface to steering gear control, handsteering override, watch alarm, direct i/o type central alarm panel, pulse log input and pendulum ferry function.



The LED is green when handshake output is on.

→ **Note:** The Handshake must be defined as described in “Dockside - Drive system” on page 47.

### Central alarm panel with direct I/O interface

Connects to: AP70 MK2 Control unit, and AD80 board or SD80 board.

The interfacing described below applies for central alarm panels that use direct lines for alarm, mute and acknowledge. For alarm panel using serial interface, refer to “IEC61162-1/2 (NMEA 0183) devices” on page 26.

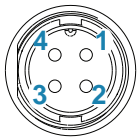
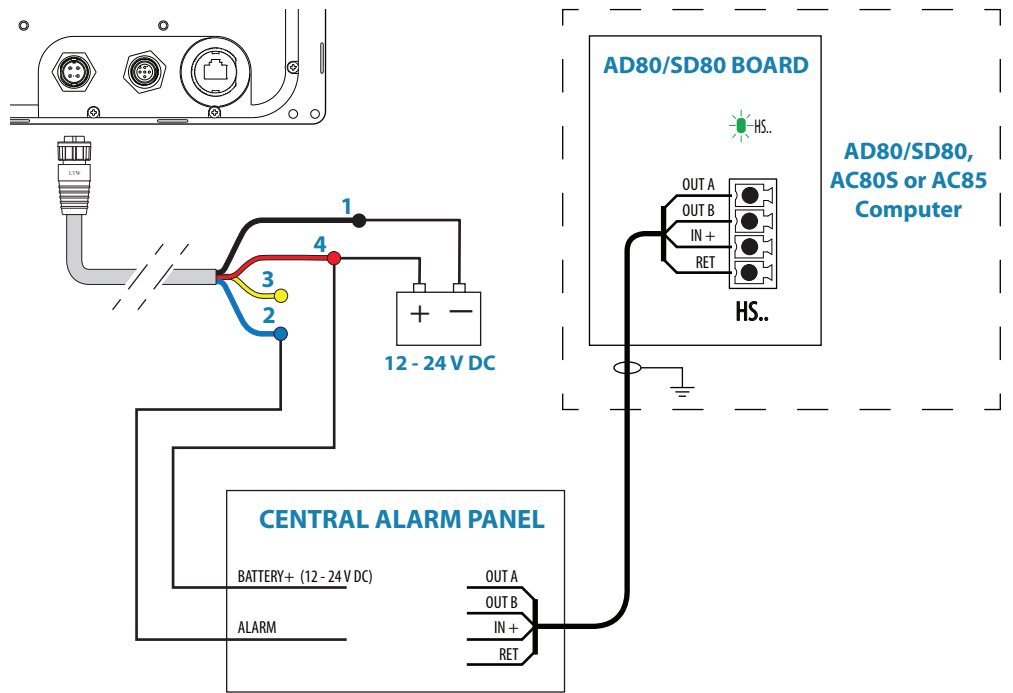
The autopilot system will have two cable connections to a Central Alarm panel;

- one from the autopilot control unit
- one from the autopilot computer

From the autopilot control unit we are using the same two wires (red and blue) as for external alarm relay connection.

Under normal operation you will see 12/24 V between these two wires. In an alarm situation, or when power is lost, you will see no voltage.

From the autopilot computer we are using the handshake connection on the SD80 or AD80 board for alarm, mute and acknowledge.



| Pin | Color  | Description               |
|-----|--------|---------------------------|
| 1   | Black  | Battery (-)               |
| 2   | Blue   | Alarm/Active              |
| 3   | Yellow | External command          |
| 4   | Red    | Battery (+), 12 - 24 V DC |

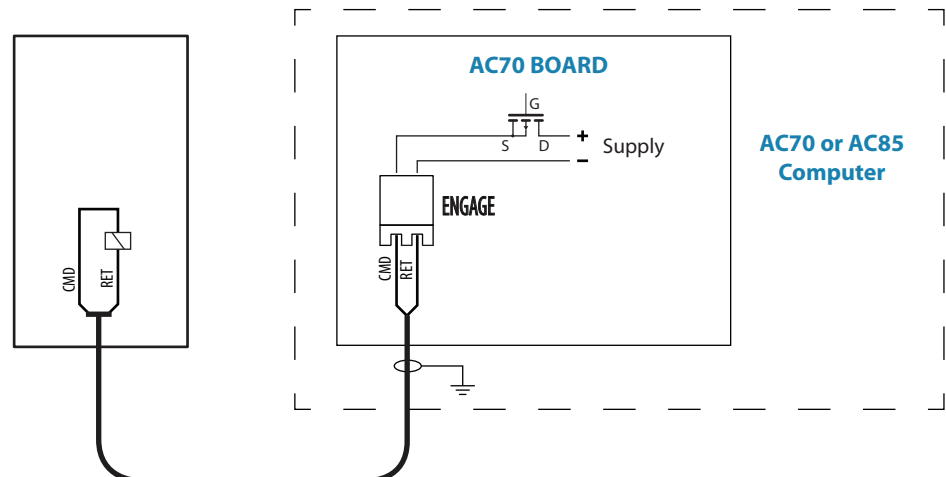
### Engage signal

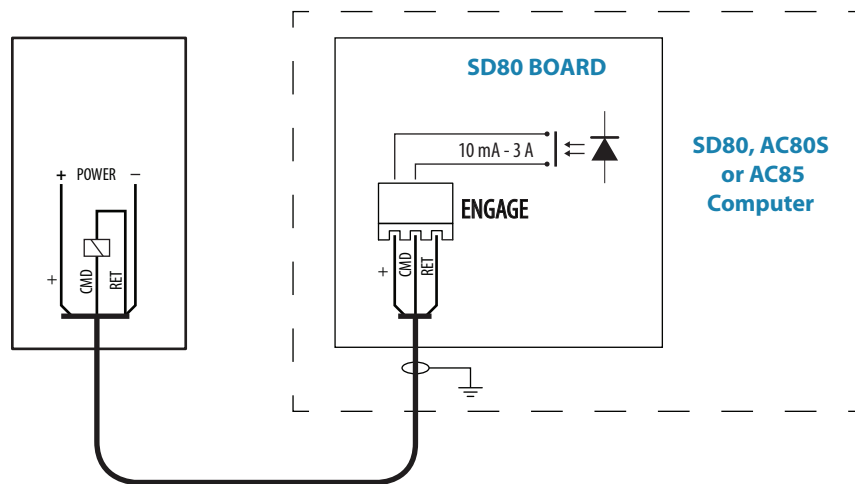
Connects to: AC70 board (in AC70 or AC85 Computer) or SD80 board (in SD80, AC80S or AC85 Computer).

Engage is primarily for operating bypass or dual speed valve, clutch etc for hydraulic or mechanical drive units. The output can be software configured for activating in all steering modes except STANDBY or in AUTO modes only.

For AC70 the drive voltage is internally supplied and the voltage level follows the nominal drive voltage set in software configuration of the AC70 drive.

For SD80 the drive voltage is galvanic isolated and has to be externally supplied. The output can also be software configured for proportional valve control.

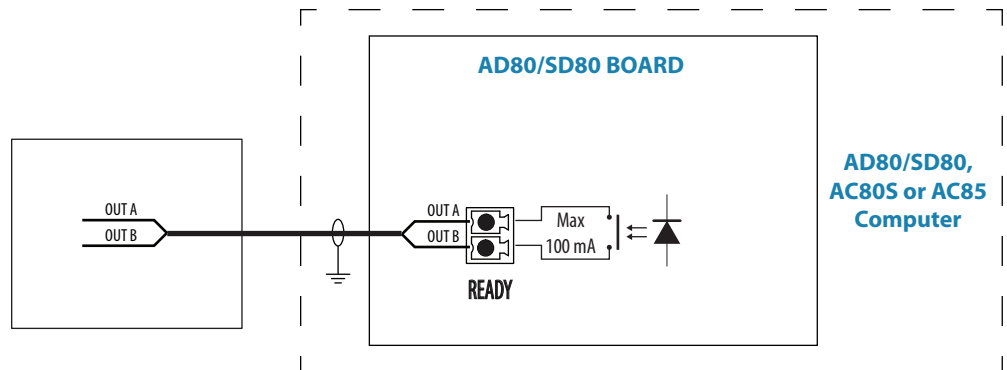




### Ready signal

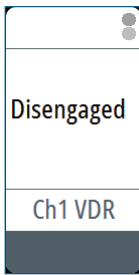
Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80A or AC85 Computer).

The Ready signal is given when the autopilot system is operative for taking control. In case of serious software or hardware failure and when the system is turned off, the signal line will open. Some steering gears will use the signal to block rudder/thruster command in case of a serious autopilot failure.



## External system selection

Connects to: SD80 board (in SD80, AC80S or AC85 Computer) or AD80 board (in AD80, AC80A or AC85 Computer).

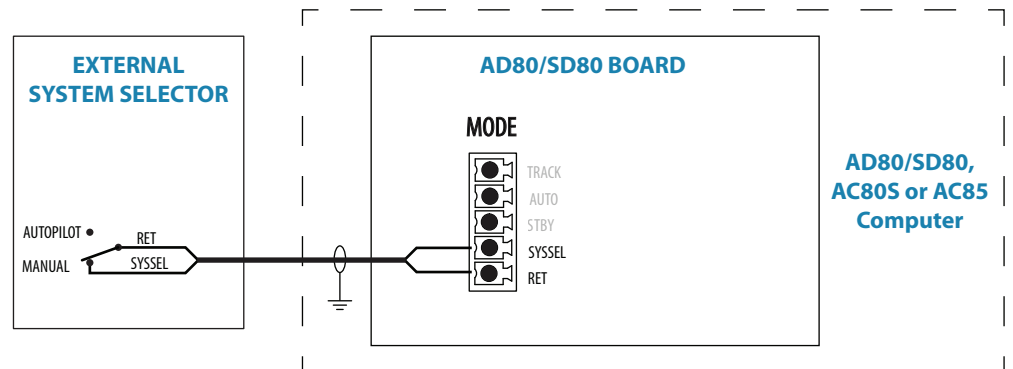


The system select (Sys sel) input signal can be used to alternate between the vessel's own manual steering system and the autopilot system from an external system selector. Refer to IMO resolution MSC 64, sec. 4.

A closing contact between the **SYSEL** and **RET** terminals will disengage the autopilot from the vessel's steering system. The disengaged status will be shown on the autopilot display.

When the contact is re-opened, the autopilot will go to Auto mode with current compass heading as set heading.

→ **Note:** The autopilot will always return to Auto mode, even if it was in NoDrift or Nav mode.

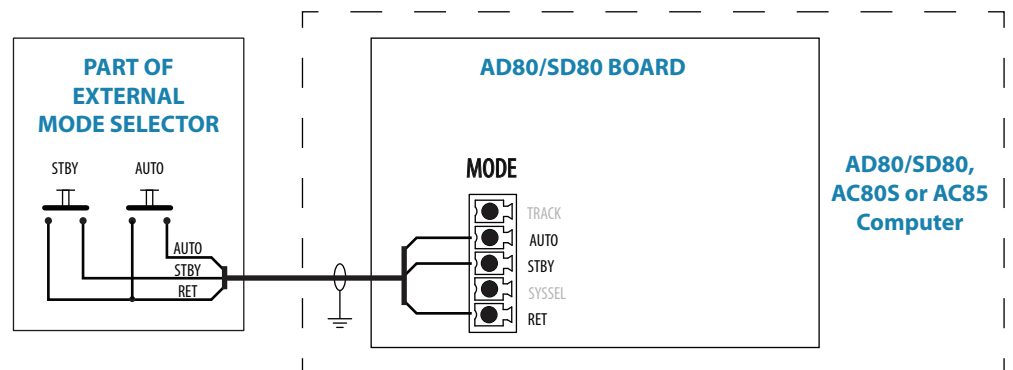


## External mode selection - pulse

Connects to: SD80 board (in SD80 or AC85 Computer) or AD80 board (in AD80A or AC85 Computer).

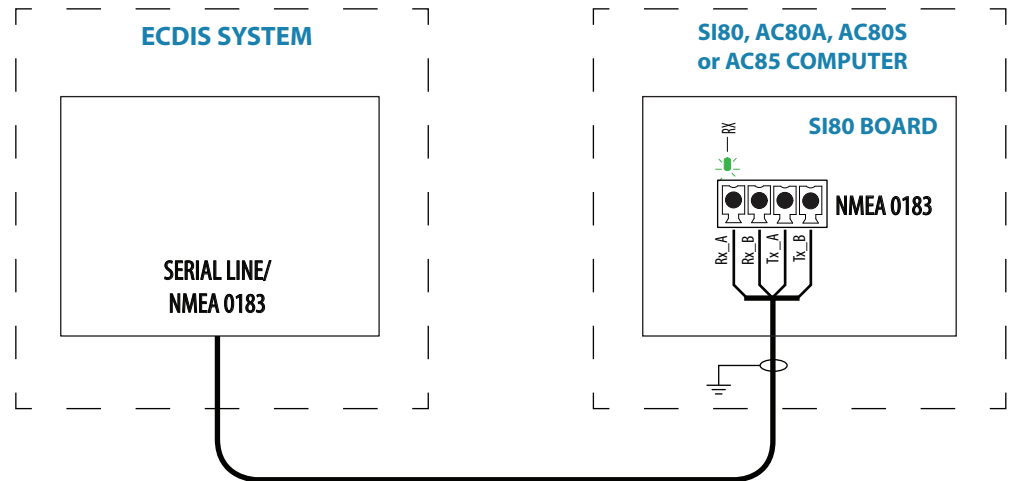
External mode selection can be arranged with push buttons as shown in the figure below. The two push buttons will have similar function as the Standby and Auto keys on the AP70 MK2 control unit.

→ **Note:** If the system has more than one board, SD and/or AD, the external mode selectors should only be connected to one of the boards.



## ECDIS system

Connect the NMEA 0183 serial line from the ECDIS to Ch. 3 NMEA terminal on the SI80 board.



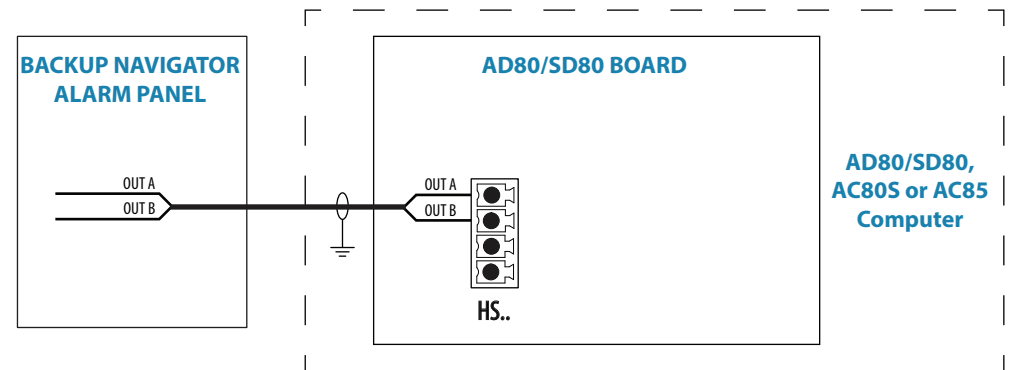
The green LED at the NMEA terminal lights up when serial data is received.

## Backup navigator alarm

A backup navigator alarm is available when the AP70 MK2 is connected to an ECDIS in a Track system.

If an alarm is not acknowledged within the specified timeframe e.g. "wheelover", "end of route" or "track control stopped", a backup navigator alarm can be activated to notify bridge officer off duty.

To enable this feature, the autopilot system provides a configurable handshake port on SD80 or AD80 that can be connected to an external alarm panel or loudspeaker.



# 4

## System configuration

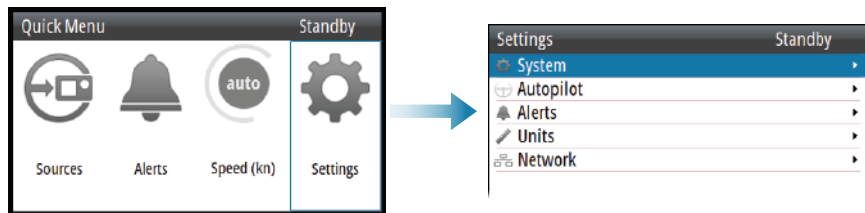
### General

When the autopilot installation is completed, the system must be configured and the commissioning procedures performed. Failure in setting up the autopilot correctly may prevent the autopilot from functioning properly.

For alert settings and alert handling, refer to the Operator manual.

### Settings dialog and submenus

The system configuration settings are logically grouped in the Settings dialog, and each group is presented with an icon. This dialog is accessed by pressing the Settings icon available in all mode specific menus, or by double-clicking the Menu key.



### Turning on for the first time

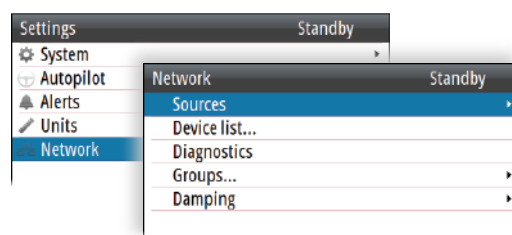
Before attempting to turn on the autopilot and perform an Installation set-up, the hardware installation and electrical installation must be completed and performed in accordance with the installation instructions.

The first time the autopilot system is started up and after a factory reset, you will be guided through a set of initial settings. On additional control heads, acknowledge language selection and cancel all other setup requests.

If the settings are not completed, you can configure the autopilot system manually as described in the following sections.

### Network settings

Setup and selection of sources are done from the Network menu.



### Selecting data sources

A data source can be a sensor or a device connected to the network, providing data to other devices.

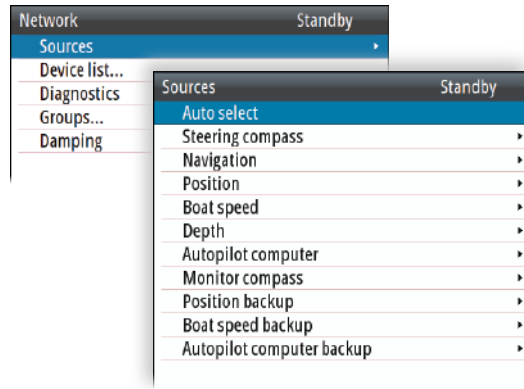
Source selection is required on initial start-up of the system, if any part of the CAN bus network has been changed or replaced, or if an alternative source is made available for a given data type and this source has not been selected automatically.

At the first turn-on of a group of network devices, data sources are automatically selected from an internal priority list. If a data source is connected to the network after the first turn-on, this will be identified and automatically selected if no other data source is selected for the given data type.

You can let the system select your sources automatically, or you can set up each source manually as described below.



## Auto select



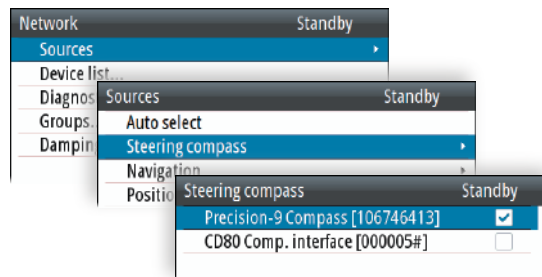
The Auto Select option will look for all sources connected to the network. If more than one source is available for each data type, the system will automatically select from an internal priority list.

The Auto Select function is mainly for situations where the automatic source selection needs to be updated because a selected data source is not supplying data or has been physically replaced with another one. The update secures that the existing source selections are valid and maintained. Missing sources are either automatically exchanged with an alternative source from the list of available sources for the given data type, or the replacing source is selected.

## Manual source selection

You can manually select the preferred source. This is useful if you have more than one of the same type of device on the network.

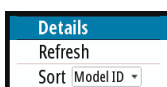
Available sources are listed as shown in the example below. You select the active source by ticking the preferred unit.



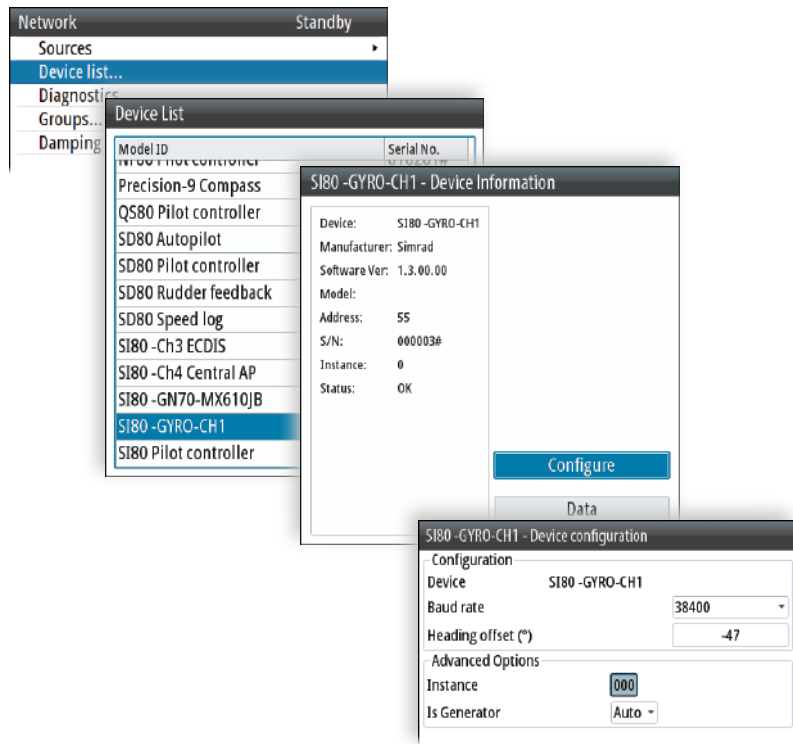
## Device list

From the device list you can:

- list all of the active devices on the network, showing model description and serial number. Devices can be sorted by model ID or by serial number
- display information relating to a device such as: name, manufacturer, software version, instance, status
- give the device a logical name relevant to the user
- see data coming from the device
- get access to configuration page for the device



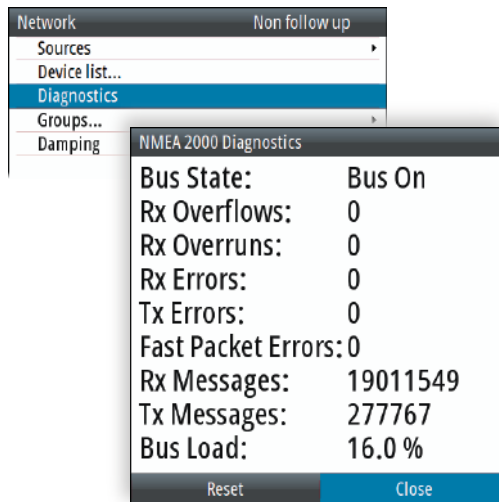
- Press the Menu key to sort the device list
- Press the Menu key, the Starboard key or the rotary knob to see selected device details.



→ **Note:** The graphics show gyro input on an SI80 board. Device details and options depend on data type.

### Diagnostics

The diagnostic page shows details for the NMEA 2000/CAN bus network.

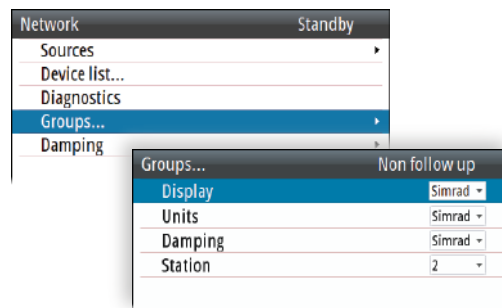


| Option       | Description   |
|--------------|---|
| Bus State    | Indicates if network backbone is operating. Check power: Check termination.   |
| Rx Overflows | Value greater than 0 could indicate the software is very busy and unable to keep up with incoming messages.   |
| Rx Overruns  |   |
| Rx Errors    | CAN interface error counters. Count up when there are errors on the CAN bus, and down when things are ok. Should normally be 0. Goes bus off when 255 is reached. Check same things as for Bus state if greater than 0 is observed. |
| Tx Errors    |   |

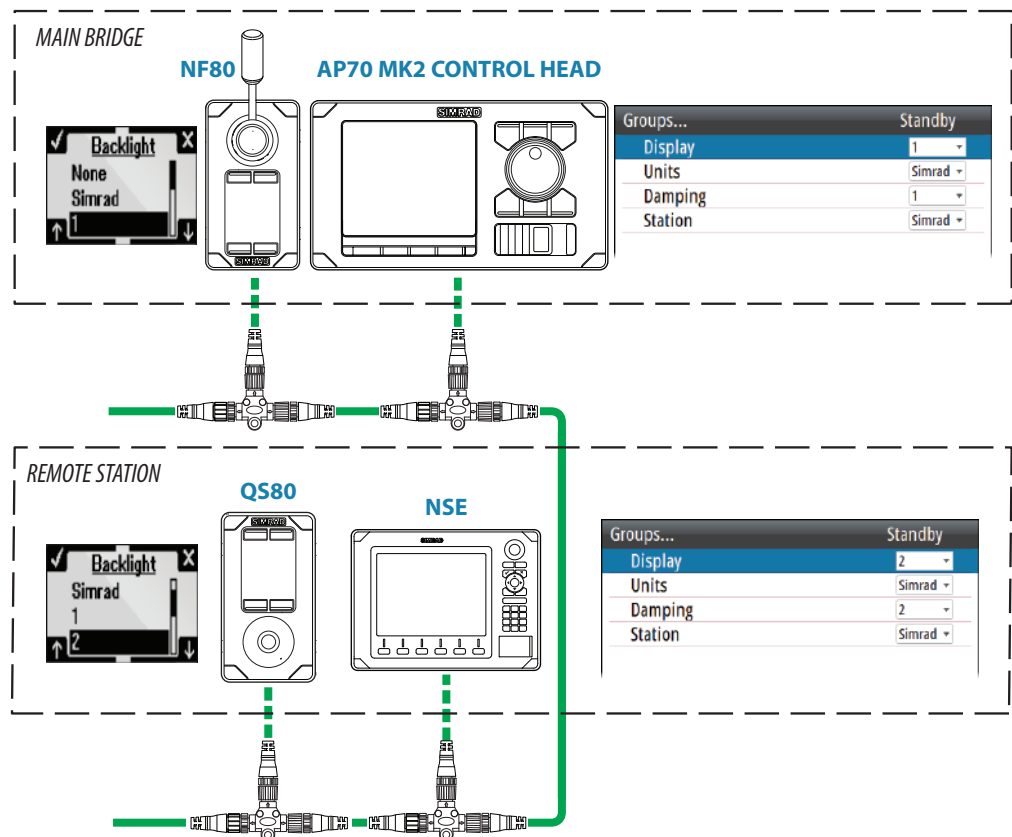
| Option              | Description  |
|---------------------|--|
| Fast packet Errors: | Detected errors since power up. Check the network if this is continually increasing. |
| Rx Messages         | A count since power up of messages received / transmitted.                           |
| Tx Messages         |  |
| Bus Load            | Real time bus load in percentage of max. capacity.                                   |

## Network groups

The network group function is used to control parameter settings, either globally or in groups of units. The function is used on larger vessels where several units are connected via the network. By assigning several units to the same group, a parameter update on one unit will have the same effect on the rest of the group members.



The illustration below shows a two station installation. Units in the Remote Station have their backlight and damping settings in different network groups from the units on the Main Bridge. If the backlight is adjusted in a display on the Main Bridge, it will change in all displays on the Main Bridge. It will not change the light settings in the Remote Station. If the damping is adjusted on the AP70 MK2 control unit, this will not affect damping on the NSE unit in the remote station.



## Master systems

The international standard for heading control systems (ISO 11674/ISO 16329) requires controlled command transfer when remote stations are provided. The delegation of control to the remote station and the return of control shall be incorporated in the autopilot system, and shall avoid unintended operation from a remote station.

To fulfil this requirement the AP70 MK2 system includes a Master function. This is used in larger Wheelmarked systems where you permanently want to control command transfer to remote stations.

In a Master system, one steering station is defined as the Master station. There can be several control units in a master station, but only one of them can be set as the Master unit.

All units included in the master station will be unlocked, and command transfer within the master group will be as in an open system.

Units not included in the master station will be locked. It is not possible to take command from units outside the master station unless the master control unit opens for this. All units outside the master station will have a lock symbol.

In the illustration below the main bridge is defined as master station. One QS80 and two AP70 MK2 control units are included in the master station. One of the AP70 MK2 control units is defined as the Master unit.

The illustration includes network group settings for each unit, showing how the units are defined as part of different network group stations.



### MAIN BRIDGE

| Advanced          | Standby                             |
|-------------------|-------------------------------------|
| Simulate          | <input type="checkbox"/>            |
| Supply voltage    | 5.0V                                |
| Bus voltage       | 5.0V                                |
| Internal temp     | 5.0 °C                              |
| Master            | <input checked="" type="checkbox"/> |
| Autopilot logging | <input type="checkbox"/>            |

| Groups... | Standby  |
|-----------|----------|
| Display   | Simrad ▾ |
| Units     | Simrad ▾ |
| Damping   | Simrad ▾ |
| Station   | Master ▾ |

### AFT STATION

| Groups... | Standby  |
|-----------|----------|
| Display   | Simrad ▾ |
| Units     | Simrad ▾ |
| Damping   | Simrad ▾ |
| Station   | 1 ▾      |

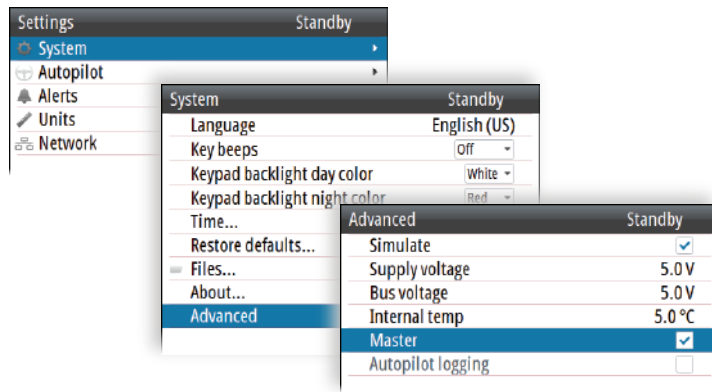
### WING STATION

## Defining a Master system

A master station is usually defined and units assigned to the master station during system setup.

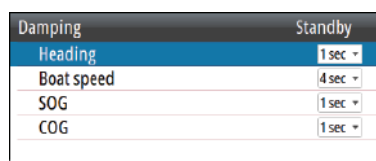
| Groups... | Standby  |
|-----------|----------|
| Display   | Simrad ▾ |
| Units     | Simrad ▾ |
| Damping   | Simrad ▾ |
| Station   | Master ▾ |

→ **Note:** When a network group Station is set to Master, one control unit in this steering station has to be defined as the Master unit as shown below.



## Damping

Controls how quickly the display updates values from sensors.



Increasing the damping applies more averaging or smoothing of the data update rate on the display.

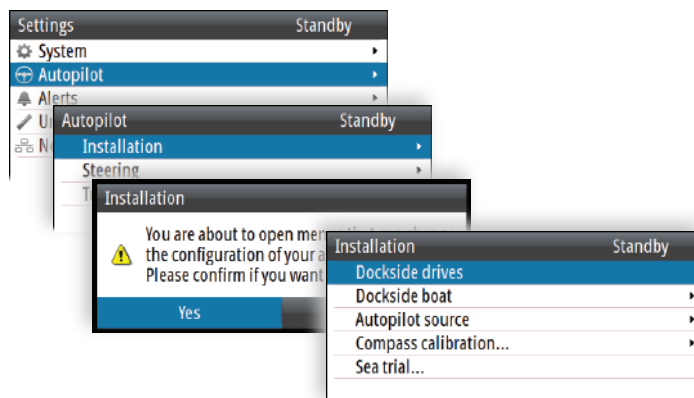
Damping settings are applied to units belonging to particular damping network groups.

→ **Note:** If the damping factor for heading is high, the captured heading might differ from the heading read on the display when using the heading capture function.

## Installation settings

The installation setup includes dockside and sea trial configuration of drives, together with compass calibration.

When the autopilot is delivered from factory AND ANY TIME AFTER AN AUTOPILOT RESET HAS BEEN PERFORMED, all installation settings are reset to factory preset (default) values. A notification will be displayed, and a complete setup has to be made.

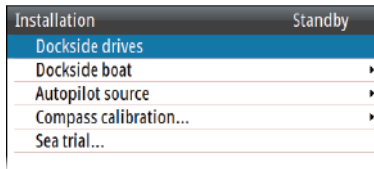


→ **Note:** The Installation settings can only be accessed in Standby mode.

**⚠ Warning:** The installation settings must be performed as part of the commissioning of the autopilot system. Failure to do so correctly may prevent the autopilot from functioning properly!

→ **Note:** The sea trial settings are dependent on successful completion of the dockside settings.

## Dockside - Drive system








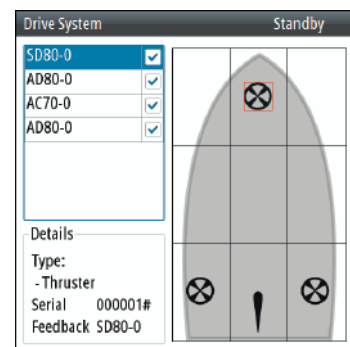
Drive units must be configured and calibrated before they can be used.

The drive system configuration dialog lists all drive units available on the network. The details field includes drive type, serial number and source name.

When the drive configuration is completed this is indicated with a tick after the drive name. The dialog will not illustrate drive type and location before the drive location and type is defined.

The following symbols are used to illustrate drive type:

|   |                 |
|---|-----------------|
|    | Tunnel thruster |
|    | Azimuth         |
|    | Voith Schneider |
|   | Rudder          |
|  | WaterJet        |

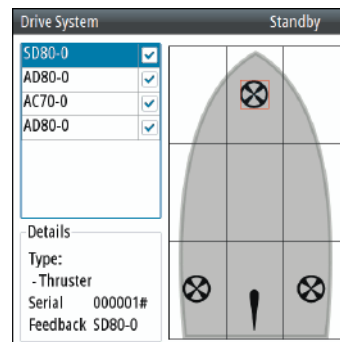


The figure shows a completed commissioning for a vessel.

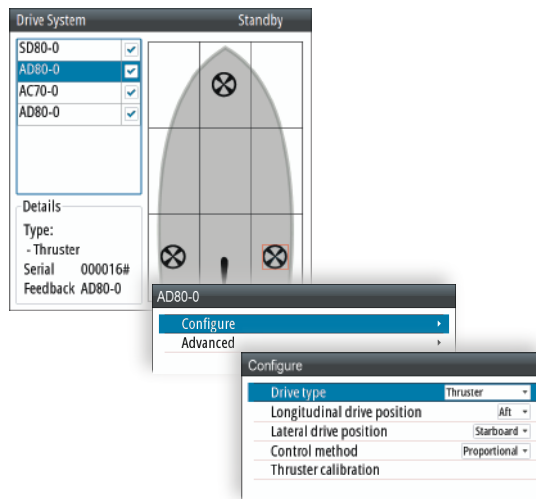
## Configuring the drive system

The drive system configuration is accessed from the drive system configuration dialog.

1. Select the drive to be configured, and press the rotary knob or the Starboard (confirm) key to proceed to the device information dialog



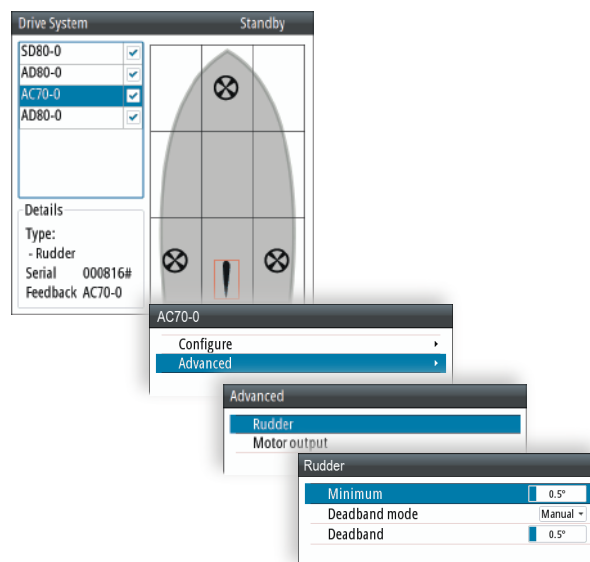
2. Select the Configure option to proceed to device configuration dialog. The dialog differs slightly for the different drive types



3. Select relevant settings for the selected drive, and save your settings

→ **Note:** There is no configuration when using an SG05 PRO. No Rudder- or Feedback calibration is required.

### Advanced rudder settings



#### Minimum rudder

Some boats may have a tendency of not responding to small rudder commands around the course keeping position because of a small rudder, a rudder deadband, whirls/disturbance of the water-stream passing the rudder or it is a single nozzle water jet boat.

By manually adjusting the minimum rudder function, the course keeping performance might be improved on some boats. This will however increase the rudder activity.

→ **Note:** Only set a value for minimum rudder if it proves to give a better course keeping performance in calm sea. It should be set after the autotune has been performed and a fine tuning of the rudder parameter.

#### Deadband mode

Auto or Manual (default: Auto).

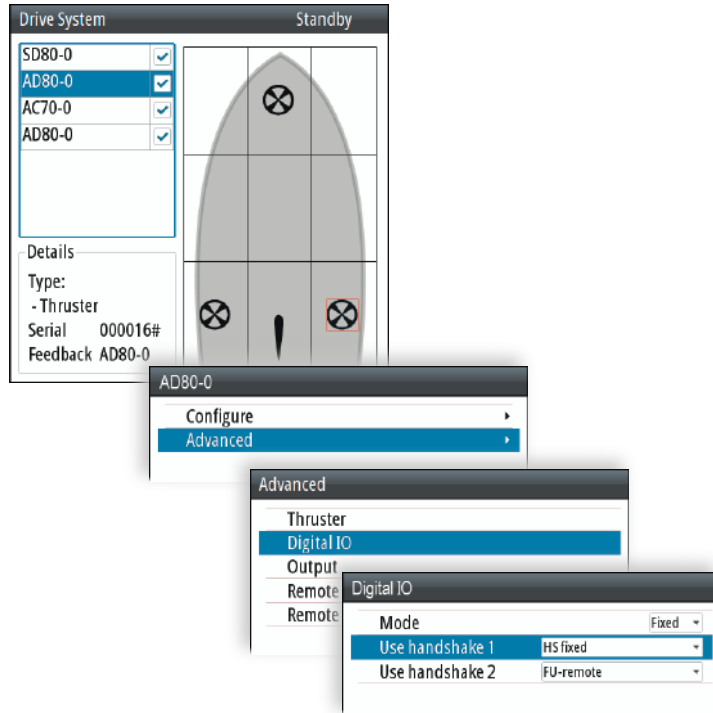
- **Auto:** The rudder deadband is adaptive and is continuously operative. It will also optimize the deadband to the speed of the vessel and the pressure on the rudder.
- **Manual:** If the Auto setting doesn't perform properly due to extreme rudder speed and/or overshoot, it can be adjusted manually.

Find the lowest possible value that will prevent the rudder from continuous hunting. A wide deadband will cause inaccurate steering. It is recommended to check rudder stability in AUTO mode at cruising speed to get pressure on the rudder. (Slight hunting observed dockside may disappear at cruising speed.)

### Rudder deadband

Prevents the rudder from hunting caused by high rudder speed and/or overshoot in the steering gear.

### Configuring the handshake



### Handshake settings

| Handshake setting | Function   | Description   |
|-------------------|--|---|
| HS fixed          | Autopilot/steering gear interface with fixed level signals | Output contact is closed when autopilot requests steering gear control.<br>Input to be closed for as long as steering gear is available for autopilot control (normally a "ready" signal).  |
| HS pulse          | Autopilot/steering gear interface with pulse signals       | Output contact is closed for 1 sec when autopilot requests steering gear control.<br>Input to be closed for as long as steering gear is available for autopilot control.  |
| Override Dodge    | Manual override with fallback to <b>AUTO</b>               | When input contact is closed, the autopilot will give override warning, acknowledge with closed output contact and go to Standby mode. When input opens, output contact will open and the autopilot returns to Auto mode on present heading. Typically used for joystick handsteering with override button on top.<br><br>→ <b>Note:</b> must be limited to one autopilot computer board. |



| Handshake setting | Function   | Description   |
|-------------------|--|---|
| Override Standby  | Manual override to Standby                       | When input contact is closed, the autopilot will give override warning, acknowledge with closed output contact and lock to Standby mode. When input opens, output contact will open and the autopilot will unlock. This function is normally related to regulations for automatic override when main handsteering is operated.<br><br>→ <b>Note:</b> Must be limited to one autopilot computer board. |
| FU-remote         | External FU/DP control by command transfer       | When input contact is closed, a command transfer dialogue is started (refer Command transfer description in the AP70 MK2 Operator Manual). When accepted, the output contact will close and use the installed current or voltage input to the <b>RUD UI</b> plug of SD80/AD80 board for follow-up rudder control. Output will open if control is taken from another unit again.                       |
| Alarm panel       | Interface to central alarm panel with direct I/O | Refer "Central alarm panel with direct I/O interface" on page 36.   |
| P-log & Auto      | Pulse log input, auto mode output                | If a pulse log of 200 p/NM to the input, it will show up as a speed source on the CAN network.<br>The output will be a closed contact whenever the autopilot is in Auto, NoDrift or Nav/Track mode. The signal can be used for reducing oil flow to rudder, watch alarm activate etc.   |
| Pendulum & WA     |  | If input signal is closed, steering and monitor compass will be offset by 180°. Output contact will close for 0.5 sec. when active control unit is operated. Can be used for watch alarm systems that require information about operation of equipment.   |

### Pendulum feature

The pendulum feature is intended for pendulum ferries where it is required to turn the heading 180° when the vessel is going «backwards».

The feature can be enabled in AP70 MK2 systems equipped with SD80 or AD80 boards, by connecting an external switch to one of the Handshake inputs. When the contact is closed, the heading from the main compass and the monitor compass will change 180 degrees.

It can be used with the following compass sources:

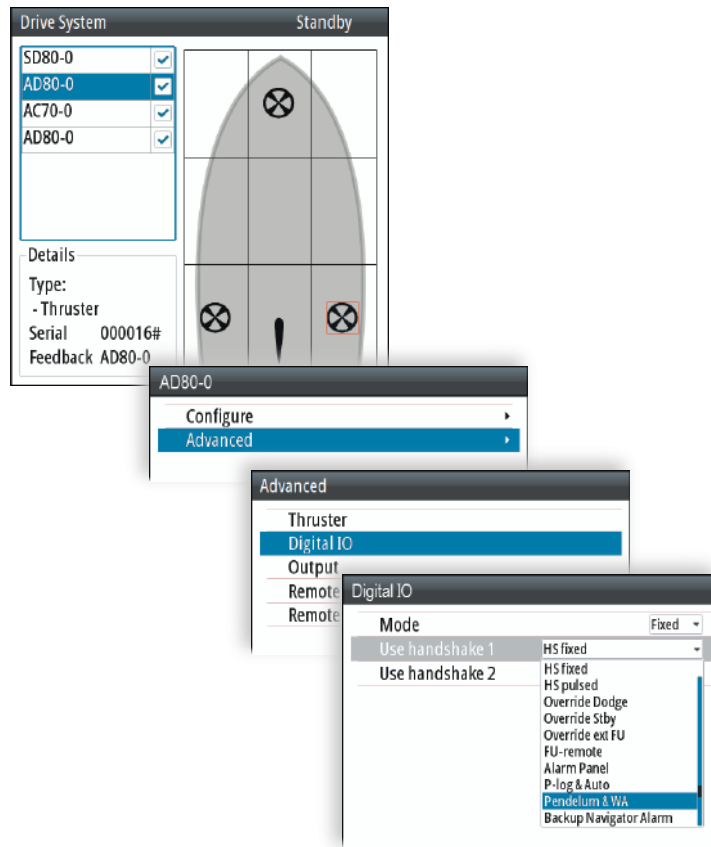
- Precision-9
- RC42
- CDI80
- HS80
- A NMEA 0183 device connected to AC70 or SI80

For NMEA 0183 compasses, this applies an offset to the heading read from the serial interface. For NMEA2000 compasses, this changes the installation offset. All devices on the NMEA 2000 bus will pick up the modified heading.

## Configuration

The AP70 MK2 must be configured for the pendulum function as shown below.

Select Pendulum & WA for handshake 1 or 2, depending on physical connection of external switch.

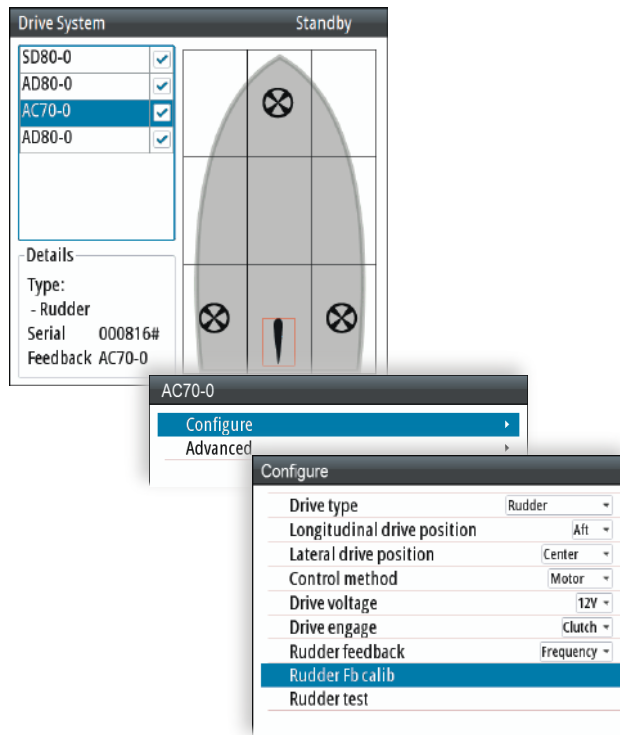


## Rudder feedback/thruster feedback calibration

If a rudder or thruster feedback is available, this must be calibrated. This is required for the autopilot to know signal for mid-position, port/starboard side and rudder movement range.

→ **Note:** The graphics below shows the dialog when the rudder is controlled by an AC70. The configuration dialog varies with drive device and drive type.

1. Select feedback calibration option in the device configuration dialog

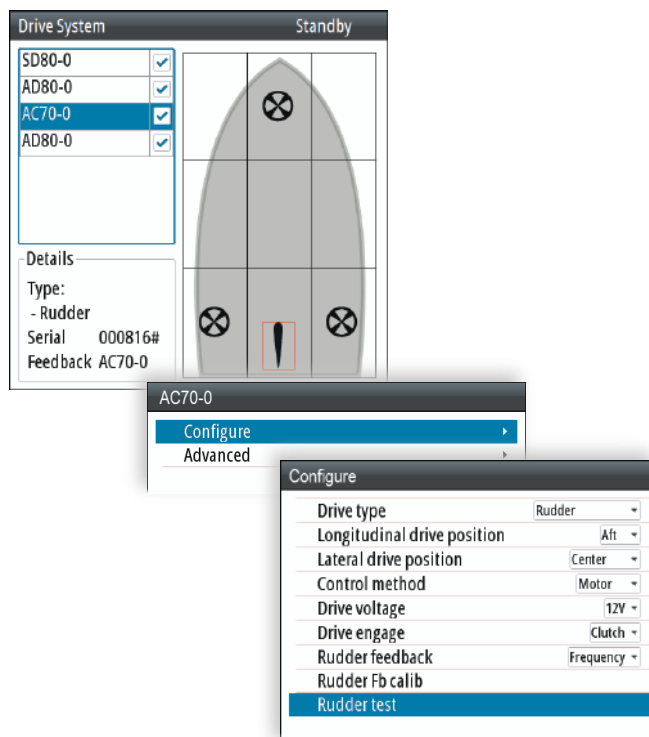


2. Follow the guided steps through the calibration process
3. Save the settings when completed

### Drive test/calibration

When the drives are configured and calibrated, the autopilot need to know drive output level for standstill, polarity for port/starboard movement, the speed/signal- level relationship and max. signal levels allowed. This is learned during the drive test or drive calibration.

1. Select the test option in the device configuration dialog

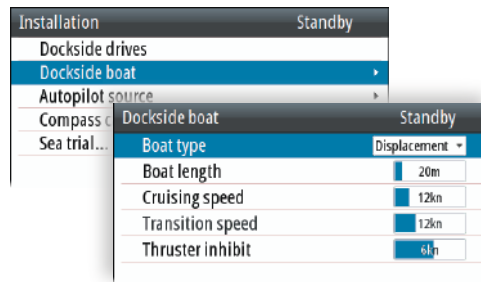


2. Follow the guided steps through the testing process

3. Save the settings when completed

→ **Note:** When a rudder feedback signal is set in the configure view, the feedback must always be calibrated before drive test or drive calibration is allowed.

## Vessel configuration



→ **Note:** The unit of measurement in the dialog reflects your unit settings.

### Boat type

The boat type setting is used by the system to select appropriate preset steering parameters. It will also affect available autopilot features.

### Boat length

The boat length affects the steering parameters.

### Cruising speed

The cruising speed is used if no speed info is available, and if manual speed is set to Auto. It is also used by the autopilot system to calculate steering parameters.

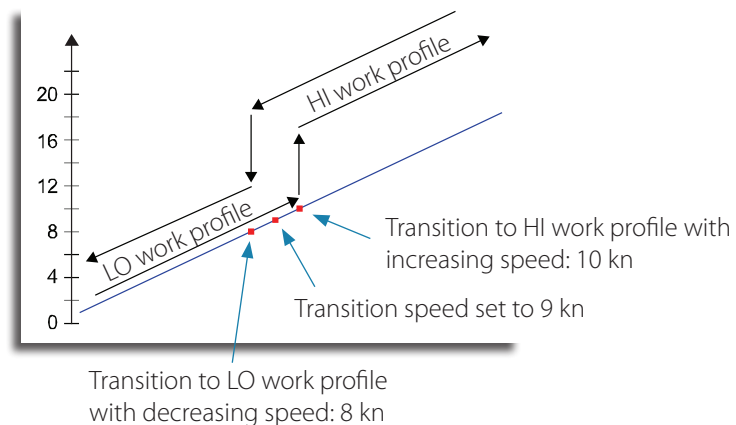
### Transition speed

→ **Note:** Only available if the boat type is set to planing.

The transition speed is the speed at which the system automatically changes from LOW to HIGH work profile.

These two work profiles are automatically defined when you set the boat profile to planing. The work profiles are set up with high and low speed parameters to control the different steering characteristics before and after planing.



On power boats it is recommended that you set a value that represents the speed where the hull begins to plane or the speed where you change from slow to cruising speed.



### Thruster inhibit speed

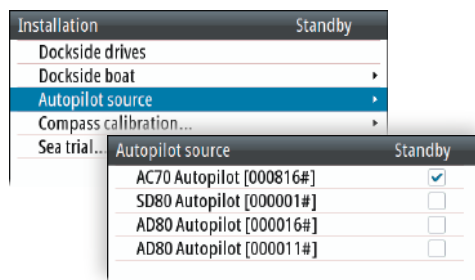
This feature will block the thruster from running above a set vessel speed. It is a safety feature to prevent, especially electrical on/off thrusters, from overheating if out of water or for instance a planing boat or in rough weather.

When the speed exceeds the set limit the thruster indication on the autopilot page will change as shown below.

|   |   |
|---|---|
|  |  |
| <i>Thruster(s) in use</i>   | <i>Thrusters unavailable when speed exceed inhibit limit</i>                        |

→ **Note:** The Thruster inhibit limit will only apply when speed source is Log or SOG, not if the speed is set manually.

### Autopilot source



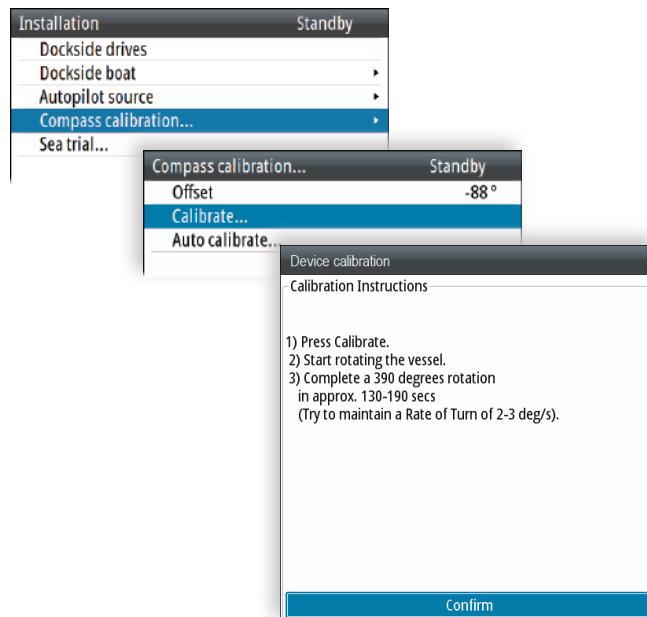
Select the main steering computer as the autopilot source.

## Sea trials

### Compass calibration

All magnetic compasses must be calibrated as part of the autopilot sea trial procedure.

Before the compass calibration is started, make sure that there is enough open water around the vessel to make a full turn.



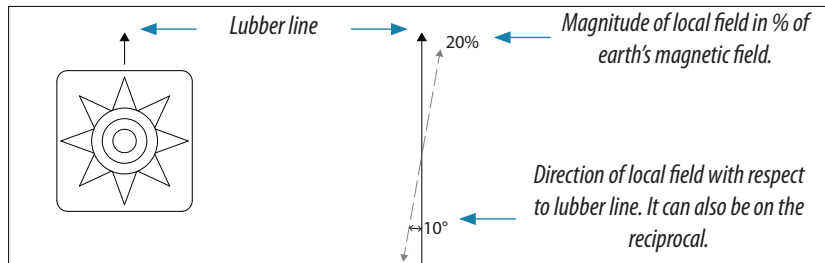
The calibration should be done in calm sea conditions and with minimal wind to obtain good results. Follow the on-screen instruction.

1. Start the calibration by selecting the Calibrate button in the device calibration dialog

2. Follow the instructions on the screen

During the calibration, the compass will measure the magnitude and direction of the local magnetic field.

- If the local magnetic field is stronger than the earth's magnetic field (the local field is reading more than 100%), the compass calibration will fail
- If the local field is reading more than 30%, you should look for any interfering magnetic objects and remove them, or you should move the compass to a different location. The (local) field angle will guide you to the local interfering magnetic object.

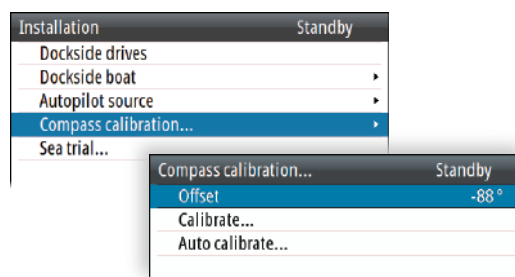


- **Note:** Calibration must be made on the compass that is active for the autopilot. If another model compass from Simrad or another manufacturer is installed, refer to the calibration instruction for that compass.
- **Note:** In certain areas and at high latitudes the local magnetic interference becomes more significant and heading errors exceeding  $\pm 3^\circ$  may have to be accepted.

### Compass mounting offset

The difference between the compass lubber line and the boat's center line should be compensated for.

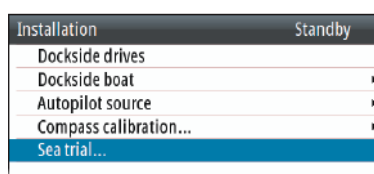
1. Find the bearing from the boat position to a visible object. Use a chart or a chart plotter
2. Steer the boat so the center line of the boat is aligned with the bearing line pointing towards the object
3. Activate the device configuration dialog as shown below
  - Ensure that the active compass is selected
4. Change the offset parameter so that the bearing to the object and the compass readout becomes equal



- **Note:** Make sure that both the compass heading and the bearing to the object have the same unit (Magnetic or True).

### Drive configuration

The drive setup can usually be done while at dock, and only minor adjustments may be required at sea trial. Refer "Dockside - Drive system" on page 47.



## Tuning the autopilot for optimum steering performance

Providing you have entered correct vessel type, length and cruising speed, you may not have to perform further manual or automatic tuning. Refer "Vessel configuration" on page 53.

### → Notes:

- If steering compass is magnetic type, perform any autopilot tuning steering East or West, as this will yield the best balanced parameters
- The speed during tuning should be as close as possible to cruising speed. Ensure that this is set correctly and as described in "Vessel configuration" on page 53
- Active work profile that should be used during sea trial depends on vessel type.
  - For displacement boats **NORMAL** work profile should be used
  - Planing boats will have to tune both **LO SPD** and **HI SPD** work profiles
- All tuning should always be performed in open waters at a safe distance from other traffic

### Initial automatic learning process

Before doing any manual or automatic tuning, the autopilot needs to learn the turn characteristic of the boat. This is done in Auto mode by making a major course change (min. 90°) to port and starboard. For this test you may use the U-turn function (180°).

The autopilot will now find the appropriate amount of rudder to maintain the set turn rate during the turn.

When the automatic learning process is done, now proceed as follows to verify satisfactorily steering:

1. Stabilize the vessel on a heading, and then select Auto mode
2. Observe course keeping and rudder commands
  - The autopilot should keep the vessel on the set heading within an average of +/-1 degree, providing calm sea and wind
3. Make some small and bigger heading changes to port and starboard and observe how the vessel settles on the new heading
  - The vessel should have a minimum of overshoot (see example "Manual tuning" on page 57)

If the autopilot is not keeping the heading satisfactorily or not making the turns satisfactorily, you may now either try the Autotune function or go directly to Manual tuning.

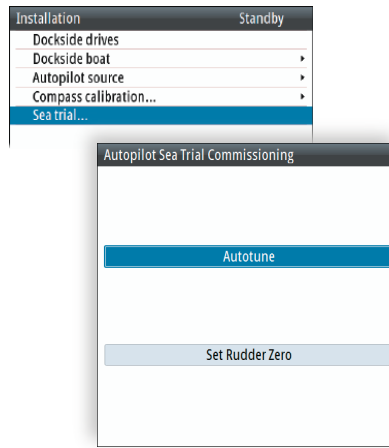
→ **Note:** If the vessel is more than approximately 30 m/100 ft it may be unpractical to perform Autotune, and it is suggested to proceed with manual tuning.

Both Autotune and Manual tuning should be performed in calm or moderate sea conditions.

### Autotuning

When performing an Autotune, the vessel will automatically be taken through a number of S-turns. Based on the vessel's behavior, the autopilot will automatically set the most important steering parameters (Rudder and Counter rudder). The scaling factors for the parameters are set automatically as a function of the set boat type.

1. Stabilize the vessel on a heading
2. Set the speed as close to cruising speed as possible
3. Start autotuning from the dialog
  - The pilot will take control of the vessel. Autotuning may take up to 3 minutes to complete



After the autotuning is completed the autopilot will return to Standby mode, and the rudder must be controlled manually.

→ **Note:** Autotuning can be stopped at any time by selecting Cancel.



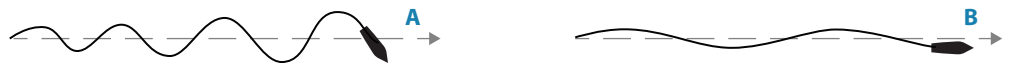
### Manual tuning

1. Stabilize the vessel on a heading, and then select Auto mode
2. Set the speed as close to cruising speed as possible
3. Activate the Quick menu by pressing the Menu key
4. Select Rudder and adjust according to the description below
5. If required, slightly adjust Counter rudder

### Rudder

This parameter determines the ratio between commanded rudder and the heading error. The higher rudder value the more rudder is applied.

- A. The value is set too high. Steering becomes unstable and often the overshoot will increase
- B. Rudder is too small. It will take a long time to compensate for a heading error, and the autopilot will fail to keep a steady course



### Counter rudder

Counter rudder is the amount of counteracting (opposite) rudder applied to stop the turn at the end of a major course change.

The settings depend on vessel's characteristics, loaded/ballast conditions and rate of turn.

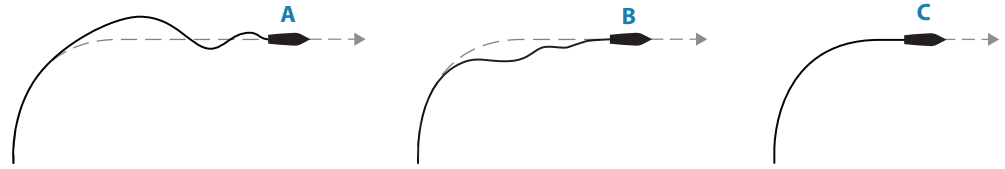
- If the vessel has good dynamic stability, relatively small settings will be sufficient
- An unstable vessel will require high settings
- The greater the vessel's inertia, the greater value will be required

Increasing counter rudder settings may result in some higher rudder activity also when steering a straight course.



The best way of checking the value of the Counter rudder setting is when making turns. The figures illustrate the effects of various Counter Rudder settings;

- A. Counter rudder too low; overshoot response
- B. Counter rudder too high; sluggish and creeping response
- C. Correct setting or counter rudder; ideal response



Perform various course changes and observe how the boat settles on the new heading. Start with small changes, 10-20 degrees and proceed with bigger changes, 60-90 degrees. Adjust Counter rudder value to obtain best possible response as illustration C.

→ **Note:** As many boats turn differently to port versus starboard (due to propeller rotation direction), do the course changes in both directions. You may end up with a compromise setting of Counter rudder that gives a little overshoot to one side and a bit sluggish response to the other.

# 5

## Installation checklist

---

### General

When all units are installed, external equipment connected and the software configured according to the previous sections, the installation should be verified according to the check lists in the following pages.

### Checklist

| Description  | Refer                             | Yes/No | N/A |
|--|-----------------------------------|--------|-----|
| Units mounted and secured according to instructions      | "Mounting" on page 17             |        |     |
|  |                                   |        |     |
| CAN bus powered and terminated according to instructions | "Wiring" on page 21               |        |     |
| Correct power and polarity to computer and control units |                                   |        |     |
|  |                                   |        |     |
| Sources selected   | "System configuration" on page 41 |        |     |
| Network groups defined                                   |                                   |        |     |
| Master station defined                                   |                                   |        |     |
| Drive units configured and calibrated                    |                                   |        |     |
| Vessel configured  |                                   |        |     |
| Compass calibrated                                       |                                   |        |     |
| Sea trial completed (Manual tuning)                      |                                   |        |     |
|  |                                   |        |     |
| Connected equipment approved according to certificate    |                                   |        |     |
|  |                                   |        |     |
| User training provided                                   |                                   |        |     |

Date: \_\_\_\_\_

\_\_\_\_\_  
Signature Installer

\_\_\_\_\_  
Signature Captain

## Installation settings

### Drives

| Setting                     | AC70 | SD80 | AD80 |
|-----------------------------|------|------|------|
| Configure                   |      |      |      |
| Instance                    |      |      |      |
| Name (product info method)  |      |      |      |
| Drive type                  |      |      |      |
| Longitudinal drive position |      |      |      |
| Lateral drive position      |      |      |      |
| Drive control method        |      |      |      |
| Nominal drive voltage       |      | N/A  | N/A  |
| Drive engage                |      |      | N/A  |
| Rudder feedback             |      |      |      |
| Rudder feedback calibration |      |      |      |
| Advanced                    |      |      |      |
| Min rudder                  |      |      |      |
| Deadband mode               |      |      |      |
| Rudder deadband             |      |      |      |
| Thruster Response delay     | N/A  |      |      |
| Thruster hysteresis         | N/A  | N/A  |      |
| Thruster operation          | N/A  | N/A  |      |
| Mode select                 | N/A  |      |      |
| Handshake 1                 | N/A  |      |      |
| Handshake 2                 | N/A  |      |      |
| Dither frequency            | N/A  |      | N/A  |
| Dither amplitude            | N/A  |      | N/A  |
| Max output port             | N/A  |      |      |
| Max output stbd             | N/A  |      |      |
| Rudder zero                 | N/A  | N/A  |      |
| Zero output                 | N/A  |      |      |
| Min output                  |      |      |      |
| Max output                  |      |      | N/A  |
| Remote FU/DP                | N/A  |      |      |
| Remote FU/DP calibrate      | N/A  |      |      |

### Boat

| Setting                |  |
|------------------------|--|
| Dockside boat          |  |
| Boat type              |  |
| Boat length            |  |
| Cruising speed         |  |
| Transition speed       |  |
| Thruster inhibit speed |  |
| Sea trial boat         |  |
| Turn type              |  |

| Setting              |  |
|----------------------|--|
| Turn value           |  |
| Track approach angle |  |

### Work profiles

| Setting              |           |  |  |  |  |  |
|----------------------|-----------|--|--|--|--|--|
| Profile name         | Normal    |  |  |  |  |  |
| Auto steering        |           |  |  |  |  |  |
| Turn                 |           |  |  |  |  |  |
| Wave filter          |           |  |  |  |  |  |
| Adaption             |           |  |  |  |  |  |
| Rudder gain          |           |  |  |  |  |  |
| Counter rudder       |           |  |  |  |  |  |
| Autotrim             |           |  |  |  |  |  |
| Off heading limit    |           |  |  |  |  |  |
| Low speed limit      |           |  |  |  |  |  |
| Track steering       |           |  |  |  |  |  |
| Track response       |           |  |  |  |  |  |
| Track approach angle |           |  |  |  |  |  |
| Course change limits |           |  |  |  |  |  |
| XTD limit            |           |  |  |  |  |  |
| Drive select         |           |  |  |  |  |  |
|                      |           |  |  |  |  |  |
|                      |           |  |  |  |  |  |
|                      |           |  |  |  |  |  |
|                      |           |  |  |  |  |  |
|                      |           |  |  |  |  |  |
| Rudder               |           |  |  |  |  |  |
| Init rudder          |           |  |  |  |  |  |
| Rudder limit         |           |  |  |  |  |  |
| Tow angle            |           |  |  |  |  |  |
| Thruster             |           |  |  |  |  |  |
| Thruster sensitivity |           |  |  |  |  |  |
| Thruster assist      |           |  |  |  |  |  |
| Push boat to         |           |  |  |  |  |  |
|                      | Port      |  |  |  |  |  |
|                      | Starboard |  |  |  |  |  |

## Installed units

| Unit          | Type | Location | Date |
|---------------|------|----------|------|
| Control units |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
| Remotes       |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
| Computers     |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
| Feedbacks     |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
| Compass       |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
| Other units   |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |
|               |      |          |      |

# 6

## Specifications

### AP70 MK2 Autopilot system

→ **Note:** For updated technical specifications, compliance and certifications, refer to our websites.

|                                  |  |
|----------------------------------|--|
| Boat type:                       | Power (displacement, outboard and planing). From 30 ft and up  |
| Steering system types:           | Hydraulic; Reversible pump/Solenoids<br>Mechanical; Rotary drive/Linear drive.<br>Max 6 rudder/thruster drives |
| Inter-unit connection:           | CAN bus/NMEA 2000  |
| System ON/OFF:                   | From control units   |
| Supply voltage:                  | 12/24 V DC +30 -10%  |
| Power consumption:               | Dependent on system configuration (See spec for individual units)  |
| EMC protection:                  | IEC 60945: 2002-08   |
| Performance:                     | IMO A.342(IX) & A.822(19), ISO 11674 & 16329   |
| Rate of turn:                    | Within $\pm 10\%$ of preset value or $3^\circ/\text{min}$ . Ref. ISO 11674: 4.3.7                              |
| Heading indication error:        | $<0.5^\circ$ . Ref. ISO 11674: 4.3.5   |
| Heading stability:               | Within $\pm 1^\circ$ . Ref. ISO 11674: 4.3.13  |
| Automatic Steering Control       |  |
| Rudder/thruster Drive            | Reversible pump, solenoid on/off, proportional valve, analog   |
| Electronic interface:            |  |
| Serial data input/output ports:: | AC70: 1<br>AC80, AC85, SI80: 4<br>Refer to "Supported data" on page 71   |
| Heading sensors:                 | Gyrocompass, Fluxgate/Rate compass, Magnetic compass, GPS compass (NMEA)                                       |
| Course selection:                | Rotary course knob and buttons   |
| Alerts:                          | Audible and visual, external optional (AC70)   |
| Alert modes:                     | See "Alert system" on page 61  |
| Steering modes:                  | Standby, Non-follow-up, Follow-up, Auto, NoDrift, Nav  |
| Special turn modes:              | U-Turn and S-Turn  |

## AP70 MK2 control unit

| DISPLAY   |  |
|---|--|
| Size  | 127 mm (5")  |
| Resolution (HxW)  | 480x480  |
| Type  | 16-bit color TFT   |
| Antifog   | bonded   |
| Best viewing direction  | any direction  |
| Backlight   | Cold Cathode Fluorescent Lamp (CCFL)                             |
| NETWORKING  |  |
| CAN bus   | 1 port   |
| USB   | 1 port   |
| Ethernet  | 1 port   |
| POWER   |  |
| Local supply  | 12/24 V DC +30-10%   |
| Consumption local supply                                      | 0.7/0.4 A at 12 V DC 0.4/0.3 A at 24 V DC<br>backlight full/off" |
| NMEA 2000 Load Equivalent number (50 mA)                      | 1  |
| INTERFACE   |  |
| External alarm/Active unit output                             | Maximum 100 mA, 4.5 A short circuit limit                        |
| External Take CMD input contact current                       | Maximum 8 mA   |
| ENVIRONMENT   |  |
| Temperature, operation  | -30°C to +55°C (-22°F to 131°F)                                  |
| Temperature, storage  | -25°C to +70°C (-13°F to 158°F)                                  |
| Category  | Exposed, IPx6  |
| MECHANICAL  |  |
| Weight  | 1,4 kg (3.1 lbs)   |
| Size  | Refer "Drawings" on page 72                                      |
| Mounting  | Panel (flush) or optional bracket                                |
| Compass safe distance   | 0.4 m  |
| Material  | Epoxy coated seawater resistant aluminium, plastic front bezel   |
| Color   | Black and grey   |
| Cable inlet, refer to "AP70 MK2 connector pinouts" on page 70 | 1 Power/alarm, 1 Micro-C con.                                    |

## Autopilot computers

→ **Note:** For signal specification of the board(s), see “Computer boards” on page 67.

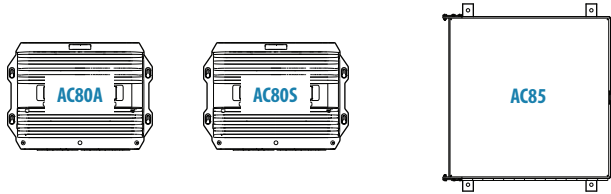
### SI80, AC70, AD80 and SD80 computers



|  | SI80  | AC70   | AD80  | SD80 |
|--|---|--|---|------|
| <b>Board</b>                             |   |  |   |      |
| SI80 board                               | x   |  |   |      |
| AC70 board                               |   | x  |   |      |
| AD80 board                               |   |  | x   |      |
| SD80 board                               |   |  |   | x    |
| <b>POWER</b>                             |   |  |   |      |
| Local supply                             | 12/24 V DC, +30 - 10%.<br>Need 12 V CAN supply                      |  | N/A   | N/A  |
| Consumption local supply                 | 0,3 - 5 A<br>CAN bus load dependent                                 | 100/65 mA<br>at 12/24 V<br>DC + load of<br>connected<br>equipment<br>(motor,<br>solenoids,<br>clutch etc.) | N/A   | N/A  |
| NMEA 2000 Load Equivalent number (50 mA) | 1   | 1  | 4   | 3    |
| Output for CAN bus supply                | 15 V DC,<br>+/- 5%, 4 A<br>max                                      | N/A  | N/A   | N/A  |
| <b>ENVIRONMENT</b>                       |   |  |   |      |
| Temperature, operation                   | -15°C to +55°C (5°F to 131°F)                                       |  |   |      |
| Temperature, storage                     | -30°C to +70°C (-22°F to 158°F)                                     |  |   |      |
| Category                                 | Protected, IPx2   |  |   |      |
| <b>MECHANICAL</b>                        |   |  |   |      |
| Weight                                   | 0,9 kg (2 lbs)  | 1 kg (2.2 lbs)   | 0,5 kg (1.1 lbs)                            |      |
| Size (length x width x height)           | See “AC70 and SI80 computer”<br>on page 73                          |  | See “SD80 and AD80<br>computers” on page 73 |      |
| Mounting                                 | Bulkhead  |  |   |      |
| Compass safe distance                    | 1 m   |  |   |      |
| Material                                 | Plastic front and anodized<br>aluminum back                         |  | Plastic                                     |      |
| Color                                    | Black   |  |   |      |
| Cable inlet                              | Slots:<br>9 x 95 mm and 18 x 45 mm<br>(0.4" x 3.7" and 0.7" x 1.8") |  |   |      |



## AC80A, AC80S and AC85 computers



|  | AC80A  | AC80S | AC85   |
|--|--|-------|--|
| <b>Board</b>                             |  |       |  |
| SI80 board                               | x  | x     | x (1 Basic), (+1 optional)   |
| AC70 board                               |  |       | Optional<br>Max. 4 boards  |
| AD80 board                               | x  |       |  |
| SD80 board                               |  | x     |  |
| <b>POWER</b>                             |  |       |  |
| Local supply                             | 12/24 V DC +30-10%   |       |  |
| Consumption local supply                 |  |       |  |
| NMEA 2000 Load Equivalent number (50 mA) | 5  | 4     | Config. dependant. Max. 13   |
| Output for CAN bus supply                | 15 V DC, +/- 5%, 4 A max.  |       |  |
| <b>ENVIRONMENT</b>                       |  |       |  |
| Temperature, operation                   | -15°C to +55°C (5°F to 131°F)  |       |  |
| Temperature, storage                     | -30°C to +70°C (-22°F to 158°F)  |       |  |
| Category                                 | Protected, IPx4  |       | Protected, IPx4  |
| <b>MECHANICAL</b>                        |  |       |  |
| Weight                                   | 4.1 kg (9 lbs) (basic)   |       |  |
| Size (length x width x height)           | See "AC80A and AC80S computer" on page 74  |       | See "AC85 computer" on page 74   |
| Mounting                                 | Bulkhead   |       |  |
| Compass safe distance                    | 1 m  |       |  |
| Color                                    | Black  |       |  |
| Cable inlet                              | Grommets:<br>7 for cable diameter<br>7 - 10 mm (0.3" - 0.4")<br><br>4 for cable diameter<br>10 - 14 mm (0.4" - 0.6") |       | Grommets:<br>8 for cable diameter<br>10 - 14 mm (0.4" - 0.6")<br><br>7 for cable diameter<br>14 -20 mm (0.6" - 0.8") |

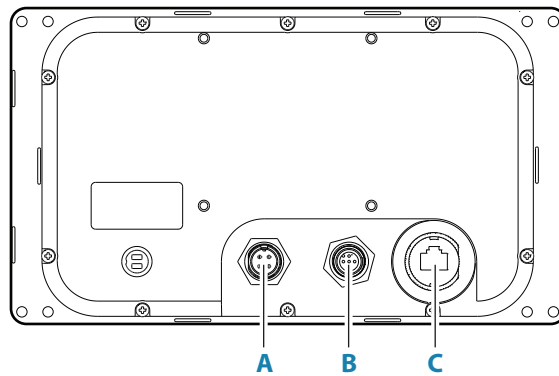
## Computer boards

|  | SI80                                | AC70  | SD80   | AD80  |
|--|-------------------------------------|---|--|---|
| <b>NETWORKING</b>  |                                     |   |  |   |
| NMEA 0183, IEC 61162-1, IEC 61162-2, input                 | 4 ch                                | 1 ch  |  |   |
| NMEA 0183, IEC 61162-1, IEC 61162-2, output                | 4 ch                                | 1 ch  |  |   |
| NMEA 0183, IEC 61162-1, IEC 61162-2, baud rate             | 4.8, 9.6, 19.2 and 38.4 kBaud       | 4.8, 9.6, 19.2 and 38.4 kBaud   |  |   |
| CAN bus  | x                                   | x   | x  | x   |
| <b>POWER</b>   |                                     |   |  |   |
| Local supply   | 12/24 V DC +30 - 10%                | 12/24 V DC + 30 - 10%. Need 12 V CAN supply   | N/A  | N/A   |
| Consumption local supply                                   | 0,3 - 5 A<br>CAN bus load dependent | 100/65 mA at 12/24 V DC + load of connected equipment (motor, solenoids, clutch etc.) | N/A  | N/A   |
| NMEA 2000 Load Equivalent number (50 mA)                   | 1                                   | 1   | 3  | 4   |
| Output for CAN bus supply                                  | 15 V DC, +/- 5%, 4 A max.           | N/A   | N/A  | N/A   |
| <b>INTERFACE</b>   |                                     |   |  |   |
| Reversible motor control of rudder/thruster                | N/A                                 | Max. continuous load 30 A, peak 50 A for 1 sec  | N/A  | N/A   |
| On/off solenoid control of rudder/thruster                 | N/A                                 | 12/24 V DC, common lo, load range 10 mA to 10 A. (Off state <1 mA)                    | Externally supplied 12/24 V DC, common hi or lo, load range 10 mA to 10 A. (Off state <1 mA) | N/A   |
| Analog voltage control of rudder/thruster, internal supply | N/A                                 | N/A   | N/A  | Range $\pm 10$ V, max. load 5 mA  |
| Analog voltage control of rudder/thruster, external supply | N/A                                 | N/A   | N/A  | "Supply range: 5-24 V DC<br>Control range: 5-95% of supply range with zero ref at min or half ref. voltage, max. load 5 mA" |

|   | SI80  | AC70  | SD80   | AD80    |
|---|---|---|--|---------|
| Analog current control of rudder/thruster           | N/A   | N/A   | N/A  | 4-20 mA |
| Proportional directional control of rudder/thruster | N/A   | N/A   | Solenoid control for direction, "Engage" output for speed  | N/A     |
| "Engage" output for bypass/clutch                   | N/A   | 12/24 V DC, min. 10 mA, max. 3 A  | Externally supplied 12/24 V DC on/off or proportional, min load 10 mA, max load 3 A, superimposed dither 0-10% amplitude, off or 70-400 Hz | N/A     |
| "Ready" output for rudder/thruster                  | N/A   | N/A   | Max. load 100 mA, 32 V DC, software and watchdog controlled, galvanic isolated (closed = ready), polarity independent                      |         |
| Rudder angle, frequency input                       | N/A   | 15 V (out), 1.4 to 5 kHz, resol. 20 Hz/°, center 3.4 KHz  | 15 V (out), 1.4 to 5 kHz, resol. 20 Hz/°, center 3.4 kHz   |         |
| Rudder angle or remote FU/DP, voltage input         | N/A   | N/A   | Ranges ±5 V, ±10 V, 0-5 V, 0-15 V  |         |
| Rudder angle or remote FU/DP, current input         | N/A   | N/A   | 4-20 mA  |         |
| NFU port/stbd input and mode indicator output       | External open/close contact, common ret, contact current max. 30 mA | External open/close contact, common ret, contact current max. 30 mA   | N/A  | N/A     |
| Mode input  | N/A   | External open/close or pulse contact for SYSTEM SELECT, common ret, close to activate, contact current max. 30 mA | External open/close or pulse contact for SYSTEM SEL, STBY, AUTO, TRACK, common ret, close to activate, contact current max. 30 mA          |         |

|   | SI80 | AC70                                      | SD80   | AD80 |
|---|------|---|--|------|
| Programmable handshake output, 2 ports (Steering gear/thruster interface, Alarm panel, Watch alarm, Remote FU/DP acknowledge)   | N/A  | N/A                                       | Internal open/close polarity independent solid state contact, galvanic isolated, max load 100 mA, 2 V DC |      |
| Programmable handshake input, 2 ports (Steering gear/thruster interface, Alarm panel, Pulse log, Pendulum ferry, Mains steering wheel override, remote FU/DP request) | N/A  | N/A                                       | External open/close contact, contact current max. 30 mA  |      |
| External alarm output for buzzer/relay  | N/A  | Max 100 mA, voltage level as local supply | N/A  | N/A  |
| EVC (Electronic Vessel Control) interface   | N/A  | CAN via SG05 Gateway                      | CAN via SG05 Gateway   |      |

## AP70 MK2 connector pinouts



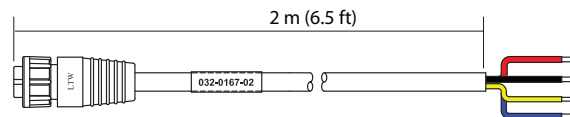
- 1 Power**
- 2 CAN bus**
- 3 Ethernet**

### Power

#### Cable connector (female - front view)

| Layout | Pin | Wire color | Function                  |
|--------|-----|------------|---------------------------|
|        | 1   | Black      | Battery (-)               |
|        | 2   | Blue       | Alarm/Active              |
|        | 3   | Yellow     | External command          |
|        | 4   | Red        | Battery (+), 12 - 24 V DC |

#### Power cable



### CAN/NMEA 2000/SimNet

#### Micro-C cable connector (female - front view)

| Layout | Pin | Wire Color | Function      |
|--------|-----|------------|---------------|
|        | 1   | (Bare)     | Shield        |
|        | 2   | Red        | NET S (+12 V) |
|        | 3   | Black      | NET C (-)     |
|        | 4   | White      | NET H         |
|        | 5   | Blue       | NET L         |

### Ethernet

The ethernet port is not used.

## Supported data

### IEC61162-1/2 interface channels

| Channel | Default name (can be changed by user) |
|---------|---------------------------------------|
| AC70    | NMEA 0183                             |
| SI80-1  | VDR                                   |
| SI80-2  | GYRO                                  |
| SI80-3  | ECDIS                                 |
| SI80-4  | BAM (Bridge Alert Management)         |

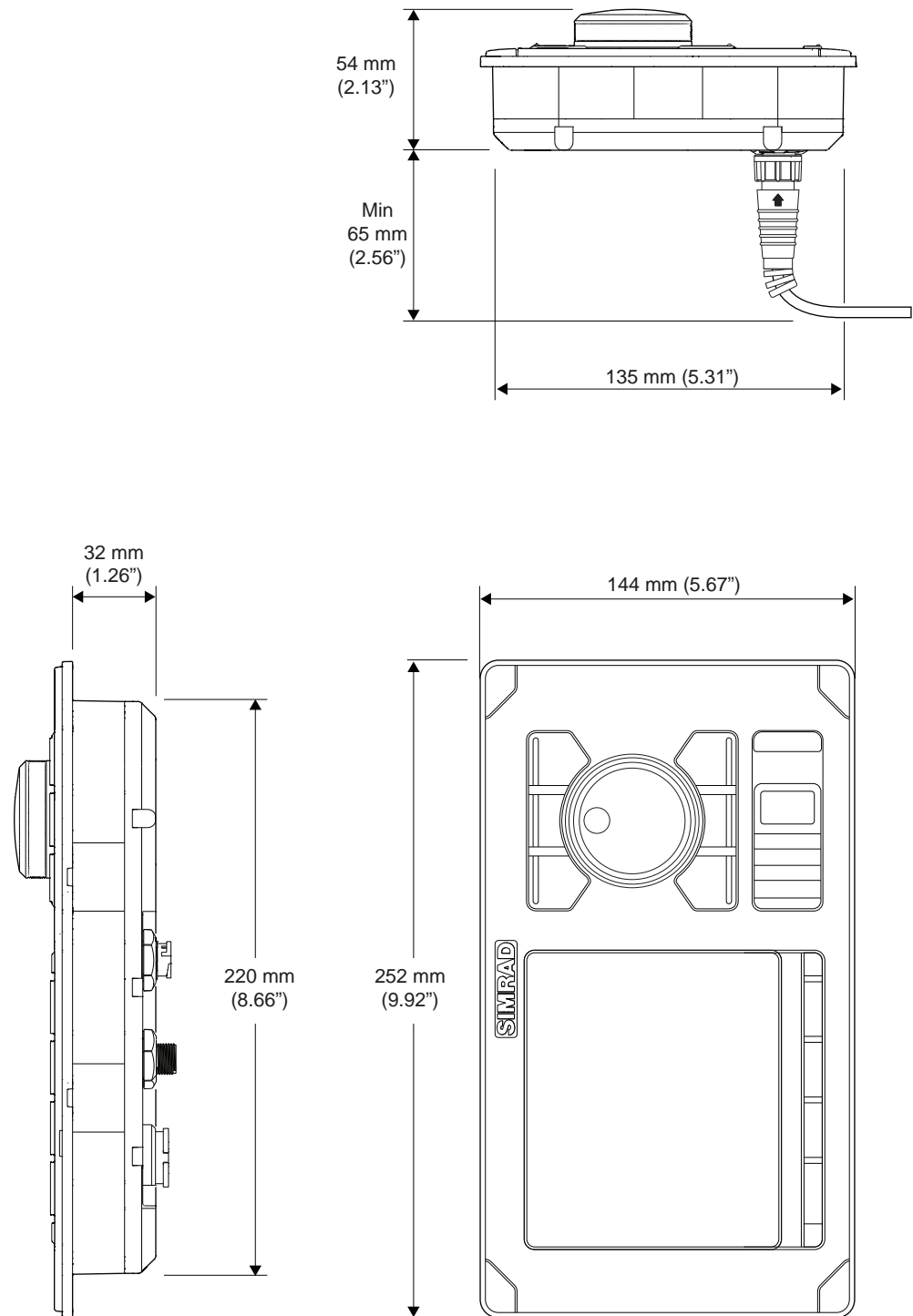
### Sentences

| Sentence | In | Out (number is output repeat rate in Hz) |        |        |        |        | NMEA 2000 PGN                         | Comments                                |
|----------|----|--|--------|--------|--------|--------|---------------------------------------|---|
|          |    | AC70                                     | SI80-1 | SI80-2 | SI80-3 | SI80-4 |                                       |   |
| AAM      | x  |  |        |        |        |        | 129284                                |   |
| ACK      | x  |  | x      |        |        | x      | 130850                                | Output: When alarm is acknowledged      |
| ALR      |    |  | x      |        |        | x      | 130850                                | When alarm activate, ack and deactivate |
| APB      | x  |  |        |        |        |        | 129283,129284,129285                  |   |
| BOD      | x  |  |        |        |        |        | 129284                                |   |
| BWC      | x  |  |        |        |        |        | 129284                                |   |
| DPT      | x  |  |        |        |        |        | 128267                                |   |
| GGA      | x  |  |        |        | 1      | 1      | 129025,129029                         |   |
| GLL      | x  |  |        |        | 1      | 1      | 129025,129029                         |   |
| HDG      | x  | 10                                       | 1      | 10     |        |        | 127250                                | Output: When magnetic heading source    |
| HDT      | x  | 10                                       | 1      | 10     |        |        | 127250                                | Output: When true heading source        |
| HTD      |    |  | 1      |        | 1      | 1      | 127237                                |   |
| MWV      | x  |  |        |        |        |        | 130306                                | SI80 only                               |
| RMA      | x  |  |        |        |        |        | 129025, 129026, 127258                |   |
| RMB      | x  |  |        |        |        |        | 129283, 129284                        |   |
| RMC      | x  |  |        |        |        |        | 127258,129025, 129026, 129029, 129033 |   |
| ROT      | x  |  |        | 2      |        |        | 127251                                |   |
| RSA      |    | 5  | 3      | 5      | 5      | 5      | 127245                                |   |
| THS      | x  |  | 3      |        | 10     | 10     | 127250                                |   |
| TLB      | x  |  |        |        |        |        | 128520                                | SI80 only                               |
| TNT      | x  |  |        |        | 5      |        | 130862                                | Proprietary track control               |
| TTD      | x  |  |        |        |        |        | 128520                                | SI80 only                               |
| TTM      | x  |  |        |        |        |        | 128520                                | SI80 only                               |
| VBW      | x  |  |        |        |        |        | 128259, 130578                        |   |
| VHW      | x  |  |        |        |        |        | 127250, 128259                        |   |
| VLW      | x  |  |        |        |        |        | 129026                                |   |
| VTG      | x  |  |        |        | 1      |        | 129026                                |   |
| ZDA      | x  |  |        |        | 1      |        | 129033                                |   |

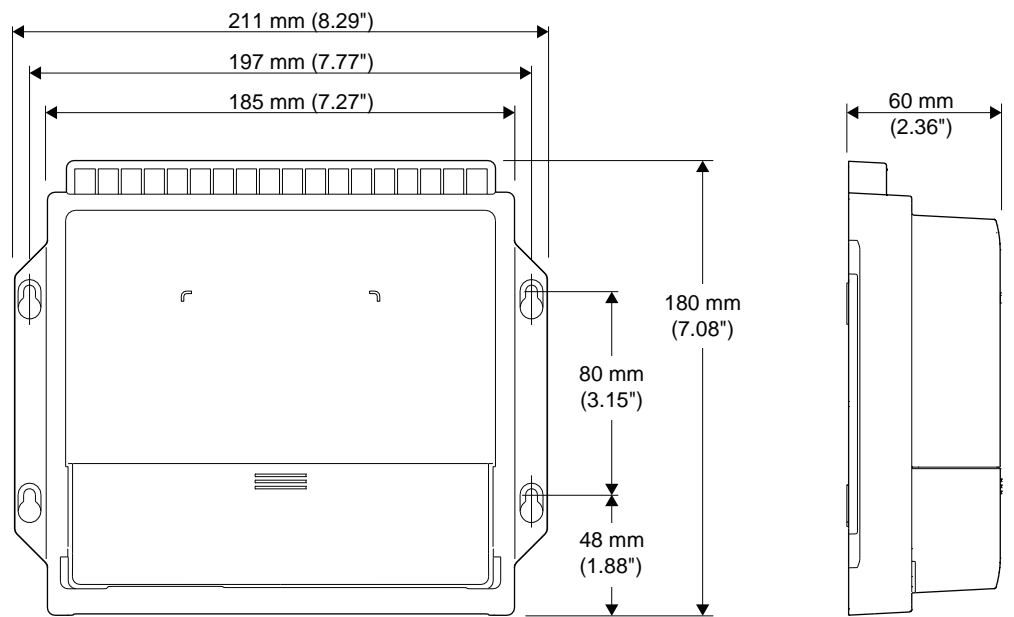
# 7

## Drawings

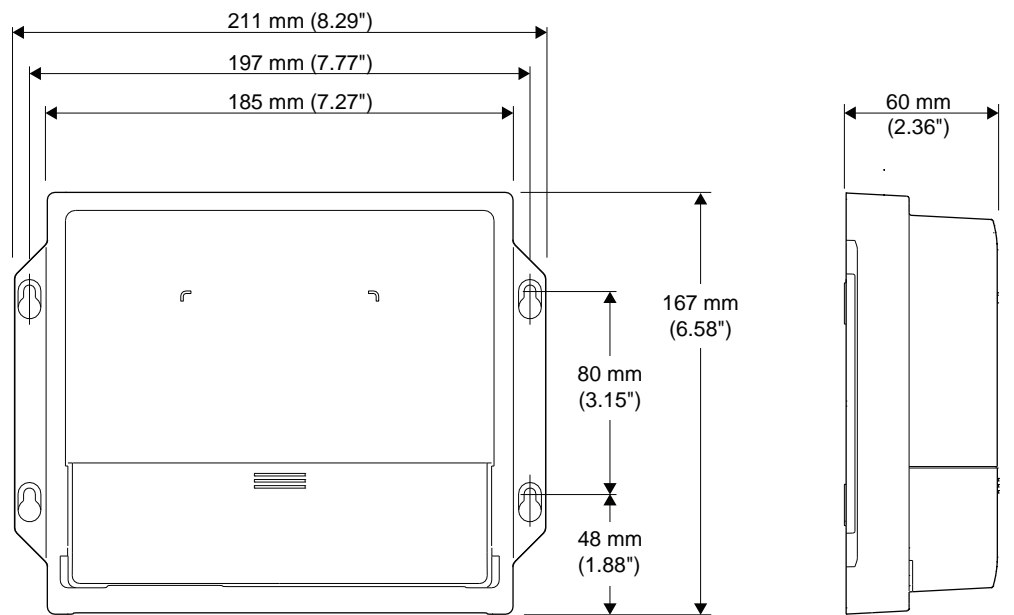
### AP70 MK2 control unit



## AC70 and SI80 computer

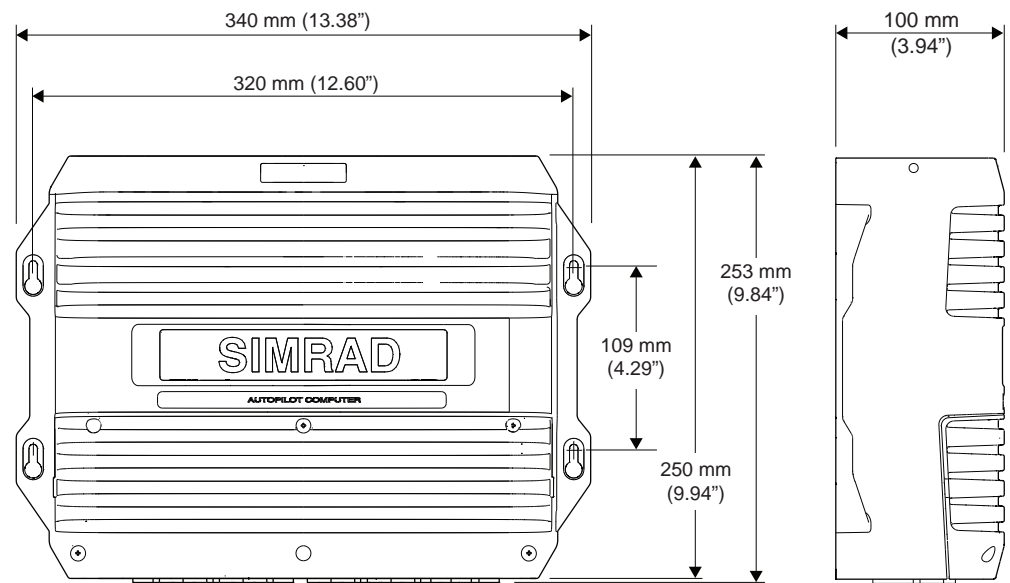


## SD80 and AD80 computers

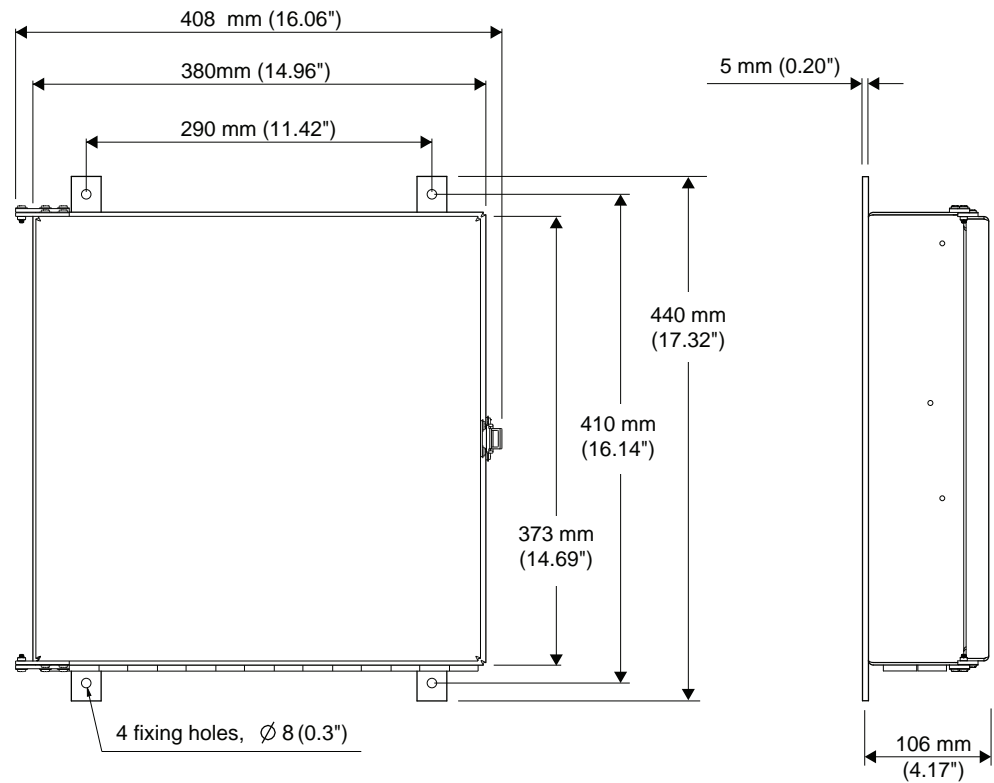




## AC80A and AC80S computer



## AC85 computer



**SIMRAD**

# AP70 MK2

Operator Manual

ENGLISH



# Preface

---

## Disclaimer

As Navico is continuously improving this product, we retain the right to make changes to the product at any time which may not be reflected in this version of the manual. Please contact your nearest distributor if you require any further assistance.

It is the owner's sole responsibility to install and use the equipment in a manner that will not cause accidents, personal injury or property damage. The user of this product is solely responsible for observing maritime safety practices.

NAVICO HOLDING AS AND ITS SUBSIDIARIES, BRANCHES AND AFFILIATES DISCLAIM ALL LIABILITY FOR ANY USE OF THIS PRODUCT IN A WAY THAT MAY CAUSE ACCIDENTS, DAMAGE OR THAT MAY VIOLATE THE LAW.

This manual represents the product as at the time of printing. Navico Holding AS and its subsidiaries, branches and affiliates reserve the right to make changes to specifications without notice.

## Governing language

This statement, any instruction manuals, user guides and other information relating to the product (Documentation) may be translated to, or has been translated from, another language (Translation). In the event of any conflict between any Translation of the Documentation, the English language version of the Documentation will be the official version of the Documentation.

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## Compliance statements

Navico declare under our sole responsibility that the product conforms with the requirements of:

- C-tick
- CE under EMC Directive 2014/30/EU
- European Council Directive 2014/90/EU on Marine Equipment modified by Commission Implementing Regulation (EU) 2018/773 (MED) - Wheelmark

→ **Note:** The AP70 MK2 system is Wheelmark approved only when installed according to the relevant AP70 MK2 MED-B certificate.

## About this manual

This manual is a reference guide for operating the unit. It assumes that all equipment is installed and configured, and that the system is ready to use.

Images used in this manual might not exactly match the screen on your unit.

### Intended audience

This manual is written for system operators.

The manual assumes that the reader has basic knowledge about this type of equipment in regards to:

- operation
- nautical terminology and practices

### Important text conventions

Important text that requires special attention from the reader is emphasized as follows:

→ **Note:** Used to draw the reader's attention to a comment or some important information.

**⚠ Warning:** Used when it is necessary to warn personnel that they should proceed carefully to prevent risk of injury and/or damage to equipment/personnel.

### Manual version

This manual is written for software version 1.0. The manual is continually updated to match new software releases.

### Change log

| Part no       | Date and description |
|---------------|----------------------|
| 988-12375-001 | 2019-Jan-11          |
|               | First version.       |

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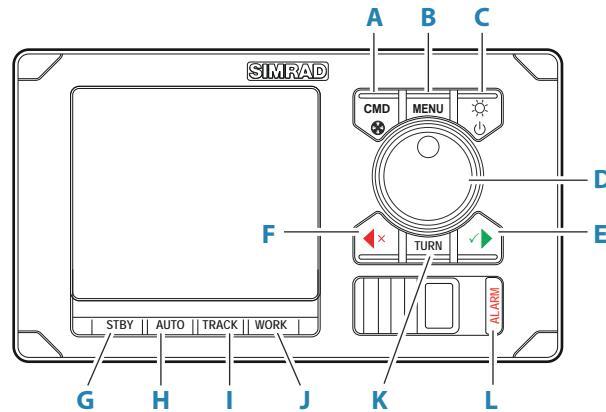
## Menu overview

- Quick menus

# 1

## Introduction

### Front panel keys



#### A Command/Thruster key

- Press to take/request command
- Press and hold to activate/deactivate available thrusters

#### B Menu key

- Press once to display the Quick menu
- Press twice to show the Settings menu

#### C Power/Brilliance key

- Press to display the Display setup dialog
- Press and hold to turn the unit to sleep mode

#### D Rotary knob

Menu and dialog operation:

- Turn to move up and down in menus and dialogs
- Turn to adjust a value
- Press to select a menu option and to enter the next menu level

In Standby and NFU mode:

- Press and hold to activate Follow up (FU) mode

In FU mode:

- Turn to set the rudder angle

In automatic modes:

- Turn to change the set heading/set course, press to re-activate automatic mode with current heading/course as reference

#### E Starboard (confirm) key

Menu and dialog operation

- press to confirm/enter next menu level

In Standby mode:

- press to activate NFU mode

In automatic modes:

- press to change set heading/set course to starboard

## **F Port (cancel) key**

Menu and dialog operation:

- press to cancel and to return previous menu level
- press and hold to close the menu

In Standby mode:

- Press to activate NFU mode

In automatic modes:

- press to change set heading/set course to port

## **G Standby key**

- Press to turn the autopilot to Standby mode

## **H Auto key**

- Press once to activate Auto or NoDrift mode
- Re-press to toggle between the Auto and NoDrift mode options

## **I Track key**

- Press to activate Nav mode

## **J Work key**

- Press to display the Work quick menu

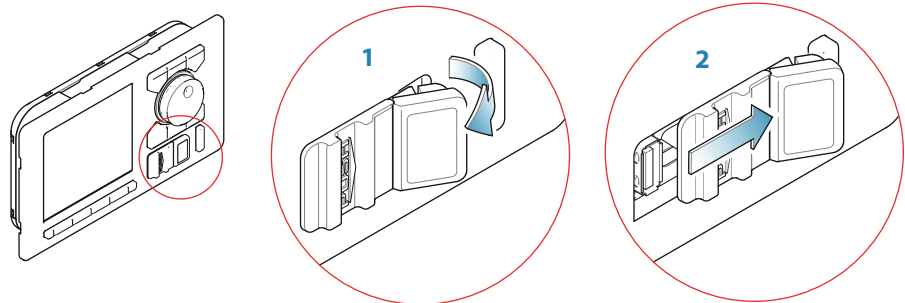
## **K Turn key**

- Press to display the Turn quick menu

## **L Alarm key**

- Press to display the list of active alerts

## **USB port**



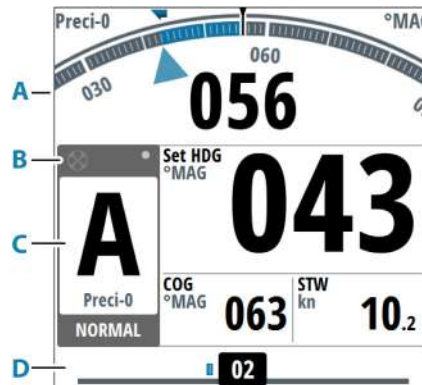
The USB port can be used to:

- connect a storage device

The USB devices should be standard PC compatible hardware.

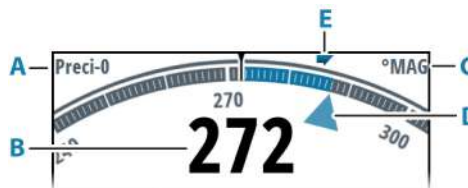
When not in use, the protective door should always be securely shut to prevent possible water ingress.

## The autopilot page



- A** Heading repeater
- B** Status panel
- C** Mode info panel
- D** Rudder bar

### Heading repeater



- A** Heading source
- B** Current heading
- C** Heading unit (True or Magnetic)
- D** Set heading
- E** Rate of Turn (ROT) indicator

### Status panel

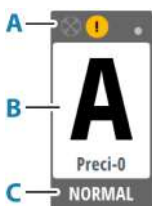
The panel includes status icons (**A**), active mode with steering reference (**B**), and active profile (**C**).

The following mode abbreviations are used:

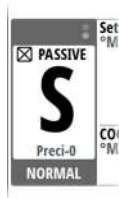
- **S**: Standby
- **A**: AUTO
- **FU**: Follow-up
- **ND**: No Drift
- **NFU**: Non-Follow Up
- **N**: NAV
- S-turn icon

If the autopilot is operated from another control unit, the passive icon is shown in the mode indication field.

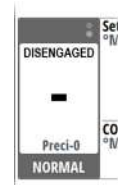
If the autopilot is controlled by an external system selector, the mode indication will be replaced as below.











Passive control unit



Autopilot disengaged by external system selector

Available status icons are shown below. Only active icons are visible.

-  Icon available if a thruster is installed. The icon will be shaded when the thruster is deactivated for steering
-  Active alert. Red icon for alarms, yellow for warning. See more details in *"The alert system"* on page 36.
-  Locked control unit
-  Picture freeze indicator. Two dots alternate slowly to show that the screen is alive and that information from sensors is updated

### Mode info panel

The panel contains mode specific content and varies with the operational mode. See *"Autopilot modes"* on page 20 onwards for more details.

If a thruster is available and active, the mode info panel will be split to show thruster information.



No thruster available



Thruster in use

→ **Note:** If sensor input is missing, the numbers will be replaced with hyphens.

### Rudder bar

Rudder position indicator with digital and analog readout. Direction indicator (**A**) is shown when rudder movement is commanded and rudder feedback is available.



# 2

## Basic operation

### Safe operation with the autopilot

⚠ **Warning:** An autopilot is a useful navigational aid, but DOES NOT replace a human navigator.

⚠ **Warning:** Ensure the autopilot has been installed correctly, commissioned and calibrated before use.

Do not use automatic steering when:

- In heavy traffic areas or in narrow waters
- In poor visibility or extreme sea conditions
- When in areas where use of an autopilot is prohibited by law

When using an autopilot:

- Do not leave the helm unattended
- Do not place any magnetic material or equipment near the heading sensor used by the autopilot system
- Verify at regular intervals the course and position of the vessel
- Always switch the autopilot to standby and reduce speed in due time to avoid hazardous situations

### Autopilot alerts

For safety reasons it is recommended to turn on all autopilot alerts when operating the autopilot.

For more information, refer to "*The alert system*" on page 36.

### External system selector

IMO resolution MSC.64(67) and other regulations require that an external switch is used for controlling change-over from manual to automatic steering.

The mode descriptions in this manual assumes that an external system selector has opened for autopilot operation, or that no external selector is installed.

### Manual steering

When an external system selector is set to manual steering, the autopilot will be disengaged. The control unit will display information as in Standby mode. It is not possible to change to FU, NFU or to any automatic mode. The menus can however be used, alerts acknowledged and illumination adjusted.

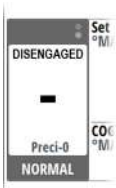
When the autopilot is disengaged by an external switch, this will be indicated in the mode display.

### Autopilot operation

When the external selector is set to automatic steering, the autopilot will go directly to AUTO heading mode with present heading as set reference. The autopilot can then be used in all operational modes.

### External EVC override (SG05 PRO)

You may at any time, irrespective of the autopilot mode, take manual control of the steering by means of the helm. The autopilot will then go to Standby mode and display Override to indicate the steering is from the helm. Autosteering can be resumed by pressing the **AUTO** or the **WORK** key.



## The Pendulum feature

The pendulum feature is intended for pendulum ferries where it is required to turn the heading 180° when the vessel is going backwards. The feature can be included in systems equipped with SD80 or AD80 boards.

The pendulum feature is activated by using an external switch. When the contact is closed, the heading from the main compass and the monitor compass will change 180°. The heading is changed before heading data enters the CAN bus network, and all devices on the bus will pick up the modified heading.

→ **Note:** The system must be configured for the pendulum feature as described in the separate installation manual.

## Turning the system ON and OFF

### Turning ON

Press the standby/brilliance key to turn the system ON.  
The system will be ON as long as power is connected.

### Switch the system to sleep mode

Press and hold the Standby/Brilliance key on an active control unit to switch the system to sleep mode.

During the shut-down procedure the system will automatically go to Standby mode before it is turned off.

→ **Note:** The Standby/Brilliance key will remain lit on units that are in sleep mode. To stop the system from drawing current a separate breaker should be installed.

## Taking command

You can take command from any control unit and/or remote by pressing the Command key. In an open system (no command transfer restrictions) you will get immediate control from the control unit requesting command. A steering handle without a Command key will get control when the lever is operated.

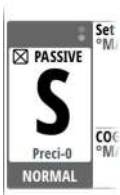
In a multi-station system with active lock function, the command request must be confirmed on the active control unit.

### Active/passive units

In a system including more than one control unit and/or remote units, only one unit can be in control at a time. All other units will be passive.

A passive unit is indicated with a passive icon in the mode status field.

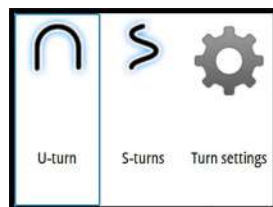
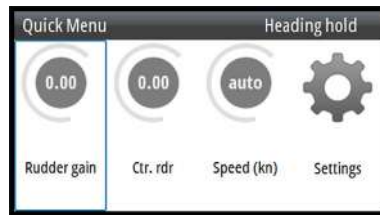
On a passive/locked unit illumination can be adjusted, alert sound can be locally silenced, and the Command key can be used for requesting command. All other functions are unavailable.



## The menu system

### Quick menus

The system includes 3 different quick menus:



- Mode Quick menu, activated by pressing the Menu key. See "*Autopilot modes*" on page 20.
- Work profile Quick menu, activated by pressing the Work key. See "*Selecting work profile*" on page 14 and "*Work profiles*" on page 30.
- Turn Quick menu, activated by pressing the Turn key. See "*Turn patterns*" on page 23.

### The Settings menu

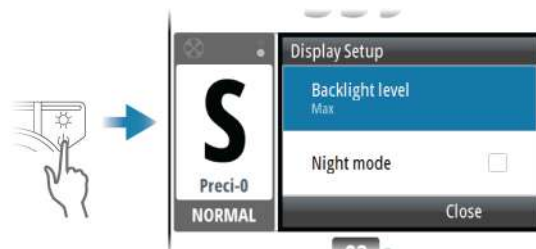
The Settings menu are used for system setup and configuration.



To access the Settings menu:

- press the Menu key twice
- select the Settings option in the Mode Quick menu

## Display setup



The display setup can be adjusted at any time from the Display setup dialog.

To access the dialog:

- Press the power key
- **Note:** All changes made to the display setup will apply to all units belonging to the same display group. For more information about network groups, refer to the separate Installation manual.

## Backlight level

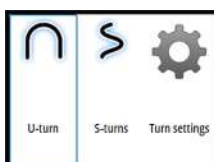
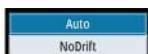
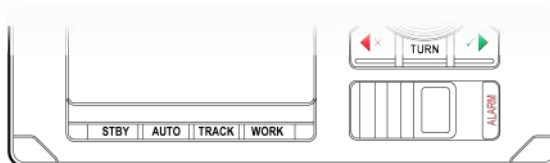
Adjusts the backlight level.

When the dialog is active, you can cycle the preset backlight levels by short presses on the power key.

## Night mode color

Sets the night mode color palette.

## Selecting autopilot mode



- Standby mode or Nav mode: press the Standby or Track key
- Auto mode or NoDrift mode: press the Auto key
  - last active mode (Auto or NoDrift) is activated immediately, and the mode pop-up menu is displayed
    - repeat pressing the Auto key to toggle the pop-up menu options. The selection times out and triggers the mode shift
- Turn mode: press Turn key, then select the turn option from the Turn Quick menu
- NFU (Non Follow Up) mode: press the port or starboard key when the system is in Standby mode
- FU (Follow Up) mode: press and hold the rotary knob when the system is in Standby or NFU mode

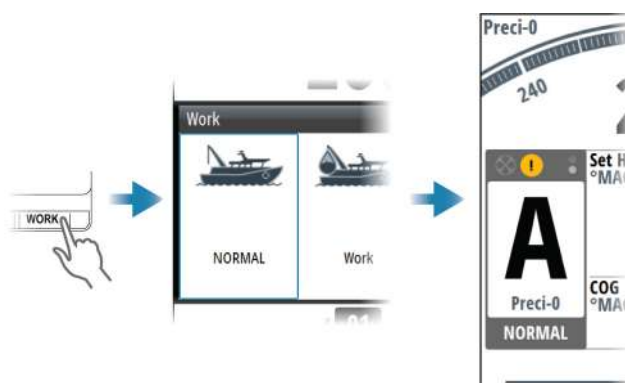
See more details in *"Autopilot modes"* on page 20.

## Selecting work profile

The autopilot can be set up with different profiles associated with different work modes. See more details in *"Work profiles"* on page 30.

1. Press the Work key to display the Work quick menu
2. Repeat pressing the Work key or use the rotary knob to select preferred profile
  - The selection times out and triggers the work profile shift. You can also confirm your selection by pressing the rotary knob.

The name of the work profile in use is displayed in the mode status panel.



## Working with thrusters

Thruster(s) can be connected to the autopilot system.

For number of thrusters that can be connected, refer to the specifications in the separate Installation manual for the autopilot system.

The thruster(s) can be configured to different work profiles, and the work profile in use will then decide if the vessel can be controlled by rudder, thruster(s), or both rudder and thruster(s).

### Thruster settings

Two settings affect how the thrusters are used by the autopilot:

- **Thruster inhibit** speed - set during dockside setup
  - This setting will turn the thrusters OFF when the vessel is running above a set speed limit
- The **Thruster assist** function - set when configuring the thrusters for the work profiles
  - ON: the thrusters will automatically be used by the autopilot system. If the thrusters are turned off when the vessel increases inhibited speed, the thrusters will automatically be turned on again when the speed goes below the inhibited limit
  - OFF: you must manually turn thrusters ON

For more information see "*User configurable settings*" on page 30.

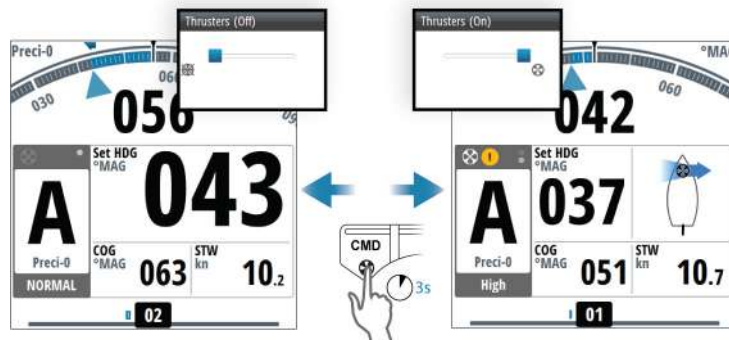
### Activating and de-activating the thruster

If a thruster is activated for a profile, the thruster can manually be turned OFF and ON.

To turn the thruster ON and OFF:

- press and hold the Command key

A popup with slide bar is displayed to indicate change in thruster status.



### Thruster presentation

When a thruster is installed and activated in the work profile, the thruster status icon and the thruster information in the mode info panel are as shown below.



- Thruster available for present work profile, no thrust applied



- Thruster in use. Image including thrust direction



- Thruster manually deselected
- Thruster unavailable (vessel speed is above inhibit limit)

# 3

## Delegation of control in multiple station systems

### Steering stations

An autopilot system with multiple stations can be set up with different steering stations. This setting is done during installation of the system, and the separate autopilot Installation manual details how to define network groups.

The network group Station settings determines lock/unlock and command transfer principle between active and passive control units. Based on this setting the system is defined as an open system or a master system as described in the following sections.

On a locked unit you can only adjust illumination and silence an alert locally. All other functions are unavailable.

### Open systems

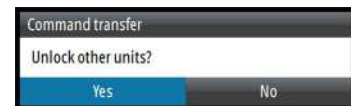
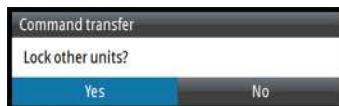
In a default installation the system is open, and control is accessible from every control unit connected to the autopilot system. One control unit is active and provides the user with access to all functions. All remaining control units are inactive and have no effect on course changes. A single press on the Command key on an inactive control unit will allow transfer of command and make the unit active. On steering levers without a command key, command is taken by moving the lever.

### Locking and unlocking units in an open system

You can temporarily lock units in an open system if you want to avoid accidental control from another control unit.

An active control unit can lock and unlock all passive control units.

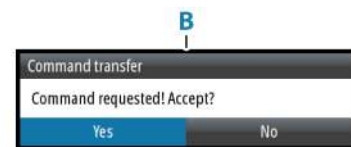
1. Activate the lock function from any active control unit by a single press on the Command key
2. Deactivate the function with a second press on the Command key



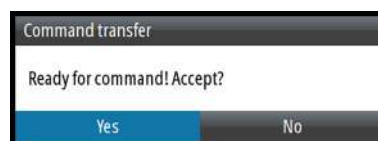
Active locking function is indicated with a lock symbol on both active and passive units.

### Taking command from a locked unit in an Open system

1. Press the Command key on the locked unit
  - A dialog will be shown on the unit requesting command (A)
  - A command request dialog will be shown on the active unit, accompanied by a 2 second sound (B)



2. Accept the command request on the active unit
  - All passive units will be opened for command transfer, indicated as below
  - The lock function will be deactivated, and the lock symbol removed from all units



3. Take command on selected remote unit



## Master systems

The international standard for heading control systems (ISO 11674/16329) requires controlled command transfer when remote stations are provided. The delegation of control to the remote station and the return of control shall be incorporated in the autopilot system, and shall avoid unintended operation from a remote station.

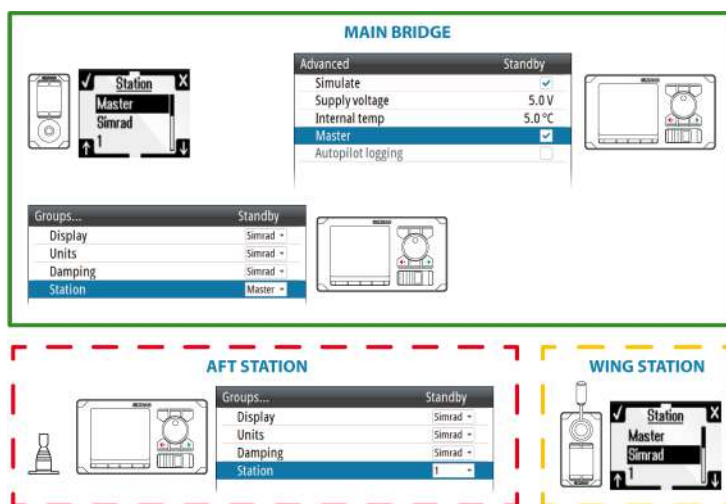
To fulfil this requirement the AP70 MK2 system includes a Master function. This is used in Wheelmarked systems where you permanently want to control command transfer to remote stations.

In a Master system, one steering station is defined as the Master station. There can be several control units in a master station, but only one of them can be set as the Master unit.

All units included in the master station will be unlocked, and command transfer within the master group will be as in an open system.

Units not included in the master station will be locked. It is not possible to take command from units outside the master station unless the master control unit opens for this. All units outside the master station will have a lock symbol.

In the illustration the main bridge is defined as master station. One QS80, and two AP70 MK2 control units are included in the master station. One of the AP70 MK2 control units is defined as the Master unit. The illustration includes network group settings for each unit, showing how the units are defined as part of different network stations.

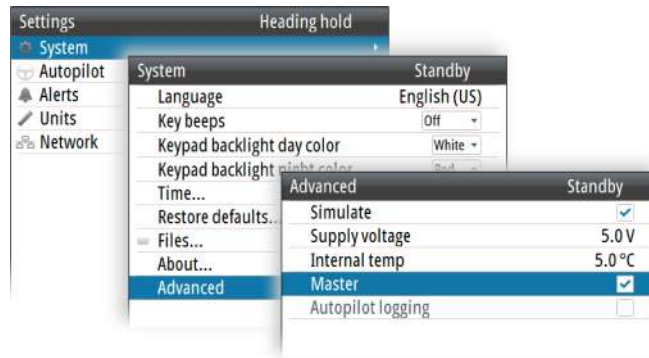


### Defining a Master system

A master station is usually defined and units assigned to the master station during system setup. Refer to the separate autopilot installation manual for details.

| Groups... | Standby |
|-----------|---------|
| Display   | Simrad  |
| Units     | Simrad  |
| Damping   | Simrad  |
| Station   | Master  |

→ **Note:** When a network group Station is set to Master, one control unit in this steering station has to be defined as the Master unit.

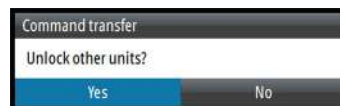


In a Master system command can be transferred to a remote unit either by opening the system for remote operation from the Master unit, or by requesting command from one of the remote units.

→ **Note:** You can at any time return to control from the Master station by pressing the Command key on one of the units in the master station.

### Opening a Master system for operation from a remote unit

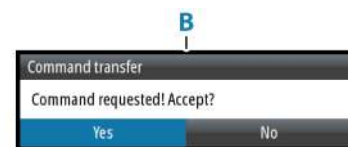
1. Press the Command key on the Master unit



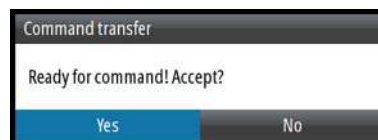
2. Accept the command request on the master unit
  - The system will now be open and command can be taken from any station
3. Take command on the selected remote by pressing the Command key
  - Command will be transferred to this remote, accompanied by a 2 second sound
  - All other remote units will return to locked status

### Taking command from a locked unit in a Master system

1. Press the Command key on the locked unit
  - A dialog will be shown on the unit requesting command (A)
  - A command request dialog will be shown on the master unit (B)



2. Accept the command request on the master unit
  - The requesting unit will now be opened for command transfer. Other units will remain locked



3. Press the Command key on the unit requesting command
  - Command will be transferred to this unit, accompanied by a 2 seconds sound

# 4

## Autopilot modes

The autopilot has several steering modes. The number of modes and features within the mode depend on the autopilot computer, the boat type and available inputs.

### External system selector

An external switch can be used for controlling change over from manual to automatic steering.

The mode descriptions in the following pages assumes that an external system selector has opened for autopilot operation, or that no external selector is installed.

### Hand steering

#### Standby mode

Standby mode is used when you steer the boat at the helm.

- Switch to Standby mode by pressing the **STBY** key.

→ **Note:** If sensor data vital for autopilot operation (e.g. rudder response) is lost when the autopilot is running in an automatic mode, the system will automatically switch to Standby mode.



#### Non-Follow Up (NFU) mode

In NFU mode you can use the port and starboard keys on the controller to operate the rudder. The rudder will move as long as the key is pressed.

- Switch to NFU mode by pressing one of the port or starboard keys when the autopilot is in Standby mode or FU mode.



#### Follow-up (FU) mode

In FU mode you turn the rotary knob to adjust the set rudder angle.

The rudder will move to the commanded angle and then stop.

- Switch to FU mode from Standby mode or NFU mode by pressing and holding the rotary knob.



#### Quick menus in STBY, FU and NFU mode



From the Quick menu in Standby, NFU and FU you can change sources used for steering, display active alerts and set manual speed.

### Automatic modes

This autopilot system includes two automatic modes:

- Auto compass mode keeps the vessel on set heading
- NoDrift mode combines heading and position information, and keeps the vessel on a straight track

You toggle between Auto and NoDrift mode by repeated presses on the Auto key. The selection times out and triggers the mode shift. You can also confirm your selection by pressing the Starboard key or the rotary knob.

## Defining the heading/course change for the arrow keys

By default the set heading (Auto mode) and set course (NoDrift mode) will change 1° each time you press the port or starboard key. You can change this increment setting from the Turn settings dialog. The dialog is activated from the Turn Quick menu and from the Autopilot settings dialog.

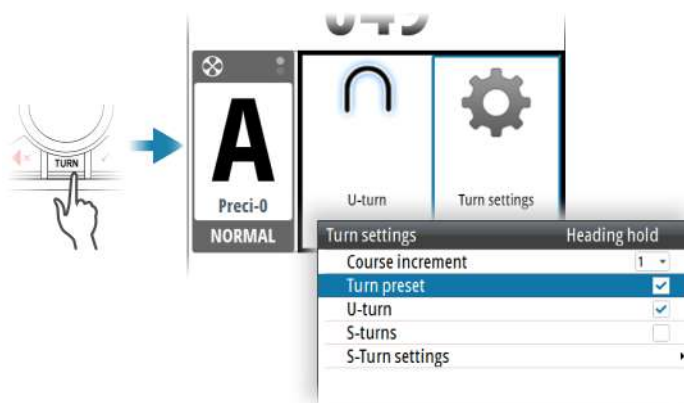


## The turn preset function

The system includes a turn preset feature for Auto and NoDrift mode. This allows for setting the new heading/course, turn radius and turn type before the turn starts. The function gives a more precise starting point for the turn, and it also avoids unintended heading/course changes when accidentally turning the rotary knob.

→ **Note:** The port and starboard keys will always give immediate action, also when the turn preset function is active.

## Enabling the turn preset function



## Using the turn preset function

When in Auto or NoDrift mode:

1. Turn the rotary knob to display the turn preset dialog
2. Set the new heading/new course, radius and turn type in the dialog
3. When the vessel reaches the selected turn point, initiate the turn by selecting the Activate button (A)
  - The pre-set heading/course will immediately be shown in the course display
  - The dialog will change to show turn adjust options. If the settings are adjusted the changes will take effect immediately

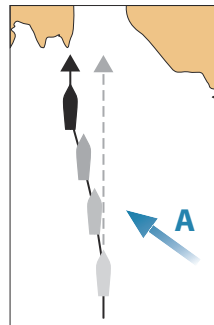


You can close the dialog at any time without disturbing the pre-setting or the execution of a turn. If closed, the dialog is recalled by turning the rotary knob.



## AUTO mode (Heading hold)

In AUTO mode the autopilot issues rudder commands required to steer the vessel automatically on a set heading. In this mode the autopilot does not compensate for any drifting caused by current and/or wind (**A**).



- Switch to AUTO mode by pressing the **AUTO** key. Repress the key to highlight the **Auto** option in the pop-up menu

When the mode is activated, the autopilot selects the current boat heading as the set heading.

### Changing set heading in AUTO mode

You adjust the set heading by turning the rotary knob or by pressing the port or starboard keys.

An immediate heading change takes place. The new heading is maintained until a new heading is set.

### Heading capture

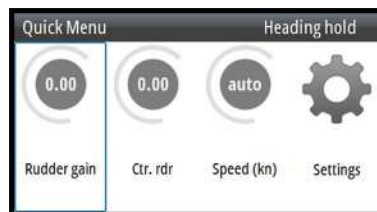
When the vessel is turning in AUTO mode, an instant re-press on the **AUTO** key or the rotary knob activates the heading capture function. This will automatically cancel the turn, and the vessel will continue on the heading read from the compass the very moment you pressed the **AUTO** key or the rotary knob.

### Temporary heading changes

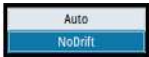
If you need to avoid an obstacle when in **AUTO** mode, you can press the **STBY** key and power steer or use the helm until the obstacle is passed.

If you re-press the **AUTO** key within 3 minutes you can select to continue on previous set heading. If you don't respond within 3 seconds the menu will disappear, and the autopilot will go to **AUTO** mode with current heading as set heading.

### Quick menu in AUTO mode



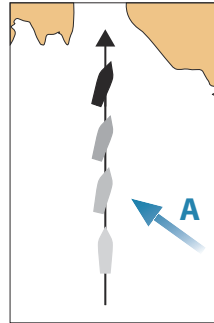
From the Quick menu in AUTO mode you can change rudder parameters and set manual speed.



### NoDrift mode

→ **Note:** It is not possible to select NoDrift mode if GPS position and heading information is missing.

In NoDrift mode the vessel is steered along a calculated track line, from present position and in a direction set by the user. If the vessel is drifting away from the track line due to current and/or wind (**A**), the vessel will follow the line with a crab angle.



- Switch to NoDrift mode by pressing the **AUTO** key. Repress the key to highlight the NoDrift option in the pop-up menu

When the mode is activated, the autopilot will draw an invisible track line based on current heading from the vessel's position.

The autopilot will now use the position information to calculate the cross track distance, and automatically steer along the calculated track.

### Changing set course in NoDrift mode

You adjust the set course by turning the rotary knob or by pressing the port or starboard keys.

An immediate course change takes place. The new course is maintained until a new course is set.

### Dodging

If you need to avoid an obstacle when using NoDrift mode, you can set the autopilot to Standby mode and power steer or use the helm until the obstacle is passed.

If you return to NoDrift mode within 60 seconds you can select to continue on previous set bearing line.

If you do not respond, the dialog disappears and the autopilot goes to NoDrift mode with current heading as set bearing line.

### Quick menu in NoDrift mode



From the Quick menu in NoDrift mode you can change the track response, rudder parameters and set manual speed.

### Turn patterns

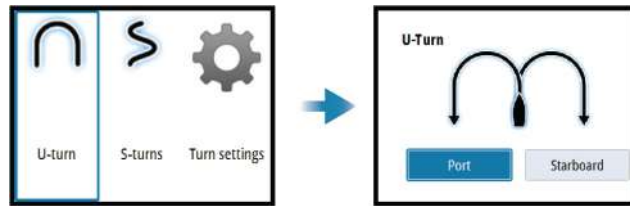
The system includes the following turn patterns:

- U-turn
- S-turns (optional)

### Starting and stopping a turn

To start a turn:

- Select the port or starboard button

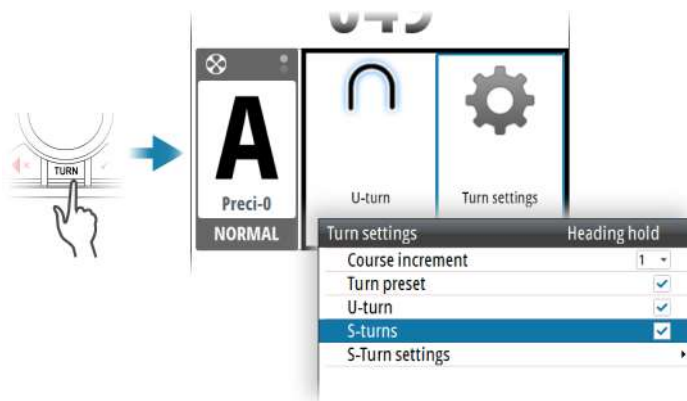


To stop the turn:

- press the Standby key

The autopilot will return to Standby mode and manual steering.

### Activating optional turn patterns



#### U-turn

Changes the current set heading by 180°. When activated, the autopilot is switched to Auto mode.

The vessel will turn with the defined turn rate or turn radius for active profile. Refer to "Turn" on page 31.

#### S-turn

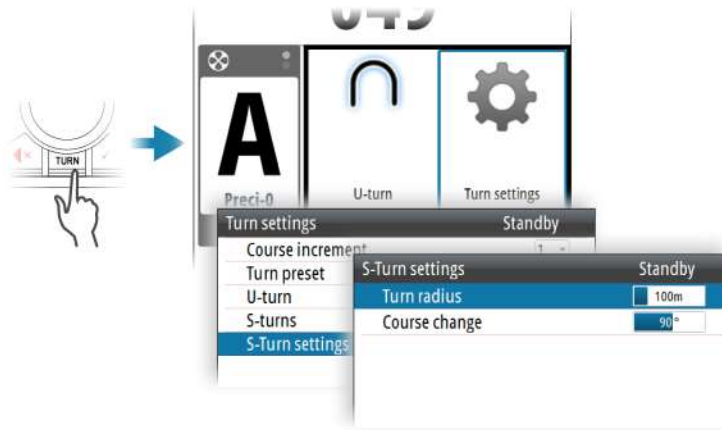
Makes the vessel yaw around the main heading. When activated, the autopilot is switched to S-turns mode.

Turn variables:

- Course change
- Turn radius

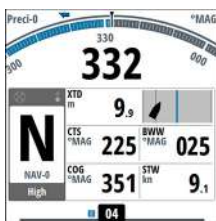
#### S-turn settings

The S-turn settings can be set as default values.



The default values can be changes at any time when the boat is in a turn.

## NAV mode



→ **Note:** NAV mode requires a compatible navigator connected to the network.

It is not possible to select NAV mode if heading information is missing, or if steering information is not received from the external chartplotter.

In NAV mode the autopilot uses steering information from an external navigator to direct the vessel to one specific waypoint location, or through a series of waypoints.

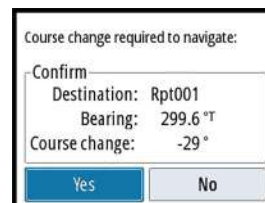
In NAV mode, the autopilot's heading sensor is used as heading source for course keeping. Speed information is taken from SOG or from selected speed sensor. The steering information received from the external navigator alters the set course to direct the vessel to the destination waypoint.

To obtain satisfactory navigation steering, the autopilot system must have valid input from the navigator. Autosteering must be tested and determined satisfactory prior to entering NAV mode.

→ **Note:** If the navigator does not transmit a message with bearing to next waypoint, the autopilot will steer using Cross Track Error (XTE) only. In that case you must revert to AUTO mode at each waypoint and manually change set course to equal bearing to next waypoint and then select NAV mode again.

Prior to entering NAV mode the navigator must be navigating a route or towards a waypoint.

- Initiate NAV mode by pressing the **NAV** key
- Confirm to switch to NAV mode in the dialog



## Turning in NAV mode

When your vessel reaches a waypoint, the autopilot will give an audible warning and display a dialog with the new course information.

There is a user defined limit for the allowed automatic course change to next waypoint in a route. If the course change is more than this set limit, you are prompted to verify that the upcoming course change is acceptable.

- If the required course change to the next waypoint is less than the course change limit, the autopilot will automatically change the course. The dialog will disappear after 8 seconds unless cleared by the **X** key.



- If the required course change to next waypoint is more than the set limit, you are prompted to verify that the upcoming course change is acceptable. If the turn is not accepted, the vessel will continue with the current set heading.



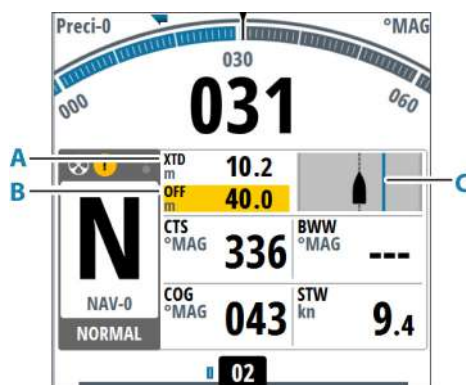
Course change less than set limit



Course change larger than set limit

Refer to "Course change limit" on page 33.

## Track offset



The track offset options allows for steering parallel to the track in NAV mode.

To activate the track offset option:

- press and hold the rotary knob  
The display will change to show current distance from track, XTD (A) and set offset, OFF (B)

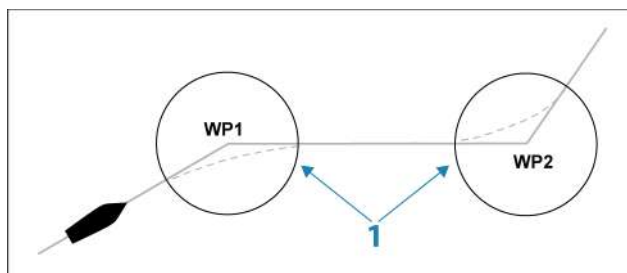
Turn the rotary knob to adjust the offset distance. The blue line (C) shows the offset in relation to the track.

The system will remain in track offset mode for as long as there is an offset value. It will time out when the offset distance is set to 0 (zero).

## Waypoint arrival circle

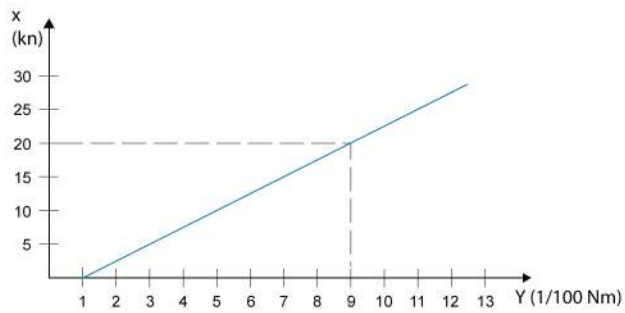
The arrival circle (radius) defines the point at which a turn is initiated when you are navigating a route.

The arrival circle is set in your chart plotter.



The arrival circle (1) should be adjusted according to boat speed. The higher the speed, the wider the circle. The intention is to make the autopilot start the heading change in due time to make a smooth turn onto the next leg.

The figure below may be used to select the appropriate arrival circle when creating the route.



**X axis** = Boat speed in knots

**Y axis** = Arrival circle, radius in 1/100 Nm

Example: With the speed of 20 knots you should use a waypoint circle with radius 0.09 Nm.

→ **Note:** The distance between any waypoints in a route must not be smaller than the radius of the arrival circle.

### Quick menu in NAV mode



From the Quick menu in NAV mode you can change navigation response and set manual speed.

## Controlling steering performance in automatic and navigational modes

The autopilot should be configured during installation and setup.

To increase steering performance, some parameters may be adjusted during operation. The parameters are available from the Quick menu.



*Quick menu, Auto mode*



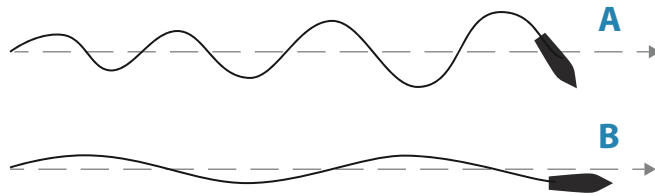
*Quick menu, Nav and NoDrift mode*

### Track response

Defines how aggressively the autopilot should steer towards the active route's leg.

### Rudder gain

This parameter determines the ratio between commanded rudder and the heading error. The higher rudder gain value the more rudder is applied. If the value is too small it will take a long time to compensate for a heading error, and the autopilot will fail to keep a steady course. If the value is set too high the overshoot will increase and the steering will be unstable.



- A** The value is set too high. Steering becomes unstable and often the overshoot will increase
- B** The value is set too low. It will take a long time to compensate for a heading error, and the autopilot will fail to keep a steady course

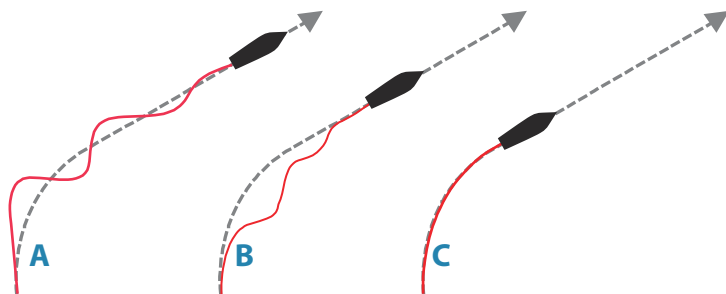
### Counter rudder

Counter rudder is the amount of counteracting (opposite) rudder applied to stop the turn at the end of a major course change. The settings depend on vessel's characteristics, inertia, hull shape and rudder efficiency.

- If the vessel has good dynamic stability, a relatively small value will be sufficient
- An unstable vessel will require high value
- The greater the vessel's inertia, the greater value will be required

Increasing counter rudder value may result in some higher rudder activity also when steering a straight course, particularly in high waves.

The best way of checking the value of the Counter rudder setting is when making turns. The figures illustrate the effects of various Counter Rudder settings.



- A** Counter rudder value too low; overshoot response
- B** Counter rudder value is too high; sluggish and creeping response
- C** Correct setting of Counter rudder; ideal response

Perform various course changes and observe how the boat settles on the new heading. Start with small changes, 10-20 degrees, and proceed with bigger changes, 60-90 degrees. Adjust Counter rudder value to obtain best possible response as in illustration **C**.

→ **Note:** As many boats turn differently to port versus starboard (due to propeller rotation direction), do the course changes in both directions. You may end up with a compromise setting of Counter rudder that gives a little overshoot to one side and a bit creeping response to the other.

### Speed

If neither boat speed nor SOG data are available and/or deemed unreliable, a manual value for speed can be entered and used by the autopilot to aid steering calculations.

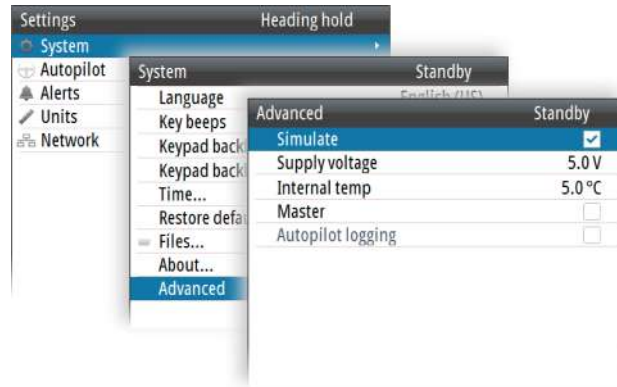
## Simulator mode

The simulate option lets you operate the unit without being connected to sensor or other devices.

It is not possible to simulate commissioning and setup.

If the unit is turned off while in simulator mode, this mode will still be active on next power on.

Active simulator mode is indicated with a flashing notification on the image.



# 5

## Work profiles

A work profile is a set of steering parameters. You can change the active work profile to adapt the autopilot steering characteristics to different operational conditions.

The AP70 MK2 has a set of predefined work profiles, depending on selected boat type. There can be up to 6 work profiles defined in the system.

During commissioning and seatrial the parameters for active profile will be tuned for optimized steering performance.

### Predefined profiles

#### Normal profile

This is the default profile and automatically assigned when you set your vessel type to **Displacement**.

It is recommended to use the Normal profile as a general profile for your vessel. This should be active during the commissioning of your vessel, and all parameter settings will then be saved to this profile.

#### High and Low profiles

High and Low profiles are automatically assigned when you set your vessel to **Planing**.

The system switches automatically between High and Low profiles based on the vessel's speed and the Transition speed setting. Refer to the separate Installation manual.

### Creating a new work profile

New profiles can be defined for operational modes where the vessel's steering parameters deviate from the default profiles.

You can also define a profile for easy access to preferred parameters for various crew members.

1. Press the Work key to display the Work Quick menu
2. Select the Add profile option
3. Select a reference profile that matches the working conditions
  - A new profile must be based on an existing or a predefined work profile. The parameters from the work profile you select as base will be copied to the new profile, and can later be edited
4. - Edit the profile settings as required
5. Complete the task by selecting the Add Profile option

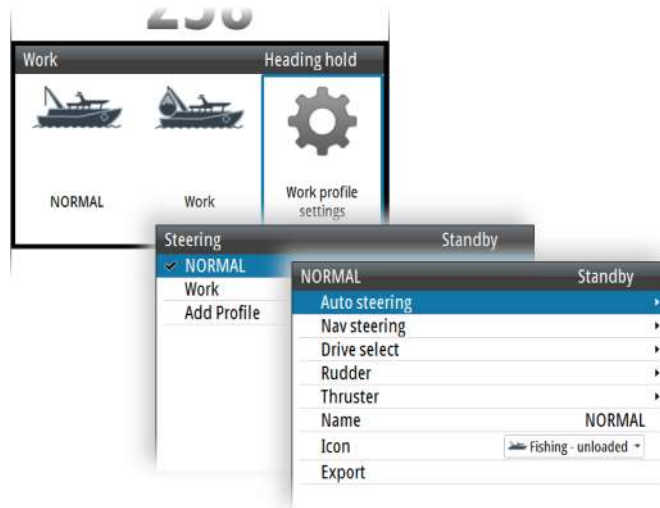


### User configurable settings

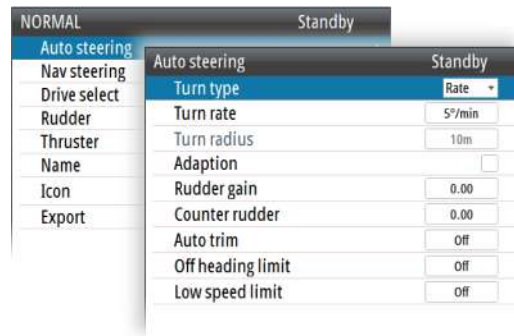
The steering parameters can be configured differently between the different profiles, depending on boat steering characteristics and user preferences.

The initial parameters are automatically assigned when you select your vessel type. During the seatrial the parameters will be tuned for optimized steering performance.

The options listed in the next pages are available and can be manually adjusted for all profiles.



## Auto steering



### Turn

Used for selecting how you want to control the vessel's turn: either by defining the Rate of Turn (Rate) or the radius.

- Rate range: 5°/minute - 720°/minute
- Radius range: 10 m - 10 NM
  - The minimum radius can however never be less than the value corresponding to a Rate of Turn = 720°/minute at the set Cruising speed

### Turn rate

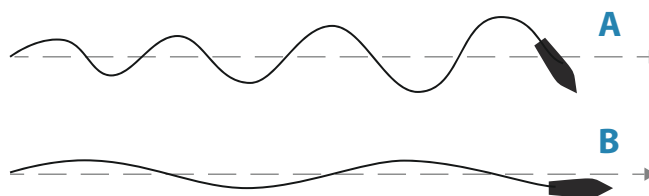
Used for manually setting the turn rate used when the heading change is larger than 5°.

### Adaption

When this setting is activated, the autopilot will continuously adapt some steering related parameters to the vessel's behavior. The adapted parameters are stored in the work profile.

### Rudder gain

This parameter determines the ratio between commanded rudder and the heading error. The higher rudder gain value the more rudder is applied. If the value is too small it will take a long time to compensate for a heading error, and the autopilot will fail to keep a steady course. If the value is set too high the overshoot will increase and the steering will be unstable.



- A** The value is set too high. Steering becomes unstable and often the overshoot will increase
- B** The value is set too low. It will take a long time to compensate for a heading error, and the autopilot will fail to keep a steady course

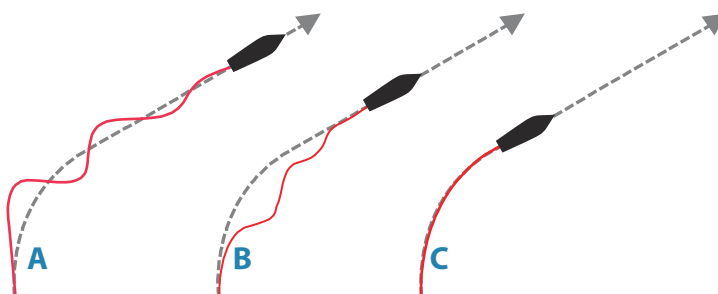
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Increasing counter rudder value may result in some higher rudder activity also when steering a straight course, particularly in high waves.

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- B** Counter rudder value is too high; sluggish and creeping response
- C** Correct setting of Counter rudder; ideal response

Perform various course changes and observe how the boat settles on the new heading. Start with small changes, 10-20 degrees, and proceed with bigger changes, 60-90 degrees. Adjust Counter rudder value to obtain best possible response as in illustration **C**.

→ **Note:** As many boats turn differently to port versus starboard (due to propeller rotation direction), do the course changes in both directions. You may end up with a compromise setting of Counter rudder that gives a little overshoot to one side and a bit creeping response to the other.

### Autotrim

Controls how fast the autopilot will apply rudder to compensate for a constant heading offset, e.g. when external forces such as wind or current affects the heading. Lower autotrim will give faster elimination of a constant heading offset

### Off heading limit

Sets the limit for the off heading alarm.

When the alarm option is activated an alarm occurs when the actual heading deviates from the set heading more than the selected limit.

### Low speed limit

Sets the limit for the low vessel speed alarm.

An alarm occurs when the vessel's speed goes below the selected limit.

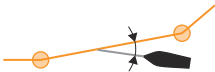
## Nav steering



### Nav response

Defines how aggressively the autopilot should steer towards the active route's leg.

### Approach angle



This setting is a limit to prevent approaching the track too steeply. Approaching the track at shallower angles is permitted depending on the cross track distance (XTD) and nav response setting.

This setting is used both when you start navigating and whenever the autopilot is working the boat towards the route.

### Course change limit

Defines the limit for automatic course change to next waypoint in a route when the autopilot is following a route (NAV mode).

If the course change is greater than this set limit, you are prompted to verify that the upcoming course change is acceptable.

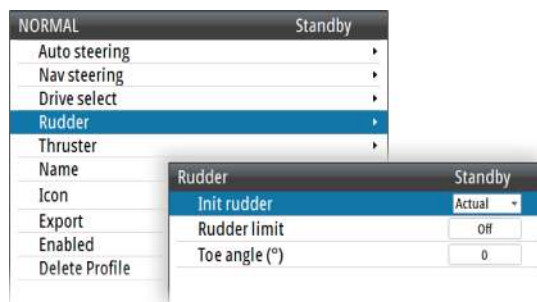
### XTD limit

Defines the vessel's accepted offset distance from the track. If the vessel goes beyond this limit an alarm will be activated.

## Drive select

Defines which drives that shall be used for the selected work profile.

## Rudder





### **Init rudder**

Defines how the system moves the rudder when switching from hand steering (Standby, FU and NFU) to an automatic mode.

The following options are available:

- Center  
Moves the rudder to zero position
- Actual  
Maintains the rudder angle, and assumes that the current rudder angle is the trim required to maintain a steady heading.

### **Rudder limit**

Determines the dynamic range of the rudder before its movement is restricted and alarm is triggered. Typical usage is to limit the amount of rudder action caused by yawing in following sea.

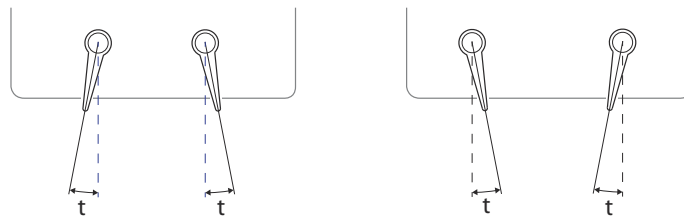
→ **Note:** Rudder limit is not a hard limitation of the rudder range, only around the current setpoint.

This Rudder limit does not affect Non-Follow-up or Follow Up steering.

### **Toe angle**

This option sets the allowed angle deviation between the rudders. The feature will enhance rudder efficiency at small rudder commands around center position, and it will reduce vibration and/or propeller/water jet noise.

The toe angle is the angle between the rudder's 0-position and the rudder's actual position (t) as shown in the illustration.



The toe angle will be applied as an offset to each rudder. Toe out (positive value), angles the two rudders apart, while Toe in (negative value) angle them towards center.

→ **Note:**

The toe angle is a work profile setting, and must be enabled for current work profile to be available.

The toe angle is only available if the vessel has 2 rudders. It applies only to rudders located on the side of the ship - it will have no effect on a rudder located in the ship center.

The toe angle is effecting all operating modes except Standby and NFU.

When the feature is enabled, one rudder will stop moving before the other one if max./min. rudder angles are demanded.

When the feature is enabled, the rudder bar shows rudder command instead of measured rudder angle.

## Thruster



### **Deadband**

Determines how many degrees the vessel must deviate from the set course before a thruster command is given. As the vessel deviates from its heading, the thruster will push the vessel back.

A higher value will reduce the thruster activity and extend the lifetime, especially for on/off thrusters.

### **Assist**

Determines how the thrusters are used by the autopilot.

When set to ON, the thrusters will automatically be used by the autopilot system if the vessel speed is below inhibited limit. If the vessel speed is above inhibited thruster speed the thrusters will be turned off, but will automatically be turned on again when the speed goes below the inhibited limit.

→ **Note:** Thruster inhibit speed is set during installation and is the max. vessel speed for which the thruster is allowed to run.

When set to OFF, thruster has to be manually enabled.

### **Push boat to**

Used for specifying if the thruster should be used for course deviations to port only, starboard only, or for any course deviation.

### **Work profile name**

Set the name to identify the profile.

→ **Note:** You can use several characters for the profile name, but only the first 6 characters will be shown as profile name.

### **Profile icon**

The system includes a number of icons that can be used to identify the profile settings.

### **Exporting and importing work profiles**

It is possible to export and import a work profile to/from a USB stick.

# 6

## The alert system

The system continuously checks for dangerous situations and system faults while running.

### Alert message types

There are two types of messages:

- Alarms
  - Generated when conditions are detected that may critically effect the capability or performance of the system. You must critically examine all alarm messages to determine their cause and effect
- Warnings
  - Informing you of conditions that could result in unwanted system response or possible failure

### Alert indication

When an alert situation occurs, a siren will sound and the alert icon will become active. The alert pop-up will show alert cause, followed by the name of the device that generated the alert.







A single alert is displayed with the name of the alert as the title, and with details for the alarm. If more than one alert is activated simultaneously, the alert pop-up can display multiple alerts. The alerts are listed in the order they occur with the alert activated first at the top. The remaining alerts are available in the Active alerts dialog.

### Alert icons

The alert icon will remain in the status panel until the alert is acknowledged and rectified. The table below shows alert icon and behavior depending on if the alert is active, acknowledged, transferred or rectified.



| Type  | Icon | State                                   | Indication   |
|-------|------|---|--|
| Alarm |      | Active - not acknowledged, not silenced | <ul style="list-style-type: none"><li>• Descriptive text</li><li>• Audible signal</li></ul>    |
|       |      | Active - not acknowledged, silenced     | <ul style="list-style-type: none"><li>• Descriptive text</li><li>• No audible signal</li></ul> |
|       |      | Active - acknowledged                   | <ul style="list-style-type: none"><li>• Descriptive text</li><li>• No audible signal</li></ul> |
|       |      | Rectified - not acknowledged            | <ul style="list-style-type: none"><li>• Descriptive text</li><li>• No audible signal</li></ul> |

| Type    | Icon  | State                                   | Indication  |
|---------|---|---|---|
| Warning |  | Active - not acknowledged, not silenced | <ul style="list-style-type: none"> <li>• Descriptive text</li> <li>• Audible signal</li> </ul>    |
|         |  | Active - not acknowledged, silenced     | <ul style="list-style-type: none"> <li>• Descriptive text</li> <li>• No audible signal</li> </ul> |
|         |  | Active - acknowledged                   | <ul style="list-style-type: none"> <li>• Descriptive text</li> <li>• No audible signal</li> </ul> |
|         |  | Rectified - not acknowledged            | <ul style="list-style-type: none"> <li>• Descriptive text</li> <li>• No audible signal</li> </ul> |

## Acknowledging a message

An alert dialog showing a single message have one or two options for acknowledging the message:

- ACK / Acknowledge  
Sets the alarm state to acknowledged, meaning that you are aware of the alarm condition. The siren/buzzer stops and the alarm dialog is removed. However, the alarm remains active in the alarm listing until the reason for the alarm has been removed.
- Silence  
Mutes the siren locally (for 30 seconds) for all units in the same network alarm group. The alert dialog remains on the display.



There is no time-out on the alarm message or siren. They remain active until you acknowledge the alarm or until the reason for the alarm is removed.

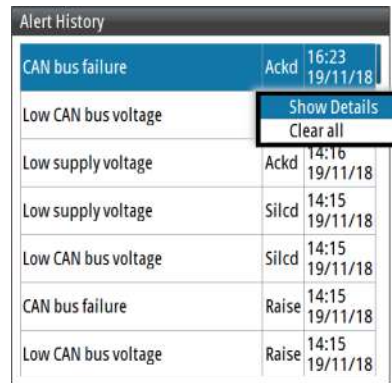
## Alert dialogs



### Active alerts

List of all active alerts.

## Alert history



| Alert type          | Status | Time/Date         |
|---------------------|--------|-------------------|
| CAN bus failure     | Ackd   | 16:23<br>19/11/18 |
| Low CAN bus voltage |        |                   |
| Low supply voltage  | Ackd   | 14:16<br>19/11/18 |
| Low supply voltage  | Silcd  | 14:15<br>19/11/18 |
| Low CAN bus voltage | Silcd  | 14:15<br>19/11/18 |
| CAN bus failure     | Raise  | 14:15<br>19/11/18 |
| Low CAN bus voltage | Raise  | 14:15<br>19/11/18 |

Alert events, including alert type, status and time/date

The Alert history dialog stores all alerts, including status and time/date. The alerts remain in the dialog until they are manually cleared.

To show alert details or to clear all alerts:

- Press the menu key and select the desired action

## Alert setting

List of all alerts that can be enabled and configured by the user.

## Setting the alert and warning limits



Most autopilot alerts are activated based on pre-set alert limits, and these limits be changed by the user.

The following setting(s) are common for all work profiles. For work profile specific settings, refer to "*Work profiles*" on page 30.

### Compass difference limit

When two compasses are used (main compass and monitor compass), there is virtually always a difference between the readings of the two. If the difference exceeds the set limit, an alarm is given.

- **Note:** The difference between the two compass readings may vary with the vessel's heading and from one area to another where a vessel is in transit. The difference between the two compass readings is automatically reset when a Compass difference alarm is acknowledged.

## Fallback and failures during automatic steering

### Rudder data missing

Alarm will be given, and steering will after 0.1 sec continue using virtual (estimated value based on known rudder speed) rudder angle data.

### Steering compass missing

#### **When monitor compass is available**

Alarm for main compass failure is given and steering continues using monitor compass. If there is a difference between the compasses, a smooth transition (2 min. filter) to the

monitor compass heading takes place. When acknowledging the alarm, the autopilot goes to Standby mode.

### ***When monitor compass is not available***

Rudder is kept at fixed angle (i.e. heading is approximately maintained if failing when heading keeping, turn is approximately maintained if failing when turning), alarm is given and autopilot goes to Standby mode.

### **Magnetic variation missing**

If heading source is set to be adjusted for magnetic variation, variation is taken from available sensors in following order:

- position source
- navigation source
- compass
- any other variation available on CAN bus.

If variation disappears, last valid variation will be used until automatic steering is cancelled and heading shown will then be corrected according to alternative variation in the order given above.

### **Jump in heading data, check heading**

If there is an abnormal heading jump in steering compass heading, an alarm will be given and a smooth transition to new heading will take place. There may also be a compass difference alarm if a monitor compass is in use.

### **Boat speed missing**

If speed in use is lost, there will be an alarm and smooth transition (2 min. filter) to fallback speed. Speed for steering and speed for navigation will use following priority and fallback:

#### *Steering*

- STW
- STW backup
- SOG
- SOG backup
- Manual speed
- Cruising speed

#### *Navigation*

- SOG
- SOG backup
- STW
- STW backup
- Manual speed
- Cruising speed

### **Position data missing**

During NoDrift steering, alarm is given and a smooth transition to position backup source takes place. If there is no position backup steering source, steering mode will change to auto heading.

### **Navigation data missing**

If lost during Nav. steering, an alarm will sound and steering will change to auto heading steering.

### **Local supply voltage missing**

When control unit(s) and CAN bus have different power source, alarm will be given on active control unit with sound and flashing red power button led (display will go "black"). Main steering computer will go to Standby mode and activate alarm on all other control units.

## **CAN bus supply voltage missing**

Active control unit will give local alarm and rudder/thruster drive units will go to Standby mode.

## **Autopilot computer missing rudder/thruster drive computer failure**

Alarm will be given and the ready signal to the steering /thruster gear will disappear. If software failure, there will be a watchdog restart of failing drive computer. The autopilot steering computer will try to maintain steering as far as possible with remaining drive computers. If the faulty unit is the autopilot steering computer, autopilot backup computer has to be selected manually.

## **Possible alerts and corrective action**

The next pages include a list of all alerts generated by the autopilot system.

The unit might also display alerts received from other units connected to the system. Refer separate documentation for the relevant equipment for further description of these alerts.

Alert type abbreviations:

- **A:** Alarm
- **W:** Warning

### **Active control unit missing (A)**

Autopilot computer has lost contact with active control unit.

- Check/repair CAN bus cable
- Replace the control unit

### **Autopilot computer missing (A)**

Active control unit has lost contact with autopilot computer.

- Check connectors and cables
- Replace autopilot computer

→ **Note:** This alarm will only show up on passive units if active control unit is defective or has lost bus communication.

### **Boat speed missing (W/A)**

(Alarm when Nav steering, else Warning).

The speed signal from the GPS or the log is missing.

- Check device list for valid speed source
- Try a new automatic source update
- Check the GPS, log, and cable connections

### **CAN bus failure (W/A)**

(Warning in standby mode, else Alarm)

Poor CAN bus backbone, defective cable/connector or defective CAN bus receiver in autopilot control head.

- Check backbone terminations
- Check cable and connectors
- Replace autopilot control unit

### **CAN bus supply overload (W/A)**

(Warning if current is >4.3 A. Alarm if current >10 A for 1 ms, hw shutdown).

Excessive current draw.

- Check summary unit loads
- Check for short circuit/defective device on network

### **Check heading (W)**

Jump in heading of more than 10°/second.

- Check steering compass
- Change to other heading source or monitor compass

**Compass difference (W)**

The difference in readings between the main compass and the monitor compass exceeds the limit set for compass difference.

- Check the operation of both compasses. If one compass is magnetic, the error may be caused by deviation change or heavy sea disturbances

**Course difference (W)**

Compass heading is deviating too much from the track course (BWW). May be caused by extreme wind and current, combined with low speed.

**Cross track distance limit (W/A)**

(Alarm when track steering, else Warning).

XTD exceeds the set XTD limit in NAV mode. May be caused by extreme wind and current or too low boat speed.

**Drive inhibit (A)**

Motor or solenoid drive electronics critically overloaded.

- Check connectors and cables

**Drive not available**

No drive response when requested from autopilot on Handshake port on SD80/AD80 board.

- Check that steering gear/thruster is set for autopilot control
- Check cabling to Handshake port on SD80/AD80 board
- Make sure Handshake port on SD80/AD80 board is configured for HS fixed/HS pulse (refer to the configuration section in the Installation manual).

**Drive overload (W/A)**

(Warning if motor/solenoid current > 30 A (AC70) or solenoid current >8 A (SD80). Alarm if motor/solenoid current > 55 A (AC70) or solenoid current >9 A (SD80)).

Reversible motor: motor stalls or is overloaded. Solenoids: shortage to ground or cabling damage.

- Fix possible mechanical blocking of rudder
- If heavy sea at high rudder angle, try to reduce boat speed or rudder angle by steering at another heading
- Make sure there is no shortage to ground or cabling damage
- Disconnect cable from autopilot computer to motor, and make sure there is no alarm when trying to run in NFU mode

**Drive reference voltage missing (A)**

Reference voltage to AD80 is missing.

- Check that the two U\_CTRL dip switches on the AD80 board is set correctly (ref. cable connection label inside faulty unit)
  - If drive control signal is 4-20 mA current or voltage using internal  $\pm 10$  V reference, switches must be set to INT
  - If external ref. voltage is connected switches must be set to EXT
- If external reference voltage, check cabling and measure correct voltage between U\_REF+ and U\_REF- on AD80 board

**Drive unit failure (W/A)**

The autopilot computer has lost communication with device.

- Check that green CPU led on the AC70 is alternating (ref. label inside unit cover for location of led)
  - If off, check local power supply/fuse
- For AD80/SD80, check CAN supply for 9-15 V between NET-S and NET-C of SimNet plug
  - If LED is ok, check cabling, T-connector backbone etc
  - If LED is on, try to restart unit by turning power off/on

**End of route (A)**

Activated on the active control unit when an end route waypoint name has been received from the Plotter/ECS.



**Engage output overload (W/A)**

(Warning when current >3.5 A. Alarm when current > 5 A).

Bypass valve or clutch is drawing excessive current.

- Ensure there is no shortage to ground or cabling damage
- Disconnect cable from autopilot computer to motor, and make sure there is no alarm when engaging FU or AUTO mode

**EVC Com error (A)**

Lost communication with EVC system (Volvo IPS and similar).

- Check connection with EVC engine interface. For IPS, engine must be running

**External mode illegal (A)**

Signals to external mode input port on AD80/SD80 has illegal combination.

- Check if alarm is given for a certain position of external mode selector
- Check cabling to MODE SEL port on the AD80/SD80 board

**High drive temp. (W/A)**

(Warning if drive electronic temperature >80°C. Alarm if drive electronic temperature close to 120°C for more than 1 second).

- Switch off autopilot
- Check for backload in drive unit/steering system
- Check that the autopilot computer specifications matches drive unit

**High internal temp (W)**

Internal temperature >75°C.

**Low boat speed (W/A)**

(Alarm when track steering, else warning if speed data is used for steering).

Speed below set limit for acceptable course keeping (in Work profile).

- Switch to hand steering or adjust Work profile settings

**Low CAN bus voltage (W)**

CAN bus voltage < 9 V.

- Check cable length, bus load and bus supply feeding point. If possible, check if fault disappears by disconnecting some units

**Low supply voltage (W)**

Supply voltage <9.5 V.

- Check battery/charger condition
- Verify mains cable has correct gauge

**Monitor compass missing (W)**

No data from the selected monitor compass.

**Nav data missing (W/A)**

(Alarm if sensor data is used for steering. Warning if missing when starting NAV mode).

Navigation data from Plotter/ECS missing.

- Check device list for valid navigation source
- Try a new automatic source update
- Check the Plotter/ECS and cable connections

**New WP (A)**

Nav mode only.

Course change from one leg to the next is exceeding set "Course change limit".

**No rudder response (A)**

No response to rudder command.

- Check all connections
- Check rudder feedback transmission link (not applicable for Virtual feedback installations)
- Check drive unit motor/brushes
- For SD80, check that port/stbd led is activated (ref label in cover for location)

- Replace the autopilot computer drive board

### **Off heading (W)**

The vessel heading is outside set off heading limit. May be caused by extreme weather conditions, and/or too slow speed.

- Check steering parameters (Rudder, Autotrim, Seastate filter)
- Increase response/rudder value
- Increase boat speed, if possible, or steer by hand

### **Override (W)**

EVC override via SG05, override via SD80/AD80 Handshake or override via SD80/AD80 RUD UI port.

- If unintended warning, make sure override handle is not being activated by loose objects
- Check cabling and override switches connected to Handshake port of SD80 or AD80 board

### **Position data missing (W/A)**

(Alarm in NoDrift mode, else Warning).

Position data from the GPS is missing.

- Check device list for valid position source
- Try a new automatic source update
- Check the GPS and cable connections

### **Rudder data missing (A)**

Rudder angle signal to autopilot computer is missing.

- If several rudder angle sensors, check which port on the board that is set up for use
- If the missing sensor is connected to an autopilot computer, check cabling
- If missing sensor is a CAN device, check network connection

### **Rudder limit (W)**

The set rudder limit has been reached or is exceeded. Might be caused by disturbance to compass (waves) speed log, sharp turn or improper parameter settings.

This warning is related to rudder command in automatic modes. The warning is automatically reset when the rudder position is within the limits.

### **Rudder too slow (W)**

Excessive load to steering gear. Air in hydraulic system, insufficient drive unit capacity.

- Look for mechanical obstructions at the rudder/tiller/ quadrant. Check the back drive force
- Bleed the hydraulic system
- Replace with larger pump unit

### **Sharp turn (W)**

Acceleration is larger than the set Sharp turn limit.

- check that the vessel speed to the autopilot is correct
- check that the set turn rate or radius corresponds to actual turn rate

### **Steering compass missing (A)**

No data from the selected steering compass.

If no monitor (back-up) compass: the autopilot goes to Standby mode.

If monitor compass: the autopilot goes to monitor compass.

If there is a difference, the autopilot will gradually synchronize with the new heading (2 minutes).

### **Thruster inhibited (W)**

The vessel speed exceed the set limit for when the thruster can be used.

- **Note:** The Thruster inhibit limit will only apply when speed source is Log or SOG, not if the speed is set manually.

# 7

## Maintenance

### Preventive maintenance

The unit does not contain any field serviceable components. Therefore, the operator is required to perform only a very limited amount of preventative maintenance.

### Cleaning the display unit

To clean the screen:

- A micro-fiber or a soft cotton cloth should be used to clean the screen. Use plenty of water to dissolve and take away salt remains. Crystallized salt, sand, dirt, etc. can scratch the protective coating if using a damp cloth. Use a light fresh water spray then wipe the unit dry with a micro-fiber or a soft cotton cloth. Do not apply pressure with the cloth.

To clean the housing:

- Use warm water with a dash of liquid dish soap or detergent.

Avoid using abrasive cleaning products or products containing solvents (acetone, mineral turpentine, etc.), acid, ammonia, or alcohol as they can damage the display and plastic housing.

Do not:

- use a jet or high pressure wash

### Cleaning the media port door

Clean the media port door regularly to avoid salt crystallization on the surface, causing water to leak into the card slot.

### Checking the connectors

Push the connector plugs into the connector. If the connector plugs are equipped with a lock or a position key, ensure that it is in the correct position.

### Restoring factory default settings

A default restore will reset the memory to factory settings.

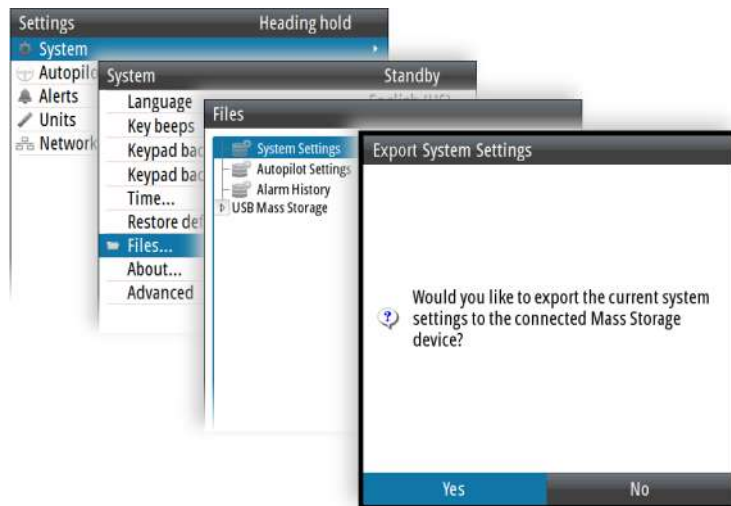
- **Note:** Unless you need to clear all stored values during the installation setup procedure, you should not perform a restore of factory settings.



### Backup and restore of system data

The system includes a backup and restore function, making it possible to back-up and restore user settings.

→ **Note:** It is strongly recommended to make a backup when the system is installed and configured.



## Software updates

Before initiating an update to the unit, be sure to back up any potentially valuable user data. Refer to "*Backup and restore of system data*" on page 44.

### Installed software and software updates

The about dialog shows the software version currently installed on this unit (A).

The product website has information about available software updates.



### Update the software from a storage device

You can download the software update from.

Transfer the update file(s) to a compatible storage device, and then insert the storage device in the unit.

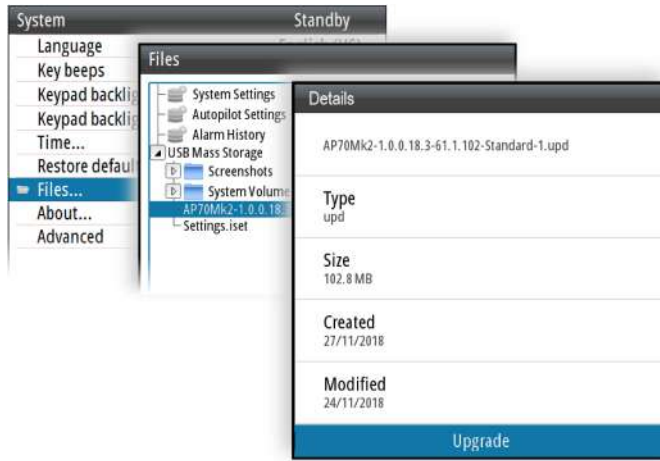
To update this unit only:

- restart the unit to start the update from the storage device

To update this unit or a connected device:

- Select the update file in the dialog

→ **Note:** Do not turn off the unit or a connected device until the update is completed, or until you are prompted to restart the unit.



# 8

## Menu overview

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### Quick menus

The Quick menus are mode dependant, and contain the most commonly used settings for the active mode. Each Quick menu have access to the Settings menus.

To access the Quick menu:

- press the Menu key.

### Quick menu in manual modes

The menu options are described in "*Quick menus in STBY, FU and NFU mode*" on page 20.

| Level 1               | Level 2                     |
|-----------------------|-----------------------------|
| <b>Sources</b>        | Auto select                 |
|                       | Steering compass >          |
|                       | Navigation >                |
|                       | Position >                  |
|                       | Boat speed >                |
|                       | Depth >                     |
|                       | Autopilot computer >        |
|                       | Monitor compass >           |
|                       | Position backup >           |
|                       | Boat speed backup >         |
|                       | Autopilot computer backup > |
| <b>Alerts</b>         | Active alerts...            |
|                       | Alert history...            |
|                       | Alert settings              |
| <b>Speed</b> (Adjust) |                             |

### Quick menus in automatic and navigational mode

These menu options are used for manually adjusting steering performance.

The menu options are described in "*Controlling steering performance in automatic and navigational modes*" on page 27.

### Auto mode

| Level 1                        | Level 2                  |
|--------------------------------|--------------------------|
| <b>Rudder</b> (Adjust)         |                          |
| <b>Counter rudder</b> (Adjust) |                          |
| <b>Speed</b> (Adjust)          |                          |
| <b>Settings</b>                | (Settings dialogs/menus) |

## NoDrift and Nav mode

| Level 1                        | Level 2                  |
|--------------------------------|--------------------------|
| <b>Track response</b> (Adjust) |                          |
| <b>Rudder</b> (Adjust)         |                          |
| <b>Counter rudder</b> (Adjust) |                          |
| <b>Speed</b> (Adjust)          |                          |
| <b>Settings</b>                | (Settings dialogs/menus) |

## Settings

During installation the system is configured, most system settings are defined, and the system is commissioned. All system configuration and Installation setup is described in the separate AP70 MK2 Installation manual.

To access the Settings menu:

- press the Menu key twice.

| Level 1          | Level 2                      | Level 3  |
|------------------|------------------------------|--|
| <b>System</b>    | Language                     |  |
|                  | Key beeps                    |  |
|                  | Keypad backlight day color   | White/Red  |
|                  | Keypad backlight night color | Red/White  |
|                  | Time...                      |  |
|                  | Restore defaults             | Autopilot drive settings                         |
|                  |                              | Global settings                                  |
|                  |                              | Alert history                                    |
|                  |                              | Local settings                                   |
|                  | Files                        |  |
|                  | About                        |  |
|                  | Advanced >                   | Simulate   |
|                  |                              | Voltage  |
|                  |                              | Master   |
|                  |                              | Status output                                    |
| <b>Autopilot</b> | Installation >               | Dockside drives >                                |
|                  |                              | Dockside boat >                                  |
|                  |                              | Autopilot source >                               |
|                  |                              | Compass calibration ... >                        |
|                  |                              | Sea trial ...                                    |
|                  | Steering >                   | (Access to settings for available work profiles) |
|                  | Turn settings >              | Course increment                                 |
|                  |                              | Turn preset                                      |
|                  |                              | U-turn (Enable/Disable)                          |
|                  |                              | S-turns (Enable/Disable)                         |
|                  |                              | S-Turn settings >                                |

| Level 1        | Level 2          | Level 3                  |            |
|----------------|------------------|--------------------------|------------|
| <b>Alerts</b>  | Active alerts... |                          |            |
|                | Alert history... |                          |            |
|                | Alert settings > | Compass difference limit |            |
| <b>Units</b>   | Distance         |                          |            |
|                | Distance small   |                          |            |
|                | Speed            |                          |            |
|                | Heading          |                          |            |
| <b>Network</b> | Sources >        | Auto select              |            |
|                |                  | Steering compass >       |            |
|                |                  | Navigation >             |            |
|                |                  | Position >               |            |
|                |                  | Boat speed >             |            |
|                |                  | Depth >                  |            |
|                |                  | Autopilot computer >     |            |
|                |                  | Device list...           |            |
|                |                  | Diagnostics              |            |
|                |                  | Groups >                 | Display    |
|                |                  |                          | Units      |
|                |                  |                          | Damping    |
|                |                  |                          | Station    |
|                |                  | Damping >                | Heading    |
|                |                  |                          | Boat speed |
|                |                  |                          | SOG        |
|                |                  |                          | COG        |



# 9

## Terms and abbreviations

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The following tables holds a list of abbreviations used in the autopilot display.

|     |                              |
|-----|------------------------------|
| BWW | Bearing Waypoint To Waypoint |
| COG | Course Over Ground           |
| CTS | Course To Steer              |
| CRS | Course                       |
| DTW | Distance to next waypoint    |
| FU  | Follow-Up mode               |
| NFU | Non Follow-Up mode           |
| HDG | Heading                      |
| MAG | Magnetic                     |
| SOG | Speed Over Ground            |
| STW | Speed Through Water          |
| WPT | Waypoint name or number      |
| XTD | Cross track distance         |