



AP500 Autopilot Display
For use with
C-Drive Motor Control Unit

OPERATION AND INSTALLATION MANUAL

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Warning!

Automatic pilots are designed to be a navigational aid. As an automatic steering aid, an autopilot can alleviate the boredom of hand steering.

This allows the operator of the vessel time to attend to other duties, keep a more accurate check of navigation duties or just relax and enjoy the trip.

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

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

Introduction

Congratulations on your wise choice and purchase of the TMQ C-Drive Autopilot system we are sure that you will enjoy the benefits that it offers.

The C-Drive Autopilot system provides steering control from up to three individual steering wheels or levers.

The C-Drive can drive up to two independent steering units. The drives may be solenoid valves, mechanical motors or reversing pumps. The system facilitates a single or dual rudder system operating from a common input.

See the ***System configuration*** section.

<p><u>Note: It is recommended that some form of emergency steering is also fitted.</u></p>

The minimum C-Drive Autopilot system must comprise of the following units:-

Essential Electronics:

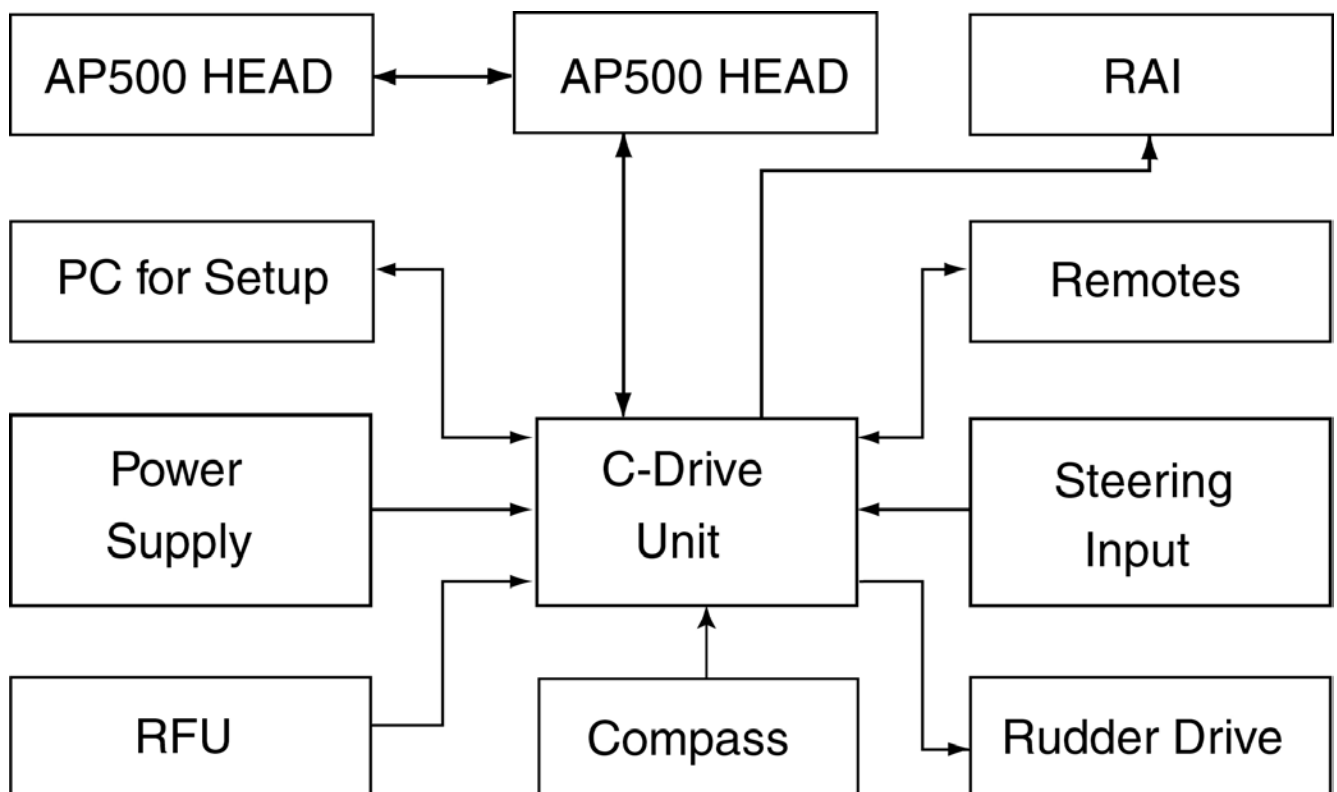
- C-Drive unit
- Rudder Feedback Unit (RFU)
- AP500 display unit or Computer operating software.
- Fluxgate compass
- Drive units, for example
 - Hydraulic system with solenoid valves.
 - Reversing hydraulic pump system.
 - Mechanical motor drive system.

Options:

- Electric steering wheel or lever
- Remote Station Devices including:-
 1. Remote panel
 2. Hand remote
 3. Steering lever
 4. Steering wheel
 5. Rudder angle indicators (RAI), if desired

See Optional Extras at the rear of this manual for details.

Block Diagram of full system



The AP500 head provides full control of the autopilot, indicating both current course and course to steer along with rudder angle.

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

The Rudder Feedback Unit (RFU), must be attached to the steering device in such a way that it can accurately measure the movement of the ship's rudder, see Rudder Feedback Installation diagram page 14. This must also be electrically connected to the C-Drive unit.

The electric steering wheel or lever (FFU) provides the input to the C-Drive unit for the required angular position of rudder. This must be connected to the C-Drive unit.

Rudder drive system, this system provides the physical movement to the rudder responding to the direction control signals provided by the C-Drive system. Rudder Actuator Systems can comprise of the following:-

- Hydraulic Ram controlled by either:-
 1. Solenoid valves connected into an existing power steering system.
 2. Solenoid valves connected to a continuous running motor and pump unit.
 3. Reversing motor and pump unit, connected into an existing hydraulic steering system.
- Mechanical Drive, a reversing motor drive unit with reduction gears to drive the steering system.

Definition of Terms

C-Drive unit:

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

Rudder Feedback Unit (RFU):

This provides the required rudder position information for steering control.

Rudder Feedback Unit Standard (RFUS)

Rudder Feedback Unit Heavy Duty (RFUH)

Two rudder feedbacks are required for an electrical tie bar system. (Either two RHUS or two RFUH.)

Remotes:

These provide the required steering input to the C-Drive unit, Remotes include:

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

Steering Levers:

1. Full Follow Up (FFU); this is a device that provides a proportional control input.
2. Non Follow Up (NFU); this type of device does not provide a proportional control.

Rudder Angle Indicator (RAI); this displays the current rudder position.

Current Course:

The magnetic heading of the vessel at the current time.

Course-to-steer:

The magnetic heading which the autopilot is attempting to achieve.

Display Unit:

The unit with digital display and keypad which is used to send commands to the C-Drive unit. This is also referred to as a steering “station”.

Remote Unit:

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

Additional AP500 Display units can also be fitted to operate the Autopilot from extra locations.

AP500 Display



Overview of Operation

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

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

- **MANUAL Mode:**

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

- **AUTO Mode:**

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

- **GPS Mode:**

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

- **POWER Mode:**

The rudder of the vessel is controlled by moving the Dial , the compass displays the compass heading.

- **REMOTE AUTO Mode:**

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

- **REMOTE POWER STEER Mode:**

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

- **RUDDER and RESPONSE Settings:**

These customise the AP500 Autopilot for your vessel's steering. They may also be used to adjust for varying sea conditions.

- **Compass Calibration:**

The AP500 compass can be calibrated on the vessel using a simple procedure.

- **Rudder Angle Displays:**

The AP500 Display Unit will indicate rudder angle on the screen.

- **Selectable backlighting:**

When using the autopilot at night, 2 levels of backlighting are available.

Turning the unit ON / OFF

Press PWR/OFF to turn on the AP500 Display Unit

Press CLR/OFF and PWR/OFF simultaneously and hold for 10 seconds to turn off the unit.

NOTE:

The above only turns the power on in the Display Unit. Power should be connected to the Motor Control Unit (C-Drive unit) via an isolator circuit breaker. The AP500 Display Unit is powered from the C-Drive unit and the C-Drive unit must have power applied for the display to operate.

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

MANUAL Mode

In this mode

- The display screen shows “Manual”,
- The drive unit clutch is disengaged,
- No steering control is generated,
- The digital display shows the vessel’s current magnetic course.

Possible alarms

- “NO MCU” alarm

AUTO Mode

- Press the AUTO button. AUTO mode will be selected.

Or

- Press the MODE button. Select the mode required by turning the dial, press the dial to select the mode. A beep will sound and the text display will change to “AUTO”.

The autopilot will lock on the current heading.

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

Disengaging AUTO mode:

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

Changing the position of the remote unit switch can select REMOTE AUTO, REMOTE POWER STEER, or MANUAL modes.

Course Adjustment:

Turning the dial will cause a one degree per segment course change in the applicable direction. The display will change to indicate the new course-to-steer.

IMPORTANT!!

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

The AP500 Autopilot will select the position of the rudder when AUTO is selected as the position of the rudder to allow the vessel to steer straight ahead. This can be an advantage in most vessels when a slight amount of helm from the physical centre position is required for the vessel to go straight.

GPS Mode

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

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

Engaging GPS Mode:

Press the MODE button. Select the GPS mode with the dial, press the dial to select the mode.

A beep will sound and the text display will change to “GPS”.

The autopilot will lock on to heading as requested by the GPS. The course-to-steer is shown on the display.

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

If no GPS data is received by the AP500, the autopilot will lock onto the course of the vessel at the time that GPS Mode was engaged, and the “NO GPS DATA” alarm will function.

Disengaging GPS Mode:

Pressing the AUTO button will return the AP500 to normal AUTO mode.

Pressing the MANUAL button will set the AP500 to MANUAL mode.

Setting up your GPS unit:

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

The GPS unit must be set up to output “NMEA 0183” data on a pair of wires which are connected to the NMEA socket on the AP500 C-Drive unit. The data generated must include at least one of the following:

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

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

Under the following conditions:

- several waypoints are linked together into a single route,
- the GPS unit is set and capable of “autosequence” between them,
- an “arrival zone” of more than 0.05 NM (Nautical Miles) is set so that the GPS can detect when the vessel has reached a waypoint, then the AP500 will be able to steer from each waypoint to the next without intervention.

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

Remember:

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

No GPS Data Alarm:

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

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

The course over ground information generated by the GPS unit should closely correspond to the Magnetic Heading signal the AP500 is receiving from its magnetic compass. The greater the difference

between these headings, the less accurate will be the GPS Mode steering.

- Ensure that the GPS unit has the correct magnetic correction factor.
- Ensure that the AP500 compass is correctly aligned and installed, and not subject to magnetic interference.

POWER Mode

Engaging POWER mode:

Press the MODE button, select the POWER mode with the Dial, press the dial to select the mode. A beep will sound and the text display will change to “POWER”.

The autopilot vessel’s rudder position will be controlled by the dial.

The compass heading is shown on the display.

The required rudder position will be displayed on the lower section of the “RUDDER ANGLE” display. The upper section of the “RUDDER ANGLE” display will indicate the actual rudder position.

Disengaging POWER mode:

Press the “AUTO or MANUAL” button, a beep will sound and the vessel will return to selected mode.

Changing the position of the remote unit switch can select REMOTE AUTO, REMOTE POWER STEER, or MANUAL modes.

IMPORTANT!!

Before entering AUTO mode, ensure that the rudder is in the centre position (ie: the vessel is steering approximately straight ahead). If you do not do this, the course indicated would not be the actual course steered.

Rudder Ratio / Sensitivity

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

To adjust, press the SENS/RUD button. The display will show “RUDDER” and the present rudder ratio setting will be displayed (between 1 and 10).

The rudder setting may be altered by turning the dial.

- A value of one signifies the minimum amount of applied rudder. When the rudder setting is too low, vessel track will be a slow “S” ie: understeer through too little rudder applied.
- A value of ten signifies the maximum amount of applied rudder. When the rudder setting is too high, vessel track will be a rapid “S” ie: oversteer through too much rudder applied.

By pressing the SENS/RUD button a second time, the display will indicate “SENS”. This setting is used for adjusting the autopilot’s response to varying sea conditions, and varying vessel capabilities.

The display shall change to show “SENS” and display shall show the current Sensitivity setting (between 1 and 10).

Turning the dial will alter the setting.

-
- A low response value the drive will operate with minimum pulsing to the required rudder position and may overshoot.
 - A high response value the drive will position the rudder with maximum pulsing and reduce the possibility of overshoot

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

Contrast and Backlighting

Pressing the “CONT/DIM” button will display the contrast setting of the LCD display. Adjust by turning the dial. The range of number can be between 1 and 24. If the display is not visible rotate the dial clockwise to increase contrast until the display is visible.

Pressing the “CONT/DIM” additional times will toggle the backlighting between “HI and LOW”

Rudder Angle Indicator

With the Normal display selected from the “MENU” button, the rudder angle will be displayed as graphic bars.

- When the rudder is at centre, there will be a single line in the centre of the display.
- As Port rudder angle is applied, the left bar will grow longer.
- As Starboard rudder angle is applied, the right bar will grow longer.

Initial Settings

Selecting the Initial settings of the Autopilot:

A number of system settings may need to be carried out prior to using the C-Drive Autopilot.

- Compass Calibration
- Rudder Limits
- Off Course Alarm
- Remote Selection

To adjust an initial setting, select MANUAL Mode, press MODE button and select “INITIAL” and push the dial.

Select the required special function with the DIAL and push to select.

Compass Calibration

The compass supplied with your AP500 autopilot has been calibrated after manufacture, and this calibration will be satisfactory for almost all installations. If you have a steel vessel, or some other factor which causes the compass to perform poorly, the calibration procedure will adjust compass characteristics to compensate.

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

If the AP500 compass displays a **constant offset** when compared to a correctly calibrated ships compass (eg: the autopilot compass reads 3 degrees high on all headings), simply rotate the AP500 compass sensor to align the displayed headings with the ships compass, **it is not necessary to re-calibrate the compass as described below.**

If the AP500 has inconsistent variation on different headings, the following calibration procedure can be carried out. **This procedure should only be done in calm waters with adequate sea room.**

1. Use the dial to select “START CAL”
2. Push the dial and “START” will display
3. Start turning the vessel slowly in one direction. Turn vessel slowly through two complete circles from this point. Each complete turn should take at least 60 seconds.
4. On completion of circles, dial up “STORE CAL” to store calibration setting into memory.

Check alignment of the AP500 compass by steering the vessel due North (000 on ships compass) and, if necessary, rotate the compass sensor until display reads 000.

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

Should you wish to abort the calibration procedure at any time during the process, do not carry out Step 3 but press MODE to return to MANUAL.

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

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

Select :- MANUAL / MODE / INITIAL / COMPASS CAL / RESET CAL

To exit “INITIAL” mode at any time press CLR/OFF

Rudder Limits

The rudder limits prevent the steering motor driving the rudder beyond its physical (mechanical) stops. The limits are factory set and should not need altering. However, the limit setting can be set from the display of the AP500 if deemed necessary.

- From the MANUAL mode select INITIAL then RUDDER LIMITS
- Select SET PORT LIMIT. Mechanically move the steering to the required maximum PORT position via the steering wheel. When the desired position is reached, push the DIAL to select.
- Select SET STBD LIMIT. Mechanically move the steering to the required starboard position via the steering wheel. When the desired position is reached, push the DIAL to select.
- Press CLR/OFF to return to the normal pilot display.
- To cancel the LIMIT settings, select RESET LIMITS and push dial to return to factory settings.

The number on the display between 0 and 256 indicate the rudder position. 000 being fully to Starboard, 128 being the centre and 256 being fully to port.

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

Remote selection

Provision is included for 2 different remote input selections :

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

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

To select the required remote style, selecting REMOTE via the INITIAL Mode allows the selection via the dial and push to accept.

Off Course Alarm

The AP500 allows for monitoring of the Autopilot course holding ability by having the angle off-course measured and alarm sounding if greater than the preset angle.

To set, select INITIAL Mode, select OFF COURSE ALARM, push dial, adjust value with the DIAL and push to accept.

CLR/OFF to exit

REMOTE AUTO Mode (Remote Unit Operation)

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

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

Engaging REMOTE AUTO Mode:

Move the remote unit switch to AUTO.

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

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

Disengaging REMOTE AUTO Mode:

Setting remote switch to OFF will select MANUAL mode.

Or

Pressing the AUTO button on the Display Unit will select AUTO mode.

Pressing the MANUAL button on the Display Unit will select MANUAL mode.

Course Adjustment:

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

REMOTE POWER STEER (Remote Unit Operation)

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

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

Engaging POWER STEER Mode:

Move the remote switch to the PWR position.

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

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

Disengaging POWER STEER Mode:

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

The autopilot will return to MANUAL mode.

Or

Pressing the AUTO button on the Display Unit will return the autopilot to AUTO mode.

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

Alarms

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

NO MCU Alarm

This indicates that the Display Unit is not receiving data from the AP500 C-Drive unit. Check that all plugs are secure and the interconnecting cable is not damaged.

NO GPS DATA Alarm

The alarm sounds if the autopilot is not receiving valid information from the GPS. The message “NO GPS DATA” blinks on and off at the same time.

OFF COURSE Alarm

The alarm sounds when vessel is more than the preset amount (default 45 degrees) from the selected course-to-steer. The message “OFF COURSE” blinks on and off at the same time.

Installation of Display Unit

Position:

The Display Unit should be mounted in a position accessible to the steering position and protected from direct rain or salt water. A mounting bracket is supplied with the AP500 Display Unit. For security, the Display Unit cable can be easily disconnected and the unit removed from its bracket for safe storage.

Wiring:

Access for wiring must be provided. Cabling will have to be run to the main computer unit (C-Drive unit). The power for the display is from the C-Drive unit. Wiring should be kept as far as possible from radio aerials and aerial cables to prevent interference to the radio and transmitted signals from the radio influencing the autopilot. Cable should also be run separately (if practical) from other current-carrying cables. There is no restriction on cable length.

Magnetic Effect:

As no steel is used in the Display Unit, there is negligible effect on a steering compass. Some radio interference may be caused by the internal electronics.

Additional Display Units:

Additional Display Units can be fitted if required. Connection is by 5-core cable between the “To Remotes” connector on the main Display Unit (connected to the C-Drive unit) and the “To MCU” connector on

the additional Display Unit. A third Display “To MCU” would be connected to the “To Remotes” connector of the second Display Unit etc.

Operation of a function on one Display Unit will indicate on other Display Units.

Installation of Compass

The AP500 Autopilot is normally supplied with a standard Compass Sensor. For steel vessels with a good quality **flat-topped** ships compass, correctly compensated for the vessel, a Compass-Top Sensor should be used.

The standard Compass Sensor should be treated with care, as the internal gimbals can be broken if the compass sensor is dropped. **Remove any internal packing before installation.**

Position:

The compass position is the most important item in the installation of the autopilot. Good course holding is dependent on the compass being free from magnetic interference.

As the compass has no moving card, it is not necessary for the compass to be mounted low in the vessel. This can be a place of high magnetic interference and should be avoided. However, **a position where excessive roll is experienced, such as the top of a mast, should also be avoided.**

In a steel vessel, if the standard Compass Sensor is selected instead of the Compass-Top Sensor, the compass sensor should be mounted a **minimum of 1 metre** above the steelwork.

The compass need not be mounted in a weatherproof position. It can be mounted on top of a flat surface, on a bulkhead or from the deck head.

NOTE: **Check other side of bulkhead for materials which may cause magnetic interference.**

Wiring:

The cable leading from the compass must be connected to the correct (COMPASS) socket on the main computer unit (C-Drive unit). Do not run the compass cable with other cables on the vessel. The compass is supplied with a standard 5 metre length cable but there is no restriction on cable length if it has to be extended.

Magnetic Effect:

Interference from any iron or steel can cause degraded operation of the compass unit. To prevent this occurring a minimum distance of 1 metre (3 feet) should be kept from any steel or other ferromagnetic materials. This includes speakers and radios with internal speakers.

Mounting:

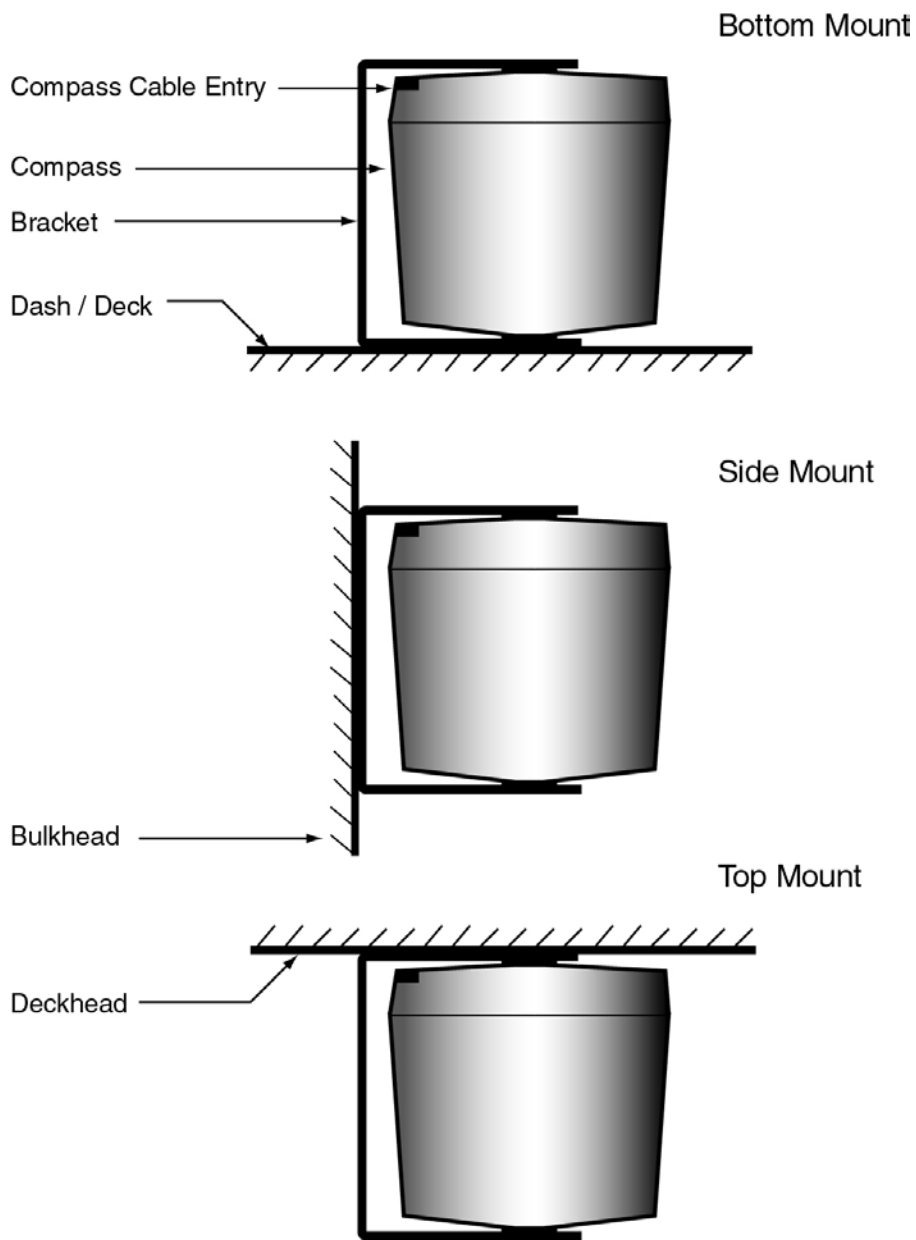
Fasten the compass with the non-magnetic screws supplied. The compass must be mounted in an approximately vertical position. See also the diagram labeled “Compass Mounting Options”.

Calibration:

The compass unit will need to be rotated for the correct heading to be displayed. During sea trials further adjustment may be required to reduce any heading error displayed.

The compass is calibrated in the factory. This will certainly be good enough for sea trials and in most cases will be as good as or better than the results of any auto-calibration on the vessel. Further calibration should not be necessary unless you find, **after sea trials**, that the autopilot compass readings have significant errors. If so, then follow the compass calibration section.

Compass Mounting Options



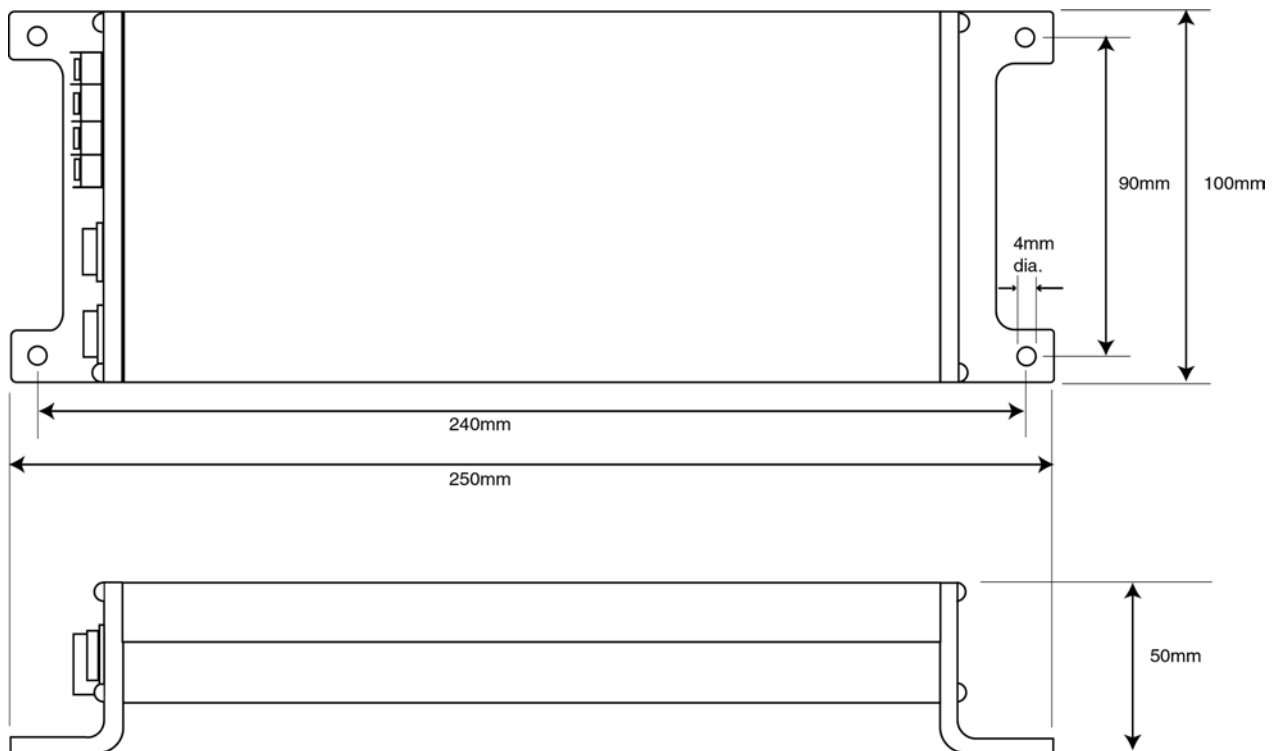
Installation of C-Drive unit

Position:

The C-Drive unit should be mounted in an easily accessible position so that it is possible for a technician to make adjustments to the unit. To access the internals of the unit, two screws either end allow the top lid to be removed.

The unit should be protected from rain, salt water, condensation and vibration. Inside a locker or on a bulkhead below decks are suitable.

C-Drive Dimensions



Wiring:

Access for wiring must be provided. Cabling will have to be run to the Power Switchboard, rudder feedback unit/s, electric steering wheel and drive unit. Wiring should be kept as far as possible from radio aerials and aerial cables to prevent interference to the radio and to prevent transmitted signals from the radio influencing the C-Drive unit.

The C-Drive must have a direct connection to power supply via a 15 amp fused circuit and an isolating switch. A power cable rated at 15 amps should be connected between the power input switch and the POWER connector on the C-Drive unit.

DIP Switch Setting:

The DIP switch is located on the PCB. These switches are factory set to suit the configuration of the unit, but can be changed as required if the C-Drive system configuration is changed.

1 & 2 Set BOTH to ON for Rudder Feedback Unit Standard
Set BOTH to OFF for Rudder Feedback Unit Heavy Duty
(Only on models with serial number greater than ES009)

3 & 4 Set BOTH to ON for Compass Top Sensor (CTS)
Set BOTH to OFF for Fluxgate Sensor (FLUX)

Rudder Feedback Unit Standard (RFUS), provides an output voltage in the range of approximately 1.6v to 3.4v. This is due to the reduced angle of movement from the potentiometer.

Rudder Feedback Unit Heavy Duty (RFUH), provides an output voltage in the range of 0v to 5v as it can travel through the entire range of the potentiometer.

Installation of Rudder Feedback

Position:

Install rudder feedback as shown in the diagram labeled “Rudder Feedback Unit Installation” on the next page. The unit should be adjacent to the tiller and must copy the angular movement of the tiller. The markings on the rudder feedback unit indicate the required movement of the tiller for course correction. It should be installed with the shaft uppermost, mounted in such a way that the four points (tiller post, feedback shaft and the adjustable linkage points) form the four corners of a parallelogram.

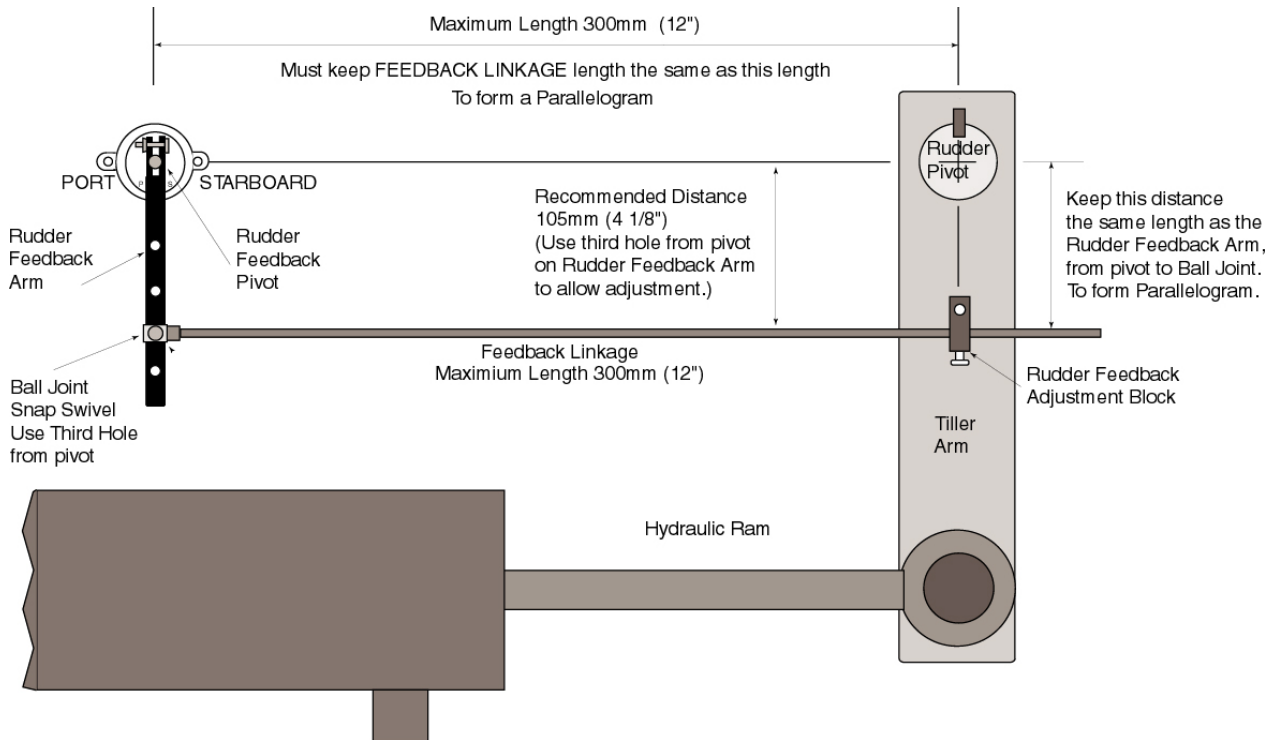
The rudder feedback unit is water resistant. However, **if it is to be mounted in a wet position, some protection should be provided to ensure the unit does not become excessively exposed to water.** If necessary, the rudder feedback unit may be mounted upside down, in which case the blue and red wires in the cable must be reversed.

(Note: yellow wire in cable is not used in the RFU).

When installation of the feedback unit is complete and the linkage is fitted, have the steering of the vessel moved from lock to lock and ensure:

- a) the direction indicated on the top of the RFU is correct.
- b) no undue mechanical strain is placed on the rudder feedback or linkage.

Rudder Feedback Installation Diagram



Rudder Feedback Installation Notes

- When the rudder is central and the rudder feedback is central all angles should be 90 degrees.
- Use the snap swivel and ball joint on the rudder feedback arm
- Use the rudder feedback adjustment block on the tiller arm
- Hydraulic ram may be mounted on the other side of the tiller arm
- Ensure that when rudder turns to Port, Rudder Feedback turns to Port as indicated on the rudder feedback unit.
- Rudder feedback unit may be mounted upside down. This would require an electrical change. (Polarity of rudder feedback requires reversing)

Wiring:

The cable from the RFU must be connected to the **Rudder** socket on the C-Drive unit. The RFU is supplied with a standard 14 metre cable but can be extended if required during installation.
See Rudder feedback wiring diagram, page 16.

**NOTE 1: THE RUDDER FEEDBACK UNIT IS FACTORY ALIGNED.
THE ARM SHOULD NOT BE REMOVED OR LOOSENED AS THE FEEDBACK ARM HOLDS AN O-RING AGAINST THE FEEDBACK BODY TO FORM PART OF THE WATER RESISTANT SEAL.**

NOTE 2: IF USING RFUH CONNECT TO THE TERMINAL STRIP RFUH 2 AND SIGNAL POSITIONS. SET THE C-DRIVE INTERNAL DIP SWITCHES TO RFUH.

RFUH Internal Terminal Strip.

RFUS 1	RFUH 2	SIGNAL	RFUH 2	RFUS 1
-----------	-----------	--------	-----------	-----------

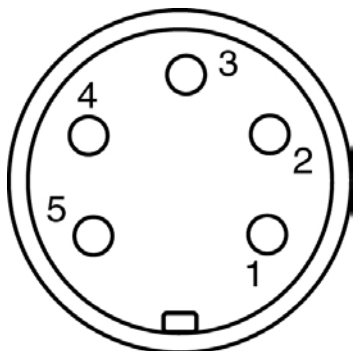
NOTE 3: ENSURE RUBBER GASKET IN RFUH IS PROPERLY FITTED TO PREVENT MOISTURE OR WATER INGRESS.

It is recommended that some form of emergency steering is also fitted.

Rudder Feedback Wiring Diagrams

Pin connections from rear of plug, solder connection side.

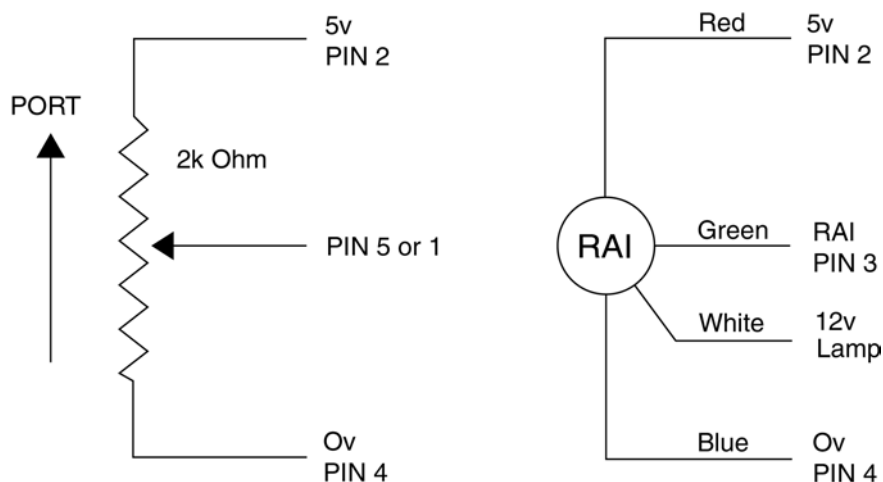
Figure 1 Rudder Feedback Connection Diagram



- Pin1 Motor Two Feedback (Green)
 - Pin2 +5v Rudder Feedback supply (Red)
 - Pin3 Rudder Angle Indicator (Green)
 - Pin4 0v Rudder Feedback Supply (Blue)
 - Pin5 Motor One Feedback (Green)
- (See NOTE Below)

NOTE: When C-Drive is used in a single rudder feedback installation, Pin 1 and Pin 5 should be connected together.

Figure 2 Rudder Feedback and Rudder Angle Indicator Wiring Diagram



GPS Connection

Data In and Out:

For GPS navigation, connect the GPS unit via the two wires coming from the back of the 6 pin DIN socket connecting the AP500 Display Unit to the C-Drive unit. The connections on the plug are:

Pin 1	DATA IN+	White
Pin 2	DATA COM	Green

Data In Connection Examples:

For any GPS unit which has a BNC type output plug (a bayonet plug, with a core and shield), connect the core to DATA IN+ and shield to DATA COM.

For any GPS having open wires connect TX + to DATA IN+ and TX – to DATA COM.

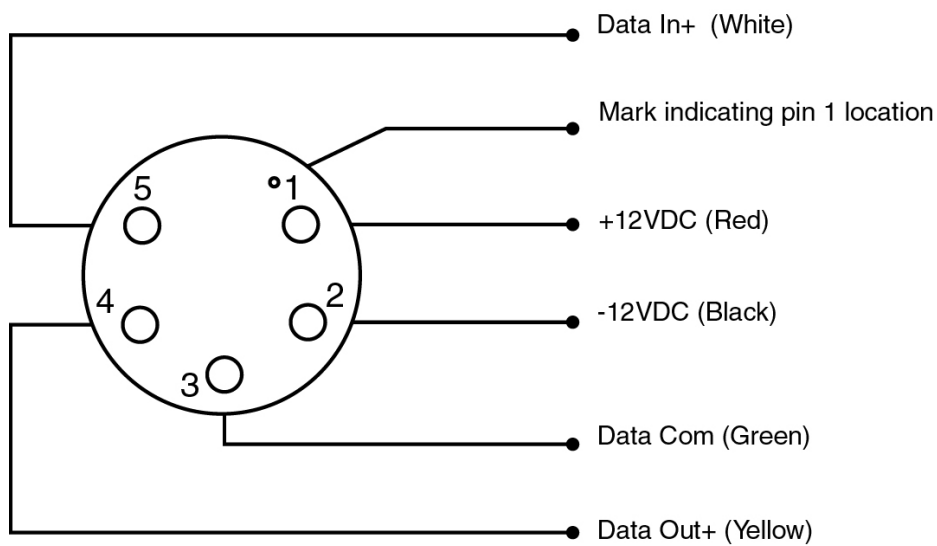
For a GPS with the following marking connect Data Out + to DATA IN+ and Common to DATA COM.

For information on connecting other types of GPS units, refer to the owners manual.

Connections for AP500 Display Unit / C-Drive cable:

C-Drive (NMEA)	Function	AP500 Display (To C-Drive)	Colour
Pin 1	GPS In +	Pin 5	White
Pin 2	GPS In -	Pin 2 & Pin 3	Black/Green
Pin 3	Data Tx +	Pin 4	Yellow
Pin 4	Negative	Pin 1	Red
Pin 5	Data Rx +		
Pin 6	+10 volt		

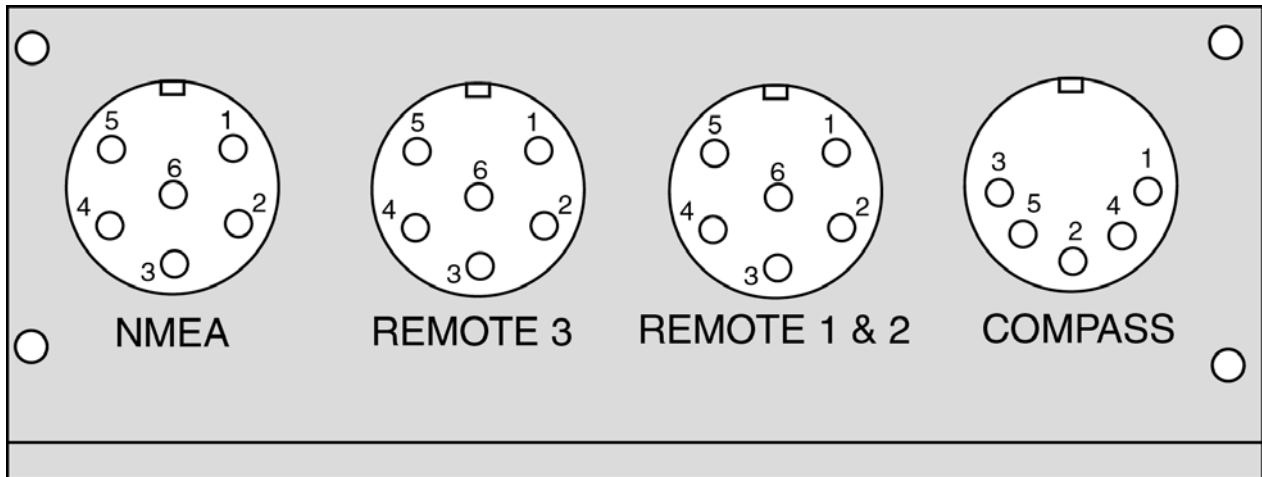
Power for the AP500 Display Unit is fed from the MCU



AP500 Display Unit Connections

C-Drive unit Connection Layout

Figure 3 Input Connections Panel



NOTE: Pin identification from end of C-Drive unit
 (Also solder side of plug pins.)

Compass

Pin 1 White
Pin 2 Blue (Square wave drive)
Pin 3 Red
Pin 4 Yellow
Pin 5 Green

Remotes 1& 2 (connections shown for remotes 1 and 2)

Pin 1 +5v Power Out (Red)
Pin 2 Remote 1 Wiper Return Signal (Green)
Pin 3 0v, Common Ground (Blue)
Pin 4 Remote 1 Auto / Manual Select (Yellow)
Pin 5 Remote 2 Wiper Return Signal (Green)
Pin 6 Remote 2 Auto / Manual Select (Yellow)

Remote 3

Pin 1	+5v Power Out (Red)
Pin 2	Remote 3 Wiper Return Signal (Green)
Pin 3	0v, Common Ground (Blue)
Pin 4	Power steer / Auto select (White)
Pin 5	GPS / Standby select (Black)
Pin 6	Rudder / Response select (Yellow)

NMEA In / Out

Pin 1	NMEA One	Input +	GPS
Pin 2	NMEA One	Input -	GPS
Pin 3	Transmit NMEA	Data +	TMQ Data
Pin 4	NMEA Two	Input -	TMQ Data
Pin 5	NMEA Two	Input +	TMQ Data
Pin 6	+10v Power Out		Display Power

NMEA Heading Data, Internal Connector Strip

A screw terminal connector strip within the C-Drive unit is available for sending NMEA Heading Data to other equipment if required.

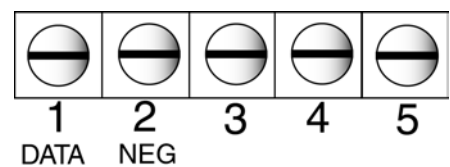
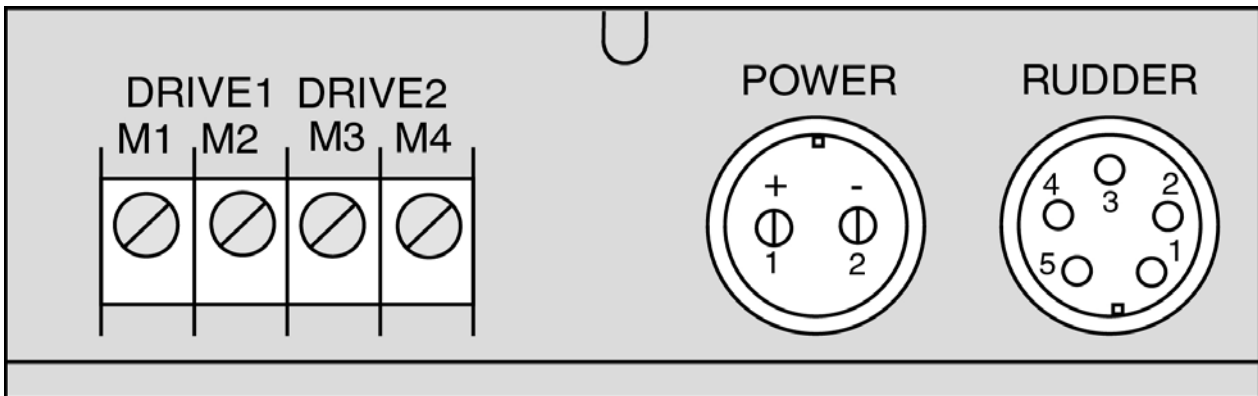


Figure 4 Output Connections Panel



Drive1 and Drive 2

Output terminals for connection to rudder position actuators. Can be connected directly to reversing hydraulic pump motors or to reversing mechanical drive motors, with a maximum current rating of 15 Amps. If solenoid valves are implemented the addition of diodes can remove the need for a positive supply to the solenoid valves as shown in Figure 7.

NOTE: The motor wires may require reversing to provide the correct rudder direction movement.

For constant running pump sets Drive 2 can be used to power constant running pump. (Contact TMQ for special setup requirements)

Figure 5 Single rudder motor and clutch configuration

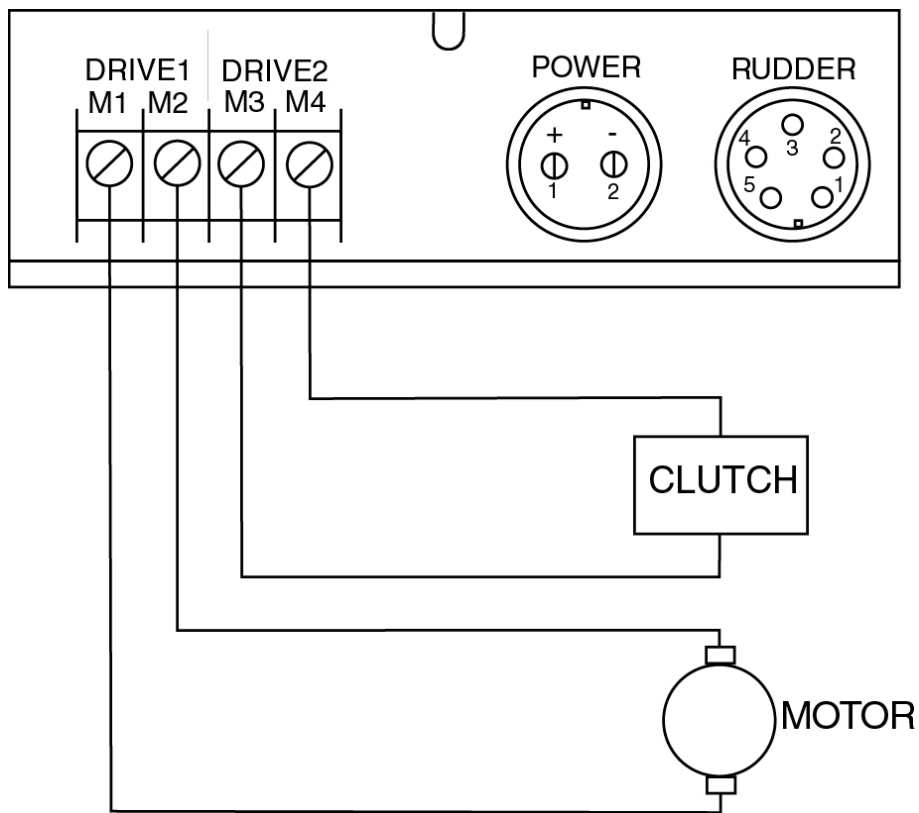


Figure 6 Solenoid Valve Connection Diagram

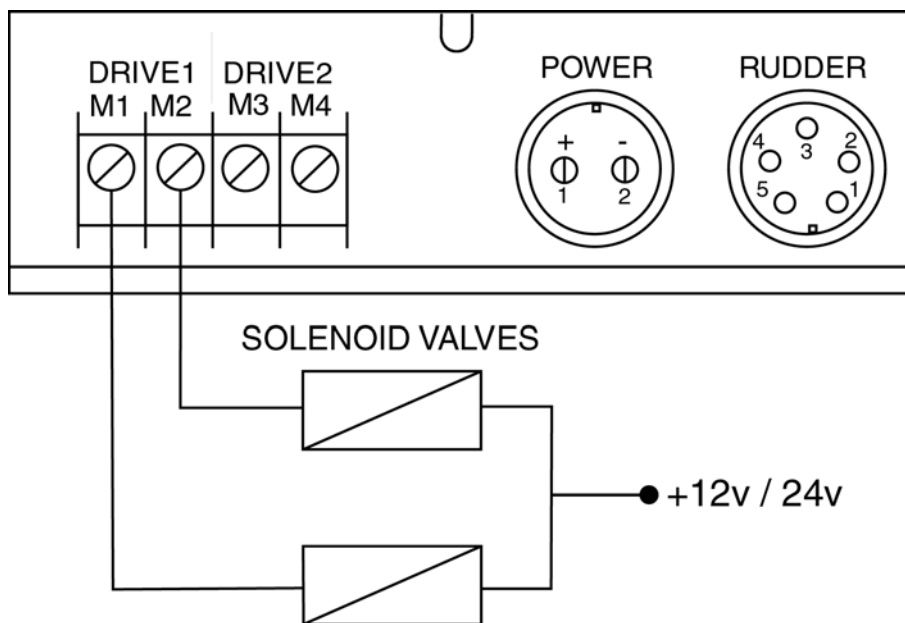
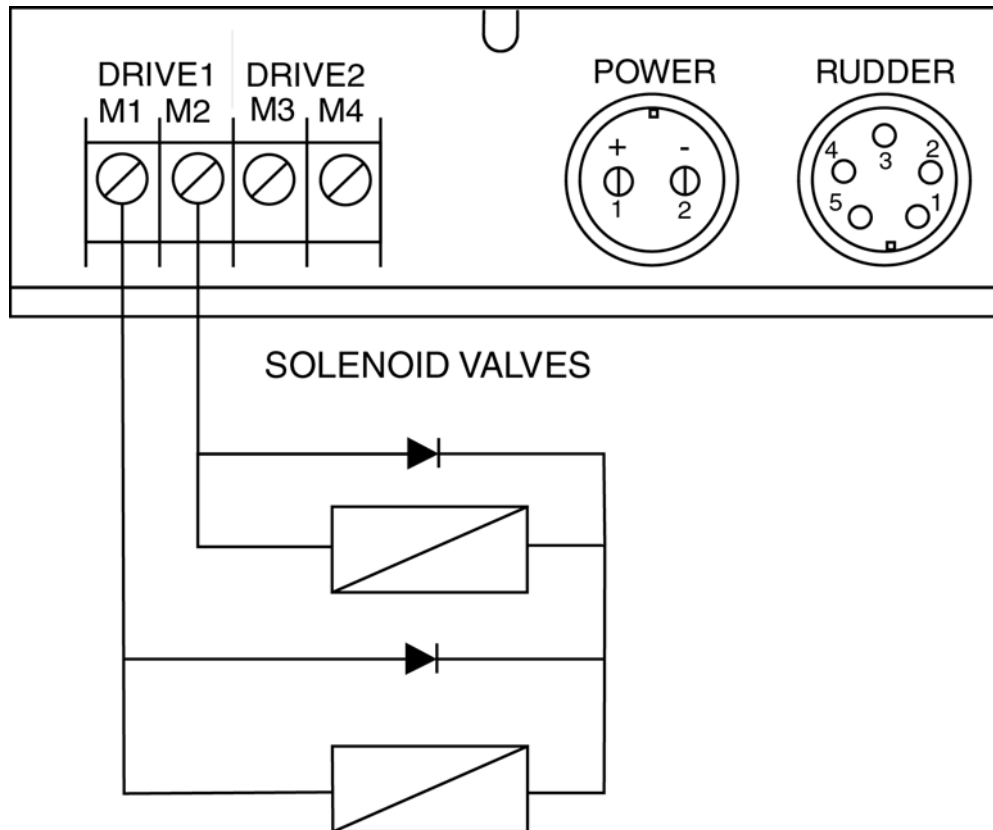


Figure 7

Without using a positive supply to the solenoid valves



Use the diodes available from TMQ or a high current rated device, 2 Amp rating minimum recommended.

The above circuit should be replicated for Drive 2 if solenoid valves are used with the addition of diodes.

Figure 8 Dual rudder system using solenoid valve
and external power supply

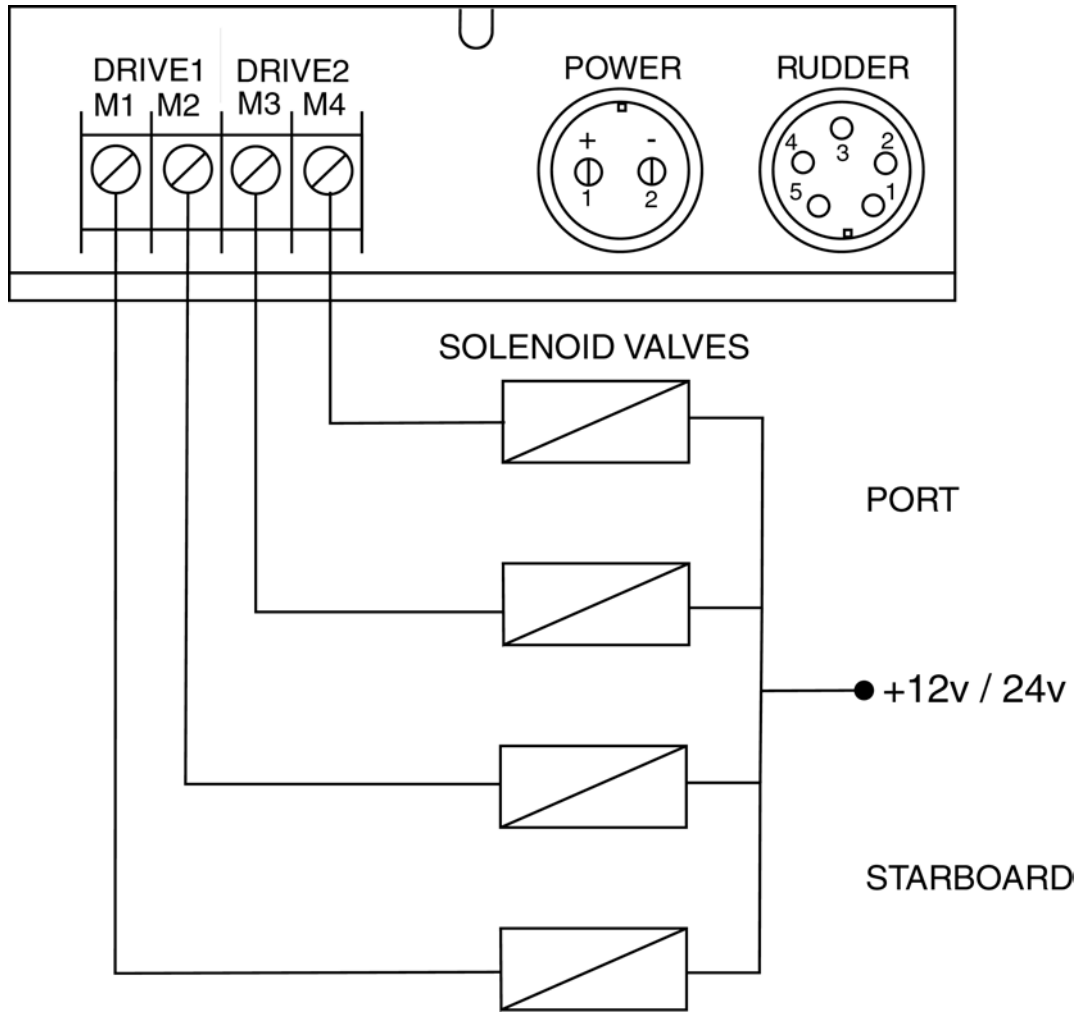
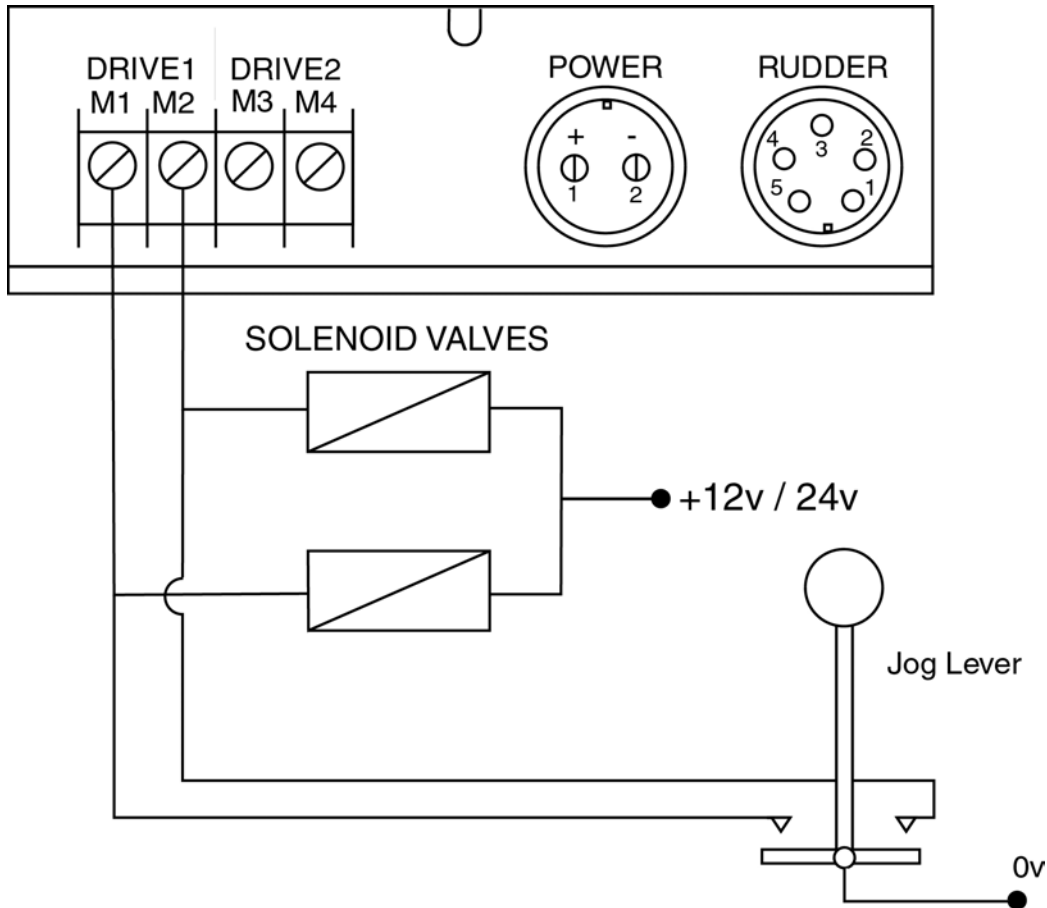


Figure 9 Incorporating a Jog Lever

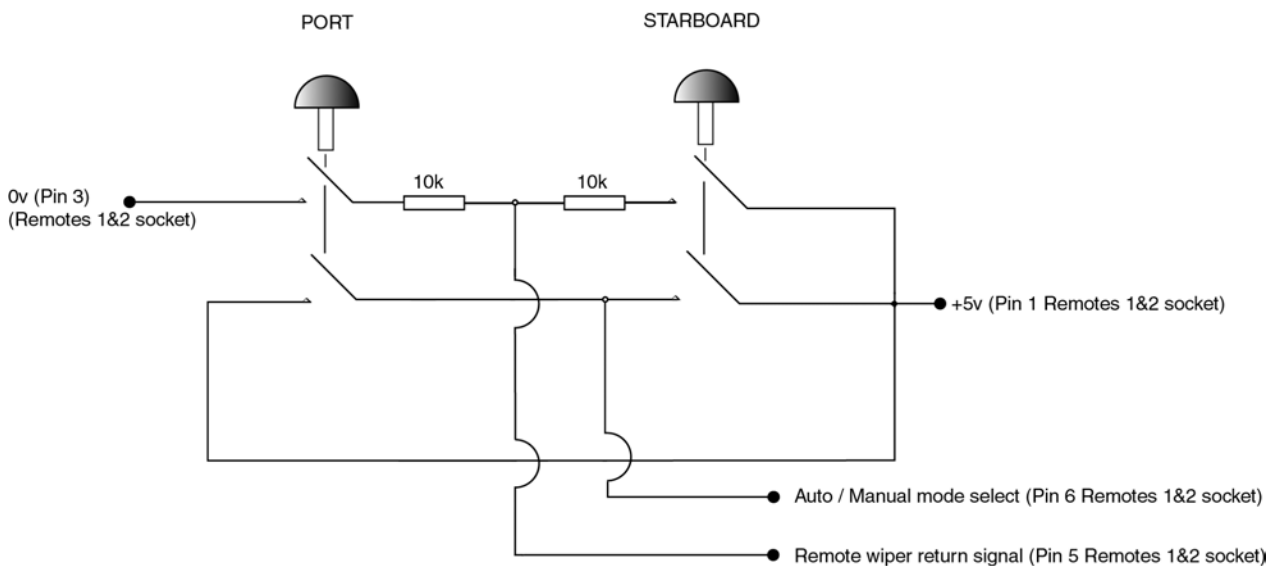


NOTE:

- Jog levers are an easy method to fit extra steering stations to the AP500
- The internal links “Link 1” and “Link 2” must be cut in the C-Drive unit.
- Manual must be selected for the jog lever to operate correctly.

Figure 10 Jog lever system as Remote 2 using the Autopilot

Uses Remote Mode 1 on the C-Drive.



The jog lever or press buttons switch the C-Drive into Power during operation and return the C-Drive to Manual after operation.

NOTE:

- Two 10k Ohm resistors as shown above are required to prevent the possibility of a short circuit.
- An FFU lever or Electric Wheel can still be used as Remote 1 or Remote 3.

Installation of Remote Units

Hand Remotes, Panel Remotes, Steering Levers and Steering Wheels:

These units are robust and any of these may be mounted where it is subjected to occasional splashes of water. If mounted in direct sunlight, the unit may fade. The cable leading from the unit requires to be connected to the REMOTE sockets of the C-Drive.

Remote unit configuration options

The C-Drive system allows for many configuration options, such as follows:

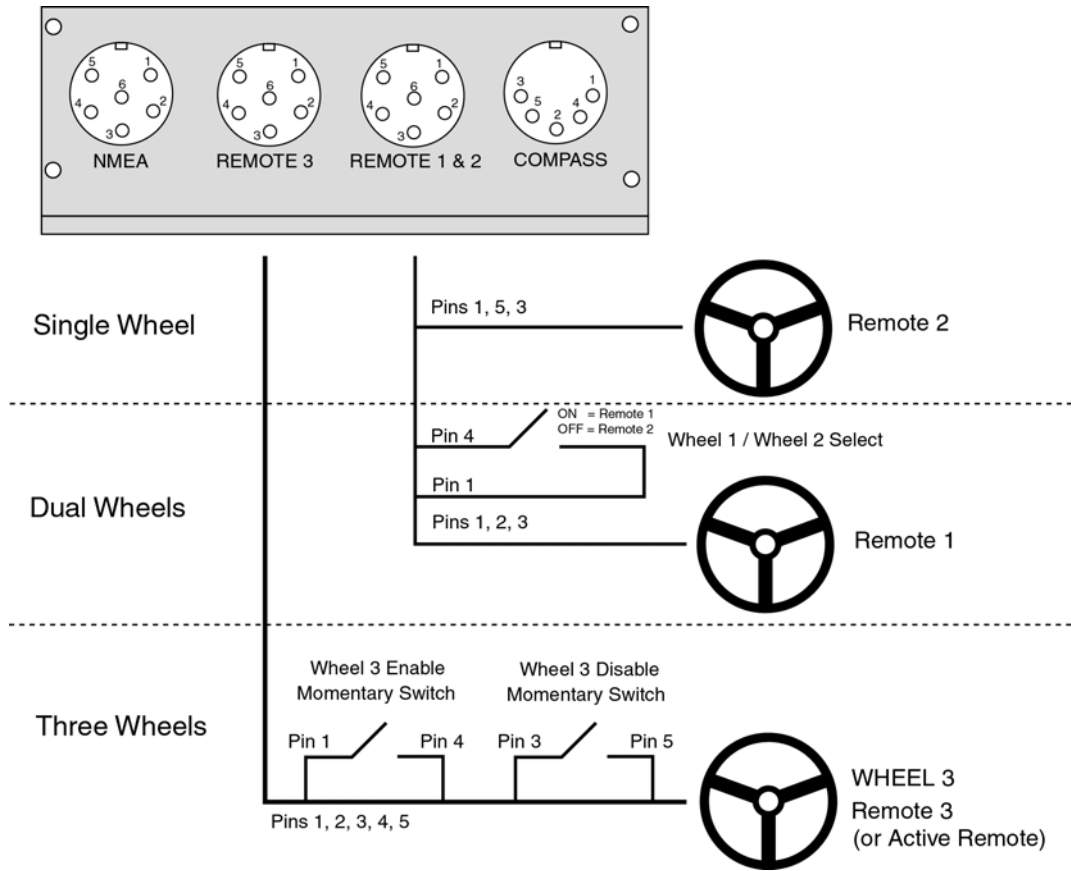
- 1 Electric wheel with single rudder.
- 1 Electric wheel with dual rudder.
- 1 Electric wheel and 1 remote with single or dual rudder.
- 1 Electric wheel and 2 remotes with single or dual rudder.
- Multiple combinations of the above to suit.

See C-Drive unit Connection Layout for connection information.

There are two setting options for the C-Drive, Mode 1 and Mode 4. These provide different steering input configurations as required, see Figure 10 and Figure 11.

The Mode can be altered via the Computer lead and a computer running a serial program.

Figure 11 Remote Mode 4



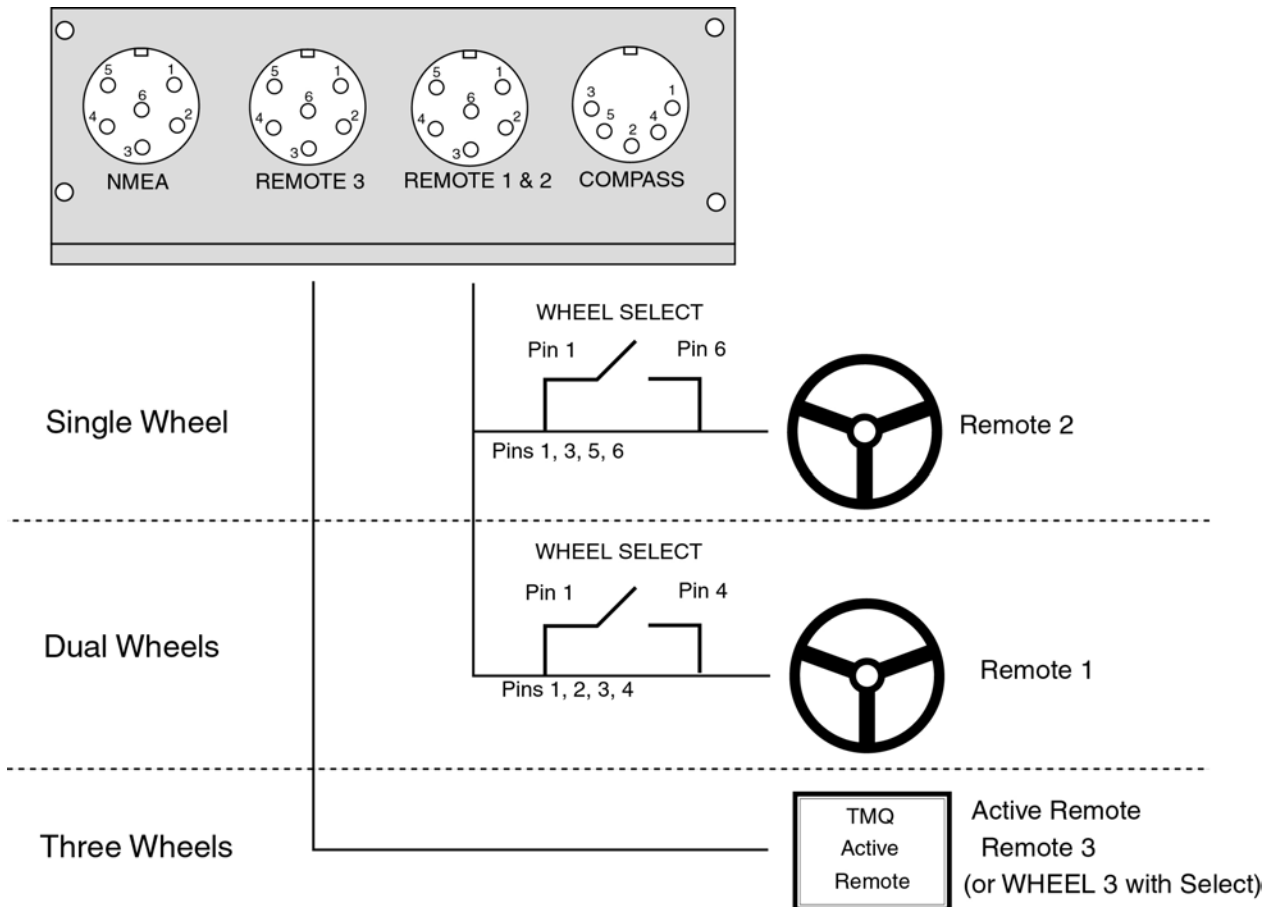
Remote 1 & 2

- Pin 1 +5v Power Out (Red)
- Pin 2 Remote 1 Wiper Return Signal (Green)
- Pin 3 0v, Common Ground (Blue)
- Pin 4 Remote 1 Auto / Manual Select (Yellow)
- Pin 5 Remote 2 Wiper Return Signal (Green)
- Pin 6 Remote 2 Auto / Manual Select (Yellow)

Remote 3

- Pin 1 +5v Power Out (Red)
- Pin 2 Remote 3 Wiper Return Signal (Green)
- Pin 3 0v, Common Ground (Blue)
- Pin 4 Power steer / Auto select (White)
- Pin 5 GPS / Standby select (Black)
- Pin 6 Rudder / Response select (Yellow)

Figure 12 Remote Mode 1



Remote 1 & 2

- Pin 1 +5v Power Out (Red)
- Pin 2 Remote 1 Wiper Return Signal (Green)
- Pin 3 0v, Common Ground (Blue)
- Pin 4 Remote 1 Auto / Manual Select (Yellow)
- Pin 5 Remote 2 Wiper Return Signal (Green)
- Pin 6 Remote 2 Auto / Manual Select (Yellow)

Remote 3

- Pin 1 +5v Power Out (Red)
- Pin 2 Remote 3 Wiper Return Signal (Green)
- Pin 3 0v, Common Ground (Blue)
- Pin 4 Power steer / Auto select (White)
- Pin 5 GPS / Standby select (Black)
- Pin 6 Rudder / Response select (Yellow)

System Configuration

Operational settings and Rudder Limits are factory set and will suit most operating situations, the settings are as follows:-

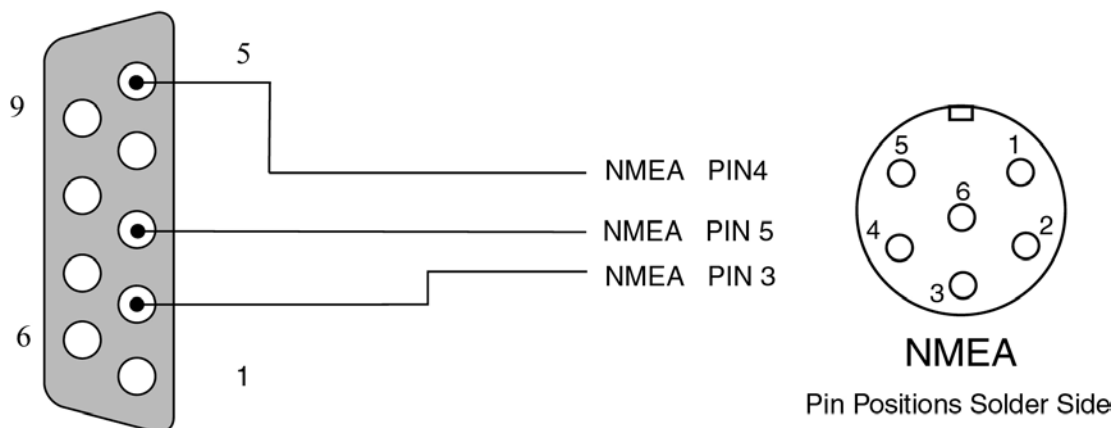
<u>Function</u>	<u>Factory Setting</u>	<u>Range</u>
Rudder Limit Settings:	+30 Degrees.	Adjustable +/- 10 to 35 Degrees.
Remotes Mode	1	1 or 4
Steering Types	S	S or D (Single or Dual)
Reverse Delay	m	a to z (50mS to 1.2 Seconds)
Pulse Delay	d	a to z (50mS to 1.2 Seconds)

See Recommended System configuration.

The above settings can be altered depending on the specific requirement of the installation. This can be carried out by the TMQ dealer or by using a computer and the computer lead with the connections detailed below. (Lead not supplied)

9 Pin Female D-Type

6 PIN DIN PLUG



Computer lead.

Setup Procedure

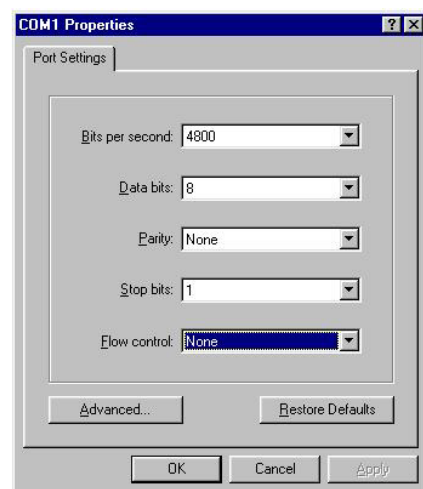
Adjustment of the installation settings can be made using the following procedure.

1. Connect the programming lead to the NMEA Port on the C-Drive unit and your Computer's Communication (com.) port; this requires to be an unused port for the duration of the system configuration.
2. Run a com. Server program such as HyperTerminal which is included on the installation disks for Windows 95, Windows 98, Windows 98SE etc.
3. Start a new connection and name it Electric Steering. For example in Hyper Terminal.




4. Select connection to the Com port that the programming lead is connected to, for example, connect using: Direct to COM1

5. Set the baud rate to 4800,
Data Bits = 8,
Parity = None,
Stop Bits = 1,
Flow Control = None.



-
6. Switch on the C-Drive system, using the Hyper Terminal Program connect to the com. port. Data should now be visible in the text editor window.
 7. In that window enter the text '@cal ' The text is not visible as it is typed. The 'TMQ Steering Unit' configuration option menu will now be displayed.
 8. Following the instruction in the Menu to alter the configuration settings as required, save and exit the configuration menu.
 9. These settings will be retained in the C-Drive memory.



```
$PTMQA, @gM
  @>gM*02
$PTMQA, @gM
  @>gM*02
$PTMQA, @gM
  @>gM*02

TMQ Steering Unit
1: Remotes
2: Steering Type
3: Rudder Limits
4: Pulse Delay
5: Reverse Delay
Q-Quit, D-Display menu
:-> _
```

Connected 1:09:36 ANSI 4800 8-N-1

TMQ Setup Option Menu

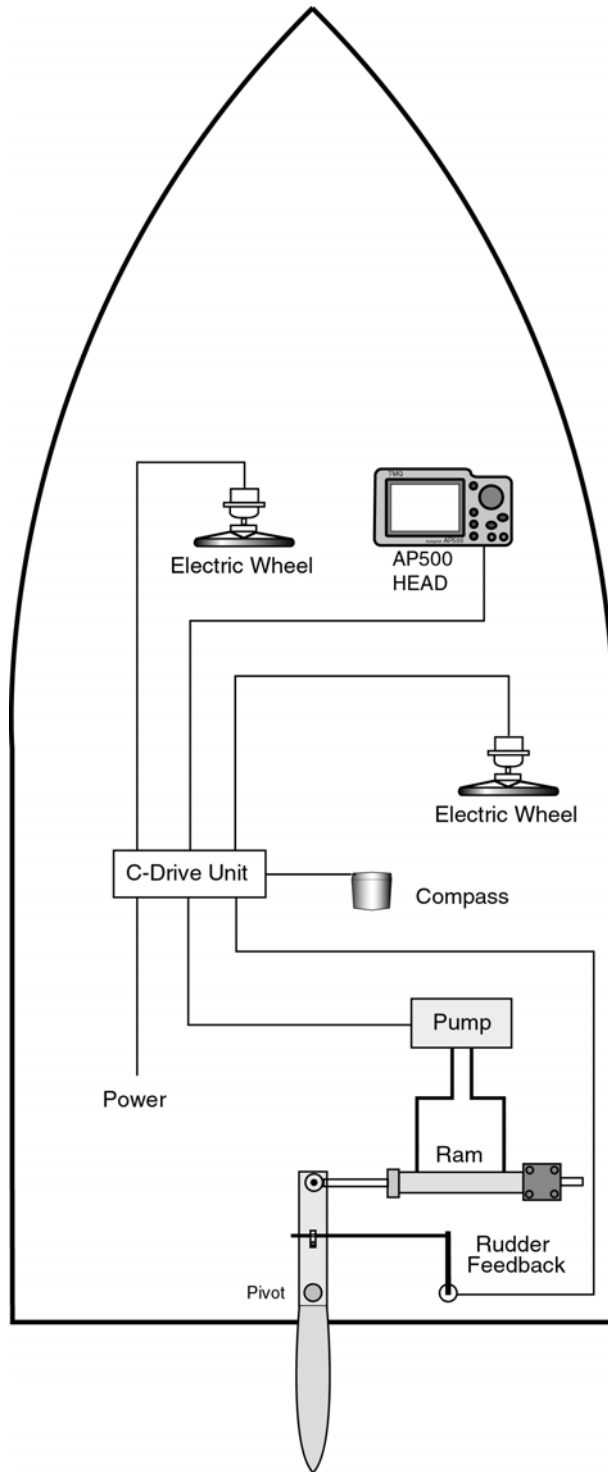
Recommended System configuration

For solenoid valve applications it is recommended that for option **4: Pulse Delay** a value of between 'd ' and 'z' is implemented This is due to the pulse length possibly not being long enough if a value between 'a' and 'd' is used. This would therefore not activate the solenoid valves.

For option **5: Reverse Delay** it is not recommended that a setting between 'a' and 'h' is implemented as this will increase the possibility of 'hunting' in the steering system causing undue noise and wear. A reverse delay set to mid range 'm' would suit most applications.

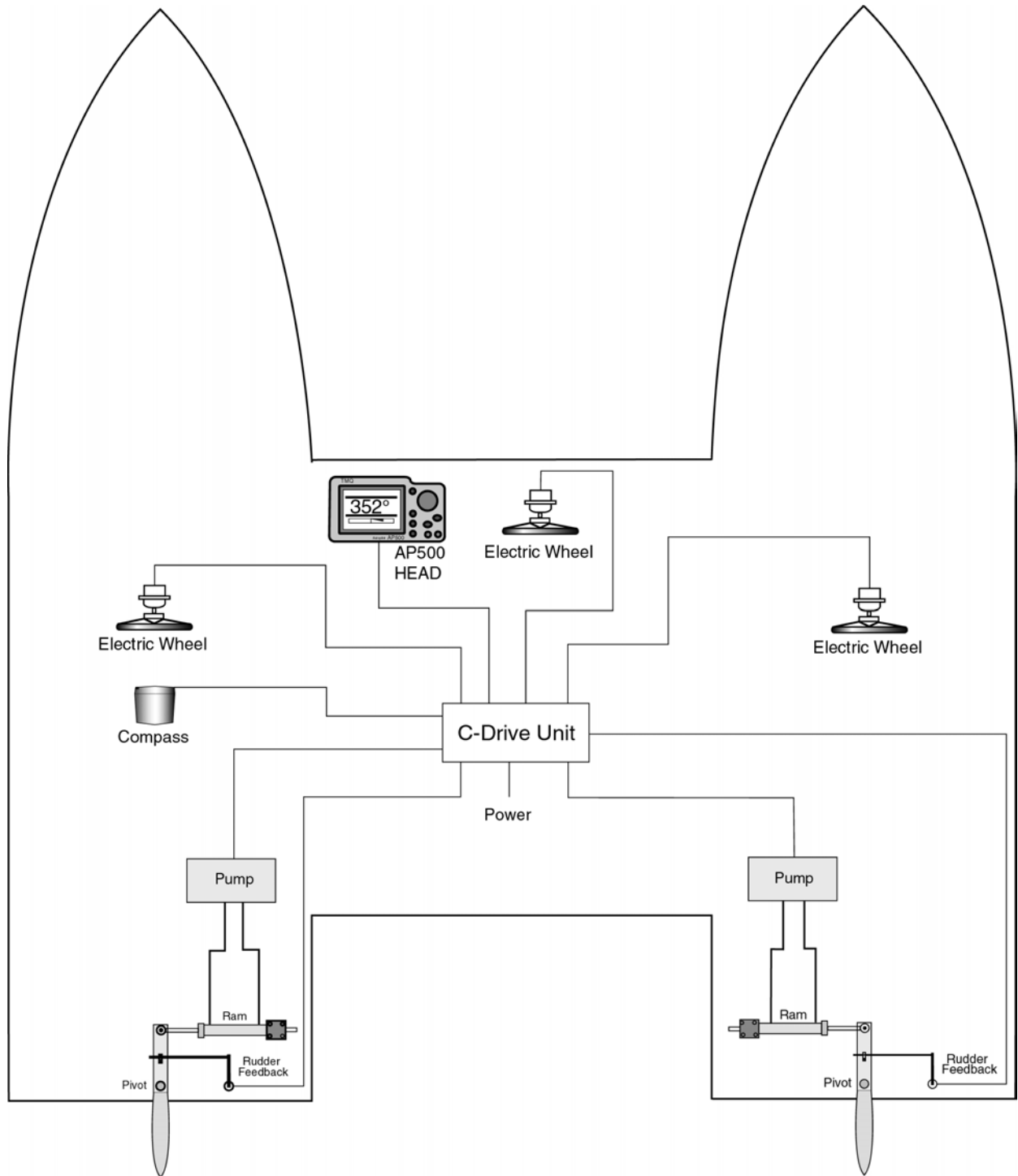
Electric steering connection examples.

Dual Station Electric Steering (C-Drive unit set to Remote Mode 4)



Three Station Electric Steering

C-Drive unit set to Remote Mode 4



Testing Procedure

Initial Inspection and Testing



1. Confirm power to be connected is the required DC voltage.	
2. Power Supply 12v DC.	
3. Power Supply 24v DC	
4. Ensure polarity of the voltage supply is correct.	
5. All electrical connections are correct.	
6. Loose cables are clipped or tied up.	

Dockside Tests

1. Turn steering wheel fully clockwise and visually check that moving and mechanical parts do not foul; visually check that RFU has moved in correct direction as indicated on the RFU label on top.	
2. Repeat step 1 for anti-clockwise.	
3. Return Steering to centre and Ensure RFU is at centre.	
4. Centre any electric steering wheel or lever	
5. Switch on C-Drive Autopilot system	
6. If drive goes hard over to mechanical stop change motor connection wiring. (See Trouble Shooting Section)	
7. Check Rudder direction follows Wheel or Lever	
8. Check Wheel or Lever provides sufficient Rudder movement	
9. Adjust Rudder Limits using a display or computer if required	
10. Check magnetic heading display on AP500	

Trouble Shooting

Unit does not move rudder

- Check voltage is present at the Electric Steering Unit power plug.
- Confirm that the supply voltage is within the range or 12-24 volts dc.
- Check and replace the Electric Steering Unit 15A internal fuse if necessary.
- If using solenoid valves with an external power supply check if it is present.
- Check all motor and / or solenoid valve wiring.
- If using a hydraulic system
 1. Ensure there is sufficient hydraulic fluid.
 2. Purge the system of possible air locks / contamination.
 3. Ensure that any flow restricting valves are not completely closed.
 4. Check all connections for leaks.
- Reset rudder limit switches to factory settings. (see Rudder limits section) Note: L1 should only be on if either rudder limit is reached.
- After ensuring all the above check that the internal LED, L2 is flashing when the unit is powered. If not, the C-Drive unit requires replacing.

Rudder(s) drive hard over

- After installation of the Electric Steering Unit if either of the rudders drive hard over to their mechanical stops in the wrong direction, the solenoid valves may be wired incorrectly (the wrong way around) or the motor connections may need reversing.
- Rudder drives hard over to the mechanical stops in the correct direction;

-
1. Check rudder feedback unit(s) is/are connected to the rudder arm
 2. Check rudder feedback cable(s) for damage.
 3. Ensure the rudder feedback plug is firmly connected to the electric steering unit.

Solenoid valves do not operate

- Check the motor connections on the electric steering unit
- Check connections on solenoid valves and the required diodes (see: Solenoid valve connection diagram)
- Test coil resistance of solenoid valves
- Confirm that the value for Pulse Delay on the electric steering unit is set between 'd' and 'z' (see: System configuration)

Motor unit does not operate

- If using a continuous running pump check the power supply to the pump
- If using a reversible pump
 - Check the connections to the pump
 - Check the internal 15A fuse, replace if necessary

Safe Mode

- ◆ Reset Rudder Limits.
- ◆ Reset Compass Calibration.
- ◆ Ensure L2 is flashing.
- ◆ Ensure L1 is off. (wheel is in centre)
- ◆ Check Wiring for Power and Motor.
- ◆ Check Fuse. (Powers motor circuit only)
- ◆ Check DIP Switch settings for Compass and Rudder fitted.

Optional Extras

There are a range of optional extras that can be connected to the C-Drive system as the need or circumstances require. The C-Drive system can be adapted to suit many applications.

Further information can be obtained from the TMQ website at www.tmq.com.au

Rudder Angle Indicator



The rudder angle indicator is a flush mounted instrument providing a clear indication of rudder position, which is critical when docking or maneuvering in close quarters.

Electric Wheel



The TMQ Electric steering wheel provides precise, light steering on any vessel with a power steering system installed. It simplifies vessel fitout by eliminating long hydraulic lines to the helm position

Panel Remote



The TMQ panel remote provides basic autopilot control providing course changes from a second station such as a flybridge.

Hand Remote



Hand remotes and Active remotes provide the freedom to maintain full control of the autopilot and steering while moving around the vessel.

Active Remote



AP500 Head



The AP500 head provides full control of the autopilot, indicates both current course and course to steer along with rudder angle.

Steering Lever



These levers allow single handed control of any size vessel with power steering. Movement to port or starboard causes the rudder to follow proportionally.

Full Follow Up lever



Hydraulic Drives and Pump Units

Reversible pumps



Hydraulic pumps available in either 12 or 24 volts DC with 1, 2 or 3 litre capacity to suit recreational, work boat or fishing applications.

Continuous pumps



Constant running pumps available in 2 or 3 litre for 24 volt DC systems. Accurate flow adjustment to set lock to lock time.

Linear drives



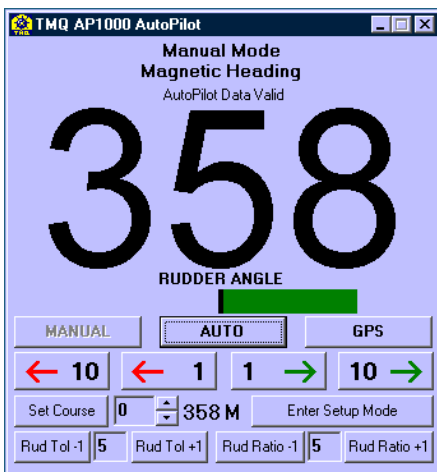
Single rod linear drives can be fitted to a wide variety of vessels. May be attached directly to the tiller or rudder quadrant.

Mechanical drives



Mechanical drive units in 12 or 24 volt DC to suit vessels with existing mechanical steering. Supplied with standard chain and socket.

Computer Software



TMQ AP1000 Autopilot operating Software.

Computer control program enabling autopilot control from a standard PC with serial com ports. (Cable required)