

Distributed by
Raymarine

Any reference to Raytheon or RTN in this manual should be interpreted as Raymarine. The names Raytheon and RTN are owned by the Raytheon Company.

Installation and Operating Handbook

ANALOGUE

AutohelmTM 5000

AUTOHELM 5000

The Autohelm 5000 is a modern high performance autopilot specifically developed for sailing and motor vessels of up to 40' (13m) LOA. It is exceptionally easy to operate and its advanced micro-electronic control circuit gives outstanding steering performance.

The Autohelm 5000 is distinguished by its automatic course locking capability which permits change-over from manual to automatic steering by a single push-button control. From then on the original heading is rigidly maintained by the automatic trim system which continuously monitors trim changes and offsets the mean wheel position to compensate. In addition, the rate of wheel rotation is regulated in proportion to the rate at which the vessel moves off course, giving the Autohelm 5000 the smooth steering capability of an experienced helmsman.

The basic system comprises a Drive Unit and Control Unit inter-connected by a pluggable multi-core cable. A complete range of optional remote control accessories are available which are also pluggable to the Control Unit. After fitting the system it is only necessary to make a single adjustment to the Control Unit in order to match the system's response range to the character of a particular vessel.

The Autohelm 5000 is exceptionally easy to install and prepare for sea trials. Sound installation however is vital if the system's high standard of performance and reliability is to be achieved. The installation notes should be followed carefully and in cases where special advice may be needed you are encouraged to contact our Technical Sales Department where expert assistance is always available.

1.0 SYSTEM DESCRIPTION

The Autohelm 5000 is a modular system that can be built up from a minimum number of standardised units to match the individual requirements of a wide range of sailing and power vessels. The rudder drive system may be chosen from a range of rotary, linear and hydraulic drive units to best suit the vessel's particular steering system.

The most basic installation (Fig. 1) consists of a control unit inter-connected by a pluggable cable system to a drive unit. This installation would be suitable for a motor vessel with a single enclosed steering position, and where no requirement exists for remote control facilities. Hand-held remote control unit type DO73 may be plugged directly into the Control Unit auxiliary socket.

A simple remote control installation is illustrated in Fig. 2. The auxiliary control unit repeats the basic working controls of the main control unit and is suitable for extending autopilot control to a secondary steering position. Alternatively, in the case of a sailing yacht for example, the auxiliary control unit provides a watertight cockpit control enabling the control unit to be mounted in a protected position below deck.

The full remote control system (Fig. 3) provides the addition of a hand-held remote control unit.

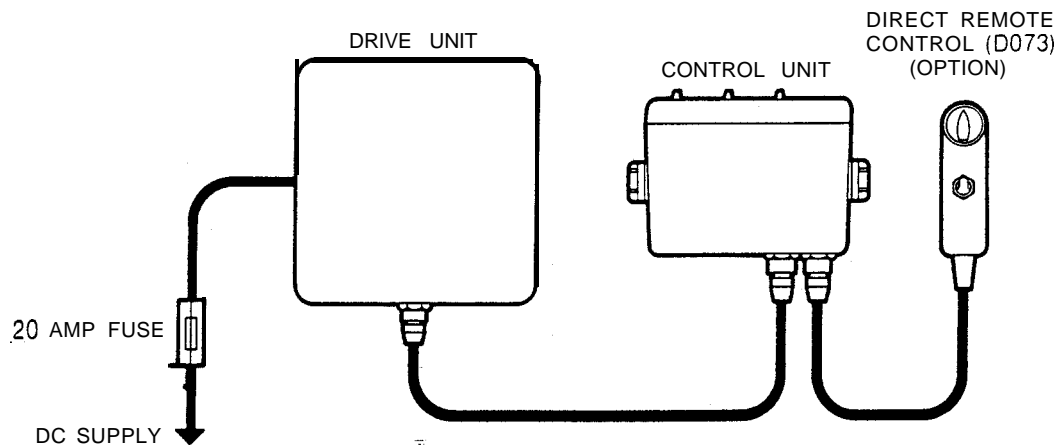


Fig. 1 Basic System

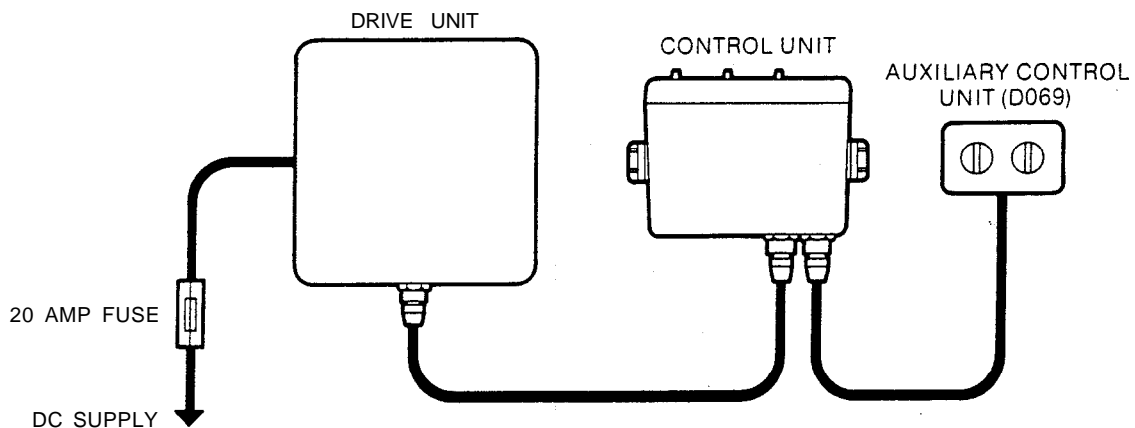


Fig. 2 Basic Remote Control System

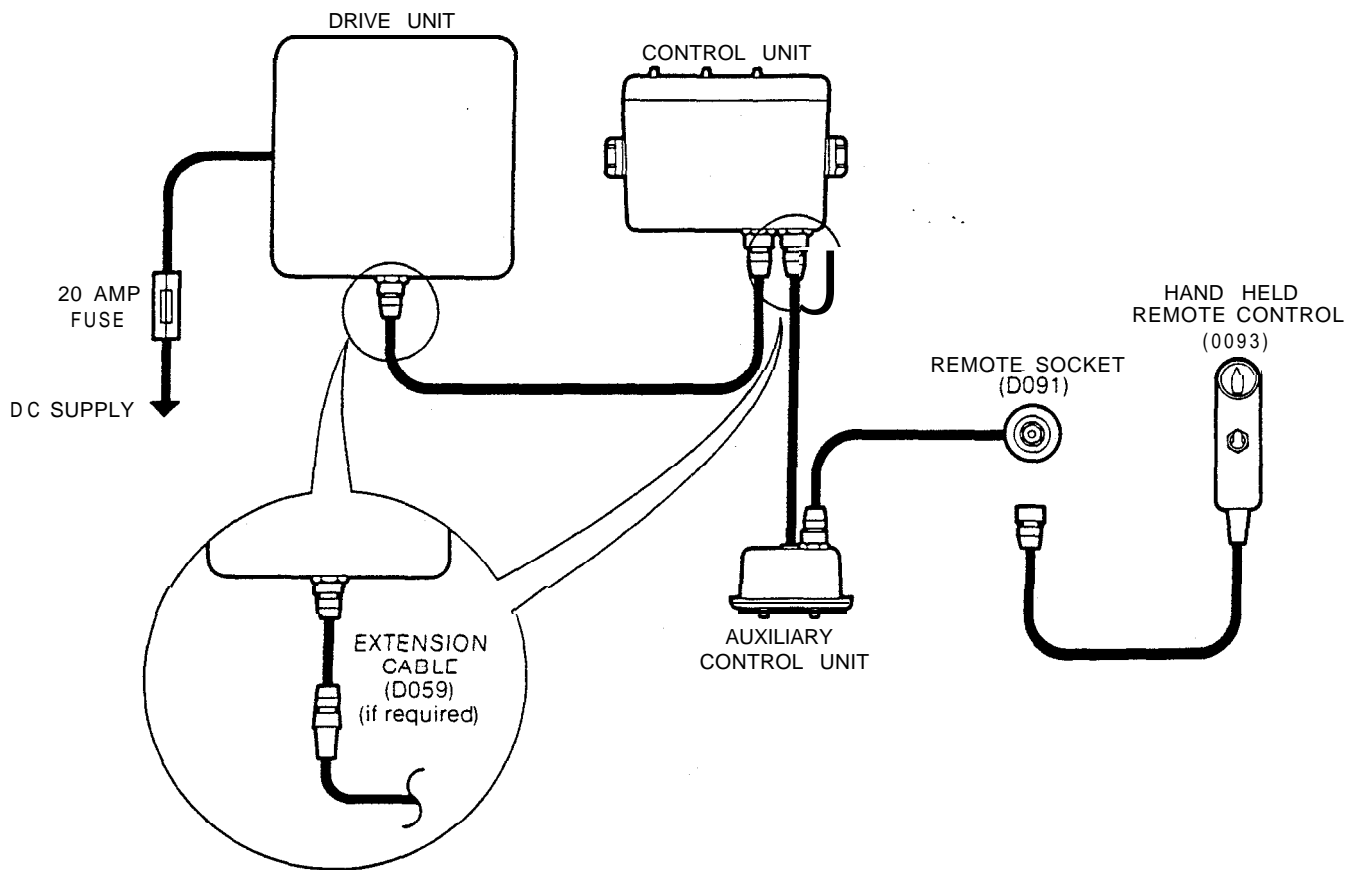


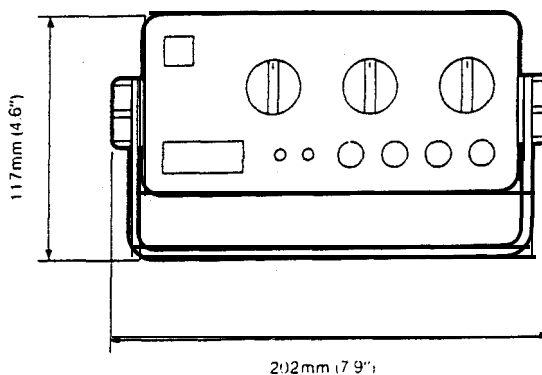
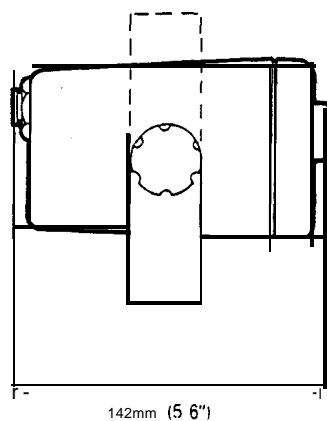
Fig. 3 Full Remote Control System

1 .1 CONTROL SYSTEM

1.1 .1 CONTROL UNIT

The control unit is common to all installations and is provided with six metres of multi-core cable with pre-connected plugs and sockets to connect to the drive unit. It houses the main control circuit PCB together with the automatic course following compass system. The control unit case is splash proof, but not watertight, and is, therefore, intended for mounting in a dry and protected position. Two sockets are provided on the rear case for connecting the drive unit and remote control system.

Rotary controls for course alteration, rudder response and sea state are grouped on the control unit facia, together with the push-button primary working controls. A secondary gain control is inset into the rear case to allow adjustment of the system's rudder response range to match the widely differing steering characteristics of both planing and displacement vessels. The control unit is suitable for use on 12 volt systems.

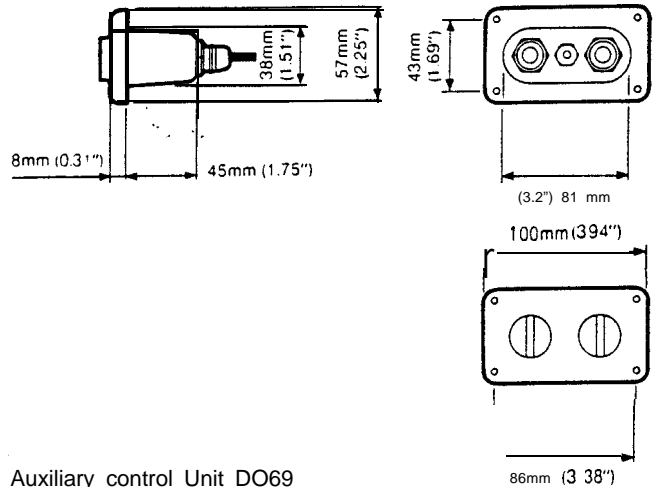


1.1.2 REMOTE CONTROL ACCESSORIES

1.1.3 AUXILIARY CONTROL UNIT

Autopilot control may be transferred to the auxiliary control unit by depressing the **Remote** push-button on the main control unit facia. The auxiliary control unit is watertight and designed for flush mounting in severely exposed positions.

It is provided with six metres of cable terminated in a waterproof plug for direct connection to the control unit. A connector is situated on the rear case for connecting hand-held remote control deck socket.



Auxiliary control Unit DO69

1.1.4 REMOTE CONTROL UNITS

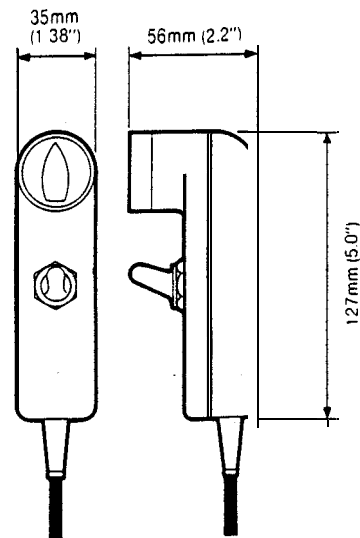
The remote control is a hand-held unit that enables the autopilot to be overridden and the vessel to be power steered from anywhere on board. The unit is fitted with a six-metre flying lead, Type DO73 is suitable for direct connection to the Control Unit auxiliary socket. Type DO93 is fitted with a waterproof plug for connection to a waterproof deck socket.

1.1.5 REMOTE SOCKET

The remote socket provides a watertight socket for the hand-held remote control. The socket is supplied with 6 metres of 3 core cable terminating in a **plug** for direct connection to the Auxiliary Control Unit.

1.1.6 CABLE EXTENSION

The cable extension facilitates the lengthening of all multi-core cables in six-metre increments. The extension cable is terminated with compatible waterproof connectors for insertion into the cable harness in the positions shown in Fig. 3.

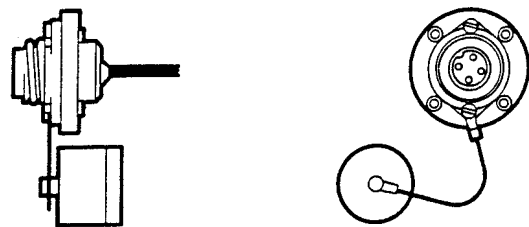


Hand Held Remote Control Unit (D093)
Direct Remote Control (D073)

1.1.7 CATALOGUE NUMBERS

CONTROL SYSTEMS

Control Unit	2068
Auxiliary Control Unit	D069
Remote Control	D093
Direct Remote Control	D073
Remote Socket	D091
Cable Extension	D059
DRIVE SYSTEMS	12v only
Rotary	Z069
Linear	2070
Hydraulic	2071



Remote Socket D091

1.2 DRIVE SYSTEMS

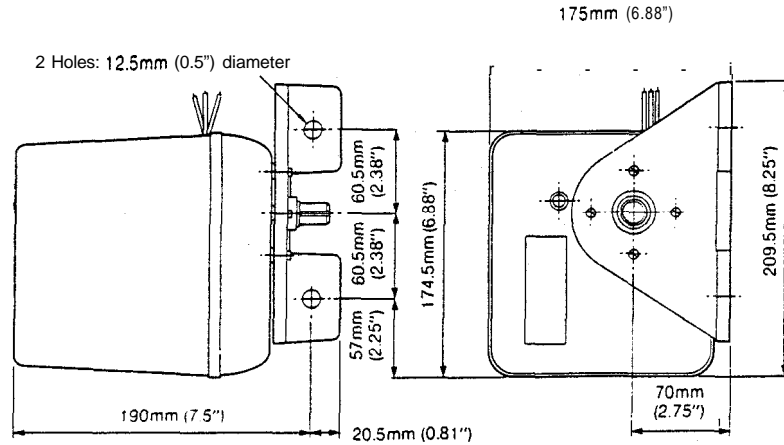
Mechanical steering systems may be driven by either a rotary or linear drive unit. Some steering systems are fitted with an autopilot drive shaft, and in such cases the choice of a rotary drive system is straightforward. In general, if a drive shaft exists and lost motion does not exceed 2% of total rudder movement, the rotary drive unit becomes the most economic choice. In all other cases the linear drive unit will provide the simplest installation since it may be connected directly to a tiller link on the rudder stock. Total independence of the mechanical steering linkage also allows the linear drive unit to be used to power steer the vessel in the event of steering linkage failure, and this is an important safety feature. In addition, minimisation of working parts improves the overall efficiency of the rudder drive system and reduces lost motion to an absolute minimum.

All vessels with hydraulic steering systems will require a hydraulic drive unit.

1.2.1 ROTARY DRIVE UNIT

The output shaft is driven by a continuously rated servo motor via an efficient reduction gearbox. The gearbox is dry lubricated to permit operation in any attitude. A fail safe friction clutch within the gear train engages automatically when the autopilot is switched to Duty and will disengage instantly even under extreme load when the autopilot is switched to Set.

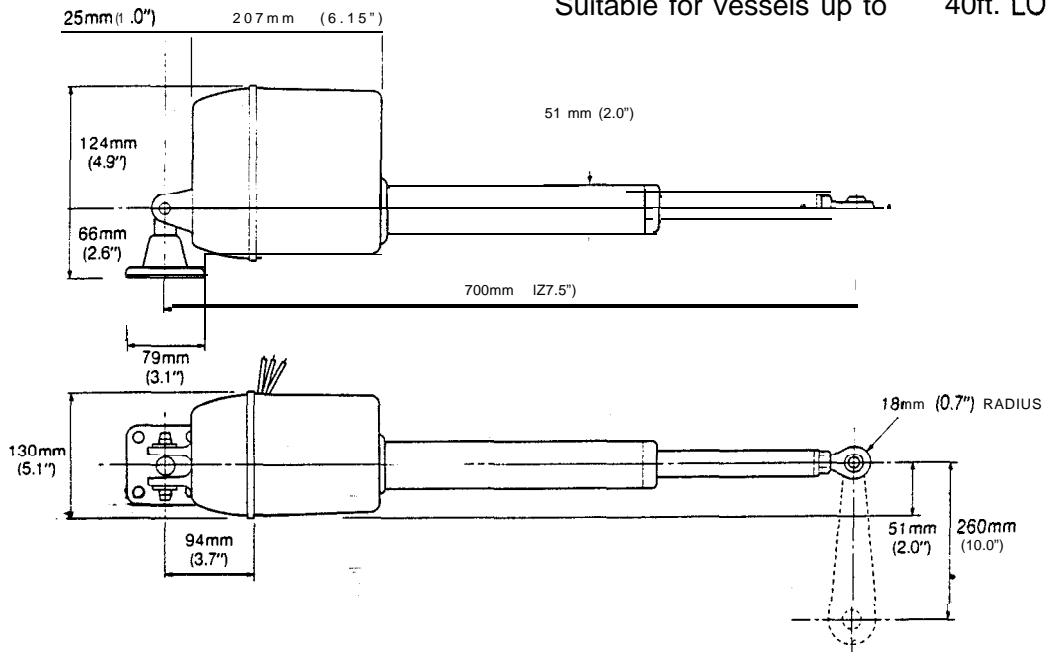
Supply voltage	12 volts
Peak output torque	240lb.in. (27Nm)
Maximum shaft speed	18 rpm
Power consumption (typical average)	1 S-3 amps
Suitable for vessels up to	40ft. LOA (12m)



1.2.2 LINEAR DRIVE UNIT

The output ram of the linear drive unit is driven by a declutchable re-circulating ball leadscrew which enables the drive unit to be permanently coupled to the rudder stock via a simple crank or tiller arm. The drive is automatically engaged by means of an internal friction clutch when the autopilot is switched to **Duty** and will disengage instantly even under heavy load when the autopilot is switched to Set or **Off**.

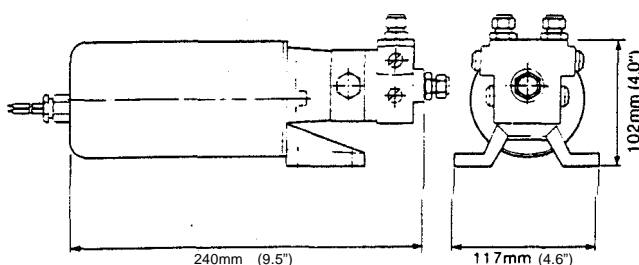
Supply voltage	12 volts
Peak thrust	550lbs (225Kg)
Maximum stroke speed	1.2in./sec. (30mm/sec.)
Maximum stroke	12in. (300mm)
Overall length at mid stroke	27.5in. (700mm)
Tiller arm length (±35° rudder)	10in. (260mm)
Maximum rudder torque	500lb.in. (570Nm)
Power consumption (typical average)	1.5-3 amps
Suitable for vessels up to	40ft. LOA (12m)



1.2.3 HYDRAULIC DRIVE UNIT

The hydraulic drive unit consists of a precision gear pump with integral valve block driven by a continuously rated servo motor. A special pressure balance valve corrects the effects of hydraulic slip and isolates the pump from the steering circuit when the autopilot is not energised.

Supply voltage	12 volts
Regulated peak pressure	450lb.in ² (30 bar)
Flow control	integral pilot check and pressure balance valve system
Peak flow rate (unloaded)	40in ³ /min (650cc/min)
Maximum ram capacity	1.5in ³ (250cc)
Power consumption (typical average)	2-3.5 amps
Overall length	9.5in. (240mm)



2.0 INSTALLATION

The Autohelm 5CCC is exceptionally easy to install and prepare for sea trials. Sound installation however is vital if the system's high standard of performance and reliability is to be achieved. The installation notes should be followed carefully and in cases where special advice may be needed you are encouraged to contact our Technical Sales Department where expert assistance is always available.

2.1 CONTROL SYSTEM

2.1.1 CONTROL UNIT

The control unit is the most sensitive part of the system and care should be taken to select a mounting position that is reasonably free from vibration and protected from external weather conditions. The control unit is mounted in an aluminium frame which can be pivoted to permit fixing to either horizontal or vertical surfaces. The frame is finally fixed into position by two No. 8 (4mm) diameter countersunk head stainless steel or brass screws.

In the case of a vessel with an enclosed wheelhouse, it would normally be desirable to mount the control unit sufficiently near to the wheel so that the controls are easily accessible to the helmsman. However, since the control unit incorporates a magnetic compass it is necessary to position it at least 2ft 6in (80cm) away from the nearest steering compass in order to avoid ~~order~~ **deviation of** both compasses. Deviation of the control unit compass is much less critical because of its auto-following capability. Nevertheless excessive deviation should be avoided as far as possible in order to maintain uniform sensitivity on all headings. The control unit should thus be mounted as far away as possible from iron or other magnetic devices. If any doubt exists, the chosen site should be checked by means of a handbearing compass. The handbearing compass should be fixed into the chosen position and the vessel swung through 360 degrees. Relative differences in reading between the handbearing compass and the main steering compass should not vary by more than 20 degrees.

In rare cases even the above extreme deviation tolerance may not be achievable, in which case an alternative site remote from the steering position must be selected. In such a case it will be necessary to operate the autopilot through an auxiliary control unit situated near the steering position. Installation in steel hulled vessels invariably presents difficulties and the advice of a compass adjuster should always be sought.

Sailing yachts with a single external steering position are a special case where it is

essential to operate the autopilot via a weather-proof auxiliary control unit. The auxiliary control unit would normally be mounted in the cockpit adjacent to the steering position and the control unit situated below in a suitably protected position.

The compass within the control unit is capable of satisfactory operation at roll and pitch angles of up to ± 30 degrees. The control unit should, therefore, be positioned as near to horizontal as possible to maximise gimballed action in all directions. In the case of a sailing yacht where sustained heel angles may on occasions exceed the above limit, it will be necessary to readjust the control unit to a near horizontal position on each tack. To facilitate this, the control unit's suspension frame should be mounted parallel to the direction of the heel axis.

2.1.2 AUXILIARY CONTROL UNIT

The Auxiliary Control Unit is connected directly to the auxiliary connector on the Control Unit. The unit is waterproof and should be positioned close to the steering wheel. It is designed for discreet flush mounting and a pattern is provided to assist panel cutting before fitting. Matching black self-tapping screws are provided to secure the auxiliary control unit facia in position. A good quality silicone sealant should be used to seal between the facia and the mounting panel.

2.1.3 HAND-HELD REMOTE CONTROL SYSTEM

It is usually desirable to arrange for operation of the hand-held control unit from anywhere on deck. For this purpose up to two remote sockets may be strategically positioned to make this practical without the need for long and potentially hazardous flying leads on the hand-held unit. In the case of a sailing yacht for example, one socket position in the foredeck area and another in the cockpit usually makes a perfect arrangement. The sockets are flush mounted and a pattern is provided to simplify panel cutting. Matching black self-tapping screws are also supplied. A good quality silicone sealant should be used to seal the joint between the socket facia and the mounting face. When more than one remote control socket is required, the three core inter-connecting cables may be paralalled together using a standard cable junction box before connection to the Auxiliary Control Unit.

2.2 DRIVE SYSTEM

The following notes describe the installation of both the rotary and linear drive units.

2.2.1 ROTARY DRIVE UNIT

The rotary drive unit is coupled to the vessel's steering mechanism by a simple chain drive. Most steering gear manufacturers supply special autopilot drive attachments and many include this facility as standard.

Fig. 7 shows recommended rudder hardover to hardover times for both planing and displacement vessels up to 42 feet (13m) LOA. The charts shown in Fig. 8 enables the chain reduction ratio for optimum rate of rudder application to be selected for both planing and displacement vessels. To use the charts, it is first necessary to determine the number of turns of the driven sprocket when the rudder is driven from hardover to hardover.

Example:

A 40 foot (12m) LOA displacement vessel requiring two turns of the driven sprocket to drive the rudder from hardover to hardover will require a chain reduction ratio of approximately 3:1 (as indicated by the dotted line on the chart). The table on the left hand side of the chart gives suitable sprocket combinations. In this example, the required reduction ratio of 3:1 would be best achieved by a 38 tooth sprocket driven by a 13 tooth sprocket on the drive unit.

It should be borne in mind that the reduction ratios recommended are for the 'average case' and that vessels broadly classified by length and hull type can vary significantly in steering characteristics. Selection of the correct chain reduction ratio is not over critical however, and any slight mismatch can usually be corrected later during sea trials by an adjustment to the gain control on the control unit.

Standard $\frac{3}{8}$ " pitch chain is recommended for the chain drive. Sprockets of 13, 15, 17, 19 and 25 teeth are available as standard accessories. Bore and keyway dimensions for the drive unit sprocket are detailed in Fig. 4. If sprockets other than those supplied by Nautech are fitted, it is essential that bore and keyway dimensions specified in Fig. 4 are strictly adhered to. The recommended driven sprockets tabulated in Fig. 8 are common standard sizes and should be obtainable from local suppliers of chain drive equipment. All sprockets must be "keyed" and grub screwed to their shafts, and finally secured with 'Loctite'.

The drive unit is mounted by bolting to a substantial frame member (Fig. 5). The 'L' shaped mounting foot is secured by four

equally spaced caphead screws, and may be rotated through 90 degrees to provide a more convenient mounting position if required (Fig. 6). In some cases, it may be *necessary* to fabricate a special frame to mount the drive unit. It should be noted that chain tension can exceed 300lb (150kg), and thus an extremely rigid mounting structure is vital to maintain good chain alignment. Installation failures frequently occur in this area, and as a general rule it is desirable to 'over engineer' the drive unit mounting.

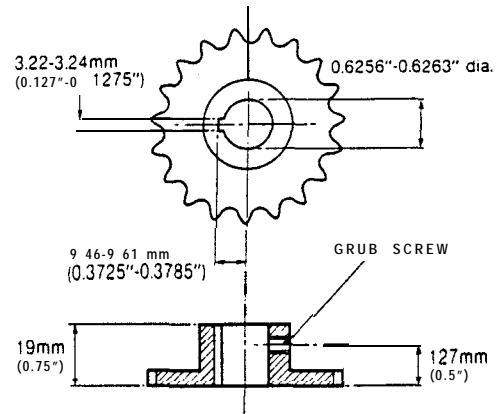


Fig. 4

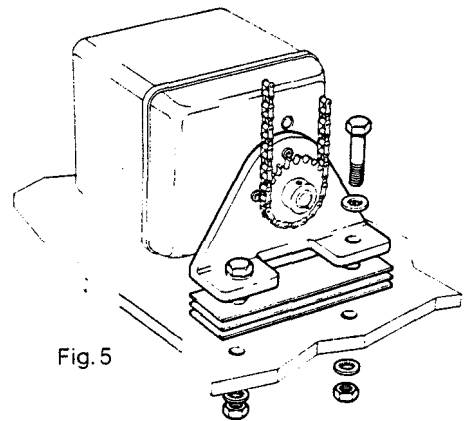


Fig. 5

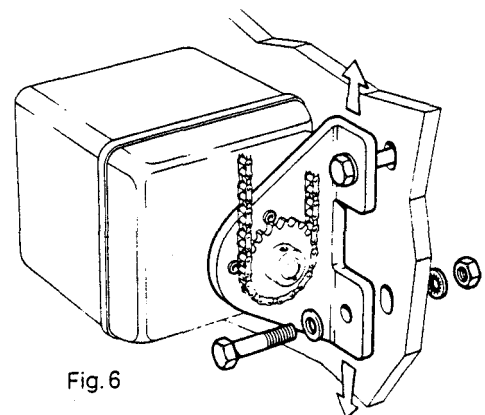


Fig. 6

Provision must also be made for chain adjustment, which is most easily achieved by removable shims placed under the mounting foot, or by elongated clearance holes in the mounting frame as illustrated in Fig. 6. Both sprockets must be accurately aligned to run in the same plane, and this must be carefully checked by means of a straight-edge.

The grease lubricated gearbox permits mounting of the drive unit in any convenient attitude without risk of oil leakage. The drive unit's sprocket may also face any direction, since steering sense can be corrected by means of a phase switch located in the control unit.

Finally, the chain should be tensioned until it is 'just' tight and contributes negligible lost motion to the drive system. Total lost motion between the driven sprocket attached to the steering system and the rudder stock should not exceed 2% of total movement. If lost motion exceeds this level, it should be corrected, otherwise steering performance will be impaired.

Fig. 8

HARDOVER-HARDOVER TIME RECOMMENDATIONS

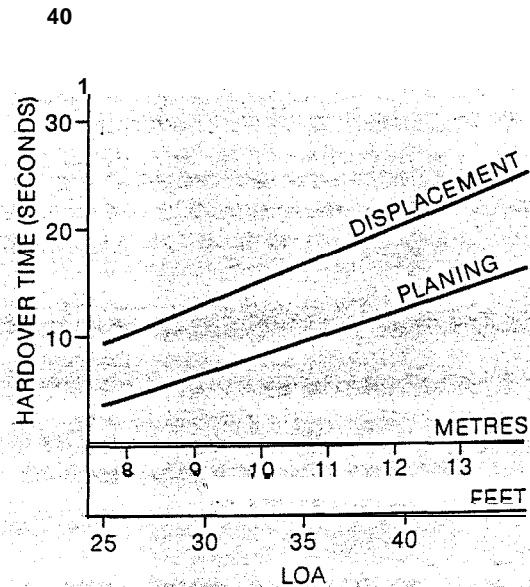
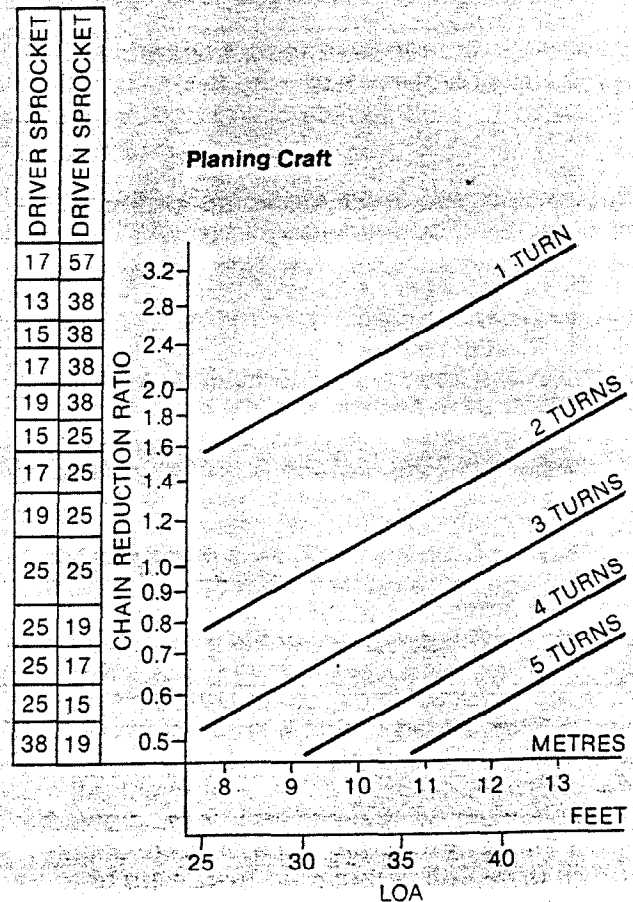
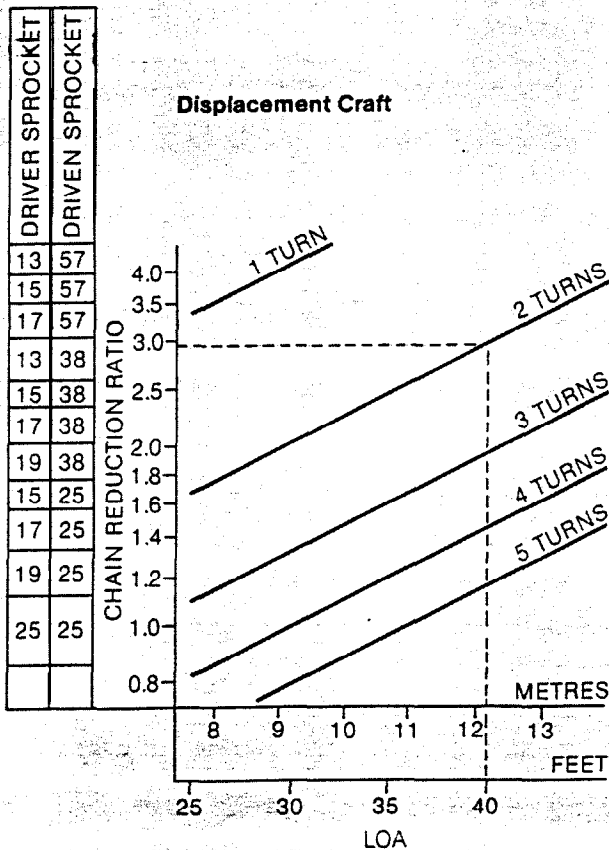


Fig. 7

ROTARY DRIVE CHAIN REDUCTION RATIOS



2.2.2 LINEAR DRIVE UNIT

The linear drive unit couples directly to the rudder stock at the tiller arm length recommended in Fig. 9. It is usually preferable to couple the linear drive unit to the rudder stock via an independent tiller arm (Edson offer a standard fitting). In certain cases, however, it may be possible to couple the pushrod to the same tiller arm or rudder quadrant employed by the main steering linkage. It is important to note that the linear drive system can exert a thrust of 550lbs. If any doubt exists about the strength of the existing tiller arm or rudder quadrant the steering gear manufacturer must be consulted.

The method of bolting the pushrod ball end to the tiller arm or rudder quadrant is illustrated in Fig. 11. It is **vitaly important** that the coupling bolt is fully tightened and the nut locked by means of the locking tab provided. The standard ball end fitting will allow for a maximum angular misalignment between the pushrod and the tiller crank plane of rotation of up to 5°. Accurate angular alignment is extremely important and under no circumstances should the above extreme limits be exceeded. The body of the drive unit is mounted by bolting to a substantial frame member (Fig. 10). As a general rule it is desirable to 'over engineer' the linear drive unit's mounting structure to ensure reliability and maintenance of correct alignment. An excessively **flexible** mount can also severely impair the steering performance of the autopilot.

It is important to ensure that the total rudder movement is limited by the rudder stops built into the vessel rather than the end stops of the linear drive output.

LINEAR DRIVE
TILLER ARM LENGTHS

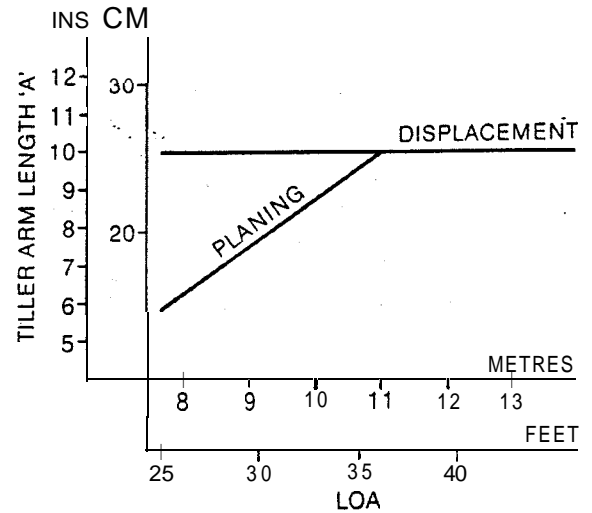


Fig. 9

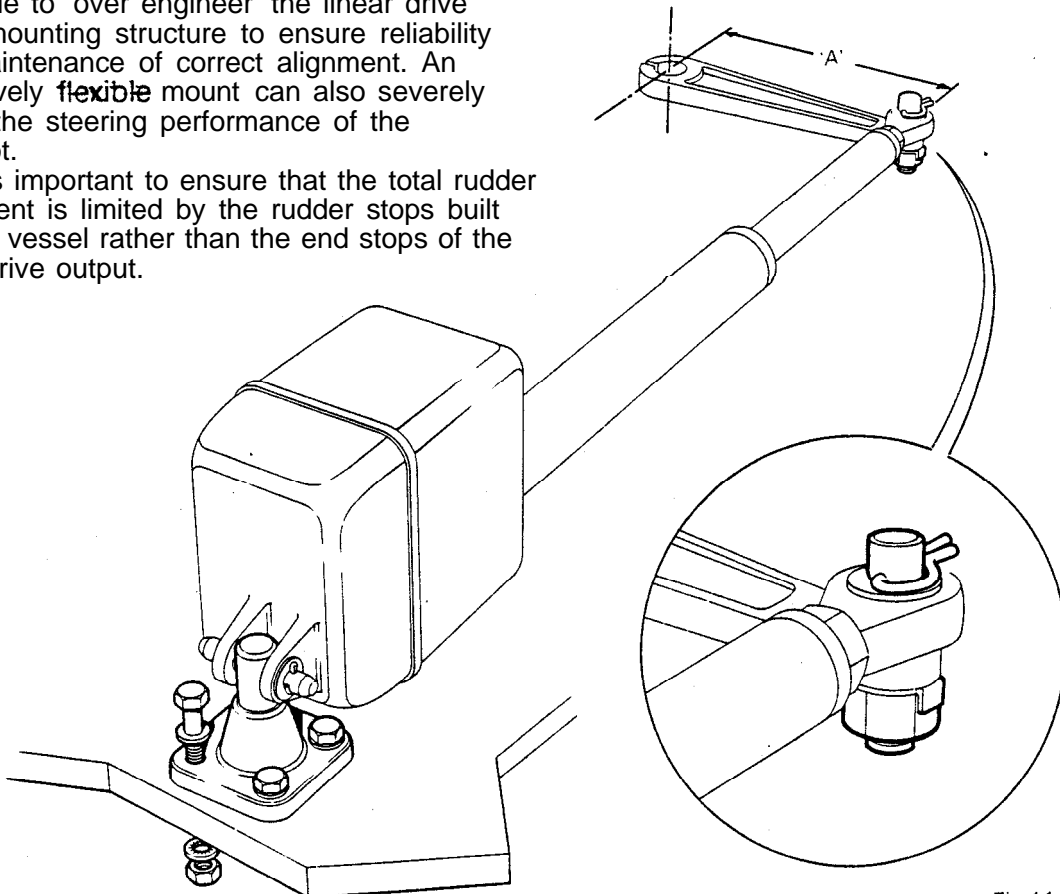


Fig. 10

Fig. 11

2.2.3 HYDRAULIC DRIVE UNIT

The hydraulic drive unit should be mounted clear of spray and the possibility of immersion in water. It should be located as near as possible to the hydraulic steering cylinder. It is important to bolt the hydraulic drive unit securely to a substantial member to avoid any possibility of vibration that could damage the inter-connecting pipework.

The drive amplifier (Fig. 13) should be mounted between the drive unit and the power supply (batteries) in order to minimise the total length of power cable. It should also be mounted in a position clear of bilge water and spray. The drive amplifier is mounted by first removing the cover marked 'Autohelm' and bolting or screwing to a suitable vertical bulkhead through the four holes in the base (Fig. 14).

There are three basic types of hydraulic steering system (Fig. 12). Typical connection points for the drive unit are shown in each case. **In all cases it is strongly recommended that the steering gear manufacturer be consulted.** The drive unit valve block is tapped 1/4" BSP to accept suitable pipe fittings and Dowty sealing washers are supplied (Fig. 15).

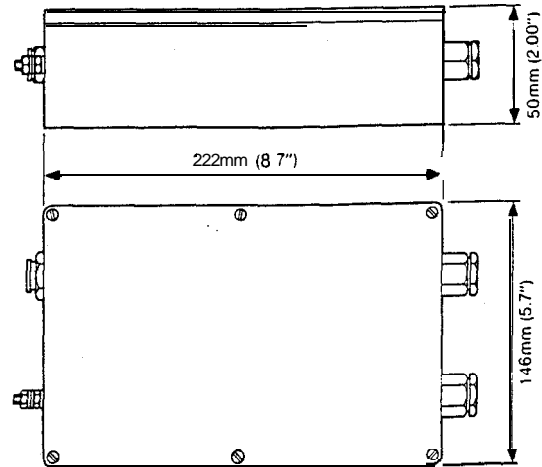


Fig. 13 Drive Amplifier

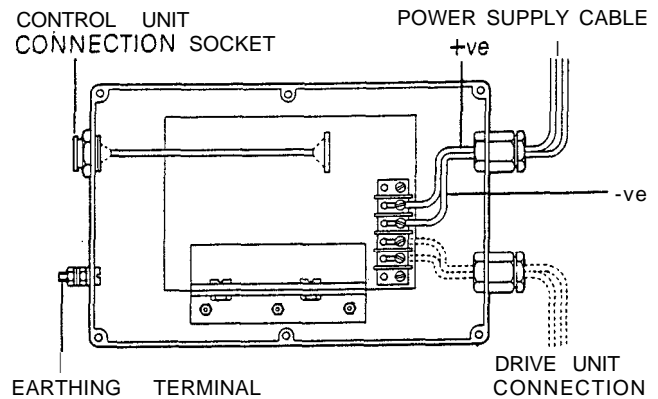


Fig. 14 Drive Amplifier Wiring Diagram

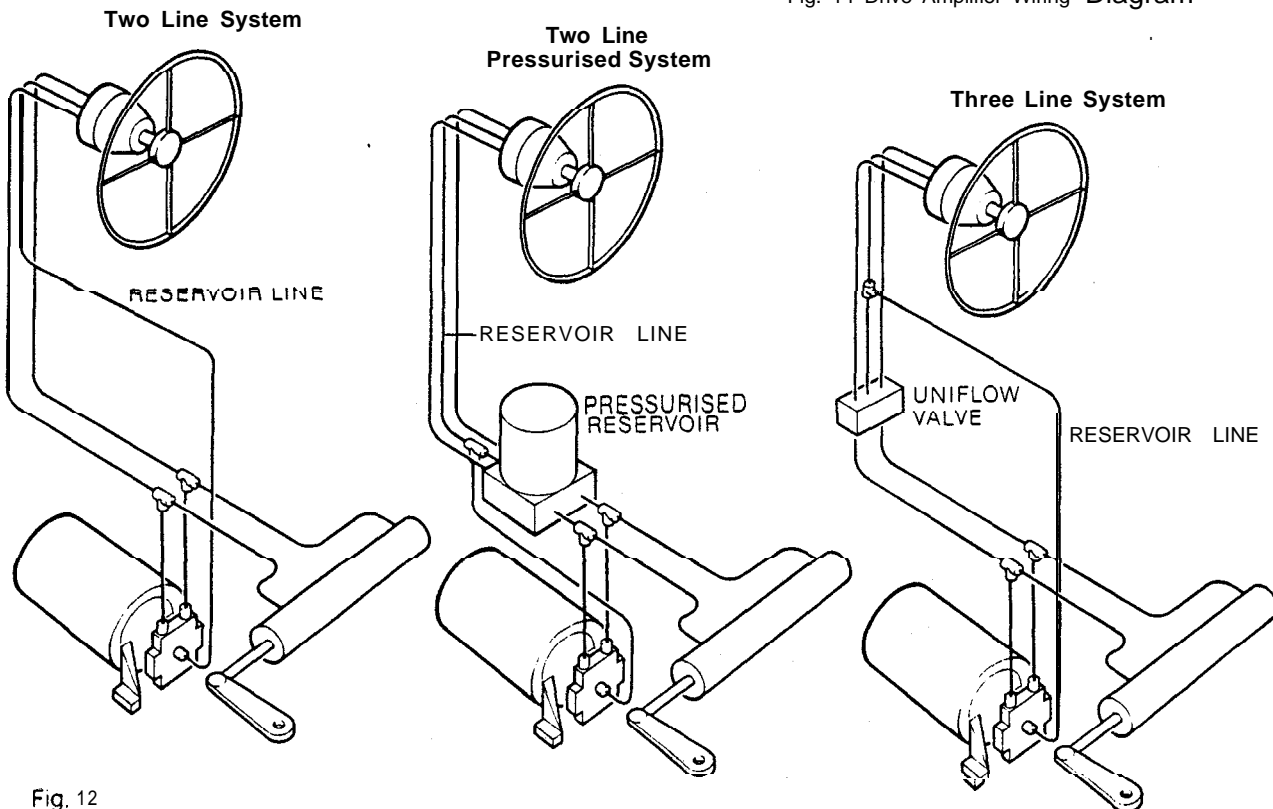


Fig. 12

Minimisation of hydraulic fluid loss during connection of the drive unit will help to reduce the time and effort required later to bleed the system of trapped air. Absolute cleanliness is essential since even the smallest particle of foreign matter could interfere with the correct function of precision check valves in the steering system.

When the installation has been completed the hydraulic pump may be operated by switching the control unit to **Duty** and operating the Steer control. Greater motor movements will be obtained if the gain control on the course computer is set to No. 10 and the rudder control set to maximum.

The hydraulic steering system should be bled according to the manufacturer's instructions. From time to time during the bleeding process the drive unit should be run in both directions to clear trapped air from the pump and inter-connecting pipe work.

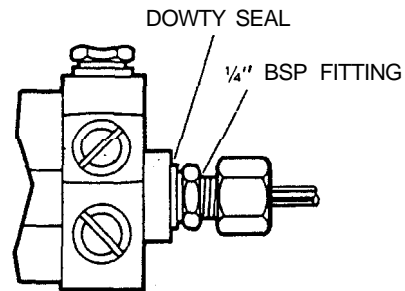
If air is left in the system the steering will feel spongy particularly when the wheel is rotated to the hardover position. Trapped air will severely impair correct operation of the autopilot and the steering system and must be removed.

During the installation of the system it has not been necessary to keep track of the connection sense to the hydraulic steering circuit since operating sense of the autopilot can be corrected if necessary by reversing the polarity of* **pump drive** motor connections (see section 3.3.1).

To check correct phasing of the autopilot, switch to Duty and rotate the **Steer** control clockwise. If phasing is correct starboard rudder movement will result. If opposite rudder movement occurs, reverse the phase switch direction to correct as described in Section 3.2.

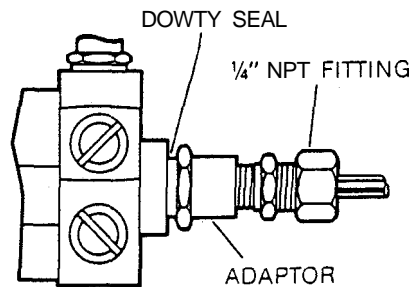
The gain control located on the back of the Control, Unit sets the rudder response of the autopilot to match the particular installation. The recommended gain control setting is given in Fig. 16.

CONNECTION OF HYDRAULIC LINES TO PUMP



Assembly for 1/4" BSP Line Fitting

Fig. 15



Assembly for 1/4" NPT Line Fitting

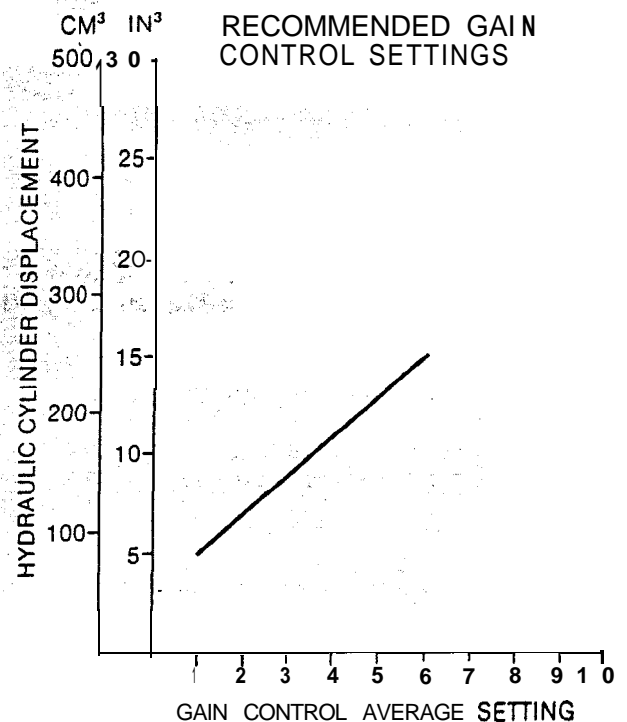


Fig. 16

2.3 CABLING AND POWER SUPPLIES

2.3.1 SIGNAL CABLING

Cable inter-connections between system sub-units are shown schematically in Figs. 1, 2, and 3. The interconnecting multi-core cable between the control unit and drive unit is 20 feet (6m) long, and is supplied with the control unit. All other interconnecting cables are supplied with their related sub-unit and are also 20 feet (6m) in length. All 7 core cables are supplied with pre-wired waterproof connectors and are extendable in 20 feet (6m) increments by the addition of standard cable extensions (Cat. No. D59) as shown in Fig. 3.

Cable connector clamp nuts should be securely tightened to ensure watertight joints. All cables should be run at least 3ft (1 m) from existing cables carrying radio frequency or pulsed signals, and should be clamped at 1.5 foot (0.5m) intervals.

2.3.2 DC SUPPLY CABLE

As a general rule the DC supply cable to the drive unit should be kept as short as possible, and have a conductor area of 1 .0 sq.mm per metre run to minimise voltage drop.

Example:

Length of cable	Conductor area	Cable size
Up to 2.5m	2.5 sq.mm	50/0.25mm
Up to 4m	4 sq.mm	56/0.3mm

The two supply cables must run directly from the vessel's battery or alternatively from the main distribution panel, and a 20 amp fuse or overload trip should be included in the circuit. It is important not to tap into supplies to other into supplies to other equipment to avoid the possibility of mutual interference.

The drive unit is supplied with 1.5ft (0.5m) power supply cable tails. These should be connected to the main power supply cable via a heavy-duty terminal block. The red cable tail should be connected to the positive supply and the black cable to the negative supply. If polarity is accidentally reversed the equipment will not operate, but no damage will result.

The drive unit case must be bonded to the metal hull or engine frame and a heavy duty conductor (2.5mm²) should be used for this purpose.

3.0 OPERATION

3.1 BASIC PRINCIPLES

The following description of the Autohelm 5000 principle of operation will help in providing a complete understanding of its controls. The control unit houses an extremely sensitive auto-setting electronic compass. When the autopilot is in operation, deviation from course is continuously monitored by the compass and corrective rudder is applied by the drive unit to return the vessel to course. The amount of applied rudder is proportional to the course error at any time, and thus when the original course is restored the rudder will be neutralised. The amount of the rudder applied for a given off-course error is adjustable to match both the steering characteristics of the vessel and speed through the water. A vessel with a small rudder for example, will require more corrective helm than a similar sized vessel with a larger rudder. Similarly, a high speed power boat will require considerably less corrective helm at planing speeds than it will at lower displacement speeds (Fig.1 8.)

The characteristic which distinguishes the Autohelm 5000 is its ability to make automatic correction for changes in trim or weather helm. When changes in trim occur the set course can only be maintained by the application of permanent rudder offset to restore balance. Many automatic pilots are incapable of this and will allow the vessel to bear on to a new heading to achieve a new state of balance. Under these circumstances the Autohelm 5000 detects that the original course has not been restored and will continue to apply additional helm in the appropriate direction until the vessel returns to the original heading. This facility ensures that the originally set course is held irrespective of changes in balance that may occur during the course of a passage.

3.2 CONTROLS

3.2.1 CONTROL UNIT

Fig.1 7 shows the position of all controls. Each control has the following functions:

OFF

Push to de-energise the autopilot. The electromagnetic clutch in the drive unit is disengaged for manual steering.

SET

Push to energise the compass circuit and initiate the automatic compass setting sequence. The compass is finally set to the manually steered heading when both the red and green pilot lights are extinguished.

DUTY

Push to fully energise the autopilot for automatic steering duty.

REMOTE

Push to transfer basic automatic pilot control to the auxiliary control unit.

SEA

Rotate to adjust compass sensitivity to suit sea conditions. In position '0' the compass is fully sensitised for operation in calm sea conditions. Clockwise rotation to position '7' progressively densensitises the compass for operation in rough sea conditions. Adjustment of this important control is fully discussed later.

R U D D E R

Rotate to adjust rudder response. In position '0' rudder movement is minimised. Clockwise rotation to position '7' progressively increases the amount of applied rudder. Adjustment technique is fully discussed later.

STEER

Rotate counter-clockwise or clockwise to alter course to port or starboard respectively. Each scale division represents 5 degrees of course alteration. The steer control will rotate automatically when the control unit is switched to **Set**.

The controls on the rear case are used to adjust the auto-pilot's response to suit the particular installation and the vessel's steering characteristics.

Each control has the following functions:

GAIN

Presets the overall system gain to compensate for variations in the mechanical reduction between the drive unit and the rudder and the vessel's steering characteristics. For initial sea trial purposes this control is set according to the recommendations given in Fig.1 8.

PHASE SWITCH

The phase switch is located on the internal PCB and is accessible by removal of a blank rubber grommet from the rear case. The phase switch reverses the direction of *corrective* rudder action and its setting procedure is described later.

NB Recommended gain control settings for hydraulic drive installations are given in the hydraulic drive unit instructions.

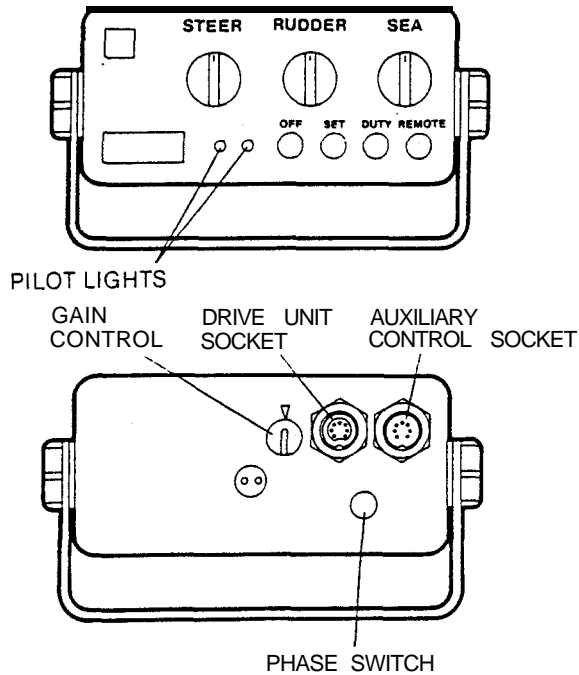


Fig. 17

3.2.2 AUXILIARY CONTROL UNIT

Autopilot control may be transferred to the auxiliary control unit (Fig.1 9) by depressing the **Remote** push-button on the main control unit facia.

Two independent rotary switches are provided on the auxiliary control unit. The first permits **change-over between Set and Duty** modes. The second control permits remote alteration of heading. Switch movement to the left or right initiates course alteration to port or starboard respectively at approximately one degree per second.

3.2.3 REMOTE CONTROL UNIT

The hand-held remote control unit (Fig.20) enables the autopilot to be switched out and the vessel to be power steered from anywhere on board. Its flying lead may be plugged into any one of the remotely positioned waterproof sockets and should be switched to **Auto** for normal automatic steering operation. The autopilot may be overridden by switching to **Manual** and the vessel then power steered by means of the control wheel. The automatic trim system continues to operate in the manual steering mode and a straight course will be steered when the 'boat' on the control wheel is aligned with the remote control centre line. The original course is remembered and will be resumed immediately the change-over switch is returned to **Auto**. If the vessel has been power steered by the remote control for a long period it is important to check that there is no chance of collision when the original automatic heading is acquired by switching back to **Auto**.

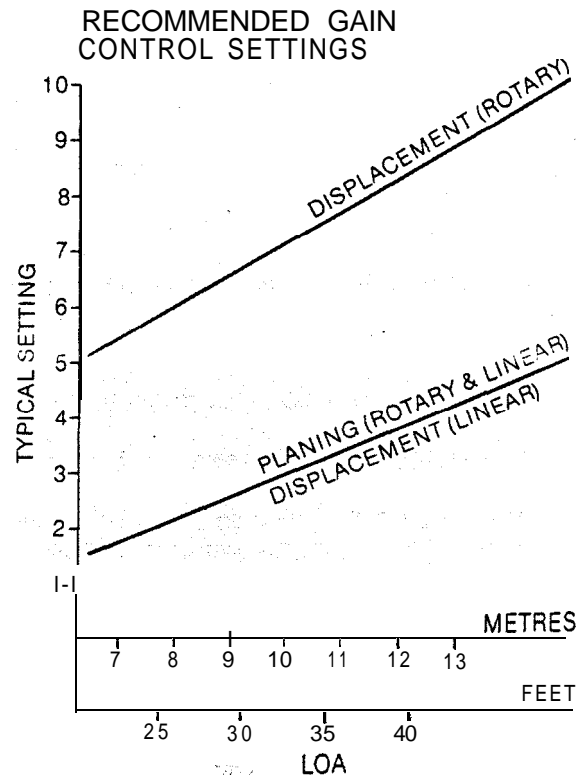


Fig. 18

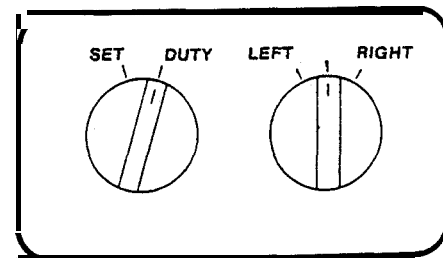


Fig. 19

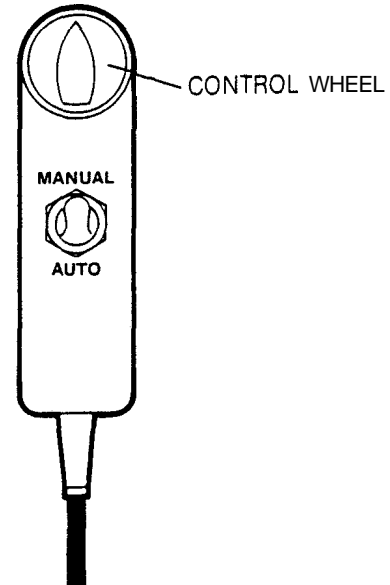


Fig. 20

4.0 FUNCTIONAL TEST PROCEDURES

The following functional test procedure is recommended before attempting sea trials.

4.1 MAIN CONTROL UNIT

- Switch to **Set** and observe that the compass automatically sets to the present heading. The **Steer** control will rotate while the compass is setting and slow down as the null position is approached. When the compass is finally set both pilot lights will be extinguished.
- Switch to **Duty** and check that the drive unit clutch is engaged by attempting to rotate the steering wheel.
- Adjust the **Sea** and Rudder controls to '0'. Then adjust the Steer control one or two divisions clockwise and then counter-clockwise. The steering wheel should rotate in the same direction as the **Steer** control. If opposite wheel rotation occurs, reverse the phase switch. (A small screwdriver will be required to operate the phase switch after removal of the blank rubber grommet from the rear case).
- Increase **Rudder** control setting and note that larger wheel movements result when the **Steer** control is adjusted.
- Increase the **Sea** control setting and note that larger movements of the **Steer** control are necessary in either direction before steering wheel movement commences.

The automatic trimming capability of the autopilot can be observed by the following test:

Switch to **Set** to realign the compass. Then switch to **Duty** and offset the **Steer** control by approximately two divisions i.e. approximately 10 degrees of heading change. This effectively simulates a condition where the need for standing helm has developed and the vessel is not returning to course. You will notice that after an initial fixed helm has been applied the drive unit continues to apply further helm movements, but at a much slower rate. If left in this condition the wheel will eventually rotate hardover. If, however, the vessel is moving through the water the progressive application of additional helm will eventually return the vessel to its original course with the necessary standing helm applied. This can be simulated by rotating the steer control back to the original course position. The progressive application of standing helm will cease when the compass senses that the original course has been restored.

4.2 AUXILIARY CONTROL UNIT

- Switch the auxiliary control unit to **Set** and then depress **Remote** on the main control unit. In this position the compass automatically sets to the present heading.
- Switch the auxiliary control unit to **Duty** and check that the drive unit clutch is engaged by attempting to rotate the steering wheel.

4.3 MECHANICAL TEST PROCEDURES

Before attempting sea trials it is important to verify that the vital link between the Autohelm 5000 drive actuator and the vessel's steering system is free of obstruction and operating correctly.

It is strongly advised that the following simple checks are carried out.

Warning

When the steering system is being moved manually or under drive from the actuator **do not** touch any part of the system, sprockets, chains or limit stops. The forces exerted are considerable and could cause injury.

Rotary Drive Unit

Locate the actuator and with an assistant to turn the main steering wheel switch on the pilot.

- Press **Set** - turn the steering wheel from hardover to hardover.
- Ensure that the chain and sprockets driving the actuator move freely and in alignment.
- Ensure that chain tension is adjusted correctly (see 2.2.1)
- Select **Duty** and rotate the **Rudder** control several turns to the right to drive the rudder hardover.
- When the actuator drives the rudder onto the mechanical limit stops ensure that the mounting of the drive actuator shows *no* sign of movement.
- Rotate the **Rudder** control in the opposite direction to reverse the rudder drive to the opposite end stop. Check for any movement.

Linear Drive Unit

- Proceed as for rotary drive unit.
- Check that at no point during movement of the steering quadrant and linear drive actuator from **hardover** to **hardover** does the actuator foul any part of the quadrant, steering mechanism or yacht's structure. Any fouling under load could damage the drive actuator.
- Check that the Drive actuator operates **horizontally** and that angular movement of the ball end fitting is minimal (5° maximum).
- Select **Duty** and rotate the **Rudder** control several times to drive the rudder hardover.
- When the rudder is driven hardover check that the mechanical limit stop on the vessel's steering system is reached **before** the actuator reaches **its** mechanical limit.
- When the rudder drives hard against the end stop check there is no visible movement of the actuator mounting pedestal or the structure supporting it.
- Rotate the **Rudder** control in the opposite direction and repeat the checks with the rudder driven **hardover** in the opposite direction.

Hydraulic System

- Proceed as for the rotary drive unit.
- Check that all unions are tight and there is no seepage of hydraulic fluid.
- Select **Duty** and rotate the **Rudder** control several times to drive the rudder hardover.
- Rotate the **Rudder** control in the opposite direction and drive the rudder hardover in the opposite direction.
- Check that the steering ram moves smoothly and that there is no excessive play or jerkiness in the movement.

The performance of the Autohelm 5000 will only reach the designed levels if the installation of the actuator and steering system is correctly engineered and adjusted. It is strongly advised that these be checked **before** sea trials.

5.0 SEA TRIALS

Initial sea trials should be carried out in calm conditions and with plenty of sea room. The previously conducted functional test will have verified that the autopilot is operating correctly and that you are familiar with all of its controls.

Check that the gain control on the rear of the control unit is adjusted to the setting recommended for the particular vessel category given in Fig. 3.1. Then set the **Sea** control to '0' and the **Rudder** control to '4'.

Initial sea trials on fast planing vessels should be conducted at no more than half engine throttle under which conditions the recommended mid-way setting of the rudder control should give acceptable steering performance. A mid-way setting of the rudder control will also give acceptable steering performance in sailing and displacement power vessels under all conditions for initial trial purposes. Fine setting of the **Rudder** control is discussed later.

5.1 FIRST TRIALS

The following initial trial procedure is recommended:

- Steer manually on to a fixed heading and hold the course steady.
- Switch the autopilot to **Set** and allow up to 1.5 seconds for the compass to adjust automatically to the manually steered heading.
- Switch to **Duty** and the autopilot will automatically take control. In calm conditions an extremely constant heading will be maintained.
- Increase the setting of the **Sea** control until a good heading is achieved with a minimum number of wheel movements. Correct setting of this control for varying sea conditions is essential to avoid unnecessary wear and tear on the autopilot and to minimise electrical power consumption.
- Alter course to port or starboard using the **Steer** control on the main control unit, (or the **Left/Right** control on the auxiliary control unit with the main control unit switched to **Remote**). Major course alterations are best applied by switching to **Set** and then manually steering the vessel on to the new heading. When the new course is acquired, hold for a few seconds and then switch the autopilot back to **Duty** to maintain the new heading.
- If a hand-held remote control is fitted, switch from **Auto** to **Manual** and then power steer the vessel by the control wheel. Switch back to **Auto** and the vessel will return promptly to the original heading.

- When the autopilot is set to **Duty** return to manual steering may be instantly achieved by switching to **Set** or **Off** on the main control unit. It is very important to remember that manual control can only be obtained on the auxiliary control unit if the main control unit is switched to **Remote**. The importance of being able to regain manual control of steering must be stressed. The **Off** button is coloured red for easy identification and manual take-over procedures should be practised at an early stage.

5.2 RUDDER CONTROL ADJUSTMENT

The gain control on the rear of the control unit has been previously set according to the recommendation given in Fig. 3.1. This control sets the range of adjustment available on the main panel **Rudder** control and in all but extreme cases should not need further adjustment.

In all cases, excessive rudder application results in 'oversteer' which can be recognised by the vessel swinging slowly from side to side of the controlled heading. In addition, distinct overshoot will be observed when the course is changed. This extreme condition may be corrected by reducing the **Rudder** control setting.

Similarly, insufficient rudder application will result in sluggish steering response which is particularly apparent when changing course using the **Steer** control. This condition is corrected by increasing the **Rudder** control setting.

Oversteering and understeering tendencies are most easily recognised in calm sea conditions where wave action does not mask basic steering performance.

The operational adjustment technique for the **Rudder** control varies significantly between planing and displacement craft and is described separately below.

5.2.1 PLANING CRAFT

Planing craft operate over a very large speed range. Rudder effectiveness increases very significantly at higher hull speeds and it is thus necessary to reduce the **Rudder** control setting as speed increases to avoid oversteer. In normal cases the rudder control setting would be reduced almost to '0' at maximum planing speed and increased towards '7' at minimum displacement speeds. Oversteer can be extremely violent at planing speeds and it is thus essential to reduce the rudder setting before opening the throttle.

5.2.2 DISPLACEMENT POWER VESSELS

The **Rudder control** setting is much less critical on this type of vessel and it is not normally necessary to change the setting for different engine speeds. As a general guide initial testing should be carried out at setting '4' and reduced as much as possible 'consistent with good heading control to minimise wear and tear on the steering 'system.

5.2.3 SAILING CRAFT

Sailing craft average hull speeds do not vary greatly and thus the **Rudder control** setting can remain fixed most of the time. Initial testing should be carried out at setting '4'. Sailing craft, however, are particularly stable when sailing close hauled and under these conditions it is usually possible to reduce the **Rudder control** setting to minimise rudder movement and hence power consumption. Conversely, when sailing down wind, directional stability is least, and improved *course* holding will result from increasing the rudder setting. The optimum range of adjustment is easily found by experiment.

6.0 OPERATING HINTS

Unlike sailing yachts, power vessels do not generally suffer with violent changes in trim, and thus, provided the operating instructions are carefully followed, extremely good course holding performance will result in all weather conditions.

Sailing yachts are very different since in gusting wind conditions violent changes in trim often occur. When a yacht is sailing badly out of balance, sudden gusts will generally cause it to luff violently to windward. When hand steering, the tendency is overcome by applying sufficient weather helm to maintain the original heading. The Autohelm 5000's automatic weather helm compensation circuit however, is intended only to take account of the gradual changes in standing *helm* that typically occur when passage making due to changing wind conditions.

When a sudden change in helm balance occurs the automatic compensation circuit will take approximately one minute to restore the original heading. In gusty conditions the course will tend to meander particularly if the sails are badly balanced. Significant improvement to course keeping can be obtained by ensuring that sail balance is maintained.

Bear in mind the following important points.

- Do not allow the yacht to heel excessively.
- Ease the mainsheet traveller to leeward to reduce heeling and weather helm.
- If necessary reef the mainsail a little early.

It is also worth mentioning the more obvious and that is that an autopilot cannot anticipate. Sailing downwind in breaking seas needs particular care.

One should avoid sailing under autopilot when the wind is dead astern. Ideally, the wind should be brought at least 30 degrees towards the beam, and in breaking seas it is often better to remove the mainsail altogether and to sail under boomed out headsail alone.

Providing you ensure that your vessel is properly canvassed for the prevailing conditions, your Autohelm 5000 will be capable of sailing you through gale force winds. Moreover, it is at times like this that it will endear itself most of all by leaving you fresh and alert to sail in safety.

Passage making under automatic pilot is a wonderful experience that can easily lead you into the temptation of relaxing permanent watch-keeping. This must be avoided however clear the sea ahead may appear to be. Remember, a large ship can cover two miles in five minutes – just the time it takes to brew a cup of coffee!

7.0 ROUTINE MAINTENANCE

The autopilot is one of the most used and hardest working items of equipment on board and, therefore, must receive its fair share of attention and routine maintenance. The working parts of the drive unit and the control unit are sealed and lubricated for life during manufacture and do not need servicing

Regular inspection and routine maintenance of the installation is recommended in the following areas:

- 1 Check tension and alignment of the drive chain and lubricate with a good quality waterproof light grease.
- 2 Check for the development of excessive lost motion (backlash) in the steering gear and correct if necessary. Lost motion at the wheel should not exceed 5% of the total wheel movement from lock to lock.
- 3 Check that all inter-connecting cable sockets are fully tightened and free from corrosion.
- 4 Check that external waterproof sockets are capped when not in use and periodically spray with WD40 (or similar) to protect from corrosion.
- 5 Check that the power supply cable connections are tight and free from corrosion.

The Autohelm 5000 has an advanced micro-electronic circuit requiring special equipment and knowledge to service. In the unlikely event of failure occurring in any part of the system you are advised to contact your nearest appointed Service Agent who will provide you with competent and efficient service.

Nautech Limited, Anchorage Park, Portsmouth
Hampshire PO3 5TD, England. Telephone **(0705)** 693611
Fax **(0705)** 694642, Telex 86384 NAUTEC G