COURSEMASTER

AUTOPILOTS

Australia's world leader in autopilot technology

CM80*i* SYSTEM MANUAL

04-08

CM80*i* SYSTEM MANUAL

Your Coursemaster CM80*i* 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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04-08

Third Edition

The Third Edition of this Manual applies to systems fitted with Version 1.26 Junction Box software or higher. The dynamic performance of the autopilot has been optimised for use with a CM437 Rate Gyro Compass.

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.

CM80*i* SYSTEM MANUAL

CONTENTS

CONTENTS

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

THE MENU

CONTROL MODE - NORMAL / ROUGH
RUDDER FACTOR
RATE FACTOR
RATE GYRO OFF / ON
HEADING ADJUST
AUTO COMPASS CALIBRATION
MANUAL COMPASS CALIBRATION
COLD START
RUDDER LIMITS
TURN RATE
HELM ALERT
STEER DRIVE
HEADING SOURCE
NMEA OUTPUT
MAGNETIC VARIATION
TUNE MONITOR OFF/ON
AUTO BALANCE OFF/ON

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

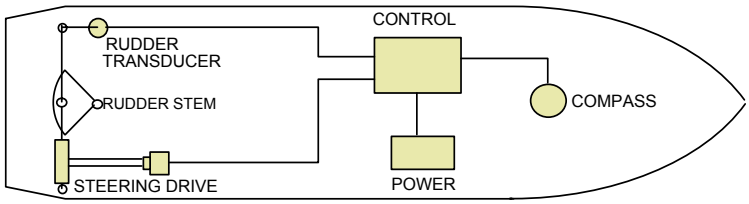


Figure 1.1 Basic components of a conventional marine autopilot.

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. If the rudder factor is too high, oversteering or 'snaking' may occur. Too low a setting causes understeer and a sluggish response.

Counter Rudder

Counter Rudder, or rate feedback, compensates for turning inertia and is generally used in vessels above 10 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.

Sea State

The Sea State control is used to introduce 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 CM80*i*, 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 CM80*i* is mainly intended for light vessels in the 5 - 10 m range. These 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 addition of a Rate Gyro overcomes this problem, as well as reducing rudder activity in choppy conditions. We now recommend that the CM437 Rate Gyro Compass be fitted as the standard compass.

1.1.5 OPTIONS

As an alternative to using the standard rate gyro compass, the CM80i 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 CM80*i* SYSTEM

The core of the CM80*i* 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.

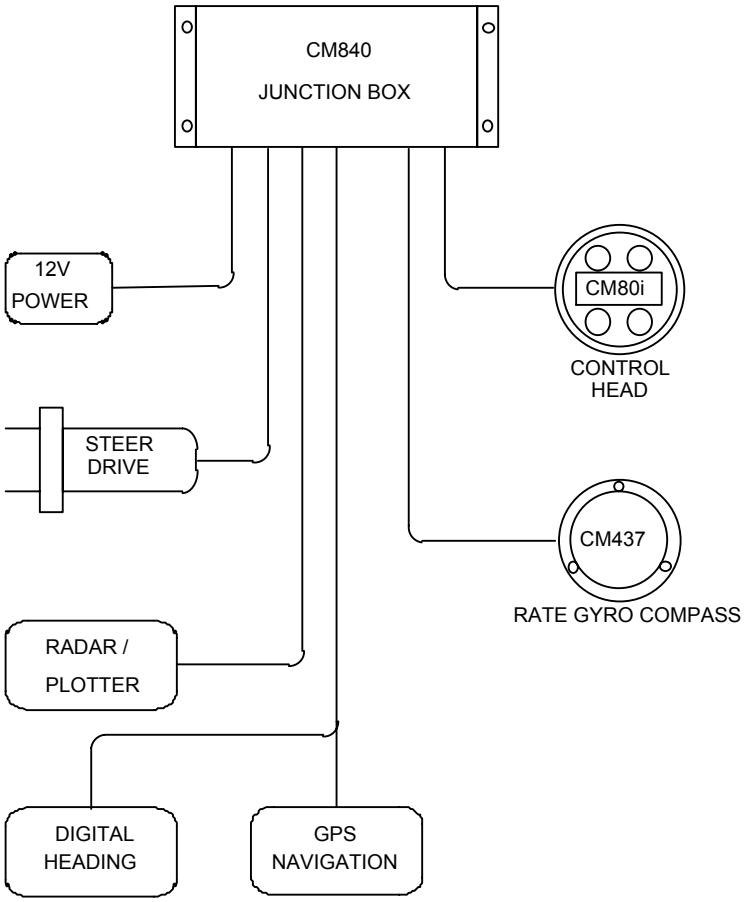


Figure 1.2 The CM80*i* system.

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.

CM80*i* 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 by 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 Control Head (Fig 2.1) contains a text display and four keys. The use of these controls is described in this chapter.

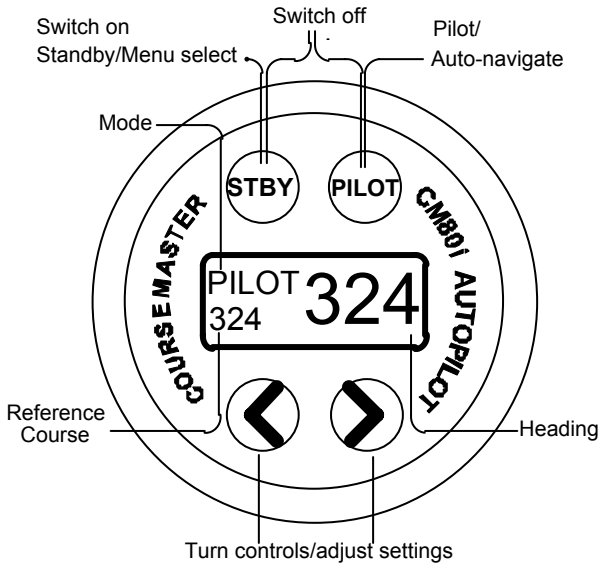
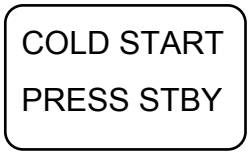


Figure 2.1 The Control Head Panel.

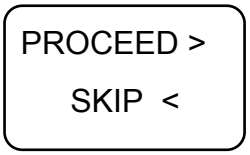
2.2 GETTING STARTED

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.)

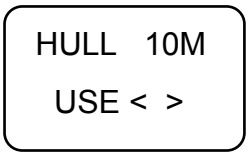
To switch on for the first time, press the STANDBY key. The system enters a set-up mode so that the size of the vessel can be entered and the steering gear calibrated. The screen shows the prompt:



Press STANDBY and the screen reads:



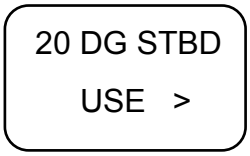
There are two choices. If you wish to examine some of the features without carrying out the setup, select SKIP by pressing the left arrow. This will bypass the setup and let you scroll through the displays, but there will be no response to the PILOT key. The system will return to SYSTEM SETUP the next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



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.



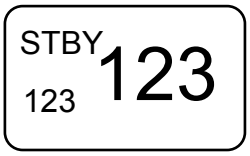
Centre the helm. Then watch the steering gear as you press the right arrow. It should move a few degrees to starboard for each press of the key. If it moves the wrong way, switch off the system and reverse the motor lead connections. Continue pressing until 20 deg helm is applied. If you move too far, use the left arrow to bring it back. 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.

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 nature of the fault is displayed after the self-test period.

SWITCHING OFF

Press the STANDBY and PILOT keys together.

AUTOPILOT

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. The display will show 'PILOT' in the top left corner.

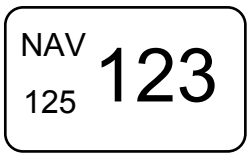
ADJUSTING THE COURSE

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 that the reference will not change if in the auto-navigate mode.)

AUTO-NAVIGATE

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. Press it again to turn it off.



If valid navigation data is being received, the lower left of the display alternates between the heading to-to-steer and the cross-track error (if present). If no data is being received, the lower left of the display reads WAIT and the vessel continues to hold its current course.

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. The menu can only be accessed in the STANDBY mode.

Hold STBY down for two beeps. The first menu option should now show. Scroll down the menu using single presses of the STANDBY key. Use the left or right arrow keys to change settings. Return to the main screen by holding STANDBY for two beeps. The menu options are:

AUTOTUNE

After a COLD START, the system is set in the auto-tune mode of operation in which settings will change automatically to adapt to sea conditions and speed. But if you wish to operate with fixed settings, select one of these options:

NORMAL

After a COLD START the system is set in the NORMAL mode, which provides direct proportional control using the preset value of counter rudder (Rate). It suits medium or small vessels in smooth or choppy conditions and will give reasonable control in all vessels.

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

This shows the preset Rudder Factor, which may be increased or reduced from the preset value of 4. Suitable settings will lie in the range 2 to 5 for virtually all vessels.

RATE FACTOR

Controls the amount of counter-rudder mode applied during a turn. If the vessel is suddenly pushed off course, the RATE mode applies a larger correcting helm than NORMAL. When turning towards a course, reverse helm is applied before the course is reached, in order to cancel the turning momentum. RATE should be set in the range 0 to 3 for the types of vessel

which are suited to a CM80*i* autopilot. (See Chap 1 for further information.)

RATE GYRO OFF/ON

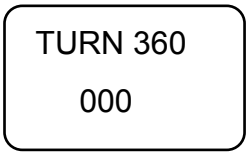
The Rate Gyro option is preset to be ON during the initial set-up. If an older style fluxgate (CM427) is fitted, the Rate Gyro should be turned OFF. Note that the rate gyro is also turned off during compass calibration. Please remember to turn it back on when calibration is complete.

HEADING ADJUST

The current fluxgate heading is displayed and compass mounting errors may be compensated using 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:



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 lower line on the display shows the heading relative to your starting point. When the circle is complete, the display shows the calibration results, eg.

MAG FIELD
MEDIUM

If the calibration report shows a low field strength, the compass performance will compromise the course holding of the vessel and you should consult Sec 3.3 for guidance on improving the compass position. Press STANDBY to return to the menu.

Note. If a rate gyro is fitted, it is turned off automatically by selecting the calibration option and should be turned on again when calibration is complete.

MANUAL COMPASS CALIBRATION

Manual calibration can be carried out independently of auto calibration, but is best done after an auto calibration procedure. Press the right arrow for the following display: (All settings are initially zero after an auto calibration, but the settings from any previous manual calibration are shown.) The display shows:

MAN 228
OK +01

The top line shows the current heading. If the second line shows ‘OK’ the heading is close enough to an adjustment point for a correction to be made. The second line also shows the correction being made at that point.

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.

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.

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 value.

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

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.

HEADING SOURCE
This allows a selection between a heading input from a fluxgate compass (MAG) 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.

NMEA OUTPUT
The NMEA heading output may be selected between HDG (magnetic) and HDT (true). Some versions may also show a LOG option. This may be used by a technician for recording performance data and is not used in normal operations.

MAGNETIC VARIATION
Sets the conversion between true headings, received from a navigation system, and magnetic bearings. The readout is on a 360 deg scale, so that 13 deg east appears as 013 and 13 deg west appears as 347.

TUNE MONITOR

This option enables the display of the operation of the auto-balance feature for propeller torque compensation. The monitor is only displayed in the PILOT mode. If the TUNE MONITOR is turned on, a single press of the PILOT key produces the following typical display:

H276	R 4
ST18	PT18

The top left shows the current heading and the top right shows the working value of the rudder factor. (The working rudder factor is adjusted automatically during a turn.)

The bottom values show the degree of prop torque compensation that has been applied. Values of 18 and 18 indicate perfect balance. This pair of numbers may vary up to 6 and 30, or 30 and 6. Such a case indicates a very unbalanced drive and if this happens, the trim tabs on the outboards or stern drives should be re-adjusted.

Note that enabling the tune monitor may interfere with the GPS auto-navigate mode and should only be used when steering to a fixed reference course.

2.5 ALARMS

The CM80*i* has a number of alarm functions. When an alarm occurs, the beeper sounds and an alarm message flashes on the display, alternating with the normal information. To cancel an alarm, press the STANDBY or PILOT key. If the system is in PILOT and this key is used to cancel an off-course alarm, for example, the reference course is not changed.

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.

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 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.

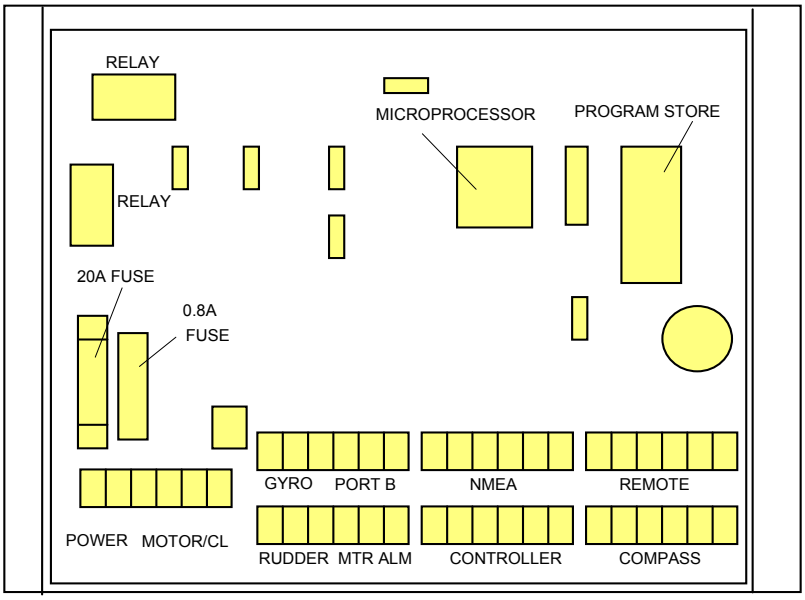


Figure 3.1 Layout of CM 840 Junction Box components and connectors.

Note that the CM840 Junction Box is common to several autopilot systems and may have sockets which are not used in the CM80*i* system.

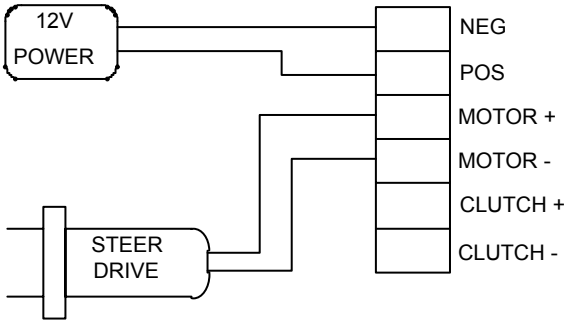


Figure 3.2 Power and Steer drive connections to the Junction Box.

3.2 CONTROL HEAD

The Control Head is designed for flush mounting on a dashboard as shown in Fig 3.3. Although the face of the controller is weather-proofed, it is recommended that it not be mounted where it is exposed directly to rain or spray. The rear of the case should also not be exposed directly to the weather.

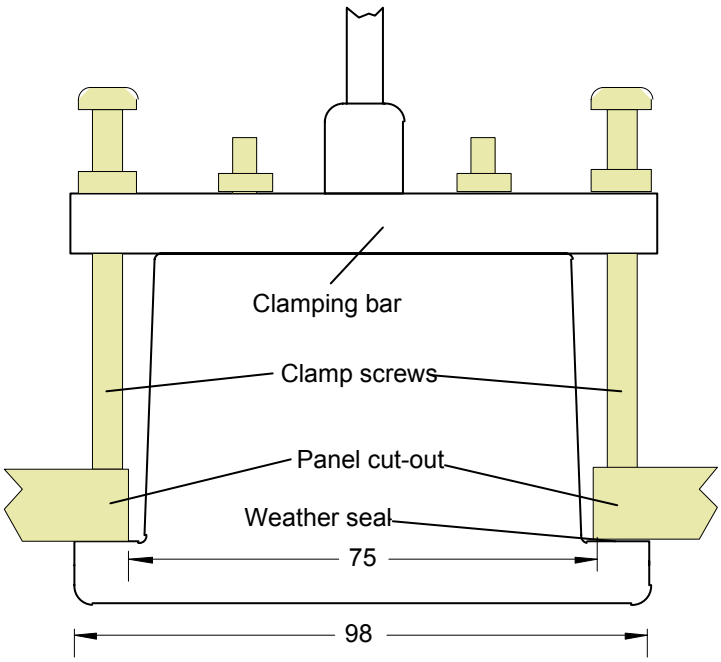


Figure 3.3 Mounting detail for the Control Head

Cut a 75 mm (3”) dia hole in the dashboard. If necessary, the clamping bar may be removed from the rear of the Control Head case before inserting it into the hole. Insert the case and re-attach the clamping bar. Tighten the two clamping screws against the rear of the dashboard and tighten the lock-nuts. **Note.** When removing the clamping bar from the case, do not loosen the two nuts which sit against the back of the case - these support internal components in the 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, 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.

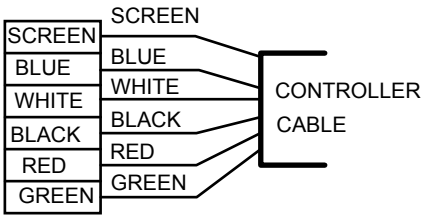


Figure 3.4 Controller cable connections.

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.

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

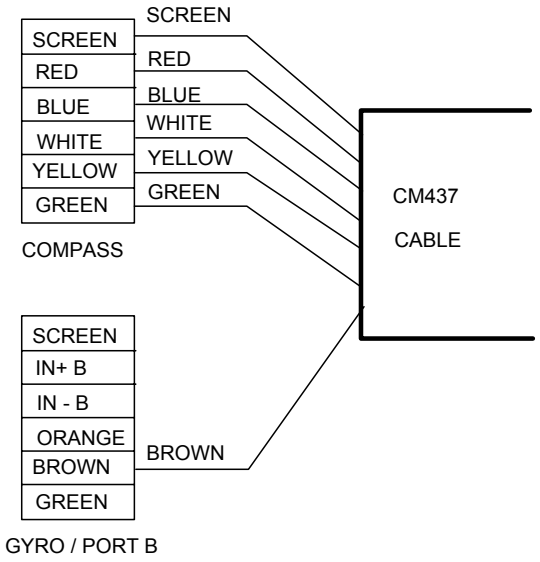


Figure 3.5. Connections for a CM437 Rate Gyro Compass.

Steel Vessels

Though the CM80*i* 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.

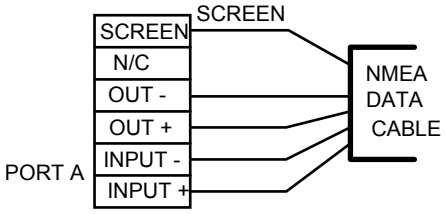


Figure 3.6 NMEA data cable connections – Port A.

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 CM80*i* system is intended for use with existing hydraulic steering systems. If the CM80*i* 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 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.

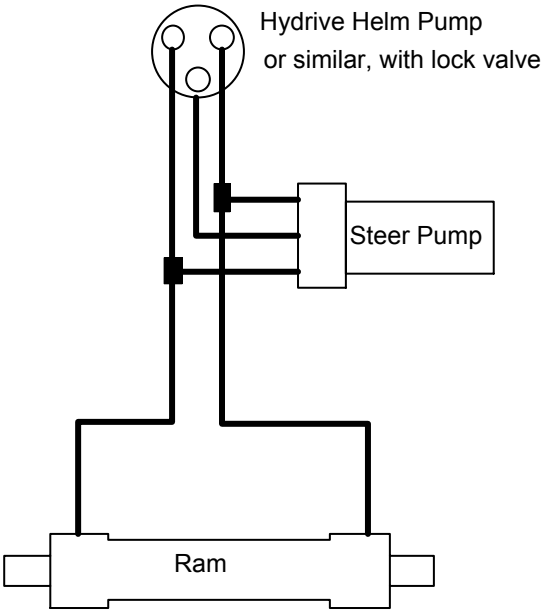


Figure 3.7 Connection to a typical two-line system

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.

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 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. Finally, air in the hydraulics, or free-play in the steering drive will also cause steering problems.

4.2 ERROR MESSAGES

The CM80*i* 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. They are listed alphabetically below and users are advised to read

through the list so that they know which ones call for action. After each message follows the direct condition which triggers the message, the response of the CM80*i* to the condition and a list of possible causes. By using this as an aid, many problems can be fixed simply by the owner. If the assistance of a Coursemaster agent 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, the motor drive current has exceeded the rated current for 1 second and the internal check for reaching the helm stops has failed. 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 fault is corrected.

Causes.

The most likely cause is that the vessel has been allowed to drift while in PILOT and the system continues to apply correction while the helm is ineffective. Care should be taken to avoid this happening, as it placed additional stress on the steering gear.

The fault can occur if the hydraulic pump motor has stalled because of an internal or hydraulic fault. 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.

5 SYSTEM SPECIFICATIONS

AUTOPILOT

Supply Voltage Range (nominal)	12 to 14V dc
Maximum Supply Voltage Range	10 to 16V dc
Supply Current	
Basic system in STANDBY	0.33A
In Pilot with 20% duty	2.5A
Compass	Fluxgate
Typical deviation	2.5 deg rms.
Steering Drive	
Output for 12V supply	10V (min) at rated load
Max continuous current	16 A
Max current for 15 sec.	30A
Max current for 1 sec.	50A

Recommended rudder response times:

Hull length 5 to 10 m	7 to 10 sec. for -20 to +20 deg

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 agent for cleaning and rectification.

6.2 INSTALLATION OF NEW SOFTWARE

It is recommended that software upgrades be installed by a Coursemaster agent, 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 CM845V..... 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.