CM82i SYSTEM MANUAL

Your Coursemaster CM82i 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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Copyright 2009. This manual, the mechanical and electronic design of the CM82i autopilot system and its associated software are protected by copyright. Unauthorised copying may result in prosecution.
QUICK START

- Press the STANDBY key to turn the system on.

- Hold down the STANDBY and PILOT keys together to turn the system off.

- Steer to the desired course and press PILOT.

- Use the arrow keys to change course.

- To engage the auto-navigate system, hold the PILOT key down for two beeps. Press PILOT once to cancel the auto-navigate mode.

- To select the menu, hold the STANDBY key down for two beeps. Scroll down with single presses of the STANDBY key. Hold the STANDBY key down for two beeps to exit the menu.
CM82/ SYSTEM MANUAL

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QUICK REFERENCE

INSTALLATION

- Mount the Junction Box as described in Sect 3.1
- Mount the Control Head as described in Sect 3.2
- Mount the Compass as described in Sect 3.3
- Install the Steering Drive as described in Sect 3.5.
- Connect optional attachments as described in Sect 3.4
- Carry out the system set-up as described in Sect 2.2
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 are set to strike a balance between these two factors.

1.1.1 CONVENTIONAL AUTOPILOTS

A conventional autopilot is illustrated schematically in Fig 1.1

![Figure 1.1 Basic components of a conventional marine autopilot.](image-url)
The four basic components are a compass, an electronic control box, a rudder angle sensor (transducer) and the steering drive.

A Junction Box, mounted below decks, contains most of the system electronics and a Control Head, mounted at the steering station provides the interface with the user.

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.

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 is another way 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.

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, the effectiveness of its rudder and the weather conditions. This choice is managed by four parameters within the autopilot, as follows.

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. Fortunately, most vessels tolerate a range of settings and still steer well.
Counter Rudder

Counter Rudder, or rate feedback, compensates for turning inertia and is generally used in vessels above 8 m length. Near the end of a turn, counter rudder is applied to slow the turn rate so that the heading settles accurately on the new reference course. Counter rudder also improves stability in a following sea.

The action of the rate or counter-rudder during a turn is illustrated in Fig 1.3. 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.
Sea State
When the Sea State or Control Mode is set to ROUGH, it introduces a ‘deadband’ in the course control, so that rudder activity is reduced when the vessel rolls and yaws in a heavy sea. Full rudder control is applied when the vessel yaws off course by more than a preset amount.

Trim
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.

1.1.3 THE ‘INTELLIGENT’ AUTOPILOT

An ‘intelligent’ autopilot, such as the CM82i, works on the same principles as those just described, but with two practical differences. There is no rudder angle sensor. Instead, the angle is calculated within the system, using inputs from the steering drive and the compass. Secondly, some internal settings in the autopilot adapt themselves automatically to conditions such as propeller torque and offset effects arising from the weather and the trim of the vessel.

1.1.4 COURSE HOLDING AND TURNING

The CM82i is mainly intended for vessels in the 5 - 10 m range, usually with outboard motors. These vessels have two features that affect course holding and turning. First, they are more responsive to wind load and wave effects than heavy vessels and can yaw quickly when hit by a wind gust, for example. Secondly, they are often used at speeds above 15 kt and are therefore susceptible to the southerly/northerly heading error effect.

The autopilot responds quickly to correct heading shifts caused by wind or waves and a yaw of 3 degrees around the reference course is typical in choppy and windy conditions. But when there is a constant weather offset, the automatic trim acts progressively to apply weather helm and bring the average heading of the vessel onto the reference course. This action may take 10 - 15 seconds to complete. The weather helm effect can be seen particularly during a large course change. If the conditions are not calm, the wind and wave load on the vessel will be different at the end of the turn and the vessel may undershoot or overshoot the new reference course until the trim adjusts to the new conditions.
The northerly/southerly heading error is a result of the dip angle of the earth’s magnetic field lines. For vessels travelling above about 15 kt, it produces northerly course holding errors in regions north of latitude 30N and southerly errors when south of latitude 30S. The use of the CM437 Rate Gyro Compass overcomes this problem, as well as reducing rudder activity in choppy conditions.

1.1.5 OPTIONS

As an alternative to using the standard rate gyro compass, the CM82i has an option to use a digital heading input, which would typically come from a GPS compass. Note that the course-over-ground data available from GPS navigation systems does not respond quickly enough to be used as the primary heading input.

1.1.6 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. Coursemaster 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 CM82i SYSTEM

The core of the CM82i system consists of Control Head, Junction Box, Rate Gyro Compass and Steering Drive. The system, together with its optional attachments is illustrated in Fig 1.2 below.

**Figure 1.2** The CM82i system.

**CM840 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 and hydraulic pump steering systems.

**CM82i Control Head**

The Controller has four push-buttons to control the system and displays information on the current operation of the autopilot.
CM437 Rate Gyro Compass
The CM437 Rate Gyro Compass combines a fluxgate sensor with a rate gyro.

Steering Drive
The autopilot is intended for hydraulic steering systems, of which there are a number of options. A suitable drive may either be supplied by Coursemaster or the autopilot may be connected to an existing steering drive on the vessel. One of the recommended pumps, supplied by Coursemaster, is a 0.6 litre/min reversing gear pump.
2 OPERATING INSTRUCTIONS

2.1 THE CONTROL HEAD

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

Figure 2.1 The CM82i 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 are being used, these can be fitted after initial trials of the system.)

To switch on for the first time, press the STANDBY key. The system enters a set-up mode so that the size of the vessel can be entered and the steering gear calibrated. The screen shows the prompt:

```
SET N Y
```

There are two choices. If you wish to examine some of the features without carrying out the setup, select NO by pressing the left arrow. 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.

SETTING THE HULL LENGTH

The screen now shows:

```
STBY
HULL LGTH
```

Set the approximate boat length by using the arrow keys. These will step up or down in 2 m steps. This is an important operation and sets the initial tuning of the autopilot to values which best suit your vessel.
Then press STANDBY again to calibrate the steering drive.

Centre the helm. Then watch the steering gear as you press the right arrow. It should move a few degrees to starboard for each press of the key. If it moves the wrong way, switch off the system and reverse the motor lead connections. Continue pressing until 20 deg helm is applied. If you move too far, use the left arrow to bring it back. It takes typically 8 – 10 key presses to apply 20 deg of helm. Then press STANDBY. The helm will now pulse back to the centre and the display reads AUTO RETURN as it moves back. The setup is now complete and the screen should show its normal display.

If the helm does not return close to centre during this last operation, there may be air in the hydraulic system and it should be bled again. Small centring errors will not affect the operation of the autopilot.

**THE SETUP IS NOW COMPLETE**

### 2.3 NORMAL OPERATION

**SWITCHING ON**

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**
Press the STANDBY and PILOT keys together.

With the system in STANDBY, steer the vessel to the desired heading and press PILOT. The autopilot will now lock onto that heading and maintain it.

**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, the selected steering mode and the rudder factor. Mode B shows the current heading in large digits and the Reference Course below it. The preferred mode may be selected via the PILOT DISPLAY option in the menu.
To adjust the current reference course, press either the left or right arrow key. A single press changes the course by 1 degree. Holding a key down changes the course continuously in 10 degree steps.

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

If a GPS receiver or other source of navigation data is connected, the vessel can be steered to head towards a waypoint with minimum cross-track error. Hold the PILOT key down for two beeps to turn on auto navigation. The NAV symbol will appear at the top of the screen. If no valid navigation sentence is being received, the NAV symbol will blink on and off. Press the PILOT key again to cancel the NAV mode.

### 2.4 THE MENU

The menu provides access to autopilot settings. Changing these is not essential for correct operation, but may improve performance or bring other options into operation. A navigation map for the menu is shown below. The menu can only be accessed in the STANDBY mode.

Hold STANDBY down for two beeps. The first menu option should now show. Scroll down the menu using single presses of the STANDBY key. Use the or right arrow key to select a sub-menu, eg for heading control options. Use the left or right arrow keys to change settings. Return to the main screen by holding STANDBY for two beeps.
The use of each menu item is described below.
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).

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 arrow keys. There is more about the rudder factor in Sec 2.6.

RATE FACTOR The RATE FACTOR controls the amount of counter rudder applied in both control modes. Guidelines for setting it are given in Sect 2.6.
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, assuming that a CM437 is fitted. If rate gyro is selected, but not operating correctly, the heading display will lag behind the actual heading by 2 seconds or more, resulting in poor heading control. The gyro function is turned on or off via the arrow keys.

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:

TURN 360 DEGREES

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.

CAL OK B

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 the rate gyro is turned ON, we recommend turning it OFF during auto calibration and then turning it ON upon completion.

**MANUAL**
The **COMPASS CALIBRATION**

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

\[
\text{DEV } +00
\]

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

**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.

**HEADING SOURCE**

This allows a selection (using the ARROW keys) between a heading input from a RATE GYRO COMPASS (fluxgate) 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.

RUDDER CONTROL GROUP

RUDDER LIMITS
This setting controls the maximum rudder angle used when the system is in PILOT mode. It is preset to a value which suits the size of the vessel and may be changed using the arrow keys.

TURN RATE
This sets the maximum rudder angle applied during a course change. It should always be set to a value less than the rudder limits. For high-speed vessels, you may wish to reduce the setting below its preset value.

AUTOBALANCE ON / OFF
As mentioned in Sec 1.1.3, the CM82i includes a feature whereby the system compensates automatically for propeller torque effects. This compensation may be turned on or off with this option.

STEER DRIVE
This provides a manual drive to the steering gear and is mainly used for hydraulic bleeding. It should be used with caution to avoid running the gear against the stops. Pressing one of the arrow keys starts the steer drive in that direction. Pressing it again stops the drive.

HELM ALERT
Sets the time interval between Helm Alert alarms to 5, 10 or 15 minutes. A setting of 0 disables the alarm.

OTHER OPTIONS

NMEA OUTPUT
The NMEA heading output may be selected between HDG (magnetic) and HDT (true). Some version may also show a SIM option. This is for factory testing and is not used in an installed pilot.
PILOT DISPLAY Used to select between the two display modes described in Sec 2.3

COMPASS VOLTS This option is intended for use by a service technician. The output voltages from the blue and yellow wires from a fluxgate compass are displayed in compressed form, eg a reading of +37 means +0.37V.

BALANCE If the balance monitor is selected ON and the vessel is in pilot mode, pressing the PILOT key a second term displays the propeller torque compensation on the message line at the bottom of the screen, eg.

ST 18  PT 18

If there is a prop torque effect, one of these numbers will gradually decrease and the other will increase, indicating that the rudder is being driven at different rates for starboard and port helm. After switching the autopilot off, the BALANCE MONITOR is also switched off and must be reactivated if needed again. The compensation is also returned to its balanced condition.

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 arrow. After the presets have been re-loaded, the system returns to the SETUP mode.

2.5 ALARMS The CM82i 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. In many cases, the alarm condition is also removed. But if the fault is still present, the alarm symbol at the top left of the screen remains on. In the background, the system periodically
attempts to clear the fault. If it succeeds, the alarm symbol will disappear after 30 seconds.

**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 operates in three stages. One minute before the preset time (5, 10 or 15 sec.), the HELM ALERT message flashes on the display without the beeper sounding. At the preset time the message is on continuously and the internal beeper sounds. One minute later, the external alarm sounds. The alarm is cancelled and reset by the PILOT or STANDBY key.

**DRIVE 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.

**COMPASS FAULT**
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.

**NO HEADING DATA**
If a digital heading input has been selected, a valid heading sentence is not being received.

### 2.6 RECOMMENDED SETTINGS

During the setup procedure, internal settings are preset to values appropriate to the length of the hull. But there may be cases where you wish to change these presets via the menu. The following guidelines are suggested for making these adjustments.

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 a nominal 0.5 degree of helm for each degree off course.

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.
3 INSTALLATION

Before proceeding with the installation, check the contents of the shipment to ensure that all components ordered are present and undamaged. 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. Check that vessel voltage is 12volt DC. 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 Control Head 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. Install and connect any additional attachments as described in Sect 3.4. (Or, if preferred, these could be installed after initial commissioning.)

5. Install the steering drive as described in Sect 3.5

6. 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.

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. (See Figs 3.1 and 3.2) 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.
Figure 3.1 Layout of CM 840 Junction Box components and connectors.

Note that the CM840 Junction Box is common to several autopilot systems and may have sockets which are not used in the CM82i system.

Figure 3.2 Power and Steer drive connections to the Junction Box.
3.2 CONTROL HEAD

The Control Head is designed for mounting through a dashboard or bulkhead panel. Although the front of the unit 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 3.3. Tighten the nuts sufficiently for a firm mounting, but not enough to distort the mounting clamp bracket.

![Diagram of panel mounting of the CM82i Control Head](image)

Figure 3.3 Panel mounting of the CM82i 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 remade. 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 3.4. 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.
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.

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 CM437 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 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 3.5.
Steel Vessels

Though the CM82i autopilot is intended for smaller vessels, which are unlikely to be steel, the following notes may be useful in some cases.

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:

In the first instance, try siting 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.

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 deviation exceed 20 deg. in any position, keep re-siting 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 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 20 deg. A compass calibration (See Sec 2.5) is recommended after the installation is complete.

### 3.4 NMEA INTERFACES

The Junction Box has two NMEA input ports for navigation and heading data. There is also one output port for heading data. Both input ports are sampled continuously so that a given cable can be connected to either. But two cables must not be connected in parallel to one input. The Port A socket is shown in Fig 3.6, while the Port B input, which is shared with the gyro, is shown in Fig 3.5.

![Figure 3.6 NMEA data cable connections – Port A.](image)

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 hold the PILOT key down for 2 sec. The left side of the display may now show the message ‘NAV WAIT’ for up to ten seconds, until it receives the correct data. to 15 sec. If it stays longer, there is 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.
3.5 STEERING DRIVE

The CM82i system is intended for use with existing hydraulic steering systems. If the CM82i is fitted to a power steering system with solenoid controls, the power steering system must be fitted with a suitable pressure relief valve to prevent damage to the steering if it is driven into the steering stops.

Instructions are given below for adding a Coursemaster pump motor. But for pumps supplied by other manufacturers, they should have an output flow rating of 0.6 litre/min, which suits a typical ram of 80 to 160 cc capacity. Installers should consult the data supplied by the manufacturer.

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.
Typical Steering Systems

Two-line systems are by far the most common and are manufactured by many companies worldwide. The best known types include Hydrive, Marol, Morse, Seastar, Seipem, Tenfjord, Teleflex and Vetus.

Figure 3.7 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, a Vetus system. If a lock valve is installed, it must be fitted as shown in Fig 3.7.

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 mounting feet 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 suitable high-pressure hose should be used to isolate mechanically the 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'.

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 Fig 3.2), noting that no connection is made to the clutch drive in this type of installation. The polarity of the connection can be checked and corrected during the autopilot setup operation.

7. The system is now ready for the setup procedure as described in Sec 2.1

Pump Maintenance

The hydraulic pump has a minimum of moving parts and should give hundreds of hours of service without requiring attention. If the pump fails to run, check first that it is receiving the correct drive voltage from the Junction Box.

If the pump runs but does not pump oil, make sure that the system is purged. If that does not succeed, contact your Coursemaster dealer.
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 three 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 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. Secondly, the presence of air in the hydraulics, free-play or backlash in the steering linkage will also cause steering problems.

The third factor, propeller torque, applies particularly to outboard motor drives. One effect of prop torque is to make the load on the steering drive heavier in one direction than the other. This, in turn, makes the rudder move more slowly in one direction than the other and this can introduce errors in the way the autopilot positions the rudder. Medium and high-power outboard motors have a trim tab mounted below the cavitation plate. This should be set so that the starboard helm and port helm steering loads are balanced. This balance should be judged while hand-steering, adjusting the angle of the trim tab in small steps until the effort required to apply starboard helm matches the effort required to apply port helm. It may take a few runs to set it correctly.
It is also the case that prop torque changes with speed, the tilt of the motor and the hull angle. So make the adjustment under mid-range cruising conditions and the automatic balance feature of the autopilot will apply the necessary compensation as these conditions change.

4.2 ERROR MESSAGES

The CM82i system is programmed to provide a number of messages on its display when a fault occurs. Some of these are warnings which relate to 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 Coursemaster 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.
**DRIVE OVERLOAD**

The system is in PILOT or one of the power steer modes and the motor drive current has exceeded 20A 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 overcurrent 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.

**HELM ALERT**

This is only a warning. If the alarm is selected, a timer is started in the system when in autopilot, which brings up this message and an alarm tone every 5, 10 or 15 minutes. The condition does no affect autopilot operation and is cancelled by the PILOT or STANDBY keys.

**OFF COURSE**

The system is in autopilot and the vessel has been more than 8 deg. off course for 30 seconds. This alarm does not affect the normal operation of the pilot. It cancels itself when the vessel returns to course or may be reset by the PILOT key or switching the system out of PILOT.

**4.3 OTHER FAULTS**

The Junction Box contains 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, another possibility is that the program store (EPROM) has not been fitted correctly or that a pin is bent or broken. If that is not the problem, a service call is 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 Coursemaster for repair.

**Slow Compass Response**
If the displayed heading is slow to respond to the actual heading and this is accompanied by poor course holding, there could be a Rate Gyro fault. Turn the rate gyro off (via the menu) and check again. If the speed of the heading display response now appears normal, check the brown wire connection in the Junction Box and try again with the Rate Gyro turned on.

**4.4 FUSES**

The system has two fuses. The main 20A fuse protects the complete system, while a 0.8A miniature fuse (See Fig 3.1) protects the control electronics against supply surges or circuit board faults.
# 5 SYSTEM SPECIFICATIONS

## AUTOPILOT

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage Range (nominal)</td>
<td>12 to 14V dc</td>
</tr>
<tr>
<td>Maximum Supply Voltage Range</td>
<td>10 to 16V dc</td>
</tr>
<tr>
<td>Supply Current</td>
<td></td>
</tr>
<tr>
<td>Basic system in STANDBY</td>
<td>0.33A</td>
</tr>
<tr>
<td>In Pilot with 20% duty</td>
<td>2.5A</td>
</tr>
<tr>
<td>Compass</td>
<td>Combination Fluxgate and Rate Gyro.</td>
</tr>
<tr>
<td>Typical deviation</td>
<td>2.5 deg rms.</td>
</tr>
<tr>
<td>Steering Drive</td>
<td></td>
</tr>
<tr>
<td>Output for 12V supply</td>
<td>10V (min) at rated load</td>
</tr>
<tr>
<td>Max continuous current</td>
<td>16 A</td>
</tr>
<tr>
<td>Max current for 15 sec.</td>
<td>30A</td>
</tr>
<tr>
<td>Max current for 1 sec.</td>
<td>50A</td>
</tr>
</tbody>
</table>
Recommended rudder 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, the system looks for sentences in this order:

RMB
APB
APA
BOD and XTE

The search stops when the highest sentence in the above list is found. If cross-track data, for example, is missing, the autopilot operates from the heading-to-steer data alone.

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

OUTPUT DATA
The system outputs heading data in either the HDG sentence (without deviation or variation data) or as HDT, using the magnetic variation set within the autopilot. The repetition rate is a minimum of 8 per second.
6 MAINTENANCE AND WARRANTY

6.1 MAINTENANCE

Great care has been taken in the selection and sealing of materials in the system to minimise the risk of corrosion. If, however, the controller or any other component is accidentally immersed in water, it should be drained immediately and returned promptly to your Coursemaster dealer for cleaning and rectification.

6.2 INSTALLATION OF NEW SOFTWARE

It is recommended that software upgrades be installed by a Coursemaster dealer, but if this is not possible, the following procedure should be followed carefully by the owner. The memory package containing the software for the main circuit board in the Junction Box has a label beginning CM846V..... Open the Junction Box and, referring to Fig 3.1 in the manual, locate the Program Store. Slip a slim bladed screwdriver through the access hole at the rear of the base, inserting it between the package and its socket. With a gentle twisting movement of the screwdriver, lever the package up so that it remains parallel to the surface of the board until free of the socket.

Check the new package to ensure that all pins are straight and at right angles to the package. If they tend to splay outwards, bend them inwards by rocking the package on a hard smooth surface. Insert the package in the socket, making certain that the small notch at the end of the package lines up with the small notch on the socket.

The software in the Control Head cannot be upgraded in the field. If an upgrade is required, please return it to your dealer or direct to Coursemaster.
6.3 WARRANTY

Coursemaster Autopilots Pty. Ltd. is committed to the principles of product support and customer satisfaction. It warrants its autopilots and accessories against defective materials and workmanship, under normal use, for a period of twelve months from the date of installation, provided that the total period does not exceed eighteen months from the date of shipment from Coursemaster.

The defective item shall be returned, ‘freight pre-paid’ to Coursemaster. A return Australian address shall be provided to enable the repaired item to be returned by road freight. Coursemaster shall not be liable for the cost of removing or refitting the item to the vessel.

Proof of purchase is required.

This warranty does not apply to items that have been damaged or rendered defective as a result of incorrect installation, service, modification, misuse, accident, water damage, abuse or other external causes.

Coursemaster shall not be liable in any event for any consequential or indirect loss or damage incurred resulting from the use and operation of this product. Coursemaster reserves the right to make changes and improvements to this product without incurring any obligation to install similar changes to equipment already supplied. Some states do not allow the exclusion or limitation of incidental or consequential damages; therefore the above limitations or exclusions may not apply to you.