



AP45 Autopilot

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 AP45 Autopilot system. We are sure that you will enjoy the benefits that it offers.

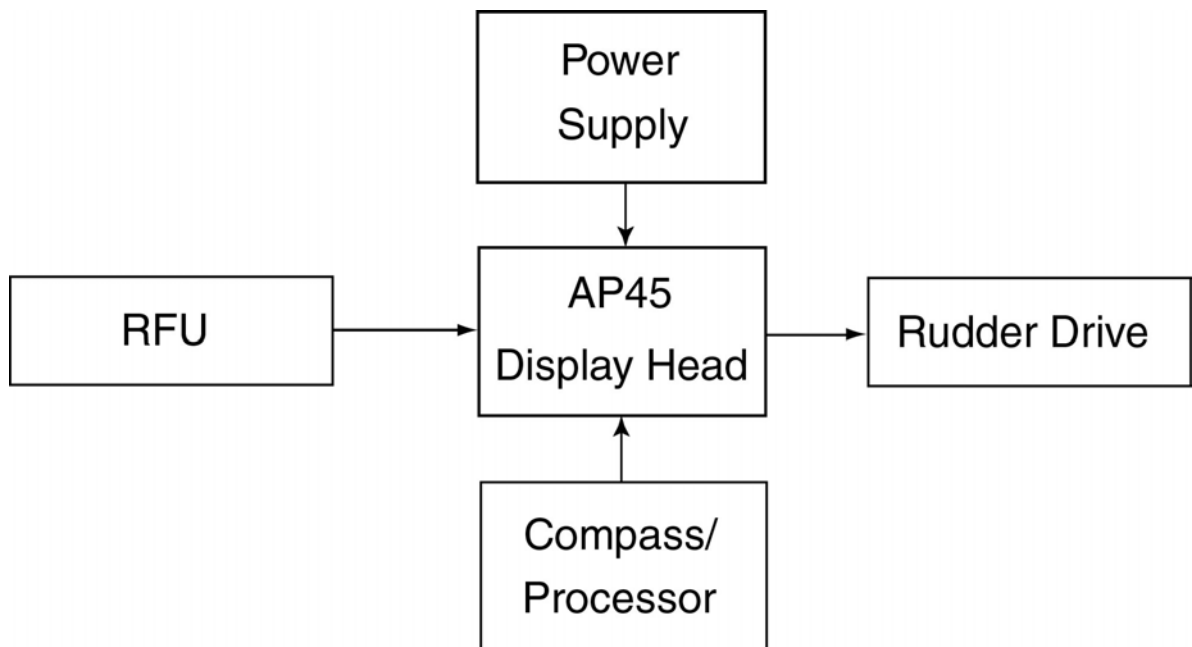
<h3><u>AP45 Autopilot System</u></h3>
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The AP45 Autopilot system comprises the following units: -

Essential Electronics:

- AP45 Display head.
- Rudder feedback unit.
- Fluxgate compass / processor unit
- Drive unit, for example
 - Hydraulic system with solenoid valves.
 - Reversing hydraulic pump system.

Block Diagram of full system



The AP45 head provides full control of the autopilot, indicating in different modes heading, course to steer and rudder angle.

It requires a supply voltage of 12 volts DC.

The Rudder Feedback Unit (RFU) must be attached to the steering tiller device in such a way that it can accurately measure the movement of the ship's rudder (see Rudder Feedback Installation diagram page 30). The RFU must also be electrically connected to the AP45 Head unit.

Rudder drive system, this system provides the physical movement to the rudder responding to the direction control signals provided by AP45 system. Rudder Actuator Systems can comprise of the following: -

-
- Hydraulic Ram controlled by either: -
 1. Reversing motor and pump unit, connected into an existing hydraulic steering system.
 2. Solenoid valves connected into an existing power steering system.
 3. Solenoid valves connected to a continuous running motor and pump unit.

Definition of Terms

AP45 Display:

The Operation unit, with LCD Display and pushbuttons.

Rudder Feedback Unit (RFU):

This provides the required rudder position information for steering control.

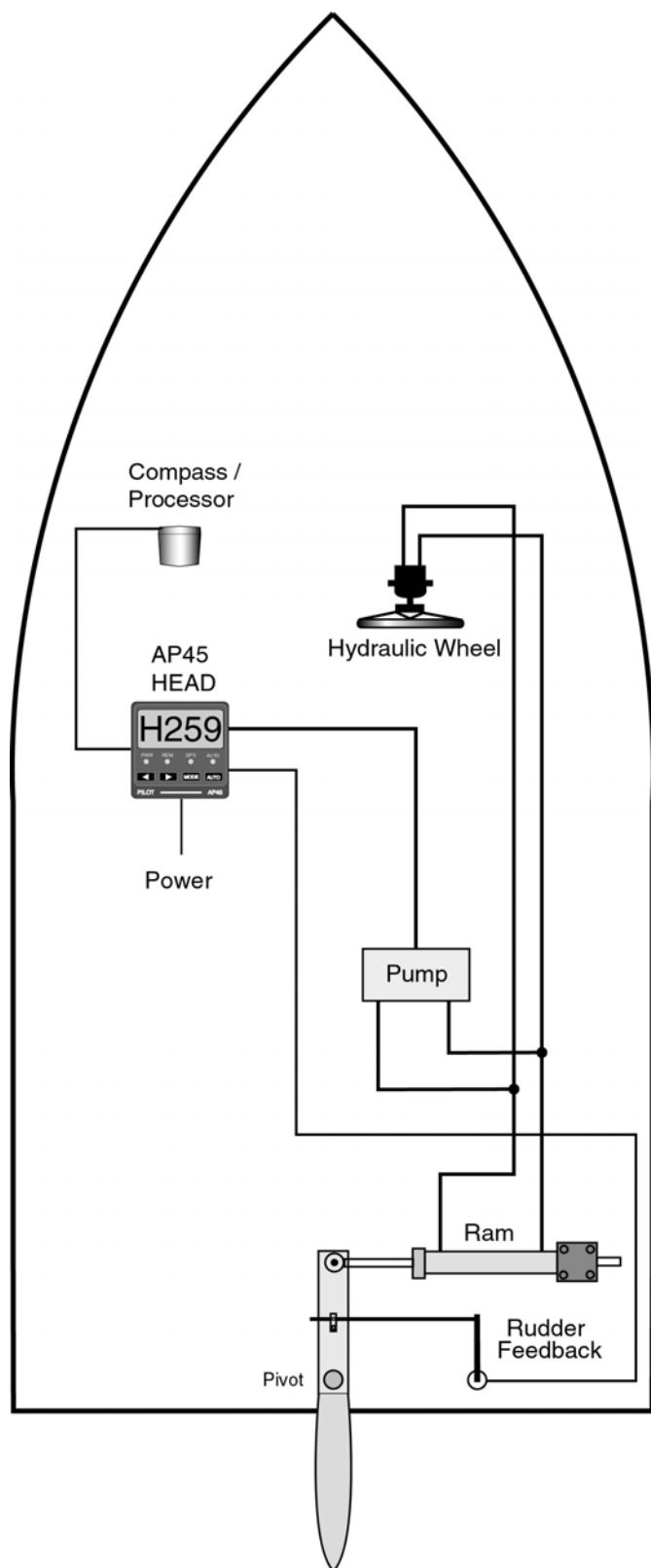
Heading:

The magnetic heading of the vessel at the current time.

Course-to-steer:

The magnetic heading which the autopilot is attempting to achieve.

AP45 System setup example



The AP45 Autopilot system can be fitted to an existing hydraulic steering system. Implemented by using a reversing pump or a continuous running pump with solenoid valves

Overview of Operation

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

- **MANUAL Mode: “H***”**

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: “A***”**

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

- **GPS Mode: “A***”**

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.

- **RUDDER and RESPONSE Settings:**

These customise the AP45 Autopilot for your vessel's steering. They may also be used to adjust for varying sea conditions.

- **Rudder Angle Displays:**

The AP45 Display Unit LCD can be set to display the rudder angle as a numeric number.

- **Backlighting:**

When using the autopilot at night, the backlighting can be turned on.

Turning the unit ON / OFF

The power to the AP45 unit should be via a suitable 15 amp circuit breaker.

MANUAL Mode

In this mode

- The display screen shows “H***”, *** being the current vessel magnetic heading in degrees.
- No steering control is generated.

AUTO Mode

- Press the AUTO button. AUTO mode will be selected. A beep will sound and the text display will change to “A***”. The Auto LED will light

The autopilot will lock on the current heading.

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

Disengaging AUTO mode:

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

Course Adjustment:

Each press of the < or > buttons will cause a one degree per segment course change in the applicable direction. The display will change to indicate the new course-to-steer. By pressing and

holding the buttons pressed will cause the change to be at 10 degrees per second for larger turns.

IMPORTANT!!

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

The AP45 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 or plotting system generating NMEA 0183 data output in the correct sentence format. GPS mode allows the autopilot to be directed by the GPS, enabling automatic heading changes and eliminating the effects of wind and tide.

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

Engaging GPS Mode:

Press the MODE button and, while the MODE button is pressed, press the AUTO button.

A beep will sound and the GPS and AUTO LED will be illuminated.

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

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

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

If no GPS data is received by the AP45, 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 AP45 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 AP45 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 “auto-sequence” between them,
- An “arrival zone” of more than 0.05 NM (Nautical Miles) is set so that the GPS can detect when the vessel has reached a waypoint.

Then the AP45 will be able to steer from each waypoint to the next without intervention.

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

Remember:

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

No GPS Data Alarm:

If the autopilot is not receiving valid information while in GPS Mode, the alarm will sound, and GPS and AUTO LED will flash. This could be caused by:

- Incorrect wiring of the GPS to the AP45 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 vessel heading information generated by the GPS unit should closely correspond to the magnetic heading signal the AP45 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 AP45 compass is correctly aligned and installed, and not subject to magnetic interference.

Rudder Sensitivity / Ratio

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

To adjust, press the MODE button. The display will show “S **” and the present sensitivity setting will be displayed (between 1 and 10).

- The sensitivity setting may be altered by the < - > Buttons. A low response value the drive will operate with minimum pulsing to the required rudder position and the autopilot system may work continuously.
- A high response value the drive will position the rudder with maximum pulsing.

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.

By pressing the MODE button a second time, the display will indicate “r **”. This setting is used for adjusting the autopilot’s rudder ratio setting to allow for varying vessel size and speed.

The display shall change to show “r **” and display shall show the current Rudder ratio (between 1 and 10).

The rudder setting may be altered by the < - > buttons.

-
- A value of 1 signifies the minimum amount of applied rudder. When the rudder setting is too low, vessel track will be a slow “ S ” ie: understeer through too little rudder applied.
 - A value of 10 signifies the maximum amount of applied rudder. When the rudder setting is too high, vessel track will be a rapid “ S ” ie: oversteer through too much rudder applied.

Backlighting

Pressing the MODE button four times will display the message “LitE”
Pressing the < > buttons together will toggle the backlighting on and off.

The backlighting will always be off when the unit is powered up.

Rudder Angle Indicator

Pressing the MODE button three times will display the rudder position in numeric value Port or Starboard

- When the rudder is at centre it will display “ 00”
- As port rudder angle is applied, the number will be “Pt**”.
- As starboard rudder angle is applied, the numbers will be “St**”.

Pressing MODE or AUTO will cancel the rudder display.

Initial Settings

Selecting the Initial settings of the Autopilot:

A number of system settings may need to be carried out prior to using the AP45 Autopilot. Two initial settings can be carried out from the Display Head.

- Rudder Limits
- Compass Calibration

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 AP45 if deemed necessary.

- Set the rudder to the desired Port position
- Select SET PORT LIMIT. By pressing the MODE button five times until “PL**” is displayed
- Press the < > buttons simultaneously to set the Port Limit.
- Set the rudder to the desired Starboard position
- Select SET STARBOARD LIMIT. By pressing the MODE button six times until “SL**” is displayed
- Press the < > buttons simultaneously to set the Starboard Limit.

The number on the display will be between 0 and 31 to indicate the rudder position. “SL31” being fully to Starboard and “PL31” being fully to port.

If “ oor” (Out of range) is displayed it indicates the rudder is not in the correct position to set the rudder limit. I.e. **Rudder is to port when setting the Starboard limit.**

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

Reset Rudder Limits

It is possible to reset the rudder limits to the factory settings if unsure of the settings.

Press the MODE Button 7 Times

“ rLr” will Display (Reset Limit Rudder).

Press < > both simultaneously to reset rudder limit.

Compass Calibration

The compass supplied with your AP45 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 AP45 compass heading displays a **constant offset** when compared to a correctly calibrated ships compass (eg: the autopilot compass reads 3 degrees high on all headings), simply rotate the AP45 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 AP45 has inconsistent variation on different headings, the following calibration procedure can be carried out. **This procedure should only be done in calm waters with adequate sea room. Auto must not be selected to carry out the calibration.**

1. Press the MODE button 8 times to enter the compass calibrate mode “CCAL”
2. Press the < > buttons simultaneously to start the compass calibrate. The Display will change to “StrC”
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, press the < > buttons together to store the calibration setting into memory.

Check alignment of the AP45 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 ship's compass can have heading errors as a result of the vessel's magnetic signature. These errors can be minimised by having the ship's compass swung and compensated by a licensed compass adjuster. In any case it is highly unlikely that the ship's compass and autopilot compass will be congruent for every heading.

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

Auto must not be selected to reset the compass calibration.

Press the MODE Button nine times and "rStC" is displayed

Press the < > buttons simultaneously to reset the compass calibration to factory settings.

Off Course Alarm

The AP45 allows for monitoring of the autopilot course holding ability by having the angle off-course measured and alarm sounding if greater than 45 degrees from the desired course.

If the difference is greater than 45 degrees between the heading and the course to steer, the alarm will sound and the Auto LED will flash

Alarms

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

NO MCU Alarm “ nrd”

This indicates that the Display Unit is not receiving data from the Compass / Processor assembly. 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 GPS and AUTO LEDs blink 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 AUTO LED blinks on and off.

Installation of AP45 Head Unit

Position:

The AP45 Head unit should be mounted in a position accessible to the steering position and protected from direct rain or salt water. A hole of 70mm (2.5inches) is required for the rear of the unit.

Wiring:

Access for wiring must be provided from the AP45 Head to compass assembly. 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 AP45 Head, there is negligible effect on a steering compass. Some radio interference may be caused by the internal electronics.

Installation of Compass

The AP45 Autopilot is supplied with a Compass Sensor /Processor. The Compass Sensor should be treated with care, as the internal gimbals can be broken if the compass sensor is dropped. **Remove internal packing before installation.**

Position:

The compass / processor 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 not be used.**

The compass is weatherproof, not waterproof. A position not open to the elements should be selected. 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 / processor must be connected to the **COMPASS** socket on the AP45. Do not run the compass cable with other cables on the vessel. The compass is supplied with a standard 5 metre length cable.

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:

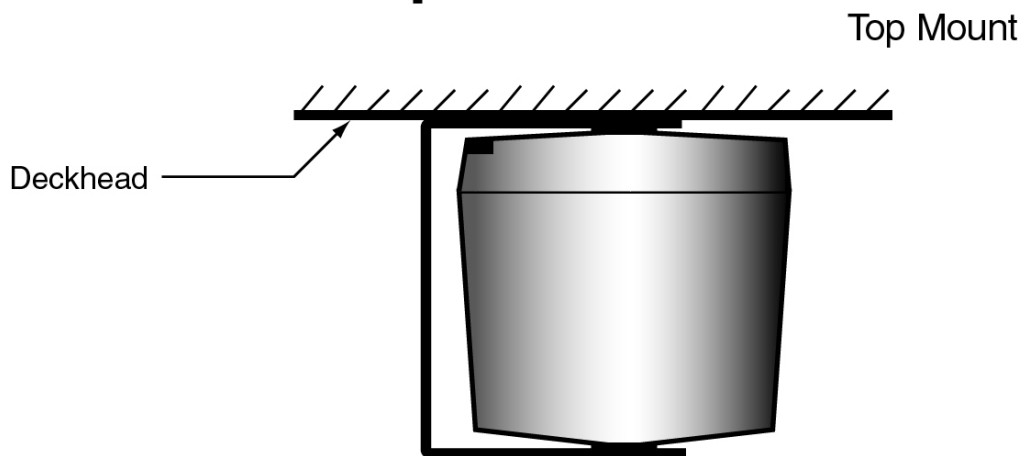
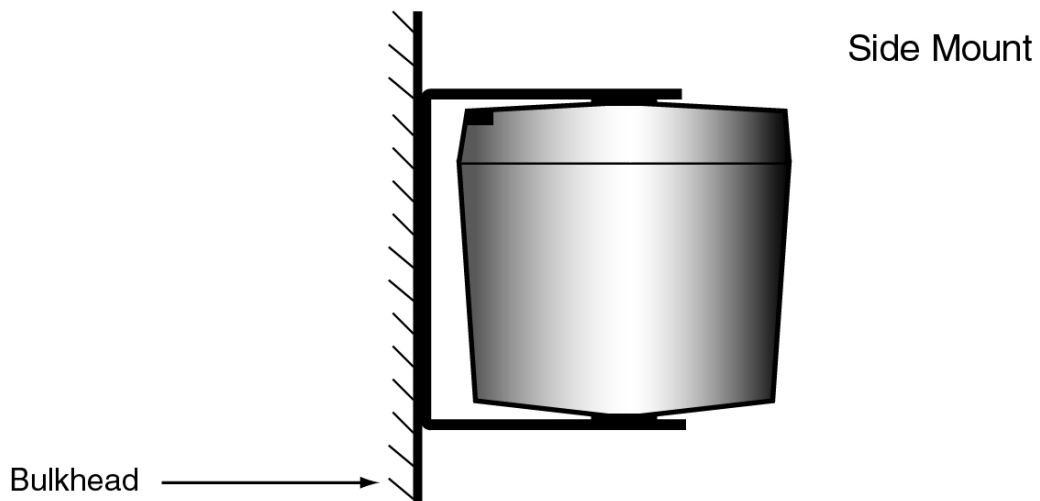
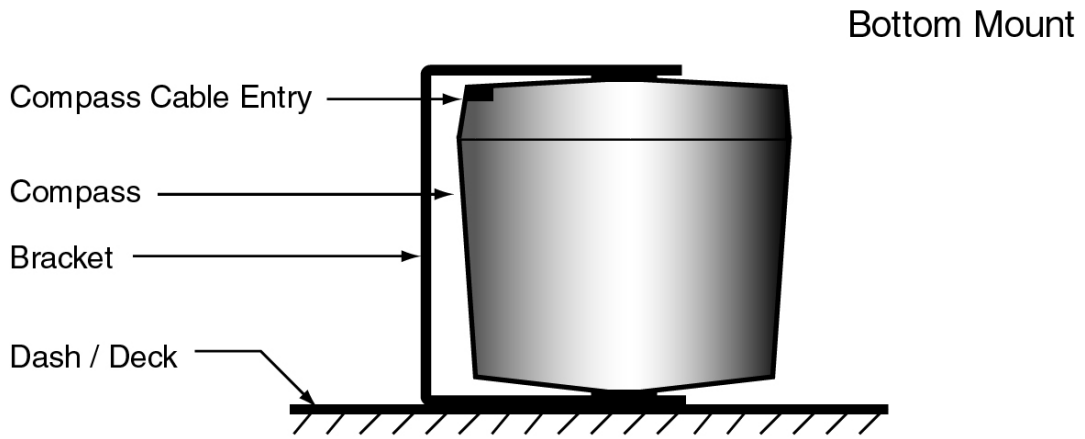
Fasten the compass with the non-magnetic screws supplied. The compass must be mounted in an approximately vertical position. See also the diagram labelled “Compass / Processor Mounting Options”.

Calibration:

The compass / processor 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 / Processor Mounting Options

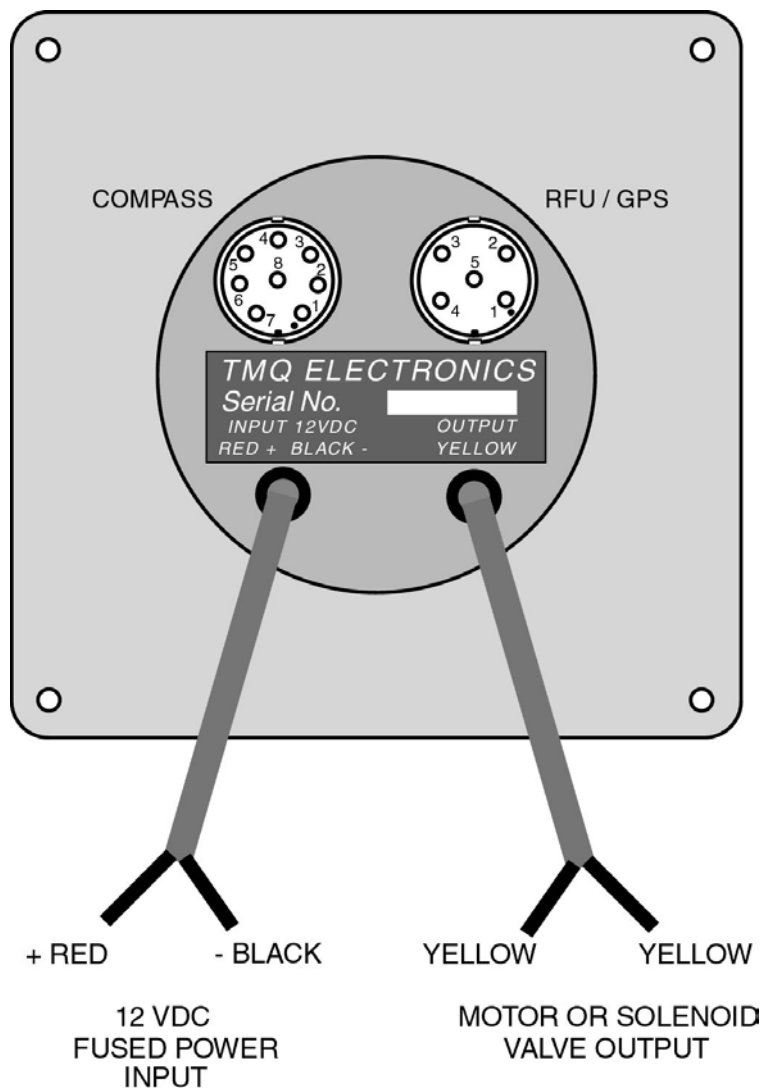


Wiring:

Access for wiring must be provided. Cabling will have to be run to the power switchboard, rudder feedback unit, display head 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 AP45 unit

The AP45 must have a direct connection to power supply via a 15 amp fused circuit and an isolating switch.

AP45 Head Wiring Diagram



Installation of Rudder Feedback

Position:

Install rudder feedback as shown in the diagram labelled “Rudder Feedback Unit Installation” (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 two adjustable linkage points) form the four corners of a parallelogram.

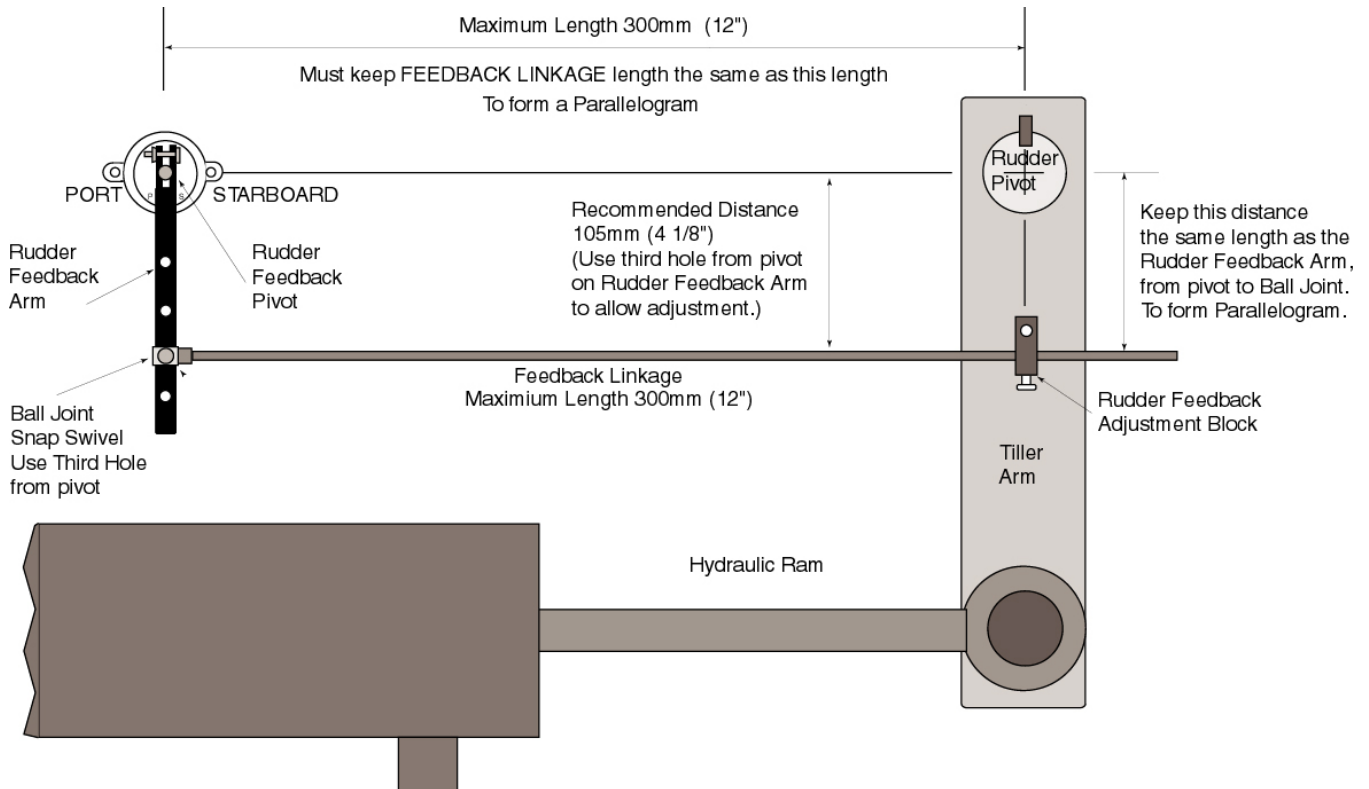
The rudder feedback unit is water resistant. However, **if it is to be mounted in a wet position, some protection should be provided to ensure the unit does not become excessively exposed to water.** If necessary, the rudder feedback unit may be mounted upside down, in which case the blue and red wires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

RFU Wiring:

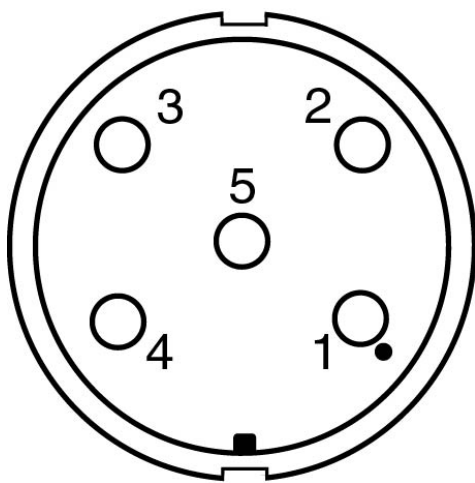
The cable from the RFU must be connected to the **RUDDER** socket on the AP45 unit. The RFU is supplied with a standard 14-metre cable but can be extended if required during installation. See Rudder feedback wiring diagram, page 30.

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.

Rudder Feedback / GPS Wiring Diagrams

Pin connections from rear of plug, solder connection side.

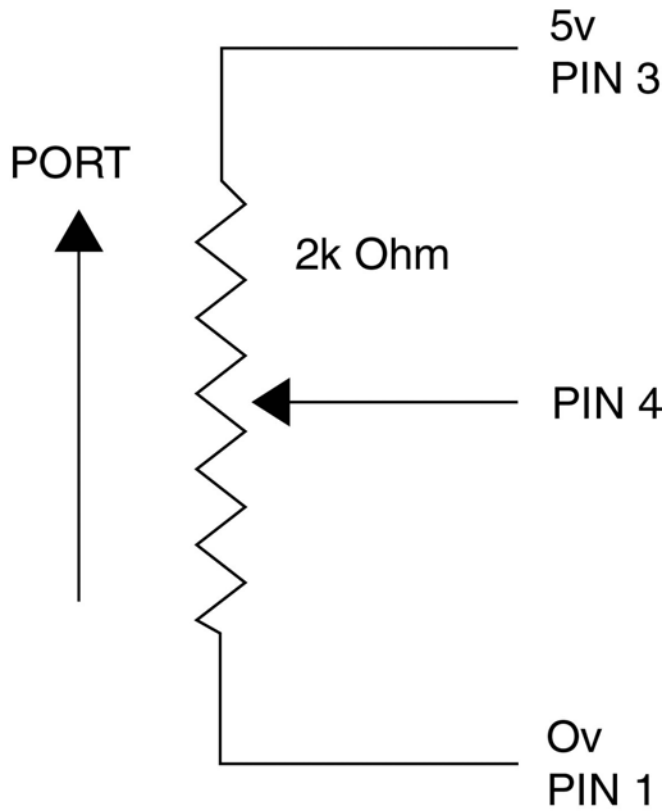
Figure 1 Rudder Feedback / GPS Connection Diagram



Pin1 0v Rudder Feedback Supply
Pin2 - GPS Input (Negative)
Pin3 + 5v Rudder Feedback Supply
Pin4 Rudder Feedback Wiper Return
Pin5 + GPS Input (Positive)

Note: Pin locations are as viewed from the front.

Figure 2 Rudder Feedback Wiring Diagram



GPS Connection

For GPS navigation, connect the GPS unit via the two wires coming from the back of the 5-pin socket on the AP45 Display Unit. The connections on the plug are:

Pin 5	DATA IN+
Pin 2	DATA COM

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.

Testing Procedure

Initial Inspection and Testing



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

Dockside Tests

1. Turn steering wheel fully clockwise and visually check that moving (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. Switch on AP45 Autopilot system and select Rudder Angle Indicator by pressing the Mode button three times.	
5. Check that Port and Starboard are in the correct direction.	
6. Select Auto. If drive goes hard over to mechanical stop reverse motor connection wiring. (See Trouble Shooting Section)	
7. Check Rudder direction follows Course change request	
8. Check Course change provides sufficient Rudder movement	
9. Adjust Rudder Limits with display if required	
10. Check magnetic heading display on AP45	

Trouble Shooting

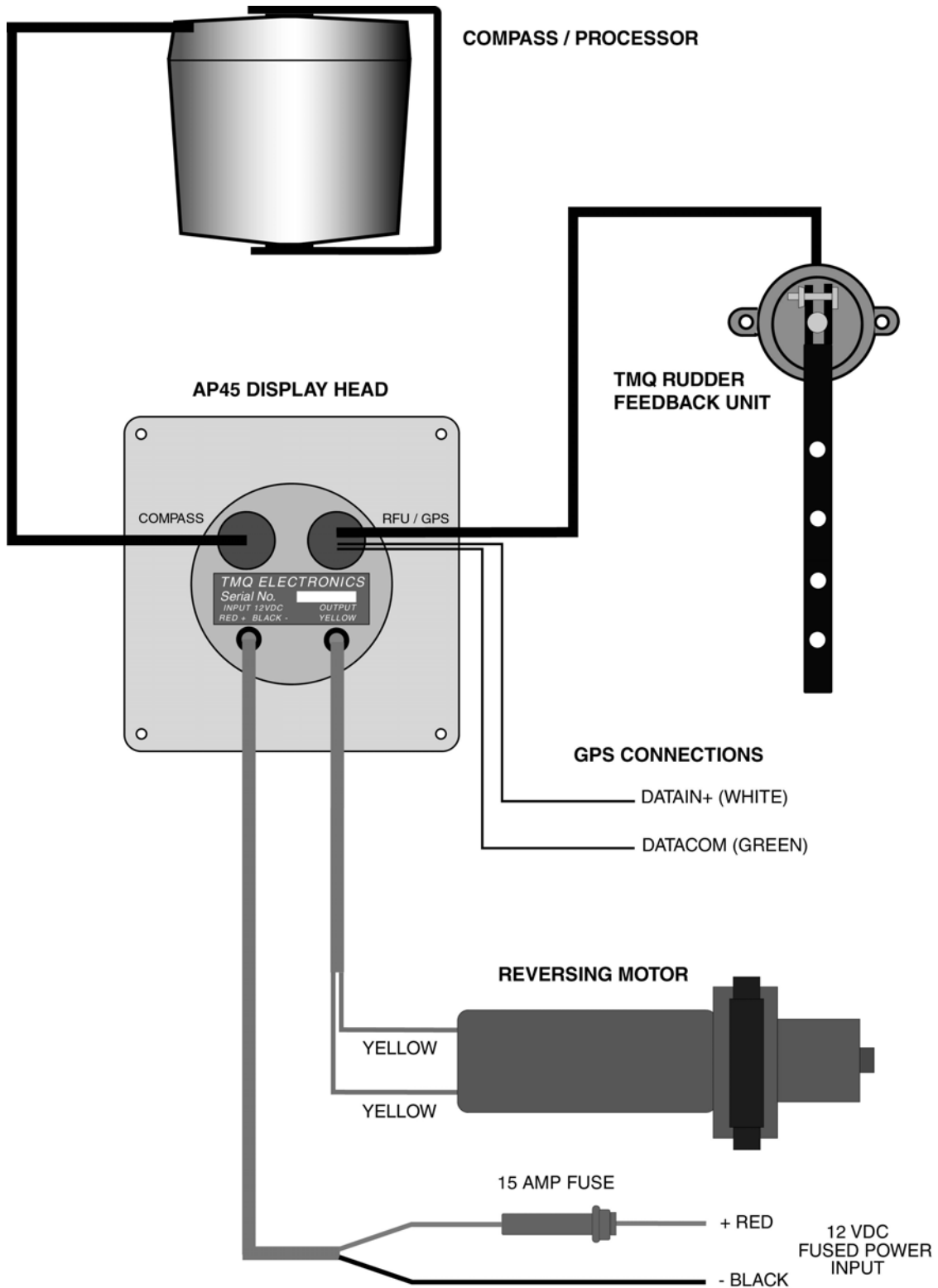
Unit does not move rudder when AUTO is selected

- Confirm AP45 LCD is displaying information.
- Check voltage is present at the AP45 motor connections (Yellow).
- Confirm that the supply voltage is 12 volts dc (Red and Black).
- If using solenoid valves with an external power supply, check that it is present.
- Check all motor and / or solenoid valve wiring.
- Check the 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.

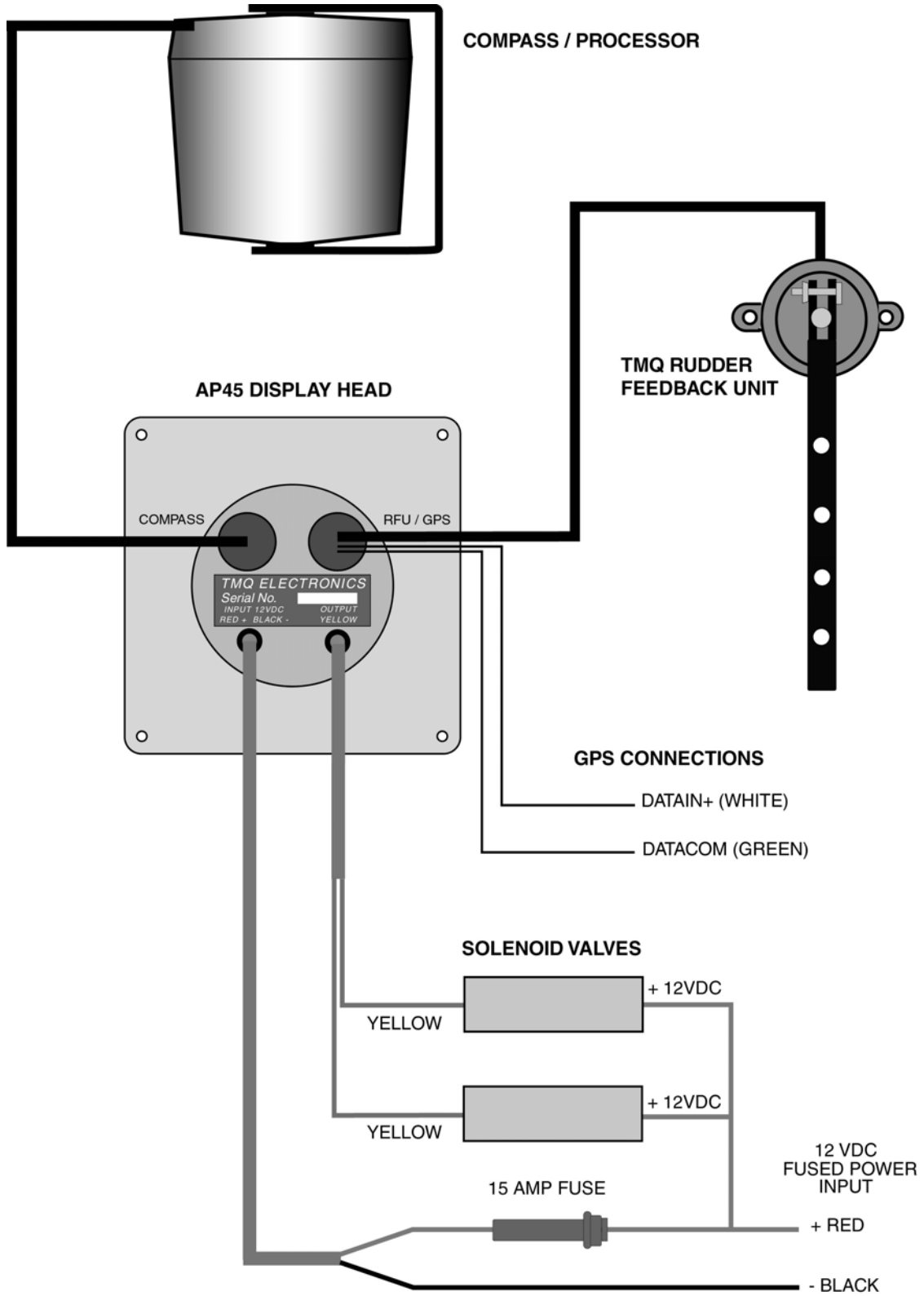
Rudder drive hard over

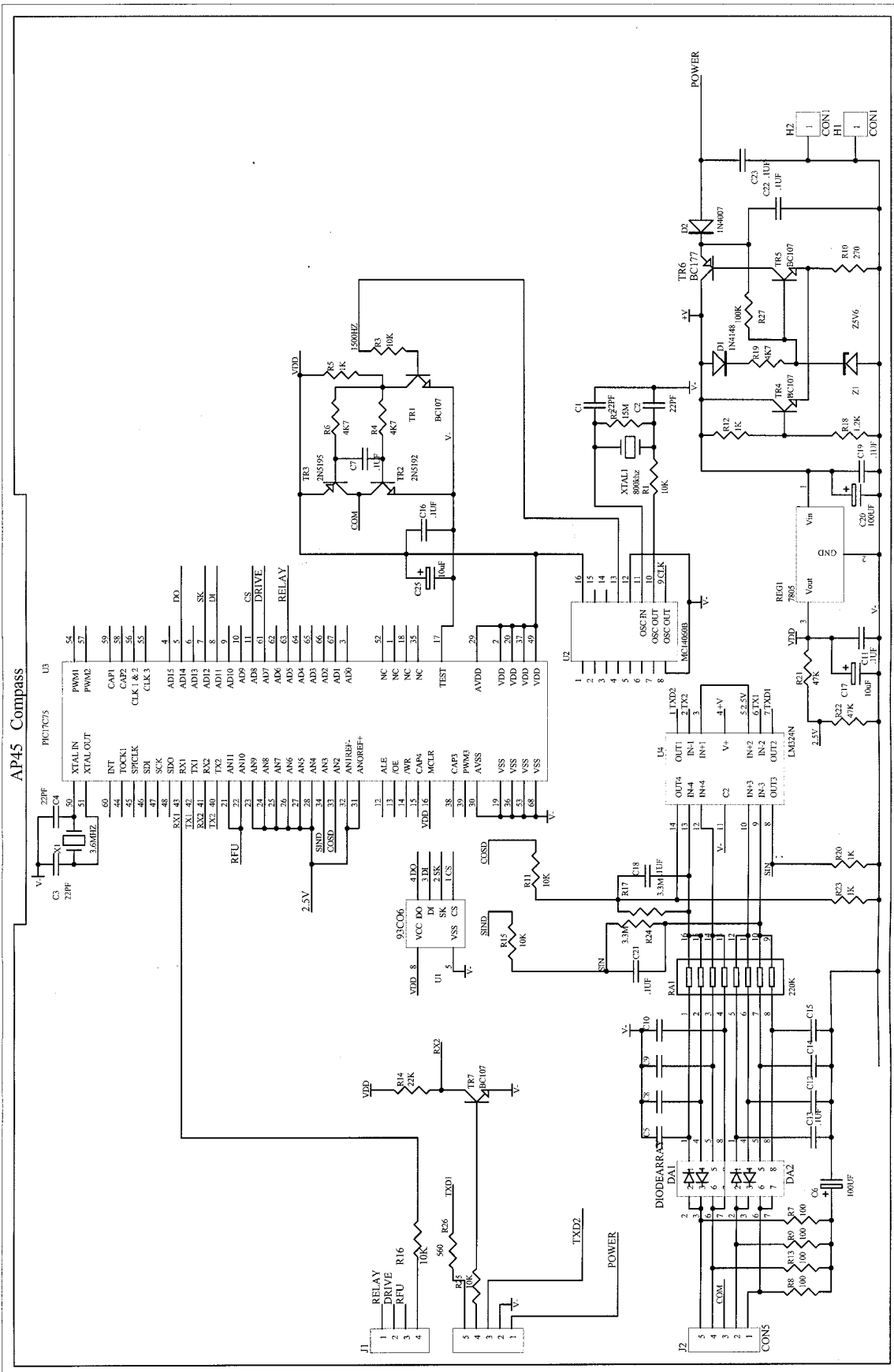
- After installation of the autopilot System if the rudder drives hard over to their mechanical stops in the wrong direction, the motor connections may need reversing or the solenoid valves may be wired incorrectly (the wrong way around).
- Rudder drives hard over to the mechanical stops in the correct direction;
 1. Check rudder feedback unit is connected to the rudder arm
 2. Check rudder feedback cable for damage.
 3. Ensure the rudder feedback plug is firmly connected to the AP45 unit.

Reversing Pump Connection

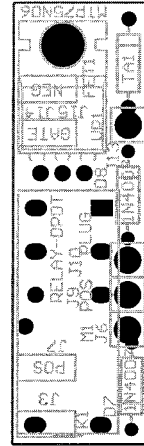
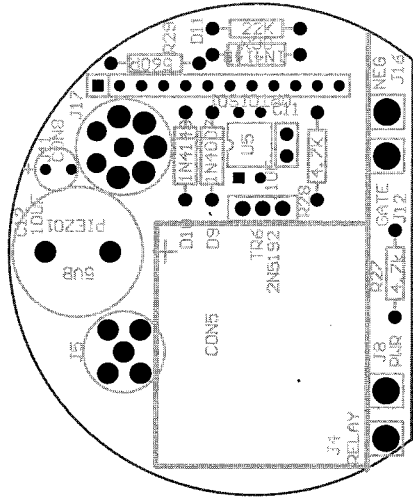
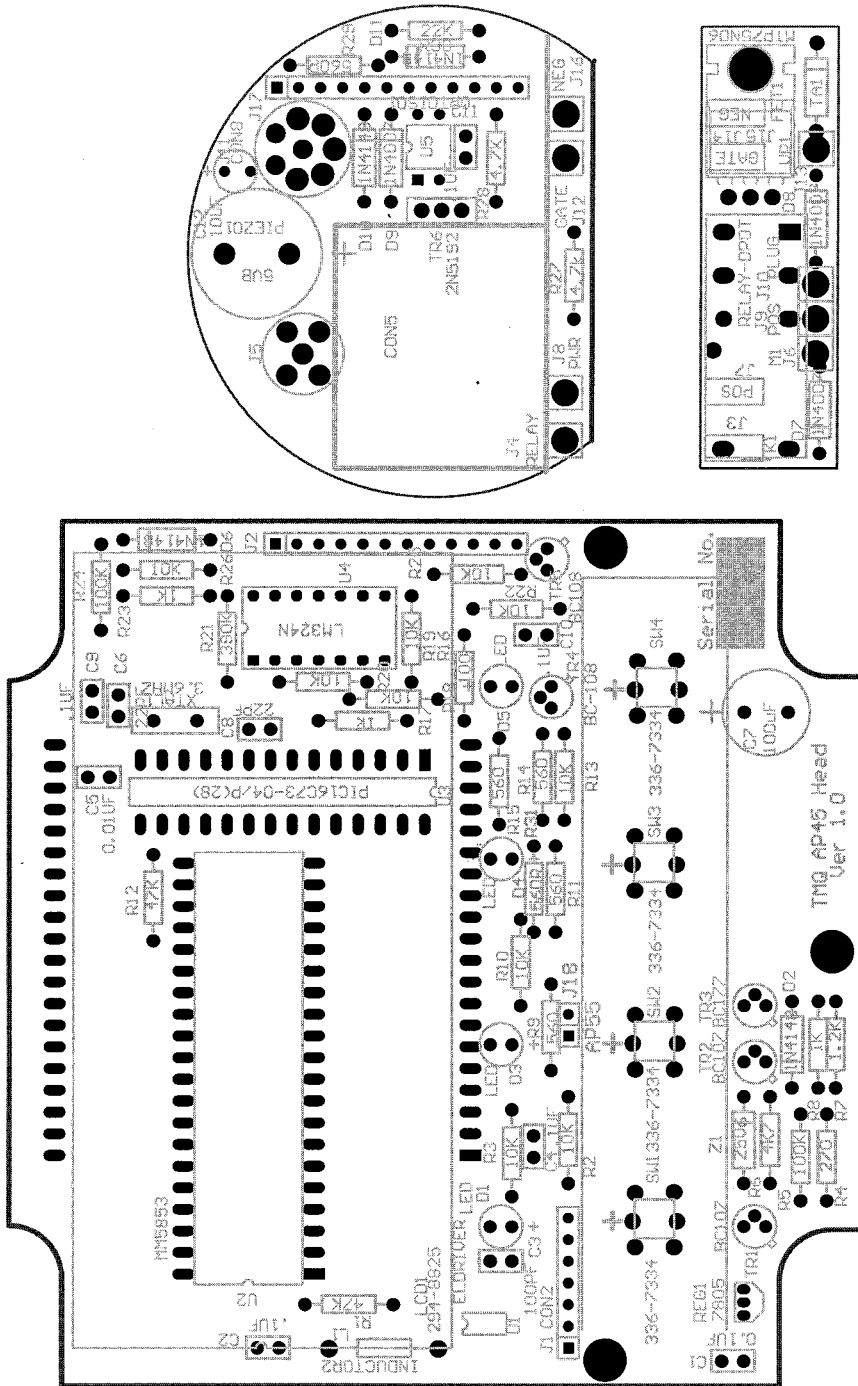


Solenoid Valve Connection

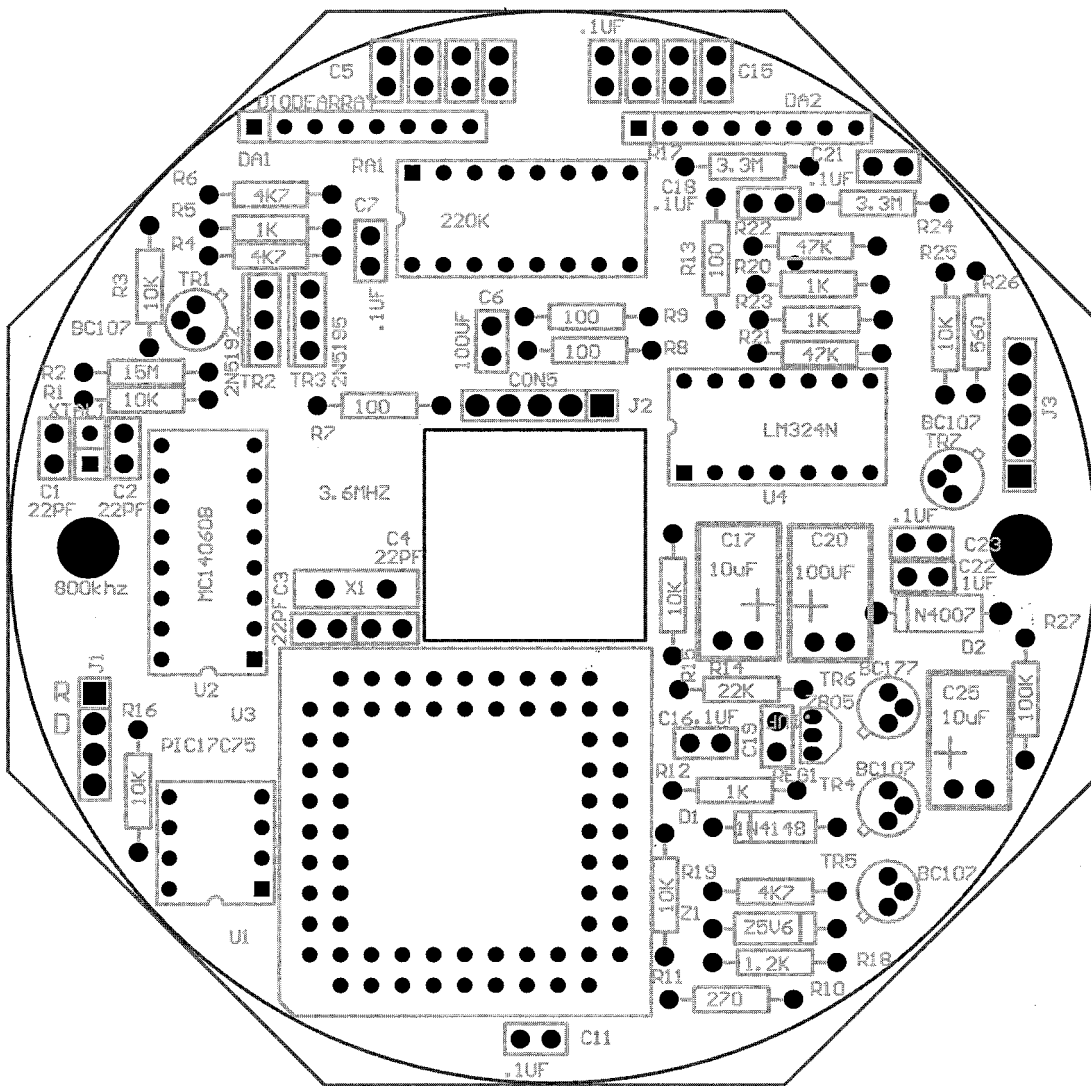




AP45 Head Overlay



AP45 Compass Overlay



Optional Extras

TMQ Electronics can supply a range of pumps for the AP45 Autopilot. Further hydraulic pump information and other product information can be obtained from the TMQ website at www.tmq.com.au

Hydraulic Drives and Pump Units

Reversible pumps



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

Continuous pumps



Constant running pumps available in 2 or 3 litre for 12 volt DC systems. Accurate flow adjustment to set lock-to-lock time.