AP46 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 AP46 Autopilot system. We are sure that you will enjoy the benefits that it offers.

AP46 Autopilot System

The AP46 Autopilot system comprises the following units: -

Essential Electronics:

- AP46 display and control head.
- Rudder feedback unit.
- Elproma Compass ECS1
- Drive unit, for example
    - Hydraulic system with solenoid valves.
    - Reversing hydraulic pump system.

Block Diagram of full system

The AP46 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 25). The RFU must also be electrically connected to the AP46 Head unit.

Rudder actuator system: this system provides the physical movement to the rudder responding to the direction control signals provided by AP46 system. A rudder actuator system comprises 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; or,
    3. Solenoid valves connected to a continuous running motor and pump unit.

Definition of Terms

AP46 Display:

The Operation unit, with LCD Display and push buttons.

Rudder Feedback Unit (RFU):

This provides the required rudder position information for steering control.

Heading:

This is the magnetic heading of the vessel at the current time.

Course-to-steer:

The magnetic heading which the autopilot is attempting to maintain.

Overview of Operation

- **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 the magnetic course indicated. This course can be set or altered 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 (waypoint), or through a sequence of latitudes and longitudes (route).

- **RUDDER and RESPONSE Settings:**

  These customise the AP46 Autopilot for your vessel's steering. They may also be used to adjust for varying sea conditions.

- **Rudder Angle Displays:**

  The AP46 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.

- **Jog Mode:**

  When the autopilot is in manual mode, the port or starboard buttons may be pressed and the steering will be driven in that direction.

Turning the unit ON / OFF

The power to the AP46 unit should be connected 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 give a course change of 1˚ in the applicable direction. The display will change to indicate the new course-to-steer. By pressing and holding the buttons

pressed the course changes in 10 ˚ increments. This is used for larger turns.

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 from that displayed.

The AP46 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 AP46, 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 AP46 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 AP46 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 AP46 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 AP46 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 AP46 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 AP46 compass is correctly aligned and installed, and not subject to magnetic interference.

Jog Mode

In MANUAL mode

- The display screen shows "H***", *** being the current vessel magnetic heading in degrees.
- The steering will operate in the direction selected by a < or > button press.

NOTE.

Do not hold either button down for too long a time (maximum 4 seconds) or the steering will be driven to the stops.

Note: The limit controls are not operating in this mode.

Driving the steering into the physical stops will damage your autopilot

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. With 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 either the < or > buttons will turn 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 AP46 Autopilot. Two initial settings can be checked from the display Head.

- Motor Direction
- Rudder Limits

Motor Direction

In manual mode with the display showing a compass heading, pressing port or starboard buttons (< >) should drive the rudder in the direction indicated on the button. Reverse motor wires if incorrect.

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 AP46 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 "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 “ ---” (out of range) is displayed it indicates the rudder is not in the correct position to set the rudder limit, eg: **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 is set to carry out an automatic compass calibration if the vessel is turned through 360˚ within 4 minutes.

If the AP46 compass heading displays a **constant offset** when compared to a correctly calibrated ships compass (eg: the autopilot compass reads 3˚ high on all headings), simply rotate the AP46 compass sensor to align the displayed headings with the ships compass.

If the compass is reading “H000”, the possibility is the compass is not functioning or disconnected.

Alarms

A number of conditions will cause alarms to sound and an alarm message to flash on the display

Off Course Alarm

The AP46 allows for monitoring of the autopilot course holding ability by having the angle off-course measured and alarm sounding if greater than 45˚ from the desired course.

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

GPS Alarm

NO GPS DATA Alarm
The alarm sounds if the autopilot is not receiving valid information from the GPS. The ALARM LED will flash.

Installation of AP46 Head Unit

Position:

The AP46 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 AP46 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 theAP46 Head, there is negligible effect on a steering compass. Some radio interference may be caused by the internal electronics.

Installation of Compass

The AP46 Autopilot is supplied with a Compass Sensor
The Compass Sensor should be treated with care.

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 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 AP46. 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 as near as possible to a vertical position.

Calibration:

The compass 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 and set for auto calibrate.

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 AP46 unit
The AP46 must have a direct connection to power supply via a 15 amp circuit breaker or a 15 amp fused circuit and an isolating switch.

AP46 Head Wiring Diagram

Installation of Rudder Feedback

Position:

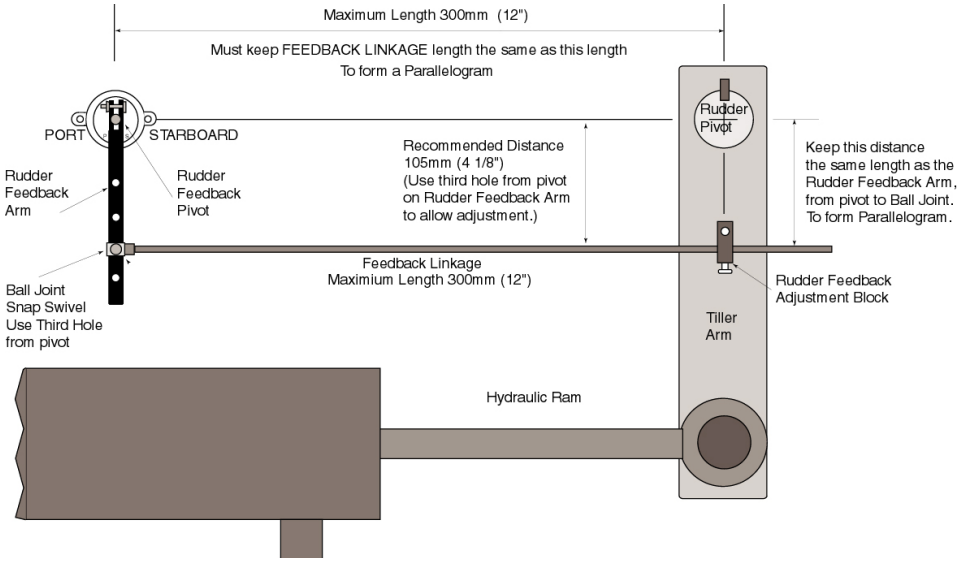
Install rudder feedback as shown in the diagram labelled "Rudder Feedback Unit Installation" (next page). The unit should be adjacent to the tiller and must copy the angular movement of the tiller. The markings on the rudder feedback unit indicate the required movement of the tiller for course correction. 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 °.
- 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 AP46 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 32.

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. Pin 1 has adjacent dot.

Figure 1 Rudder Feedback / GPS Connection Diagram

Pin1 5V Rudder Feedback Supply
Pin2 Rudder Feedback Wiper Return
Pin3 0v Rudder Feedback Supply
Pin4 TX Data (heading information)
Pin5 + GPS Input (Positive)
Pin6 - GPS Input (Negative)

Note: Pin locations are relative to pin 1 which always has a dot adjacent.

GPS Connection

For GPS navigation, connect the GPS unit via the two wires coming from the back of the rudder feedback plug on the AP46 display unit. The connections on the plug are:

Pin 5	DATA IN+	(white)
Pin 6	DATA COM	(green)

For information on connecting different brands of GPS units, refer to the relevant GPS manual.

Reversing Pump Connection

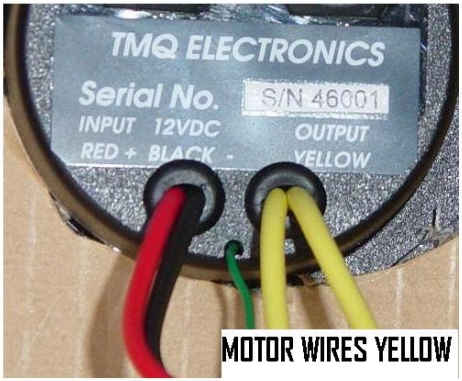
The reversing pump is connected to the yellow wires from the display unit.

Cable length can be shortened or extra cable added.

Check cable used is off sufficient size to carry the motor current (Can be up to 15 amps peak)

Check motor direction with jog mode, reverse if required.

Where a bypass valve or clutch is required the green wire supplies switched negative power whenever POWER or AUTO is selected.



Testing Procedure

Initial Inspection and Testing

1. Confirm power to be connected is the required DC voltage.	
2. Power Supply 12V DC is available.	
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 AP46 Autopilot system and select Rudder Angle Indicator by pressing the Mode button three times.	
5. Press arrow button to operate steering in that direction	
6. Check that rudder moves in correct direction	
7. Check Rudder direction follows change request	
8. Check Course change provides sufficient Rudder movement	
9. Adjust Rudder Limits with display **ONLY** if required	
10. Check magnetic heading display on AP46	

Trouble Shooting

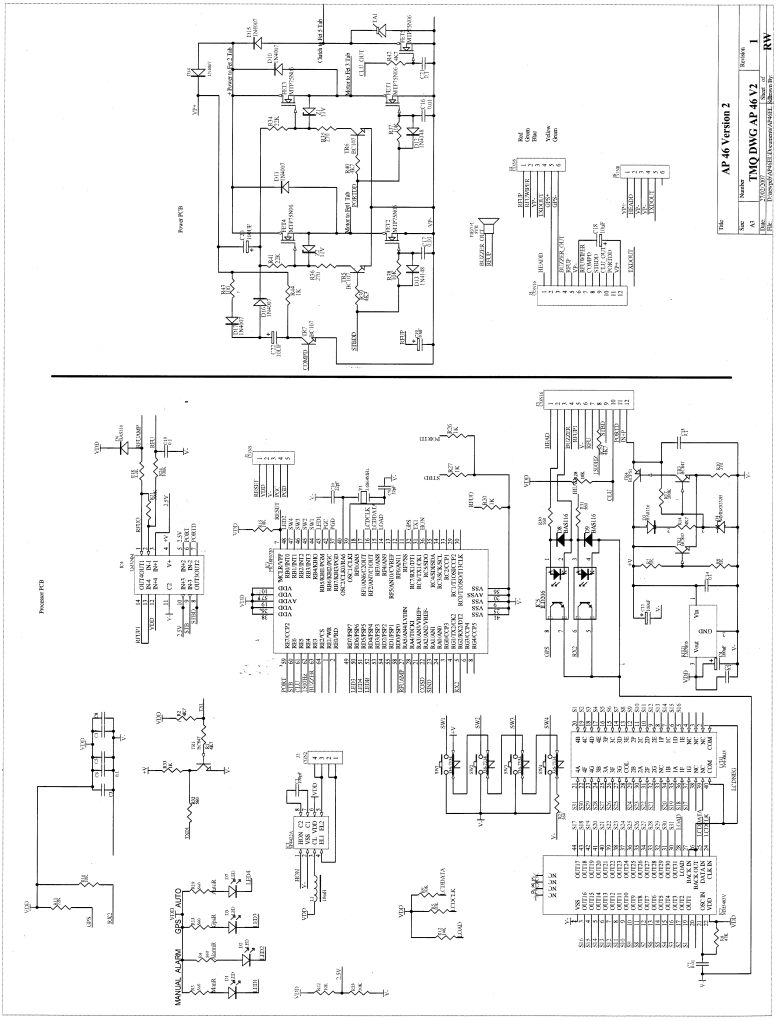
Unit does not move rudder when AUTO is selected

- Confirm AP46 LCD is displaying information.
- Check voltage is present at the AP46 motor connections (Yellow) when AUTO is selected and a course change applied.
- Confirm that the supply voltage is 12 volts DC (Red and Black).
- If using solenoid valves with an external power supply, check that power 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 connectors may need to be swapped.

- 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 AP46 unit and indicates on display when RFU mode selected.


AP 46 Version 2
TMQ DWG AP 46 V2
Power PCB
Processor PCB

Optional Extras

TMQ Electronics can supply a range of pumps for the AP46 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.

Technician set up procedure

A procedure has been included in the software to adjust the motor control response.

This can be entered when in standby (MANUAL) by pressing the mode button until “P-10” is displayed. Then pressing the two arrow (< >) buttons together twice.

The motor routine will then be displayed in 4 settings.

1 Pulse length
2 Reverse delay
3 Dead band
4 Pulsing frequency

To adjust, select the number to be adjusted, press both arrows together to select the mode.

Indicated by 1 = 05

Adjust up or down with the arrows.

Press both arrows together to deselect the mode.

Indicated by 1 - 05

Press MODE or AUTO to return to normal pilot operation.