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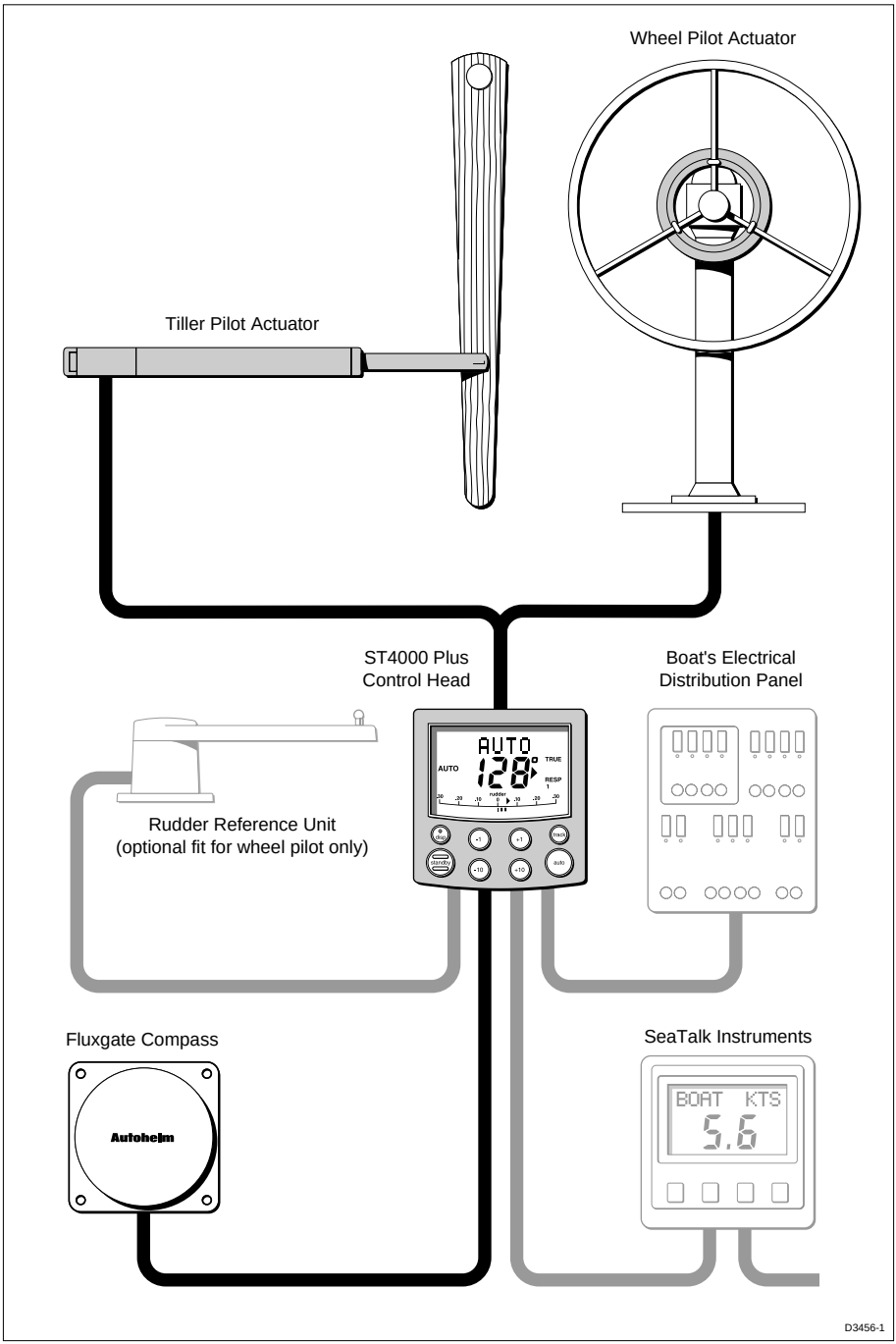
ST4000 Plus Wheel & Tiller Autopilots

Owner's Handbook

Document number: 81131_4
Date: 18th April 1999


Wheel Pilot Actuator
Tiller Pilot Actuator
ST4000 Plus
Control Head
Boat's Electrical
Distribution Panel
AUTO
128°
TRUE
AUTO
RESP
1
Rudder Reference Unit
(optional fit for wheel pilot only)
Fluxgate Compass
Autohelm
SeaTalk Instruments
BOAT KTS
5.6
D3456-1

Raytheon Electronics, as part of its commitment to continuous improvement and updating, reserve the right to make changes, without prior notice, to the equipment, equipment specifications, and the instructions contained within this handbook.

To the best of our knowledge, the information contained within this handbook was correct as it went to press.

A great deal of care has been taken to ensure that this handbook is as accurate as possible. However, liability cannot be accepted for inaccuracies or omissions.

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Preface

This handbook contains information on the operation and installation of your new equipment. In order to obtain the best performance from your autopilot, please read this handbook thoroughly.

How this handbook is organised

This handbook is divided into the following chapters:

Chapter 1: Introduces the autopilot, its features and its use.

Chapter 2: Covers basic autopilot operation.

Chapter 3: Explains how to use Track and Vane (WindTrim) modes and adjust autopilot performance, and summarises the ST4000 Plus alarms.

Chapter 4: Explains how to use the CodeLock security feature.

Chapter 5: Provides details on how to make adjustments to customise the autopilot to your particular vessel.

Chapter 6: Explains how to install your autopilot and its components.

Chapter 7: Covers functional testing and dockside procedures after installation, and intial sea trials.

Chapter 8: Provides general maintenance procedures.

Chapter 9: Provides information to help you resolve any problems you may encounter with your autopilot.

An index is included at the end of this handbook, followed by templates for the installation of the control head, SeaTalk deck connector and rudder reference transducer.

Warranty

To verify the ownership of your new autopilot, please take a few minutes to complete the warranty card. It is important that you complete the owner information and return the card to the factory to receive full warranty benefits.

Safety information

Passage making under autopilot control is an enjoyable experience that can, if you are not careful, lead to the relaxation of the permanent watch. A permanent watch MUST be maintained no matter how clear the sea may appear to be.

Remember, a large ship can travel two miles in five minutes – just the time it takes to make a cup of coffee.

The following rules should always be observed:

- Maintain a permanent watch and regularly check all around for other vessels and obstacles to navigation – no matter how clear the sea may appear a dangerous situation can develop rapidly.
- Maintain an accurate record of the vessel's position either by use of a radio navigation receiver or visual bearings.
- Maintain a continuous plot of position on a current chart. Ensure the locked autopilot heading steers you clear of all obstacles. Make proper allowance for Tidal Set – the autopilot cannot!
- Even when your autopilot is locked onto the desired Track using a radio navigation receiver, always maintain a log and make regular positional plots. Radio navigation signals can produce significant errors under some circumstances and the autopilot cannot detect this situation.
- Make sure that all members of crew are familiar with the procedures to disengage the autopilot.

Your Raytheon autopilot will add a new dimension to your boating enjoyment. However, it is the responsibility of the skipper to ensure the safety of the vessel at all times by careful observance of these basic rules.

EMC Conformance

All Raytheon equipment and accessories are designed to the best industry standards for use in the leisure 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.

Contents

Chapter 1: Introduction

1.1 Overview

The ST4000 Plus is a SeaTalk® compatible autopilot available for tiller or wheel drive steering systems, which can also repeat instrument data in a programmable selection of Data Pages.

The ST4000 Plus can share all data transmitted from other Raytheon SeaTalk instruments:

- Wind information from a wind instrument can be used for wind trim (Vane) steering without the need to install a separate vane.
- Track information, from a navigation instrument, provides waypoint control from the autopilot.
- Boat speed from the Speed instrument provides optimum track-keeping performance.

The ST4000 Plus autopilot can also be used with any navigator (GPS, Decca, Loran) transmitting NMEA 0183 data.

There are four operating modes:

Standby: Autopilot off
Auto: Autopilot engaged and locked onto a heading
Track: Autopilot maintains a track between two waypoints created using a navigation system
Vane: Autopilot maintains a course relative to an apparent wind angle

When the ST4000 Plus is being used to repeat instrument data, "pop-up pilot" pages are displayed for 5 seconds whenever a change in autopilot control is made.

The ST4000 Plus also provides the following:

- Automatic tack facility, which can be used in Auto and Vane modes
- Automatic compass deviation correction
- Northerly/Southerly heading compensation
- Automatic heading deadband – seastate control
- Waypoint advance feature
- Setup and calibration options to suit each installation, giving maximum performance with many types of boat, with three calibration menus (user, intermediate and dealer)

- Dockside rudder calibration feature, which automatically determines the characteristics of your installation, and adjusts for them, before you set sail
- Raytheon CodeLock security support

1.2 Extended systems

The ST4000 Plus is compatible with other Raytheon SeaTalk instruments. Additional fixed and hand-held SeaTalk autopilot control units can be connected at secondary steering and control positions.

A rudder reference unit can be fitted as an optional extra, and will improve the wheel pilot's performance. It is especially recommended if there is significant backlash in the steering system, or optimum performance is required from a mechanical or cable steering system.

Note: *You MUST fit a rudder reference if the ST4000 Plus is installed on a hydraulic steering system.*

1.3 Specification

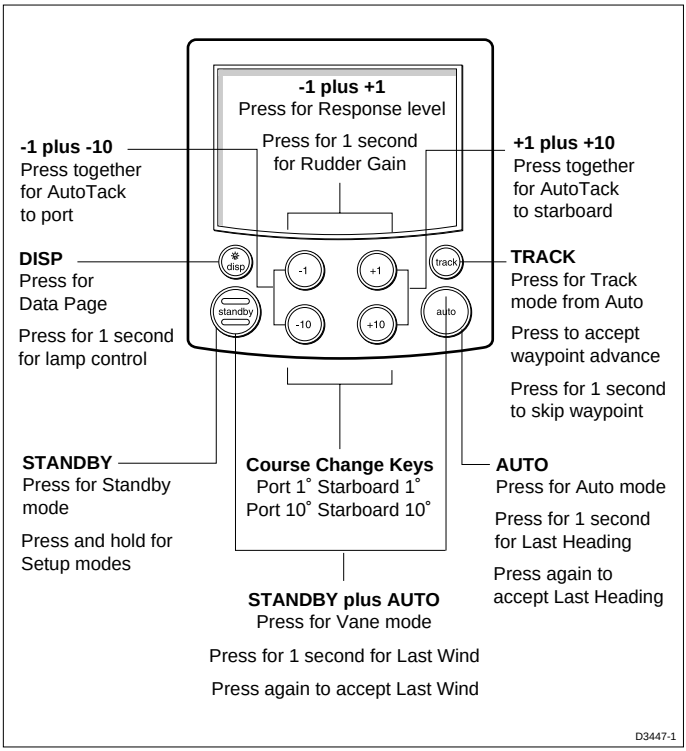
- Power Supply: 10 to 15 V dc
- Drive mechanism: Wheel or Tiller, low current FET drive
- Current consumption:
  Standby: 60 mA (less than 200 mA with full lighting)
  Auto: between 0.5 A and 1.5 A depending on drive type, boat trim, helm load and sailing conditions
- Operating temperature: 0°C to +70°C (32°F to 158°F)
- Eight button illuminated digital keypad
- LCD display of heading, locked course and navigational data, with three levels of illumination
- Input connections for SeaTalk, power, fluxgate compass, rudder reference unit and NMEA
- Output connections for SeaTalk and motor drive

Chapter 2: Basic Operation

This chapter first provides summary diagrams of the key functions and screen layout. It then gives operating instructions for engaging the autopilot and using Auto mode, changing the lighting, and displaying Data Pages.

2.1 Key functions

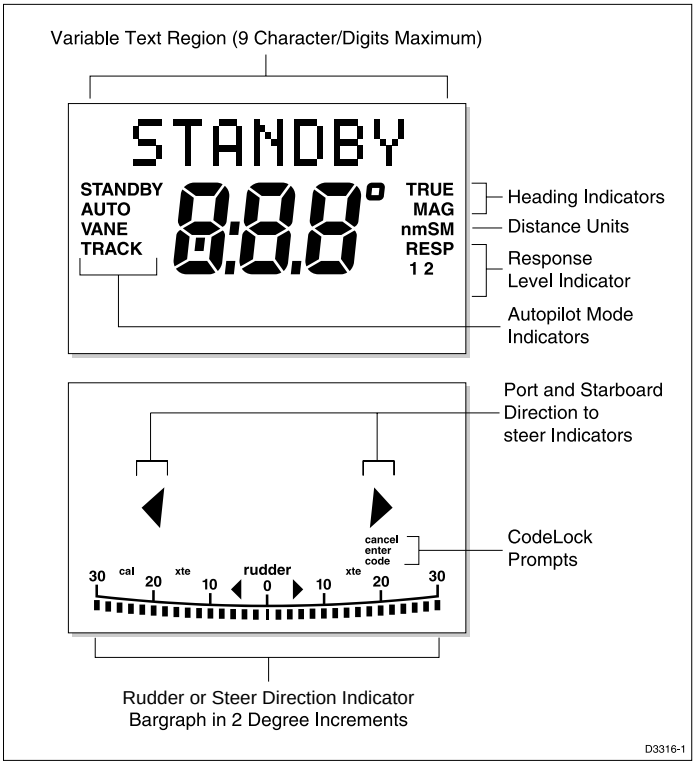
The autopilot is controlled using simple push-button operations, all of which are confirmed with a beep. In addition to the main single key functions, there are several dual key functions.



- The autopilot always powers up in Standby mode. (If the text CODE LOCK is displayed, enter your code as described in *Chapter 4*.)
- Course changes can be made at any time using the **–1**, **+1**, **–10** and **+10** keys.
- You can return to manual steering at any time by pressing **standby** and disengaging the autopilot.

2.2 Display layout

The following illustration shows all the elements, together with a brief description, that make up the ST4000 Plus autopilot LCD display.



- The bar graph at the bottom of the display is normally a rudder bar. If it has been set as a direction-to-steer indicator, the display depends on the current mode, as follows:

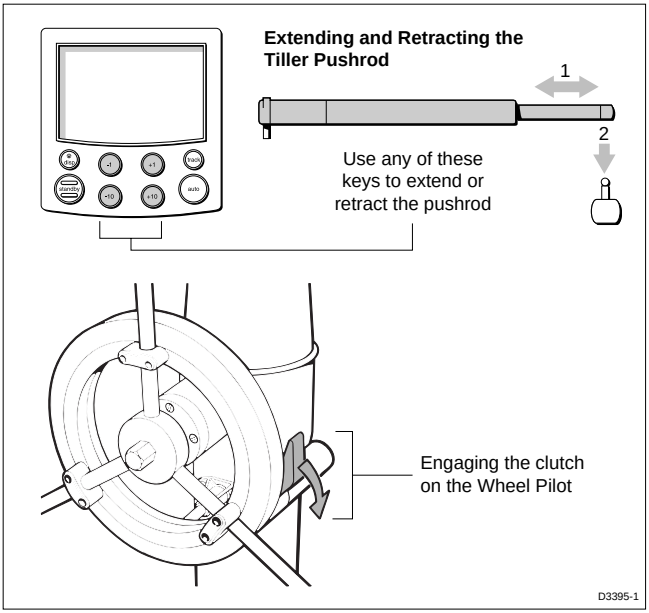
Mode	Bar
Standby	Not used
Auto	Heading error bar
Track	Cross track error (XTE) bar, in 0.02 nm increments
Vane	Wind angle error bar

- If neither distance units (nm or SM) is displayed, the distance is in Km.

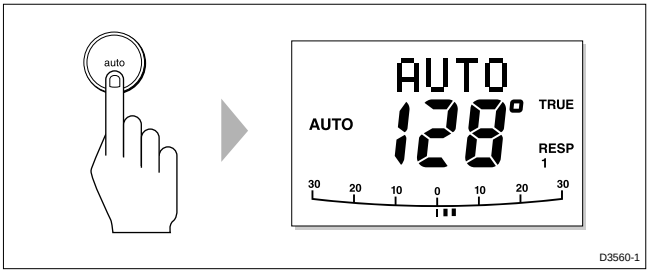
2.3 Using Auto mode

Engaging the autopilot (Auto)

1. Steady the vessel on the required heading.
2. Engage the clutch lever (Wheel Pilot) or place the actuator over the tiller pin (Tiller Pilot).



3. Press **auto**.



- In Auto mode, the display shows the locked autopilot heading.

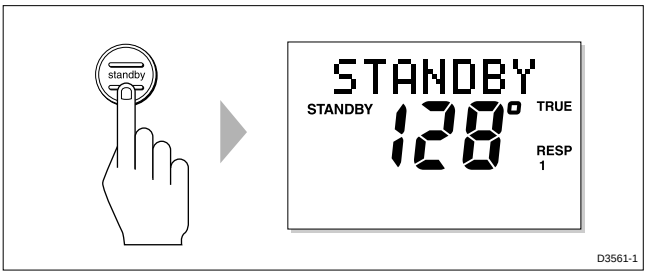
CAUTION:

Passage making under autopilot control is an enjoyable experience that can, if you are not careful, lead to the relaxation of the permanent watch. A permanent watch MUST be maintained no matter how clear the sea may appear to be.

Remember, a large ship can travel two miles in five minutes – just the time it takes to make a cup of coffee.

Disengaging the autopilot (Standby) to return to hand steering

1. Press **standby**.



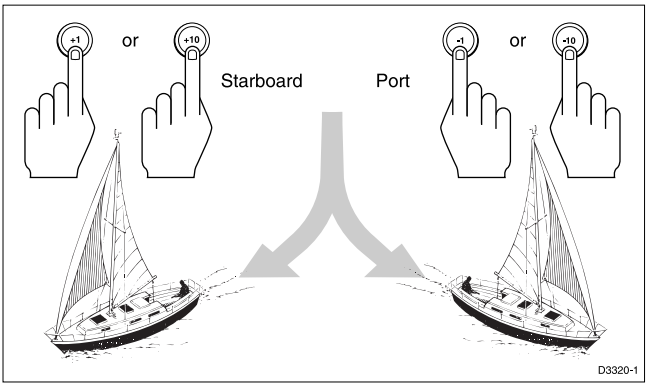
   - In Standby mode, the display shows the vessel's current compass heading.

2. Disengage the clutch lever (Wheel Pilot) or remove the actuator from the tiller (Tiller Pilot) to return to hand steering.
   - The previous autopilot heading is memorised and can be recalled (see *Returning to previous locked heading*).

Changing course in Auto mode

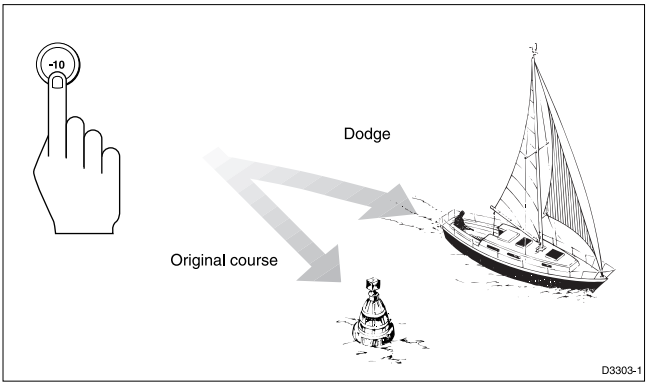
- The **+1** and **+10** (starboard) and **–1** and **–10** (port) keys are used to change the locked heading, in increments of 1° and 10°, when the autopilot has control.

  Example: a 30° course change to port = press **–10** three times.



Dodging obstacles in Auto mode

In order to avoid an obstacle when your vessel is under autopilot control, select a course change in the appropriate direction (for example, port 30° = press **–10** three times).

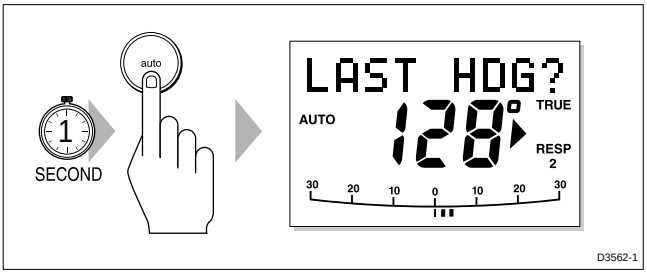


- When safely clear of the obstacle, you can reverse the previous course change (for example, press **+10** three times), or return to the previous locked heading (LAST HDG).

Returning to the previous locked heading (LAST HDG)

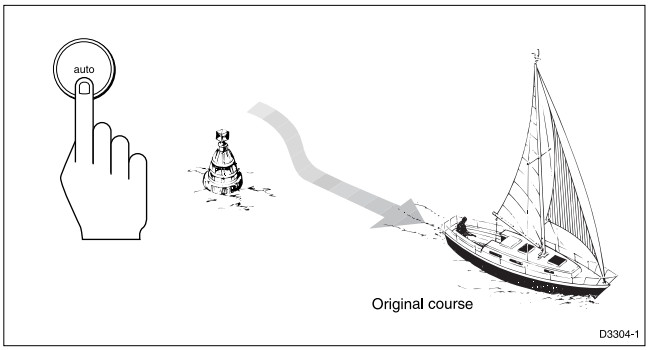
If for any reason the vessel is steered away from the selected locked heading (for example, executing a dodge manoeuvre or selecting Standby) you can return to the previous locked heading:

1. Press **auto** for 1 second. The previous locked heading (LAST HDG) is displayed for 7 seconds.



Note: *A direction-to-steer indicator is displayed to show you the direction the vessel will turn.*

2. To accept this heading, and resume the original course, press **auto** once within this 7 second period.



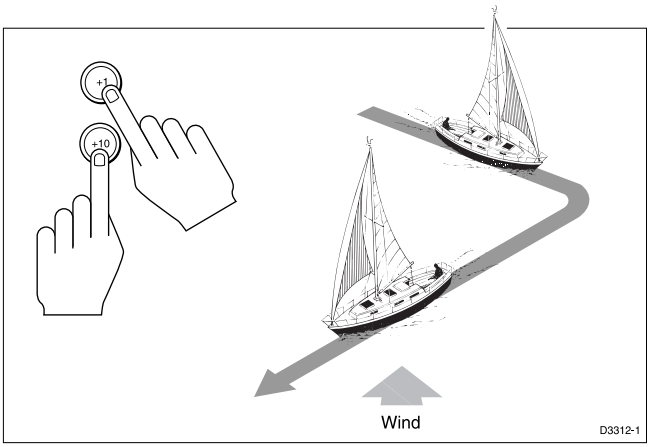
If you do not press **auto** while the display is flashing, the current heading will be maintained.

Automatic tack (AutoTack)

The ST4000 Plus has a built in automatic tack facility that turns the vessel through a predetermined angle (the factory default is 100°) in the required direction.

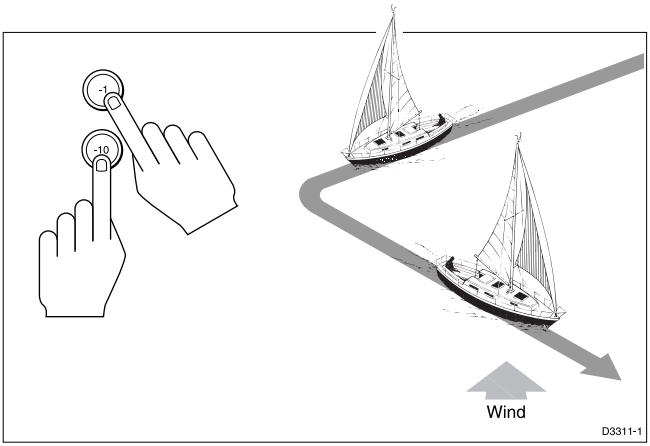
AutoTack to starboard

- Press the **+1** and **+10** keys together to tack to starboard.



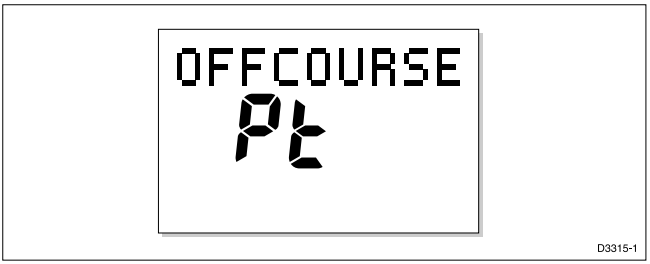
AutoTack to port

- Press the **-1** and **-10** keys together to tack to port .



Off course alarm

The off course alarm will sound if the locked autopilot heading and the vessel's current heading differ for more than 20 seconds, by more than the alarm angle set in calibration (the factory default is 20°).



1. To cancel the off course alarm, press **standby** to return to hand steering.
2. Check whether your vessel is carrying too much sail, or whether the sails are badly balanced. Significant improvements in course keeping can usually be obtained by improving sail balance.

Operating hints

Making major course changes

- It is sound seamanship to make major course changes only when steering manually.
- Manual course changes ensure that obstructions or other vessels can be cleared properly, and due account taken of the changed wind and sea conditions on the new heading prior to engaging the autopilot.

Course changes under autopilot control

It is important to understand the effect of sudden trim changes on steering performance. When a sudden trim change occurs, due, for example, to weather helm or sail imbalance, there will be a delay before the automatic trim applies rudder to restore the locked heading. This correction can take up to one minute.

Large course changes which change the apparent wind direction can produce large trim changes. In these situations, the autopilot will not immediately assume the new automatic heading, and will only settle onto course when the automatic trim has been fully established.

To eliminate this problem, the following procedure can be adopted for large course changes:

1. Note the required new heading.
2. Select **standby** and steer manually.
3. Bring the vessel onto the new heading.

4. Select **auto** and let the vessel settle onto course.
5. Bring the vessel to the final course with 1° increments.

Gusty conditions

In gusting conditions, the course may tend to wander slightly, particularly if the sails are badly balanced. A significant improvement in course keeping can always be obtained by improving sail balance. Bear in mind the following important points:

- Do not allow the yacht to heel over excessively
- Ease the mainsheet traveller to leeward to reduce heeling and weather helm
- If necessary, reef the mainsail a little early

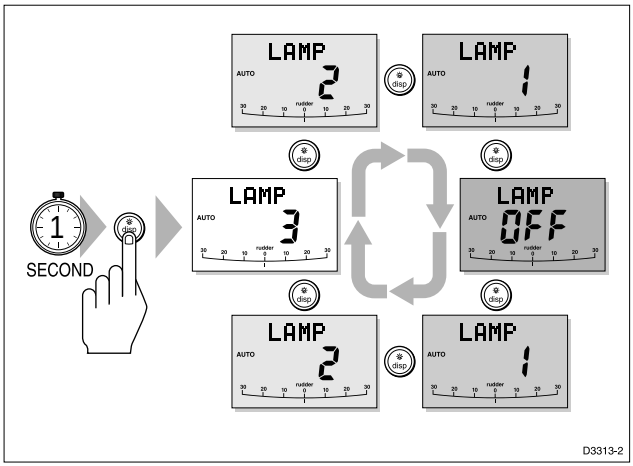
It is also advisable, whenever possible, to avoid sailing with the wind dead astern in very strong winds and large seas.

Ideally, the wind should be brought at least 30° away from a dead run and, in severe conditions, it may be advisable to remove the mainsail altogether and sail under headsail only.

Provided these simple precautions are taken, the autopilot will be able to maintain competent control in gale force conditions.

2.4 Display and keypad illumination

- Press **disp** for 1 second, from any mode, to enter illumination adjustment mode and turn the lights on.



- Subsequent presses of the **disp** key cycles the possible illumination settings: L3, L2, L1, OFF, L1, L2, L3 etc. where L3 is the brightest setting.

The display times out to normal operation after 7 seconds of keypad inactivity.

Pressing any other key before the 7 second time-out will select the mode assigned to that key (for example, **auto** selects Auto mode, **standby** selects Standby mode).

Notes: *If other SeaTalk instruments or autopilot control units are connected to SeaTalk, the illumination can be adjusted from these units.*
Any adjustments to the illumination are lost when the unit is switched off.
The keys are still lit at a courtesy level when the display lighting is off.

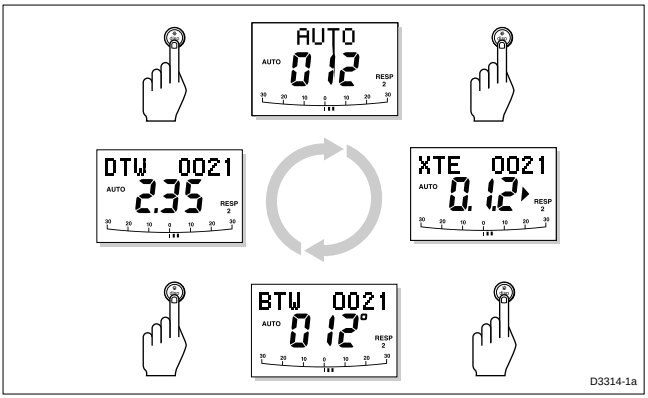
2.5 Data pages

The **disp** key is used to cycle "pages" of SeaTalk or NMEA data. Once a Data Page is selected, this page becomes the principle autopilot display. The autopilot mode displays (Standby, Auto, Track and Vane) then become "pop-ups", and are displayed for 5 seconds when the autopilot mode is changed or a course change is made.

- Press **disp** to display each Data Page in turn.
- When the last Data Page is cycled, the display returns to the current autopilot mode display (for example, Standby).
- To return to a previous Data Page, press **disp** for 1 second within 2 seconds of displaying a page. You can continue to move backwards through the Data Page sequence in this way.

Up to 7 Data Pages are available using the **disp** key. The number of pages, and the information displayed on each page, depends on the the selections made in User Setup (see section *5.1*).

The following illustration shows the default settings for the Data Pages.



- If the required data for a page is not available, dashes are displayed instead of a value.
- Most displays are repeated data, and cannot be adjusted. The exceptions are the Response and Rudder Gain pages (if selected for display), which can be adjusted using the **+1** and **-1** keys.
- The current autopilot mode is shown at the left of the display, and the autopilot bar graph remains in use.
- The “direction-to-steer” arrows relate to the Data Page information.

Chapter 3: Advanced Operation

This chapter provides information on:

- Operation in Track mode
- Operation in Vane mode (WindTrim)
- Adjusting the response level and rudder gain
- Alarms

3.1 Operation in track mode

Track mode is used to maintain a track between two waypoints created on a GPS, Decca, or Loran navigation system. The ST4000 Plus will then compute any course changes to keep your boat on track, automatically compensating for tidal streams and leeway.

The ST4000 Plus can receive cross track error (the distance your vessel is from a planned track) from:

(a) A SeaTalk navigation instrument or chartplotter

or

(b) A non-SeaTalk navigation system transmitting data in the NMEA 0183 format – this can be connected directly to the ST4000 Plus NMEA input, as described in the Installation Chapter.

Track mode is selected by pressing the **track** key, but can only be selected from Auto mode. You can return to either Auto or Standby mode from Track mode, as follows:

- Press **auto** to leave Track mode and return to Auto mode.
- Press **standby** to leave Track mode and return to manual steering.

Initiating track mode

When initiating Track mode, the track can be acquired in one of two ways:

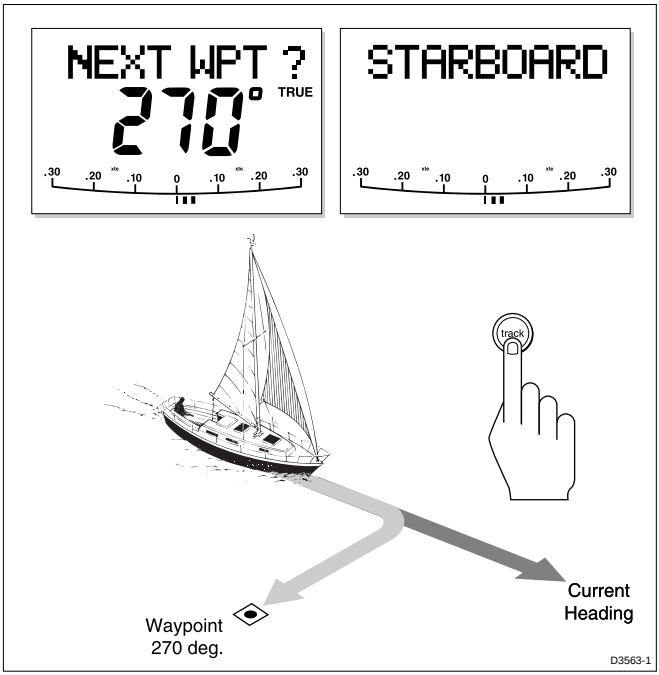
- Automatic acquisition, when cross track error and bearing to waypoint data are available
- Manual acquisition, when cross track error is the only available data

Automatic acquisition

Automatic acquisition can only be achieved if the pilot is receiving cross track error and bearing to waypoint information (via SeaTalk or NMEA 0183). It is initiated as follows:

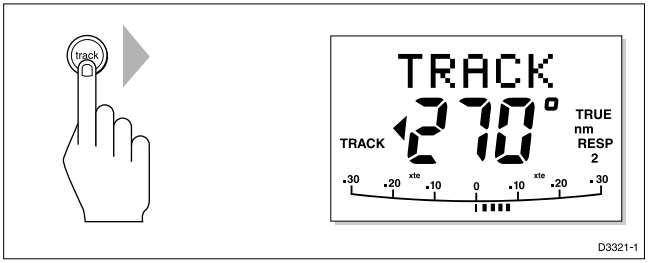
1. Bring the vessel to within 0.1 nm of track.
2. Press **auto** .
3. Press **track** to enter Track mode, with the current locked heading displayed.

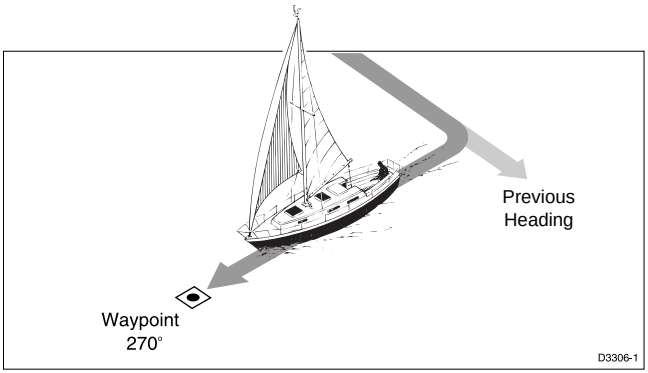
After a short delay for data acquisition, the Waypoint Advance alarm will sound, and the display will show the planned bearing to waypoint alternating with the direction in which the boat will turn.



Note: *If the vessel is further than 0.3 nm from the track, the Large Cross Track Error alarm will sound. Press* **standby** *to cancel the alarm, hand steer closer to the track, and press* **auto** *and* **track** *again.*

4. Check that it is safe to turn onto the new course.
5. Press the **track** key. The boat will turn onto the new course and the alarm will be cancelled.





- The display shows the new bearing to waypoint.

Manual acquisition

For manual track acquisition, when only cross track error data is available:

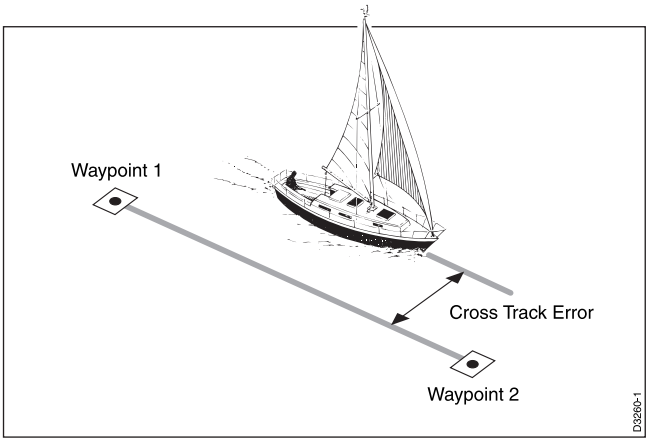
1. Steer the vessel to within 0.1 nm of track.
2. Bring the heading to within 5° of the bearing to the next waypoint.
3. Press **auto**.
4. Press **track** to enter Track mode.
    - The display shows the locked pilot heading.

Note: *At low speeds, the effect of tidal streams is far more significant than it is at higher speeds. Providing the tidal flow is less than 35% of the vessel's speed, no noticeable difference should occur in the performance of Track mode. However, extra care should be taken during manual acquisition, as follows:*

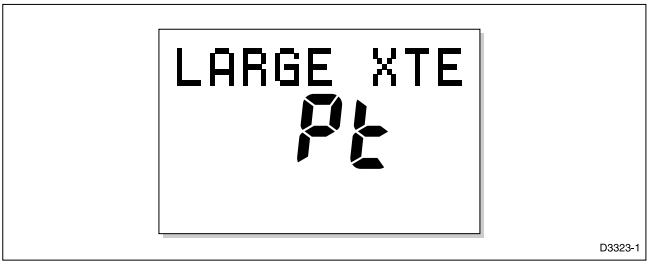
- *Ensure that the vessel is as close as possible to track, and the direction made good over the ground is as close as possible to the direction of the next waypoint, before selecting Track mode.*
- *Make positive positional checks at regular intervals, especially if navigational hazards are close by.*

Cross track error

Cross track error (XTE) is the distance between the current position and a planned route. This is displayed in nautical miles (nm), statute miles (SM) or kilometres, and is taken directly from your navigator.



The Large Cross Track Error alarm sounds if the cross track error exceeds 0.3 nm.



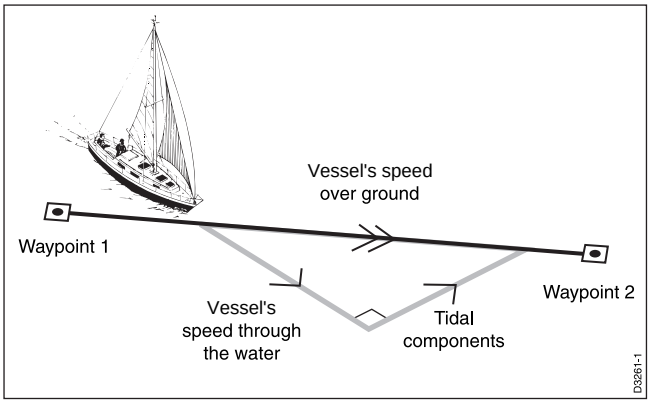
- The direction of the error is identified as port (**Pt)** or starboard (**Stb**).
- To cancel the alarm, press **standby** to return to hand steering, or **auto** to return to Auto mode and retain the current heading.

Note: *If the Large Cross Track Error alarm sounds, it is usually an indication that the cross tide is too great for the vessel's current speed.*

Tidal stream compensation

Under most conditions, Track mode will hold the selected track to within ±0.05 nm (300 ft) or better.

The autopilot takes account of vessel speed when computing course changes to ensure optimum performance over a wide range of vessel speeds. If speed data is available, the ST4000 Plus uses the measured vessel speed. Otherwise, the Speed Over Ground (SOG) or specified cruise speed is used, depending on the calibration setting (see *Dealer Setup* in *Chapter 5*).



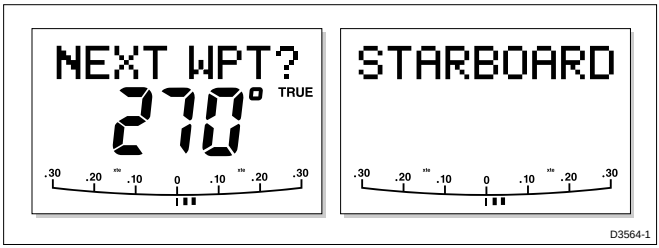
Waypoint arrival and advance

If your navigation receiver transmits valid NMEA waypoint number and bearing to waypoint data, it is possible to advance from one waypoint to the next by simply pressing **track**.

Arrival

As the vessel passes the target waypoint, the navigation receiver should select (manually or automatically) the next target waypoint.

The ST4000 Plus detects the new target waypoint number, sounds the Waypoint Advance alarm and displays the Waypoint Advance information. This display shows the new bearing to waypoint and the direction the boat will turn to acquire the new track.



To accept the next target waypoint, press **track.**.

Note: *When you reach the last waypoint in the track, the NO DATA alarm will sound to indicate that there is no further waypoint information. Press* **auto** *to continue on the same heading, or* **standby** *to return to hand steering.*

Skipping a waypoint – SeaTalk navigators only

If you wish to advance to the next waypoint before you have arrived at the target waypoint, press **track** for 1 second. The Waypoint Advance information for the next waypoint is displayed.

Advance

While the Waypoint Advance alarm is sounding, Track mode is suspended and the ST4000 Plus maintains the current boat heading.

1. Check that it is safe to turn onto the new track.
2. Press the **track** key. This will cancel the Waypoint Advance alarm and turn the boat towards the next waypoint.

Unless the Waypoint Advance is accepted in the above manner, the alarm will continue to sound and the current heading will be maintained.

Dodges

Full control is still available from the keypad when the autopilot is in Track mode.

Initiating a dodge manoeuvre

In track mode, dodge manoeuvres are accomplished by simply selecting the desired course change using the course change keys (**-1**, **+1**, **-10** or **+10**).

Cancelling a dodge manoeuvre

Once the hazard has been avoided, the course change selected for the dodge manoeuvre should be cancelled by selecting an equal course change in the opposite direction.

Note: *Provided the vessel remains within 0.1 nm of track, there is no need to steer back towards the track.*

Safety

Passage making in Track mode removes the chores of compensating for wind and tidal drift, and will aid precise navigation. However, it is important to maintain an accurate log with regular plots.

Position confirmation at the start of a passage

At the start of a passage you must always confirm the fix given by the position transducer, using an easily identifiable fixed object. Check for fixed positional errors and compensate for them.

Verifying computed positions

- Verify the computed position with a dead reckoned position, calculated from the average course steered and the distance logged.

Plot frequency

- In open water, plots should be at least hourly.
- In confined waters, or when potential hazards are near, plots should be more frequent.
- Local variations in radio signal quality, and changes in the tidal stream, will produce deviations from the desired track.

Setting waypoints

- When setting waypoints, remember that deviations will occur.
- Thoroughly check along each track.
- Check up to 0.5 nm each side of the track to ensure that there are no hazards within the zone.

General

The use of Track mode will enable accurate track keeping even in complex navigational situations. However, it cannot remove the responsibility of the skipper to ensure the safety of his vessel at all times by careful navigation and frequent position checks.

3.2 Operation in Vane mode (WindTrim)

Vane mode, also known as WindTrim, allows the ST4000 Plus to maintain a course relative to an apparent wind angle. It uses wind trim to eliminate the effects of turbulence and short term wind variations,

and provides smooth precise performance under Vane mode operation with minimal power consumption.

Vane mode uses the fluxgate compass as the primary heading reference and, as changes in the apparent wind angle occur, the locked compass heading is adjusted to maintain the original apparent wind angle.

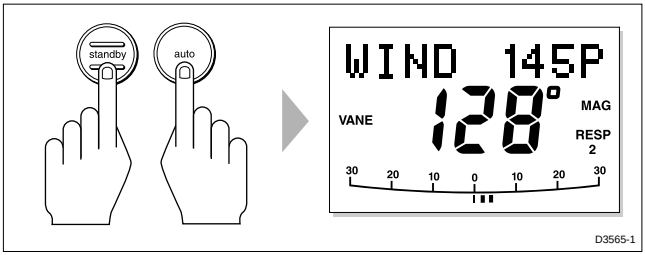
To use Vane mode, the ST4000 Plus must receive wind information from one of the following sources:

- SeaTalk Wind instrument, connected to the ST4000 Plus via SeaTalk
- NMEA wind information
- Autohelm wind vane connected to a SeaTalk interface box

Selecting Vane mode

Vane mode can be selected from either Standby or Auto modes, as follows:

1. Steady the vessel onto a heading at which the apparent wind angle is close to the angle you require.
2. Press **standby** and **auto** together to select Vane mode and lock the current apparent wind angle.



- The locked heading is displayed in large characters. The locked apparent wind angle is displayed above the heading, with a P (port) or S (starboard) direction indicator.
- The boat heading is adjusted by the ST4000 Plus to maintain the locked apparent wind angle.

Adjusting the locked wind angle

The locked wind angle can be adjusted by changing course using the **-1**, **+1**, **-10** and **+10** keys.

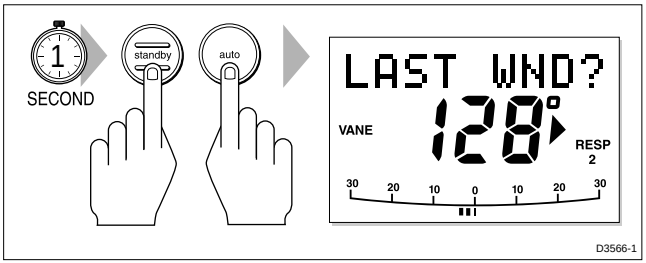
For example, to bear away by 10° when the vessel is on starboard tack, press **-10** to turn the vessel 10° to port. The locked apparent wind angle and locked heading both change by 10°. The new apparent wind angle is maintained, and the locked heading adjusted by the autopilot as required.

Note: *This method should only be used for minor adjustments to the apparent wind angle, since turning the boat affects the relationship between the true and apparent wind angles. For major changes, return to Standby mode, steer onto the new heading, and reselect Vane mode.*

Returning to the previous apparent wind angle (LAST WND)

If for any reason the vessel is steered away from the selected apparent wind angle (for example, a dodge manoeuvre or selecting Standby) you can return to the previous locked wind angle:

1. Press **standby** and **auto** together for 1 second to display the previous apparent wind angle (LAST WND?).



   The LAST WND? text alternates with the previous wind angle and direction. The previous locked heading is displayed, with an indicator to show you the direction in which the vessel will turn.
2. Check that it is safe to turn on to this course.
3. To accept this apparent wind angle, press **standby** and **auto** together within 7 seconds.

If you do not accept the previous wind within this time, the autopilot will lock on to the current apparent wind angle.

Dodges

Full control is still available from the keypad when the autopilot is in Vane mode.

- Dodge manoeuvres are accomplished by simply selecting the desired course change using the course change keys (**-1**, **+1**, **-10** or **+10**). Both the locked heading and locked apparent wind angle are adjusted.
- Once the hazard has been avoided, you can reverse the previous course change, or return to the previous wind angle (LAST WND?).

Wind shift alarm

The wind shift alarm sounds, and the text WINDSHIFT is displayed, if a wind shift of more than 15° is detected.

- To cancel the alarm and retain the existing wind angle and new heading, press **standby** and **auto** together.
- Alternatively, to cancel the alarm and return to the previous heading, either: adjust the locked wind angle using the **-1**, **+1**, **-10** and **+10** keys; or press **standby** to return to hand steering, steer onto the required heading, and press **standby** and **auto** together to return to Vane mode with the new apparent wind angle.

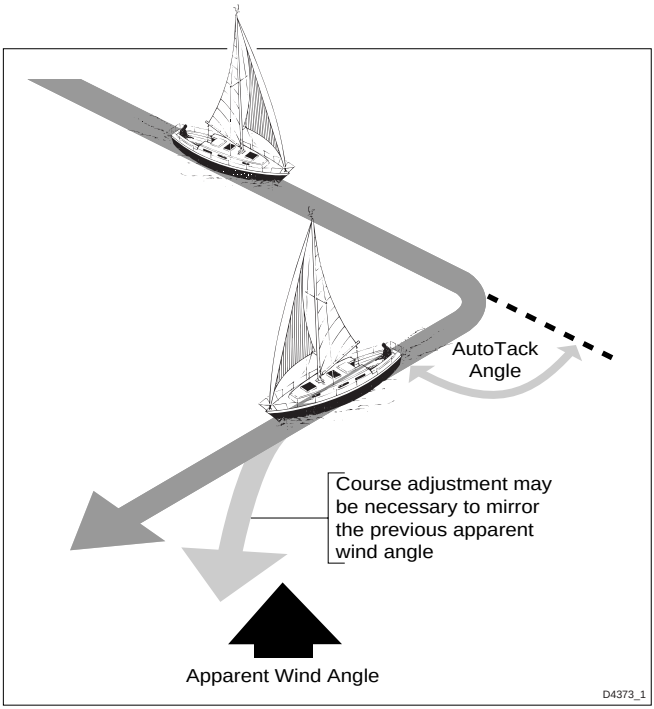
Using AutoTack in Vane mode

The automatic tack function, when used in Vane mode, turns the vessel so that the locked apparent wind angle is changed to an equal angle on the opposite bow.

Initially, the ST4000 Plus turns the vessel through the specified tack angle (the factory default is 100°). Then the locked heading is adjusted until the required apparent wind angle is achieved.

- To tack to starboard, press the **+1** and **+10** keys together.
- To tack to port, press the **-1** and **-10** keys together.

Note: *If you use the AutoTack function in Vane mode, it is important to check that the wind vane has been centred accurately when it was installed.*



Operating hints

- Major changes to the selected apparent wind angle should be made by returning to Standby mode, changing course manually, then reselecting Vane Mode.
- Vane mode filters the windvane output. This provides the optimum response for off-shore conditions where genuine shifts in wind direction occur gradually.
- In gusty and unsteady inshore conditions, it is best to sail a few degrees further off the wind so that changes in apparent wind direction can be tolerated.
- It is important to ensure that the amount of standing helm is minimised by careful sail trimming and positioning of the mainsheet traveller.
- The headsail and mainsail should be reefed a little early rather than too late.

3.3 Adjusting autopilot performance

The response level and rudder gain can be adjusted during normal operation using a combined key-press. Alternatively, you can set up these two control displays as default Data Pages (see section *2.5*).

The default calibration settings for response level and rudder gain, as specified in Dealer Setup, are restored whenever the system is powered on.

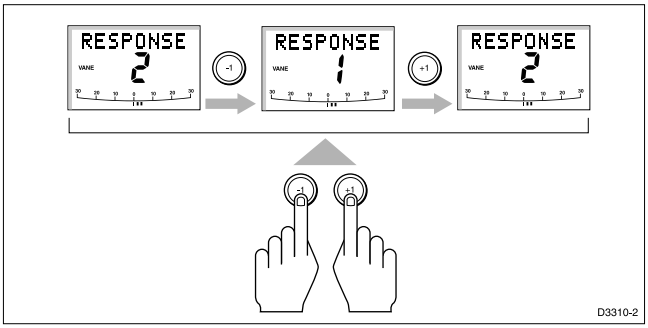
Changing the response level (AutoSeastate)

The response level controls the relationship between the autopilot's course keeping accuracy and the amount of helm/drive activity.

- **Response Level 1**, AutoSeastate (Automatic Deadband), causes the autopilot to gradually ignore repetitive movements of the vessel and only react to true variations in course. This provides the best compromise between power consumption and course keeping accuracy, and is the default calibration setting.
- **Response Level 2** (Minimum Deadband) provides the tightest course keeping possible. However, tighter course keeping results in increased power consumption and drive unit activity.

The response can be changed at any time. To do so:

1. Press the **+1** and **-1** keys together momentarily to display the Response screen.
2. Press **+1** or **-1** to change the response level.
3. Wait for 5 seconds, or press **disp**, to return to the previous display.



Changing the rudder gain

Press the **+1** and **-1** keys together for 1 second to display the Rudder Gain screen, and adjust the setting in the same way as for the response level. Refer to *Chapter 7, Post Installation Procedures*, for instructions on how to check that the rudder gain is set correctly.

3.4 Alarms

This section summarises the alarms (in order of priority) that are reported by the ST4000 Plus. Press **standby** to clear an alarm and return to hand steering, unless otherwise stated.

SeaTalk failure

STLK FAIL

This silent alarm indicates that there is a wiring fault in the SeaTalk connection.

Off course

OFFCOURSE

This alarm is activated when the vessel has been off course from the locked heading by more than the specified angle for more than 20 seconds (see section *2.3, Using Auto mode*).

The alarm is cleared if the heading recovers or the course is changed, or if the operating mode is changed.

Wind shift

WINDSHIFT

This alarm is activated when a change in the apparent wind angle of more than 15° is detected (see section *3.2, Operation in Vane mode*).

Large cross track error

LARGE XTE

This alarm is activated when the cross track error exceeds 0.3 nm (see section *3.1, Operation in Track mode*).

The autopilot stops adjusting the locked heading as soon as this condition occurs.

The alarm is cleared if the heading recovers or the course is changed, or if the operating mode is changed.

Drive stopped

DRIVESTOP

This alarm is activated if the autopilot is unable to turn the rudder. This occurs if the weather load on helm is too high, or if the requested rudder position is past the pre-set rudder limits or the rudder end-stops.

Data not received

NO DATA

This alarm is displayed in the following circumstances:

- Track mode is engaged and the vessel arrives at the last waypoint in the track
- Track mode is engaged and the autopilot is not receiving SeaTalk navigation data
- Track mode is engaged and the position transducer (GPS, Loran, Decca) is receiving a low strength signal – this will clear as soon as the signal strength improves
- Vane mode is engaged and the autopilot has not received wind angle data for 30 seconds

The autopilot stops adjusting the heading as soon as data is lost.

Waypoint advance

NEXT WPT?

The Waypoint Advance alarm sounds whenever the target waypoint number changes, which occurs in the following circumstances:

- Automatic acquisition is selected by pressing **track** from Auto
- Waypoint advance is requested by pressing **track** for 1 second in Track mode (SeaTalk navigators only)
- The target waypoint changes when in Track mode (for example, when a Man Overboard (MOB) message has been received)

When the alarm sounds, the pilot continues on its current heading, but displays the bearing to the next waypoint and the direction in which the boat will turn to take up that bearing.

Check that it is safe to turn onto the new track, and press **track** to accept the waypoint advance.

Alternatively, to cancel the alarm without accepting the waypoint advance, press **standby** to return to hand steering, or **auto** to return to Auto mode.

Note: *The waypoint advance will only operate on pilots receiving valid bearing to waypoint and waypoint number information.*

Low battery

LOW BATT

The Low Battery alarm sounds when the supply voltage drops below 10 V (±0.5 V).

Press **standby** to clear the alarm and return to hand steering.

Start the engine to recharge the battery.

Watch alarm

WATCH

The Watch alarm is activated in Watch mode when the timer reaches 4 minutes. It is not available from Standby mode.

If you wish to set the Watch mode, the WATCH screen must be configured as one of the Data Pages for display, as described in section *5.1*.

To set and control the Watch alarm:

1. Select Auto, Track or Vane mode.
2. Press the **disp** key until the WATCH Data Page is displayed.
   - The watch timer starts counting.
   - When the timer reaches 3 minutes, the text on the display starts flashing to indicate the last minute of Watch alarm.
   - When the timer reaches 4 minutes, the audible Watch alarm is activated.
3. Press **auto** at any time to silence the alarm and reset the timer to 4 minutes. (Pressing any other key resets the timer and performs the key's normal function.)
4. To clear Watch mode, press **disp** to display a different page, or press **standby**.

Note: *You cannot engage Auto mode from Watch mode – pressing* **auto** *only resets the Watch timer.*

Shallow alarm

SHALLOW

The Shallow alarm is activated on the ST4000 Plus if a shallow depth alarm is received via SeaTalk.

- Press **standby** or **disp** to cancel the alarm.

Man overboard (MOB)

If a man overboard (MOB) message is received from another instrument on the SeaTalk system, the text MOB is shown instead of the waypoint number for the XTE, DTW and BTW Data Pages.

If the autopilot is operating in Track mode, the Waypoint Advance alarm will sound to notify the change in waypoint.

Chapter 4: CodeLock

CodeLock is a personal four-digit security feature designed to protect your valuable instruments against theft. You don't have to activate the system, but it's there if you need to. You can activate it using any CodeLock-compatible control unit on your SeaTalk system.

When you first enter a code and activate CodeLock, the code is sent to all the CodeLock-compatible units on the system. After this, whenever you power on the system, the units will only start up if they receive the correct code.

Remember to fix a CodeLock sticker by each instrument, to deter potential thieves.

4.1 CodeLock modes

When you set up CodeLock, you can choose whether the code will be sent automatically or must be entered manually at power on, as follows:

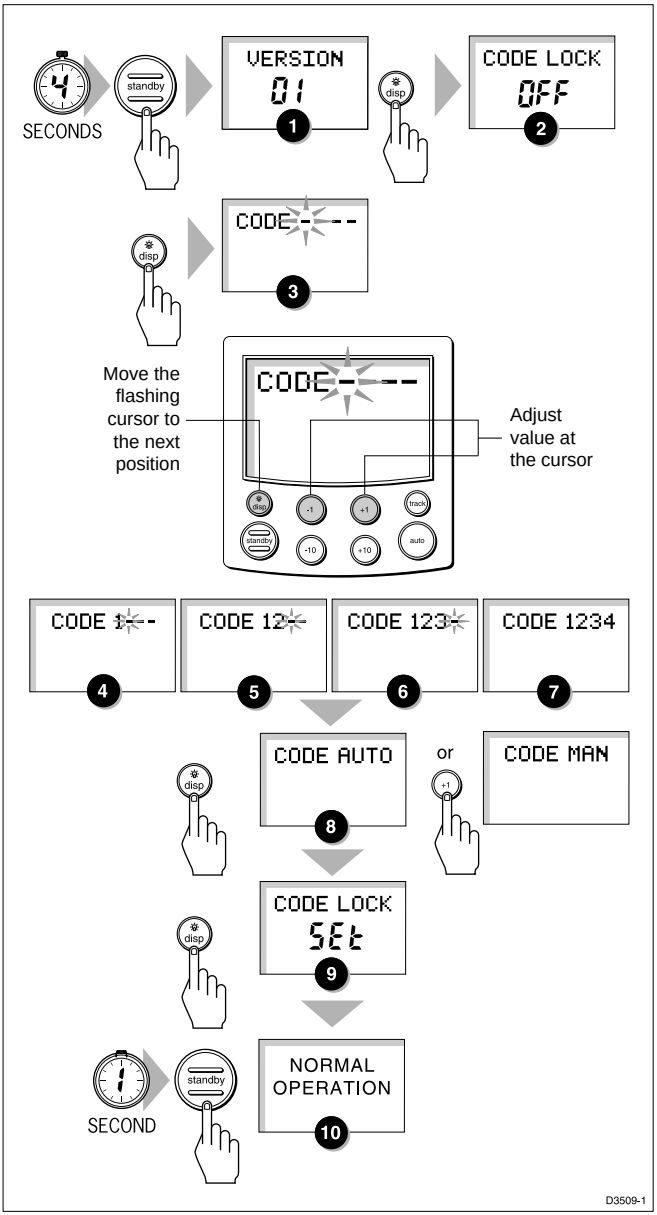
- **Auto** mode is used when there is a display unit situated in a secure location, ideally below deck, or one which can be unplugged and removed to a secure location. You enter your chosen code on this "master" unit when you first activate CodeLock. This code is then automatically sent to all CodeLock-compatible display heads on SeaTalk, without further intervention, every time the system is powered on.
- **Manual** mode is used to provide a higher degree of security, perhaps when all your instruments are mounted in exposed locations. In this case, you must enter your personal code every time the system is switched on. The code can be entered into any convenient CodeLock-compatible control unit, and is then sent to all the other compatible units via SeaTalk.

4.2 Setting up CodeLock

CodeLock is set up and activated on the ST4000 Plus using the Intermediate Setup options.

Initial setup

When you first install your ST4000 Plus, CodeLock is set OFF. To activate CodeLock, refer to the flow diagram on the next page.



- Make sure that the autopilot is in Standby mode before accessing Intermediate Setup.
- If the CAL LOCK screen is displayed instead of the VERSION screen, you need to turn off the lock feature in Dealer Setup.

The Intermediate Setup displays have the following functions:

- **Control unit version number:** Displays the current ST4000 Plus version number. You cannot adjust this display.
- **CodeLock status:** Reports the current status, which can be OFF or SET. You cannot adjust this display directly.
- **CodeLock entry:** Used to enter a new code if CodeLock is OFF, or to turn CodeLock off if it is already set.
- **CodeLock mode:** Used to select Auto or Manual CodeLock mode, when a new code has been entered.

Changing the code or master unit

You can change the code from any CodeLock compatible control unit on your SeaTalk system, provided you know the current code.

Note: *If you set up CodeLock in Auto mode, the unit on which you enter the new code becomes the new master unit.*

To change the code:

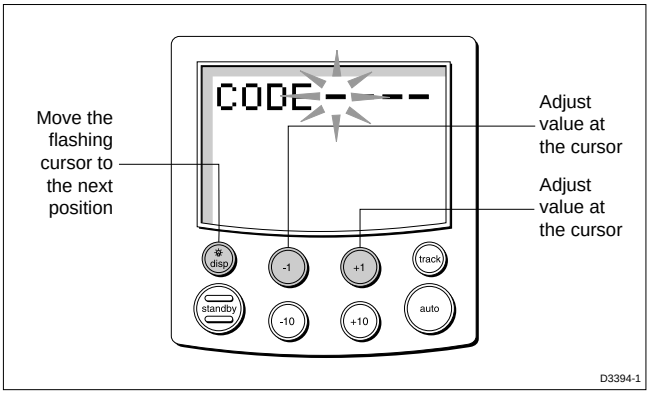
1. Display the CodeLock entry screen and enter your current code, as shown in the flowchart.

   The code is checked. If it is incorrect, the four dashes are redisplayed and you must enter the code again. If it is correct, the CodeLock status screen is displayed, with the status set to OFF.
2. Press **disp** to display the CodeLock entry screen again.
3. Enter the new code and move on to the CodeLock mode selection screen.
4. Set the mode to Auto or Manual, as required.
5. Press and hold **standby** for 1 second to exit Intermediate Setup and save the new settings.

4.3 Entering your code (Manual mode only)

If CodeLock has been set up in Manual mode, the correct code must be entered on one of the control units every time the system is switched on. The code number created on the master is entered via the keypad from any CodeLock-compatible instrument, and this code is then sent to all compatible instruments on the same SeaTalk bus. Once this code has been received the instruments operate in the normal way.

To enter your chosen code number on the ST4000 Plus display unit, use the keys as shown.



To enter the code on any other master display unit, refer to the handbook for that unit for details of the code entry procedure.

4.4 Code number problems

- If an incorrect code number has been entered, the four dashes are redisplayed, with the prompt "enter code". Repeat the procedures illustrated above entering the correct four digit number.
- If you forget your code number, you must take your master unit to an authorised dealer, together with appropriate proof of ownership such as the original invoice. The dealer will be able to reset the unit so that you can enter a new code.

Chapter 5: Customising the ST4000 Plus

The ST4000 Plus provides setup and configuration options that are used to adjust the settings for the ST4000 Plus itself, the compass, and the autopilot.

Note: *You should perform the post installation procedures described in Chapter 7 before adjusting any other calibration features.*

There are three setup levels:

- **User Setup**, which controls compass setup, rudder calibration and the ST4000 Plus display features
- **Intermediate Setup**, which controls the CodeLock security feature and displays status and version number information (see *Chapter 4*)
- **Dealer Setup**, which controls the autopilot settings, and also the calibration lock which can be used to prevent accidental access to User and Intermediate Setup

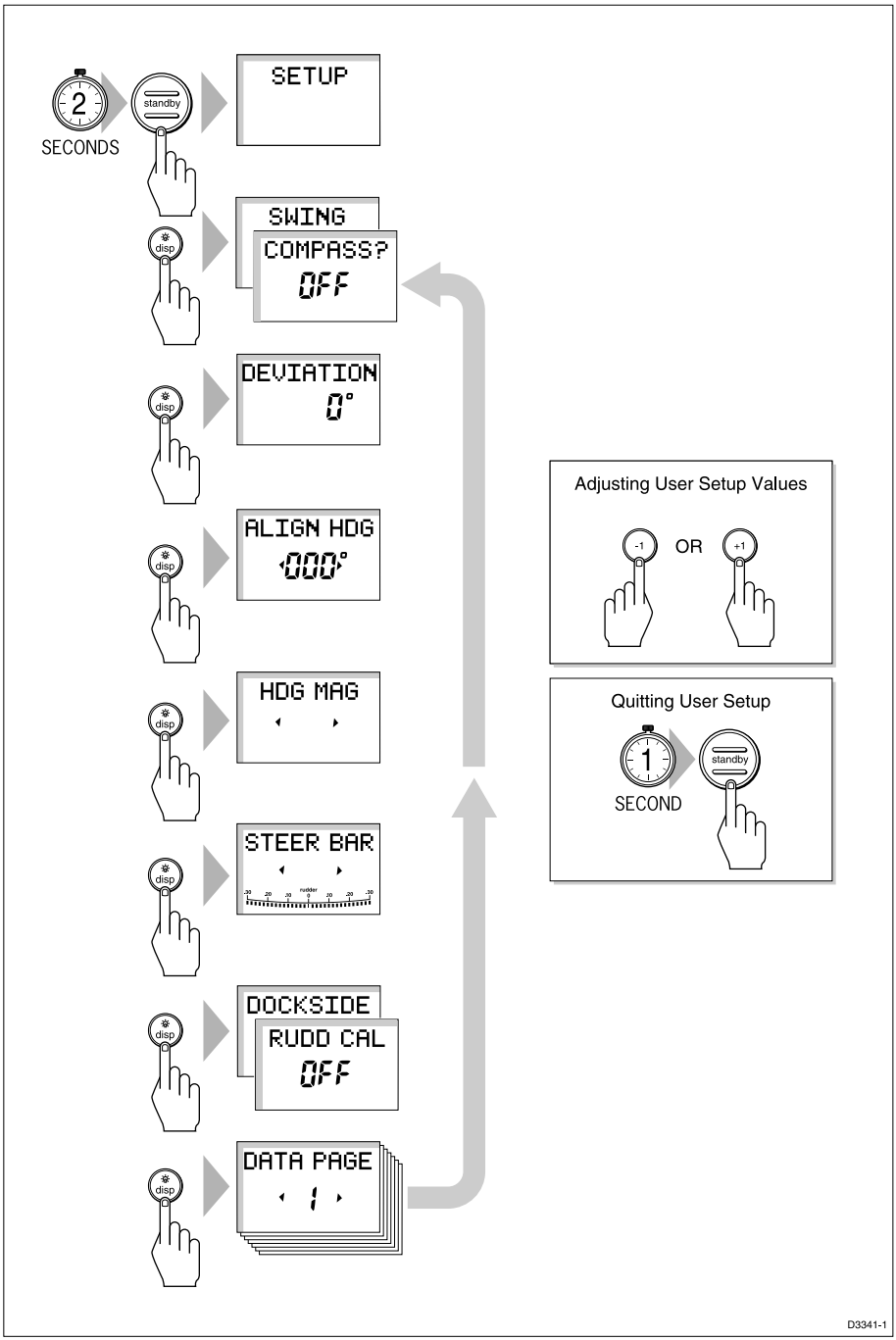
The ST4000 Plus is calibrated at the factory to provide stable performance for most yachts. Although many of the setup and calibration features available in the ST4000 Plus can be fine tuned, it should not normally be necessary to adjust the Dealer Setup values once the initial installation and trials have been performed.

5.1 User Setup

The flow chart on the following page shows the User Setup control procedure, and the setup screens with their default settings. Information on the functions of the different settings is given in the remainder of this section.

The following points should be considered:

- Make sure that the autopilot is in Standby mode before you access User Setup
- If the CAL LOCK screen is displayed instead of the initial page, you need to turn off the lock feature in Dealer Setup
- Setup options are always saved on exit


2
SECONDS
standby
SETUP
disp
SWING
COMPASS?
OFF
DEVIATION
0°
ALIGN HDG
000°
HDG MAG
STEER BAR
rudder
DOCKSIDE
RUDD CAL
OFF
DATA PAGE
1
Adjusting User Setup Values
-1
OR
+1
Quitting User Setup
1
SECOND
standby
D3341-1

Compass deviation correction (SWING COMPASS)

The compass deviation correction option allows you to correct the compass for deviating magentic fields. The procedure must be performed as the first item in your initial sea trial, and is described in detail in *Chapter 7, Post Installation Procedures*.

Deviation display (DEVIATION)

This screen shows the current deviation value, calculated from the correction procedure (Swing Compass). You cannot edit this value.

Heading alignment (HDG ALIGN)

The heading alignment screen shows the current reported heading.

Note: *Always check compass alignment after compass deviation correction (see "Post Installation Procedures"). However, once the initial correction procedure has been carried out, make any alignment adjustments as often as you wish, without re-correcting your compass.*

- Steer your vessel onto a known heading and check the heading.
- If required, adjust the heading value to match the known value, using the **-1**, **+1**, **-10** and **+10** keys.

Heading mode (HDG)

Select either magnetic or true heading mode. When heading data is displayed in normal operation, the screen indicates whether true or magnetic mode has been selected.

Bar selection (RUDD BAR)

Select the type of bar graph that is shown at the bottom of the displays. The options are as follows:

RUDD BAR: This shows the rudder position. Note that a rudder reference transducer is required for accurateWheel Pilot rudder position information.

STEER BAR: This is the default setting. The bar graph is used as follows:

Mode	Bar
Standby	Not used
Auto	Heading error bar
Track	Cross Track Error (XTE) bar
Vane	Wind angle error bar

Dockside rudder cal (DOCKSIDE RUDD CAL)

The dockside rudder calibration function automatically calibrates the rudder range, for systems with a rudder reference unit. If a rudder reference unit is not installed, the function sets the helm drive speed.

WARNING:

This procedure moves the helm, and should only be used when the vessel is at the dockside.

The Dockside Rudder Calibration procedure is described in detail in *Chapter 7, Post Installation Procedures*. If you start the procedure by mistake, press any key to cancel it.

Data pages (DATA PAGE)

The next 7 User Setup pages allow the default settings for the Data Pages to be modified. These are the SeaTalk/NMEA data pages available during normal operation (seesection *2.5*).

Each setup page initially shows the title DATA PAGE. After 1 second, this changes to the title of the data currently set for that page.

The available pages are as follows:

Data	Displayed as
Speed Knots	SPEED KTS
Log	LOG XXXX.X
Trip	TRIP XXX.X
Average Speed, Knots	AV. SPD KTS
Wind Direction	E.g. WIND PORT

Wind Speed	WIND KTS
Depth Metres	DEPTH M
Depth Feet	DEPTH FT
Depth Fathoms	DEPTH FA
Heading	HEADING
Water Temperature, Degrees C	WATER ºC
Water Temperature, Degrees F	WATER ºF
Course Over Ground	COG
Speed Over Ground, Knots	SOG KTS
Cross Track Error	XTE
Distance to	WaypointDTW
Bearing to Waypoint	BTW
Rudder Gain	RUDD GAIN
Response	RESPONSE
Watch	WATCH
Univeral Time Constant	UTC

The default settings are:

Data Page	Default Setting	Sequence Number	New Setting
1	XTE Cross Track Error	12	
2	BTW Bearing to Waypoint	14	
3	DTW Distance to Waypoint	13	
4	NOT USED	19	
5	NOT USED	19	
6	NOT USED	19	
7	NOT USED	19	

- For each setup page, scroll forwards or backwards through the available data pages, using the **+1** or **-1** keys, until the required page title is displayed.

Note: *If you set a page to NOT USED, it is omitted from the display cycle during normal operation. For example, with the default page settings only three pages are displayed in the sequence.*

There are 3 depth pages and 2 water temperature pages. Data is displayed in the units defined by the selected page.

- Press **disp** to move on to the next Data Page selection screen, and repeat the selection procedure.

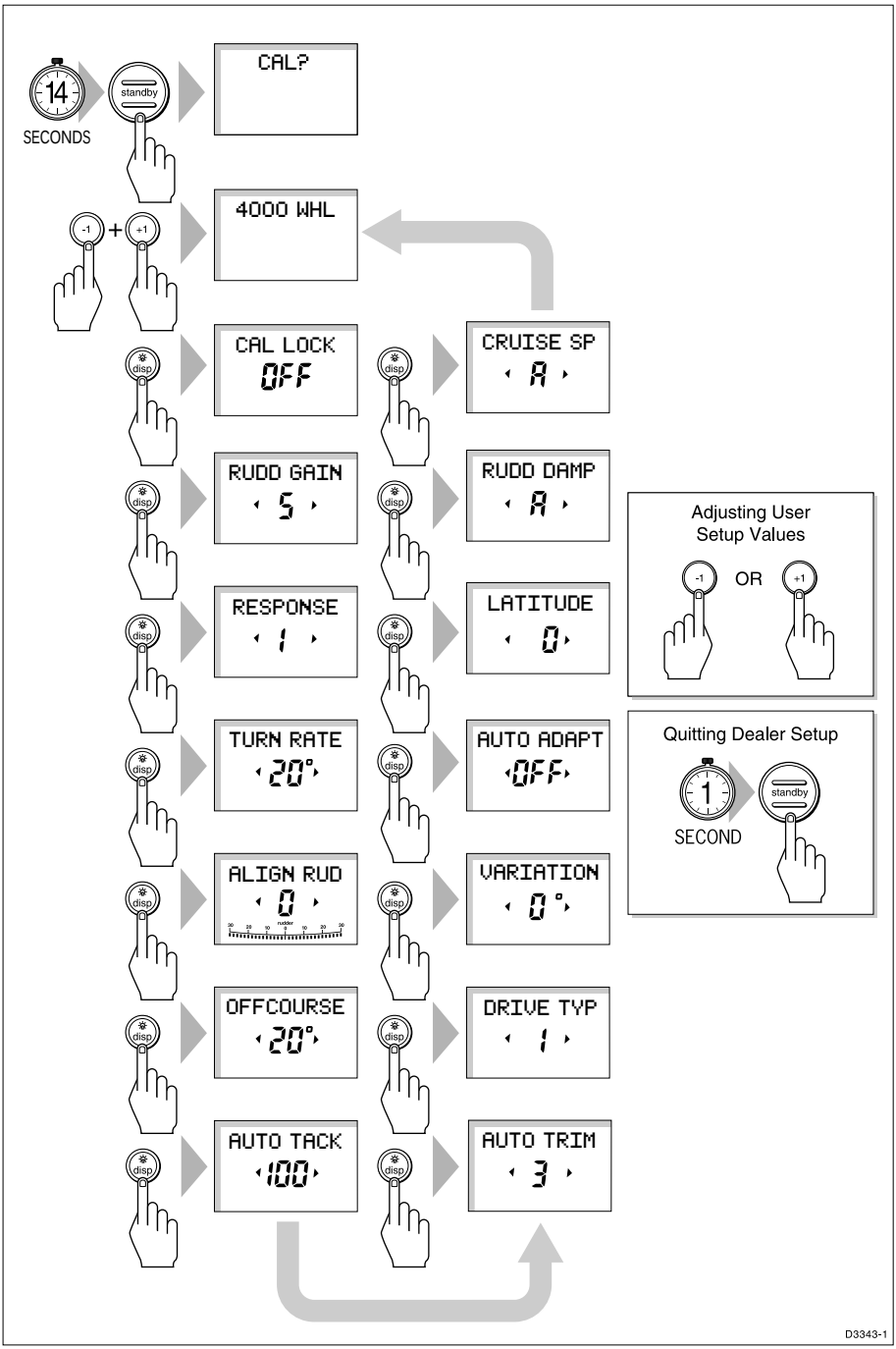
Note: *If a man overboard (MOB) message is received by the autopilot, the BTW and DTW pages will display the bearing and distance to the MOB location, so it is good practice to retain these pages for display.*

5.2 Dealer Setup

Dealer Setup allows you to customise the autopilot to your boat. However, the factory default settings will provide safe performance for the initial sea trial, and fine tuning is not normally required. The flow chart on the next page shows you how to enter Dealer Setup, scroll through the setup displays, adjust the values and exit. The features that can be adjusted are listed in the table following the flowchart. If you change any of the settings you can record them in the *New Setting* column for future reference.

Information on the functions of the different settings is given in the remainder of this section. The following points should be noted:

- Make sure that the autopilot is in Standby mode before you access Dealer Setup
- Setup options are always saved on exit


14
SECONDS
standby
CAL?
-1
+1
4000 WHL
CAL LOCK
OFF
RUDD GAIN
5
RESPONSE
1
TURN RATE
20°
ALIGN RUD
0
OFFCOURSE
20°
AUTO TACK
100
CRUISE SP
A
RUDD DAMP
A
LATITUDE
0
AUTO ADAPT
OFF
VARIATION
0°
DRIVE TYP
1
AUTO TRIM
3
disp
Adjusting User Setup Values
OR
Quitting Dealer Setup
1
SECOND
D3343-1

Feature	Options/ Range	Default Setting	New Setting
Calibration lock	ON or OFF	OFF	
Pilot type		4000 WHL or 4000 TILL	
Rudder gain	1 to 9	5	
Response	1 or 2	1 (AutoSeastate)	
Turn rate limit	5 to 20°	20	
Align Rudder	-7 to +7	0	
Off course alarm	15 to 40	20	
AutoTack angle	40 to 125	100	
AutoTrim	OFF, 1 to 4	3	
Drive type	1 or 2	1 (soft drive)	
Variation	OFF, -30 to +30	O	
AutoAdapt	N, S, OFF	OFF	
Latitude	0 to 80	0	
AutoRelease	-	N/A	
Rudder damping	A, 1 to 9	1 (A)	
Cruise speed	A, 1 to 60	A (use value from SOG)	

* Values in brackets represent defaults after auto dockside has been completed.

Calibration lock

Calibration lock controls whether User Setup and Intermediate Setup are available, and is intended for charter boat users.

Pilot type

The default setting of 4000 WHL should be retained for wheel drive systems, and 4000 TILL for tiller pilots.

Rudder gain

This is the "power-on" rudder gain setting, and should be adjusted to the setting that gives the best steering performance as described in *Chapter 7, Post Installation Procedures*.

Response

This is the power-on response setting. The response level can be changed during normal operation (see section *3.3*) or via the Response Data Page, if this is set for display (see section *2.5*).

Turn limit

This limits the rate of turn of your vessel when under autopilot control. The value must be within the range 5 to 20°. For sailboat applications it should be set to 20°.

Align rudder (Rudder Offset)

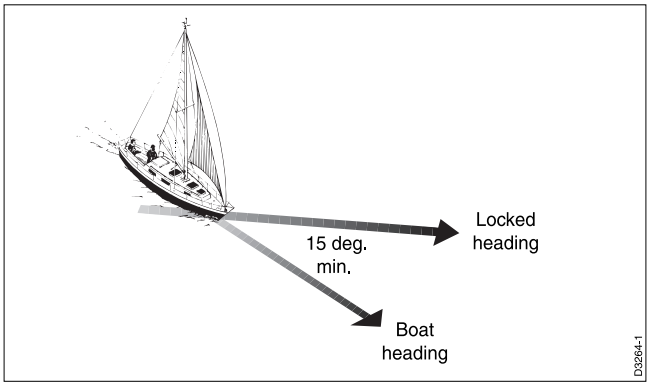
You only need to set this option if your system includes a rudder reference unit.

- Manually place the helm in a central position. The reported rudder angle is indicated on the rudder bar graphic at the bottom of the screen.
- Adjust the offset value, using the **+1** and **-1** keys, until the rudder position is shown as central on the rudder bar. The offset must be within the range -7 to +7.

Off course alarm

This is the off course alarm angle. It controls the alarm that warns you if the autopilot is unable to maintain its set course. The alarm operates if the autopilot strays off course by more than the alarm angle limit for more the 20 seconds.

The value must be within the range 15 to 40°, and can be adjusted in 1° steps.



AutoTack angle

The AutoTack angle is the angle through which the vessel will turn when automatic tack is selected (see *Chapter 2*). The value must be within the range 40 to 125°, and can be adjusted in 1° steps.

Autotrim

The AutoTrim level setting determines the rate at which the autopilot applies "standing helm" to correct for trim changes caused by varying wind loads on the sails or superstructure. The settings are:

Setting	Effect	Recommended for:
Off	No trim correction	
1	Slow trim correction	Heavy displacement vessels, with full keel or transom rudder.
2	Medium trim correction	Heavy displacement vessels.
3	Fast trim correction	Moderate to light displacement vessels.
4	Super fast correction	Planing power vessels

The default setting (Level 3) should provide optimum performance with the ST4000 Plus autopilot. However, depending on the vessel's dynamic stability, an incorrect rate of trim application may result in poor course keeping due to autopilot instability. After gaining experience with the ST4000 Plus, you may wish to change the setting. The effect of the setting must be evaluated while under sail.

- Decrease the AutoTrim level if the autopilot gives unstable course keeping or excessive drive activity with a change in the heel angle.
- Increase the AutoTrim level if the autopilot reacts slowly to a heading change due to a change in the heel angle.
- For systems without a rudder reference unit, these settings have no effect and the trim is set to Level 3.

Drive type

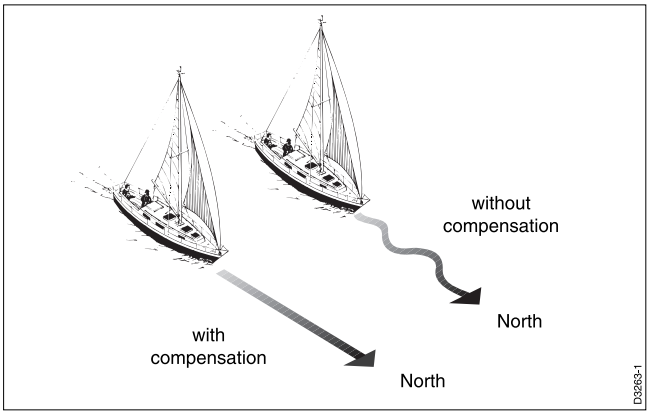
The drive type controls the way which the autopilot drives the steering system. The default setting (soft drive) should be retained for mechanically driven vessels.

Variation

If required, set this value to the level of magnetic variation present at your vessel's current position. +ve variation = East, -ve variation = West. The variation setting is sent to other instruments on the SeaTalk system, and can be updated by other SeaTalk instruments.

AutoAdapt

The patented AutoAdapt feature allows the ST4000 Plus to compensate for heading errors at higher latitudes, which are caused by the increasing dip of the earth's magnetic field. The increased dip has the effect of amplifying rudder response on northerly headings in the northern hemisphere, and on southerly headings in the southern hemisphere.



Set AutoAdapt to N in the northern hemisphere, or S in the southern hemisphere. You then need to enter your current latitude in the next setup screen, so that the ST4000 Plus can provide accurate course keeping by automatically adjusting the rudder gain depending on the heading.

Latitude

Use the **-1**, **+1**, **-10** and **+10** keys to set the value to your vessel's current latitude, to the nearest degree.

Note: *If valid latitude data is available via SeaTalk, it will be used instead of this calibration value.*

Rudder damping

You only need to set this option if your system includes a rudder reference unit, and the drive "hunts" when trying to position the rudder. Test for this when your vessel is moored dockside, by pressing **auto** and then **+10** . If the helm overshoots and has to drive back or starts to hunt back and forth, you need to increase the damping level.

In auto damping mode (A), the ST4000 Plus applies damping compensation derived from auto dockside (if it has been carried out). Alternatively, you can set a value in the range 1 to 9. Adjust the damping one level at a time, and always use the lowest acceptable value.

Cruise speed

If boat speed is not available via SeaTalk or NMEA, the cruise speed should be set to the boats normal cruising speed – SeaTalk boat speed is used in preference to SOG.

Chapter 6: Installation

6.1 Planning the installation

This chapter explains how to install and connect the following:

- Control head
- Fluxgate compass
- Rudder reference transducer (optional)
- Wheel drive actuator (wheel pilots only)
- Tiller actuator (tiller pilots only)
- NMEA interface

Before starting the installation, decide how you will site the units and run the cables.

EMC installation guidelines

All Raytheon equipment and accessories are designed to the best industry standards for use in the leisure 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. Although every effort has been taken to ensure that they will perform under all conditions, it is important to understand what factors could affect the operation of the product.

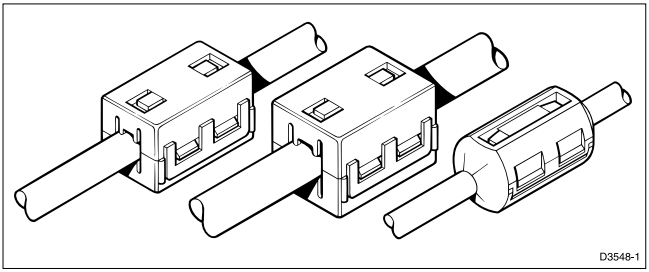
To minimise the risk of operating problems, all Raytheon equipment and cables connected to it should be;

- At least 1 m (3 ft) from any equipment transmitting or cables carrying radio signals e.g. VHF radios, cables and antennas. In the case of SSB radios, the distance should be increased to 2m (7ft).
- More than 2 m (7ft) from the path of a radar beam. A radar beam can normally be assumed to spread 20 degrees above and below the radiating element.
- The equipment should be supplied from a different battery than the one used for engine start. Voltage drops below 10 V in the power supply to our products can cause the equipment to reset. This will not damage the equipment, but will cause the loss of some information and can change the operating mode.

- Raytheon specified cables should be used at all times. Cutting and rejoining these cables can compromise EMC performance and so must be avoided unless doing so is detailed in the installation manual.
- If a suppression ferrite is attached to a cable, this ferrite should not be removed. If the ferrite has to be removed during installation it must be reassembled in the same position.

Suppression ferrites

The following illustration shows the typical range of suppression ferrites fitted to Raytheon equipment. Always use the ferrites specified by Raytheon.



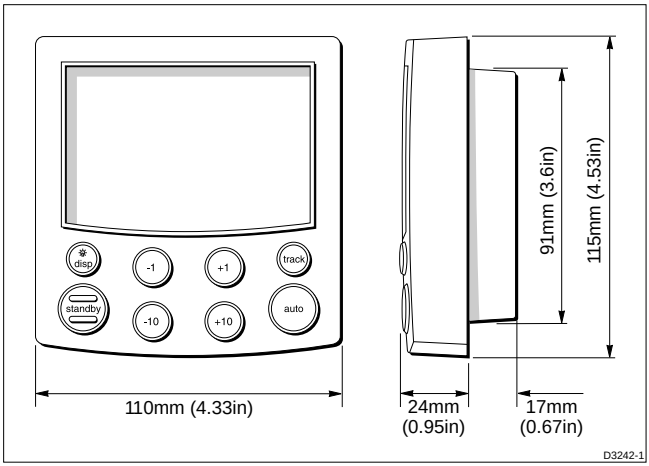
Connections to other equipment

If your Raytheon equipment is going to be connected to other equipment using a cable not supplied by Raytheon, a suppression ferrite MUST always be fitted to the cable close to the Raytheon unit.

Cabling

- Avoid running cables through bilges where possible
- Secure coiled lengths at regular intervals
- Avoid running cables close to fluorescent lights, engines, radio transmitting equipment etc

6.2 Control head



Siting

The control head is completely waterproof and should be sited where it is:

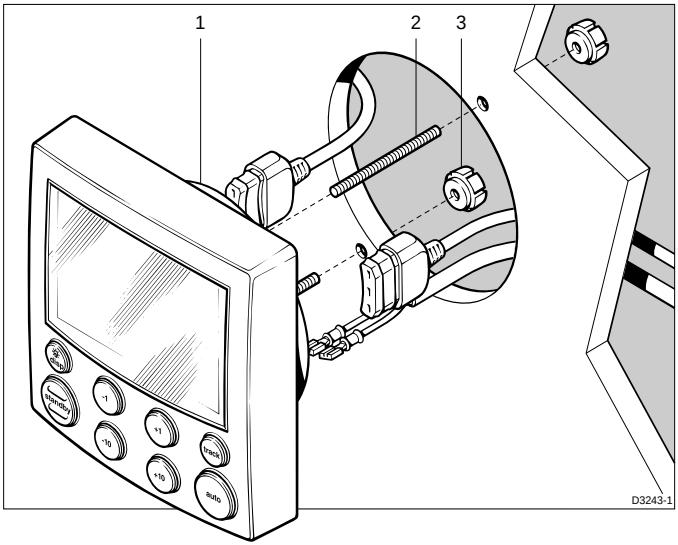
- Easily reached from the steering position
- Viewed straight on, or with a maximum viewing angle of 30°
- Protected from physical damage
- At least 230 mm (9 in) from any compass
- At least 1 m (3 ft) from any radio/radar receiving/transmitting equipment
- Accessible from behind to secure and run cables

Note: *The back cover is designed to breath through the cable boss to prevent moisture accumulation. This must be protected from the weather by following the Mounting Procedure.*

Mounting procedure

1. Apply the paper template to the selected bulkhead.
2. Mark the centres of the two fixing holes and cable boss – make sure the surface is smooth and flat.

Note: *Adjacent control heads, or instruments, must have a 6 mm (1/4 in) gap between them to allow the protective sun covers to be fitted.*



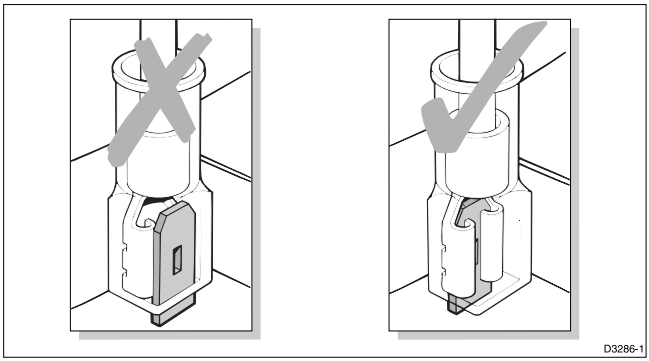
1 Cable boss **2** Fixing studs **3** Thumb nuts

3. Drill two 4 mm (5/32 in) diameter holes for the fixing studs.
4. Use a 90 mm (3.5 in) diameter cutter to drill the hole for the cable boss (1).
5. Screw the fixing studs (2) into the display head.
6. Pass the cables (SeaTalk, power, compass etc.) through the bulkhead.
7. Attach the cables to the appropriate terminals (see relevant subsection for connection details).
8. Assemble the control head to the bulkhead.
9. Secure the control head with the thumb nuts (3) provided.

Cable connectors

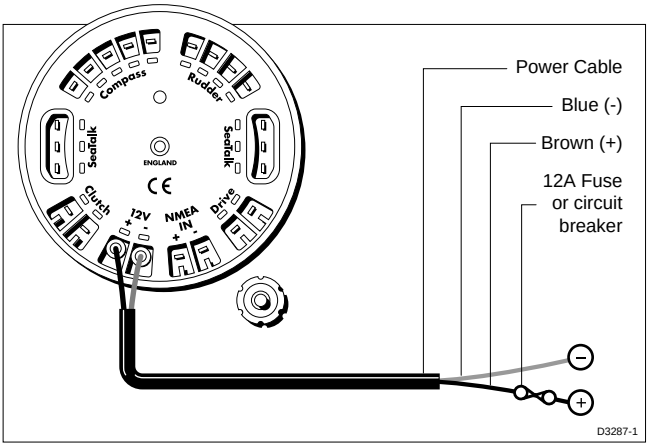
With the exception of the SeaTalk cables, all connections to the control head are made using spade connectors.

When fitting the spade connectors, make sure the connector fits securely over the blade and not between the connector and its plastic insulating boot – incorrect fitting will give intermittent contact which will lead to faulty autopilot operation.



Power supply connection

- The control head requires its own dedicated power supply. It cannot source power from SeaTalk, and must supply the power to the rest of the SeaTalk system.
- A 2 m (6.5 ft) power lead terminated with 1/4 inch spade connectors is supplied for this purpose.
- A 12 A circuit breaker, or fuse, must be fitted to the +12 V supply.



- The power lead can be extended if required. The following table shows the minimum acceptable cable sizes :

Cable Length	Copper Area	AWG
Up to 2.5 m (8 ft)	1.0 mm2	18
Up to 4.0 m (13 ft)	1.5 mm2	16
Up to 6.0 m (19.5ft)	2.5 mm2	14

Note: *Use of the correct cable size is critical for correct autopilot operation.*

If the cable is too small, a voltage drop will occur between the supply and the control head. This will reduce the power to the drive, causing slower response to course changes and corrections.

Connections to SeaTalk

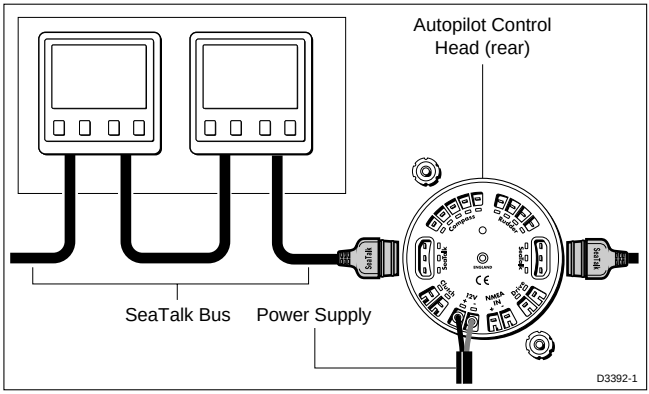
Because different installations have different cabling requirements, SeaTalk cables are not supplied with the ST4000 Plus – cables must be purchased from your Autohelm dealer.

SeaTalk cables

The following table lists the cables available from your Autohelm dealer:

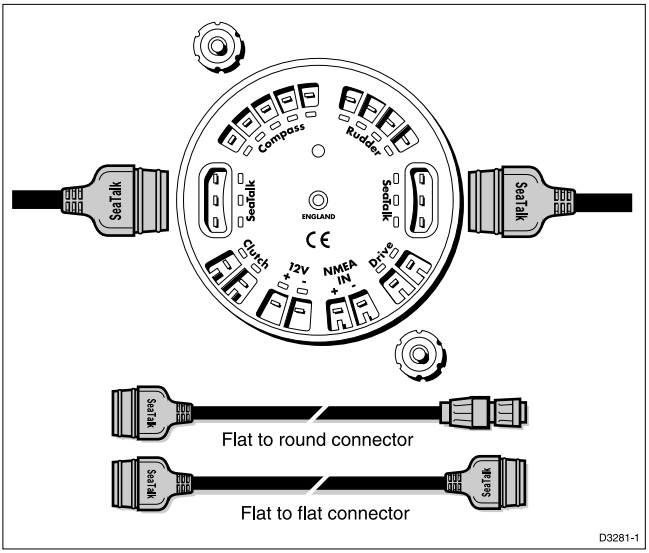
Part No:	Description
D187	Flat to a male round connector – 0.3 m (12 in) long
D188	Flat to a female round connector – 0.3 m (12 in) long
D284	Flat moulded plugs at both ends – 1 m (3 ft 3 in) long
D285	Flat moulded plugs at both ends – 3 m (9 ft 9 in) long
D286	Flat moulded plugs at both ends – 6 m (19 ft 6 in) long
D287	Flat moulded plugs at both ends – 9 m (29 ft 3 in) long

Typical SeaTalk cabling



Cable types

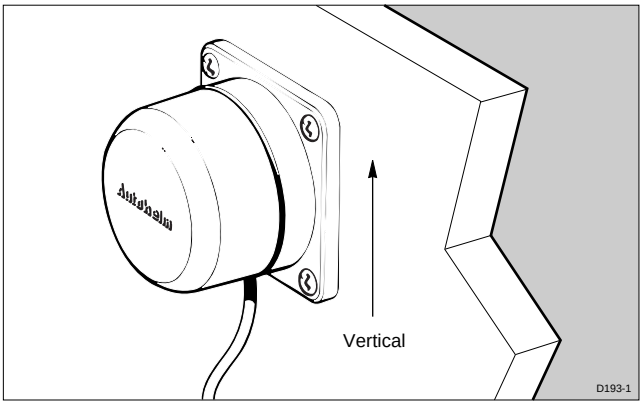
The following illustration shows the types of SeaTalk cable available.



6.3 Fluxgate compass

Mounting location

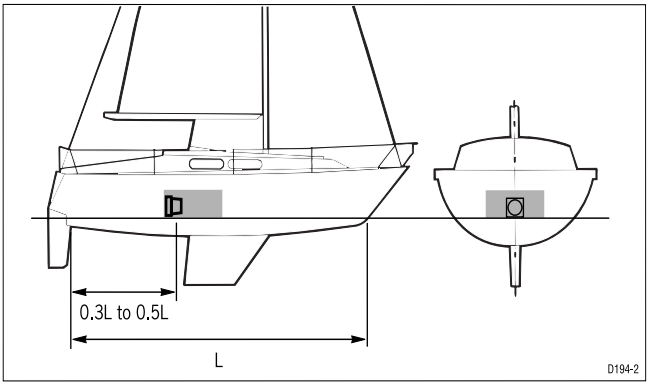
Attach the fluxgate compass to a convenient vertical surface using the self-tapping screws provided. There is no need to set the fluxgate compass fore and aft, as heading alignment is made electronically.



Note: *A label is supplied to warn people that the compass is mounted behind or below the bulkhead. This label should be attached where it can be clearly seen.*

Correct positioning of the fluxgate is crucial if ultimate autopilot performance is to be achieved.

The fluxgate should, to minimise gimbal disturbance, be positioned as near as possible to the pitch and roll centre of your boat.



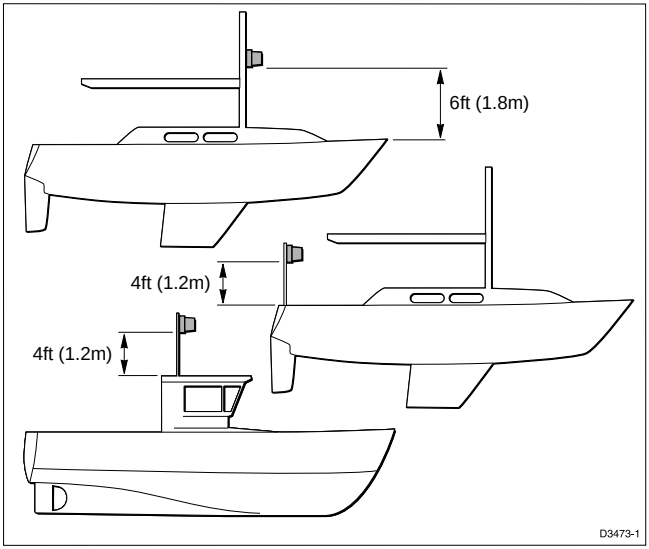
- It is important to ensure that the fluxgate compass is sited at least 0.8 m (2.5 ft) away from the steering compass to avoid deviation of both compasses.
- The fluxgate must also be positioned as far away as possible from large iron masses, such as the engine and other magnetic devices, which may cause deviation and reduce the sensitivity of the sensor.
- If any doubt exists over magnetic suitability of the chosen site, the position may be surveyed using a simple hand bearing compass. The hand bearing compass should be fixed in the chosen position and the vessel swung through 360°.
- Relative differences between the hand bearing compass and the steering compass should ideally not exceed 20° on any heading.

Mounting location for steel-hulled vessels

If you have a steel-hulled vessel and mount the compass in the conventional location, you will obtain significant deviation due to the effects of steel on the Earth's magnetic field.

To minimise this effect, you should raise the compass transducer above the main deck or wheelhouse. However, the higher above the waterline

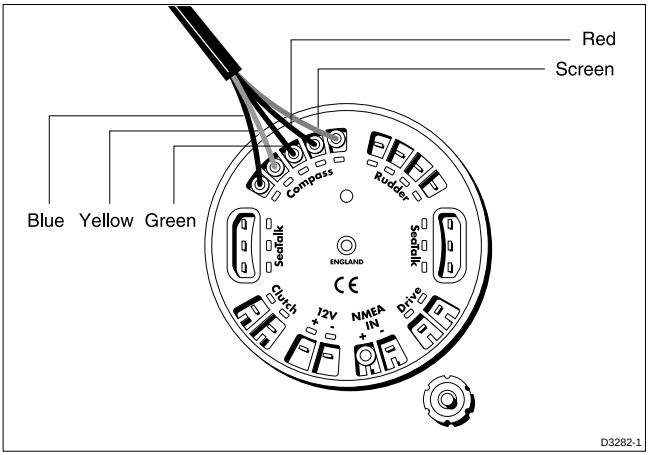
you mount the transducer, the more the vessel's pitch and roll will affect the compass performance. Recommended mounting positions are shown in the following diagram.



As an alternative, you can mount a pick off coil (Z110) below a fully compensated Class A compass or similar.

Cabling

1. Route the fluxgate compass cable back to the control head
2. Connect the five core cable (colour for colour) to the **Compass** terminals.



6.4 Rudder reference transducer

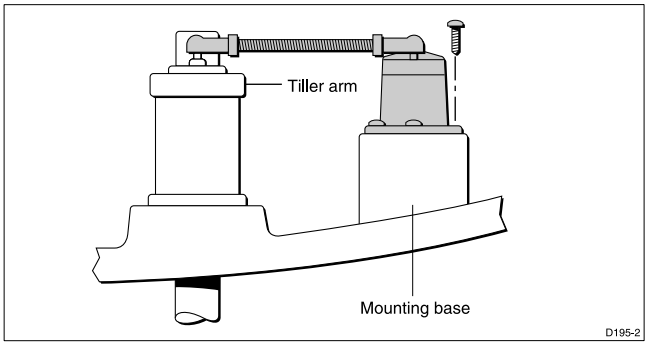
This section describes the installation of the Autohelm rudder reference transducer (Catalogue No. Z131 – not supplied) with the ST4000 Plus Wheel autopilot.

The use of this transducer is not mandatory; however, it does provide the autopilot with accurate information on the position of the rudder.

Note: *If you add a rudder reference transducer after the main installation, you need to run the Dockside Rudder Calibration function again so that the autopilot can determine the characteristics of your system (see section 7.2).*

Mounting position

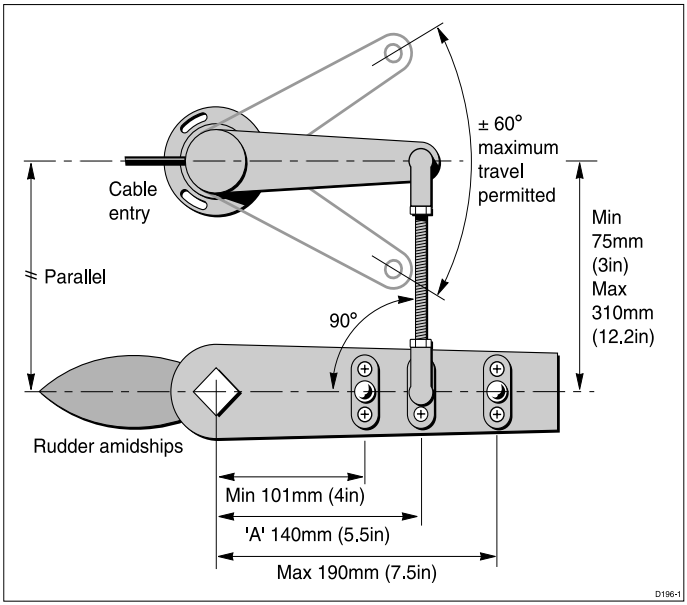
- Mount the transducer on a suitable base adjacent to the rudder stock, using the self tapping screws provided.
- The base height must ensure correct vertical alignment of the transducer arm and tiller arm.
- If it is more convenient, the transducer may be mounted upside down (logo downwards). The Dockside Rudder Calibration procedure will automatically compensate for the mechanical reversal.
- The transducer has a built in spring to remove any free play in the linkage to the tiller. This gives very precise rudder position.



- Transducer arm movement is limited to + /– 60°.
- Care must be taken during installation to ensure the transducer arm is opposite the cable entry when the rudder is amidships. Failure to position the arm correctly could result in damage if the arm is driven onto its end stops by the steering system.

Control dimensions

- It is important to ensure that the dimensions (refer to the illustration) are within the specified limits.
- The tiller and transducer arms must be parallel to each other.
- With the rudder amidships, the transducer arm should be opposite the cable entry and at 90° to the connecting bar.
- Minor adjustments can be made by slackening off the retaining screws and rotating the transducer body.



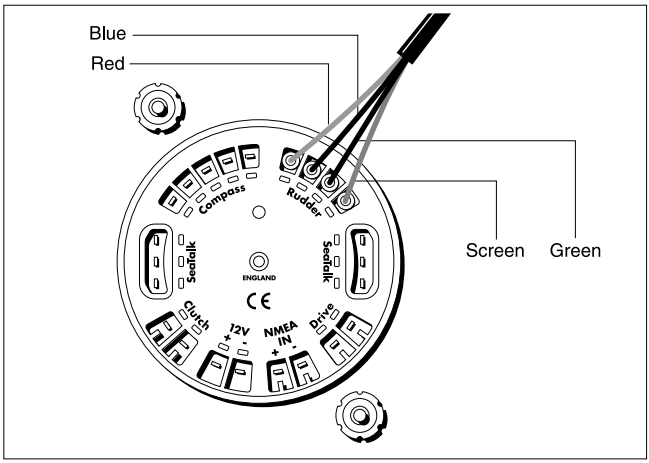
Installing the rudder reference transducer

1. The tiller pin must be within the limits shown in the previous illustration.
2. Dimension **A** should (ideally) be 140 mm (5.5 in). However, changes this within the limits shown will not degrade the autopilot performance, but will slightly alter the scaling of the rudder angle display.
3. Secure the tiller pin to the tiller arm using the self-tapping screws provided.
4. Cut the threaded rod to the required length and screw on the lock nuts and ball pin sockets.

5. Press the sockets onto the tiller pins.
6. Move the rudder from side to side to ensure the linkage is free from obstructions at all rudder angles.

Cabling

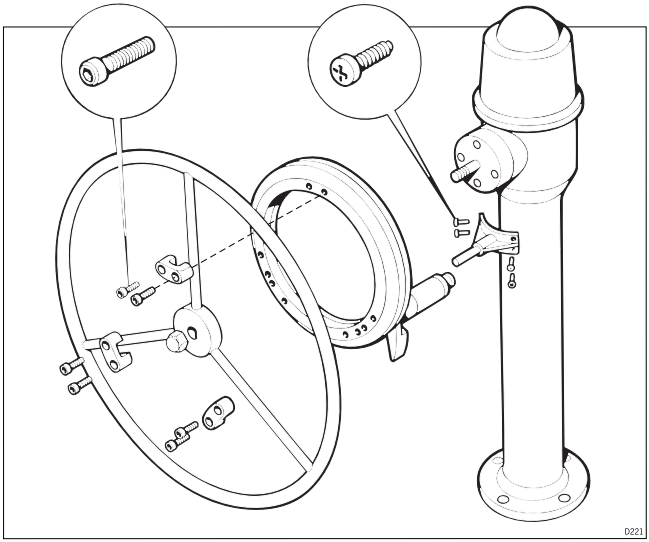
1. Run the rudder reference transducer cable back to the control head.
2. Connect the four wires (colour for colour) to the **Rudder** terminals.



6.5 Wheel drive actuator

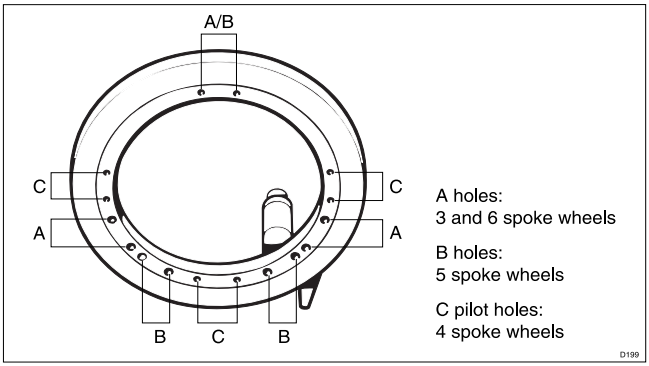
General information

- The Autohelm ST4000 Plus Wheel Actuator is designed to operate with steering systems having between 1 and 3.5 turns lock to lock.
- Steering systems with more than 3.5 turns may cause impaired steering performance due to reduced rate of rudder application.
- Lost motion in the steering system must not exceed 1% of total movement – this is equivalent to 7.5° of free wheel movement for a system with two turns lock to lock.
- If lost motion exceeds 1%, it must be either corrected or a rudder reference transducer must be fitted, otherwise steering performance will be impaired.

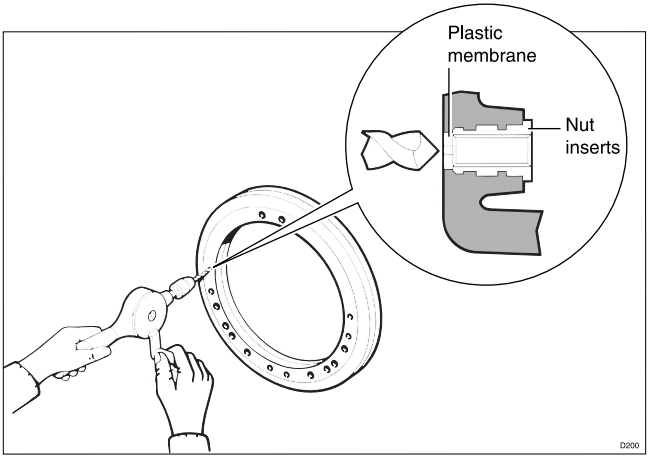


Clamp selection

- The drive unit can be used on wheels with 3, 4, 5 or 6 spokes.
- The drive unit is clamped to the wheel spokes using the bolts and clamps provided.



- An additional set of clamps and bolts for the fourth spoke are available from your Raytheon stockist.

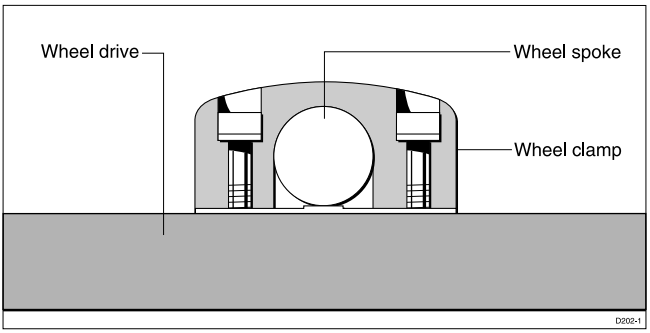


1. For 4 spoke wheels, use a 4.0 mm (5/32 in) drill to open out the C pilot holes to gain access to the additional mounting points.
2. The plastic membrane covering the additional nut inserts is only 1.0 mm (0.04 in) thick. Care must be taken to ensure that the nut inserts are not damaged when drilling.
3. Mount the drive between the wheel and the pedestal – three sets of clamps are supplied to accommodate different spoke diameters. Marked alongside each clamp is a range of spoke diameters. The appropriate clamps are broken off as required.
4. When the actuator is fitted to a dished wheel, use the supplied spacers to prevent distortion of the drive unit when the fixing bolts are tightened.

Fitting to metal wheels

Remove the wheel and attach the drive as follows:

1. Place the drive unit with the clamping face uppermost ie. drive motor and gearbox tube downwards.
2. If the wheel is dished, position one spacer at each of the three attachment positions.
3. Place the wheel on top of the drive unit making sure the face which is nearest the pedestal is downwards.
4. Fit the clamps over the spokes and lightly tighten the bolts supplied.

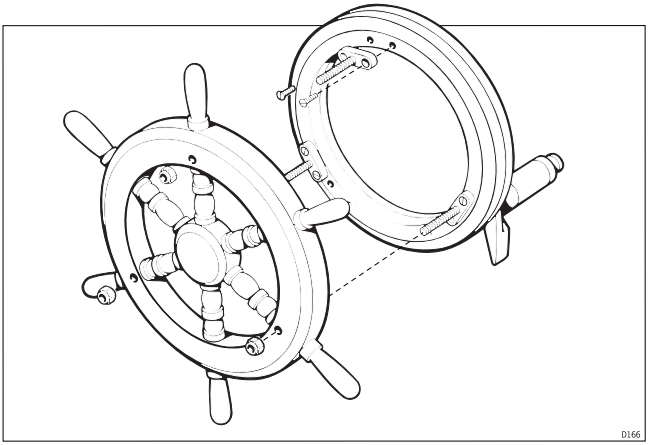


5. Proceed to *Fitting the Pedestal Bracket*.

Fitting to wooden wheels

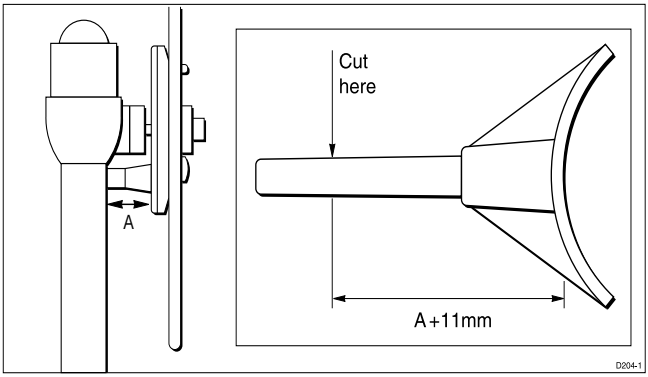
An attachment kit (Catalogue No. D119) for use with wooden wheels is available from your Raytheon stockist.

Drill the wheel as shown and secure the clamp brackets with the nylock nuts provided.



Fitting the pedestal bracket

Cut the pedestal bracket pin to length to suit the pedestal as follows:

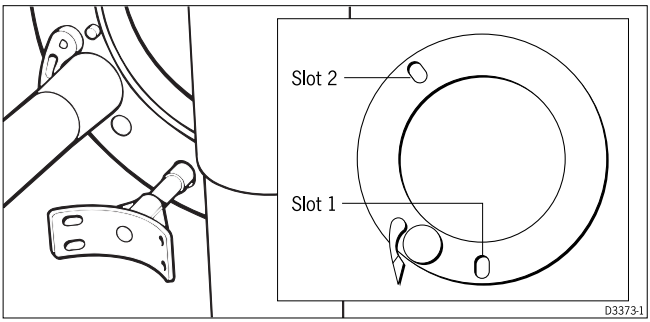


1. Replace the wheel and measure the distance between the backplate of the drive unit and the pedestal as shown.

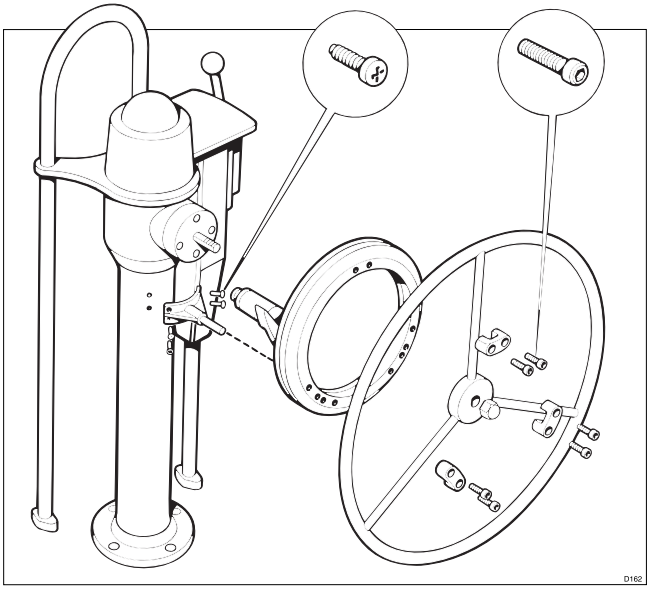
Note: *If the wheel is bent or not running true, the distance will change with the wheel position. Measure the smallest distance.*

2. Cut the pin 11 mm (0.4 in) longer than dimension A. Remove any burrs and fit the plastic cap (supplied) over the cut end.
3. Slide the wheel forward and place the pin end with the plastic cap in **Slot 1** if mounting the actuator on an unobstructed pedestal.
   - The motor will be as shown in the first diagram.
   - Controls mounted on the pedestal might prevent installation of the actuator to **Slot 1**.
   - Fit the pedestal bracket pin in **Slot 2** – the motor will be on the other side of the pedestal and higher up (as shown in diagram two).
   - If there is a compass mounted in the pedestal, check that running the motor does not affect compass readings when **Slot 2** is used.

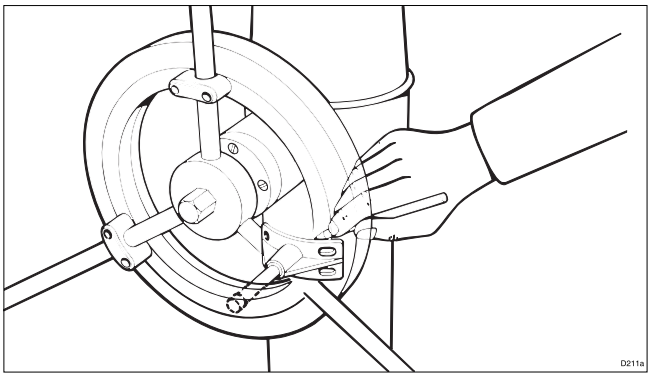
Slot 1 fitting



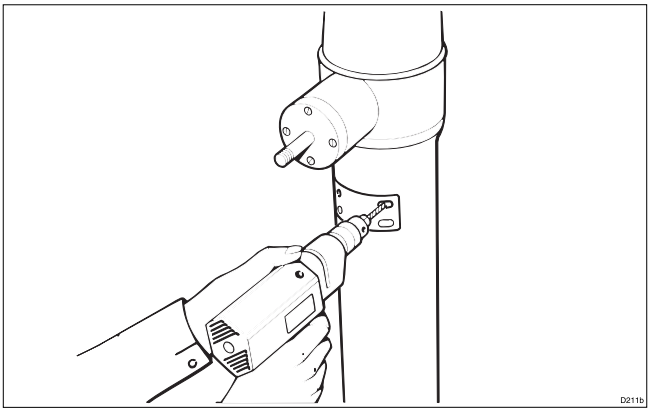
Slot 2 fitting



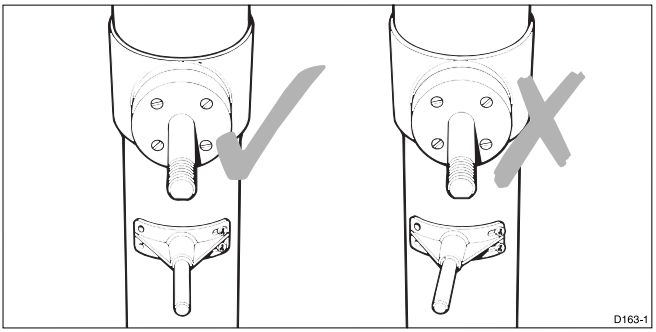
4. Return the wheel to its normal position and, with the pin midway in the slot, carefully mark round the bracket to record its position.
5. Remove the wheel, reposition the bracket on the pedestal and mark around the inside of the right hand side slotted holes.



6. Remove the bracket. Drill two 4. 0mm (0.16 in) diameter holes in the centre of the slotted marks (use the supplied drill bit).



7. Attach the bracket and lightly tighten the two screws whilst adjusting the bracket to ensure correct fore and aft positioning.



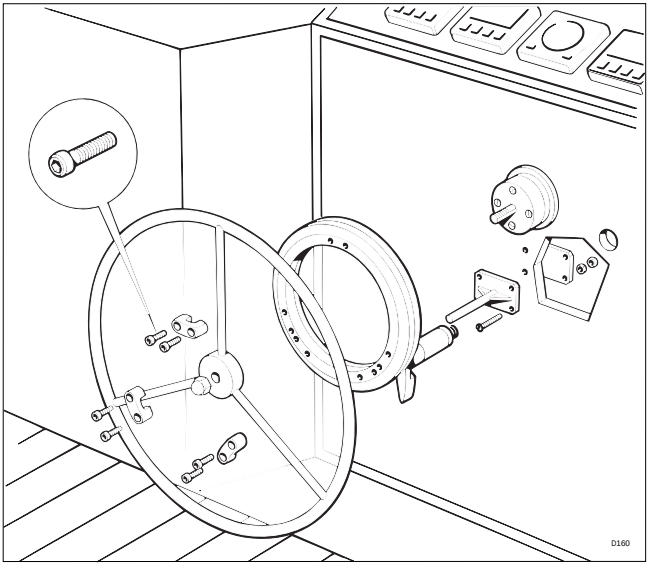
8. Mark the position of the two remaining mounting holes.
9. Remove the bracket and drill the two 4 mm (0.16 in) holes.
10. Re-attach the bracket and **lightly** tighten all four mounting screws.
11. Replace the wheel, making sure the pin locates in the correct slot.
12. Turn the wheel to confirm the bracket is correctly positioned. If the wheel is bent or the wheel drive is off centre, the pin will move up and down in the back plate slot. Provided the pin does not reach the end of the slot this will not affect operation of the actuator.
13. Fully tighten all four screws.

Bulkhead bracket fitting

If the drive unit is used to operate a wheel which is not pedestal mounted, a bulkhead bracket is available (Catalogue No. D136).

The mounting procedure is exactly the same as the pedestal bracket.

Note: *A clearance hole for the motor/gearbox tube may be needed.*

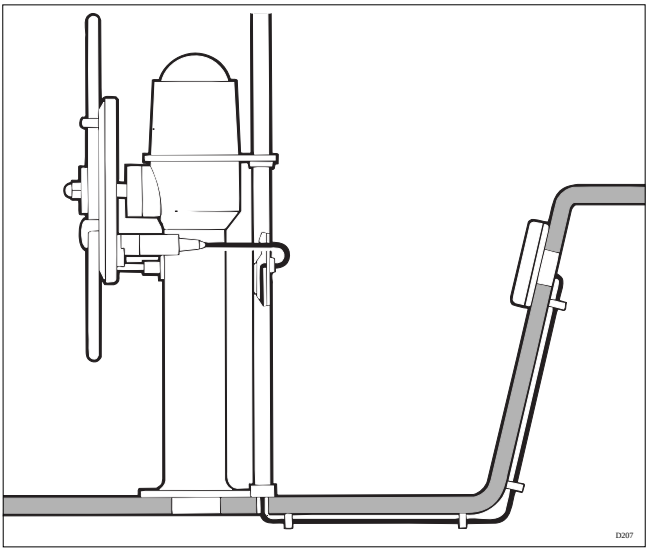


Cabling

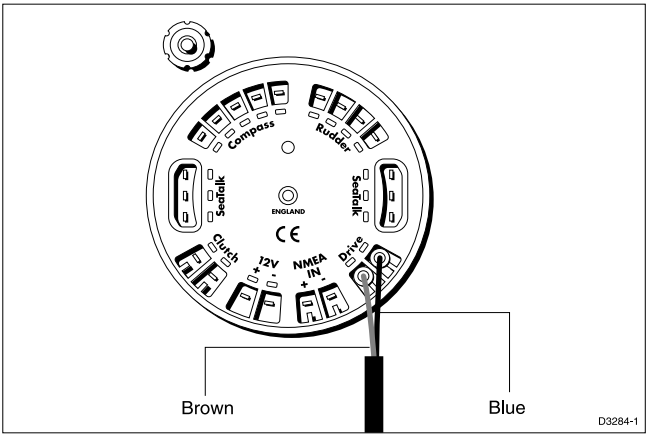
The drive actuator is supplied with 4.5 m (15 ft) of two core cable.

1. Route the cable through the pedestal (or guard rail) and back to the control head.

   On pedestals, route the cable down the cable duct (there is usually one fitted for the compass light) to make sure the cable cannot foul the steering mechanism.

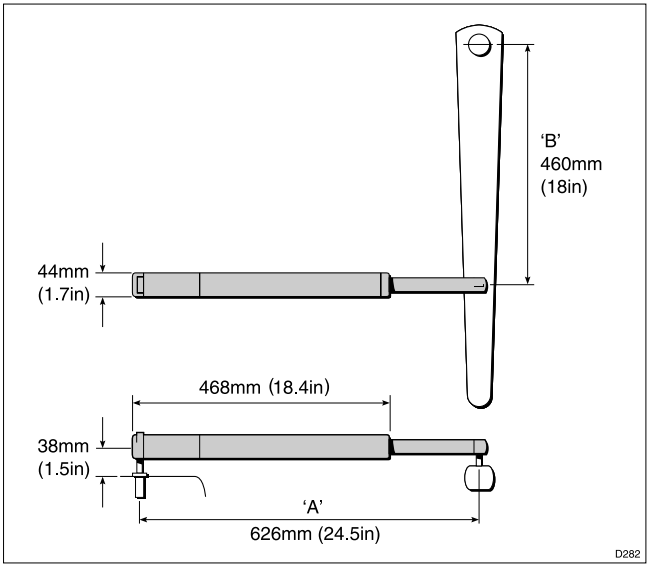


2. Run the drive cable back to the control head and connect to the **Drive** terminals. The actuator is supplied with a waterproof plug fitted to the rear of the gearbox tube. This allows the wheel and actuator to be removed for maintenance/storage and leaves the cabling intact aboard the boat. To remove the plug, pull back the cover and twist the locking ring anti clockwise.



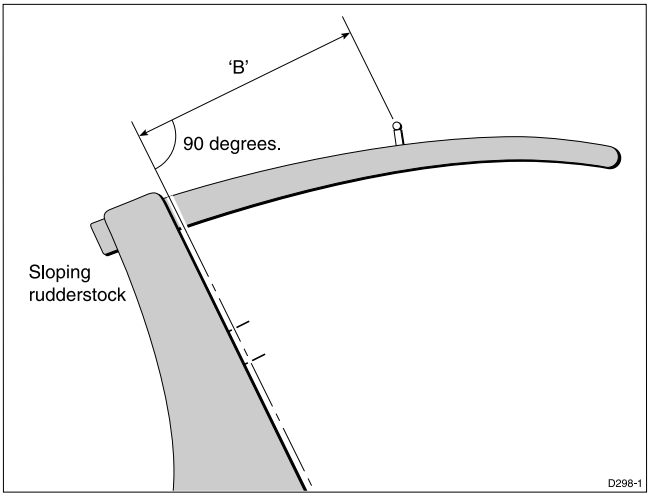
6.6 Tiller actuator installation

The drive unit is mounted between the tiller and a single attachment point on the yacht structure. For correct installation two basic dimensions are critical.



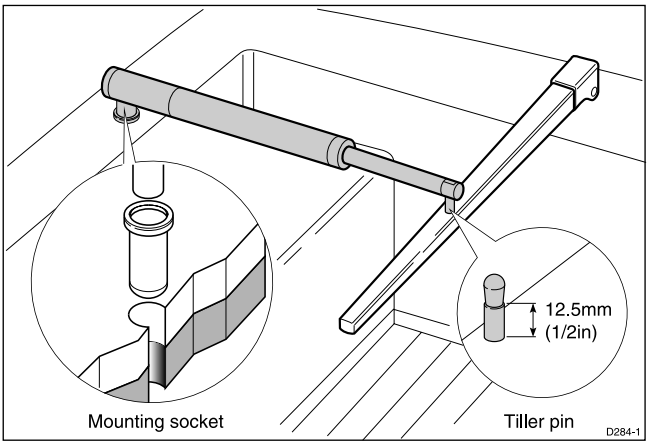
- **Dimension A = 620 mm (24.5 in)** – mounting socket to tiller pin. Pull out the actuator pushrod to this dimension. If a pushrod extension or a cantilever mount are required, tables later in this chapter define the amount by which measurement A is increased.
- **Dimension B = 460 mm (18 in)** – rudder stock centre line to tiller pin.

1. Clamp the tiller on the yacht centre line and mark off dimensions **A** and **B**. (**A** is measured on port or starboard side of the cockpit depending on which side the actuator is to be mounted. If a port mounting is chosen, the autopilot operating sense must be corrected as detailed in *Chapter 7*. It is not a long job.) Use masking tape to locate the fixing points.
2. Make sure the measurements are at right angles as shown.
3. Make sure that the drive unit is mounted horizontally.



Basic installation

After establishing the control dimensions, the ST4000 Plus actuator can usually be mounted directly onto the cockpit seat.



Tiller pin installation (Part No. D001)

1. Drill 6 mm (1/4 in) hole x 25 mm (1 in) deep at point marked.
2. Using a two part epoxy (e.g. Araldite), epoxy the tiller pin in place.
3. Position the shoulder of the pin 12.5 mm (1/2 in) above the tiller surface.

Mounting socket installation (Part No. D002)

1. Drill a 12.5 mm (1/2 in) hole x 25 mm (1in) deep in the cockpit seat.
2. If the structure at the mounting position is less than 25 mm (1 in) thick, reinforce the underside with plywood bonded into position.
3. Install the mounting socket using a two part epoxy adhesive.

The pilot is capable of generating high pushrod loads. Ensure that:

- The epoxy is allowed to harden thoroughly before loads are applied.
- All holes are drilled to correct size and, where necessary, reinforcing is provided.

Installation accessories

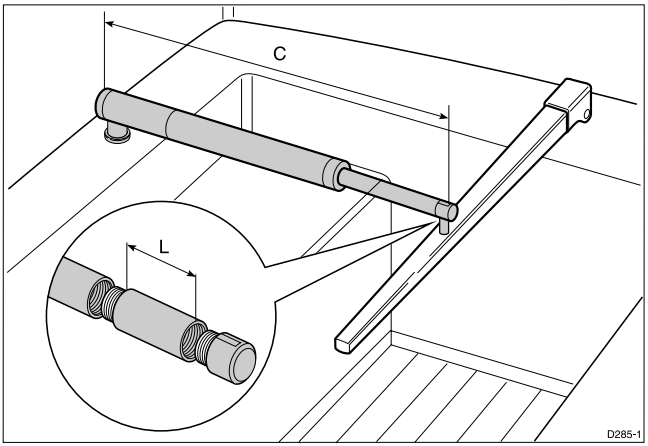
If it is not possible to install the drive unit directly onto the cockpit seat or tiller as described, one of the following accessories (or a combination) will ensure a perfect installation.

Pushrod extensions

The length of the pushrod can be extended using one of the standard extensions.

Dimension **C** is modified as follows:

Dimension C	Pushrod Extension Length L	Part No.
622 mm (24.5 in)	Standard dimension	
648 mm (25.5 in)	25 mm (1.00 in)	D003
673 mm (26.5 in)	51 mm (2 in)	D004
699 mm (27.5 in)	76 mm (3 in)	D005
724 mm (28.5 in)	102 mm (4 in)	D006
749 mm (29.5 in)	107 mm (5 in)	D007
775 mm (30.5 in)	152 mm (6 in)	D008

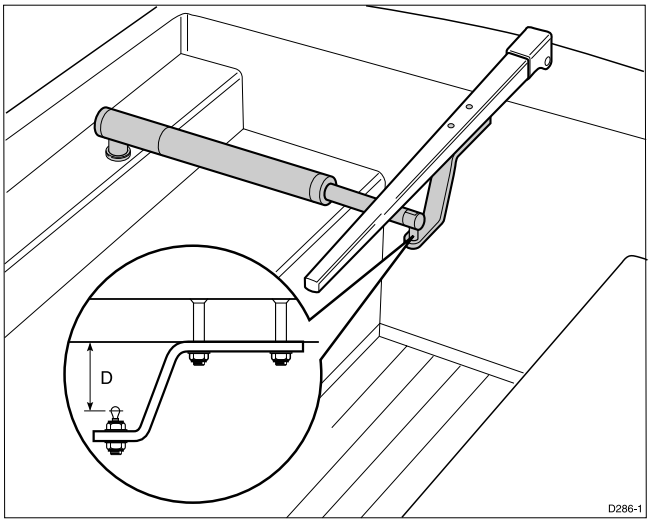


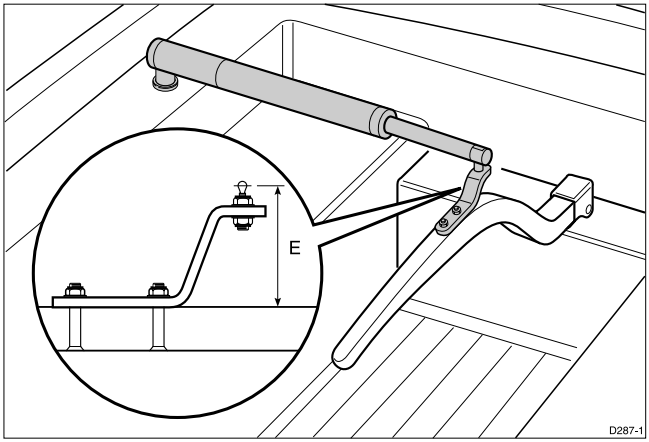
Tiller brackets

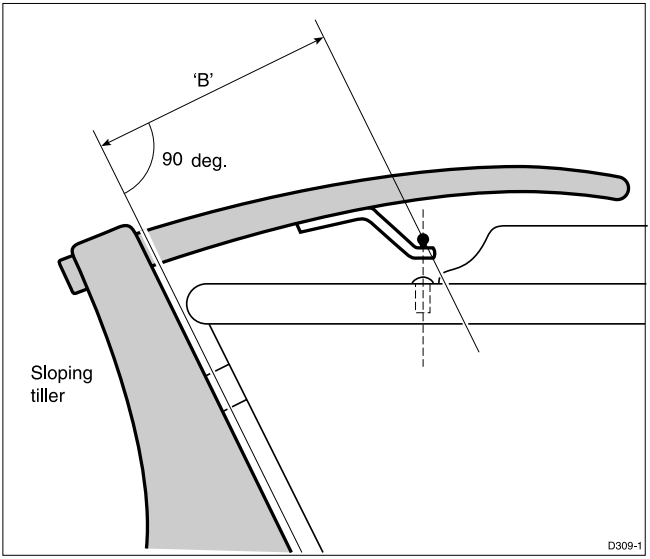
Where the height of the tiller above or below the cockpit seat or mounting plane is such that standard mounting is not practical, a range of tiller brackets allow the tiller pin offset to be varied.

1. Position the tiller bracket on the centre line (upper/lower) of the tiller and establish control dimensions **A** and **B.**
2. Mark the position of the centres of the two fixing bolt holes.
3. Drill two 6 mm (0.25 in) diameter clearance holes through the centre line of the tiller.
4. Install the tiller bracket using two 6 mm (1/4 in) diameter bolts, nuts and washers.
5. Bond the fixing bolts in place with epoxy adhesive and fully tighten the nuts.

Dimension D (Below Tiller)	Dimension E (Above Tiller)	Part No
25 mm (1.00 in)	51 mm (2.00 in)	D009
51 mm (2.00 in)	76 mm (3.00 in)	D010
76 mm (3.00 in)	102 mm (4.00 in)	D011
102 mm (4.00 in)	127 mm (5.00 in)	D012
127 mm (5.00 in)	152 mm (6.00 in)	D013


D
D286-1

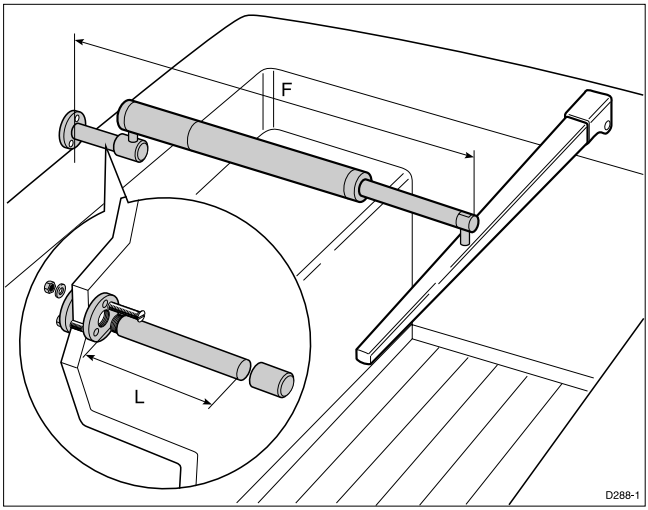

E
D287-1



Cantilever mounting

- When it is necessary to attach the autopilot to a vertical face, such as the cockpit sidewall, a cantilever socket assembly must be used.
- The maximum extension offset is 254 mm (10 in).
- The cantilever is cut to the exact length during mounting.

1. Clamp the tiller on the yacht centre line.
2. Measure dimension **F** (actual).
3. Refer to the table to establish a cutting length for cantilever rod – **double check measurements before cutting**.
4. Cut the cantilever rod to length **L** using a hacksaw. **Measure from threaded end.** Remove any burrs with a file.
5. Temporarily assemble the cantilever by screwing the rod into the mounting flange.
6. Ensure the drive unit is horizontal and mark off the location of the mounting flange.
7. Mark and drill three 6 mm (1/4 in) clearance holes (ignore the two inner holes).



Dimension F	Cut Length L
686 mm (27 in)	51 mm (2.00 in)
711 mm (28 in)	75 mm (3.00 in)
737 mm (29 in)	102 mm (4.00 in)
762 mm (30 in)	127 mm (5.00 in)
787 mm (31 in)	152 mm (6.00 in)
813 mm (32 in)	178 mm (7.00 in)
838 mm (33 in)	203 mm (8.00 in)

1. Mount the flange using three 6 mm (1/4 in) diameter bolts with nuts and washers. Make sure the backing plate is installed correctly – bed the flange on a thin coat of silicone sealant.
2. Screw the rod firmly into place using a tommy bar.
3. Roughen the end of the rod and inside the cap to provide a key. Apply the two part epoxy adhesive provided to the rod end and cap.
4. Place the cap over the rod end. Make sure the hole for the drive unit mounting pin is facing up. Allow the epoxy adhesive at least 30 minutes to fully harden before applying any load.

When the autopilot is not in use, the complete rod assembly may be unscrewed to leave the cockpit unobstructed.

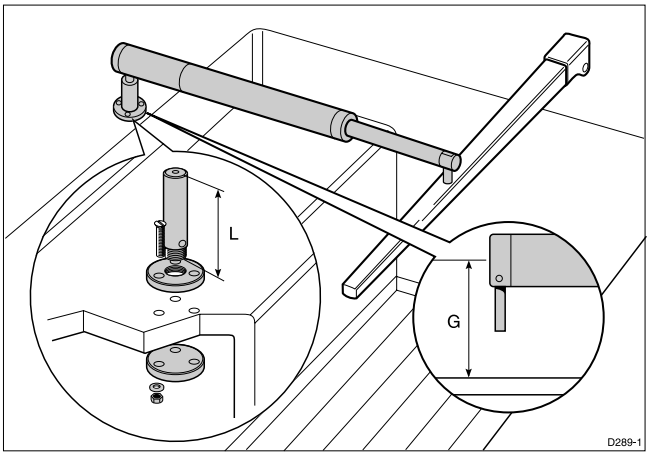
Pedestal socket mounting

It may be necessary to raise the height of the drive unit mounting socket. A pedestal socket assembly must be used.

1. Lock the tiller on the yacht centre line.
2. Establish the standard control dimensions **A** and **B**.
3. Measure dimension **G** ensuring the autohelm actuator is horizontal.
4. Select the pedestal socket assembly from the table shown.

Installation

1. Mark the position of the mounting flange on the cockpit seat/ counter.
2. Ensure that control dimensions **A** and **B** are correct.
3. Mark and drill three 6 mm (1/4 in) diameter clearance holes (ignore the two inner holes).
4. Mount the flange using three 6 mm (1/4 in) diameter bolts, nuts and washers (make sure that the back plate is installed correctly and bed the flange on a thin coat of silicone rubber sealant).
5. Screw the mounting socket firmly into place.



When the autopilot is not in use, the mounting socket may be unscrewed to leave the cockpit unobstructed.

Dimension G	Pedestal Socket Length L	Part No.
38 mm (1.50 in)	Standard dimension	
76 mm (3.00 in)	38 mm (1.50 in)	D026
89 mm (3.50 in)	50 mm (2.00 in)	D027
102 mm (4.00 in)	64 mm (2.50 in)	D028
114 mm (4.50 in)	76 mm (3.00 in)	D029
127 mm (5.00 in)	89 mm (3.50 in)	D030

Tiller pins

For certain non-standard installations a range of tiller pins is available.

Description	Size	Part No.
Small threaded tiller pin	25 mm (1.00 in)	D014
Extra length tiller pin	72 mm (2.80 in)	D020
Extra length threaded tiller pin	72 mm (2.80 in)	D021

Cabling and socket installation

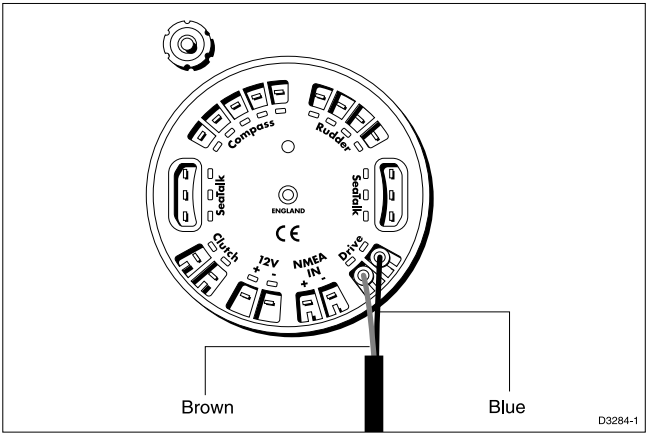
- The actuator is connected to the control head using a water proof plug and socket.
- The plug comes ready assembled to the actuator.
- The socket should be mounted in the cockpit next to the actuator.

Cabling

Using the following table as a guide, route a cable of a suitable size from the rear of the socket back to the control head.

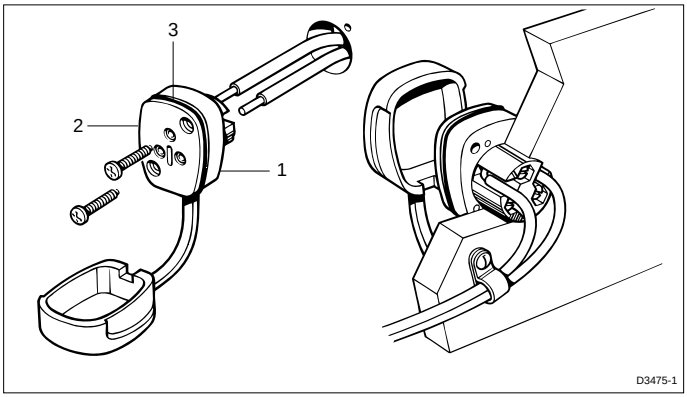
Cable length	Copper area	AWG
Up to 2.5 m (8 ft)	1.0 mm2	18
Up to 4.0 m (13 ft)	1.5 mm2	16
Up to 6.0 m (22 ft)	2.5 mm2	14

Using a suitable tool, crimp the spade receptacles supplied to the cables and connect, colour for colour, to the **Drive** terminals.

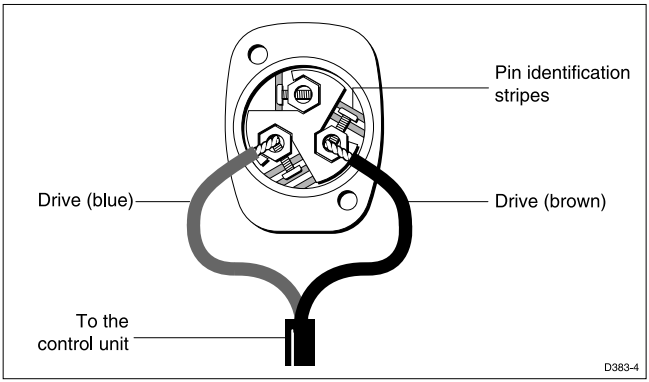


Socket installation

1. Apply the template to the bulkhead.
2. Carefully drill an 18 mm (23/32 in) clearance hole and two 2.4 mm (3/32 in) pilot holes. Remove the template.
3. Fit the plug cap to the socket body.
4. Fit the O - ring (3) to the groove between the plug cap (2) and socket body (1).
5. Pass the cable through the bulkhead and wire to the socket as shown making sure the wires are connected to the correct pin.



1 Socket body **2** Plug cap **3** O-ring



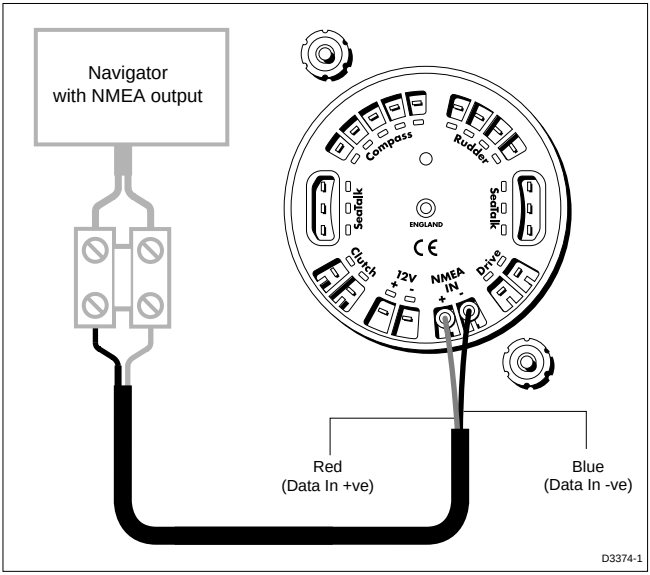
6. Attach the socket to the bulkhead using the two self-tapping screws. Secure the drive cable at regular intervals, using cable clamps.

6.7 NMEA interface

ST4000 Plus will accept navigation data in the NMEA format for use in Track and Vane (WindTrim) modes. The required data formats are shown in the table at the end of this section.

Cabling

The NMEA data port is on the rear of the ST4000 Plus and should be connected to a Navigator or Wind Instrument.



NMEA data transmission to other equipment

If you wish to transmit NMEA information to other equipment you will need to install a SeaTalk Interface (Catalogue Number Z290).

Data Formats

The following NMEA 0183 wind and navigation data can be decoded by the ST4000 Plus.

Data	NMEA 0183
Course Over Ground	VTG, RMC, RMA
Speed Over Ground	VTG, RMC
Cross Track Error	APB, APA, RMB, XTE
Bearing to Waypoint	APA, APB, BWR, BWC, RMB
Distance to Waypoint	BWR, BWC, RMB
Waypoint Number	APB, APA, BWR, BWC, RMB
Apparent Wind Speed	VWR, MWV

Apparent Wind Angle	VWR, MWV
Speed Through Water	VHW
Depth	DBT
Water Temperature	MTW

Note: *The autopilot only decodes the last four characters of waypoint names. Therefore, if long waypoint names are used, the last four characters must be unique to enable the waypoint advance function to work.*

Transmission of NMEA data on SeaTalk

If any of the above NMEA data is received and the equivalent data is not present on SeaTalk, the autopilot will transmit the data onto SeaTalk to make it available to other SeaTalk compatible instruments.

Depth is transmitted in the units defined by the first page in the data page rollover. Water temperature is always transmitted in ºC.

Chapter 7: Post Installation Procedures

Once you have installed the system, you need to confirm that the system is wired correctly and is also set up to suit your type of boat.

This chapter provides instructions for the following procedures:

- **Functional test**, consisting of a few simple tests to confirm that the system is wired correctly
- **Dockside procedures**, to calibrate the autopilot automatically according to your rudder installation
- **Initial sea trial**, to swing the compass and align the heading, check the autopilot's operation and check the rudder gain

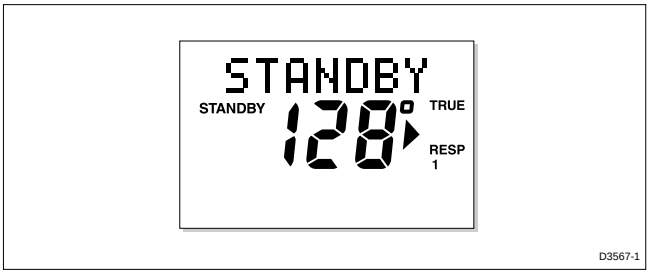
Further customisation can be performed after the sea trial, as described in *Chapter 5*.

7.1 Functional test

Switch on

Having installed your ST4000 Plus autopilot, switch on the main power breaker. If the control head is active and the system operating, the following will occur:

- The control head beeps and displays the pilot type (4000 WHL or 4000 TILL).
- If your pilot is a wheel driven (4000 WHL) system, then 1 second after power-on the pilot drives to starboard for 3 seconds. This is to allow even wear on the drive belt.
- After the pilot type has been displayed for 2 seconds, the Standby mode screen should be displayed.



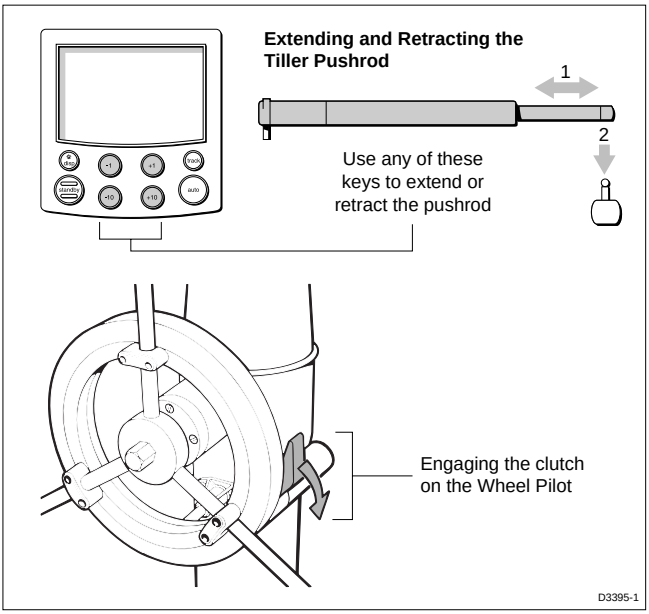
If the head does not beep, check the fuse/circuit breaker. If the SEATALK FAIL alarm is displayed, check the SeaTalk connections.

Operating sense

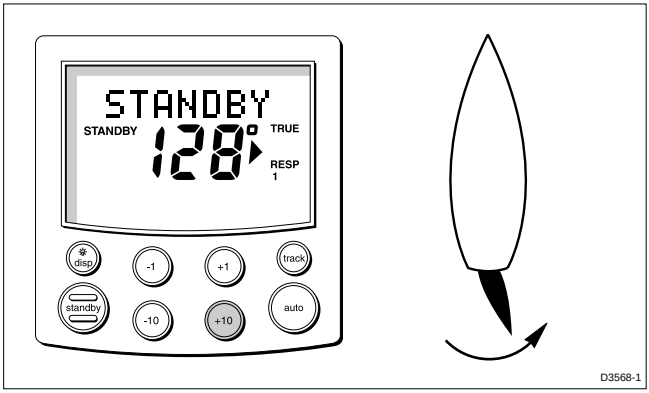
The operating sense defines the direction the helm will be applied when a course change key is pressed or the vessel goes off course. Check the operating sense as follows:

1. **Wheel Pilot:** Engage the clutch lever.

   Tiller Pilot: Place the actuator over the tiller pin. If necessary, extend or retract the push rod using the **-1**, **+1**, **-10** or **+10** keys.



2. Press the **+10** key. The helm should move to produce a turn to starboard.



3. If the helm produces a turn to port, reverse the drive connections on the back of the control head.

Note: *If the helm overshoots and has to drive back or starts to hunt back and forth, you need to increase the Rudder Damping option in Dealer Setup (see Chapter 5).*

Navigation interface (GPS, Decca, Loran)

If the ST4000 Plus is interfaced to a navigator, via its NMEA data port, the interface can be checked by displaying the default Data Pages. These are XTE, BTW and DTW.

Press **disp** to display the first page, and check that the expected data is displayed. Press **disp** again to check each successive page.

If dashes are displayed instead of data values, the cause could be one or more of the following:

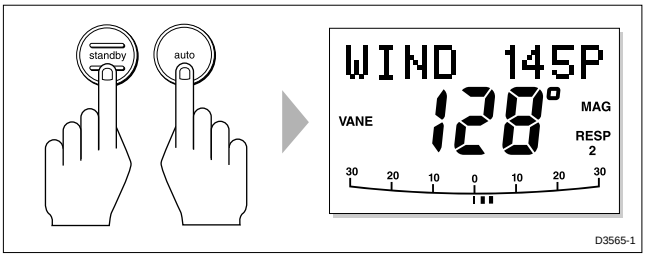
- A cabling error. Check for an open circuit, short circuit or reversed wires.
- The navigator is not configured to transmit the required data format.
- The signals being received by the navigator are too weak for reliable navigation. Refer to the navigator handbook for further action.

Wind transducer interface

If the ST4000 Plus is connected to a wind instrument via its NMEA data port or SeaTalk, then the link between the two instruments should be checked as follows:

Press **standby** and **auto** together.

The ST4000 Plus should display the Vane mode screen, with the locked wind angle and locked heading as shown.

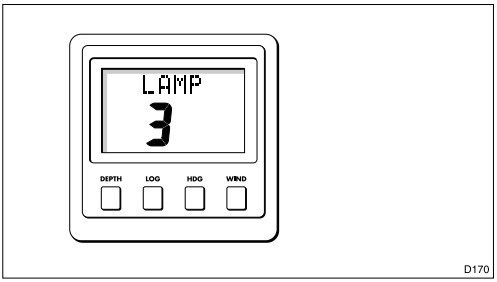


Alternatively, if the wind data is not received , the ST4000 Plus will display a NO DATA error message.

SeaTalk interface

If the ST4000 has been linked to other SeaTalk instruments via SeaTalk, the link can be checked as follows:

1. Press **standby**.
2. Select display illumination level 3 on any other SeaTalk instrument or autopilot control unit.



The ST4000 Plus should immediately respond by switching on its display illumination.

If the illumination does not switch on then a cabling fault exists in the SeaTalk cabling between the ST4000 Plus control head and the instruments/control unit.

7.2 Dockside procedures

The dockside procedures must be performed before your initial sea trial. They are:

- Dockside Rudder Calibration procedure
- Rudder offset adjustment, for systems with a rudder reference unit

Dockside rudder calibration procedure

The Dockside Rudder Calibration function calibrates the rudder position control. When it is selected, the autopilot performs the following procedure:

1. Drives the wheel hard to port until the end stop is reached.
2. Drives the wheel hard to starboard until the end stop is reached.
3. Drives the wheel hard to port until the end stop is reached.
4. Centres the helm (halfway between the two recorded limits) and beeps to confirm completion.

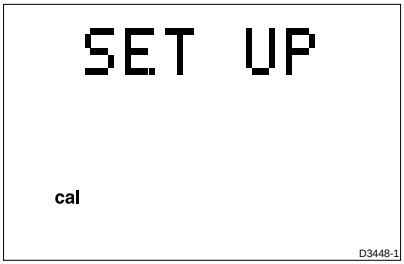
WARNING:

This procedure should only be used when the vessel is at the dockside. Make sure the autopilot actuator is connected and the tiller is free to move, or that the wheel drive clutch is engaged.

The Dockside Rudder Calibration function checks for the presence of a rudder reference unit. If you have one installed, it checks and, if neccessary, corrects the phase so that the direction of the reported rudder angle is correct.

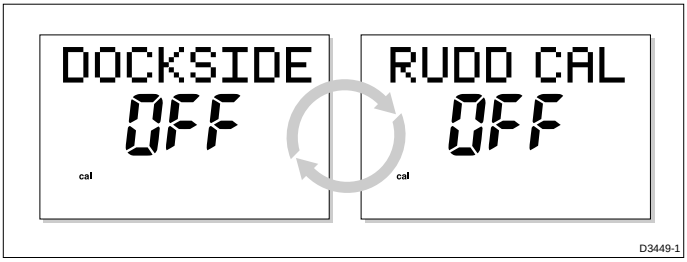
To perform the Dockside Rudder Calibration procedure:

1. Make sure that the autopilot is in Standby mode with the drive unit engaged.
2. Press and hold the **standby** key for 2 seconds to display the User Setup entry page.



If CAL LOCK is displayed, you need to turn off the lock feature contained in Dealer Setup (see *Chapter 5*).

3. Press the **disp** key to scroll through the options until the Dockside Rudder Calibration screen is displayed. (To step back to the previous screen, press and hold the **disp** key for one second. You can only do this within two seconds of advancing to the current screen.)



4. To start the procedure, press the **+1** key.

The following screen is displayed while the autopilot performs the Dockside Rudder Calibration procedure:

Note: *You can cancel the procedure by pressing any key.*

When the procedure has completed or been aborted, the following screen is displayed.

6. Press and hold **standby** for one second to exit calibration and save the new settings.

Note: *Setup options are always saved on exit.*

Rudder offset adjustment

This procedure checks that the rudder reference transducer is correctly aligned with the rudder. It is only required if a rudder reference transducer is fitted.

To check and correct for rudder offset:

1. Move the helm to its centre position, using the **-1**, **+1**, **-10** and **+10** keys.
2. Check the rudder bar display. The rudder angle should be within ± 7° of centre.
3. To improve the alignment, slacken the rudder reference mounting bolts and rotate the base until the reported rudder angle is as close to zero as possible. Then tighten the bolts again.
4. Fine adjustment, to align the display and helm accurately, is achieved using the Rudder Offset option in Dealer Setup (see *Chapter 5*). However, this cannot be used to correct an offset of more than ± 7°.

7.3 Initial sea trial

EMC conformance

- Always check the installation before going to sea to make sure that it is not affected by radio transmissions, engine starting etc.
- In some installations, it may not be possible to prevent the equipment from being affected by external influences. In general

this will not damage the equipment but can lead to it resetting, or momentarily may result in faulty operation.

Overview

Having checked that the system is functioning correctly, a short sea trial is now required to complete the setup. It involves the following procedures:

- Automatic compass deviation correction
- Heading alignment adjustment
- Autopilot operation check
- Rudder gain adjustment

Note: *The ST4000 Plus has a built-in calibration capability which enables it to be fine tuned to suit the individual vessel, its steering system and dynamic steering characteristics. As supplied from the factory the unit is calibrated to provide safe stable autopilot control for the majority of vessels.*

The initial sea trial should be performed in the following circumstances:

- After all the installation, functional test and dockside procedures have been completed successfully
- Before any other changes have been made to the default calibration settings: check and, if necessary, reset the values to the recommended levels, as described in *Chapter 5*
- In conditions of light wind and calm water, so that autopilot performance can be assessed without the influence of strong winds or large waves
- In waters clear of any obstructions

Note: *At any time during the sea trial you can disengage the wheel drive clutch, or lift the actuator off the tiller pin, to return to hand steering.*

Automatic compass deviation correction

The ST4000 Plus will correct the fluxgate compass for most deviating magnetic fields. Compass errors due to deviating magnetic fields can be in the up to 15° or even 45°, depending on your vessel type. The correction procedure reduces these to a few degrees, so it is essential to perform the procedure as the first item in your initial sea trial.

CAUTION:

Failure to carry out the deviation correction may result in impaired autopilot performance on some compass headings.

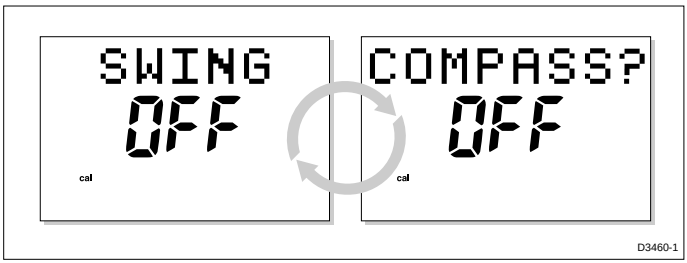
To allow the system to determine the deviation and calculate any correction required, you must turn your vessel in slow circles. This procedure must be carried out in calm conditions and preferably in flat water.

To perform the deviation correction:

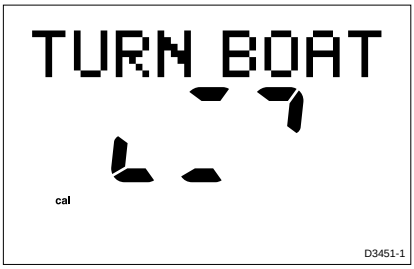
1. Make sure that the autopilot is in Standby mode with the drive unit engaged.
2. Press and hold the **standby** key for 2 seconds to display the User Setup entry page.

If CAL LOCK is displayed, you need to turn off the lock feature contained in Dealer Setup (see *Chapter 5*).

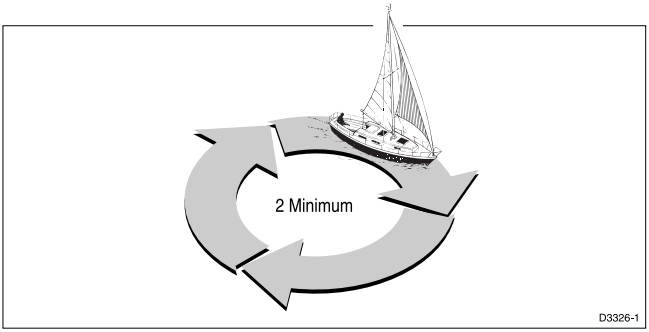
3. Press the **DISP** key to move on to the Swing Compass page.



4. Press the **+1** or **-1** key to change the setting from OFF to YES. The Turn Boat page is then displayed.

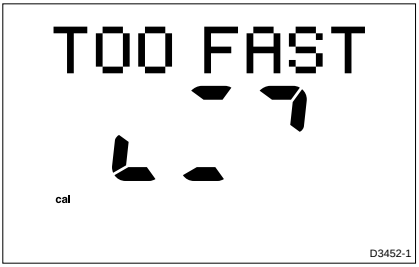


5. Keeping the boat speed below 2 knots, turn your vessel in slow circles. It should take at least 3 minutes to complete 360°.



What if I turn the boat too quickly?

If you turn the boat too quickly for the compass to be corrected correctly, the text TOO FAST will be displayed. Apply less helm to turn in a larger circle.



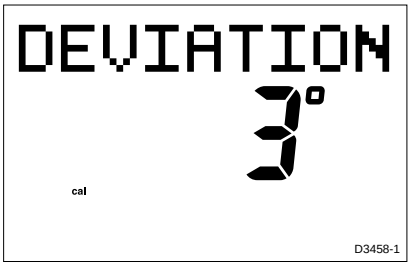
Can I cancel the process?

You can abort the correction process by pressing the **disp** key to move on to the Deviation screen.

If you wish to attempt deviation correction again, you can step back to the Swing Compass page or keep pressing **disp** to cycle through

the calibration options until the page is displayed again. (To step back to the previous screen, press and hold the **disp** key for one second. You can only do this within two seconds of advancing to the current screen.) Repeat the procedure from step 4.

6. Keep turning your boat until the unit beeps and the Deviation screen is displayed.

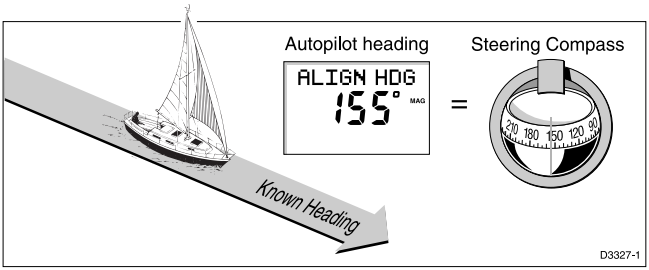


This shows the maximum deviation detected, and indicates that compass correction has been completed successfully.

Notes: *If the deviation value exceeds 15° or a deviation value is not displayed at all, you should consider moving the fluxgate compass to a better location.*

7. Press the **disp** key to move on to the Heading Alignment page.

8. Use the **+1** and **-1**, keys, or the **+10** and **-10** keys, to increase or decrease the displayed heading, until it agrees with the ship's steering compass or a known transit bearing.



9. Press and hold **standby** for 2 seconds to exit calibration and save the new settings.

Note: *Setup options are always saved on exit.*

Further heading alignment adjustment

You should always check the compass alignment after swinging the compass. However, once the initial deviation correction procedure has been performed, you can make adjustments to the alignment as often as you wish, without swinging the compass again.

Although the compass deviation correction procedure removes most of the alignment error, you will probably be left with small errors (of the order of a few degrees) that will vary depending on the heading.

Ideally, you should 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. This value can then be entered 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 slower and in move favourable conditions.

Checking autopilot operation

Having calibrated the compass the following proceedure is recommended to familiarise yourself with autopilot operation:

1. Steer onto a compass heading and hold the course steady.
2. **Wheel Pilot:** Engage the wheel drive clutch by rotating the wheel drive clutch lever clockwise.

   Tiller Pilot: Place the actuator over the tiller pin. If necessary,

extend or retract the push rod using the **-1**, **+1**, **-10** and **+10** keys.

3. Press **auto** to lock onto the current heading. A constant heading should be achieved in calm sea conditions.
4. Use the **-1**, **+1**, **-10** and **+10** keys to alter course to port or starboard in multiples of 1° and 10°.
5. Press **standby** and disengage the autopilot to return to hand steering:

   Wheel Pilot: Disengage the wheel drive clutch by rotating the clutch lever anti-clockwise.

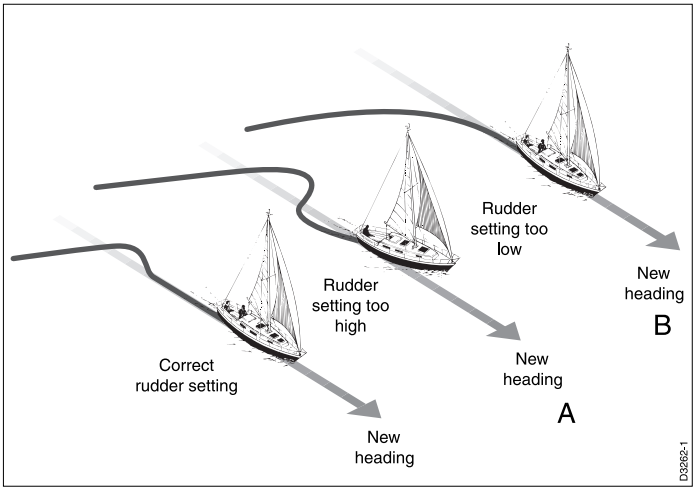
   Tiller Pilot: Remove the actuator from the tiller pin. You can retract the push rod, using the **–1** and **+10** keys, for stowage.

Checking the rudder gain

The factory set rudder gain level will provide stable control for initial sea trials. However, vessels can vary widely in their response to the helm, and further adjustment to the rudder gain may improve the autopilot's steering characteristics.

The following test will determine whether the rudder gain is set too high or too low.

1. In clear water and with the autopilot in Auto, alter course to starboard by 40° by pressing the **+10** key four times.
   - At cruising speeds, course changes of 40° should result in crisp turns followed by an overshoot of no more than 5°. If this occurs the rudder gain is adjusted correctly.
   - An excessively high rudder setting results in oversteer. This is recognised by a distinct overshoot of more than 5° (A). This condition can be corrected by reducing the rudder gain setting.
   - Similarly, an insufficient rudder control setting will result in understeer which gives sluggish steering performance (B). If the vessel takes a long time to make the turn and there is no overshoot then the rudder setting is too low.



These actions are most easily recognised in calm sea conditions where wave action does not mask basic steering performance.

2. To make a temporary adjustment to the rudder gain, press the **-1** and **+1** keys together for 1 second to display the Rudder Gain screen, then press **+1** or **-1** to change the level. Wait for 5 seconds, or press **disp** , to return to the previous display.
3. Repeat the test until a crisp course change with no more 5° of overshoot is achieved.

   The rudder control setting should be set to the lowest setting consistent with accurate course keeping. This will minimise helm movements and hence reduce power consumption and wear and tear.
4. Once you have determined the correct setting, change the default Rudder Gain setting in *Dealer Setup*, as described in *Chapter 5, Customising the ST4000 Plus*

Chapter 8: Maintenance

General

- In certain conditions, condensation may appear on the LCD window. This will not harm the unit, and can be cleared by switching on the illumination for a while.
- **Never** use chemical or abrasive materials to clean your autopilot. If the pilot is dirty, wipe it with a clean, damp cloth.
- Periodically check the cabling for chafing or damage to the outer casing – replace any damaged cables.

Servicing and safety

- Raytheon equipment should be serviced only by authorised Raytheon service engineers. They will ensure that service procedures and replacement parts used will not affect performance. There are no user serviceable parts in your autopilot.
- Some products generate high voltages, and so never handle the cables/connectors when power is being supplied to the equipment.
- Always report any EMC related problem to your nearest Raytheon dealer. We will use any such information to improve our quality standards.

Advice

Should any difficulties arise with this product, please contact the Raytheon Product Support department in the UK, or your own national distributor who will be able to provide expert assistance.

The working parts of the drive system are sealed and lubricated for life during manufacture – servicing is not required.

Before you consider returning the autopilot, make sure that the power supply cable is sound and that all connections are tight and free from corrosion.

If the connections are secure, refer to the Fault Finding chapter of this handbook. If the fault cannot be traced or rectified, please contact your nearest Raytheon dealer or Service Centre.

Always quote the product serial number, which is printed on the rear cover of the autopilot, and the software version number, which is displayed when you enter Intermediate Setup (see *Chapter 5*).

Chapter 9: Fault Finding

All Raytheon products are subjected to a comprehensive test procedure prior to packing and shipping. In the unlikely event that a fault does occur with your autopilot, the following check list should help identify the problem and provide a cure.

The autopilot display is blank

- No power – check the fuse/circuit breaker.

The autopilot display shows CODE LOCK at power on

- The CodeLock code must be entered manually (see *Chapter 4*).

The displayed compass heading does not agree with the ships compass

- The compass has not been corrected for deviation – carry out the deviation and alignment procedures.

Vessel turns slowly and takes a long time to come on to course

- Rudder gain too low.

Vessel overshoots when turning on to a new course

- Rudder gain too high.

The autopilot appears to be unstable in Track mode, or track-holding is slow

- If tide speed exceeds 35% of boat speed, and boat speed is not available via SeaTalk, change the Cruise Speed setting in Dealer Setup from Auto (A) to the boat's cruising speed.

The autopilot appears to be unstable on Northerly headings in the Northern hemisphere and Southerly headings in the Southern hemisphere

- Northerly/Southerly heading correction (AutoAdapt) not set up.

Display shows CAL LOCK when entering calibration

- Calibration locked out – calibration protection feature is turned on in Dealer Setup.

The autopilot will not "talk" to other SeaTalk instruments
- Cabling problem – make sure all the cables are connected properly.

Position information not received
- Navigator not transmitting the correct position data.

The autopilot will not auto advance to the next waypoint
- No bearing to waypoint information received from the navigator.

A series of rotating dashes are displayed on screen
- Compass deviation correction or dockside rudder calibration is running.

The display shows a series of stationary dashes
- Data is not being received – check the cabling.

The display shows NO DATA
- The signals received from the navigator are too weak – refer to the navigator handbook for further action.
- Wind trim data is not available – check the connection to the wind transducer.

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D3441-1
Drill 5mm (3/16in)
Machine hole
90mm (3.54in)
diameter
Drill 5mm (3/16in)

PLUG TEMPLATE
DRILL TWO
2.4MM (3/32IN)
DIAMETER
HOLES
DRILL ONE
18MM (23/32IN)
DIAMETER
HOLE

Limited Warranty Certificate

Raytheon Marine Company warrants each new Light Marine/Dealer Distributor Product to be of good materials and workmanship, and will repair or exchange any parts proven to be defective in material and workmanship under normal use for a period of 2 years/24 months from date of sale to end user, except as provided below.

Defects will be corrected by Raytheon Marine Company or an authorized Raytheon dealer. Raytheon Marine Company will, except as provided below, accept labor cost for a period of 2 years/24 months from the date of sale to end user. During this period, except for certain products, travel costs (auto mileage and tolls) up to 100 round trip highway miles and travel time of 2 hours, will be assumed by Raytheon Marine Company only on products where proof of installation or commission by authorised service agents, can be shown.

Warranty Limitations

Raytheon Marine Company Warranty policy does not apply to equipment which has been subjected to accident, abuse or misuse, shipping damage, alterations, corrosion, incorrect and/or non-authorized service, or equipment on which the serial number has been altered, mutilated or removed.

Except where Raytheon Marine Company or its authorized dealer has performed the installation, it assumes no responsibility for damage incurred during installation.

This Warranty does not cover routine system checkouts or alignment/calibration, unless required by replacement of part(s) in the area being aligned.

A suitable proof of purchase, showing date, place, and serial number must be made available to Raytheon Marine Company or authorized service agent at the time of request for Warranty service.

Consumable items, (such as: Chart paper, lamps, fuses, batteries, styli, stylus/drive belts, radar mixer crystals/ diodes, snap-in impeller carriers, impellers, impeller bearings, and impeller shaft) are specifically excluded from this Warranty.

Magnetrons, Cathode Ray Tubes (CRT), hailer horns and transducers are warranted for 1 year/12 months from date of sale. These items must be returned to a Raytheon Marine Company facility.

All costs associated with transducer replacement, other than the cost of the transducer itself, are specifically excluded from this Warranty.

Overtime premium labor portion of services outside of normal working hours is not covered by this Warranty.

Travel cost allowance on certain products with a suggested retail price below $2500.00 is not authorized. When/ or if repairs are necessary, these products must be forwarded to a Raytheon Marine Company facility or an authorized dealer at owner's expense will be returned via surface carrier at no cost to the owner.

Travel costs other than auto mileage, tolls and two (2) hours travel time, are specifically excluded on all products. Travel costs which are excluded from the coverage of this Warranty include but are not limited to: taxi, launch fees, aircraft rental, subsistence, customs, shipping and communication charges etc..

Travel costs, mileage and time, in excess to that allowed must have prior approval in writing.

TO THE EXTENT CONSISTENT WITH STATE AND FEDERAL LAW:

(1) THIS WARRANTY IS STRICTLY LIMITED TO THE TERMS INDICATED HEREIN, AND NO OTHER WARRANTIES OR REMEDIES SHALL BE BINDING ON RAYTHEON MARINE COMPANY INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABLE OR FITNESS FOR A PARTICULAR PURPOSE.

(2) Raytheon Marine Company shall not be liable for any incidental, consequential or special (including punitive or multiple) damages.

All Raytheon Marine Company products sold or provided hereunder are merely aids to navigation. It is the responsibility of the user to exercise discretion and proper navigational skill independent of any Raytheon equipment.

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Factory Service Centers

United States of America
Raytheon Marine Company
address as above

UK, Europe, Middle East, Far East
Raytheon Marine Company
address as above

Stick barcode label here

Purchased from

Purchase date

Dealer Address

Installed by

Installation date

Commissioned by

Commissioning date

Owner's name

Mailing address

This portion of card should be completed and retained by the owner.