

COURSEMASTER

AUTOPILOTS

Australia's world leader in autopilot technology

CM880 SYSTEM MANUAL

09-08

CM880 SYSTEM MANUAL

Your Coursemaster CM880 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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THIRD EDITION

This edition of the CM880 System Manual applies to autopilots fitted with software Version 1.10G or higher.

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OPERATING SUMMARY

- Install and check the system as described in Chapter 3.
- Turn the main switch to STANDBY to turn the system on.
- Steer to the desired course and turn the main switch to PILOT.
- Use the course knob to change course and the arrow keys to trim the course.
- To steer a course set by a GPS system, turn the main switch to NAV.
- Use the rudder factor knob to adjust the strength of the helm response.
- Use the Yaw knob to control the compass deadband, or yaw, and the Rate knob to set the amount of counter-rudder.
- The manual Trim knob may be used to compensate for weather helm.

CM880 OWNER'S MANUAL

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CHAPTER 1 SYSTEM DESCRIPTION

1.1 INTRODUCTION TO AUTOPILOTS

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

The four basic components of an autopilot are a compass, an electronic control box, a rudder angle sensor (transducer) and the steering drive. See Fig 1.1.

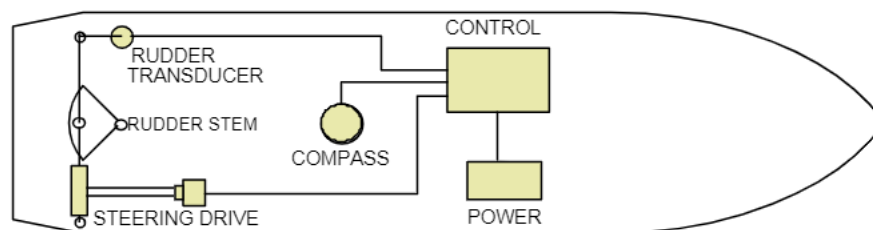


Figure 1.1 Basic components of a marine autopilot.

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

1.1.1 THE REFERENCE COURSE

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

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 and the effectiveness of its rudder. This choice is managed by two adjustments which the user can make and are described below.

Rudder

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 can cause 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.

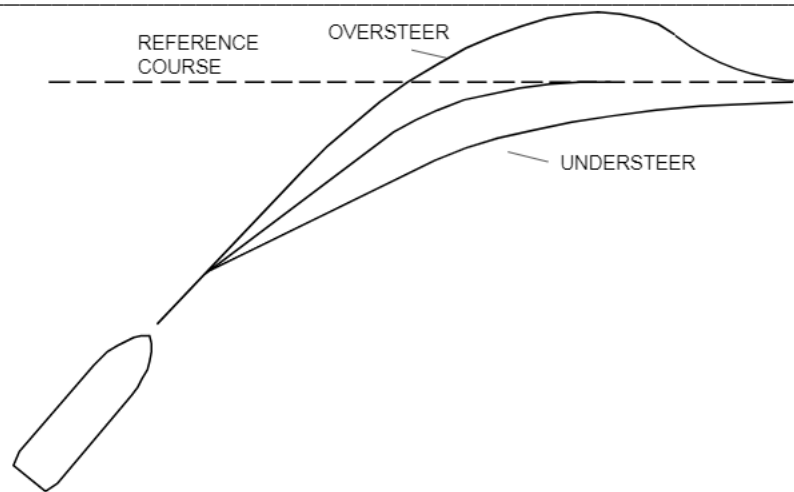


Figure 1.2. Illustration of oversteer if the rudder factor is set too high and understeer if it is set too low.

Yaw

When the vessel rolls and yaws in a heavy sea, rudder activity can be quietened down by not reacting to small heading shifts. The Yaw control introduces a dead-band in the compass heading to achieve this, but full control is applied as the heading shift becomes larger.

Counter Rudder

The Counter Rudder or Rate control is intended for vessels whose helm response is slow and/or continue to turn for some time after helm is removed. In this mode, normal helm is applied to start the vessel turning. As the turn rate builds up, the helm is backed off. When the vessel is close to the reference course, reverse helm or counter-rudder is applied to stop the turn.

The action of Counter Rudder during a turn is illustrated in Fig 1.3. Generally, vessels using Counter Rudder (Rate) can operate with a higher Rudder Sensitivity setting. They hold a course better but change course more slowly. This mode also improves control for most vessels operating in a following sea.

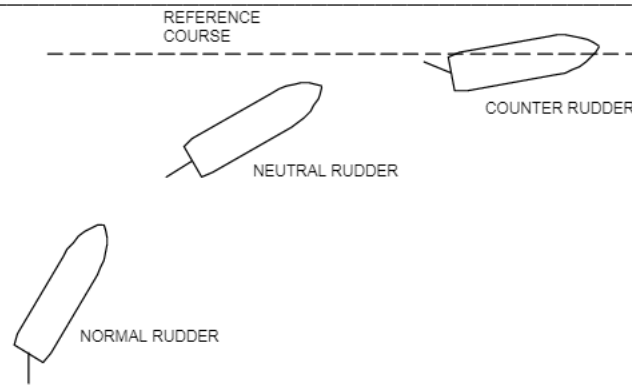


Figure 1.3 Counter Rudder action during a turn.

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. This can be done automatically by the autopilot or, in the case of the CM880, can also be done manually.

1.1.3 POWER STEERING

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

1.1.4 OPTIONS

The autopilot commonly uses a fluxgate compass for its heading measurement. Such compasses, though effective, suffer from acceleration errors on smaller vessels and a very effective way to reduce these errors is to combine a fluxgate with a rate-of-turn gyro. A further option is to fit a pickup device (slave) on the ship's compass and take advantage of its dynamic performance and the fact that it has been magnetically compensated. This version of the CM880 also offers the option of using a digital heading input from a ship's gyro or other electronic heading sensor. The autopilot has built-in facilities for automatic or manual compass calibration.

When connected into an NMEA data system, the autopilot can receive navigation data, as mentioned above or wind direction data. Some of this data, which is not used for autopilot operation, is displayed on the autopilot screen for convenience. There are two digital data input ports and the system automatically reads data from both. The

autopilot generates output data containing the current heading, which can be fed into a plotter or radar system.

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

1.1.5 WORKING WITH OTHER EQUIPMENT

The physical and electrical environment in a boat can be harsh. This autopilot has been engineered with this in mind and tolerates poorly regulated power supplies, overloaded steering, radio transmitters, radars and the like. Conversely, it has also been engineered to operate without causing interference to radio receivers and other communications equipment. 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 in this environment. Please study and follow them!

1.2 THE CM880 SYSTEM

The full system, with its optional attachments, is shown in Fig 1.4.

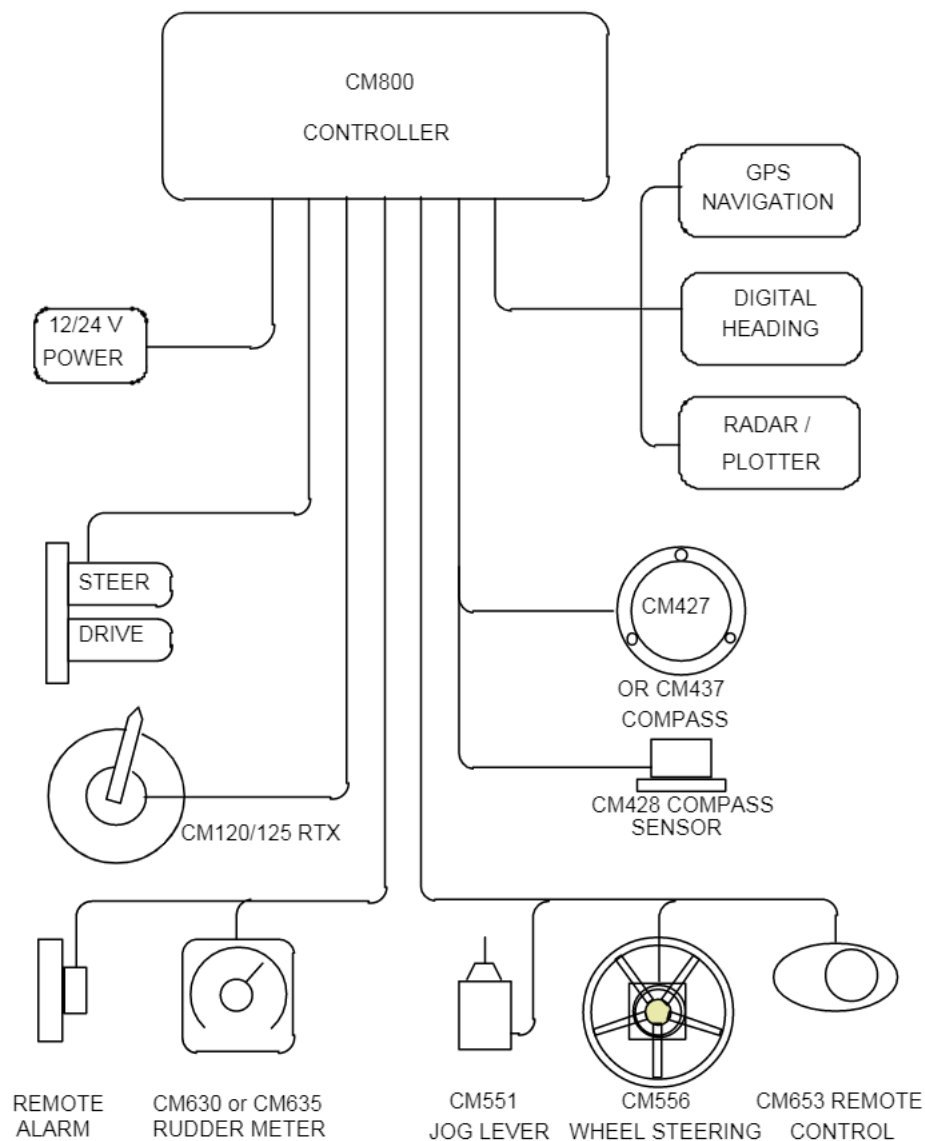


Figure 1.4 System Configuration, showing standard and optional attachments.

CM880 Controller

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

The front panel has six knobs for the main controls and three push-buttons to select and adjust other functions. An LCD display shows information on the current operation of the autopilot.

Compass

The system uses a CM427 electronic fluxgate compass to measure the heading, or a CM428 compass follower which is 'slaved' to the ship's compass. The CM880 also supports a rate gyro input, when coupled to a fluxgate sensor. Rate gyros are not normally used with large vessels, but if required, the CM437 Rate Gyro Compass can be fitted instead of the CM427.

Rudder Transducer

The standard rudder transducer is a CM120, which is suitable for recreational vessels. For commercial vessels, the heavy-duty CM125 is recommended. Both are fully sealed potentiometer types and are interchangeable.

Steering Drive

The CM880 is intended for solenoid-controlled steering systems, but may also be used, via relays, to control a reversing hydraulic pump or a direct mechanical steering drive.

1.3 OPTIONAL ATTACHMENTS

Remote Steering

A number of remote steering options are available. The CM653 is a hand-held remote control with a cable and a single knob. Rotating the knob away from its centre position activates the remote control function. The CM654 is similar, but is fitted with a steering knob and a three-position switch (PILOT-STANDBY-HAND/REMOTE).

The CM551 is a panel-mounted Jog Lever and the CM556 is heavy-duty steering wheel hub suitable for a full power-steer second station. Finally, a mode switch to switch between STANDBY and PILOT is available as part number CM553.

Rudder Angle Indicator

This indicator gives an analog display of the rudder angle and may be located either with the Controller or on another part of the vessel. It is available in two versions: the CM630, which is a moving needle meter and the CM635, which is an electronic meter with an LED display.

Remote Alarm

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

CHAPTER 2 OPERATING INSTRUCTIONS

2.1 THE CONTROL PANEL

The front panel of the Controller is shown in Fig 1. This section describes the use of the controls.

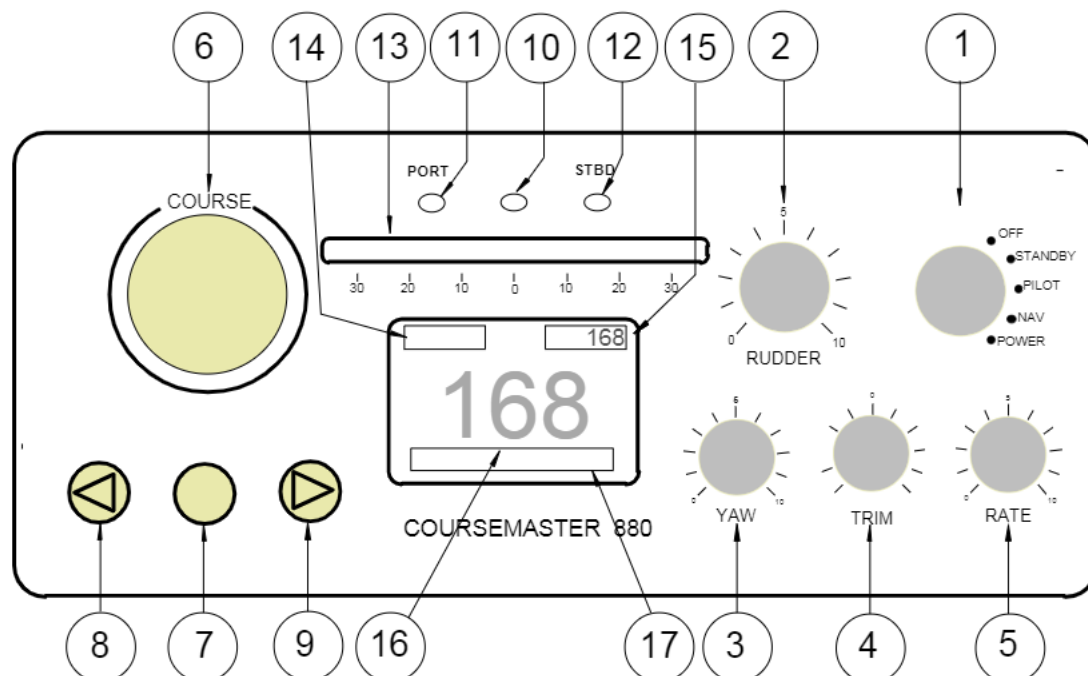


Figure 2.1 The Control Panel

1. MAIN SWITCH

STANDBY	Switches the system on, but no power is applied to the steering drive.
PILOT	The current heading is stored as the reference course and the steering drive is turned on.
NAVIGATE	The steering drive is on. The reference course and cross-track error are received from a GPS system
POWER	The steering drive is on and the rudder angle is controlled by the Course knob (6) for hand steering.

2. RUDDER

Controls the amount of helm applied for a given course error.

3. YAW

This Introduces a variable dead-band in the course error.

4. TRIM

Adjusts the neutral position of the helm to compensate for weather and other offsets.

5. RATE

Controls the amount of counter rudder applied to compensate for the turning inertia of the vessel.

6. COURSE

Adjusts the reference course in 5 deg steps.

7. MODE

Used to select the display, cancel alarms and to access the internal program menu.

8, 9. LEFT/RIGHT KEYS

Used to trim the reference course when in pilot mode or to adjust system settings when the menus are displayed.

DISPLAY

10, 11, 12. COURSE LAMPS

The amber lamp indicates that the vessel is on course within 8 degrees. The red or green lamps indicate an error greater than 9 degrees.

13. RUDDER ANGLE

An illuminated bar display shows the coarse rudder angle in 2 deg. steps.

14. OPERATING MODE

The top left of the display shows the operating mode of the autopilot, eg STANDBY, PILOT, POWER, REMOTE, JOG.

15. REFERENCE COURSE

The top right shows the reference course, if in 'local' mode, or shows an alternating heading-to-steer and cross-track error in the NAV mode.

16. HEADING

The main digits show the current heading. If a fluxgate or compass slave or HDG digital heading input is used, the heading is 'magnetic'. If a digital HDT input is used, the heading is 'true'.

17. ALARM DISPLAY

If an alarm occurs, the message is shown here.

2.2 GETTING STARTED

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

To switch on for the first time, turn the power switch to STANDBY. The system enters a special mode to ensure that the steering drive and rudder transducer have been phased correctly. After the SELF TEST display, the screen will show:

SYSTEM SETUP

PROCEED >

SKIP <

There are two choices. If you wish to examine some of the autopilot features without carrying out the setup, press the LEFT ARROW. This will bypass the setup and will permit various displays to be examined. However, the system will not switch into PILOT.

To carry out the setup, follow these steps:

1. Press the RIGHT ARROW key. The display shown below on the left appears and allows you to select the hull length of the vessel. Making this selection automatically adjusts the range of steering controls to suit a typical vessel of that size.
2. Press the MODE key. The display shown below on the right appears for the selection of the heading input. The 'magnetic compass' option applies to a fluxgate or a compass slave. Press the right arrow to select one of the digital heading inputs - either HDG or HDT. Then press the MODE key again and the set-up is complete.

HULL LENGTH

10 - 30 M

USE < >

PRESS MODE

HEADING

MAG COMPASS

CHANGE < >

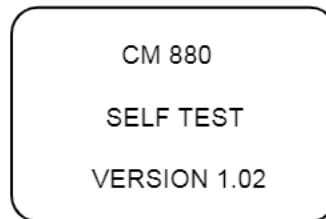
PRESS MODE

If a digital heading was selected and no data is coming in, the NO HDG DATA alarm will now appear. The beeper will become silent after 10 seconds and this alarm can be ignored until the autopilot is to be used.

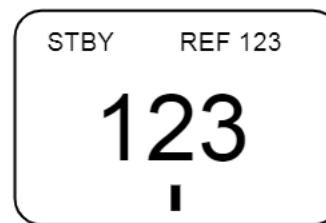
2.3 NORMAL OPERATION

SWITCHING ON

Turn the power switch to STANDBY. The system does a self-test for 6 seconds and displays the version number of the software installed, eg:



When the self-test is complete the normal STANDBY display appears and shows the current heading of the vessel.

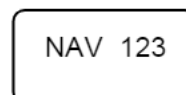


AUTOPILOT

With the system in STANDBY, steer the vessel to the desired heading and turn the switch to PILOT. The autopilot will now lock onto that heading and maintain it. The display will show 'PILOT' in the top left corner.

AUTONAV

If a GPS receiver or other source of navigation data is connected, the vessel can be steered to head towards a waypoint with a minimum cross-track error. Turn to NAV to turn on auto navigation. If only heading-to-steer data is being received, the top right of the display shows this heading, eg.



If the cross-track error is also being received, the vessel steers to minimise the error and the top right of the display alternates between the heading-to-steer and the cross track error, eg.

XT 0.07 L

If NMEA data is not being received, the top right of the display reads:

NAV WAIT

and the vessel will continue to hold the previous reference course. If this message does not clear within 15 seconds, consult the NMEA installation section of Chap 3.

POWER STEER

To steer the vessel manually, switch to POWER. The current position of the helm is now held and may be turned port or starboard by the COURSE knob. Half a turn of the knob produces the maximum a rudder angle of 25 degrees.

RUDDER FACTOR

The RUDDER FACTOR knob gives a continuous control of the amount of helm applied for a given course error. For most vessels, a factor between 30% and 50% of maximum is best. Too low a setting will give a soft course holding and slow course changes, while too high a setting causes over-steering and may make the vessel 'snake' from side to side around the programmed course. If the vessel is fully laden or travelling at 6 kt or less, a Rudder Factor of 80% may be more suitable.

The maximum rudder sensitivity depends on the hull size setting as follows:

Hull Length	Max sensitivity - deg helm/deg off course
10 - 30 m	1.4
30 - 80 m	2.8
80 - 200 m	4.2

In smooth water, the vessel should hold course within 3 deg and on the open sea, it should hold course within 5 deg.

**ADJUSTING
THE COURSE**

To adjust the current heading, turn the COURSE knob. The reference course shown in the top right of the display will change in 5 degree steps for each click in the knob position. For fine adjustments in 1 degree steps, press the left or right arrow keys. The top right hand corner of the display shows the new reference course.

Note. In the auto navigate mode the reference will not change, since it is controlled by the GPS or other navigation device.

YAW

The Sea State control applies a compass deadband which is adjustable from 0 to 10 deg. In smooth water, this can be set to zero, but in heavy seas it should be increased to reduce excessive rudder motion.

RATE

A counter rudder mode which applies a correction according to both the error and the rate of turn. When turning towards a course, reverse helm is applied before the course is reached, in order to cancel the turning momentum. The Rate factor is set according to the turning inertia of the vessel. If the Hull Size option has been set correctly, the RATE knob is normally set between 20% and 40% of full scale. The range and the time-constant used in the counter rudder control changes automatically according to the hull length selected.

The best way to check the Rate setting is to carry out a course change of 20 - 30 deg. If the vessel turns past the course by more than 3 deg., increase the Rate setting. If the turn becomes very slow before it reaches the reference course, reduce the Rate setting.

TRIM

The manual Trim control has a range of +/- 10 deg and can be used at any time to compensate for weather helm. If autotrim is

also turned on, the latter will work with the manual trim to hold the heading close to the reference course.

REMOTE STEER

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

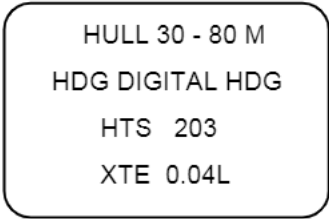
For a remote control with a knob and a switch (CM 654) and wheel steering (CM 656), REMOTE is activated by switching to REMOTE. The rudder angle now follows the knob position. When it is switched back to PILOT, the current heading becomes the reference, or in NAV mode it reverts to the GPS heading to steer. For the unswitched remote control (CM 653), moving the knob away from the centre automatically puts the system in REMOTE and it returns to PILOT when the knob is centred. For a jog lever (CM551), moving it places the system in REMOTE and runs the helm out until the lever is released. When it is released, the helm stays in that position. The system is returned to PILOT by switching to STANDBY and back to PILOT.

The CM880 system responds to the most recent input from either the control panel or a remote attachment. Therefore, when the system is turned on, the setting of all remotes is ignored until some input is made to them. Similarly, switching to STANDBY on the control panel will override a remote. If two remote attachments are fitted, the system responds to whichever has been used most recently.

2.4 THE MODE KEY

The MODE key cancels alarms if they are present, returns the system to normal after using a Jog Lever and gives access to alternative displays and program menus.

SYSTEM DISPLAY Pressing the MODE key once brings up a screen which displays the selected hull length and the selected heading source. If navigation data is being received from the GPS or other device, the heading-to-steer and cross-track error are also displayed.



HULL 30 - 80 M
HDG DIGITAL HDG
HTS 203
XTE 0.04L

Parts of the display may be blank if some of the data is not available and if no valid NMEA data is being received, the screen reads WAITING FOR DATA.

2.4.1 PROGRAM MENUS

Three program menus give access to a number of system settings which may be used to fine-tune the performance and select various options. Adjusted settings are stored in permanent memory and are retained while the system is turned off. Hold the MODE key for 2 - 3 seconds. The screen reads:

MENU 1 PRESS MODE

MENU 2 PRESS >

MENU 3 PRESS <

The content of the menus is summarised below. Select one and use single presses of the MODE key to scroll down. **To exit the menus** at any time and return to the normal display, **hold down the MODE key for 2 - 3 seconds.**

MENU 1

BACKLIGHT 3

RATE GYRO OFF

HELM ADJUST 00

MAG COMPASS

HEAD ADJ 027

AUTO COMP CAL

MAN COMP CAL

COLD START

MENU 2

RUDD LIMIT 22

HULL 10 – 30 M

MAN TRIM ON

TURN RATE 4

HELM ALERT 0

VARIATION 013

NMEA OUT HDG

MENU 3

COMPASS MON

HELM DAMP 3

HELM DEADBD 1

AUTOTRIM 1

STALL ALM ON

PANEL 5351

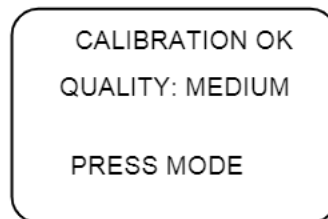
STEP STEER OFF

Menu 1

BACKLIGHT	The backlight for the display can be set to 4 different brightness levels. Use the arrow keys to adjust.
RATE GYRO	If a CM437 Rate Gyro Compass has been fitted, it is activated by pressing the right arrow to turn it on. If a rate gyro is not fitted, leave this option off, otherwise the heading response will be slowed down and the steering will be compromised.
HELM ADJUST	For best overall performance, it is recommended that the displayed rudder angle be adjusted to read zero when the helm is dead ahead. This adjustment compensates for errors in the transducer linkage and other offsets in the steering gear. The current helm angle is displayed and should read 00 at the centre. Use the arrow keys to trim the reading.
HEADING SOURCE	Repeats the heading source options used in the original set-up.
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 will read:

TURN 360 DEG
TURN PROGRESS
012

With the vessel under way and steering it by hand, turn it slowly through a full circle. The display shows the angle turned through, relative to the starting point. You may turn in either direction, but should continue in that direction until finished. When the circle is complete, the display shows a report on the quality of the field and calibration, eg:

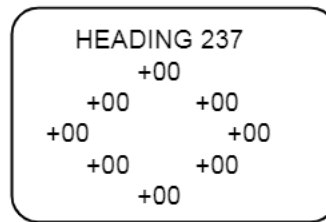


The results is for guidance only, but a 'poor, calibration result indicates that more attention should be given to the location of the compass. (Sec 3.3) If auto-calibration is used with a slave, the field measured is that of the card compass and does not indicate the field quality in the vessel.

Press the MODE key to return to normal operation. This method of calibration is simple and is a recommended procedure for all vessels. But there are some magnetic anomalies which are not fully removed. Fine-tuning the calibration, after the automatic step, gives the highest level of compass accuracy.

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 and the display shows the current heading and shows the deviation stored for each of the eight cardinal and inter-cardinal points. (All deviations are initially zero, even if an auto calibration has been carried out.)



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 deg.

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 MODE.

The 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. The System Setup must be done again after a Cold Start. When the Cold Start prompt appears, press the right arrow. After the presets have been re-loaded, the display confirms that a Cold Start has been carried out. Press Mode to commence the set-up.

Menu 2

RUDDER LIMITS

This setting controls the maximum rudder angle used when the system is in PILOT mode. It is preset to 20 degrees and may be

changed using the arrow keys. It must always be less than the mechanical limits of the steering system.

HULL SIZE

Repeats the selection options available during set-up.

MANUAL TRIM

This provides an option to disable the manual trim knob and rely only on automatic trim.

TURN RATE

The turn rate of the vessel during course changes may be set, over the range 1 - 6 deg/sec. If the turn rate is set high in larger vessels, the rate will be limited by the maximum helm applied.

HELM ALERT

As a safety feature, a HELM ALERT alarm is sounded after a selectable delay of 5, 10 or 15 minutes. One minute before the alarm sounds, the HELM ALERT message flashes at the top of the normal display and is cancelled by pressing the MODE switch. This is an aid to ensure that the helmsman is keeping watch. This function may be switched off, but we strongly recommend that it be left switched on.

**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 COURSE keys to adjust the variation.

NMEA OUTPUT

The Controller may be set to transmit the current heading using either the HDG (magnetic) or HDT (True) sentence. In some versions there may also be a SIM option. This is used in factory tests and is not intended for normal use.

COMPASS MONITOR	Used to measure fluxgate output voltages for diagnostics.
HELM DAMPING	The Helm Damping control compensates for inertia or overshoot in the steering drive, which may be present in most hydraulic or electrical systems. To check the suitability of the preset value of 3, turn the helm manually to about 20 deg. rudder angle and press PILOT to centre the helm. Observe the rudder movement. If the rudder stops short and then "inches" into the centre position, reduce the damping factor. If it overshoots and "inches" back, increase the damping factor. (In some versions the setting of Helm Damping may be automatic and this option will not appear.)
HELM DEADBAND	The deadband acts as a filter which prevents the steering drive from pulsing on and off in response to very small error signals. If it is set too high, the steering will be slow to respond to small corrections. The best setting is one just above the value which produces continuous pulsing of the steering gear.
AUTOTRIM	The autotrim continuously adjusts the helm centre by averaging the course errors over time. A setting of 2 is recommended, but it may be increased if the vessel takes too long to settle on course in the presence of offsetting wind or current forces. Autotrim is disabled by setting it to 0.
STALL ALARM	The Drive Stall alarm is activated after a Cold Start, but this option may be used to disable it, if necessary. We recommend that it not be disabled for normal use.
PANEL KNOBS	A diagnostic display for checking the settings of the panel knobs.
STEP STEER	For vessels above 30 m this introduces a steering law which minimises rudder activity during course holding. It is not used

for the smallest hull size range. The factory setting turns it off, but it may be switched on if desired.

2.5 ALARMS

The CM880 has a number of alarm functions. When an alarm occurs, the beeper sounds and an alarm message appears in the centre of the normal display. To cancel an alarm, press the MODE key. If the alarm is non-urgent, the beeper becomes silent after 15 sec., but the alarm message remains on the display.

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 by pressing the MODE key.
HELM ALERT	In PILOT mode, this sounds at preset intervals as a safety feature to ensure that the wheel is attended. (See Menu 3 for more details.)
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.
DRIVE STALLED	If the steering drive is activated and the helm moves less than 1 degree in 2.5 seconds, the system is switched to STANDBY and this alarm is set.
RUDDER OVER RANGE	Either the rudder has travelled past the limits set during System Setup or an electrical fault has developed in the Rudder Transducer. The system switches to STANDBY.
RUDDER OVER RANGE	The rudder has travelled past its preset limits and the drive has been turned off. This could indicate a mechanical or electrical problem with the transducer. (See Chap.4). The limits are set during the System Setup operation.

- COMPASS FAULT** The magnetic field being sensed by the compass is above or below preset limits. Further information is given in Chap. 4. This alarm is disabled if a digital heading input is used.
- NO HEADING DATA** If a digital heading input has been selected, a valid heading sentence is not being received.
- FULL HELM** The beeper does not sound when this message appears. It is simply an advisory message that the helm has reached the preset pilot limits.

5. Connect the steering drive as described in Sect 3.5
6. Apply power to the Controller. Now turn to Section 2.2 of this Manual - Getting Started - and carry out the initial setup as described.

3.1 CONTROLLER

The Controller may be either flush mounted in a dashboard cut out or surface-mounted using the bracket provided. It should be protected from the weather. The rear of the case should be easily accessible for making connections and that there is a space of at least 50mm on all four sides to permit air circulation.

All connections to the Controller are made via external locking plugs. The plugs are fitted with solder cups for cable termination. Some attachments are shipped with cables already terminated in plugs, but installation may require the cutting of cables or temporary removal of plugs. It is important to ensure that screens are connected through from the attachment to its respective plug.

A rear view of the Controller sockets is shown below in Fig 3.1.

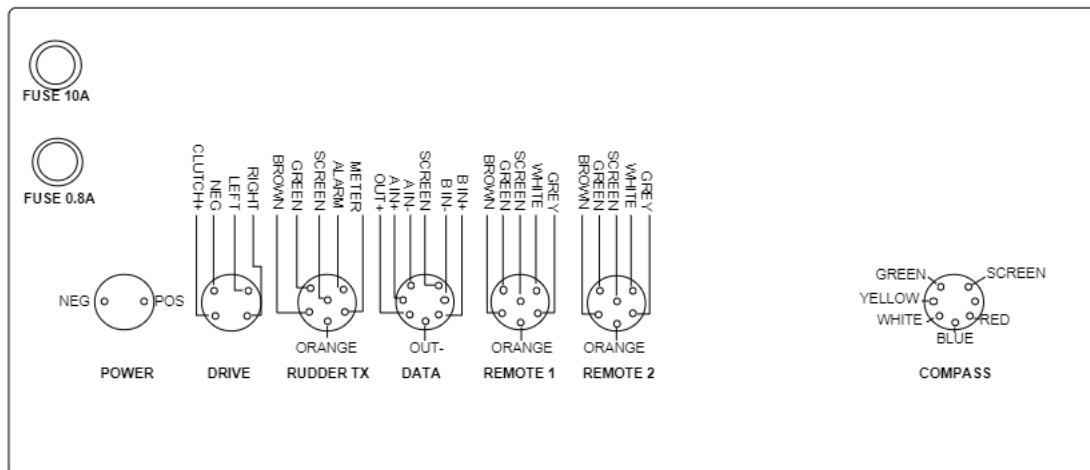


Figure 3.1 Rear view of the CM880 Controller.

For flush mounting, make a cut-out in the dashboard 264 mm wide and 118 mm high. Attach the clamping plates to each side of the case using the short M6.0 screws provided. Insert the Controller in the cut-out and tighten the four clamping screws as illustrated in Fig 3.2. Finally, tighten the lock-nuts on the clamping screws.

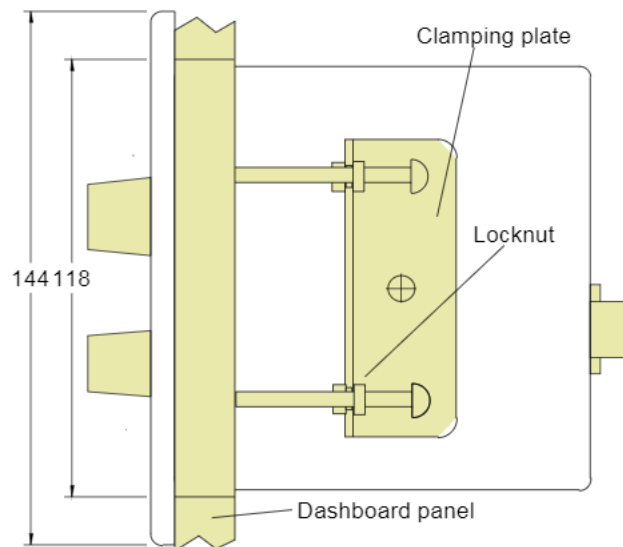


Figure 3.2 Detail of flush-mounting option.

For surface mounting, use the tilt bracket supplied and clamp the case in the bracket using the moulded knobs.

Before commencing the wiring, remove the fuses from the holders at the rear of the case.

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 10 amp twin-core cable to the vessel's supply and terminate it in the power plug. We recommend inserting a 10amp switch between the Controller and the power bus so that the CM880 can be isolated during unattended periods. Connections to the steering drive are given in Sec 3.5.

3.2 COMPASS

The compass to be fitted is either a CM427 fluxgate a CM437 gyro fluxgate or a CM428 compass slave. The guidelines below apply mainly to a fluxgate. If a compass slave is fitted, it is mounted on the window covering the ship's compass card and the autopilot performance then depends on the performance of the ship's compass. The connections for all three are shown below in Fig 3.3. (The brown wire is only used by the CM437.)

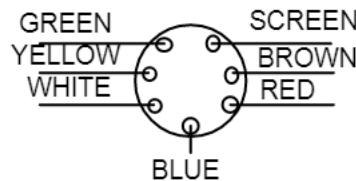


Figure 3.3 Cable connections for a CM427 fluxgate, CM437 gyro fluxgate or CM428 compass slave.

The CM427 or CM437 is mounted on a vertical surface, with its mounting flange towards the bow and its cable gland facing down.

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. 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 carries 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 steel vessel are given below.

STEEL VESSELS

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

1. In the first instance, try 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.
2. As an initial check, complete the other steps in the installation and turn the autopilot on to STANDBY. Turn the vessel through a full circle, noting at 45 deg. intervals the difference between the heading displayed and a reference (ship's) compass.

Should the deviations exceed 15 deg in any position, keep re-siting the compass until a position giving less than 15 deg. error is found. If errors still exceed 30 deg., the compass should be mounted above deck level, preferably in the dog house near a window. If this is done, repeat (2) above.

If no position is found giving less than 15 deg deviation, the services of a compass adjuster should be sought. The autopilot will not operate satisfactorily with compass deviations above about 20 deg.

We recommend that a compass calibration (See Sec 2.4) be carried out after completing the installation.

3.3 RUDDER TRANSDUCER

Mount the rudder transducer next to the rudder post. The transducer should normally have its arm uppermost, but may be inverted if this is more convenient. The linkage schematic is shown in Fig 3.4. When fitting it is important that the effective lengths of the transducer arm and the quadrant or tiller arm (marked D1) be equal to each other and that the connector arm be the same length as the spacing between the transducer and rudder post (D2). This is to ensure that the transducer angle tracks the angle of the rudder. Mount the transducer so that its arm is over the cable entry point when the rudder is centred.

When carrying out the setup procedure (Sec 2.2) later on, it may be necessary to adjust the zero position of the transducer. To do this, loosen the nut clamping the transducer arm to its shaft. Using pliers, slowly rotate the shaft until the reading is correct and re-tighten the clamping nut.

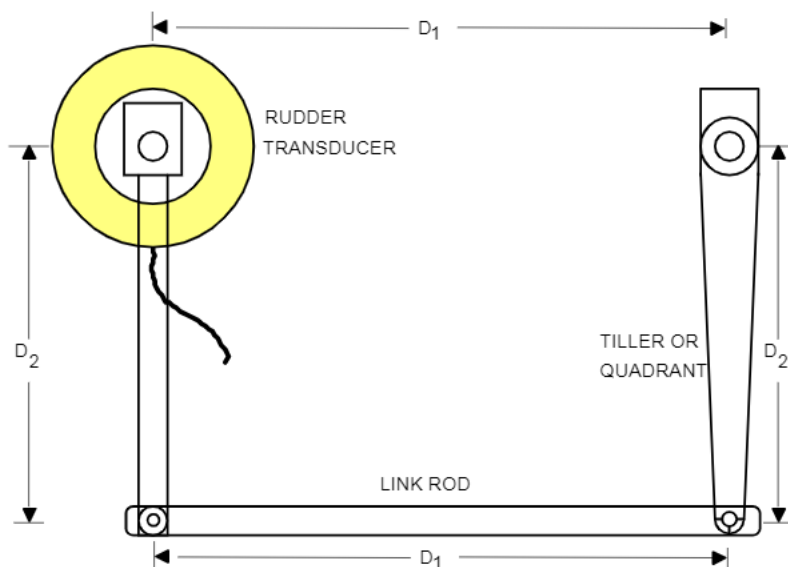


Figure 3.4 Rudder Transducer Linkage

Lay the cable back to the Controller and terminate it in the Rudder Transducer plug.
(Fig 3.5)

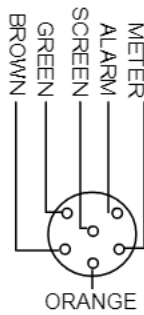


Figure 3.5 Rudder transducer connections.

3.4 ATTACHMENTS

3.4.1 REMOTE STEERING

The Junction Box has two Remote ports. Either or both ports may be used for remote controls.

Most of the of remote steering options use a five-wire cable, which is connected as shown in Fig 3.6. The CM551 Jog lever uses a three-wire cable and uses the same colour code as the five-wire cable. The four-wire CM553 switch also uses the same colour code.

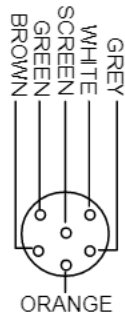


Figure 3.6. Connections for attachments to the Remote 1 or Remote 2 sockets.

3.4.2 RUDDER ANGLE INDICATOR

The CM630 Rudder Angle indicator is a two-wire meters which is connected between the METER and ORANGE pins on the Rudder Transducer socket. (Fig 3.5) It also has a 12V back-light which should be connected to a suitable power source. If a CM635 is fitted, connection instructions are supplied with the meter.

3.4.4 REMOTE ALARM

A piezoelectric beeper is available which repeats the internal alarm and key beeps of the Controller. This two-wire unit is connected between the ALARM and GREEN terminals of the Rudder Transducer plug (Fig 3.5). Any beeper may be used which is compatible with the drive available of 35mA (max) at 10V dc.

3.4.5 NAVIGATION INTERFACE

The NMEA socket (Fig 3.7) provides two input ports, A and B and one output port for a data cable using RS232 or RS422 signal levels. The data cable is normally connected to a navigation system and/or cockpit display instruments which use the NMEA 0183 standard. There is one pair of output terminals at the centre of the socket. If there is one input source, it may be connected to either port.

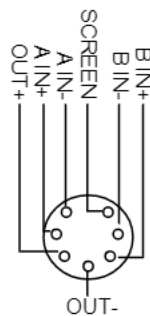


Figure 3.7 NMEA data socket connections.

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

To check reception, turn the system on and press the MODE key. The display may now show:

WAITING FOR DATA

and may remain for up 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. 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. The CM880 can select data from a number of NMEA sentences and carries out an automatic search for the most suitable sentences. Details of the suitable sentences are given in Chap 5.

The NMEA output port sends either the HDG (magnetic) or HDT (true) heading sentence.

3.5 STEERING DRIVE

The CM880 is intended primarily for coupling into a solenoid-controlled hydraulic system. It may also be coupled to a hydraulic linear drive, using a reversing pump, or into a direct-drive mechanical system. Note, however, that a relay interface must be used when driving a reversing pump or mechanical drive. For existing hydraulic systems using a helm pump, instructions are given below (3.5.2) for adding a Coursemaster/Hydrive pump motor. But for systems supplied by other manufacturers, installers should consult the data supplied by the manufacturer.

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

3.5.1. SOLENOID CONTROLLED HYDRAULICS

The motor-drive output of the Junction Box is suitable for direct connection to flow-control solenoids, provided that their operating voltage is the same as the supply voltage to the CM880 and the solenoid current does not exceed 5 amp. The connections to the Drive socket in the Controller are shown below in Fig 3.8. Relay interfaces are connected in the same way, by substituting them for the flow control solenoids. Power to the relay-controlled motor is drawn from an independent supply - not from the Controller.

IMPORTANT: Before connecting the solenoids, make sure that their wiring is not connected to ground or any other part of the vessel's wiring.

Also, if the pump has a flow control, this must be adjusted so that the rudder slew rate lies within the limits specified in Chap 5.

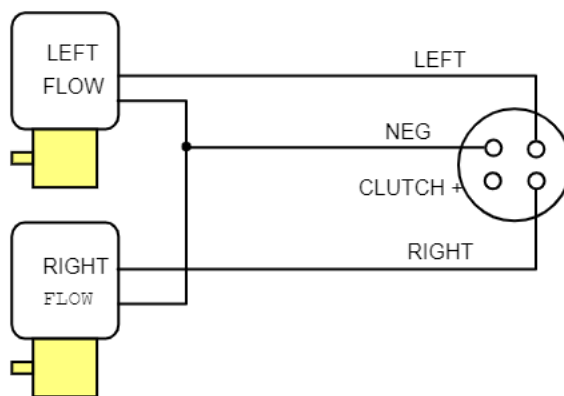


Figure 3.8 Connection to flow-control solenoids.

3.5.2 HYDRAULIC SYSTEM WITH REVERSING PUMP

Connecting autopilot pumps to hydraulic systems from different manufacturers is not difficult and the following guidelines will be adequate for most installations. If there is a doubt about the correct way to proceed, consult the manufacturer of the steering gear. A relay interface must be fitted between the CM880 and the pump (See Fig 3.9).

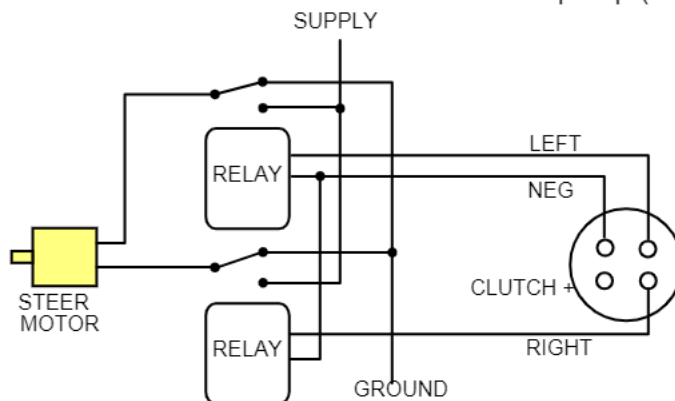


Figure 3.9 Relay interface for a reversing hydraulic pump or direct mechanical drive.

CHAPTER 4 TROUBLE-SHOOTING

4.1 ERROR MESSAGES

The CM880 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 together with a description of possible causes for the alarm condition. By using this as an guide, 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

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. The system is then held in STANDBY and the message can only be cleared by the STANDBY key 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 drive current has exceeded 7A for more than 0.5 second. The system is forced into STANDBY and the message can only be cleared by switching the main switch to STANDBY and back to PILOT after the overcurrent condition is removed.

Causes.

The fault can occur if there is a wiring error, an accidental connection between the solenoid circuits and the ship's power supply or the failure of a solenoid coil.

DRIVE STALLED

The drive is on, but the helm has not moved over a 2.5 second period. The causes for this can be in the steering drive, including excessive air, but it can also be caused by a linkage failure at the rudder transducer. The Drive Stalled alarm may be disabled via Menu 3.

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 not affect autopilot operation and is cancelled by the MODE key.

NO HEADING DATA

If a digital heading input has been selected, a valid sentence is not being received. Trouble-shooting this problem is similar to that for NMEA navigation sentence problems.

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 pressing MODE or switching to STANDBY.

RUDDER OVER-RANGE

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

Causes.

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

4.2 OTHER FAULTS

If there are large voltage spikes on the power supply, the system may reset itself and revert to STANDBY 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 two fuses (See Fig 3.1). Using a voltmeter, check that the correct voltage is applied to the two power terminals and that the polarity is not reversed. Next, disconnect all cables except the power 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 Controller should be returned to your dealer or to Coursemaster for repair.

The CM880 is fitted with an over-voltage trip which operates if the supply voltage exceeds 38V. This will switch the system off until the voltage has fallen to a safe value.

4.3 FUSES

The main 10A fuse (Fuse 1) protects the complete system. Fuse 2 is rated at 0.8A and protects the internal electronics. The most likely event to cause Fuse 1 to blow is an external short-circuit in the steering drive. For Fuse 2, the most likely cause is an excessive voltage surge on the vessel's power supply.

CHAPTER 5 SYSTEM SPECIFICATIONS

AUTOPILOT

Supply Voltage Range (nominal)	12 to 24V dc
Maximum Supply Voltage Range	11 to 32V dc
Over-voltage trip level	38V
Supply Current	
Basic system in STANDBY	0.3A (max)
Compass	Fluxgate in damped suspension or Electronic Compass Slave.
Typical deviation	3 deg peak.
Rudder Transducer	Potentiometer type
Rudder position accuracy	1 deg.
Max rudder angle	+/- 35 deg.
Steering Drive	
Output for 12V supply	10V (min) at 3A
Output for 24V supply	22V at 3A
Max continuous current	7 A
Max current for 0.5 sec.	20A

CHAPTER 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 system software is located on the rear circuit board, inside the Controller. To open the Controller case, unplug all cables and remove the four countersunk screws on the rear face of the case. Carefully separate the case from the front flange and pull it clear until you can reach the plug attaching the ribbon cable to the rear circuit board. Unplug the ribbon cable from the rear board.

