

SmartPilot X-Series Commissioning & Setup Guide for SPX-10, SPX-30, SPX-Solenoid & SPX-CAN Systems

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Preface

Safety notices



WARNING: Product installation & operation

This equipment must be installed, commissioned and operated in accordance with the Raymarine instructions provided.

Failure to do so could result in personal injury, damage to your boat and/or poor product performance.



WARNING: Electrical safety

Make sure you have switched off the power supply before you make any electrical connections.



WARNING: Navigational safety

Although we have designed this product to be accurate and reliable, many factors can affect its performance. Therefore, it should serve only as an aid to navigation and should never replace commonsense and navigational judgement. Always maintain a permanent watch so you can respond to situations as they develop.

EMC Conformance

All Raymarine equipment and accessories are designed to the best industry standards for use in the recreational marine environment. Their design and manufacture conforms to the appropriate Electromagnetic Compatibility (EMC) standards, but correct installation is required to ensure that performance is not compromised.

Product documents

This document is part of a series of books associated with the Raymarine SmartPilot X (SPX) series of autopilot systems..

Title	Part number
ST6002 SmartPilot Controller Operating Guide	81269
ST7002 SmartPilot Controller Operating Guide	81270
ST8002 SmartPilot Controller Operating Guide	81271
ST70 AutoPilot Controller - SPX System Commissioning	81287
SmartPilot Surface Mount Controller Installation Guide	87058
SPX SmartPilot System Installation Guide, SPX 10, SPX 30, SPX Solenoid	87072

Title	Part number
Fluxgate compass installation sheet	87011
Warranty Booklet	80017

These documents can be downloaded from www.raymarine.com/handbooks

To the best of our knowledge, the information in the product documents was correct when they went to press. However, Raymarine cannot accept liability for any inaccuracies or omissions in product documents.

In addition, our policy of continuous product improvement may change specifications without notice. Therefore, Raymarine cannot accept liability for any differences between the product and the accompanying documents.

Important

This book does not apply to the SPX-5series of autopilots. These have their own Installation & Setup Guides (Part Numbers 87075, 87075 and 87076).

Limitations on pressure washing

CAUTION: Do not pressure wash Raymarine products

Raymarine products must NOT be subjected to water pressures in excess of CFR46 / IPX6 standards (for example, as generated by commercial high pressure washing equipment). Products subjected to water at these high pressures may experience water intrusion and subsequent failure.

Raymarine products are waterproofed to CFR46 / IPX6 standards, which means that when installed and operated in accordance with the appropriate product documentation, they can be used in most weather and sea conditions. However, any exposure to high-pressure water that exceeds the CFR46 / IPX6 standards, on or around Raymarine products will invalidate the warranty for those products.

Warranty

To register your new Raymarine product, please take a few minutes to fill out the warranty card. It is important that you complete the owner information and return the card to us to receive full warranty benefits. You can also register online at www.raymarine.com by following the **Login or create an account** link.

Product disposal



Waste Electrical and Electronic (WEEE) Directive

The European WEEE Directive requires that waste electrical and electronic equipment is recycled.

Products carrying the crossed out wheeled bin symbol (illustrated above) must not be disposed of in general waste or landfill, but in accordance with local regulations for such products.

Although the WEEE Directive does not apply to all Raymarine products, we support its policy and ask you to be aware of the correct method for disposing of such products.

Please contact your local dealer, national distributor or Raymarine Technical Services for information on product disposal.

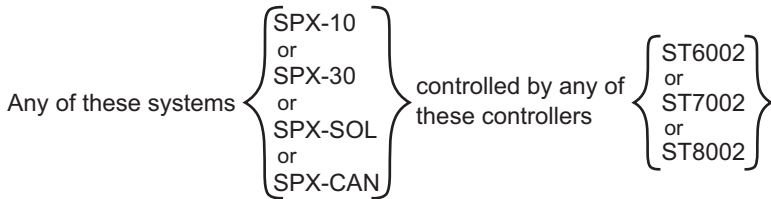
Chapter 1: Procedures



WARNING: Calibration requirement
All autopilot systems must be calibrated before use.

1.1 Introduction

This chapter describes the commissioning and initial setup procedures for the following combinations of Raymarine SmartPilot X (SPX) autopilot systems and Pilot Controllers:



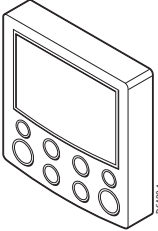
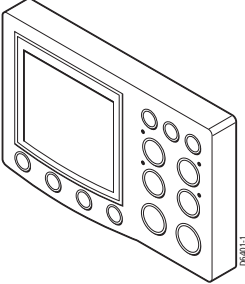
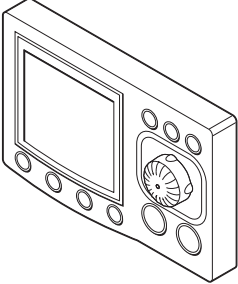
Note: *This book does NOT apply to SPX-5 systems or to systems using ST70 or p70 / p70R Pilot Controllers.*

If your SPX system is controlled with an ST70 Pilot Controller refer to document 81287.

If your SPX system is controlled with a p70 or p70R Pilot Controller refer to document 87132.

SeaTalk Controller differences

Minor differences in the control functions of the various SeaTalk Pilot Controller types are as follows:

ST6002 Controller	ST7002 Controller	ST8002 Controller
		
<ul style="list-style-type: none"> • standby & auto function keys • +1, -1, +10 & -10 course change keys • disp & track extended function keys 	<ul style="list-style-type: none"> • standby & auto function keys • +1, -1, +10 & -10 course change keys • resp, track, mode, res'm, disp, up & down extended function keys 	<ul style="list-style-type: none"> • standby & auto function keys • Rotary course change control • resp, track, mode, res'm, disp, up & down extended function keys

Requirement

The commissioning procedures are mandatory and must be carried out after installation, before an SPX system is used to steer the boat. The commissioning procedures comprises a series of dockside safety checks and a short seatrial.

Additional setup procedures enable you to fine tune your SPX system for optimum performance with your boat. These procedures are not mandatory and you may find that you do not need to use them if the SPX system operates to your satisfaction after commissioning.

1.2 Commissioning procedures

Dockside checks

The dockside checks comprise:

1. Switching on.
2. Checking SeaTalk and NMEA 0183 connections.
3. Checking autopilot steering sense.
4. Setting vessel type and drive type
5. Setting rudder limits, if rudder reference option fitted.



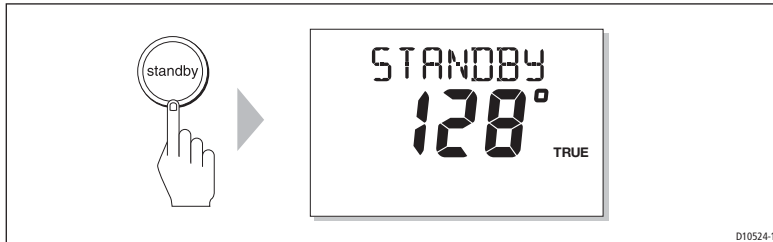
WARNING: Ensure safe control

For safe control of your boat, you **MUST** complete the dockside checks before starting the initial seatrial.

With the boat safely tied up, complete the following dockside checks.

Switching on

- When you have installed your SPX system, switch on the main power breaker.
- If the SmartPilot controller and computer are active, the controller will beep, show the controller type for a few seconds and then show the **STANDBY** screen. You may see a **CALIBRATE REQUIRED** message. This is displayed for a short time if either:
 - the vessel type is not selected.
 - the compass is not calibrated.
 These will be calibrated later in this chapter.
- Check that the **STANDBY** screen displays a live compass heading.



Troubleshooting

- If the Pilot Controller does not beep or the display is blank, check the fuse/circuit breaker and the SeaTalk fuse in the SPX Course Computer.
- If the display shows the **SEATALK FAIL** or **NO DATA** alarm message, check the SeaTalk connections.
- If the **STANDBY** screen does not display a live compass heading, check the sensor connections.

Note: *The autopilots built-in gyro requires a few minutes to stabilize after power on. During this time the heading may appear to drift until the gyro has stabilized.*

Checking SeaTalk and NMEA connections

SeaTalk connections

If you have connected the Pilot Controller to other SeaTalk instruments or controllers, check the links as follows:

- Select display lighting level 3 (**LAMP 3**) on one of the other SeaTalk instruments or controllers.
- Check that the Plot Controller display lights are on. If the lights are not on, check the SeaTalk cabling between the Plot Controller and the other units.

NMEA navigator connections

If you have connected the SPX system to a NMEA navigator, check the links by displaying the default navigation data pages on the Pilot Controller:

- Press **disp** to display the first data page (XTE), and check that this page shows the expected data.
- Press **disp** again to check each successive data page (BTW, DTW etc)

If the display shows dashes instead of data values, ensure:

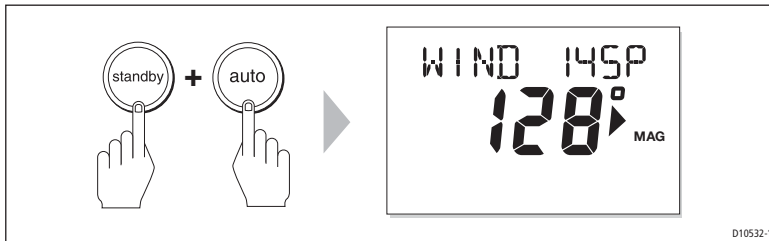
- The navigator is switched on and transmitting an active waypoint.
- The navigator is configured to transmit the required data format

- There is not a cabling error. Check for open circuit, short circuit or reversed wires

Wind instrument connections

If you have connected the SmartPilot to a SeaTalk or NMEA wind instrument, check the links as follows:

1. Simultaneously press standby and auto.
2. Check that the Plot Controller displays the Wind Vane mode screen, with the locked wind angle and locked heading. If WIND mode is not displayed, the SPX system is not receiving wind data. Check the wind instrument and connections.



Checking autopilot operating sense

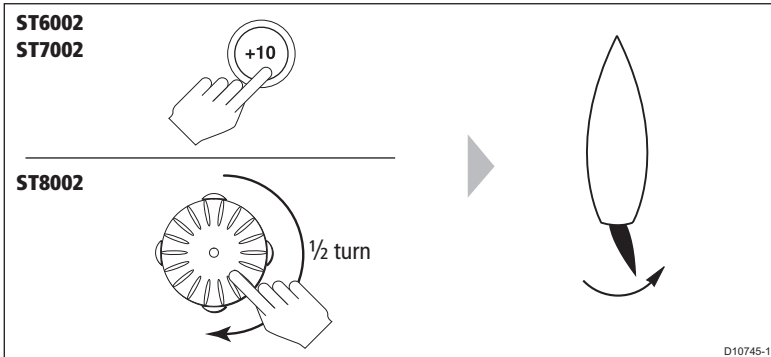
If the rudder reference option is not fitted, ignore this step and proceed from *Generic checks*, below.

If the rudder reference option is fitted:

1. Turn the wheel manually to starboard.
2. Check that the rudder bar on the controller moves to starboard.
If the rudder bar display moves the wrong way:
 - i. Turn off the power.
 - ii. Reverse the red and green wires connected to the RUDDER inputs on the SPX Course Computer.
 - iii. Switch on the power and re-check.

Generic checks

1. Manually center the wheel, then press auto so the SPX system is in Auto mode. Check that the display shows **AUTO**.
Be ready to press standby if the rudder moves hardover.
2. Press the **+10** key once or turn the **rotary control ½ turn** clockwise.



3. Check that the rudder moves to starboard a few degrees, then stops. If the rudder drives hardover, immediately press standby to prevent further rudder movement
4. If the rudder moves to port or the rudder drives hardover:
 - i. Press standby.
 - ii. Turn off the power.
 - iii. Reverse the motor wires connected to the SPX Course Computer
 - iv. switch on the power and re-check.

Note: *If the rudder overshoots and has to drive back or starts to hunt back and forth, you will need to increase the rudder damping level manually (See page 28).*

Entering Dealer calibration mode

To proceed with the commissioning, you need to enter Dealer Calibration, to set :

- Vessel type.
- Drive type.
- Rudder indicator (if rudder reference option is fitted).
- Rudder limits (if rudder reference option is fitted).



WARNING: Use Dealer calibration correctly

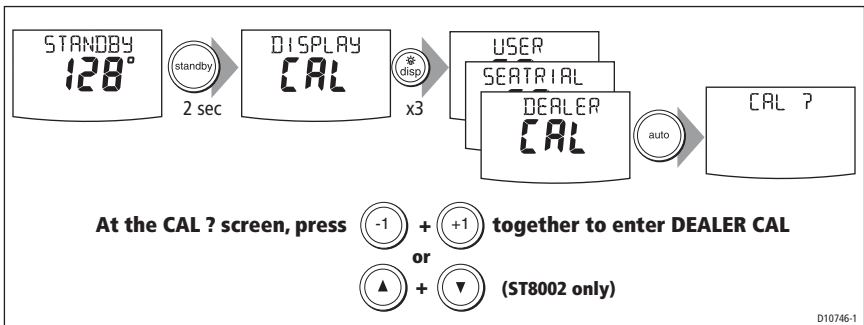
Improper use of Dealer calibration can seriously impair the SPX system performance and therefore adversely affect the steering capability. Do not change Dealer calibration settings other than as described in the product documentation.

To enter the Dealer calibration mode:

1. Ensure the SPX system is in Standby mode.
2. Referring to the following table, use the procedure appropriate to the Pilot Controller you are using to enter Dealer calibration mode.

ST6002 Controllers	ST7002 and ST8002 Controllers
<ol style="list-style-type: none"> 1 Press and hold standby for two seconds to enter the Calibration mode 2 When the screen shows DISPLAY CAL, press disp until you see the DEALER CAL screen 3 Press auto: the display will change to CAL? 4 Simultaneously press -1 and +1 to enter Dealer calibration mode 	<ol style="list-style-type: none"> 1 Press and hold standby for two seconds to enter the Calibration mode 2 When the screen shows DISPLAY CAL, press disp or the up arrow or the down arrow, until you see the DEALER CAL screen 3 Press auto: the display will change to CAL? 4 Simultaneously press -1 and +1 (on the ST7002) or the up and down arrows (on the ST8002), to enter Dealer calibration mode

Note: For more information on settings and calibration modes, refer to Section Chapter 2; SPX system settings



Setting the vessel type

When you select a vessel type, the SPX system automatically selects appropriate default values for various other calibration settings.

Some of these settings will be checked later in this procedure and others should not require any adjustment. The default values for each vessel type are listed on page 33.

To set the vessel type:

1. Use disp to scroll through the Dealer calibration pages until the display shows either **VESSEL** or one of the vessel types (e.g. **DISPLACE**).
2. Use -1 or +1, or the rotary control to select your vessel type:

Options	
DISPLACE	Power-driven boats which do not plane (Typically below 15 kts top speed)
SEMI DISPLACE	Faster power-driven boats which do not plane (Typically 15-20 kts top speed)
PLANING	Planing boats with inboard engine(s) and shaft drives (NOT boats with outdrives)
STERN DRV	Boats with outdrives or outboard engines
WORK BOAT	Commercial tugs, fishing vessels, etc
SAIL BOAT	Sailing boat

- Press **disp** to select the appropriate type of boat and move to the next calibration option.

Setting the drive type

SPX systems will operate with a range of steering drives, as follows:

Drive	Drive Type Setting
<p style="text-align: right; margin-right: 50px;">D6404-1</p>	<p>Drive Type 3 Linear Rotary Typically found on yachts</p> <p>I/O (stern) Found on Powerboats</p>
<p style="text-align: right; margin-right: 50px;">D6405-1</p>	<p>Drive Type 4 Hydraulic reversing pump Used on yachts and powerboats with hydraulic steering</p>
<p style="text-align: right; margin-right: 50px;">D6406-1</p>	<p>Drive Type 5 Constant running hydraulic pumps. Controlled by solenoid valves Found on light commercial and larger boats</p>

Select the appropriate drive type as follows.

- With the SPX system still in Dealer calibration, use **disp** to scroll through the calibration pages until you reach the **DRIVE TYP** page.
- Use **-1** or **+1**, or the rotary control to select the appropriate drive type.
- Press **disp** to select the drive type and move to the next calibration option.

Aligning the rudder position sensor

Carry out this procedure only if the rudder reference option is fitted. If the rudder reference option is not fitted, ignore this procedure.

If the rudder reference option is fitted:

- With the SmartPilot still in Dealer calibration, press **disp** to scroll through the calibration pages until you reach the **ALIGN RUD** page.
- Use the wheel to center the rudder.
- Use **-1** and **+1** or the rotary control to adjust the rudder bar so it is positioned at the center.

The maximum adjustment available is $\pm 9^\circ$. If the offset is beyond these limits, you will need to physically adjust the alignment of the sensor.

4. Press disp to select the correct alignment and move to the next calibration option.

Note: *Alternatively, you can zero the rudder bar with the boat underway during the initial seatrial, by manually steering a straight course then accessing the **ALIGN RUD** screen in Seatrial Calibration to adjust the offset.*

Setting the rudder limits

Carry out this procedure only if the rudder reference option is fitted. If the rudder reference option is not fitted, ignore this procedure.

If the rudder reference option is fitted:

1. With the SmartPilot still in Dealer Calibration press disp to scroll through the calibration pages until you reach the **RUD LIMIT** page.
2. Turn the wheel to move the rudder:
 - to the port end stop and note the angle on the rudder bar
 - to the starboard end stop and note the angle on the rudder bar
3. Use -1, +1, -10 and +10 or the rotary control to set the rudder limit to 5° less than the lowest angle you have noted.
4. Press disp to select the new value and move to the next calibration option.

Save the new settings

When you have adjusted the above settings, hold down standby for two seconds, to save your changes, leave Dealer calibration and return to the Standby mode

Seatrial Calibration

When you have completed the dockside checks, carry out a Seatrial calibration, to calibrate the compass and set up the autopilot steering characteristics.

Before commencing the seatrial:

- The dockside calibration must have been successfully completed.
- There must be no EMC problems.

The Seatrial procedures are:

- Compass calibration.
- Using AutoLearn to set the SPX system steering characteristics.

Important

If you need to return to manual steering at any time during a Seatrial or any other procedure, **press the standby button**. NEVER compromise vessel safety.

EMC conformance

Always check the installation before going to sea to make sure that it is not affected by radio transmissions, engine starting etc.

Seatrial conditions

The seatrial must be carried out only:

- In conditions of light wind and calm water.
- In waters that are clear of any obstructions, so the boat has plenty of clear space to maneuver.

In order to achieve optimum autopilot performance, course over ground (COG), speed over ground (SOG) and latitude (LAT) data must be available to the SPX system (e.g. on SeaTalk). Ensure that the equipment providing this information (e.g. GPS), is switched on and fully operational, before starting a Seatrial.

Calibrating the compass

Note: *This section does not apply if you have connected an NMEA compass to your SPX system. Refer to the handbook supplied with the NMEA compass for information about calibration.*

The compass calibration procedures are:

- Swinging the compass.
- Aligning the compass.

Swinging the compass

The magnetic deviation correction procedure (commonly called “swinging the compass”) involves turning your boat in slow circles so the autopilot can automatically determine the deviation and apply any correction required. The correction procedure reduces deviation errors to a few degrees.

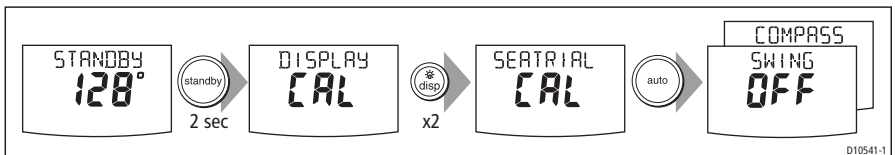
As magnetic deviation can cause significant compass errors on your boat, you **MUST** complete the compass swing before any other seatrial procedure.

To swing the compass:

1. With the SPX system in Standby mode, enter Seatrial calibration as follows:
 - i. Hold down standby for two seconds to enter Calibration mode.
 - ii. When you see the **DISPLAY CAL** screen, press disp until you see the **SEATRIAL CAL** screen.
 - iii. Press auto to enter Seatrial calibration.

Note: *If you cannot access Seatrial calibration, you need to disable the calibration lock. This can be found in Dealer calibration (see page 26).*

2. Use disp as necessary, to move through the Seatrial Calibration items until you see **SWING COMPASS**.



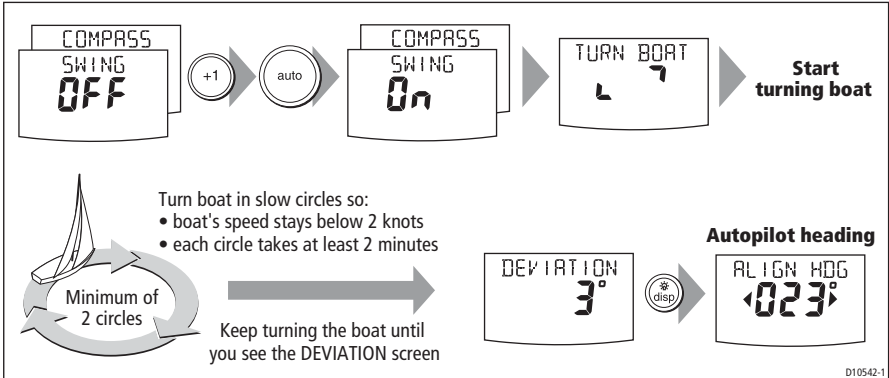
3. When you are ready to start, press +1, or turn the rotary control clockwise, to select **SWING COMPASS ON**. On ST8002 systems, you must then press auto to start the compass swing.

The controller will display **TURN BOAT** indicating the start of the calibration process.

4. Start slowly turning the boat in circles (keeping the boat's speed below 2 knots). You will need to complete at least two circles, taking at least 2 minutes to complete each 360°:

If you turn the boat too quickly, the display will show a **TOO FAST** message. If this occurs, **apply less helm to turn in a larger circle**.

Note: *If necessary, you can quit the correction process by pressing standby or disp. If you then want to repeat the deviation correction, return to the **SWING COMPASS** screen.*



5. Continue slowly turning the boat until the controller beeps and displays the **DEVIATION** screen. This indicates that the SPX system has completed the deviation correction.

Note: *This screen shows the maximum deviation encountered over 360° (not as an east/west value).*

If the deviation figure exceeds 15° or the display shows no deviation value, the compass is being affected by ferrous objects on your boat. You should move the compass to a better location. Higher deviation figures are acceptable on steel boats.

Aligning the compass heading

Once the deviation is displayed, press **disp** to move to the Heading Alignment (**ALIGN HDG**) page.

1. Manually steer the boat on a steady course at a speed sufficient to hold the course.


2. If you have a GPS connected to your SPX system:

- Increase the boat speed to more than 3 knots
- Press auto. The SPX system will then set the heading to agree with the COG (course over ground) heading received from the GPS

As many factors can cause a difference between heading and COG, you must fine-tune the heading alignment so it matches the boat's steering compass (or a known transit bearing). To do this:


1. Use -1, +1, -10 and +10 or the rotary control to adjust the displayed heading until it matches the boat's steering compass (or a known transit bearing).
2. Hold down standby for 2 seconds to exit Serial calibration and save the new compass settings.


Align the autopilot heading


a Coarse adjustment: If COG is available from GPS, press  to set autopilot heading to COG value, then fine tune manually (see below).

b Fine adjustment: If COG is not available (or after setting heading to COG), align autopilot heading manually:

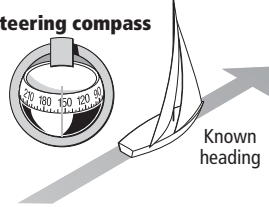
ST6001, ST7001, ST6002 & ST7002









=



Adjust the autopilot heading so it shows the same value as the boat's steering compass

Save changes


2 sec



To:

- save deviation correction
- save heading alignment
- return to STANDBY mode

D6320-2

Although the compass calibration removes most of the alignment error, small errors (a few degrees) may remain. Once you have completed the initial compass calibration, you can make further adjustments to the alignment without having to swing the compass again.

Check the heading reading against a number of known headings, plot a deviation curve, and determine the heading alignment value that will give the lowest **average** alignment error. You can then enter this value on the Heading Alignment screen, as described above.

If the average heading error is more than 5°, you should perform the compass deviation correction procedure again, circling more slowly and in more favorable conditions.

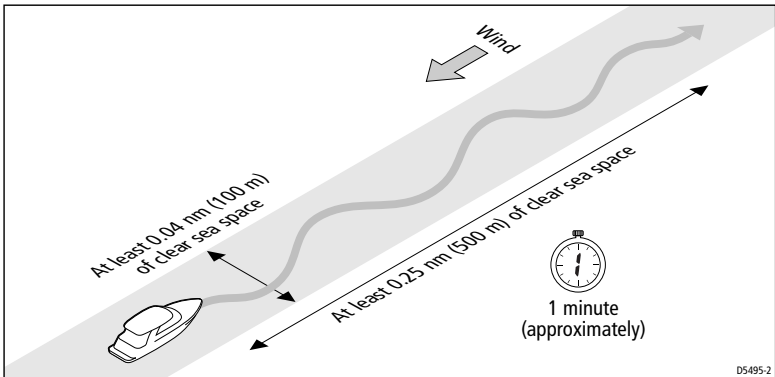
AutoLearn



WARNING: Ensure there is enough clear sea space. The AutoLearn process takes the boat through a number of maneuvers, which can result in sudden, sharp turns, especially when the AutoLearn function is run on more maneuverable boats. Therefore, ensure there is a significant amount of CLEAR SEA SPACE in front of the boat, before starting an AutoLearn process.

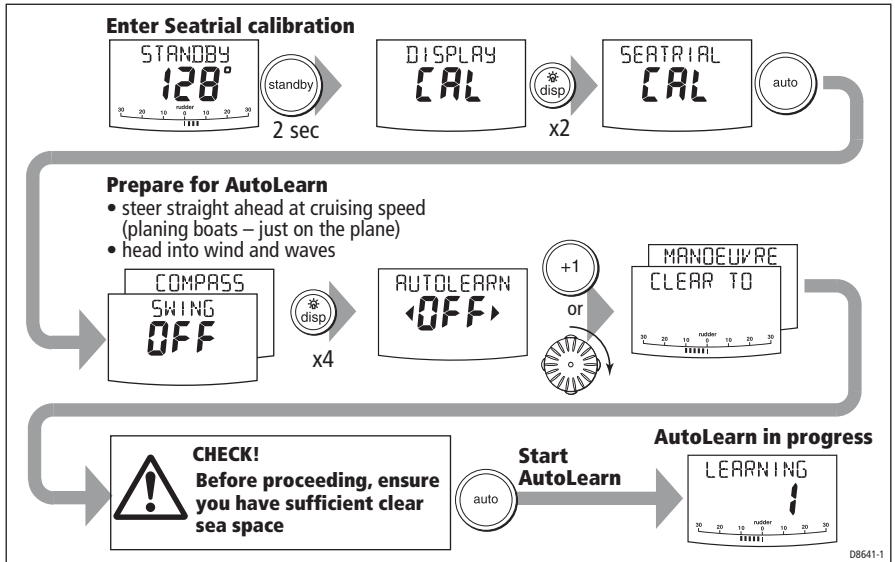
The next stage of the Seatrial is to carry out an AutoLearn routine. AutoLearn is a self-learning calibration feature that automatically adjusts rudder gain, counter rudder and AutoTrim for optimum performance for your boat.

If you need to return to manual steering at any time during an AutoLearn routine or any other procedure, **press the standby button**. NEVER compromise vessel safety.



Carry out an AutoLearn as follows:

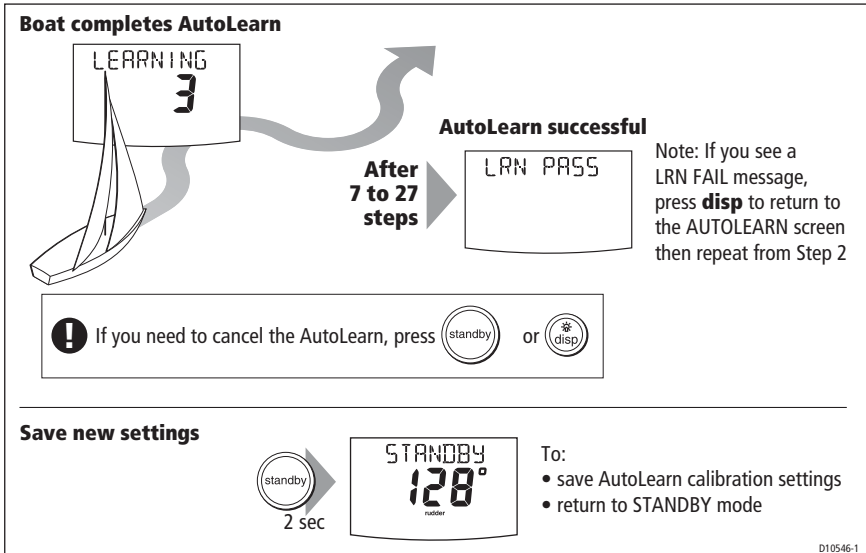
1. Ensure you have sufficient sea room to complete the AutoLearn:
2. Access the **AUTOLEARN** screen in Seatrial calibration:
 - i. From Standby mode, hold down standby for 2 seconds, then press disp twice to see the **SEATRIAL CAL** screen.
 - ii. Press auto to enter Seatrial calibration, then press disp four times to see the **AUTOLEARN** screen.
3. Prepare to start the AutoLearn:
 - **power boats:** steer straight ahead (rudder centered). For non-planing boats, set a comfortable cruising speed. For planing boats set the speed so the boat is just planing.
 - **sail boats:** with the sails down, steer straight ahead (rudder centered) and motor the boat at typical cruising speed.
4. If conditions are not calm, head into the wind and waves.



- When you are ready to proceed:
 - On ST6002 and ST7002 systems, press +1.
 - On ST8002 systems, turn the rotary control clockwise, then press auto.
- The screen will then show the **CLEAR TO MANEUVER** message. Ensure it is safe to continue, then press auto to start the AutoLearn maneuvers:
 - The boat will start a series of zig-zag turns and the display will show **LEARNING** with a number to indicate the current AutoLearn stage. This number increases as AutoLearn progresses.
 - A typical AutoLearn completes within 7 to 27 steps (depending on boat characteristics and sea conditions).

Note: To cancel an AutoLearn, press standby or disp.

- When the SPX system has finished learning, the controller will beep and display either **LRN PASS** or **LRN FAIL**:
 - LRN PASS** = AutoLearn completed successfully
 - LRN FAIL** = AutoLearn was not successful, so should be repeated. A failure code will also be displayed:
 - 1 = AutoLearn has not been carried out
 - 2 = AutoLearn failed, due to manual interruption
 - 4 = AutoLearn failed, probably due to drive or compass failure
 - 5 = AutoLearn failed, probably due to motor current limiting.
 - 6 = AutoLearn failed, probably due to boat spinning.
- If the AutoLearn was successful, hold down **standby** for 2 seconds to store the new settings.



Commissioning complete

Your SPX system is now commissioned and ready for use.

After you have used your SPX system, you may decide to change the value of some parameters to improve pilot performance with your boat. If you feel this is necessary, use the appropriate procedures under *Manual setup*, below.

1.3 Manual set-up

Checking SPX system operation

Before manually adjusting any settings, familiarize yourself with basic SPX system operation, as follows:

1. Steer onto a compass heading and hold the course steady at a normal cruising speed. If necessary, steer the boat manually for a short time to check how the boat steers.
2. Press auto to lock onto the current heading. The SPX system should hold the locked heading in calm sea conditions.
3. Use -1, +1, -10 and +10 and observe how the SPX system alters the course to port and starboard.
4. Press **standby** to return to manual steering.

If you feel you need to fine tune the SPX system performance, you can do so by using one or more of the procedures below to adjust:

- Response level.
- Rudder gain.
- Counter rudder
- AutoTrim.

Over time you may wish to repeat these adjustments using a range of sea conditions and headings to achieve optimum all-round performance for your particular vessel and preferences.

Adjust these settings when motoring your boat at cruising speed.

Response level

The principal method of adjusting the performance of SPX systems is by changing the response level. This controls the relationship between the system's course keeping accuracy and the amount of helm/drive activity.

Screen Text	Effect on operation
RESPONSE 1-3	This setting minimizes the amount of rudder activity but may compromise short-term course keeping accuracy.
RESPONSE 4-6	This setting gives good course keeping with crisp, well controlled turns under normal operating conditions.
RESPONSE 7-9	This setting provides the tightest possible course keeping and greatest rudder activity. This can lead to rough passage in open waters as the SPX system may fight the sea.

To **temporarily** change the response level:

1. Press -1 and +1 or resp to access the **RESPONSE** screen (see page 25).
2. Use the -1 or +1 key or the **up** and down arrow keys to adjust the setting.
3. Press disp to confirm the change

Rudder gain

Boats can vary widely in their response to helm, and by adjusting the rudder gain you can change the steering characteristics of the SPX system. Rudder gain is a measure of how much helm the SPX system applies to correct course errors – higher settings mean more rudder is applied.

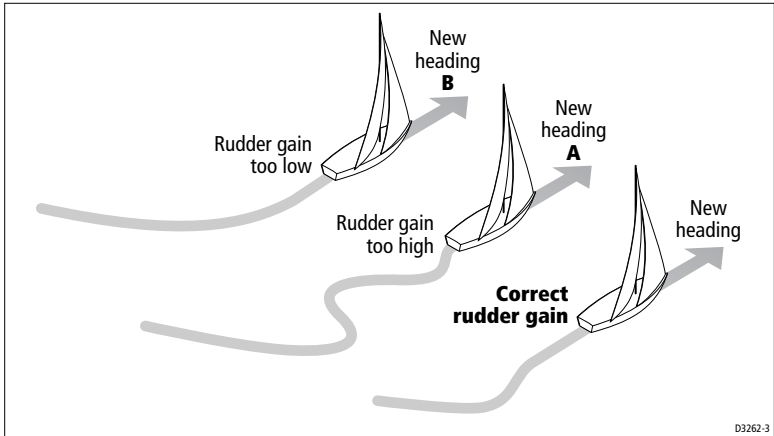
Checking

Complete the following test to determine whether the rudder gain is set correctly:

1. Set **RESPONSE** to level 5 (see above).
2. Motor your boat at a typical cruising speed in clear water.
It is easier to recognize the steering response in calm sea conditions where wave action does not mask steering performance.
3. Press auto to enter Auto mode, then alter course by 40°:
 - If the rudder gain is adjusted correctly, the 40° course change should result in a crisp turn followed by an overshoot of no more than 5°.
 - If the rudder gain setting is too high, the 40° course change will result in a distinct overshoot of more than 5° and there may be a distinct 'S' in the course, as at **(A)**.

Correct this oversteer by **reducing** the rudder gain setting

- If the rudder gain is too low, the boat's performance will be sluggish – it will take a long time to make the 40° turn and there will be no overshoot (**B**). Correct this understeer by **increasing** the rudder gain setting.



Adjusting

To adjust the rudder gain:

1. Access the **RUDD GAIN** screen in Dealer calibration (see page 28).
2. Use the -1 or +1 keys or the rotary control to adjust the rudder gain.
3. Hold down standby for 2 seconds to save the changes.
4. Press auto to check SPX system performance in Auto mode.

Adjusting the counter rudder

Counter rudder is the amount of rudder the SPX system applies to try to prevent the boat from yawing off course. Higher counter rudder settings result in more rudder being applied.

Checking

To check the counter rudder setting

1. Set **RESPONSE** to level 5 (see above).
2. Motor your boat at cruising speed in clear water.
3. Press auto to switch the SPX system to Auto mode, then make a 90° course change:
 - When gain and counter rudder are both set correctly, the boat performs a smooth continuous turn with minimal overshoot.
 - If the counter rudder is too low, the boat will still overshoot.
 - If counter rudder is too high, the boat will 'fight the turn' and make a series of short, sharp turns: this results in a very 'mechanical' feel as the boat changes course.

Adjusting

To adjust the counter rudder:

1. Access the **COUNT RUD** screen in Dealer calibration (see *page 28*).
2. Use -1 or +1 or the rotary control to adjust the counter rudder.
3. Hold down standby for 2 seconds to save the changes.
4. Press auto to check the SPX system performance in Auto mode.

AutoTrim

You may also need to adjust the AutoTrim setting. AutoTrim determines how quickly the SPX system applies 'standing helm' to correct for trim changes caused, for example, by changes in the wind load on the sails or superstructure, or an imbalance of engines.

Increasing the AutoTrim level reduces the time the SPX system takes to get back onto the correct course, but makes the boat less stable. If the SPX system:

- Gives unstable course keeping and the boat 'snakes' around the desired course, **decrease** the AutoTrim level
- Hangs off course for excessive periods of time, **increase** the AutoTrim level

Adjusting

Before attempting to adjust the AutoTrim setting, ensure you have sufficient experience using the SPX system.

On sail boats you can only evaluate the effect of AutoTrim while under sail.

If you need to adjust AutoTrim, go up one level at a time and use the lowest acceptable value. The possible settings range from **OFF** (no trim correction) to **4** (fastest trim correction).

To adjust the AutoTrim:

1. Access the **AUTOTRIM** screen in Dealer calibration mode (see *page 29*).
2. Use -1 or +1 or the **rotary control**, to adjust the AutoTrim level.
3. Hold down standby for 2 seconds to save the changes.
4. Press auto to check the SPX system performance in Auto mode.

Chapter 2: SPX system settings

2.1 Introduction

This chapter describes the SPX system calibration settings and factory default settings. The calibration settings can be adjusted to best suit your operating requirements, but as many will have been adjusted to optimum values when commissioning the system, they should not require further change.

If you change the calibration settings after the SPX system has been commissioned, you do not need to repeat the commissioning process. However, DO NOT manually adjust autopilot settings before the commissioning procedures in *Chapter 2* have been completed.

Calibration modes

There are four calibration modes, namely Display calibration, User calibration, Seatrial calibration and Dealer calibration.

Each calibration mode uses a series of screens to set calibration values.

Display calibration

The items in Display calibration affect the SPX system Pilot Controller. They are stored in the controller and do not affect any other controllers connected through SeaTalk.

You can adjust the Display calibration settings as often as necessary – for example, to add or change information displayed on data pages.

User calibration

The User calibration mode includes settings that you may need to adjust on a regular basis to respond to changing conditions.

Seatrial calibration

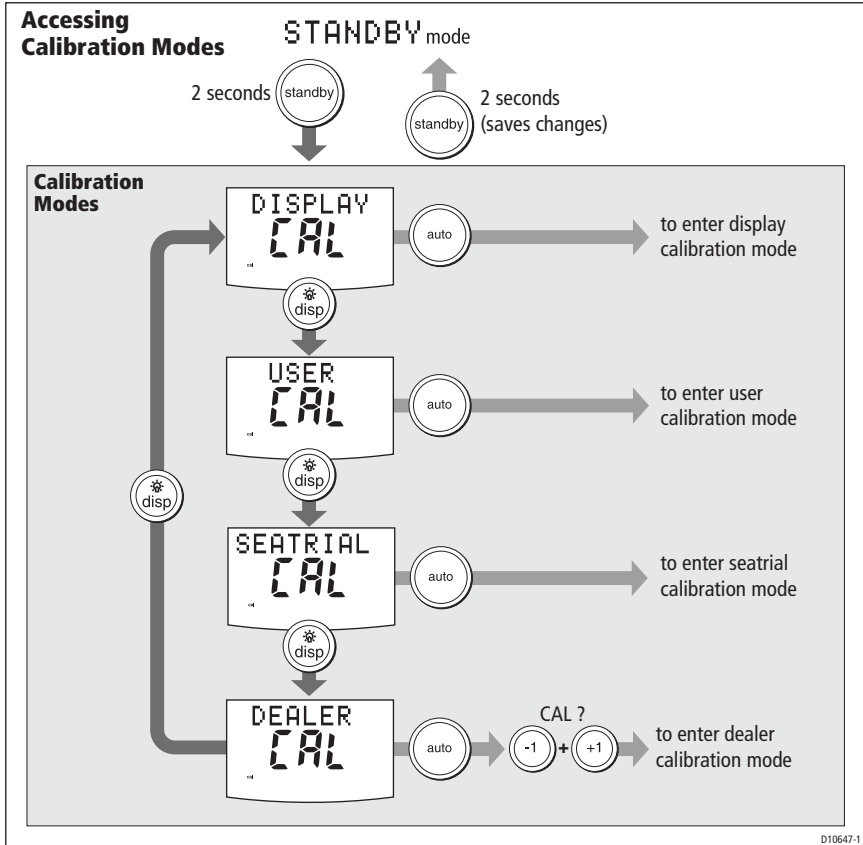
The Seatrial calibration mode is used ONLY when commissioning your SPX system, as described in *Chapter 3*, so is not described again here. **Do not access Seatrial calibration during normal operation.**

Dealer calibration

The Dealer calibration mode includes items that have a significant impact on operation and can affect your boat's safety.

After you have completed the initial installation and seatrial, you should not normally need to alter the Dealer calibration values.

Accessing the Calibration modes



Adjusting calibration values

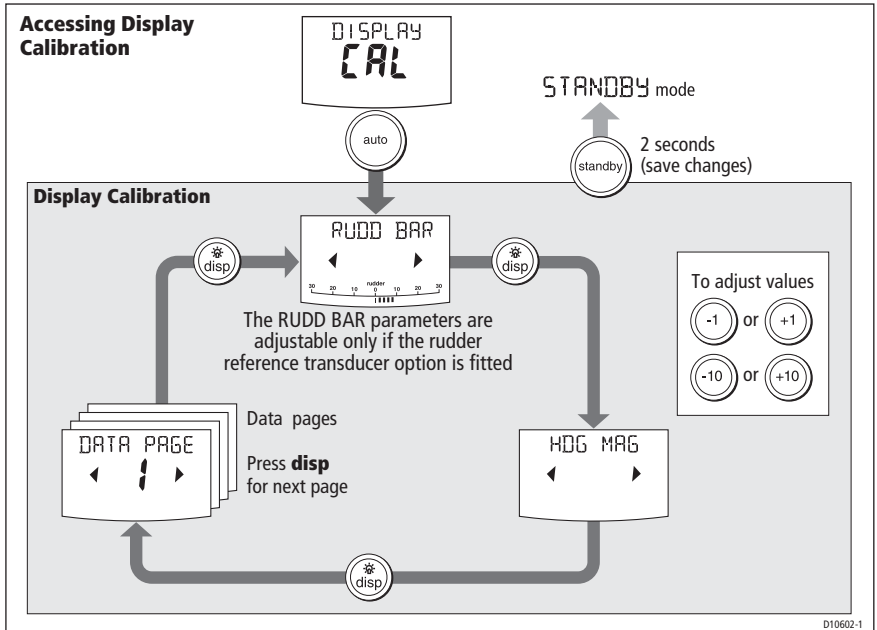
To adjust calibration values:

1. Access the required calibration mode (refer to the diagram above).
2. Press disp to scroll through the available options. To view the previous option, press and hold disp for 1 second.
3. Use -1, +1, -10 and +10 to change the values

When you have made all required changes, press and hold standby for 2 seconds to save changes and exit.

2.2 Display calibration

Display calibration provides settings to adjust the information displayed on the Pilot Controller.



RUDD BAR screen

This screen gives you access to the other Display calibration screens.

HDG screen

You can choose whether to use magnetic or true heading data values. The options are:

- **HDG MAG** - Magnetic heading. If you select this, the screen will indicate **MAG** for heading values, during normal operation.
- **HDG TRUE** - True heading. If you select this the screen will indicate **TRUE** for heading values, during normal operation.

Data pages

The Pilot Controller has fifteen user-configurable data pages. Each data page can be configured to display SeaTalk/NMEA data, which can be viewed during normal operation.

The default data page settings are:

Data Page	Default Setting
1	XTE (Cross Track Error)
2	BTW (Bearing to Waypoint) - see Note below
3	DTW (Distance to Waypoint) - see Note below
4	RESPONSE
Remaining pages	NOT USED (see <i>Setting up data pages</i> below)

Setting up data pages

When setting up your data pages, we recommend that you:

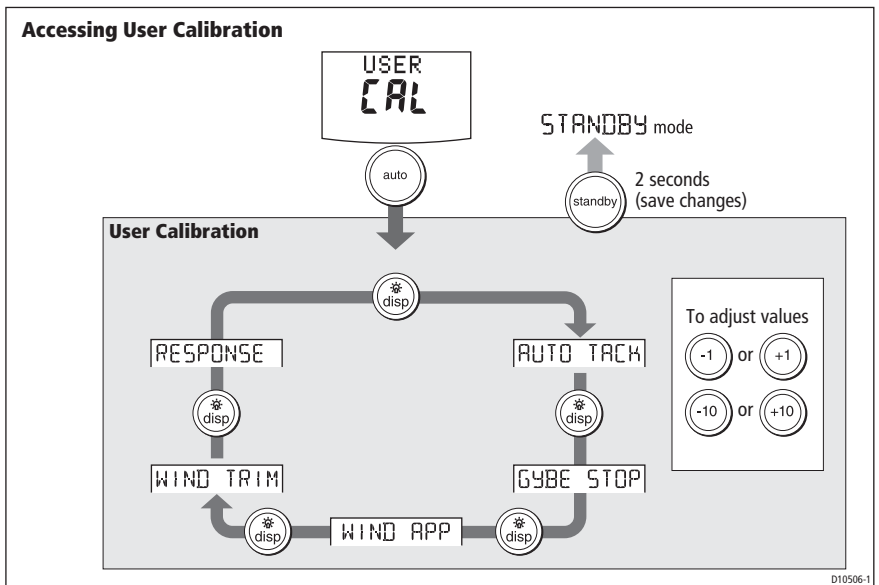
- Set data pages you do not need to **NOT USED**, as these will then not be displayed during normal operation, leaving just the data pages that you do want for you to scroll to.
- Retain the **BTW** and **DTW** data pages. If your SPX system receives a man overboard (MOB) message, these data pages will show the bearing and distance to the MOB location.

Available Data Pages	Displayed as
Speed Knots	SPEED KTS
Log	LOG XXXX.X
Trip	TRIP XXX.X
Average Speed	AV. SPD
Wind Direction	e.g. WIND PORT
Wind Speed	WIND KTS
Depth Metres	DEPTH M - see Note below
Depth Feet	DEPTH FT - see Note below
Depth Fathoms	DEPTH FA - see Note below
Heading	HEADING
Water Temperature, Degrees C	WATER °C - see Note below
Water Temperature, Degrees F	WATER °F - see Note below
Course Over Ground	COG
Speed Over Ground, Knots	SOG KTS
Cross Track Error	XTE
Distance to Waypoint	DTW

Available Data Pages	Displayed as
Bearing to Waypoint	BTW
Rudder Gain	RUDD GAIN
Response	RESPONSE
Watch	WATCH - used to control the Watch timer
Universal Time Coordinated	UTC

Note: *There are 3 depth data pages (meters, feet and fathoms) and 2 water temperature data pages (°C and °F). The SPX system will display the depth data or water temperature in the units defined by the data page you select.*

2.3 User calibration



For information on how to access User calibration, see *Accessing the Calibration modes*, page 20.

The User calibration mode includes settings that you may need to adjust on a regular basis to respond to changing conditions.

AutoTack

Use this screen to select how the vessel performs when using AutoTack. You can either:

- Set a default AutoTack angle. This is the angle through which the boat will turn when an AutoTack is performed.
or
- Select Relative Tack operation. With Relative Tack selected, the apparent wind angle when AutoTack is initiated, is mirrored the other side of the wind, on the opposite tack.

Screen Text	Options
AUTO TACK	40° to 125° in 1° steps

Setting default AutoTack angle

To set the required AutoTack angle:

- If the SPX system is receiving wind information, set the AutoTack angle to the required change of heading.
- If the SPX system is not receiving wind information, set the AutoTack angle to 20° greater than the actual required change of heading.
For example, to tack through 80° (i.e when sailing at 40° to the wind), set the AutoTack angle to 100°.

Selecting Relative Tack

To select Relative Tack, use -1 and -10, to reduce the tack angle value to 30°. This action selects Relative Tack and the screen displays **rEL**, to indicate this.

Gybe inhibit

With gybe inhibit on:

- You will be able to perform an AutoTack into the wind
- The SPX system will prevent the boat from performing an AutoTack away from the wind, to prevent accidental gybes,

With gybe inhibit off, you can perform an AutoTack into or away from the wind.

Screen Text	Options
GYBE STOP	ON (Default) = Gybe inhibit on (gybes prevented) OFF = Gybe inhibit off (gybes permitted)

Wind selection

This screen determines whether the boat steers to apparent or true wind in Wind Vane mode.

Options	
WIND APP (Default)	SPX system steers to apparent wind angle
WIND TRUE	SPX system steers to true wind angle

WindTrim

WindTrim controls how quickly the SPX system responds to changes in the wind direction. Higher wind trim settings will result in a system that is more responsive to wind changes.

Screen Text	Options
WIND TRIM	Range = 1 to 9 1 to 3 -Least responsive to wind changes (less system activity) 4 to 6 -Moderate response to wind changes 7 to 9 -Most responsive to wind changes (more system activity)

Response level

This sets the default SPX system response level. The response level controls the relationship between course keeping accuracy and the amount of helm/drive activity. You can make temporary changes to response during normal operation, as described in the Pilot Controller Operating Guide.

Screen Text	Options
RESPONSE	Range = 1 to 9 Level 1 to 3 minimizes the amount of pilot activity. This conserves power, but may compromise short-term course-keeping accuracy. Level 4 to 6 should give good coursekeeping with crisp, well controlled turns under normal operating conditions Level 7 to 9 gives the tightest course keeping and greatest rudder activity (and power consumption). This can lead to a rough passage in open waters as the SPX system may 'fight' the sea.

2.4 Dealer calibration

For information on how to access Dealer calibration, see *Accessing the Calibration modes, page 20*.

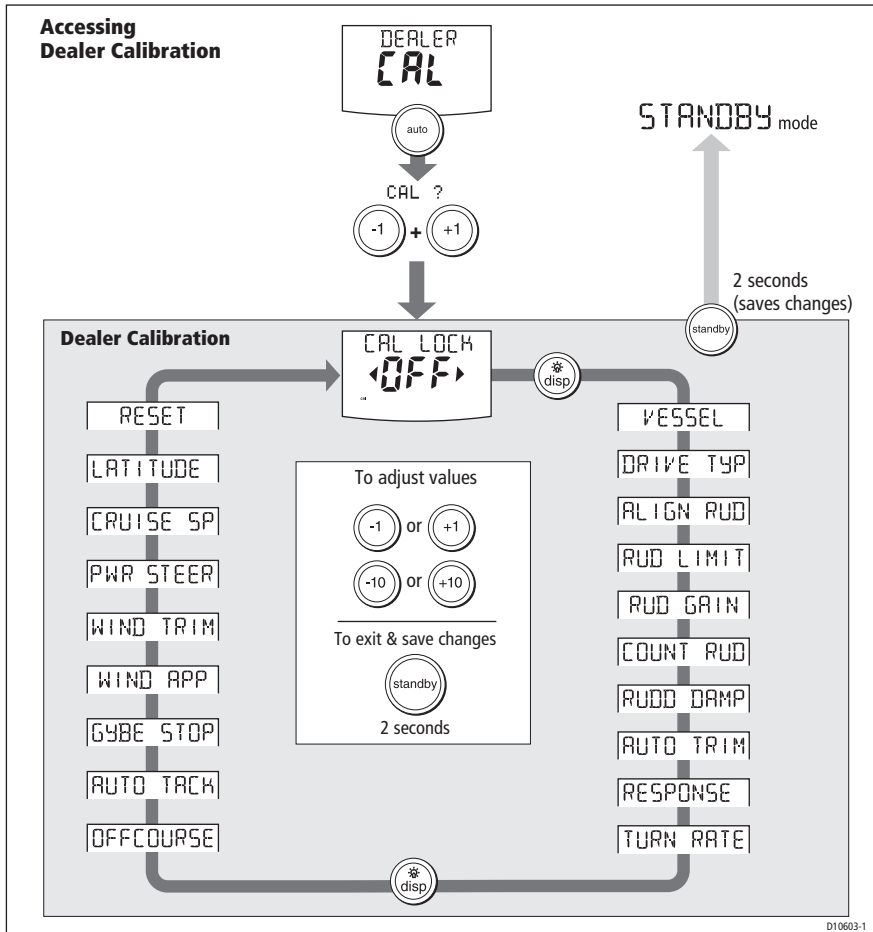


WARNING: Dealer calibration

Changing the Dealer calibration values can have a significant affect on the SPX system steering characteristics and therefore on the safety of your boat.

Some Dealer calibration values are adjusted during the commissioning process (see *Chapter 1: Commissioning & setup*), and once the SPX system has been commissioned you should not normally need to change Dealer calibration values.

However if you decide you want to change values in Dealer calibration, be aware that the Dealer calibration mode includes items that have a **significant impact on SPX-5 Wheel system operation and can affect your boat's safety**.



Seatrial calibration lock

This screen controls the access to Seatrial calibration.

Screen text	Options
CAL LOCK OFF	Calibration lock off – Seatrial calibration can be accessed (default)
CAL LOCK ON	Calibration lock on – Seatrial calibration cannot be accessed

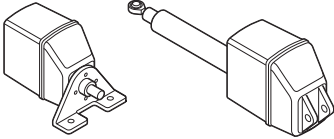
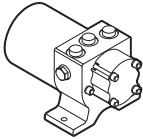
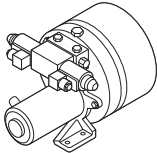
Vessel type

Selecting the correct vessel type, enables the SPX system to set appropriate values for other calibration settings, to give optimum performance. Refer to the table on page 33 for default values.

Options	
DISPLACE	Power-driven boats which do not plane (Typically below 15 kts top speed)
SEMI DISPLACE	Faster power-driven boats which do not plane (Typically 15-20 kts top speed)
PLANING	Planing boats with inboard engine(s) and shaft drives (NOT boats with outdrives)
STERN DRV	Boats with outdrives or outboard engines
WORK BOAT	Commercial tugs, fishing vessels, etc
SAIL BOAT	Sailing boat

Drive type

The drive type setting controls how the SPX system drives the steering system.

Drive	Drive Type Setting
 <p style="text-align: center;">D6404-1</p>	<p>Drive Type 3</p> <p>Linear Rotary Typically found on yachts</p> <p>I/O (stern) Found on Powerboats</p>
 <p style="text-align: center;">D6405-1</p>	<p>Drive Type 4</p> <p>Hydraulic reversing pump Used on yachts and powerboats with hydraulic steering</p>
 <p style="text-align: center;">D6406-1</p>	<p>Drive Type 5</p> <p>Constant running hydraulic pumps. Controlled by solenoid valves Found on light commercial and larger boats</p>

Align rudder

The align rudder screen is displayed only if the rudder reference option is fitted.

If the rudder reference option is fitted, this screen is used to calibrate the rudder bar display. This should be set when commissioning the SPX system (see page 34).

Screen Text	Range
ALIGN RUD	-9° to +9° in 1° steps

Rudder limit

The rudder limit screen is displayed only if the rudder reference option is fitted.

If the rudder reference option is fitted, this screen is used to set the limits of the rudder control just inside the mechanical end stops, and thus avoid putting the steering system under unnecessary load. This should be set when commissioning the SPX system (see page 8).

Screen Text	Range
RUD LIMIT	10° to 40° in 1° steps

Rudder gain

Rudder gain is a measure of how much helm the SPX system applies to correct course errors. The higher the setting the more rudder will be applied.

The rudder gain setting is set automatically as part of the AutoLearn process (see page 12).

Screen Text	Range
RUDD GAIN	1 to 9

Counter rudder

Counter rudder is the amount of rudder the SPX system applies to try to prevent the boat from yawing off course. Higher counter rudder settings result in more rudder being applied.

The default counter rudder gain is set as part of the initial sea trial AutoLearn process (see page 12).

Screen Text	Range
COUNT RUD	1 to 9 (Do NOT set to 0)

Rudder damping

If the SPX system 'hunts' when trying to position the rudder, adjust the rudder damping value to minimize this. Increasing the rudder damping value reduces hunting. Increase the damping one level at a time until the autopilot stops hunting, and always use the lowest acceptable value.

Screen Text	Range
RUDD DAMP	1 to 9

AutoTrim

The AutoTrim setting determines the rate at which the SPX system applies 'standing helm' to correct for trim changes caused by varying wind loads on the sails or superstructure.

The default AutoTrim is set as part of the AutoLearn process (see *page 12*).

If you need to change the setting, increase the AutoTrim one level at a time and use the **lowest** acceptable value:

- If the SPX system gives unstable course keeping or excessive drive activity with a change in the heel angle, decrease the AutoTrim level.
- If the SPX system reacts slowly to a heading change due to a change in the heel angle, increase the AutoTrim level.
- If the AutoTrim level is too high, the boat will be less stable and snake around the desired course.

Setting	Effect
AUTO TRIM OFF	No trim correction
AUTO TRIM 1 to 4	Auto trim applied: 1 = Slowest, 4 = Fastest

Response level

This sets the default SPX system response level setting. The response level controls the relationship between course keeping accuracy and the amount of helm/drive activity. You can make temporary changes to response during normal operation (see your *Pilot Controller Operating Guide* for details).

Screen Text	Options
RESPONSE	Range = 1 to 9 Level 1 to 3 minimizes the amount of pilot activity. This conserves power, but may compromise short-term course-keeping accuracy Level 4 to 6 should give good course-keeping with crisp, well controlled turns under normal operating conditions Level 7 to 9 gives the tightest course keeping and greatest rudder activity (and power consumption). This can lead to a rough passage in open waters as the SPX system may 'fight' the sea.

Turn rate limit

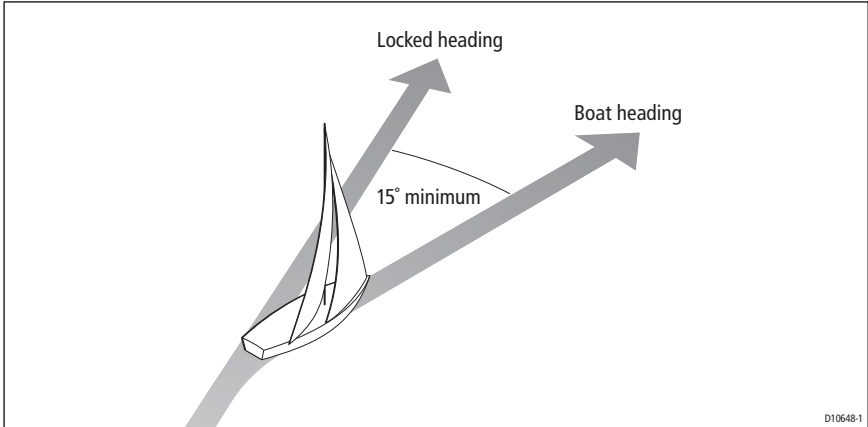
This limits your boat's rate of turn under SPX system control.

Screen Text	Range
TURN RATE	1° to 30° per second in 1° steps

Off course angle

This screen determines the angle used by the **OFF COURSE** alarm (see your *Operating Guide*). The **OFF COURSE** alarm operates if the pilot strays off course by more than the specified angle for more than 20 seconds.

Screen Text	Range
OFF COURSE	15° to 40° in 1° steps



AutoTack

The AutoTack angle is the angle through which the boat will turn when you select an automatic tack (see *page 24*).

Gybe inhibit

With gybe inhibit on:

- You will be able to perform an AutoTack into the wind
- To prevent accidental gybes, the SmartPilot will prevent the boat from performing an AutoTack away from the wind

With gybe inhibit off, you can perform an AutoTack into or away from the wind.

See *page 24*.

Wind selection

Note: *Only available if appropriate wind data is available.*

This screen determines whether the boat steers to apparent or true wind in Wind Vane mode. See *page 24*.

WindTrim

WindTrim controls how quickly the SPX system responds to changes in the wind direction. Higher wind trim settings will result in a system that is more responsive to wind changes. See *page 25*.

PowerSteer

If you have a joystick connected to your SPX system, use this screen to select the required joystick mode of operation. For detailed operating information, refer to the guide supplied with the joystick.

Options	
OFF	Joystick off
1	1 = Proportional power steer Proportional power steer applies rudder in proportion to joystick movement – the further the joystick is held over, the greater the applied rudder.
2	2 = Bang-bang power steer Bang-bang power steer applies continuous rudder in the direction of the lever movement – to improve control, the speed of rudder movement changes with the angle of the lever. For maximum speed, push the lever hard over. If you return the lever to the center position, the rudder will remain in its current position.

Cruise speed

Set the cruise speed to the boat's typical cruising speed. If neither the speed through the water nor the speed over ground are available via SeaTalk or NMEA, the SPX system will use the cruise speed value you set here as a default when calculating course changes.

Screen Text	Range
CRUISE SP	4 to 60 knots

Latitude

If valid latitude data is available via SeaTalk or NMEA, the SPX system will use this data instead of the calibration value.

Screen Text	Range
LATITUDE	0° to 80° in 1° steps

System reset

CAUTION: Losing settings at system reset

Do NOT carry out a System RESET unless advised to do so by a Raymarine dealer. If you complete a reset you will lose the SPX system calibration settings. You will then need to repeat the SPX system commissioning process.

Carrying out a System reset will reset User calibration, Seatrial calibration and Dealer calibration settings to their default values.

Note: *the Display calibration settings will not change, as these are stored in each individual controller*

To carry out a system reset:

1. Select the System reset (**RESET**) screen in Dealer calibration.
2. Press +1 then press auto.
3. The screen will then show an **ARE YOU SURE** message. Either:
 - Press auto to cancel the reset
 - or
 - Press +1 again to select YES and reset the SPX system.
4. You will then see the **CAL LOCK** screen:
 - Hold down standby for 2 seconds to save the new settings, then turn the SPX system computer power off and back on.

If you reset the system parameters, you must carry out the SPX system commissioning process before using the SPX system again.

SmartPilot X-Series Specifications

SPX SmartPilot computer specifications

Nominal supply voltage	
X-10	12 or 24 V DC (fuse protected at 15A)
X-30	12 or 24 V DC (fuse protected at 40A)
X-SOLENOID	12 or 24 V DC (fuse protected at 15A)
X-CAN	12 or 24 V DC (fuse protected at 10A)
Operating voltage range	10 V to 32 V DC
Power consumption (standby)	
X-10	300 mA
X-30	300 mA
X-SOLENOID	300 mA
X-CAN	???
Gyro	internal GyroPlus fitted onto circuit board as standard
Environmental conditions	
operating temperature	-10°C to 55°C (14°F to 131°F)
non-operating temperature	-20°C to 70°C (-4°F to 158°F)
relative humidity limit	80%
water protection	drip resistant when mounted vertically
Storage conditions when packed	
temperature range	-5°C to 50°C (23°F to 122°F)
relative humidity limit	75%
Dimensions	(width, height, depth) 307mm (12.1 in), 195 mm (7.7 in), 70 mm (2.8 in)
Weight	
X-10	1.1 kg (2.42 lbs)
X 30, X-SOLENOID	2.2 kg (4.85 lbs)
X-CAN	???
Inputs	Fluxgate compass, rudder position sensor, NMEA 0183 v2.3, SeaTalk, SeaTalk ^{ng} , power, sleep switch
Outputs	
X-10, X-0	NMEA 0183 v2.3, SeaTalk, SeaTalk ^{ng} , drive motor, drive clutch
X-SOLENOID	NMEA 0183 v2.3, SeaTalk, SeaTalk ^{ng} , bypass valve, solenoid drive
X-CAN	NMEA 0183 v2.3, SeaTalk, SeaTalk ^{ng} , IPS drive, jet drive
Steering drive compatibility	
X 10	All Type 1 drives/pumps (excluding CR pumps) (drive voltage must match boat's supply voltage)
X 30	All Type 1, Type 2 and Type 3 drives / pumps (drive voltage must match boat's supply voltage) CR pumps etc.
X-SOLENOID	Volvo Penta IPS system, Rolls Royce Kamewa water jet drive.
X-CAN	
Drive motor output	
X-10	continuous 10A at supply voltage
X-30	continuous 30A at supply voltage

SPX SmartPilot computer specifications

Drive clutch output

X-10	1.2A at 12 /24 V selectable
X-30	3.0A at 12 /24 V selectable
X-SOLENOID	2.0A at 12 /24 V selectable

SeaTalk output

X-10	2A at 12 V (fuse protected at 2A)
X-30, X-SOLENOID	3A at 12 V (fuse protected at 3A)
X-CAN	???

SeaTalk^{ng} output

X-10	2A at 12 V (fuse protected at 2A)
X-30, X-SOLENOID	3A at 12 V (fuse protected at 3A)
X-CAN	???

NMEA 0183 v2.3 inputs/outputs

See relevant installation guide for received/transmitted NMEA 0183.

Fast heading output

X-10, X-30, X-SOLENOID	NMEA 0183 - 5 Hz
X-CAN	SeaTalk ^{ng} - 10 Hz
	NMEA 2000 - 10 Hz

Fuses

Power Terminals

SeaTalk Terminals

Standard automotive blade fuses
 X-10: 15A. X-30: 40A. X-SOLENOID: 15A. X-CAN:???
 X-10: 2A. X-30 and X-SOLENOID: 3A. X-CAN: ???

EMC compliance:

Europe 2004/108/EC (EMC)
 Australia and New Zealand: C-Tick, Compliance Level 2

Glossary

Term	Meaning
AST (Advanced Steering Technology)	AST (Advanced Steering Technology) is Raymarine's unique advanced steering algorithm. It uses inputs from a wide variety of sensors to tune the autopilot's operation to provide superior control of the boat in any condition.
AutoLearn	Self-learning calibration feature available on Raymarine course computers.
AWG	American Wire Gauge
CE	Marked on products that comply with defined European Community standards
CR pump	Constant Running hydraulic pump
EMC (Electromagnetic Compatibility)	When powered up, all electrical equipment produces electromagnetic fields. These can cause adjacent pieces of electrical equipment to interact with one another, and this can degrade their performance. By following the EMC guidelines in this handbook, you can minimize these effects by ensuring optimum Electromagnetic Compatibility (EMC) between equipment.
Fluxgate	Standard Raymarine compass supplied with core pack
GPS	Global Positioning System
GyroPlus	Raymarine's GyroPlus yaw sensor that measures the boat's rate of turn. It is built into the course computer.
Hz	Hertz (cycles per second)
I/O drive	Inboard/Outboard or stem drive
MARPA	Mini Automatic Radar Plotting Aid
NMEA	The NMEA (National Maritime Electronics Association) protocol is an internationally accepted serial communication interface standard for sharing data between electronic equipment. Raymarine products can share information with non-SeaTalk equipment using the NMEA0183 protocol.
SeaTalk	SeaTalk is Raymarine's proprietary communication system. It links products to provide a single, integrated system sharing power and data.
SeaTalk bus	This refers to the continuous SeaTalk system connecting together a series of Raymarine units.
Yaw	Boat's rate of turn (°/sec)

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