SW AP05 SYSTEM MANUAL

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Your Seiwa AP05 autopilot system is engineered for accurate and reliable steering. But remember that it cannot keep a lookout.

SAFE NAVIGATION IS ALWAYS YOUR RESPONSIBILITY.

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QUICK START

- Install and check the system as described in Chapter 3.
- Press the STANDBY key to turn the system on.
- Follow the on-screen instructions to carry out the initial setup
- Press the STANDBY and PILOT keys together to turn off.
- Steer to the desired course and press PILOT.
- Use the course knob or arrow keys to change or trim the course.
- Carry out the self-tune procedure (Chapter 2) as soon as is convenient.
- To steer a course set by a GPS system, press the NAV key. To cancel this mode, press NAV again.
- To activate the DODGE function, press PILOT once to show the DODGE mode. Use the select arrow keys to dodge.
- For automatic tacking, press the PILOT key twice to show the TACK mode. Then press the LEFT or RIGHT select key.
- For wind-vane steering, press PILOT three times and press the select right arrow to turn it on.
- To access the menus, press the Menu key. To return to the main display, press STANDBY or PILOT.

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CHAPTER 1 SYSTEM DESCRIPTION

1.1 INTRODUCTION TO AUTOPILOTS

The main function of a marine autopilot is to hold the heading of a vessel on a reference course which is held in the memory of the autopilot. When it is operating, the autopilot continuously compares the vessel's heading with a reference course, and if they are different, it applies helm to bring the vessel back on course. Since there has to be a compromise between the accuracy of course holding and the activity of the rudder, the autopilot has controls which let the user set the balance between these two factors.

The four basic components of an autopilot are a compass, an electronic control box, a rudder angle sensor (transducer) and the steering drive. See Fig 1.1. In a SW AP05 system, the electronics are housed in two cases - a Junction Box containing most of the system and a Controller (Control Head), which is mounted near the steering station.

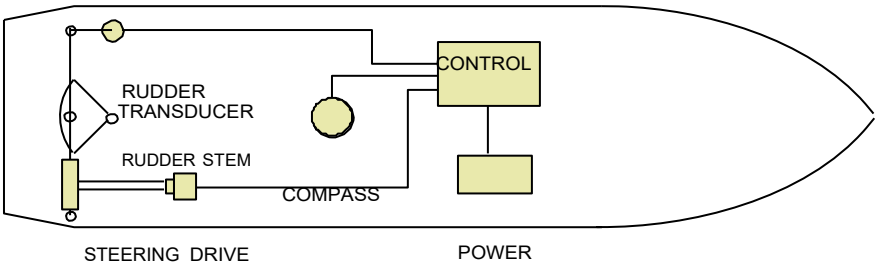


Figure 1.1 Basic components of a marine autopilot.

Modern autopilots perform other functions as well and this introduction explains how these fit in with the basic function and how they provide a wider range of options for the user.

1.1.1 THE REFERENCE COURSE

When the autopilot is first turned on, it rests in an idle (STANDBY) state in which it displays the heading, but does not steer the vessel. It is activated by switching it into the PILOT state. At the moment this is done, the current heading is put into memory as the reference course and the autopilot starts steering to hold the heading on this reference course. The user can change the reference course at any time and the heading will swing round to match the new course.

There are two other ways of setting the reference course. If the autopilot is connected to a GPS navigation receiver, the heading is then controlled to place the vessel on a direct track between the origin waypoint and the next waypoint. The third option may be used on yachts fitted with a compatible wind instrument. In this case, the reference course adjusts itself to maintain a constant apparent angle to the wind.

1.1.2 STEERING CONTROL

When the vessel swings off course or the reference course is changed, the autopilot should apply helm in a way which brings the vessel onto course quickly, but without overshooting the reference course. The correct rudder angle depends on the amount of the error, the speed of the vessel, its size and the effectiveness of its rudder. Three parameters in the autopilot affect the response of the rudder whenever a change in rudder angle is called for. The first is the rudder sensitivity or rudder factor, which determines how much the rudder moves for a given course error. The second is the control mode, which can produce a smooth linear response to a course error or can be set to ignore small heading variations. The third is the rate factor, which compensates for the turning inertia of the vessel. These are described in more detail below.

Rudder Factor

The sensitivity or RUDDER FACTOR sets how many degrees of helm are applied for a given course error. A mid-range rudder factor setting applies half a degree of helm for each degree off course. In large or slow vessels it would be more and in light, fast boats it may be less. Setting the rudder factor too high causes oversteering or ‘snaking’ as illustrated in Fig 1.2. Too low a setting causes understeer and a sluggish response. Settings in the range 2 to 4 suit the majority of vessels. Fortunately, most vessels also tolerate a range of settings and still steer well.

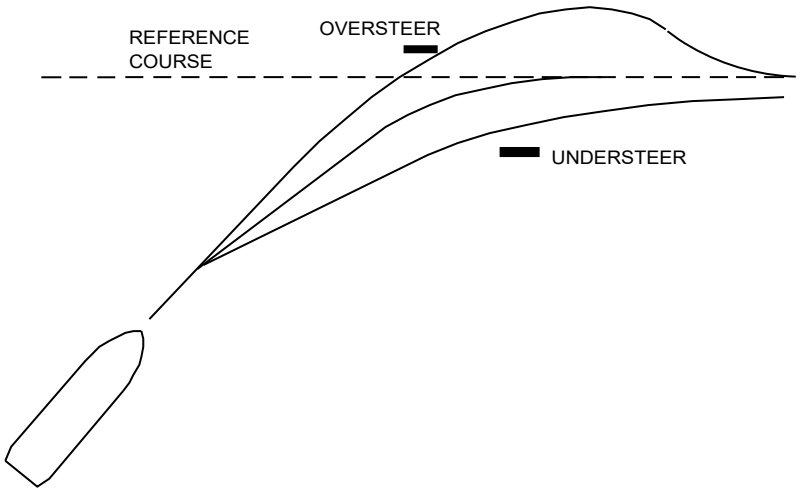


Figure 1.2. Illustration of oversteer if the rudder factor is set too high and understeer if it is set too low.

Control Mode - Normal or Rough

The CONTROL MODE setting is influenced by the sea conditions and by how active the helmsperson wants the rudder to be. The NORMAL mode applies helm in proportion to the course error and the rate of turn. In smooth to medium seas this generally gives the best compromise between rudder activity and course holding. The rudder factor may also be trimmed up or down to produce the desired performance. The ROUGH mode is used when the vessel rolls and yaws in a heavy sea. Rudder activity is quietened down by not reacting to small heading shifts, but full control is applied as the shift becomes larger.

Counter Rudder – Rate of Turn

All vessels have turning inertia, which delays the response of the turn rate to the rudder and which causes the turn to continue after the rudder is centred. In vessels shorter than 6 m this effect is barely noticeable, but becomes increasingly important as length and displacement increase. A slow response of the steering drive produces a similar effect. When the turn-rate (or counter rudder) component of the autopilot is active, normal helm is applied to start the vessel turning. As the turn rate builds up, the helm is backed off. Then, when the heading is close to the reference course, reverse helm or counter-rudder is applied to stop the turn. This is illustrated in Fig 1.3 below. The rate of turn component in the helm correction is adjustable and is more important for vessels whose helm response is slow and/or which continue to turn for some time after helm is centred.

Generally, when the rate component is increased, vessels hold a course better but react to changes in the reference course more slowly. Counter-rudder also improves control for most vessels operating in a following sea. Settings are usually in the range 2 to 4.

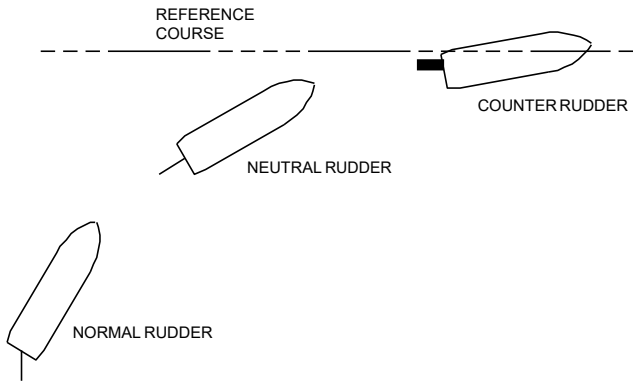


Figure 1.3 Rudder action during a turn in the RATE mode.

Autotrim

Vessels often show a steering bias or offset, which can be due to weather, propeller torque or towing a load off-centre. The autopilot responds to this by progressively trimming the centre position of the rudder until the average heading of the vessel equals the reference course.

Automatic Tuning

During the set-up of the autopilot, following a Cold Start, the operator enters information about the type of steering gear, as well as the port and starboard rudder limits. During the early use of the vessel, the autopilot puts it through some zig-zag turns and records the response of the vessel and the speed of the rudder drive. Based on this data, the system automatically calculates values of the control settings to suit this type of vessel. During use, values of these settings may be adjusted, if required.

1.1.3 POWER STEERING

Since the autopilot controls a power steering system, options are available to use this to steer the vessel by hand while away from the main wheel. This can be done by a hand-held device on a cable or a permanently mounted second steering station.

1.1.4 OPTIONS

An autopilot commonly uses a fluxgate compass for its heading measurement. Such compasses, though effective, suffer from acceleration errors and a very effective way to reduce these errors is to combine a fluxgate with a rate-of-turn gyro. The SW AP05 is now supplied with a rate-gyro fluxgate compass as standard. A further option is to fit a pickup device (slave) on the ship's compass and take advantage of its dynamic performance and the fact that it has been magnetically compensated. Alternatively, this autopilot may take its heading in digital form from a ship's gyro or other electronic heading sensor. The autopilot has built-in facilities for automatic or manual compass calibration.

When connected into an NMEA data system, the autopilot can receive navigation data, as mentioned above or wind direction data. Some of this data, which is not used for autopilot operation, is displayed on the autopilot screen for convenience. The autopilot generates output data containing the current heading, which can be fed into an instrument or radar system.

Autopilots intended for yacht use have an automatic tacking feature which is useful for single-handed sailing.

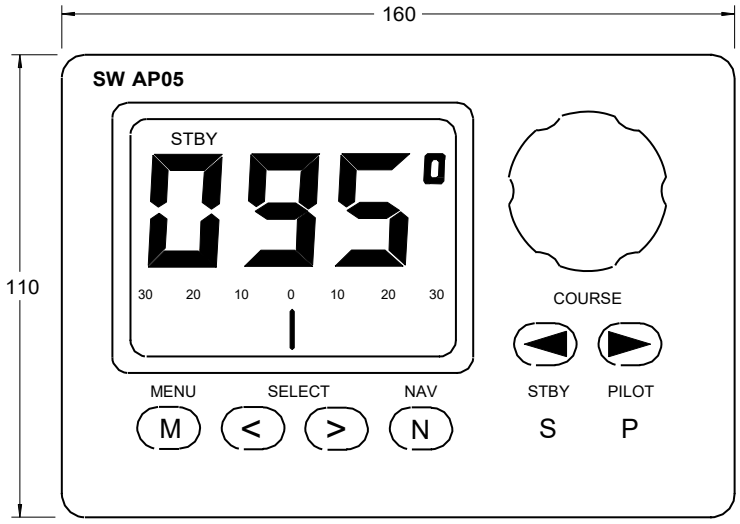
A second control head may be fitted to the autopilot to provide parallel operation from two stations.

1.1.5 WORKING WITH OTHER EQUIPMENT

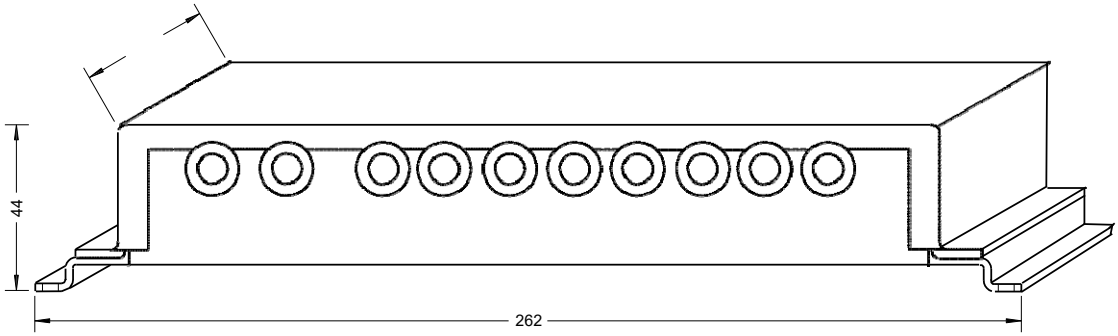
The physical and electrical environment in a boat can be harsh. This autopilot has been engineered with this in mind and tolerates poorly regulated power supplies, overloaded steering, radio transmitters, radars and the like. Conversely, it has also been engineered to operate without causing interference to radio receivers and other communications equipment. Seiwa autopilots carry a CE mark to indicate compliance with the relevant EMC standards. The installation sections of this manual have been carefully developed to minimise problems when the autopilot is in this environment. Please study and follow them!

1.2 THE **SW AP05** SYSTEM

The core of the SW AP05 system is built by connecting a Controller to a Junction Box. A table of features of the system with a Junction Box is shown in Fig 1.4 below.



SW AP05 Control Head



Features:

- For 12 to 24V power supplies.
- Drive current 30A max
- Dual Control Head sockets
- Dual Remote Control ports
- Rate gyro, compass slave or digital heading
- Footprint: 262 x 142 mm.

The shape of the final system is determined by the optional attachments and many combinations may be set up. Figs 1.5 shows a full system based on the Junction Box.

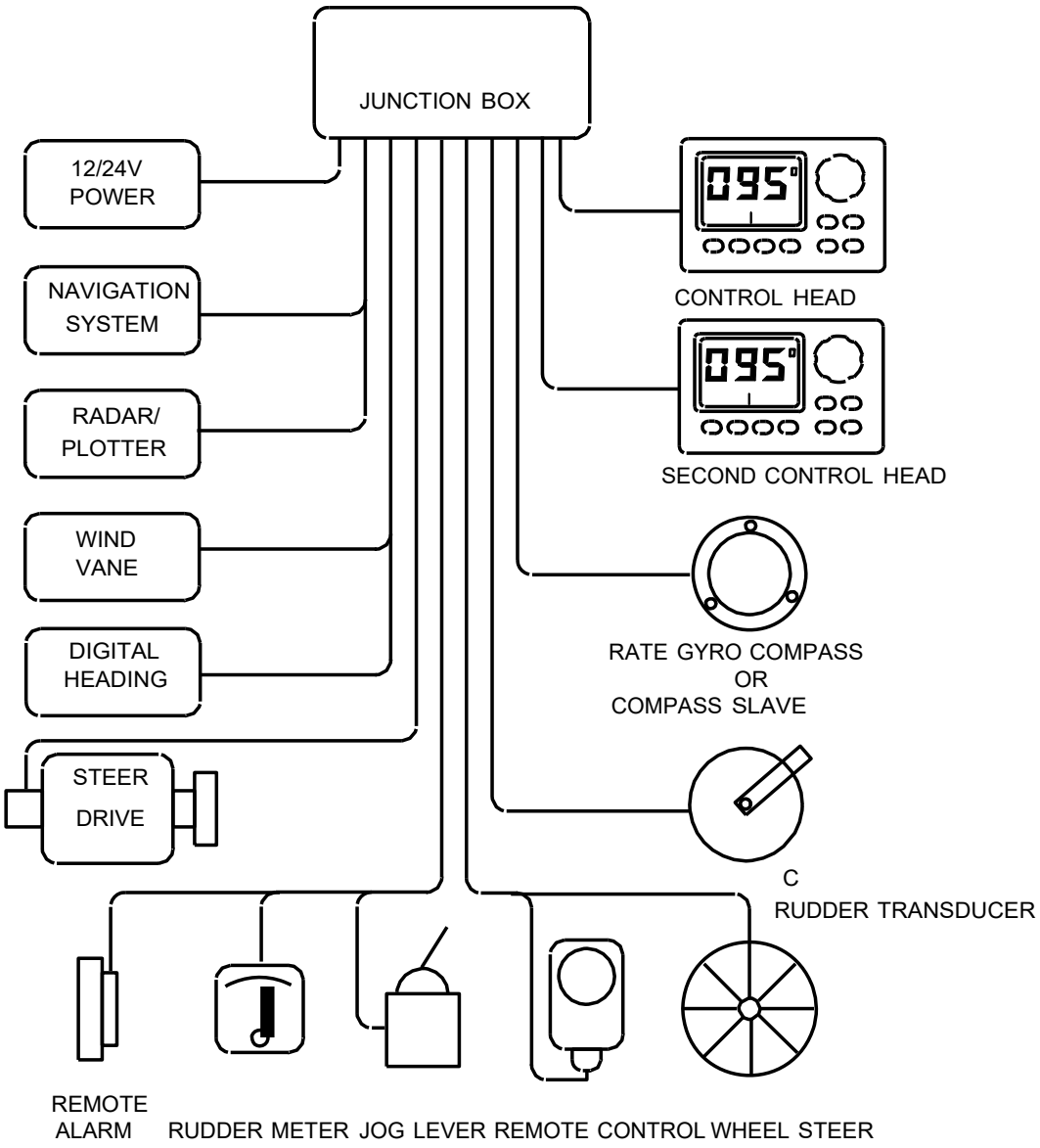


Figure 1.5 SW AP05 Autopilot system with optional attachments. The essential components are: a Junction Box, a Control Head, a Compass. A Rudder Transducer and a Steering Drive.

Junction Box

The Junction Box contains the control microcomputer, the interfaces with other system components and the steering drive electronics. All system cables are terminated in the Junction Box. The drive system is robust and is designed to drive mechanical, hydraulic pump and solenoid controlled steering systems.

Control Head

The Control Head has eight push-buttons and a rotary knob to control the system and displays information on the current operation of the autopilot.

Compass Options

The Rate-Gyro Compass combines a fluxgate compass and rate gyro in a single package. This combination should give the best steering performance over a wide range of conditions. The Rate Gyro is a vibrating crystal type which works in conjunction with the fluxgate ù compass to give more precise steering control in all sea states.
It provides a very stable short-term heading output which is independent of pitch and roll in the vessel. The fluxgate output is then used to correct for drift in the gyro so that long-term stability is also achieved. Using the rate gyro overcomes the 'southerly heading' softness encountered in the southern hemisphere, or the converse problem in the northern hemisphere. The rate gyro also quietens rudder activity in a heavy swell.

Rudder Transducer

The standard rudder transducer is a which is suitable for recreational vessels. For commercial vessels, the heavy-duty is recommended. Both are fully sealed potentiometer types and are interchangeable.

Steering Drive

There are many mechanical or hydraulic steering options. A suitable drive may either be supplied by Seiwa or the autopilot may be connected to an existing steering drive on the vessel.

1.3 OPTIONAL ATTACHMENTS

Compass Slave

If desired, the Rate-Gyro Compass may be replaced by a compass slave mounted above the ship's card compass.

Second Control Head

A second Control Head may be fitted. Each Controller operates with equal priority. The system may be switched ON or OFF from either station and both Controllers show the same display.

Rudder Angle Indicator

The Rudder Angle Indicator gives an analog display of the rudder angle and may be located either with the Controller or on another part of the vessel.

Remote Alarm

A piezoelectric beeper is available which repeats the internal alarms generated by the autopilot

CHAPTER 2 OPERATING INSTRUCTIONS

2.1 THE CONTROL PANEL

The display screen of the Controller (Fig 2.1) shows digital and text information about the current operation of the autopilot. There are eight keys and one knob which control the operation and the functions of these are described below.

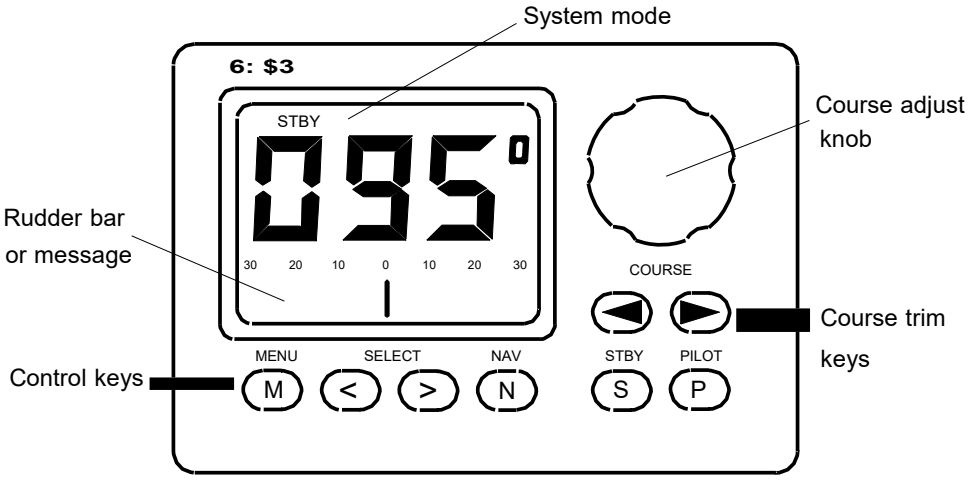


Figure 2.1 The SW AP05 Controller panel.

2.2 GETTING STARTED

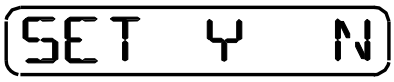
Before operating the autopilot for the first time, it must be installed and adjusted as described in Chapter 3. (If optional attachments and interfaces are being used, these can be fitted after initial trials of the system.)

The set-up process is in two parts: the first can be carried out at the wharf and involves selecting the type of steering drive you are using and then setting the mechanical limits of the rudder travel. The second is carried out while motoring and involves putting the vessel through a zig-zag manoeuvre. During this manoeuvre, the autopilot makes measurements of the vessel's response to the helm, the speed of the rudder movement and time taken to change heading. From these measurements, the autopilot calculates what are considered to be the best settings for this vessel. These settings are stored in memory, though they may be changed, if the owner wishes, at any time in the future.

The zig-zag manoeuvre takes the vessel in a pattern which swings 10 – 15 deg either side of its initial heading. The process is finished after two full zig-zag cycles. If you carry out this manoeuvre in a narrow waterway please ensure that there is enough room. If the vessel sails too close to an obstacle during this process, simply press STANDBY and hand-steer the vessel away from it. The tuning procedure can be done again when the clearance is safe.

AT THE WHARF

To switch on for the first time, press the STANDBY key. The system enters a set-up mode to ensure that the steering drive and rudder transducer have been phased correctly. The screen shows the version number of the installed software. After the SELF TEST display, the screen shows the system setup prompt:

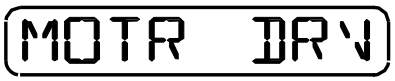


There are two choices. If you wish to examine some of the features without carrying out the setup, select NO by pressing the N (nav) key. This will bypass the setup and let you scroll through the displays, but there will be no response to the PILOT key. The system will return to SYSTEM SETUP the next time it is turned on.

To carry out the setup, select YES by pressing the right arrow under the Y symbol.

SETTING THE STEERING DRIVE

The screen now shows:



This is the right selection if you have a reversing motor driving a hydraulic pump or a reversing motor with a cable of chain coupling to the rudder quadrant. To confirm, press STANDBY. (This type of drive includes a pulse-mode drive, which is applied when the rudder is close to its target position.)

But if you have a continuously running pump (electric or engine driven) with solenoid valves, press the left or right select arrow so that the display shows:

Press STANDBY to confirm.

SETTING THE HELM LIMITS

The mechanical limits of the helm will now be stored in the autopilot so that the steering drive stops short of these in operation. The first prompt is:

Turn the helm to the STARBOARD limit. The rudder angle is displayed. If the display shows port instead of starboard, this will be corrected when STANDBY is pressed.
(Note that if the helm angle is less than 10 degrees at the stop, the system will not respond.)

Press STANDBY and the second prompt is:

Now turn the helm to port until it reaches the mechanical stop. Press STANDBY.

The final prompt is:

Bring the helm to the position which your experience shows to be centred - the indicated angle may now be different from zero. Press STANDBY.

Warning: This action will start the steering drive. Make sure that it is safe to do so before pressing STANDBY.

The current helm position is now placed in memory as the helm centre, the helm then moves to 10 - 12 deg port, pauses and then returns to centre. This operation corrects any small alignment errors in the rudder transducer, stores the correct drive phasing and completes the setup operation, returning the system to STANDBY.

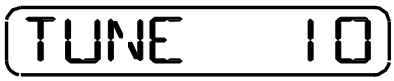
Note that if the helm is not centred within 5 degrees, the setup will not continue. Press STANDBY and re-centre the helm by adjusting the rudder transducer. Later, when the vessel is at cruising speed, it is recommended that the HELM ADJUST option be used to fine-tune the helm centre. (Sec 2.5).

WHILE MOTORING

The autopilot steering program is now operating with the original factory settings, which should give reasonable control until the self-tuning phase is completed.

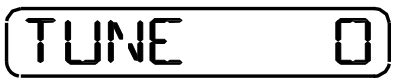
Steer the vessel to a suitable location for the zig-zag manoeuvre. If it has a displacement hull, the tuning should be carried out at its normal cruising speed. If it is a planing hull, the speed should be set a little lower than that where the bow starts to lift to the planning angle. (This may be well below its cruising speed.)

Point the vessel towards clear water and press PILOT. The display will now flash the message ‘UNTUNED’ regularly. This is not an alarm – it is just an information message. If the heading is reasonably steady, press PILOT four times until the display shows:



This indicates a tuning manoeuvre using a 10 deg rudder movement. Press the right-hand select arrow and the display reads:

When you are ready, press PILOT again. The vessel will turn left by 10 – 15 deg and the display will show:



The counter on the right of the display counts up as the zig-zag proceeds. When it reaches 9 the autpilot returns to its original course, with settings automatically updated, as required.

THE SETUP IS NOW COMPLETE

At this point, the flashing ‘UNTUNED’ message will no longer appear and the tuning option will no longer appear on the PILOT screen. If, at some later time, you wish to repeat the tuning process, go to the menu option under the OTHER heading and scroll to the screen that reads ‘TUNED’. If you press the left select arrow, this will change to ‘UNTUNED’ and the tuning process can be done again.

Caution. This option can only cancel the Tuned status. You cannot press the right arrow to return the system to ‘TUNED’. This can only be done by going through the tuning process again.

2.3 NORMAL OPERATION

Switching On

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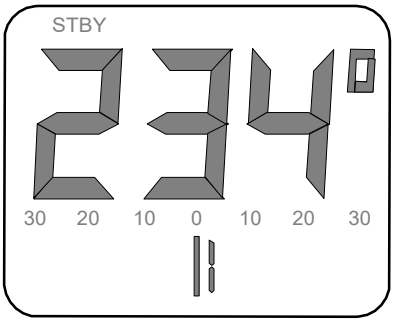
Press the STANDBY key. The system does a self-test for a few seconds and displays the version of software fitted to your autopilot. When the self-test is complete the normal STANDBY display appears and shows the current heading of the vessel.

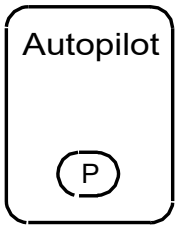


If a fault is detected during the self test, the Controller starts beeping and the type of the fault is displayed after the self-test period.

Switching Off

S P

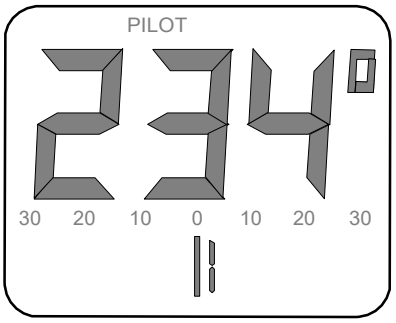
Hold down the STANDBY and PILOT keys for a second.



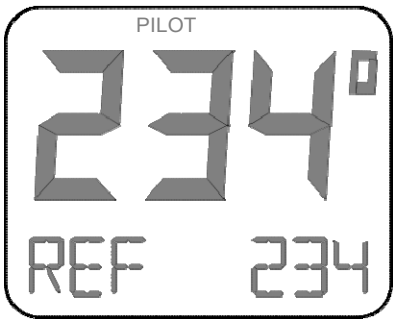
With the system in STANDBY, steer the vessel to the desired heading. Hold that heading steady and then press PILOT. The autopilot will now lock onto that heading and maintain it. The position of the rudder when the PILOT key was pressed is stored in memory as the effective helm centre.

Autopilot Display Screens

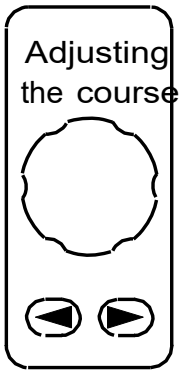
There are two display options in PILOT mode. The left-hand display is Mode A. It shows the Reference Course in large digits and the rudder angle as a bar display. Mode B shows the current heading in large digits and the Reference Course below it. The SW AP05 Control Head is preset to Mode A. The preferred mode may be selected via the PILOT DISPLAY option in the menu.



Mode A



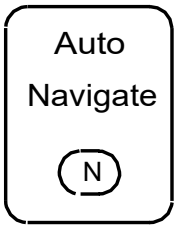
Mode B



To adjust the current reference course, press either the left or right COURSE key. A single press changes the course by 1 degree. For larger course changes, turn the COURSE knob. The reference course changes by 10 deg for each click of the knob. If you are in STANDBY, pressing the COURSE key once displays the reference course without changing it. The reference course with then respond to each subsequent press of the COURSE key. The display will return to the normal STANDBY screen after a delay.

Note. In the auto navigate mode the reference will not change, since it is controlled by the GPS system.

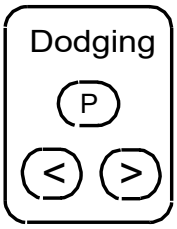
2.4 AUTOPILOT OPTIONS



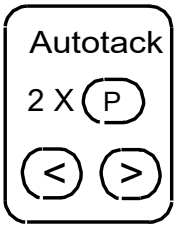
To engage the auto-navigate function, press the N key (in PILOT or STANDBY). If a valid navigation sentence is being received, the NAV symbol at the top of the screen turns on, without blinking. If the NAV symbol blinks, it means that a valid sentence is not being received. You should wait up to 15 seconds for it to become steady. If it does not, consult Chap. 3.

With a valid navigation sentence and in PILOT with mode B selected, the heading-to-steer and cross-track error are displayed alternately. In display Mode A, the large digits show the heading-to-steer.

To cancel auto-navigation, press the N key again.



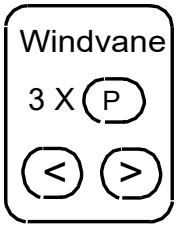
The dodge function is used to make a quick course change to avoid an obstacle. With the system in PILOT, press the PILOT key once more. With the DODGE message showing, hold the LEFT or RIGHT SELECT key. The helm moves in the required direction and the rudder bar is displayed on the screen. The helm moves until the key is released and then holds its position. To return to the original course, press the PILOT key.



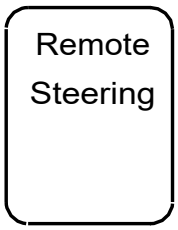
The autotack feature produces a delayed course change which is useful for single handed sailing. The tack angle is preset to 100 deg, but may be changed via the menu (See Sec 2.5). With the system in PILOT press the PILOT key twice more and, with the TACK message showing, press the LEFT or RIGHT SELECT key. A 10 second countdown show on the screen and when it reaches zero, the course change starts.

To cancel autotack during the countdown, press PILOT.

If operating with a wind instrument input, the operation is slightly different. When the vessel turns, the new heading sets up the same relative wind angle on the opposite side of the vessel. The turn direction is through the shorter arc.



With the system in PILOT, press PILOT three times and, with the WIND OFF message showing, press the RIGHT SELECT key to display WIND ON. Then, to store the current wind angle, press PILOT again. If a valid wind-vane sentence is being received the relative heading to hold is displayed. If the wind data is not being received, the message WIND WAIT is shown. The vessel should now hold a fixed relative heading to the wind, being the one when PILOT was pressed. The relative heading may be adjusted via the ARROW keys. To cancel the wind vane mode, press PILOT again.



If a Remote Helm or similar attachment is fitted, switching it to the REMOTE mode overrides normal autopilot functions and provides direct rudder control. In this mode, the display shows REMOTE on the top line.

For remote controls with a knob and a switch and wheel steering, REMOTE is activated by switching to REMOTE. The rudder angle now follows the knob position. When it is switched back to PILOT, the original reference is retained, or in NAV mode it reverts to the GPS heading to steer. For the unswitched remote control, moving the knob away from the centre automatically put the system in REMOTE and it returns to PILOT when the knob is centred. For a jog lever, moving it places the system in REMOTE and runs the helm out until the lever is released. When it is released, the helm stays in that position. The system is returned to PILOT by pressing the PILOT key.

The SW AP05 system responds to the most recent input from either the control panel or a remote attachment. Therefore, when the system is turned on, the setting of all remotes is ignored until some input is made to them. Similarly, pressing STANDBY or PILOT on the control panel will override a remote. If two remote attachments are fitted, the system responds to whichever has been used most recently. There is a menu option to disable any remote response unless the system is in PILOT.

2.5 SYSTEM MENUS

The menus give access to a number of system settings which may be used to fine-tune the performance and select various options. Adjusted settings are stored in permanent memory and are retained while the system is turned off. The menu organisation is shown in Fig 2.2 on the following page. The main menu has nine items, shown on the left. Four of these items are headings for four sub-menus, shown on the right.

If you are in STANDBY or PILOT, press the M key. Then use single presses of the M key to scroll down. When a heading for a sub-menu shows, that sub-menu is selected with one press of the RIGHT SELECT key. Then scroll down, as before, with single presses of the M key. (At the end of each sub-menu, the system returns to the main menu.) Some sub-menu items require selection to activate them, eg Compass Calibration. Press the RIGHT SELECT ARROW to select these items. To return at any time to the main operating display, press STANDBY or PILOT.

MENU TIMEOUT

For most menu options, the system will return automatically to the normal display in 1 ½ minutes after the last keystroke. Exceptions include Compass Calibration, where the calibration display will show until cancelled by a keystroke.

MENU LAYOUT

The layout of the SW AP05 menu is shown in Fig 2.2 on the following page. Use the M key to scroll down through the menu or sub-menu items, or to move back from a sub-menu to the main menu. Use the > key to select a submenu. Within a sub-menu item use the < or > keys to change a selection or adjust a numerical setting.

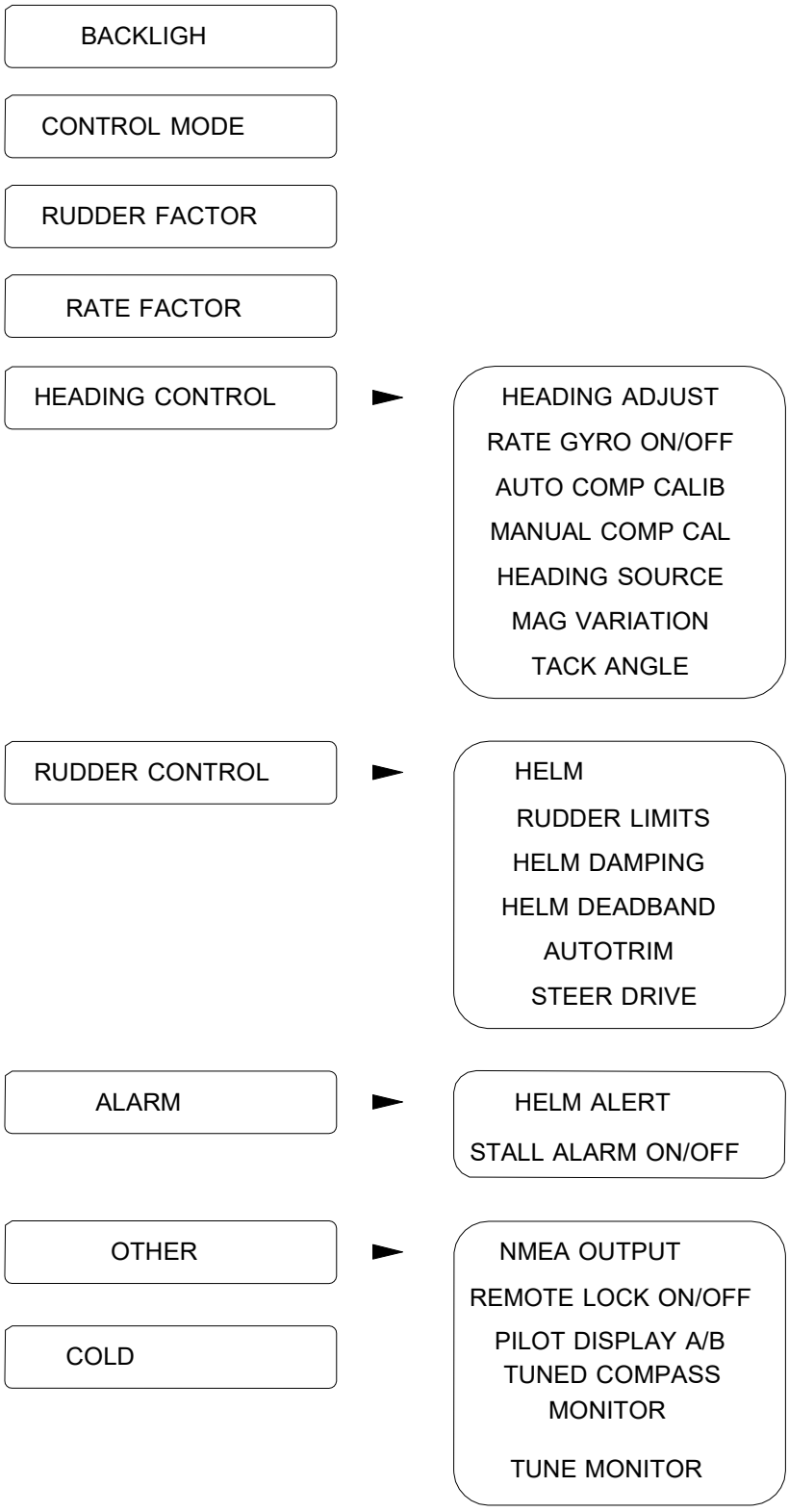


Figure 2.2 The SW AP05 System Menu

The use of each menu item is described in the following pages.

BACKLIGHT The backlight for the display can be set to 4 different brightness levels. Use the arrow keys to adjust.

CONTROL MODE The system is preset to the NORMAL mode, but may be changed to operate in ROUGH Use the arrow keys to select between the following:

NORMAL

Direct proportional control with a counter-rudder component that be adjusted from the menu (see below). More information on manual settings is given in Sect 2.7.

ROUGH

This suits most vessels in heavy conditions. The control has a deadband which permits a 5 deg yaw about the reference course before correction is applied. Outside this window, the control is as for the Normal mode. Rudder activity and power consumption are therefore kept to a minimum.

RUDDER FACTOR The Rudder Factor (or sensitivity) controls the amount of helm applied for a given course error. This may be increased or reduced using the select arrow keys. There is more about the rudder factor in Sect 2.7.

RATE FACTOR The RATE FACTOR controls the amount of counter rudder applied in both control modes. Guidelines for setting it are given in Sect 2.7.

HEADING CONTROL GROUP

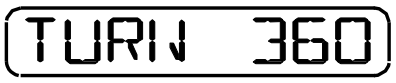
HEADING ADJUST The current fluxgate heading is displayed and compass mounting errors may be compensated using the arrow keys.

RATE GYRO The Rate Gyro option is turned on, following a Cold Start, assuming that a Rate Gyro is fitted. But if a compass slave is fitted, which does not operate with a rate gyro, turn this option off. If the rate gyro is selected, but not connected, a GYRO

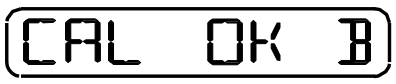
ERROR alarm is generated and the Rate Gyro is turned off. The gyro function is turned on or off via the arrow keys. Note: if the Rate Gyro function is turned on via the arrow key the system returns to the Self Test mode so that the gyro can be initialised correctly.

AUTO COMPASS CALIBRATION

This is one of two options to reduce deviations caused by magnetic components and material on the vessel. To carry out this calibration, press the right arrow. The display reads:



With the vessel under way and steering it by hand, turn it slowly through a full circle. You may turn either to port or starboard, but the same direction should be maintained until the circle is complete. The digital display shows the angle turned through so far. When the circle is complete, the display shows the calibration results, eg.



The letter at the end indicates the quality of the field. A and B are satisfactory. C indicates poor field quality and re-location of the compass and/or manual calibration is recommended.

Press STANDBY to return to normal operation. This method of calibration is simple and is a recommended procedure for all vessels. However there are some magnetic anomalies which are not fully removed. The manual calibration option provides a further refinement of compass accuracy.

Note. If a rate gyro is fitted, it is disabled automatically by selecting the calibration option and is automatically enabled again when calibration is complete.

MANUAL COMPASS CALIBRATION

Press the RIGHT ARROW when this message appears. The main digital heading shows the current heading and the message line reads:

Turn the vessel to a heading which is close to one of the cardinal or inter-cardinal points, ie.

000, 045, 090, 135, 180, 225, 270, or 315.

Then use the arrow keys to adjust the deviation up or down until the heading agrees with that of the ship's compass or other reference compass. Turn to the next point and repeat the procedure until all eight have been checked or adjusted. Press STANDBY.

Manual calibration may be fine-tuned at any time by selecting this function and turning, for example, to just one cardinal point which may need adjustment. Note that all calibration settings are cleared when a COLD START is carried out.

HEADING SOURCE

This allows a selection (using the ARROW keys) between a heading input from a fluxgate compass (or slave) and a digital heading input via one of the NMEA ports. There are two digital heading options: a magnetic heading (HDG) or a true heading (HDT). If the true input is used, all navigation headings are shown as true.

MAGNETIC VARIATION

A magnetic variation value must be entered if GPS sentences containing TRUE headings are used. The variation is displayed on a 360 degree scale, i.e. 13 degrees east appears as 013, while 10 degrees west appears as 350. Use the ARROW keys to adjust the variation.

TACK ANGLE

In auto-tack mode, the angle through which the vessel turns may be set in 5 degree steps from 20 to 160 degrees.

RUDDER CONTROL GROUP

HELM ADJUST — For best overall performance, it is important that the displayed rudder angle be adjusted to read zero when the helm is dead ahead. This adjustment compensates for errors in the transducer linkage and other offsets in the steering gear. The current helm angle is displayed and should read 00 at the centre. Use the arrow keys to trim the reading.

RUDDER LIMITS — This setting controls the maximum rudder angle used when the system is in PILOT mode. It is preset to 20 degrees and may be changed using the arrow keys. It should always be less than the mechanical limits stored during the System Setup procedure.

HELM DAMPING — The Helm Damping control compensates for inertia or overshoot in the steering drive, which may be present in most hydraulic or electrical systems. To check the suitability of the preset value of 2, turn the helm manually to about 20 deg. rudder angle and press PILOT to centre the helm. Observe the rudder movement. If the rudder stops short and then "inches" into the centre position, reduce the damping factor. If it overshoots and "inches" back, increase the damping factor.

HELM DEADBAND — The deadband acts as a filter which prevents the steering drive from pulsing on and off in response to very small error signals. If it is set too high, the steering will be slow to respond to small corrections. The best setting is one just above the value which produces continuous pulsing of the steering gear.

AUTOTRIM — The autotrim continuously adjusts the helm centre by averaging the course errors over time. It may be switched off (0) or on with a value of 1 or higher. Typically, a value of 1 gives the best results.

STEER DRIVE — This may be used to run the steering drive continuously for bleeding purposes. Note that if the rudder transducer is not

coupled, there is a risk of driving the steering gear against the stops. Press the left or right arrows to start and stop the drive.

ALARM GROUP

HELM ALERT — As a safety feature, a HELM ALERT alarm is activated at regular intervals when the system is in the PILOT mode. The time interval may be set to 5, 10 or 15 minutes or the alert may be switched off.

STALL ALARM — The stall alarm indicates that the steering drive is not operating correctly. It is activated if the drive runs for more than 15 sec. without the rudder reaching its correct position. The stall alarm may be enabled or disabled using the select arrows.

OTHER FUNCTIONS

NMEA OUTPUT — The NMEA heading output may be selected between HDG (magnetic), HDT (true) and HDM (magnetic). Some versions may also show a LOG option. This is for recording autopilot performance during engineering tests and would not be selected in normal use.

REMOTE LOCK — If the Remote Lock is switched on, the system will only respond to a remote steering attachment when it is in PILOT.

PILOT DISPLAY — Used to select between the two display modes described in Sec 2.3

TUNED — The Tuned message indicates that the zig-zag operation performed during set-up was completed. If there is a need to repeat the tuning operation, press the left select arrow and the Untuned message will appear. Note: it is only possible to cancel the tuned condition. The right select arrow will not restore the tuned condition. To restore it, the zig-zag operation must be repeated.

COMPASS MONITOR — This displays the internal voltages being generated by the fluxgate compass. See Appendix A for more detail.

TUNE MONITOR This displays some operating parameters as well as the results of internal measurements recorded during the zig-zag operation.

COLD START This option restores the original factory preset parameters in the autopilot and should be used if there has been some malfunction or if new software has been installed. When the prompt appears, press the right select arrow. After the presets have been re-loaded, the system returns to the SETUP mode.

2.6 ALARMS

The SW AP05 System has a number of alarm functions. When an alarm occurs, the beeper sounds and an alarm message flashes on the display. To cancel an alarm, press the STANDBY or PILOT key. This keystroke silences the beeper and removes the flashing message, but does not change any settings. If no action is taken, the beeper goes silent after 10 sec (in most cases) but the alarm message remains. In many cases, the alarm condition is also removed. If the alarm message is cancelled, but the fault is still present, the alarm will appear again.

OFF COURSE The vessel has been more than 8 deg off course for 30 seconds. This only operates in the PILOT mode and while the alarm is active, all other functions operate normally. Cancel it by returning to course or pressing the STANDBY or PILOT key.

HELM ALERT In PILOT mode, the helm alert is a safety feature to ensure that the helm is attended. The interval between alerts can be set via the menu.

OVERLOAD The current drawn by the steering gear has exceeded the limits and the drive has been turned off. See Chap. 4 for further information.

STALL If the steering drive is activated and the helm moves less than 1 degree in 15 seconds, the system is switched to STANDBY and this alarm is set.

RUDDER	Either the rudder has travelled past the limits set during System Setup or an electrical fault has developed in the Rudder Transducer. The system switches to STANDBY.
COMPASS	If a fluxgate compass has been selected, the magnetic field being sensed by the compass is above or below preset limits. Further information is given in Chap. 4 and Appendix A
GYRO ERROR	If the Gyro function had been turned on, this indicates that its output signal is outside the preset limits. Note: when this alarm occurs, the gyro function is automatically switched off, though the autopilot will continue to function using the fluxgate compass. When the fault is cleared be sure to switch the gyro function back on.
HEADING DATA	If a digital heading input has been selected, a valid heading sentence is not being received.
NO DATA	This alarm is generated by the Controller to indicate that no data is being received from the Junction Box. This can indicate either a fault in the Controller cable or a failure within the Junction Box.

2.7 RECOMMENDED SETTINGS

As previously stated, internal settings are preset to their recommended values during the setup procedure. There may be cases where you wish to change these presets via the menu.

The Rudder Factor is set according to the responsiveness of the steering. Yachts and power boats from 6 to 15 m in length, generally have responsive steering and a rudder factor setting of 3 or 4 is suitable. For high speed planing hulls, a setting of 2 to 3 should give better control. Vessels above 15 m length normally have less responsive steering and a good rudder factor setting is in the range 5 to 7.
A rudder factor of 4 applies 0.5 degree of helm for each degree off course.

Autotrim is normally turned on.

The Rate Factor compensates for turning inertia in the vessel and its choice is affected by both the displacement of the vessel and its directional stability. If 10 degrees of helm is applied and the turn is established within 1 to 3 seconds, then a Rate Factor of 2 is suitable. If it takes 5 to 10 seconds to reach the full turn rate, then a setting of 4 or 5 is suitable. Setting the Rate Factor too high can produce excessive rudder activity and slow down the completion of a course change. Setting it too low produces over-shooting during course change.

CHAPTER 3 INSTALLATION

Before proceeding with the installation, check the contents of the shipment to ensure that all components ordered are present and undamaged. If a steering motor or hydraulic drive is included, check that its voltage rating is suitable for the vessel's supply. Read all of this chapter before starting and then follow this step-by-step guide:

1. Mount the Junction Box as described in Sect 3.1. Take care that the polarity of the battery wires is correct and that the metal parts of the terminal blocks grip the wires and not the insulation.

2. Mount the Controller as per Sect 3.2.

3. Mount the Compass as described in Sect 3.3. Take care to keep it away from the sources of magnetic interference.

4. Mount the Rudder Transducer as shown in Sect 3.4 Ensure that the linkage geometry is correct and if it is in a storage area, ensure that heavy objects will not fall on the linkage.

5. Install and connect any additional attachments as described in Sect 3.5. (Or, if preferred, these could be installed after initial commissioning.)

6. Install the steering drive as described in Sect 3.6

7. Apply power to the Junction Box. Now turn to Section 2.2 of this Manual - Getting Started - and carry out the initial setup.

3.1 JUNCTION BOX

The Junction Box should be mounted on a vertical surface with the cable entry holes facing downwards. It should be protected from the weather and be well above the bilge water level in the vessel. Do not mount it in the engine room or other high-temperature location. Two further considerations are that the connection sockets be easily accessible when the lid is removed and that there is a space of at least 50mm on all four sides to permit air circulation. (The outer case forms a heat sink for the internal power components). Fix the case using screws through the two mounting flanges. To open the case, remove the four screws holding the cover flanges to the base and lift the cover. Before commencing the wiring, isolate the vessel's power bus from the power supply. Note that all connections to the Junction Box, except for motor and power, are made to removable plugs. Fig. 3.1 shows the location of the sockets and principal components for the Junction Box, respectively.

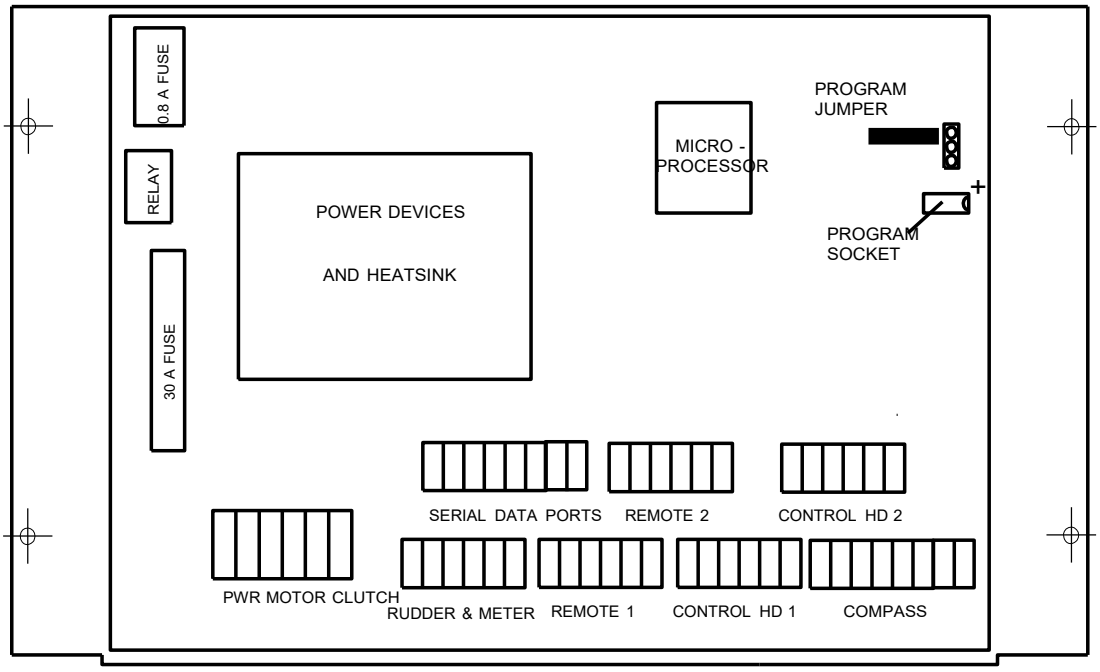


Figure 3.1 Layout of Junction Box components and connectors.

The quality of the power supply to the Junction Box is important for reliable operation. Large voltage spikes caused by switching other electrical gear on the vessel, or the supply voltage moving outside the specified limits can cause the system to reset. These problems are reduced by using heavy wiring and connecting the system to a point as close as practical to the main batteries.

Lay a 30 amp twin-core cable to the vessel's power bus, slipping a grommet over the cable where it enters the Junction Box and connecting the cable to the terminal block. It is also recommended that a 20 or 30 amp switch is installed between the Junction Box and the power bus so that the autopilot can be isolated during unattended periods.

3.2 CONTROLLER

The Controller is designed for mounting through a dashboard or bulkhead panel. Although the front of the controller is weather-proofed, it should not be mounted where it is exposed directly to rain or spray. We recommend that the clip-on weather cover be fitted when the system is not in use.

Cut a 55 mm dia hole in the panel and clamp in place as shown in Fig 3.2. Tighten the nuts sufficiently for a firm mounting, but not enough to distort the mounting clamp bracket.

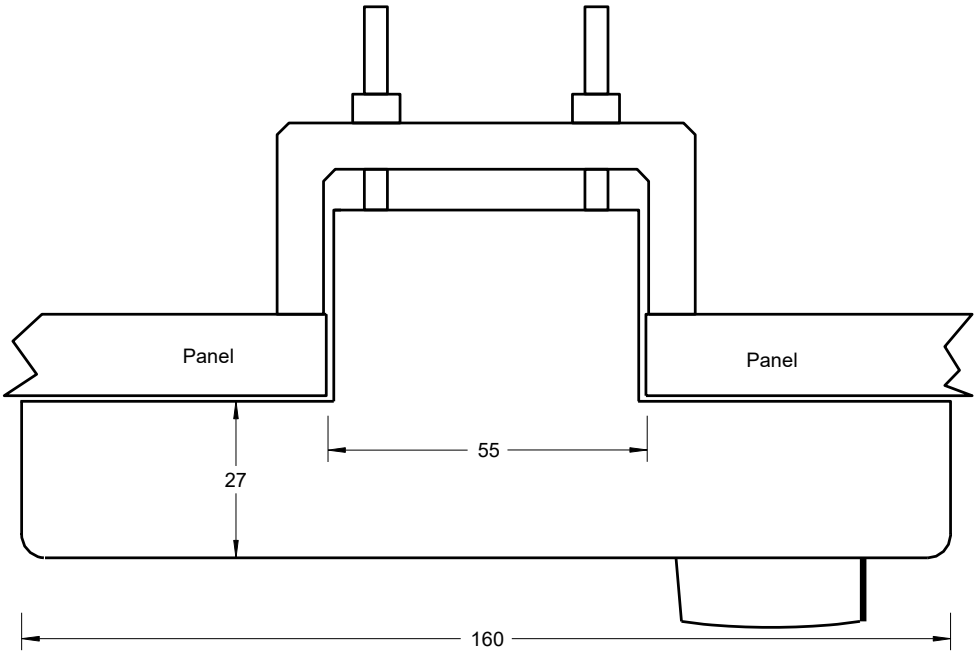


Figure 3.2 Panel mounting of the SW AP05 Control Head.

Lay the Controller cable back to the Junction Box, feed it through a grommet into the case and terminate the wires and cable screen in the Controller plug. Tighten each grub-screw firmly. If the cable is to be shortened, cut it at the end closest to the Junction Box, since the plug connection at the Controller end cannot be re-made. Allow enough spare cable length to accommodate a change in the component positions at some later date. After cutting, strip each wire before connecting it as shown in Fig 3.3. Check that the insulation is not caught in the terminal clamps and plug the cable into the socket at the rear of the Controller case.

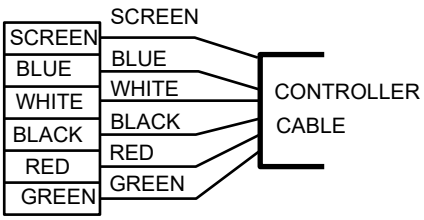


Figure 3.3 Controller cable connections.

To minimise the risk of radio interference, the Controller cable, like the others, must be kept well separated from antennas and antenna feeds. On some vessels this is difficult to do, but some extra effort to maintain separation will reduce problems in the future.

3.3 COMPASS

The performance of the compass affects the performance of the whole system and some care should be taken in locating it in the best position. If a compass slave, mounted on the glass face of the ship's flat top compass, is being used, performance is mainly dictated by the accuracy of the ship's compass. If a rate-gyro compass is being used, the following guidelines should be followed.

Ideally, the compass should be mounted at the roll centre of the vessel, at or slightly above the waterline. The unit may be damaged by long-term exposure to water and must be above the bilge level. It should be at least 1 metre away from the engine and from other objects with strong magnetic fields such as loudspeakers and wiring which carry large currents. In timber, fibreglass or aluminium hulls, these conditions should be easily met. But in steel hulls, some trial and error may be needed to find the best position. Generally, the compass will not perform well if totally enclosed in a steel structure. Further notes on mounting in a steel vessel are given below.

Mount the rate-gyro compass on a vertical surface with its mounting flange towards the bow and the cable entry facing down. (The compass will not operate correctly if mounted upside down.) Corrections for small errors in orientation can be made via the heading adjust menu option in the autopilot. Lay the cable back to the Junction Box, following the same method and precautions as for the controller cable and terminate it in the Compass socket as shown in Fig 3.4.

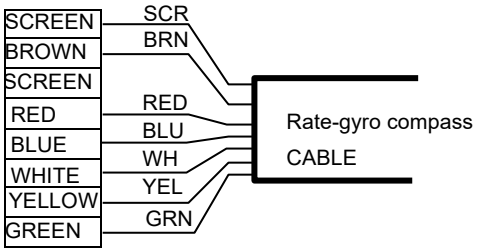


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Figure 3.4. Connections for the rate-gyro compass to the Junction Box.

The compass slave is connected to the compass socket as shown in Fig 3.5.

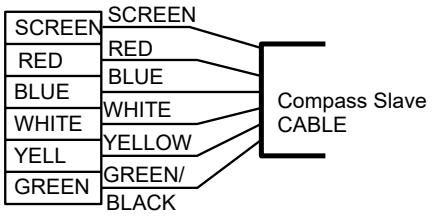


Figure 3.5. Socket connections for the compass slave or fluxgate.

Steel Vessels

Steel hulls distort the natural pattern of the earth's magnetic field. In many cases these deviations can be adjusted out through the calibration procedures. In others, a strong vertical field component may exist which will prevent the compass giving good performance. It is recommended that the compass be mounted temporarily so that the best site can be found by experimenting. The following notes should help find the best mounting:

1. In the first instance, try mounting the compass unit below decks but centrally within the vessel. Keep well clear of vertical steel bulkheads and position the compass at least 45 cm (18 in) above a steel floor.

2. As an initial check, complete the other steps in the installation and turn the autopilot onto STANDBY. (The rate gyro option must be turned off for this test.) Turn the vessel through a full circle, noting at 45 deg. intervals the difference between the heading displayed and a reference (eg ship's) compass.

Should the deviations exceed 20 deg. in any position, keep re-locating the compass until a position giving less than 20 deg. error is found. If errors still exceed 20 deg., the compass should be mounted above deck level, preferably in the dog house near a window. If this is done, repeat (2) above.

If no position is found giving less than 20 deg deviation, the services of a compass adjuster should be sought. The autopilot will not operate satisfactorily with compass deviations above 30 deg. A compass calibration (See Sec 2.5) is recommended after

the installation is complete. Appendix A1, at the rear of this manual contains further information which may be useful is optimising compass performance.

3.4 RUDDER TRANSDUCER

Mount the rudder transducer next to the rudder post. The transducer should normally have its arm uppermost, but may be inverted if this is more convenient. The linkage schematic is shown in Fig 3.6. When fitting it is important that the effective lengths of the transducer arm and the quadrant or tiller arm (marked D2) be equal to each other and that the link rod be the same length as the spacing between the transducer and rudder post (D1). This is to ensure that the transducer angle tracks the angle of the rudder. Mount the transducer so that its arm is over the cable entry point when the rudder is centred.

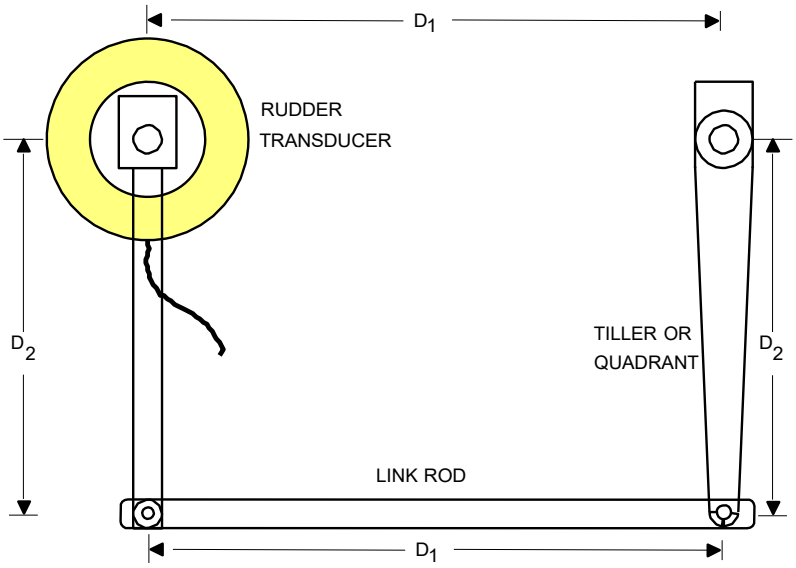


Figure 3.6 Rudder Transducer Linkage

Lay the cable back to the Junction Box and terminate it in the Rudder Transducer plug as shown in Fig 3.7.

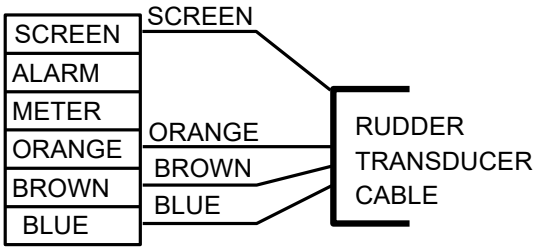


Figure 3.7. Rudder transducer connections.

When carrying out the setup procedure (Sec 2.2) at a later stage, it may be necessary to adjust the zero position of the transducer. To do this, loosen the clamp holding the transducer arm. Very slowly rotate the shaft with a screwdriver until the reading is correct. A small turn of the shaft makes a big difference to the centre.

3.5 ATTACHMENTS

3.5.1 REMOTE STEERING

The Junction Box has two Remote ports. There is no preference which attachment should be connected to which port. Most of the of remote steering options use a five-wire cable, which is connected as shown in Fig 3.8(a). The Jog lever uses a three-wire cable and is connected as in Fig 3.8(b). The standby/pilot switch is connected according to Fig 3.8(c) below.

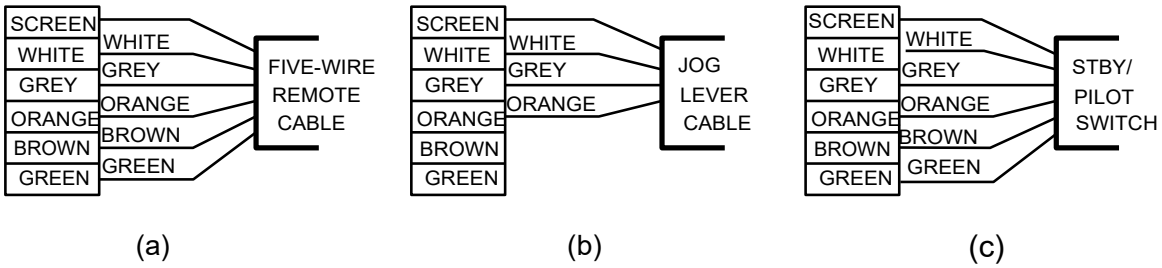


Figure 3.8. Remote attachment connections for (a) Five-wire Remotes, (b) Jog Lever and (c) STBY/PILOT switch.

Note that if a non-SW AP05 switch is used for the STBY/PILOT function, it is connected to grey, orange and green, but it is necessary to fit two 4.7Kohm resistors between orange and brown and between green and brown at the socket.

3.5.2 SECOND CONTROL HEAD

A second Control Head may be fitted to the Junction Box is used. There is a separate socket for the second unit.

3.5.3 RUDDER ANGLE INDICATOR

The Rudder Angle indicator is a two-wire meter which is connected between the METER and ORANGE terminals of the Rudder Transducer socket in the Junction Box. The polarity of the connection may be changed to obtain the correct direction of indication.

3.5.4 REMOTE ALARM

A piezoelectric beeper is available which repeats the internal alarm and key beeps of the Controller. This two-wire unit is connected between the ALARM (positive) and GREEN (negative) terminals of the Rudder Transducer socket. Any beeper may be used which is compatible with the drive available of 35mA (max) at 10.5V dc.

3.5.5 NMEA INTERFACES

The Junction Box has two NMEA input ports.

PORT A

Port A is used primarily for NMEA navigation data from a GPS receiver. Some navigation systems have an option for combining wind-vane data with the navigation sentences. If this is the case, wind-vane data will also be read by Port A.

PORT B

Port B is used for digital heading inputs (HDG, HDT or HDM). If an independent wind-vane system is used, the wind-vane sentence is supplied to Port B. The system cannot accept simultaneous digital heading and wind-vane data.

Data cables may not be connected in parallel to either port. Connections to the Junction Biox are shown in Fig 3.9.

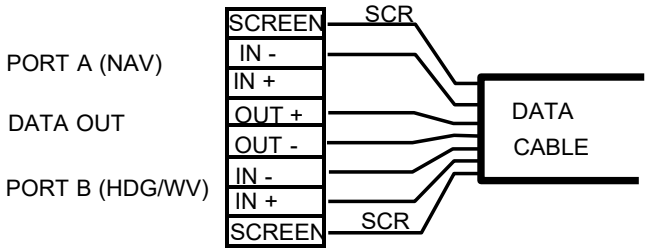


Figure 3.9 NMEA data connections to the Junction Box.

The correct polarities are such that when the external NMEA system is transmitting, the wire that goes positive is connected to the + terminal of the input pair. After the connection is made, complete the other parts of the installation before checking for correct reception, as follows:

Turn the system on and press the N key. The NAV symbol shows at the top of the screen - both in PILOT and STANDBY. If the symbol is flashing, this means that no valid NMEA data is being received. Wait for 15 sec. If it is still flashing, there may be some fault with the interface. Try reversing the input wires. Then check that the NMEA device has also been set up correctly and that a waypoint has been entered. If it is a GPS receiver, the message being sent will be read as invalid if the GPS has not acquired the required number of satellites or there is no destination waypoint. Details of the navigation sentences accepted by the system are in Chap 5. Note that, if two NMEA inputs are connected and both contain a navigation sentence, the data in these two sentences must be the same.

The NMEA output port sends an HDG or HDT or HDM sentence (as selected via the menu) containing the current heading.

3.6 STEERING DRIVE

Four options are covered in this section: electric motor drive to mechanical steering, coupling into a motor-drive hydraulic system, coupling into a solenoid-controlled hydraulic system and a hydraulic linear drive. For existing hydraulic systems using a helm pump, instructions are given below for adding a SW AP05/Hydrive pump motor. But for systems supplied by other manufacturers, installers should consult the data supplied by the manufacturer.

Through the wide variety of possible drive systems and the load placed on them, the goal is to move the rudder from 20 deg port to 20 deg stbd in not more than 15 sec. and not less than 8 sec. Steering systems which perform outside these limits may not give satisfactory autopilot operation.

3.6.1 CHAIN DRIVEN MECHANICAL STEERING

The drive sprocket on the steering motor matches 12.7mm (1/2 inch) British Standard simple chain. The size of the driven sprocket on the steering wheel is chosen to give the recommended helm response time for the length of the hull. The sprocket size is chosen from Table 3.1 or 3.2 below, depending on the voltage. If the sprocket is

mounted on an intermediate shaft in the steering system, the ‘wheel revolutions’ in the table apply to that shaft. Note that the tables are for a helm swing between 20 degree limits and are not the lock-to-lock ratings. The response times will vary according to the stiffness of the steering. The drive motor and chain linkage must be mounted in a dry area of the hull.

Table 3.1 Driven sprocket sizes for a 12V system.

Hull length	Up to 11 m	11 to 13 m	Above 13 m
Response time -20 to +20 deg	8 sec	10 sec	12 sec
Shaft revolutions for -20 to +20 deg	Driven Sprocket Size (teeth)		
1	48	60	80
2	25	30	38
3	20	25	25
4	13	15	20
5	13	13	15

Table 3.2. Driven sprocket sizes for a 24V system.

Hull length	Up to 11 m	11 to 13 m	Above 13 m
Response time -20 to +20 deg	8 sec	10 sec	12 sec
Shaft revolutions for -20 to +20 deg	Driven Sprocket Size (teeth)		
1	70	85	105
2	38	38	48
3	25	30	38
4	15	20	25
5	15	15	20

Mount the drive unit so that its shaft is parallel to the driven shaft and the two sprockets are in line. After fitting the chain and adjusting its tension, there should be 12mm of deflection for each metre length of chain. (1/2" for each 3 ft.) Lay the four-core motor/clutch cable back to the Junction Box and terminate it according to Fig 3.12. Note that the CLUTCH NEG terminal is internally connected to the negative power supply terminal.

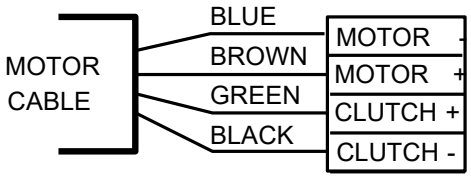


Figure 3.10. Connections to a mechanical steering drive motor.

3.6.2. SOLENOID CONTROLLED HYDRAULICS

The motor-drive output of the Junction Box is suitable for direct connection to flow-control solenoids, provided that their operating voltage is the same as the supply voltage to the SW AP05 system and the solenoid current does no exceed 10A. The connections to the Junction Box are shown in Fig 3.10.

IMPORTANT: The SW AP05 system provides for the selection of the drive control during the set-up process. The solenoid option should be selected for solenoid systems and the motor drive option for hydraulic drives which use a reversing pump. Before connecting the solenoids, make sure that their wiring does not have connections to ground or any other part of the vessel's wiring.

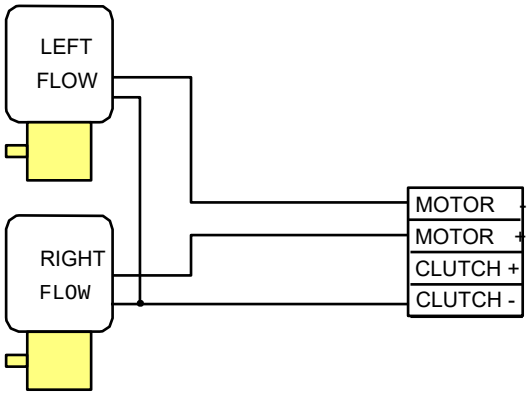


Figure 3.10 Connection to flow-control solenoids.

3.6.3 HYDRAULIC SYSTEM WITH REVERSING HYDRAULIC PUMP

Connecting autopilot pumps to hydraulic systems from different manufacturers is not difficult and the following guidelines will be adequate for most installations. If there is a doubt about the correct way to proceed, consult the manufacturer of the steering gear.

Two-Line Steering Systems

Two-line systems are by far the most common and are manufactured by many companies world-wide. The best known types include Flexatrol, Hydrive, Marol, Morse, Palm Beach, Seastar, Seipem, Servis, Tenfjord, Teleflex, Vetus, Wills Ridley and Wagner.

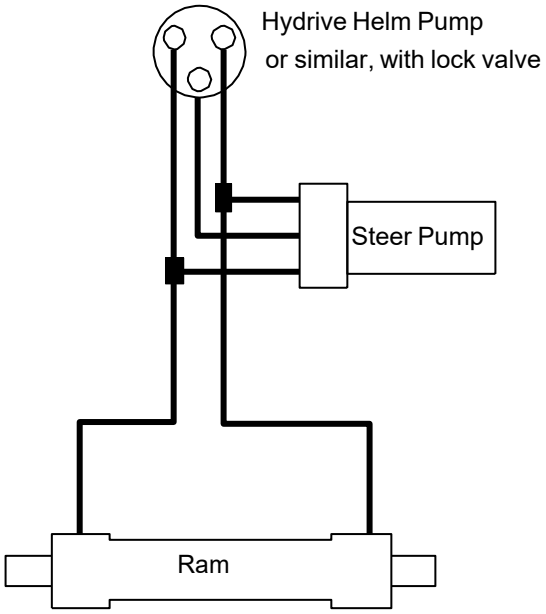


Figure 3.12 Connection to a typical two-line system

Some two-line systems are supplied with a lock valve as part of the helm pump and no additional lock valve needs to be purchased. But the lock valve is an option on, for example, Hydrive and Vetus system. It must be used on Syten outboard systems. If a lock valve is installed, it must be fitted as shown in Fig 3.12.

For information on other systems, including three-line and pressurised systems, please consult the manufacturer's data for those systems.

Installation Procedure

1. Install the pump according to the hydraulic connection instructions, mounting it close to the tubes connecting the helm pump and cylinder. The pump must be mounted with its rubber foot horizontal.

2. Connect the pump to the system tubing using hose and tubing which is rated for the steering system pressures as specified by the manufacturer. Short lengths of reinforced high pressure hose should be used to isolate mechanically the Octopus pump from the rigid tubes of the system, as this reduces noise and vibration. The bleed line should not be too narrow as the system may be difficult to purge and may cavitate. Avoid air traps by sloping the pipes upwards from the drive unit.

3. Make sure that there is no foreign matter, such as swarf, in the lines as this may foul the valves and pump. Similarly, thread sealant should be carefully applied well back from the end of the thread.

   Teflon tape should not be used.

4. Secure the pipes where necessary to avoid 'pipe whip', since sustained mechanical vibration in the pipes can cause hardening and cracking of the copper.

5. Never install a drive unit without the third (balance) pipe, since the internal pressure build-up could destroy the seals in the pump.

6. Using 20 amp cable, connect the two pump wires to the Motor terminals in the Junction Box (see Figs 3.1 or 3.2), noting that no connection is made to the clutch drive in this type of installation. The polarity of the connection is not important.

7. Fill both the steering system and the pump completely with hydraulic fluid and bleed the hand steering components according to the instructions supplied by the manufacturer.

8. After this bleeding operation, leave the reservoir in the helm open and keep it topped up with fluid. Open the bleeder nipple(s) in the slave cylinder. Run

the drive pump in one direction by temporarily removing the drive wires and connecting them directly to the battery. Allow the motor to run for 2 or 3 minutes to purge air through cylinder lines and help to clear the balance line of air. Under no circumstances allow the oil level to drop in the manual hydraulic helm units - this level must be maintained at all times during the bleeding of the pilot unit.

9. When step 8 has been successful, run the motor in the opposite direction so that both sides of the system are purged. Keep the helm pump reservoir topped up during this operation.

10. When both sides of the autopilot pump system have been bled, repeat the bleed of the drive unit once again, top up the reservoirs, close them and close the bleed nipples. Re-connect the pump wires to the Junction Box. The system is now ready for the setup procedure.

Pump Output Adjustment

Some pumps (eg Octopus) have a flow rate adjustment which can be altered to obtain the correct rudder response time. Check the Specifications chapter of this manual (page 5-2) for the right value for your vessel. To adjust the flow rate, loosen the two screws located on the pump body sufficiently to allow it to be rotated. (If they are loosened too far, oil will be lost.) Rotate the pump body clockwise to decrease the flow or anticlockwise to increase it.

Pump Maintenance

Reversing pumps have a minimum of moving parts and should give hundreds of hours of service without requiring attention. If it fails to run, check first that it is receiving the correct drive voltage from the Junction Box. Next, ensure that the pump shaft is not jammed. If it turns freely and still fails to run, check the motor brush gear.

If the pump runs but does not pump oil, make sure that the system is purged. If that does not succeed, contact your Seiwa dealer.

3.6.4 HYDRAULIC LINEAR DRIVE

Take care, when handling the ram, that the piston rod is not scratched during installation. It is vital that the cylinder is installed with the correct geometry. The final position of the mounting bracket is ascertained with the piston rod at the middle of its stroke. (Use a ruler to set this position.) With the rudder dead centre and the piston rod at right angles to the quadrant, mark the position of the bracket and fix it using four stainless steel bolts with locknuts or lock-washers.

The recommended distances from the attachment pin to the centre of the rudder-stock are given in Table 3.3.

Table 3.3 Hydraulic Ram Mounting

Stroke (mm)	Distance to rudder stock (mm).
200	175 - 200
250	200 - 250
300	225 - 300
380	300 - 380

1. Mount the hydraulic pump close to the cylinder on a horizontal surface and in a dry area of the hull. Remove the plastic reservoir cap and replace it with the vented aluminium cap.

2 Ensure that the rudder stops are installed to prevent the cylinder hitting the end of its travel.

3. There are 4 wires on the pump: two for the motor and two for the solenoid bypass valve. When not in PILOT, the bypass valve permits oil to bypass the pump and flow back to the cylinder. Connect the orange and black motor wires to the motor terminals in the Junction Box, using at least 20 amp cable. Connect the two red solenoid wires to the clutch terminals in the Junction Box. (Lighter cable may be used.) Polarity is not important.

4. The cylinder has been bled before shipping. Check the oil level in the pump and, if necessary, top up with automatic transmission fluid.

5. Go to Step 8 in the step-by-step guide at the beginning of the chapter and complete the steps.

6. The hydraulic pump has a flow-rate adjustment which should be set to give the correct rudder response time. Check page 5-2 of this manual for the correct time and adjust if necessary. To adjust, loosen the two screws on the pump body just enough to allow it to be rotated. Rotate the body clockwise to decrease the flow or anticlockwise to increase it.

7. Bleeding. If it becomes necessary to re-bleed the system, carry out the following:

   (a) Fill the reservoir with automatic transmission fluid.
   (b) Locate the two brass bypass screws, one on each side of the solenoid and loosen both 3 - 4 turns.
   (c) Disconnect the red solenoid wires from the autopilot and apply power directly to the solenoid.
   (d) Move the piston through its full stroke, one way, then the other. Any air in the system will bubble into the reservoir. Refill the cylinder and repeat until all air has been purged from the system.
   (e) Re-tighten the bypass screws and reconnect the red solenoid wires.

Maintenance

Check the oil level in the pump at regular intervals. Grease the mounting bracket every 3 months using waterproof grease.

CHAPTER 4 TROUBLE-SHOOTING

4.1 GENERAL

If no error messages are showing, but the performance of the autopilot is unsatisfactory, experience suggests looking initially at four factors.

- The compass heading should be steady. Small deviations in the heading will not cause performance problems, but random changes in heading of more than a degree or two indicate a defect in the compass performance.
- If a rate gyro is fitted and selected, two faults can indicate a defect in the gyro or its cable: either the heading displayed lags well behind the actual heading or it starts increasing or decreasing steadily when the actual heading is constant.
- If the rudder transducer is not centred correctly or its linkage is faulty, poor steering will result.
- Free-play or backlash in the steering drive will also cause steering problems.

4.2 ERROR MESSAGES

The SW AP05 system is programmed to provide a number of messages on its display when a fault occurs. Some of these are warnings arising out of the way the autopilot is being used. Others mean that a real problem has developed. A full list appears in Sec

2-6. Listed below are those messages for which a more detailed explanation is called for. By using this as an aid, many problems can be fixed simply by the owner. If the assistance of a Seiwa dealer is required, quoting the error message will expedite repairs.

COMPASS FAULT

If a fluxgate is being used, the heading signals from the fluxgate are above or below the preset limits. The fault must last more than 12 seconds before this alarm becomes active. This prevents a false alarm from being triggered, for example by the fields in a rolling steel vessel. If the system was in PILOT, it remains there with the alarm sounding. The alarm can only be cleared if the fault is corrected.

Causes.

If the error comes up on all headings and cannot be cancelled, the possible causes are a defective connection or cable to the fluxgate, a fault in the compass electronics in the Junction Box, or a defective fluxgate unit. If the message comes up only on some headings, the probable cause is the magnetic environment of the compass - either an excessive horizontal field or vertical field due to local magnetic material. In this case, consult the guidelines in Chap 3.

GYRO ERROR

The voltage on the single gyro output wire (brown) is outside preset limits. The most likely cause for this fault is a broken connection in this line between the compass and the socket in the Junction Box. It can also happen if the compass is not mounted and is twisted quickly by hand. The error message will also be generated if a plain (non-gyro) fluxgate or compass slave is fitted, but the gyro function is turned on.

The response of the system to this error is to turn off (automatically) the gyro function. This means that the autopilot can continue to be used with a plain fluxgate heading input. Note: when the fault is cleared please go into the ‘Heading’ group in the menu and turn on the gyro function.

NO HEADING DATA

This alarm appears if a digital heading has been selected and no matching sentence is being received. Check that the selected sentence matches the sentence being sent from the digital heading source. There may be a delay in synchronising to the source, so wait 15 seconds and press Standby to cancel the alarm. Try reversing the polarity of the data input wires.

DRIVE OVERLOAD

The system is in PILOT or one of the power steer modes and the motor drive current has exceeded 30A for 1 second. The response to a drive short-circuit is immediate. The system is forced into STANDBY and the message can only be cleared by pressing the STANDBY key after the over-current condition is removed.

Causes.

The fault can occur if the mechanical drive or hydraulic pump motor has stalled or jammed. Otherwise, look for a short-circuit in the drive-motor wiring. The fault can also indicate damage to the vessel's steering gear.

RUDDER FAULT

The rudder transducer output is above or below the allowed range. This alarm forces the system into STANDBY and may only be cancelled by pressing the STANDBY key after the condition has been removed.

Causes.

This alarm comes up if the rudder angle exceeds the limits which were set during the System Setup operation. If this has not occurred, the causes are probably in the rudder transducer cable, connections, mechanical linkage or in the transducer itself. Conditions which can cause the alarm to appear are if the transducer is off-centre by more than 10 deg. or the autopilot rudder limit has been set beyond the mechanical limit.

4.3 OTHER FAULTS

The Junction Boxes contain over-voltage protection circuits. If there are large voltage spikes on the power supply, the system may shut down and re-start without an error message appearing. If this happens frequently, consult your dealer about measures to filter the supply.

If the system will not switch on, check the main fuse and second fuse, if fitted. Using a voltmeter, check that the correct voltage is applied to the two power terminals and that the polarity is not reversed. A voltage of about 6V should also appear on the blue Controller lead when the system is off. If these conditions are correct, disconnect all cables except the power and Controller and try to switch on. If the self-test message

now appears, the fault is in one of the attachments. If these tests do not reveal the problem, a service call may be required.

The steering drive transistors are electronically protected, but can be damaged by extreme stress. The common symptom is that the steering will drive one way and not the other. Other types of damage can cause the main fuse to blow when the system is switched from STANDBY to PILOT. In such cases, the Junction Box should be returned to your dealer or to Seiwa for repair.

4.4 FUSES

The system has two fuses. The main 30A fuse protects the complete system, while a 0.8A miniature fuse (See Fig 3.1) protects the control electronics against supply surges.

CHAPTER 5 SYSTEM SPECIFICATIONS

AUTOPILOT

Supply Voltage Range (nominal)	12 to 26V dc
Maximum Supply Voltage Range	10 to 32V dc
Supply Current	
Basic system in STANDBY	0.33A
Add for Controller 2	0.15A
In Pilot with 20% duty	2.5A
Compass	Fluxgate in damped suspension
Typical deviation	2.5 deg rms.
Rudder Transducer	Potentiometer type
Rudder position accuracy	1 deg.
Max rudder angle	+/- 60 deg.
Clutch drive	1V below the supply voltage at 1A.

Steering Drive

Output for 12V supply	10V at rated load
Output for 24V supply	22V at rated load
Max continuous current	22 A
Max current for 15 sec.	30A
Max current for 0.5 sec	50A

Mechanical drive steering motor	Printed rotor with gearbox and electromechanical clutch
Torque	12V unit: 120kg-cm at 30 rpm/5A. 24V unit: 150kg-cm at 40 rpm/7.5A.
Hydraulic drive systems	See manufacturers' specs.

Recommended response times:

Hull length up to 11 m	8 sec. for -20 to +20 deg swing.
Hull length 11 to 13 m	10 sec. for -20 to +20 deg swing.
Hull length above 13 m	12 sec. for -20 to +20 deg swing.

NAVIGATION INTERFACE

NMEA PORTS

Data format and sentences to comply with NMEA0183 V3.00

Serial data format:

Baud Rate	4800
Character format:	start bit, 8 data bits, LSB first MSB (bit 7) = 0, no parity bit, 1 or 2 stop bits
Polarity	
Idle, stop bit,logic'1'	Line A < 0.5V above line B.
Start bit, logic '0'	Line A > 4V above Line B.

INPUT PORT(S)	Isolated via optocoupler

Input resistance	1000 ohm min.
OUTPUT PORT	Non-isolated differential output
Output voltage	18 V p-p (typical)
Source resistance	1500 ohm max

AUTOMATIC SENTENCE SELECTION
For navigation inputs applied to Port A, the system looks for groups of sentences in this order:

RMB
APB
APA
BOD and XTE

The search stops when the first sentence in the list is found. If it reaches BOD/XTE, and only one of these is present, the autopilot operates from the data in that sentence.

For wind vane inputs, with data applied either to Port A or Port B, not both, the system looks for sentences in this order:

MWV
VWR

Note that the MWV sentence must contain the symbol R following the wind angle field.

If wind-vane is selected and a valid wind sentence is received, reception of navigation sentences is suspended.

For a digital heading input, the system looks either for the HDG, HDT or HDM sentence, depending on which one is selected in the Menu. Variation and deviation fields are not read.

OUTPUT DATA

The system outputs heading data in either the IIHDG sentence (without deviation or variation data) or as IIHDT, using the magnetic variation set within the autopilot, or HDM (magnetic heading only). The repetition rate is a minimum of 8 per second.

CHAPTER 6 MAINTENANCE AND WARRANTY

6.1 MAINTENANCE

The only parts of the SW AP05 requiring maintenance are the mechanical components of the steering gear. Please refer to the hydraulic steering system manual for maintenance instructions.

6.2 INSTALLATION OF NEW SOFTWARE

Unlike earlier autopilot models, where the operating software was contained in a plug-in memory chip (EPROM), the software for the SW AP05 is stored in the microcomputer itself. If it is necessary to upgrade the software, this can be done in the factory or the field. In the latter case, a qualified technician can do it. But an owner with some experience in handling small electronic components could also carry out the upgrade.

REMEMBER that if things go wrong, they can always be recovered by returning the unit to Seiwa support.

The upgrade is carried out, first, by receiving a small chip from your dealer containing the new software. This is then plugged into the Junction Box and a program called Boot Loader, which is stored in the microcomputer, is started up. This program then erases the

previous software version from the microcomputer and then copies the software from the new chip into the microcomputer.

The software used in the SW AP05 has a code name such as CM9450V101. An abbreviated version of this is printed on the label of the new software chip, eg

450
101

The steps to follow are:

1. Turn off the autopilot and remove the cover from the Junction Box. Refer to Fig 3.1, which shows the layout of principal components on the board.
2. If the Junction Box is mounted vertically, with the cable plugs at the bottom, the location of the upgrade area is at the upper right edge of the board, where there is a blue jumper clip and an empty 8-pin dual in-line socket. If the board is horizontal, view it with the plug strip furthest away from you and the upgrade are is at the near left-hand edge. Move the blue jumper clip so that it joins the middle of the three pins with the pin closest to the socket.
3. Remove the 8-pin memory chip from its carrier. Pin 1 on the chip is at the end not covered by the white label. Pin 1 on the socket is adjacent to the + with a circle around it. Insert the chip carefully (without bending a pin) and fully into the socket.
4. Turn on the autopilot. The screen should be blank except for the

   BOOT LOADER

   Message at the bottom of the screen. If this does not happen and the pilot appears to start normally, turn it off and jiggle the jumper clip to ensure that it has made proper contact.
5. After 5 seconds the message

   SURE Y N

   Appears. Press the right select arrow to choose Yes.

6. The next message is:

   EEPR Y N

   This verifies that the chip you have plugged in is an electrically erasable memory chip (flash memory). Select Yes.

7. The next screen display will appear as:

   101

   9450 Y N

   This signifies that the software is of the right family (9450) and is version 1.01. Again, choose Yes.

8. The system now goes through two automatic cycles. The first erases the previous program and the ERASE with a counter that reaches a certain value before it triggers the second cycle, in which the new program is loaded. This is marked by the ADDRESS message appears with another counter. When complete the autopilot starts in the self test and set-up mode.
9. At this point, we recommend turning the pilot off, moving the blue jumper back to its original position and, with a fine screwdriver blade, easing the memory chip out of its socket and returning it to its carrier. The SW AP05 can now be started and set up.

6.3. WARRANTY

AvMap Srl warrants every unit to be free from defects in material and workmanship under normal use and service for a period of 24 months from original retail purchase.
During the warranty period, **AvMap Srl** will repair or replace any component which fails in normal use without charges for parts or labour. Technological developments, modifications and upgrades of software are not covered by warranty.

To receive warranty service, contact your local authorized dealer for shipping instructions. The device should be securely packed with its tracking code clearly written on the outside of the package, shipping to be paid by the customer. Include a copy of the original sales receipt as the proof of purchase. This limited warranty does not extend to any device which has been subjected to misuse, neglect, accident, incorrect wiring or improper installation. **AvMap Srl** reserves the right to repair or replace the device at its sole discretion.

For more warranty information please see the web site: **www.seiwadirect.com**

For technical advice or assistance in Europe contact:

AvMap Srl
Viale Zaccagna 6 54033 Carrara (MS) Italy
support@seiwadirect.com
Customer support: +39 0585 784044

APPENDIX 1 MONITORS

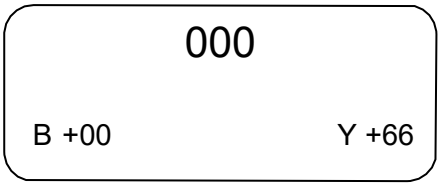
A1 MONITORS

The SW AP05 includes some menu options that display some internal settings which are not part of the standard set of adjustable parameters. These are intended for use by a technician or technically-minded owner. These readings may also be reported to Seiwa to assist in diagnosing problems.

A1.1 COMPASS MONITOR

The blue and yellow wires from the fluxgate compass sensor carry voltages proportional to the sine and cosine of the magnetic heading. The compass monitor option, which is selected from the 'Other' menu page, shows the heading and the values of the blue and yellow voltages relative to a mid-point reference voltage. Observing these voltages will assist the diagnosis of permanent magnetic and soft magnetic interference as well as the measurement of the field strength where the compass is located.

On the cardinal points, the four displays are, typically:



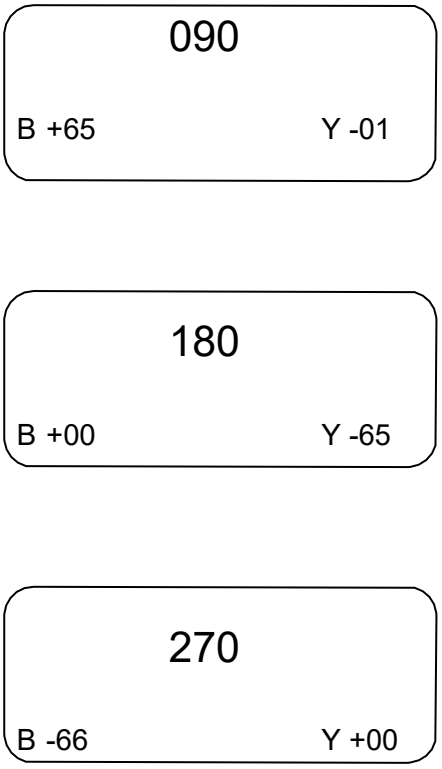


Fig A1.1 Typical compass voltage measurements at the four cardinal points.

Assessment of field strength.

The recommended range of peak voltage outputs is +/- 40 to +/- 80. The compass will continue to function outside this range, but with reduced accuracy and a compass fault alarm may be generated on certain headings. Low fields are encountered at high latitudes, say, above 50 deg or if there is a magnetic shielding effect where the compass is mounted.

High fields are encountered near the equator and, if a high-gain fluxgate is used in that region, outputs may exceed the recommended limits.

Soft magnetic deviations.

Soft deviations are caused by a mass of magnetic material (which is not permanently magnetised) being located near the compass. If the axis of the material lies parallel to the keel, the magnetic field is enhanced when the vessel points north or south. The result is that the magnitude of the peak yellow readings is greater than the magnitude of the peak blue readings, when the vessel faces east or west. If the axis of the material lies at right-

angles to the keel, the converse happens, ie the blue readings are greater than the peak yellow readings.

The effect of the soft magnetic material is generally to introduce the greatest deviations at the inter-cardinal points (45 deg etc). On the other hand, magnetic material with an axis at 45 deg to the keel will produce only small deviations.

Hard (permanent) magnetic deviations.

The presence of permanently magnetised material has the effect of adding to or subtracting from the earth's field. (A similar effect occurs if there are unbalanced current conductors.) If the axis of the material is parallel to the keel, there will be a difference in the peak yellow readings when the vessel points north, compared with pointing south. A similar thing happens to the blue readings if the mass is oriented at right angles to the keel.

Summary

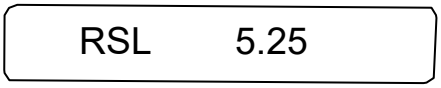
The presence of iron or steel typically sets up a mixture of soft and hard variations. The guidelines above may therefore be difficult to interpret. Thus, the best way to use the compass monitor is to assess the quality of the existing compass location and, if it is not satisfactory, to use the above observations to find a better location for the compass.

A1.2 TUNE MONITOR

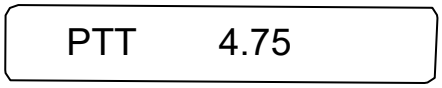
When the tune monitor is selected from the menu five displays can be selected in turn, using the left and right arrow keys. The first of these is dynamic, in that it is continuously updated as the vessel moves. The other four are static and are stored in memory during the set-up zig-zag tuning operation. The static measurements are used by the control computer to determine the best tuning for the autopilot.

The first (dynamic) display shows three data items: the 'H' indicates that the pilot is holding to a fixed heading. If the vessel is turning, a 'T' is shown. The next item shows the rudder factor – 4 in this example. The third is the rudder activity, that is, fraction of time for which the steering motor is active. In the example, the steering is active, on average, for 3% of the time.

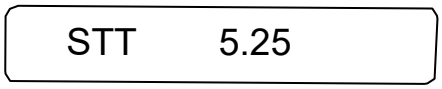
The second display gives the rudder slew rate, ie the time taken, in seconds, for the rudder to slew through 20 degrees.



The third display gives a measure of the turning effectiveness of the rudder. It shows the time in seconds for the heading to turn through 20 degrees when 10 degrees of port helm is applied.



The fourth display gives the corresponding measure for 10 degrees of starboard helm.



The final display, which measures the turning inertia of the vessel, shows the time, in seconds, for the heading to swing through 20 degrees as thee helm is switched from 10 deg. starboard to 10 deg port.