



AP60 Autopilot

(Using the C-Drive Motor Control Unit)



OPERATION AND INSTALLATION MANUAL

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Warning!

Automatic pilots are designed to be a navigational aid. As an automatic steering aid, an autopilot can alleviate the boredom of hand steering. This allows the operator of the vessel time to attend to other duties, keep a more accurate check of navigation duties or just relax and enjoy the trip.

HOWEVER, THE AUTOPILOT SHOULD NOT BE LEFT SOLELY IN CHARGE OF THE VESSEL AND AN ADEQUATE WATCH SHOULD BE MAINTAINED AT ALL TIMES.

THE AUTOPILOT SHOULD NOT BE USED WHILE NAVIGATING IN RESTRICTED WATERWAYS AS WATER CURRENTS, WIND CHANGES OR RADIO TRANSMITTER INTERFERENCE CAN ENDANGER YOUR OWN OR OTHER VESSELS.

Introduction

Congratulations on your wise choice and purchase of the TMQ AP60 autopilot system. We are sure that you will enjoy the benefits that it offers.

The AP60 autopilot system provides steering control from one main control panel and/or additional remote units.

AP60 Autopilot System

The minimum AP60 autopilot system must comprise the following units: -

Essential Electronics:

- AP60 Display head.
- C-Drive motor control unit
- Rudder feedback unit.
- Fluxgate compass
- Drive unit, for example:
 - Hydraulic system with solenoid valves.
 - Reversing hydraulic pump system.
 - Mechanical motor drive system.



Definition of Terms

AP60 Display:

The operation unit with LCD display and pushbutton controls.

C-Drive Assembly:

The Electric Steering control unit; this houses the main processor and steering circuitry.

Rudder Feedback Unit (RFU):

This provides the required rudder position information for steering control.

- Rudder Feedback Unit Standard (RFUS)
- Rudder Feedback Unit Heavy Duty (RFUH)

Remotes:

Remote units provide additional steering input for the AP60 unit; remotes include:

- Electric steering wheel
- Electric steering lever
- Steering lever, FFU or NFU
- Hand remote and or panel remotes

Steering Levers:

• Full Follow Up (FFU); this is a device that provides a proportional control input.

-
- Non Follow Up (NFU); this type of device does not provide a proportional control.

Rudder Angle Indicator (RAI);

Displays the current rudder position.

Heading:

The magnetic heading of the vessel at the current time.

Course-to-steer:

The magnetic heading which the autopilot is attempting to steer.

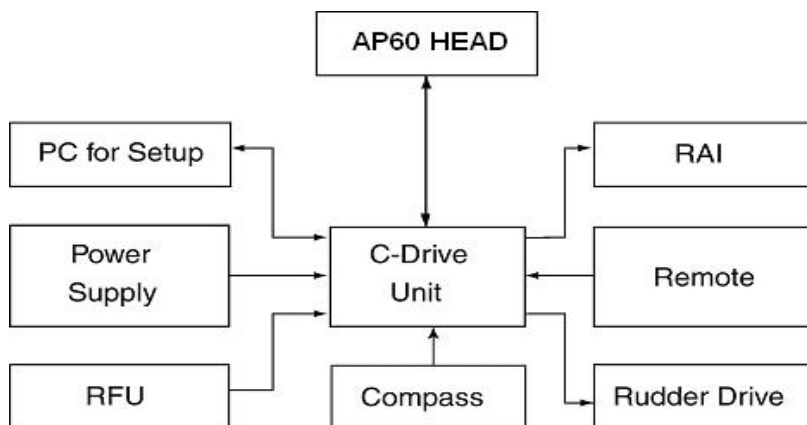
Display Unit:

The unit with LCD digital display and keypad used to send commands to the C-Drive assembly.

Remote Unit:

This is a collective term for a “panel remote”, “hand remote”, “steering lever” or “steering wheel” station. Each of these function in a similar way, but differ in appearance.

Block Diagram of Full System



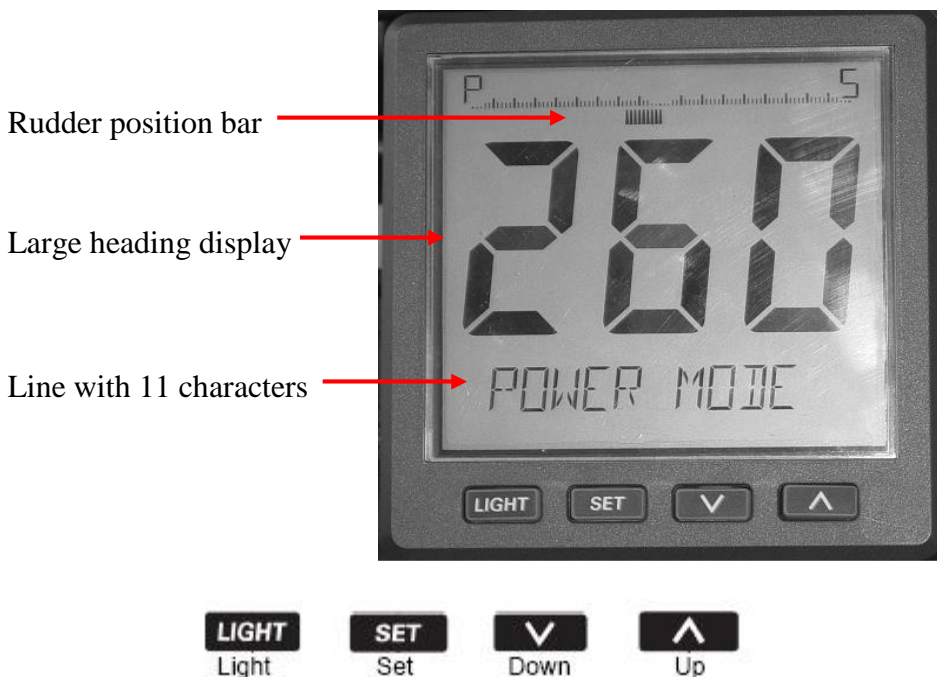
The AP60 display utilises the C-Drive assembly and provides full control of the autopilot, indicating in different modes heading, course to steer and rudder angle.

The C-Drive assembly is housed in a rugged black aluminium case, which should be installed inside a dry locker or other protected position. Mounting position should be free of moisture and vibration. It requires a supply voltage of 12 or 24 volts DC.

The Rudder Feedback Unit (RFU) must be attached to the steering tiller device in such a way that it can accurately measure the movement of the ship's rudder (see Rudder Feedback Installation diagram). The RFU must also be electrically connected to the C-Drive unit.

The compass (fluxgate) is mounted in a position free from magnetic interference. The coil of the compass is gimballed so that it may detect azimuth movement within the Earth's magnetic field (eg: vessel heading change)

Overview of Operation and Features



The unit has four control buttons. These buttons have the following functions:

- **LIGHT**: press the light button to change the backlight intensity.

If any external dimmer is connected to the AP60 display this button will be disabled.

The backlight is used for night vision; it cannot be seen in daylight.

- **SET**: press the set button one or more times to access the MODE menu, accept a mode, or change between the options in SETTINGS Mode.

- **DOWN**: when in a menu it works as a button to decrease values or settings, when in AUTO Mode it decrease the desired course-to-steer, when in POWER Mode it steer to Port.

- **UP** : when in a menu it works as a button to increase values or settings; when in AUTO Mode it increases the desired course-to-steer, when in POWER Mode it steers to Starboard

The function of a button is activated when the button is pressed; both up and down buttons have an automatic repeat function. On the press of a button you will hear a sound.

Operation of Display Unit buttons or mode selection on a remote unit will select one of the possible steering modes in the C-Drive unit. It is the C-Drive assembly, which generates signals to the steering motor (whether mechanical, hydraulic, or other type).

The following is a brief list of the capabilities of the autopilot. Each is described in more detail in a separate chapter.

- **MANUAL / STANDBY Mode: “MANUAL MODE”**

The autopilot Display Unit shows the current magnetic heading. The vessel is under **manual** steering control; **the autopilot will not apply any steering corrections.**

- **AUTO Mode: “AUTO MODE”**

The autopilot will maintain your vessel on any desired magnetic course. This course can be set from the Display Unit.

- **GPS Mode: “GPS MODE”**

When receiving information from a GPS unit, the autopilot can steer a vessel to a precise latitude and longitude, or through a sequence of latitudes and longitudes called waypoints.

- **REMOTE AUTO Mode: “REMOTE AUTO”**

With a hand remote, panel remote, steering lever or steering wheel station installed, this will allow steering by compass with the desired course adjustable from the remote station.

- **REMOTE POWER STEER Mode: “REMOTEPower”**

With a hand remote, panel remote, steering lever or steering wheel station installed, this will allow control of rudder position from the remote station.

- **SETTINGS Mode:**

All the autopilot’s settings and configurations can be set in this mode. Some of the configurations will be available just in MANUAL/STANDBY Mode.

- **Selectable and Dimmable Backlighting:**

When using the autopilot at night, the backlighting can be adjusted pressing the LIGHT button, or using an external dimmer.

External Dimmer:

The backlight input is an autosense input which means that the applied voltage is relative to the battery voltage. If the battery voltage is 12V the max. backlight is setting is on when the applied voltage to pin 2 is 12V. If the battery voltage is 24V and the applied voltage to pin 2 is 12V the brightness will be dimmed.

IF ANY EXTERNAL DIMMER IS CONNECTED TO THE AP60 UNIT THE LIGHT BUTTON WILL BE DISABLED.

THE BACKLIGHT CANNOT BE SEEN DURING THE DAYLIGHT.

Turning the unit ON / OFF

The power to the C-Drive motor control unit should be via a suitable circuit breaker. Turning this on will provide power for the C-Drive unit and the AP60 Display Head.

If the display is disconnected when the C-Drive unit is in AUTO, POWER or GPS mode, the C-Drive unit will return to MANUAL mode after 10 seconds.

Initial Settings

Selecting the Initial settings of the Autopilot:

A number of system settings may need to be carried out prior to using the AP60 Autopilot. Two initial settings can be carried out from the Display Head.

- Rudder Limits.
- Compass Calibration.

Please refer to the specific chapters for more information.

MANUAL / STANDBY Mode

In this mode:

- The display screen shows “MANUAL MODE”, the word COMPASS and the current vessel magnetic heading in degrees.

- The drive unit clutch is disengaged,
- No steering control is generated.

Possible alarms

- No C-Drive alarm “NO DATA

AUTO Mode

IMPORTANT!!

Before entering AUTO mode, ensure that rudder is in the centre position (ie: the vessel is steering straight ahead). If you do not do this, the course steered will be differ from that displayed.

Engaging AUTO Mode:

- Press the SET button, select “-SET AUTO--” option (pressing UP or DOWN buttons) and press SET again. AUTO mode will be selected. A beep will sound, the text display will change to “AUTO MODE” and the word NAVIGATOR will be shown.

The autopilot will lock on the current heading and the course-to-steer is shown on the display.

Disengaging AUTO Mode:

Press the SET button twice, a beep will sound, the vessel will return to manual steering.

Course Adjustment:

Each press of the UP or DOWN buttons will cause a one degree course change in the applicable direction. The display will change to indicate the new course-to-steer. By pressing and holding the buttons pressed will cause the change to be at 10 degrees per second for larger turns.

The AP60 Autopilot will select the position of the rudder when AUTO is selected as the position of the rudder which causes the vessel to steer straight ahead. This can be an advantage in most vessels when a slight amount of helm from the physical centre position is required for the vessel to go straight

Possible alarms

- No C-Drive alarm “NO DATA”
- Off-course alarm ”OFF COURSE”

GPS Mode

For use when interfaced to a GPS or plotting system generating NMEA 0183 data output in the correct sentence format. GPS mode allows the autopilot to be directed by the GPS, enabling automatic heading changes and eliminating the effects of wind and tide.

The digital display indicates the **course-to-steer**, which will be the bearing between the origin and destination waypoints, plus a factor to correct for the current **cross track error (XTE)**.

Engaging GPS Mode:

Press the SET button, select "--SET GPS--" option (pressing UP or DOWN buttons) and press SET again. GPS mode will be selected. A beep will sound, the text display will change to "GPS MODE" and the word GPS will be shown.

The autopilot will lock on to course to steer as requested by the GPS.

The course-to-steer is shown on the display.

The vessel will begin turning from its heading to that requested by the GPS unit, at a maximum rate of 10 degrees per second.

If no GPS data is received by the AP60, the autopilot will lock onto the course of the vessel at the time that GPS Mode was engaged, and the "NO GPS DATA" alarm will function.

Disengaging GPS Mode:

Pressing the SET button twice will return the AP60 to MANUAL MODE.

Setting up your GPS unit:

Because there are a great variety of GPS units that will work with this autopilot, the following is a guide only. For more information, consult your GPS manual.

The GPS unit must be set up to output “NMEA 0183” data on a pair of wires, which are connected to the NMEA socket on the AP60 C-Drive unit. The data generated must include at least one of the following:

- (i) The APA sentence.
- (ii) The APB sentence.
- (iii) The BOD and XTE sentences. If only the XTE data sentence is available, the pilot can steer in a restricted manner only. (See later in this section.)

The GPS unit must be programmed and activated to navigate to a waypoint, or to follow a line joining two or more waypoints (called a route). This unit should then send information to the autopilot from which can be calculated the course-to-steer.

Under the following conditions:

- Several waypoints are linked together into a single route
- The GPS unit is set and capable of “auto-sequence” between them
- An “arrival zone” of more than 0.05 NM (Nautical Miles) is set so that the GPS can detect when the vessel has reached a waypoint.

Then the AP60 will be able to steer from each waypoint to the next without intervention.

If only the XTE information is available from your GPS unit then your vessel must be on track, and heading in the correct direction, before engaging the GPS unit. The “auto sequence” feature is not available in this instance.

Remember:

Prior to engaging GPS mode, a route or destination must be programmed and selected in the GPS for the Autopilot to follow.

No GPS Data Alarm:

If the autopilot is not receiving valid information while in GPS MODE, the alarm will sound, and “NO GPS DATA” blink on the screen. This could be caused by:

- Incorrect wiring of the GPS to the C-Drive unit.
- Incorrect data output (wrong sentence) from the GPS unit.
- No route set up or selected in the GPS unit
- No location fix at the GPS unit.

The course over ground information generated by the GPS unit should closely correspond to the magnetic heading signal the AP60 is receiving from its magnetic compass. The greater the difference between these headings, the less accurate will be the GPS Mode steering.

- Ensure that the GPS unit has the correct magnetic correction factor.
- Ensure that the AP60 compass is correctly aligned and installed, and not subject to magnetic interference .

Engaging POWER Mode

Press the SET button, select “-SET POWER-” option by pressing UP or DOWN buttons then press SET again. POWER mode will be selected. A beep will sound and the text display will change to “POWER MODE”.

The vessel's rudder position will be controlled by the UP and DOWN buttons. The current vessel magnetic heading in degrees is shown on the display.

Disengaging POWER Mode:

Press the SET button twice, a beep will sound and the vessel will return to manual steering.

Possible alarms

- No C-Drive alarm "NO DATA"

REMOTE AUTO Mode (Remote Unit Operation)

Hand remotes, panel remotes and steering lever stations all come with a dial or lever and switch.

While the autopilot is in this mode, the display will show “REMOTE AUTO” and the numeric display section will show the course-to-steer.

Engaging REMOTE AUTO Mode:

Move the remote unit switch to AUTO.

The remote dial or lever now controls the course-to-steer.

If the switch has been left at AUTO and the autopilot turned OFF, or the AUTO or MANUAL button pressed on the Display Unit, you will need to move the switch to centre (OFF), and then back to AUTO to re-engage REMOTE AUTO Mode.

Disengaging REMOTE AUTO Mode:

Setting remote switch to OFF will select MANUAL mode.

OR

Pressing the SET button twice on the AP60 Display Unit will select MANUAL Mode.

Course Adjustment:

Turning the remote dial will alter the course-to-steer. This change will be reflected on the Display Unit. From the central position of the remote dial, the course may be changed to PORT or STARBOARD by 90 degrees. The vessel will steer the new adjusted heading.

REMOTE POWER STEER (Remote Unit Operation)

Hand remotes, panel remotes and steering lever stations all come with a dial or lever and a 3-way switch. The switch is labelled PWR, OFF and AUTO.

While the autopilot is in this mode, the Display Unit display will show “REMOTEPower” and the numeric display section will show the current course.

Engaging POWER STEER Mode:

Move the remote switch to the PWR position.

The remote dial or lever now acts as the helm, giving control over the angle of the rudder.

If the switch has been left at PWR and the autopilot turned OFF, or the Autopilot is placed in any other mode by the Display Unit, you will need to move the switch to centre (OFF), then back to PWR to re-engage REMOTE POWER STEER mode.

Disengaging POWER STEER Mode:

Return the remote dial or lever to centre before switching to OFF.

The autopilot will return to MANUAL mode.

OR

Pressing the SET button twice on the AP60 Display Unit will return the autopilot to MANUAL mode.

SETTINGS Mode

IMPORTANT!!

Some of the configurations will be available just in MANUAL/STANDBY Mode.

Press the SET button, select “-SETTINGS-” option (pressing UP or DOWN buttons) and press SET again. This will cause the AP60 Head enter in the SETTINGS Mode. Pressing the SET button you will have 11 different configurations that can be set:

Tolerance Settings: “SET TOLERAN”

These settings are used to determine how sensitive the autopilot system is and the amount of rudder the vessel requires for steering (actually, the amount of rudder angle applied for a given angle off-course).

To adjust, press the SET button, select “--SETTINGS--” option (pressing UP or DOWN buttons) and press SET again. The text “SET TOLERAN” will be shown with the actual tolerance (between 1 and 10). The tolerance setting may be altered by the UP and DOWN buttons. If you press any display button for 5 seconds it will exit SETTINGS Mode.

A low response value the drive will operate with minimum pulsing to the required rudder position and the autopilot system may work continuously.

A high response value the drive will position the rudder with maximum pulsing. The vessel’s course will wander slightly.

NOTE: Too low a setting may cause the steering motor to work continuously (hunting). The response setting should be increased from 1 until the rudder position is achieved with 1 or 2 motor pulses.

Ratio Settings: “SET RATIO”

By pressing the SET button again, the display will indicate “SET RATIO”. This setting is used for adjusting the autopilot’s rudder ratio setting to allow for varying vessel size and speed. The display shall show the current rudder ratio (between 1 and 10). The rudder setting may be altered by the UP and DOWN buttons. If you do not press any display button for 5 seconds it will exit SETTINGS Mode.

A value of 1 signifies the minimum amount of applied rudder. When the rudder setting is too low, vessel track will be a slow “S” ie: understeer through too little rudder applied.

A value of 10 signifies the maximum amount of applied rudder. When the rudder setting is too high, vessel track will be a rapid “S” ie: oversteer through too much rudder applied.

Rudder Angle: “RUDDER ANGL”

Pressing the SET button again will display the rudder position in numeric value Port or Starboard

- When the rudder is at centre it will display “00”
- As port rudder angle is applied, the number will be “-**”, and the rudder indicator bar will move to port.

-
- As starboard rudder angle is applied, the numbers will be “**”, and the rudder indicator bar will move to starboard.

Contrast: “CONTRAST”

Pressing SET once more you will have the display contrast adjust.

The text “CONTRAST” will be shown with the actual contrast (between 1 and 10). The contrast setting may be altered by the UP and DOWN buttons. If you do not press any button for 5 seconds it will exit SETTINGS Mode.

Remote Mode Selection: “REMOTE MODE”

Pressing SET again you will have the Remote Mode Selection. The text “REMOTE MODE” will be shown with the current remote mode. The remote mode may be altered by the UP and DOWN buttons.

To confirm the new remote mode you MUST press both UP and DOWN buttons simultaneously. If you leave the Head for 5 seconds it will get out of SETTINGS Mode.

Provision is included for 2 different remote input selections:

R-1:- Provision for 1 or 2 hand/panel remotes (Default condition)

R-4:- Basic remote plus power steer input on REMOTE connector pin 5 in MANUAL mode. (Electric steering vessel).

Off-course Alarm: “OFFCOURSE A”

Pressing SET again you will have the Off-course Alarm. The text “OFFCOURSE A” will be shown with the Off-course Alarm setting. The Off-course Alarm setting may be altered by the UP and DOWN buttons, between 1 and 60 degrees.

To confirm the new Off-course Alarm setting you MUST press both UP and DOWN buttons simultaneously. If you do not press any button for 5 seconds it will exit SETTINGS Mode.

The AP60 allows for monitoring of the autopilot course holding ability by having the angle off-course measured and alarm sounding if greater than a set amount degrees from the desired course.

If the difference is greater than the set amount degrees between the heading and the course to steer, the alarm will sound and the text “OFF COURSE” will flash.

Rudder Port Limit: “PORT LIMIT”

Pressing SET again you will have the Port Limit setting.

The rudder limits prevent the steering motor driving the rudder beyond its physical (mechanical) stops. When the rudder reaches its limit (port or starboard) an arrow will be displayed in the screen, pointing to the proper side. The limits are factory set and should not need altering. However, the limit setting can be set from the display of the AP60 if deemed necessary.

- Set the rudder to the desired Port position.
- The display will show the actual position.
- If “--” is been shown in the display, it means the rudder is in a Starboard position.
- By pressing the both UP and DOWN buttons simultaneously the new rudder port limit will be set.

Rudder Starboard Limit: “STBD LIMIT”

Pressing SET again you will have the Starboard Limit setting.

- Set the rudder to the desired Starboard position.
- The display will show the actual position.
- If “--” is been shown in the display, it means the rudder is in a Port position.
- By pressing the both UP and DOWN buttons simultaneously the new rudder port limit will be set.

If at any time during testing the motor runs under load and the rudder does not move, checks should be carried out to confirm the limit switches are operating prior to the rudder running into the stops.

Reset Rudder Limits: “RESET LIMIT”

Pressing SET again it is possible to reset the rudder limits to the factory settings if unsure of the settings.

“ RESET LIMIT” will Display, with the actual rudder position.

Press both UP and DOWN buttons simultaneously to reset rudder limit.

Compass Calibration: “COMPASS CAL”

Only for C-Drive units using TMQ Fluxgate compass

NOTE: The calibration should only be done if the compass is known to be inaccurate when compared to a chart bearing.

Calibration procedure for TMQ C-Drive units using TMQ Fluxgate compass

Press SET again to have the Compass Calibration setting. “COMPASS CAL” text will be shown, with the actual compass reading.

The compass supplied with your AP60 autopilot has been calibrated after manufacture, and this calibration will be satisfactory for almost all installations. If you have a steel vessel, or some other factor, which causes the compass to perform poorly, the calibration procedure will adjust compass characteristics to compensate.

If the AP60 compass heading displays a **constant offset** when compared to a correctly calibrated ships compass (eg: the autopilot compass reads 3 degrees high on all headings), simply rotate the AP60 compass sensor to align the displayed headings with the ships compass. It is **not** necessary to re-calibrate the compass as described below.

If the AP60 has inconsistent variation on different headings, the following calibration procedure can be carried out. **This procedure should only be done in calm waters with adequate sea room. Auto must not be selected to carry out the calibration.**

1. In the Compass Calibration setting, press both UP and DOWN buttons simultaneously to start the compass calibrate. The text will change to “STORE COMPA”
2. Start turning the vessel slowly in one direction. Turn vessel slowly through two complete circles from this point. Each complete turn should take at least 60 seconds.

3. On completion of circles, press both UP and DOWN buttons simultaneously to store the calibration setting into memory.

Check alignment of the AP60 compass by steering the vessel due North (000 on ships compass) and, if necessary, rotate the compass sensor until display reads 000.

Note: The effectiveness of the compass calibration is dependent upon all steps being completed.

It is important to realise that on any vessel the ship's compass can have heading errors as a result of the vessel's magnetic signature. These errors can be minimised by having the ship's compass swung and compensated by a licensed compass adjuster. In any case it is highly unlikely that the ship's compass and autopilot compass will be congruent for every heading.

If you are unsure of the success of the calibration, you may return to the factory calibration setting by doing the following:

Reset Compass Calibration: "COMPASS CAL"

The last option in the SETTINGS Mode is Reset Compass Calibration.

Pressing SET again it is possible to reset the compass calibration to the factory settings if unsure of the settings. "RESET COMPA" text will be shown, with the compass reading.

Press both UP and DOWN buttons simultaneously to factory settings.

Alarms

A number of conditions will cause alarms to sound and an alarm message to blink on display.

NO MCU Alarm: “NO DATA”

This indicates that the Display Unit is not receiving data from the C-Drive assembly. Check that all plugs are secure and the interconnecting cable is not damaged.

NO GPS DATA Alarm: “NO GPS DATA”

The alarm sounds if the autopilot is not receiving valid information from the GPS.

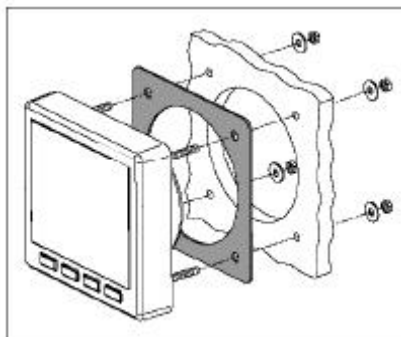
OFF COURSE Alarm: “OFF COURSE”

The alarm sounds when vessel is more than the preset amount (default 45 degrees) from the selected course-to-steer. These amount can be set in the Off-course Alarm setting, in SETTINGS Mode.

Installation of Display Unit

Position:

The Display Unit should be mounted in a position accessible to the steering position and protected from direct rain or salt water. A hole of 85mm (3.25inches) is required for the rear of the unit.



Wiring:

Access for wiring must be provided from Display to C-Drive assembly. The Display cable plugs into the **NMEA** socket of the C-Drive, which provides power and data communications for the Display. Wiring should be kept as far as possible from radio aerials and aerial cables to prevent interference to the radio and transmitted signals from the radio influencing the autopilot. Cable should also be run separately (if practical) from other current-carrying cables. There is no restriction on cable length.

The connections at the back of the AP60 Unit should be done as follow:

PIN 10 (+12/24V input):	RED
PIN 11 (Negative):	BLUE
PIN 13 (0183-Neg):	BLUE
PIN 14 (0183-out):	YELLOW
PIN 15 (0183-INA):	BLUE
PIN 16 (0183-INB):	GREEN



PIN 2 Backlight dim input (0 to 12V or 0 to 24V, autosense): external dimmer (not included).

Magnetic Effect:

As steel is not used in the Display Unit, there is negligible effect on a steering compass. Some radio interference may be caused by the internal electronics.

Additional Display Units:

Additional remote displays can be added in series (Daisy chained) with the AP60 head.

Notes