

# **Autohelm**

TYPE

# **100/300**

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**AUTOPILOT**

Installation and Set Up

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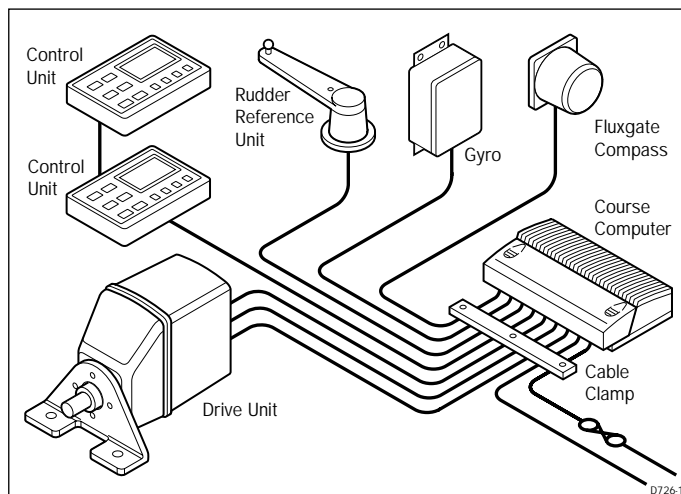
## Chapter 1: Introduction

The Autohelm Type 100/300 autopilots are modular systems that can be configured to suit the individual requirements of all types of vessels, using a range of high efficiency rotary, linear or hydraulic rudder drive units to match various types of steering systems.

The Autohelm system in its most basic form consists of a control unit, course computer, drive unit, fluxgate compass and a rudder reference transducer.

A full range of accessories are also available and include:

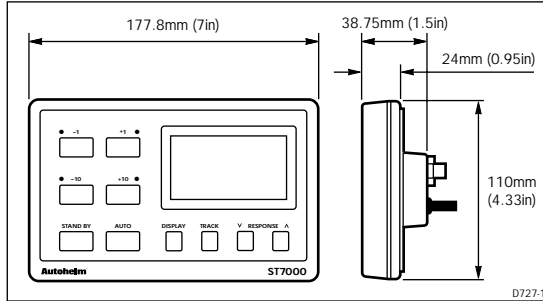
- Joystick (manual steering unit)
- Main alarm and interface
- Rate gyro
- Hand held remote control unit
- SeaTalk instrumentation
- Interface leads



### 1.1 ST7000 Control Unit

The ST7000 control unit is fully weather protected and designed for above or below deck installation. The unit is connected to the course computer via the SeaTalk bus. NMEA navigation, speed and wind information can be received via a fixed socket on the rear of the case.

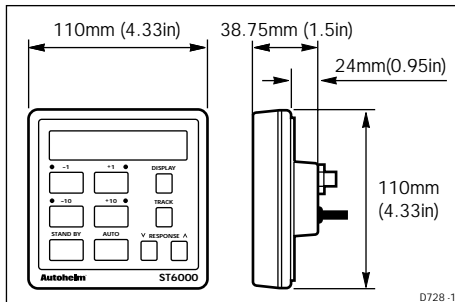
**Note:** Additional control units can also be connected via the SeaTalk bus.



### 1.2 ST6000 Control Unit

The ST6000 control unit, like the ST7000, is fully weather protected and also designed for above or below deck installation. The unit is connected to the course computer via the SeaTalk bus. NMEA navigation, speed and wind information can be received via a fixed socket on the rear of the case.

**Note:** Additional control units can also be connected via the SeaTalk bus.



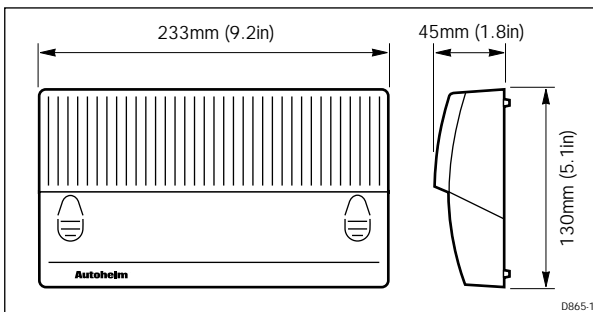
### 1.3 Course Computer

The course computer, available in both 12V or 24V versions, houses a microprocessor, drive unit electronic control circuitry and power amplifier. It is the central distribution point for the autopilot, electrical wiring and ship's power connection point.

The course computer also has NMEA input and outputs to allow operation with other manufacturer's equipment.

The unit is only splash proof and must, therefore, be installed in a dry, protected location.

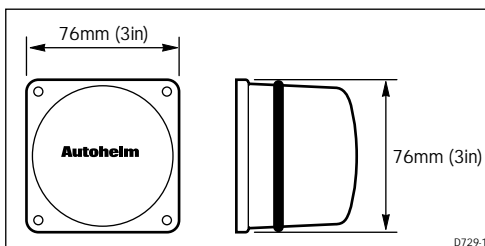
Type 100 is used for Type 1 and Type CR 12V drives. Type 300 is used with Type 2 and Type 3 drives.



### 1.4 Fluxgate Compass

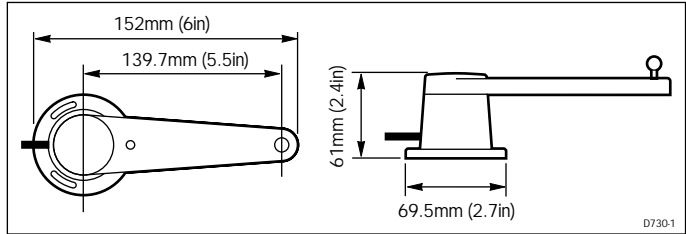
The fluxgate compass contains a gimbal mechanism that permits accurate readings with pitch and roll movements up to +/- 35 degrees. The compass is designed for below deck, bulkhead mounting and connects directly to the course computer.

On steel decked vessels the compass can be mounted above deck, however, autopilot performance may be affected due to the increased motion.



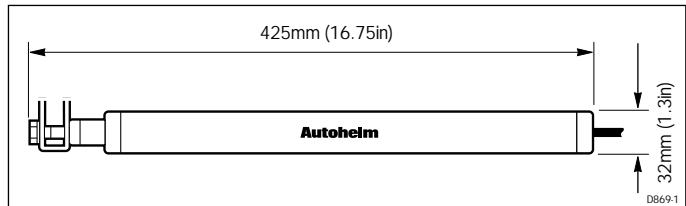
### 1.5 Rotary Rudder Reference Transducer

The rudder reference transducer provides the course computer with the precise position of the vessels rudder. The unit is mounted on a suitable base adjacent to the rudder stock. Its use is mandatory on all installations, except when a linear rudder reference transducer is connected.



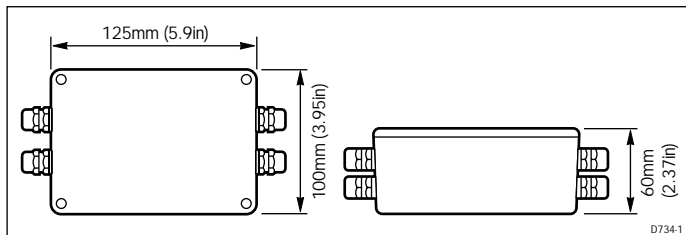
### 1.6 Linear Feedback Transducer

The linear feedback transducer is designed for installations on ‘bullhorn’ style hydraulic outboard steering systems. The unit is totally weather proof and mounted on the bullhorn ram. Its use is mandatory on all hydraulic outboard installations.



### 1.7 Type CR Interface Unit

The course computer can be connected to the solenoids on a constant running hydraulic pump using the type CR interface. The unit also provides connections to energise a solenoid operated bypass valve.



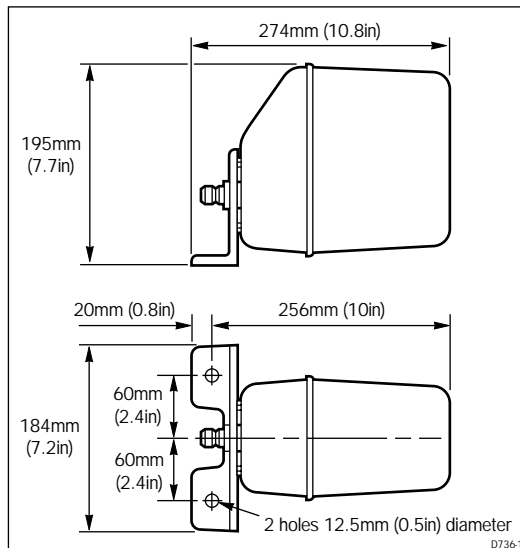
## 1.8 Drive Systems

A range of mechanical (rotary, linear and stem drive) and hydraulic drive units are available for use with the Type 100/300 system. Rotary drives are coupled to the steering system by a simple chain drive, linear drives directly to the rudder stock at the tiller arm radius and stem drives directly to the power steering valve block.

The type of hydraulic drive used is dependent on the size of the vessels hydraulic cylinder.

### Rotary Drive Units

Autohelm rotary drive units provide smooth, powerful steering commands with almost silent operation. A rugged electric motor drives a precision epicyclic gearbox via a high tensile drive belt. An electronic clutch transmits high torque loads with no slippage. The drive unit can be mounted in any attitude to simplify installation.



## Reversing Hydraulic Pump

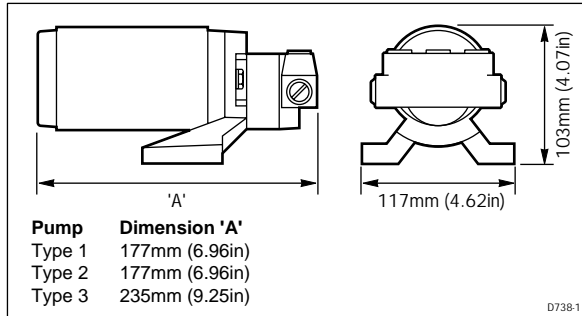
The reversing hydraulic pump consists of a precision gear pump and an integral check valve block driven by a continuously rated servo motor. The pump is connected directly to the vessels steering cylinder, with the course computer regulating the peak pump pressure.

There are three types of pump: type 1, type 2 and type 3. The different type relates to the steering ram capacity, which is directly related to the displacement of the vessel.

Type 1: 80 to 230 cc (4.9 to 14cu in)

Type 2: 160 to 350 cc (9.8 to 21cu in)

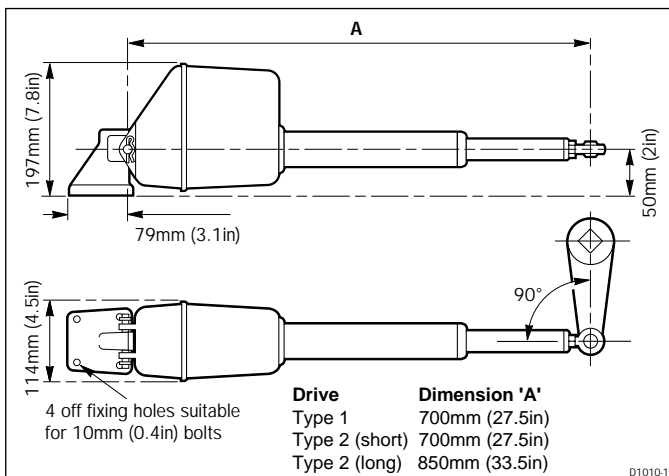
Type 3: 250 to 460 cc (15 to 28cu in)



## Linear Drive

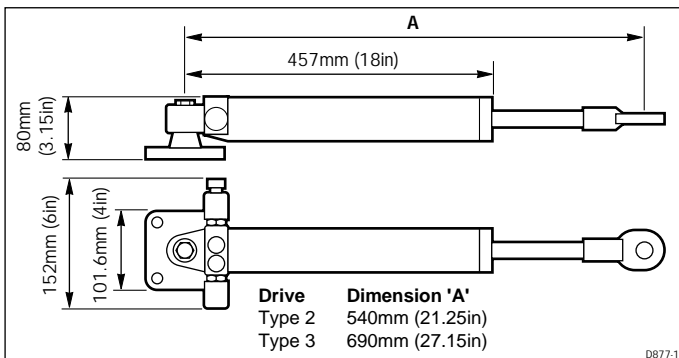
The Autohelm linear drive unit is of outstanding design which features powerful thrust, fast hard overtimes and near silent operation. When backdriven the movement is smooth with minimal backdriven force. Using a high tensile belt drive and epicyclic reduction gearbox the powerful electric motor is controlled by an electronic fail-safe clutch.

The design is highly efficient and provides high performance for minimum current consumption.



## Hydraulic Linear

The hydraulic linear drive unit is a self contained secondary steering cylinder (with a built-in solenoid bypass valve). The unit is driven by a reversing hydraulic pump to provide a totally isolated autopilot steering system.

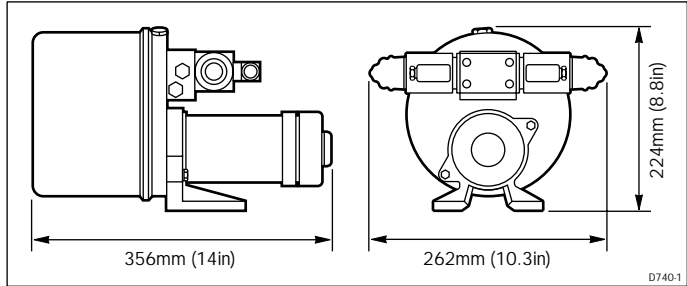


### Constant Running Hydraulic Pump

When steering loads require a ram capacity of over 460cc (28cu in) the constant running hydraulic pump provides the ideal autopilot drive system.

Hydraulic fluid is supplied from a self contained reservoir and flow to the steering ram is controlled by integral solenoid operated valves.

Used with a solenoid operated bypass valve and a separate hydraulic ram, this system is recommended for heavy duty applications on large mechanically steered vessels.

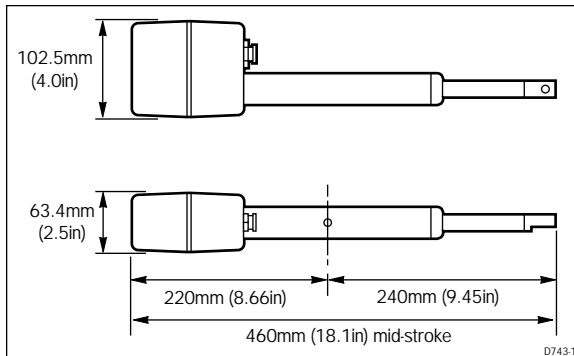


### Stern drive

The stern drive actuator must only be used on stern drives with cable operated, power assisted steering.

The drive unit operates the power steering valve in exactly the same way as the steering cable. A clutch disengages the drive unit to allow manual steering when the autopilot is disengaged.

Installation kits are available for most popular types of steering manufacturers.



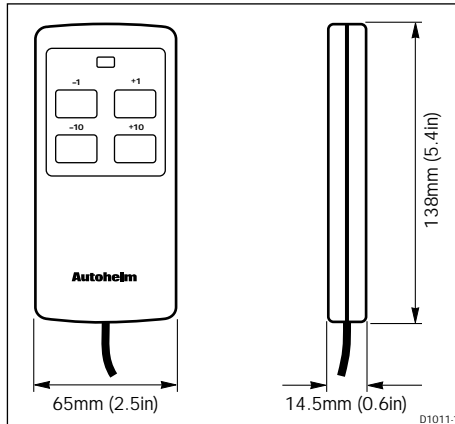


## 1.9 Options

The Type 100/300 autopilot system is available with the following optional system components:

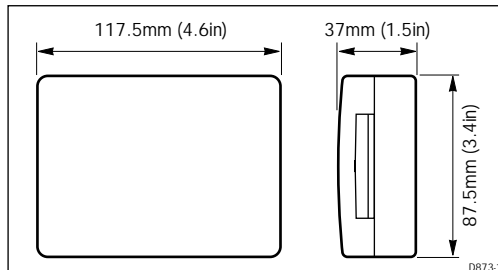
### Hand-held Remote (Z101)

The hand-held remote allows course changing from a position away from the steering station. The hand held remote is connected to the autopilot via the SeaTalk bus.



### NMEA Interface (D153)

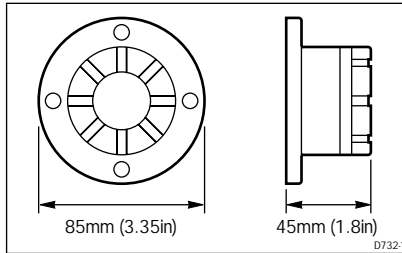
Although the Type 100/300 has its own NMEA 0183 input and output ports, you may wish to receive information from additional equipment transmitting NMEA. The NMEA interface connects to the SeaTalk bus and converts incoming data to SeaTalk. The interface also converts SeaTalk data to NMEA 0183 format.



### Auxiliary Alarm (Z035)

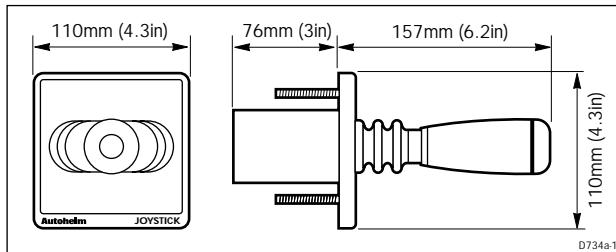
The autopilot is provided with a comprehensive automatic off-course alarm system that sounds from all control units. This provides sufficient audible warning under most conditions. However, in cases where a high powered alarm is required, an auxiliary alarm can be fitted. The auxiliary alarm is connected to the SeaTalk bus via the NMEA interface box and will sound whenever the autopilot transmits one of the following alarm conditions.

- Autopilot Off Course
- Watch Alarm
- Wind Shift
- Low Battery
- Large Cross Track Error
- NMEA Data Error
- No Autopilot Actuator Connected
- Stern drive Auto Release
- Waypoint Change Alarm



### Joystick (Z147)

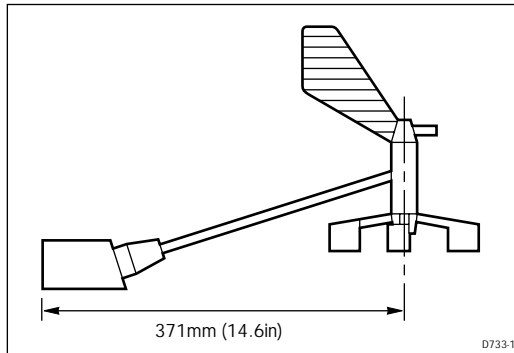
The Joystick is an electro mechanical remote steering unit that uses the course computer and its drive unit to power steer the vessels rudder.



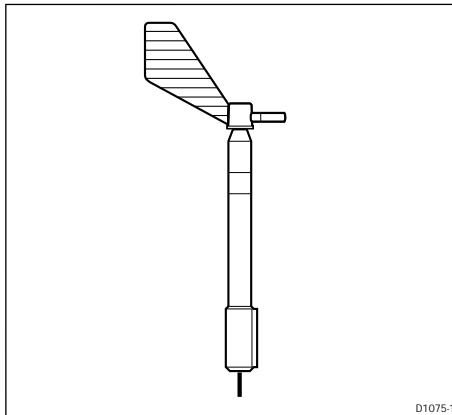
## Wind Transducer (sail only)

If the installation does not include a SeaTalk Wind instrument either the masthead or pushpit wind transducer can be connected directly to the NMEA interface box to supply wind angle information.

### ***Masthead Wind Transducer (Z080, Long Arm Version Z188)***

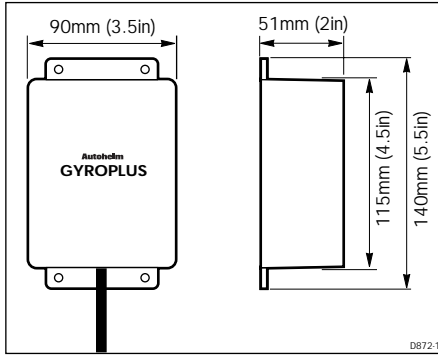


### ***Pushpit Wind Transducer (Z087)***



### Gyroplus Transducer (Z179)

The Autohelm Gyroplus is a transducer that measures the rate of turn of the vessel. This is used by the autopilot to give even better correction for boat yaw in adverse weather conditions. It is particularly beneficial downward and in following sea conditions.



# Chapter 2: Installation

## 2. General

This section describes how to install the autopilot and system components described in chapter 1.

### Planning the Installation

When selecting power cable it is important to use the stated wire gauge. The cable you choose may meet the required current specification, however, if too small, the voltage will drop between the supply and the course computer. This will reduce the power of the drive unit and may cause the electronics to malfunction.

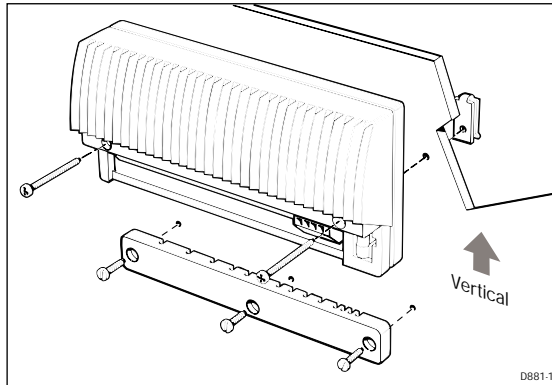
## 2.1 Course Computer

The course computer must be located in a dry, protected location free from high operating temperatures and excessive vibration. The unit must be mounted vertically with free air flow to allow heat dissipation from the power amplifier.

Avoid mounting the course computer:

- in an engine room
- where there is water splash/spray from bilge's or hatches
- where it can be subjected to physical damage from heavy items (such as hatch covers, tool boxes etc.)
- where it will be covered by other on-board equipment
- where it will be close to sources of high RF energy transmissions (generators/SSB radios/ antenna cables etc.)

## Mounting



1. With the course computer located as required, outline the two mounting holes.
2. Drill two pilot holes for the fixing screws.
3. Secure the course computer to the vessel using the two screws provided.

**Note:** If the mounting surface is less than 3mm (1/8in) thick, use the U clips provided.

4. Drill three pilot holes for the cable clamp bar.
5. Secure the cable clamp as shown.

## Cabling

**Note:** If you are installing the Type 100/300 system with a constant running hydraulic pump, refer to page 40 before running the power cable.

1. Having sited the course computer, measure the total cable length between the course computer and the vessels central power distribution panel. Using the following tables, select the appropriate cable size and circuit breaker relative to the type of drive unit used.

**Type 1 Drive Units/Stern Drive/Constant Running Pump**

Cable Length (Distribution panel to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

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**Type 2 Drive Units (12V)**

Cable Length (Distribution panel to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-02

**Type 2 Drive Units (24V)**

Cable Length (Distribution panel to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-01

### Type 3 Drive Units (12V)

Cable Length (Distribution panel to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

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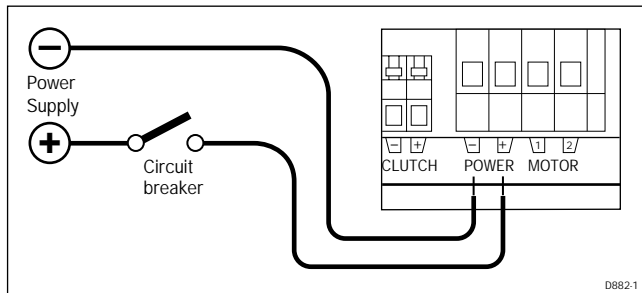
### Type 3 Drive Units (24V)

Cable Length (Distribution panel to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-02

2. Remove the connector cover from the course computer.
3. Connect the power supply cable to the course computer power terminals.

**Note:** The cable must be protected by a circuit breaker (see table for size).





Drive Unit	Circuit Breaker Size
Type 1	25
Type 2 (12V)	40
Type 2 (24V)	25
Type 3	40
Sterndrive	25
Type CR	25

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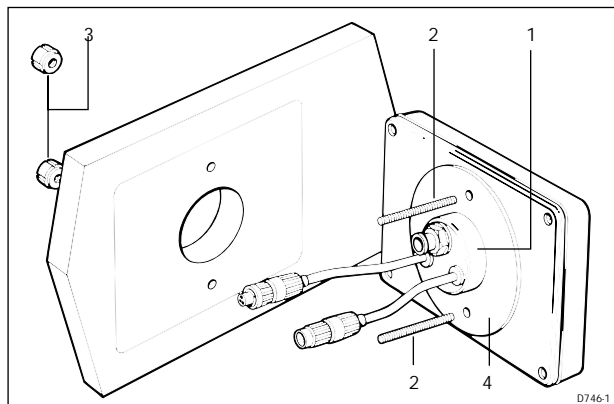
## 2.2 ST7000/6000 Control Unit

The ST6000 and ST7000 control units are identical in operation and installation. The main ST7000/6000 control unit should be mounted close to the steering station where it is:

- normally viewed straight on for the best display legibility
- well protected against physical damage
- at least 9in (230mm) from a compass
- at least 20in (500mm) from radio receiving equipment
- accessible from behind to install and run cables

**Note:** The rear case is designed to breathe through a small duct in the cable boss to prevent the accumulation of moisture. **Direct exposure to the rear of the control unit must be avoided.**

### Mounting



1 Cable boss 2 Fixing stud 3 Thumb nut 4 Sealing gasket

1. Make sure that the mounting surface is smooth and flat.
2. Use the template provided to mark the centres for the two fixing studs and the cable boss.

**Note:** Adjacent instruments should have 6mm (1/4in) separation to allow room for the protective covers.

3. Drill two 4mm (5/32in) diameter holes.
4. Using a 50mm (2in) diameter cutter, drill the hole for the cable boss (1).
5. Screw the two fixing studs (2) into the rear case of the control unit.
6. Pass the cable tails through the large hole and secure the control unit with the thumb nuts (3) provided.

**Note:** The sealing gasket (4), is already attached to the rear case of the control unit.

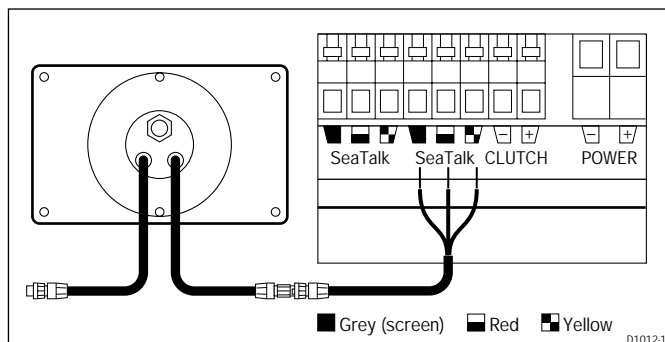
## Cabling

The control unit is provided with a SeaTalk cable fitted with a 3 pin socket on each end.

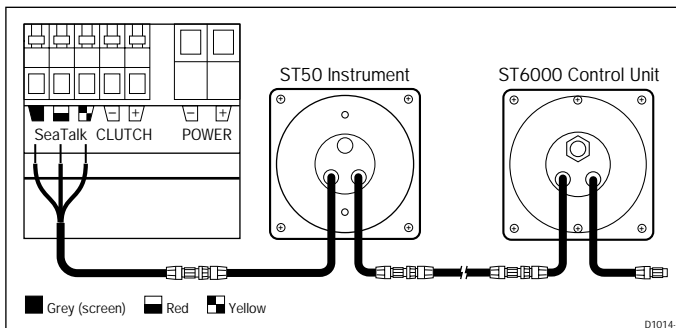
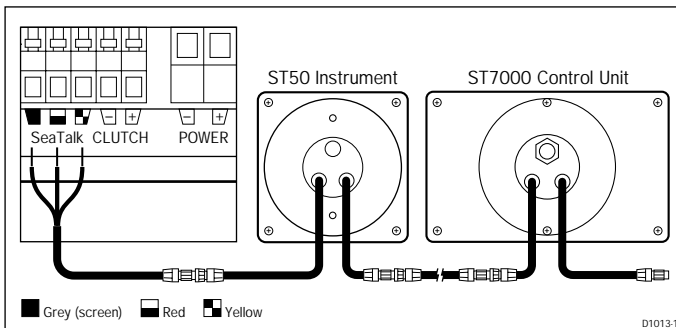
1. Plug one end of the cable into one of the two SeaTalk sockets on the back of the control unit.
2. Run the SeaTalk cable back to the course computer.

**Note:** If more than one control unit is fitted, the SeaTalk cable can be connected to the free SeaTalk socket on the first control unit.

3. Cut the remaining plug from the SeaTalk cable and connect to the the SeaTalk terminals on the course computer (as shown in the following illustration).

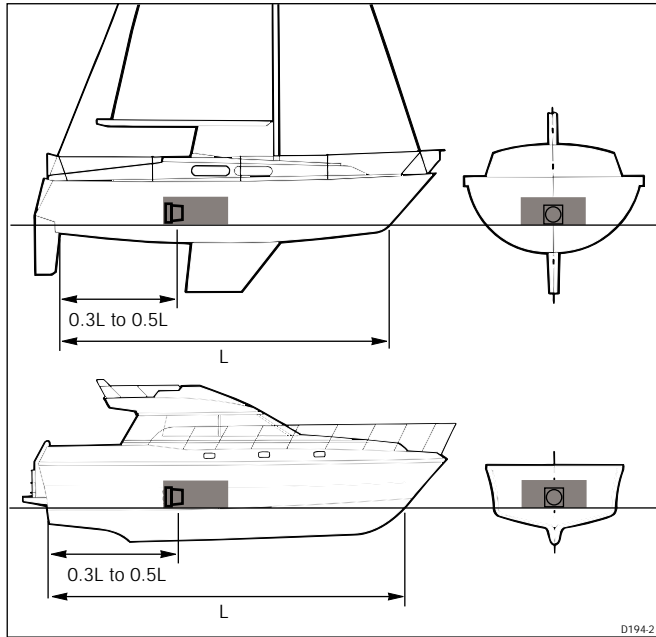


If the vessel is already fitted with Autohelm instrumentation, this should be connected to the course computer as shown, using one of the standard SeaTalk interface cables. The course computer will then supply power for the complete system.

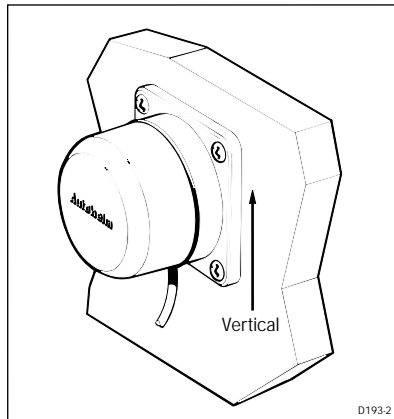


## 2.3 Fluxgate Compass

Correct positioning of the fluxgate compass is crucial if ultimate performance is to be achieved. To minimise gimbal disturbance, the fluxgate should ideally be positioned as near as possible to the pitch and roll centre of the vessel.



### Mounting

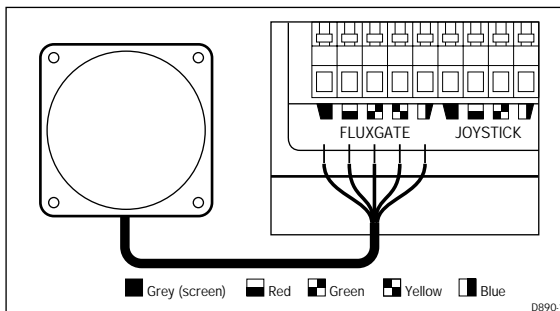


1. Locate the fluxgate compass on a suitable vertical surface.
2. Drill four pilot holes and attach the fluxgate compass using the self-tapping screws provided.
3. Make sure that the fluxgate is positioned at least 0.8m (2ft 6in) away from the vessel's steering compass in order to avoid deviation of both compasses. To avoid compass deviation and reduction in sensitivity of the sensor, the fluxgate must also be positioned as far away as possible from large iron masses.

**Note:** If any doubt exists over magnetic suitability of the chosen site, the position may be surveyed using a simple hand bearing compass. The hand bearing compass should be fixed in the chosen position and the vessel swung through 360 degrees. Relative differences in reading between the hand bearing compass and the vessel's main steering compass should, ideally, not exceed 10 degrees on any heading.

## Cabling

1. Run the cable back to the course computer.
2. Connect the to the fluxgate terminals on the course computer.



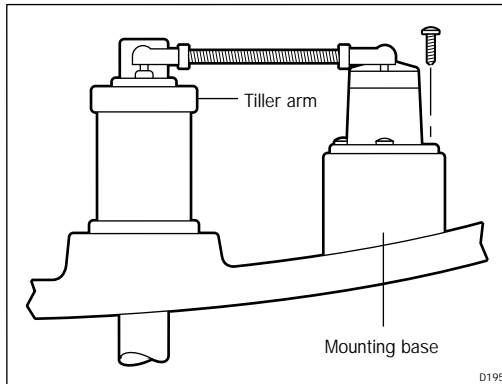
**Note:** A 10m (30ft) extension cable is available for larger installations (part no. D174).

## 2.4 Rotary Rudder Reference Transducer

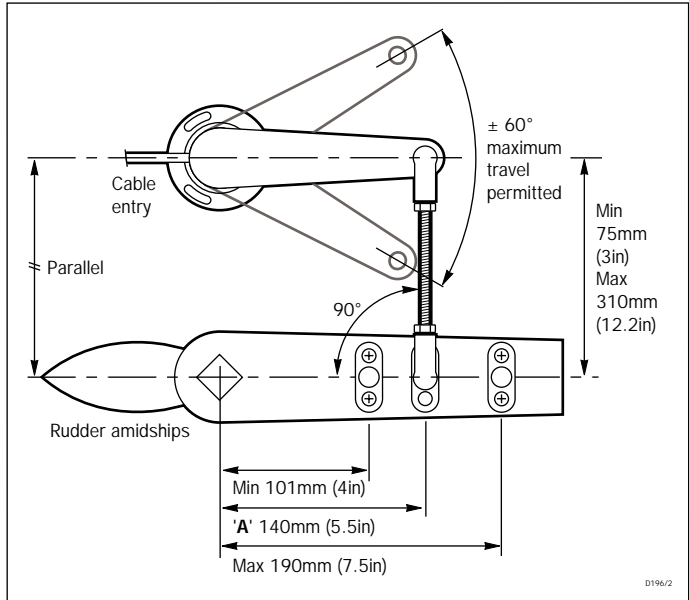
The rotary rudder reference transducer must be connected directly to the tiller arm to provide accurate rudder position to the course computer. If it is more convenient, the unit may be installed upside down. However, if mounted this way, the red and green wires must be reversed at the course computer.

### Mounting

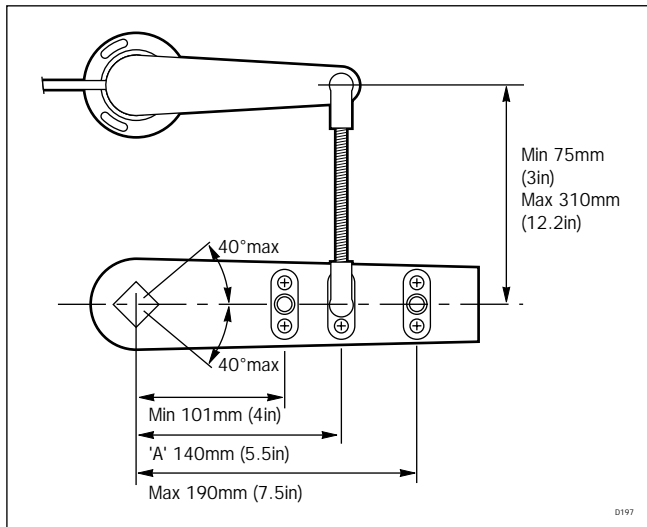
1. Using the self tapping screws provided, mount the rudder reference transducer on a suitable base adjacent to the rudder stock.



2. Make sure that the base height of the rudder reference transducer can maintain the correct vertical alignment between the rudder reference transducer arm and tiller arm (as shown).
- To give the precise rudder position, the rudder reference transducer has a built in spring to remove any free play in the linkage to the tiller .
  - The rudder reference arm movement is limited to  $\pm 60$  degrees. Care must be taken during installation to ensure that the rudder reference arm is opposite the point of cable entry when the rudder is amidships. Failure to do this could result in damage if the rudder reference arm is driven onto its end stops by the steering system.



It is important to ensure that the dimensions (set out above) are within the set limits and that the tiller and rudder reference arms are parallel to each other.

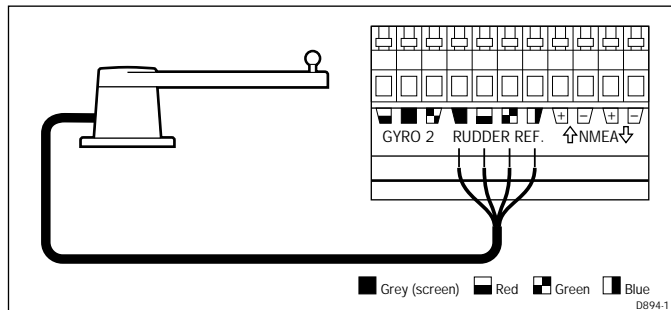


1. With the rudder amidships, the rudder reference arm should be opposite the point of cable entry and at 90 degrees to the connecting

- bar. Minor adjustments can be made by loosening the 3 securing screws and rotating the transducer body.
2. The tiller pin must be positioned within the limits shown. Ideally, dimension 'A' should be 140mm (5.5in). However, changes within the given limits will not degrade the autopilot performance, but will slightly alter the scaling of the rudder angle display on the control unit. The tiller pin is secured to the tiller arm using the self tapping screws provided.
  3. Cut the threaded rod to length and screw on the lock nuts 'Y' and the ball pin sockets - the sockets can then be pressed onto the pins. Move the rudder from side to side to ensure the linkage is free from any obstruction at all rudder angles.

## Cabling

1. Run the rudder reference cable back to the course computer.
2. Connect to the rudder reference terminals on the course computer.

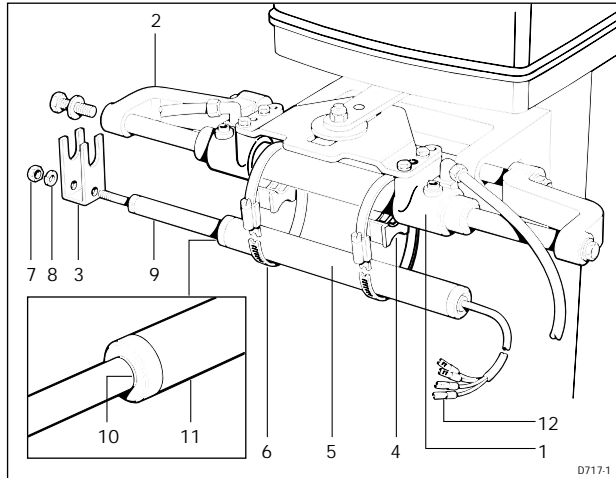


**Note:** A 10m (30ft) extension cable is available for larger installations (part no. D173).



## 2.5 Linear Feedback Transducer

The Linear Feedback Transducer is designed for use with bullhorn type outboard installations.



### Mounting

1. Operate the steering system so that the 'bullhorn' ram (1) is positioned amidships.
2. Release the hydraulic pressure from the vessels hydraulic steering system (if required). Refer to the manufacturer's instructions for correct procedures.
3. Loosen the starboard bolt that secures the 'bullhorn' ram (1) shaft to the end bracket (2).
4. Assemble the U-bracket (3) over the end bracket (2) and the shaft of the 'bullhorn' ram (1).
5. Hand tighten the starboard 'bullhorn' bolt to hold the U-bracket (3) in position.
6. Fully open the hose clamps (6) using a flat bladed screwdriver.
7. Hang the hose clamps (6) over the 'bullhorn' ram (1).
8. Site the spacers (4) on the 'bullhorn' ram (1) and hold, temporarily, with adhesive tape.
9. Pull the shaft (9) out of the linear feedback transducer (5) until the alignment mark (10) is level with the end of the body (11).

10. Position the linear feedback transducer (5) on top of the spacers (4) so that the threaded end of the shaft passes through the U-bracket (3).

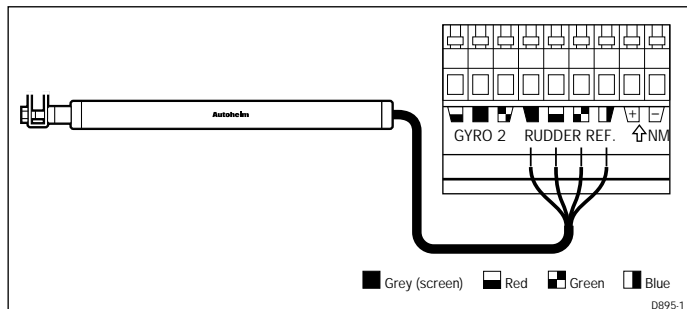
**Note:** The linear feedback transducer should, under normal circumstances, be assembled with the shaft (9) pointing towards starboard. However, if it is not possible to orientate the unit in this way, port installation is possible providing the red and green wires are reversed at the course computer.

11. With the adjustment screw and barrel aligned with the spacers, close the hose clamps (6) around the linear feedback transducer (5) and the 'bullhorn' ram (1).
12. Tighten the 'bullhorn' bolt to retain the U-bracket (3).
13. Fit and tighten the nut (7) and washer (8) to the shaft of the linear feedback transducer (5).

## Cabling

1. Run the linear feedback transducer cable back to the course computer.
2. Connect to the course computer rudder reference terminals.

**Note:** To allow for movement of the bullhorn, leave a loop of cable at the end of the Linear Feedback Transducer.



## 2.6 Hydraulic Drive Systems

This section covers the installation of hydraulic system components together with relevant plumbing and cabling procedures.

For optimum autopilot performance it is important that the pump specifications given below match the vessel's steering ram.

### Pump to Cylinder Specifications

Pump	Capacity
Type 1	80 to 230cc (4.9 to 14cu in)
Type 2	160 to 350cc (9.8 to 21cu in)
Type 3	250 to 460cc (15 to 28cu in)
CR1	350 to 500cc (21 to 30cu in)
CR2	500 to 1200cc (30 to 73cu in)

81004-04

### Reversing Hydraulic Pumps (Type 1, Type 2 & Type 3)

#### *Mounting*

The hydraulic pump should be mounted in a horizontal position clear of spray and possible water immersion. It should also be located as near as possible to the hydraulic steering cylinder.

Bolt the hydraulic pump to a substantial member to avoid vibration that could damage the interconnecting pipework.

#### *Cabling*

Using a suitably sized cable (see below) route the pump leads back to the course computer and connect to the motor terminals.

#### **Type 1 Drive Unit**

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

**Type 2 Drive Unit (12V)**

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-06

**Type 2 Drive Unit (24V)**

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

**Type 3 Drive Unit (12V)**

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

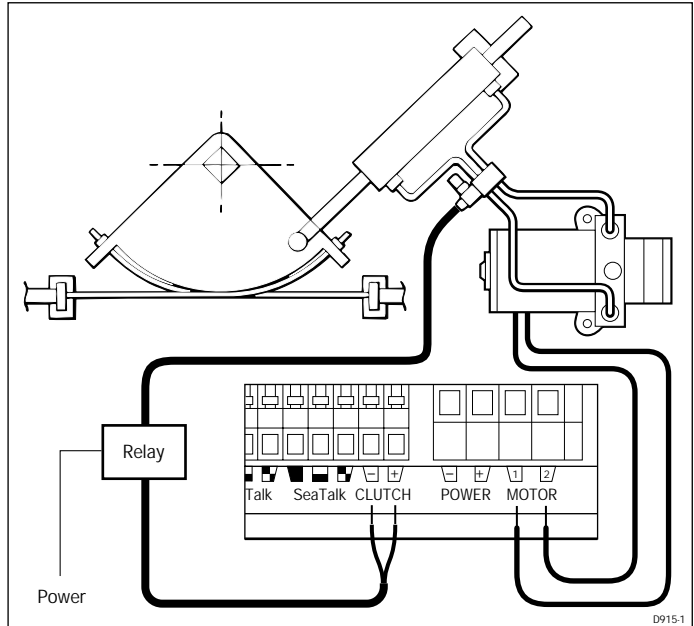
81004-06

**Type 3 Drive Unit (24V)**

Cable Length (Distribution Panel to Pump)	Cable Gauge	Copper Area
Up to 3m (10ft)	8 AWG	6 mm
Up to 7m (22ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-07

**Note:** The reversing hydraulic pumps do not require a clutch connection. If the pump is to be used to drive a secondary steering ram, a bypass valve will have to be fitted as shown in the following illustration.



**Note:** A 5 amp relay should be used to energise the bypass valve. The relay should have a 12V coil (taking less than 500ma) and be driven by the clutch output on the course computer connector.

### Plumbing

There are three basic types of hydraulic steering systems:

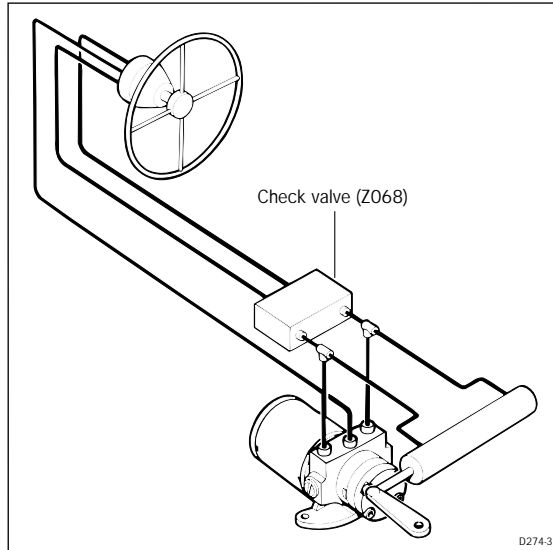
- two line system
- three line system
- two line pressurised system

Typical connection points for the autopilot pump are shown for each type.

**In all cases it is strongly recommended that the steering gear manufacturer is consulted.**

All hoses used to fit the pump should match or exceed the specification of those used in the existing steering system.

It is also necessary to ensure that the helm pump is fitted with reversing check valves, otherwise the autopilot pump will drive the helm pump (sometimes referred to as motoring the wheel) in preference to moving the ram. Single helm pump systems without check valves should incorporate a double pilot check valve and block (available as part Z068). This is shown in the following illustration.



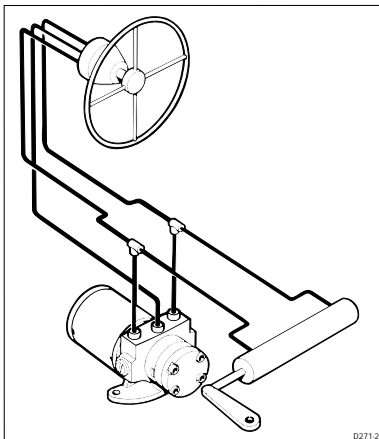
**Notes:**

1. A double pilot check valve may also be necessary on long tubing runs. Tubing expansion may result in poor autopilot performance. The valve should be installed close to the cylinder with the pump in between (as shown).
2. If the vessel has two steering positions, check valves will already be fitted to ensure independent operation of the two wheels.

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 the steering system precision check valves.

### ***Two line system***

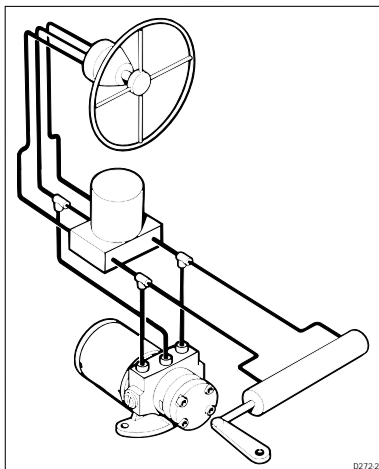
A typical two line steering system is shown in the following illustration. Hydraulic fluid can be pumped into the ram in either direction depending on the direction of the helm pump rotation. The autopilot pump is connected to the system as shown.



### ***Two line pressurised system***

Two line pressurised systems have an external pressurised reservoir. This reduces the possibility of inducing air into the system and any sponginess felt due to pipe expansion. The autopilot pump is connected to the system as shown in the following illustration.

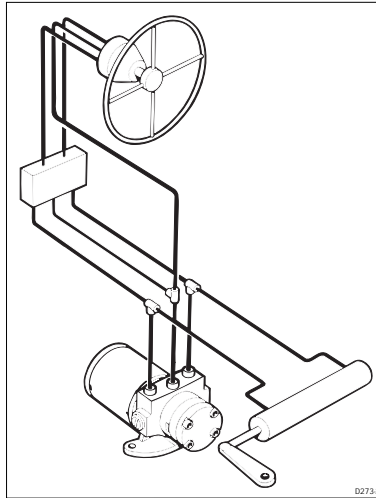
**Note:** Refer to the manufacturer's instructions on depressurising the system.



### ***Three line system***

In a three line system, hydraulic fluid flows in one direction only - out of the helm pump to the ram and then returning from the other side of the ram to the reservoir via a common return line.

A uniflow valve block will be fitted in the system to ensure that all returned fluid from the ram is directed back to the reservoir.



### ***Bleeding the system***

Correct bleeding of the hydraulic system is one of the most important steps when installing a hydraulic pump. The presence of air in the hydraulic system will not only reduce performance of the autopilot but also the overall operation of the steering system.

Further to the manufacturer's instructions for bleeding the steering system, the following procedures should be carried out to bleed the autopilot pump.

1. Press and hold the **-10** degree key : the autopilot pump will try to drive the rudder to port.
2. Counter this rudder movement by turning the helm to starboard to keep the rudder stationary. This will cause any air in the pump to rise to the helm pump and exhaust into the reservoir.



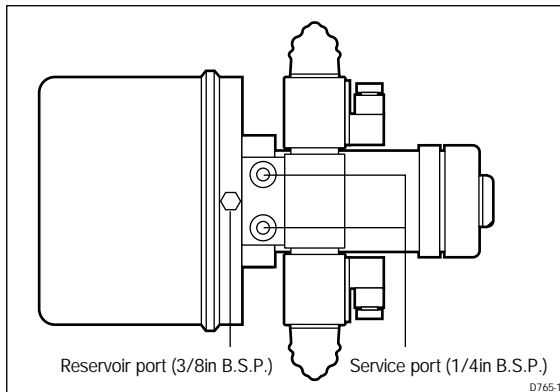
3. Reverse this action to clear any air on the other side of the pump as follows:
4. Press and hold the **+10** degree key: the autopilot will try to drive the rudder to starboard.
5. Counter the rudder movement by turning the helm to port.

**Note:** Monitor the reservoir tank at all times during the bleeding procedure, make sure it remains full of the hydraulic fluid recommended by the manufacturer. If air is left in the system the steering will feel spongy, particularly when the wheel is turned to the hardover position.

## Constant Running Hydraulic Pump

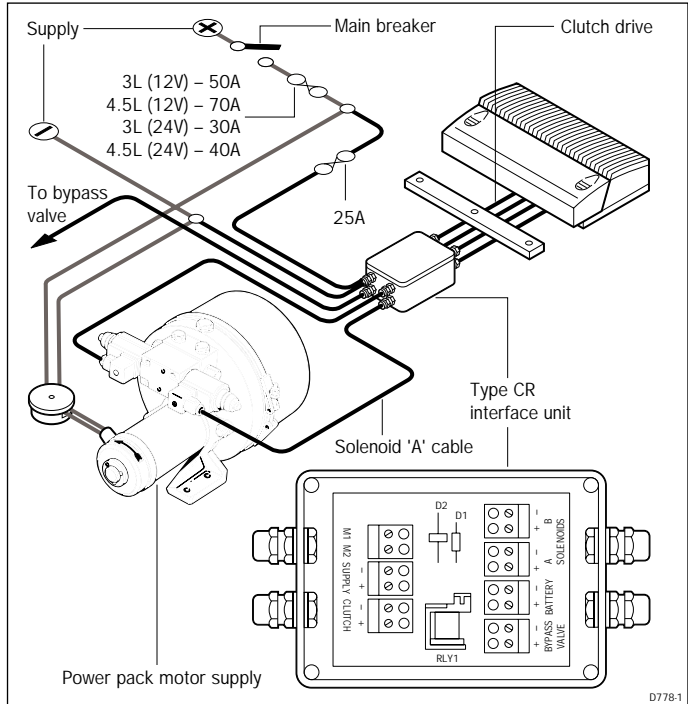
### Mounting

Bolt the constant running hydraulic pump to a suitable horizontal surface. The service ports are tapped to 1/4in B.S.P. and the reservoir port is tapped to 3/8in. B.S.P. Three N.P.T. adaptors are included for conversion to N.P.T. where required.



### Cabling

The constant running interface must be used on all installations with constant running hydraulic pumps. The main power supply is led to the interface and then onto the course computer. The interface unit has connections for the solenoid valves and the bypass valve, if one is required. The pump should be wired (as shown) using the specified cable size and designated circuit breaker.



### Pump Cable

Cable Length (Distribution Panel to Pump)	Cable Gauge	Copper Area
Up to 3m (10ft)	8 AWG	6 mm
Up to 7m (22ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-07

### Solenoid Cable

Solenoid Cable Length (Course Computer to Pump)	Cable Gauge	Copper Area
Up to 7m (23ft)	12 AWG	2.5 mm
Up to 12m (39ft)	10 AWG	4.0 mm
Up to 17m (55ft)	8 AWG	6.0 mm

81004-08

An isolator switch should be installed in the power supply to the complete system.

The solenoid valve connectors can only accept cable up to 12 AWG. If larger cable is required, 18 inches of 12 AWG should be used to wire to the connectors.

The Type CR Interface may also be connected to alternative constant running hydraulic pump providing:

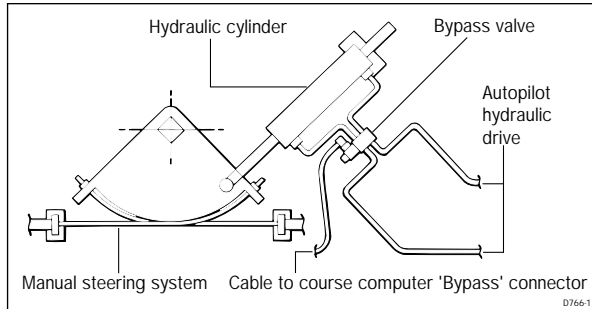
- the solenoid coils take less than 10 amps
- the response time of the solenoid valve is less than 80 milliseconds
- the operating voltage of the solenoid coils is the same as the course computer supply voltage.

It is important to minimise the overall cable length between the pump and the vessels power distribution panel.

## Plumbing

If the autopilot operated hydraulic cylinder is independent of the manual steering system, a solenoid operated bypass valve (Z079 (12V), Z122 (24V)) should be fitted to allow the cylinder to backdrive when manual steering. The bypass valve should be connected to the 'bypass' connector on the Type CR Interface Unit.

The bypass valve should be mounted between the autopilot steering cylinder ports and, under normal circumstances, be de-energised to allow the cylinder to backdrive. When the autopilot is engaged, the valve is energised by the Type CR Interface to allow the autopilot steering cylinder to drive the rudder.

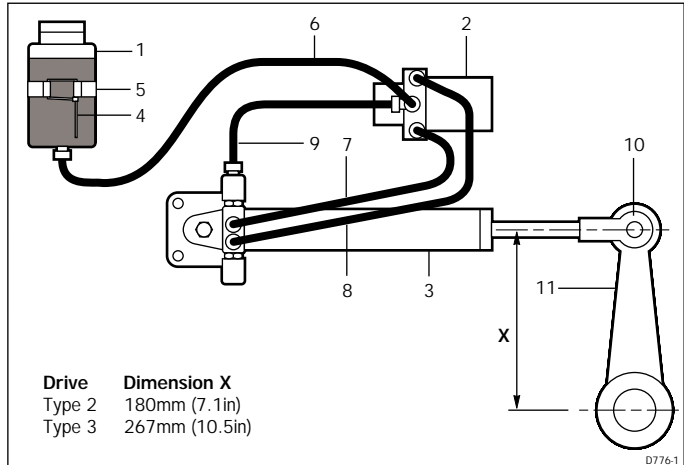


**Note:** The bypass valve voltage must be matched to the course computer supply voltage, i.e. 12V or 24V.

If the steering cylinder is unbalanced (single ended), a pilot operated pressure relief valve must be connected (as shown) to enable excess oil to be returned to the reservoir when the cylinder ram is retracting.

## Hydraulic Linear Actuator

The hydraulic linear actuator, with built in solenoid operated bypass valve and load limiting system, is designed for use as a secondary autopilot steering cylinder. The system is supplied prefilled and preplumbed for ease of installation.



1 Reservoir 2 Pump 3 Cylinder 4 Tie-wrap 5 Clip 6 Reservoir hose 7 Pump hose A  
8 Pump hose B 9 Cylinder hose 10 Cylinder ball joint 11 Quadrant

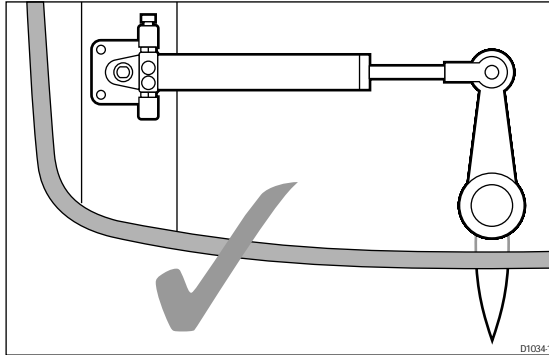
### Installation

#### Caution:

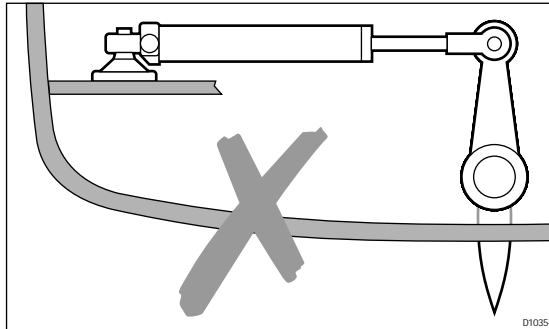
It is important to note that the hydraulic linear actuator can exert a thrust of upto 2700 lbs - this is the equivalent weight of a large family saloon car. If there is any doubt about the strength of the existing tiller arm or quadrant the steering gear manufacturer must be consulted. Also, the mounting foot should be bolted to a substantial member and always over engineer to ensure reliability and maintenance of correct alignment.

When siting the actuator the following points should be noted:

1. The actuator mounting foot must be mounted to a horizontal surface. There is insufficient movement in the swivel joint for vertical mounting.

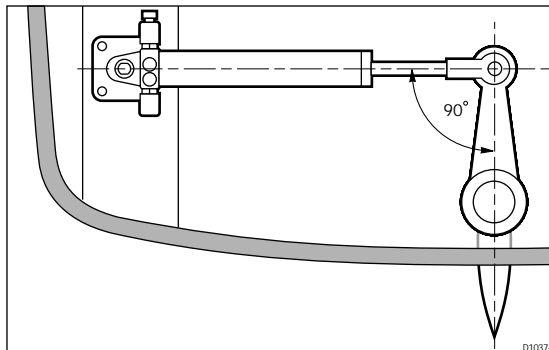


View from above



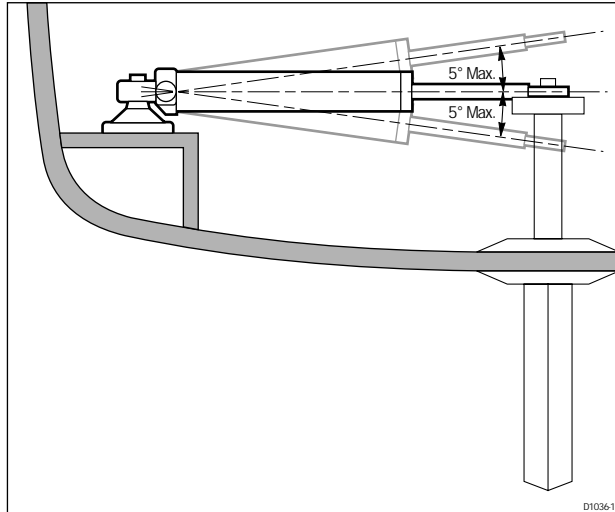
View from above

2. The drive end must be at right angles to the hydraulic cylinder when the tiller is amidships.



View from above

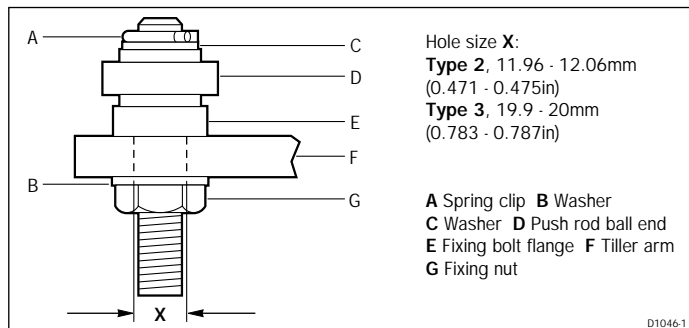
- Accurate angular alignment between the hydraulic cylinder and the tiller arm plane of rotation is extremely important – **under no circumstances should any misalignment exceed +/- 5 degrees.**



View from astern

**Caution:** The push rod must not be shortened as it contains hydraulic fluid.

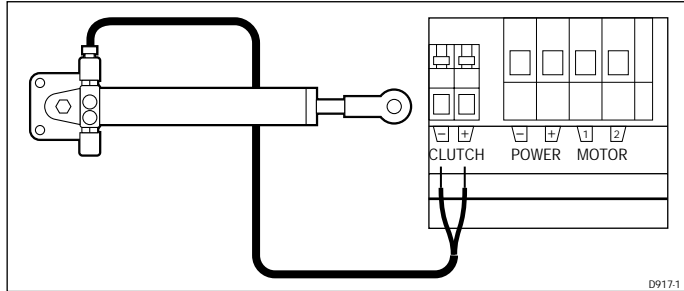
- The push rod ball end must be attached to the tiller arm at the radius specified on page 45. Use the supplied fixing bolt with its flange positioned between the ball end and the tiller arm. It is very important that this bolt is a tight fit in the tiller arm. Use Loctite 638 (or an equivalent) to secure the tiller bar bolt and lock the securing nut.



- Position the reservoir (1) so that it is at least 150mm (6in.) above the pump (2). The pump (2) should be sited above the cylinder (3).
- Use the cable tie-wrap (4) to secure the reservoir (1) to the clip (5).

### Cabling

1. Run the pump and bypass valve cable back to the course computer.
2. Wire to the course computer clutch and motor connections.



### Final Preparations Before use

1. Remove the reservoir cap and replace with the supplied standard cap.
2. Set the reservoir valve to the open position.

#### Caution:

**Make sure the mechanical limits of the steering system stop rudder movement before the cylinder reaches its end stops - failure to do this will damage the steering cylinder and will invalidate the warranty.**

3. Switch the Autopilot to 'Auto' mode and, using the 10 degree course change keys, steer hard-over to hard-over to check for correct operation and any possible leaks.
4. Set-up the autopilot end stops as described in the autopilot installation handbook.

#### WARNING:

**KEEP CLEAR OF MOVING STEERING LINKAGES AT ALL TIMES.**



## 2.8 Mechanical Drive Systems

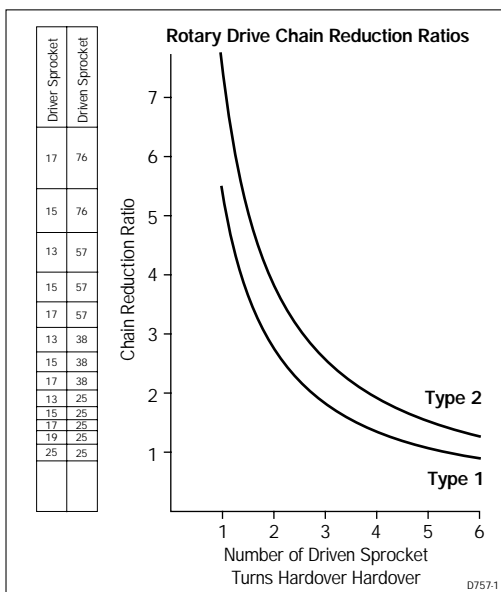
### Rotary Drive Unit

The rotary drive is coupled to the steering by a chain drive. Most steering gear manufacturer's supply special autopilot drive attachments (many include this as standard). The Edson Company is a good source.

### Mounting

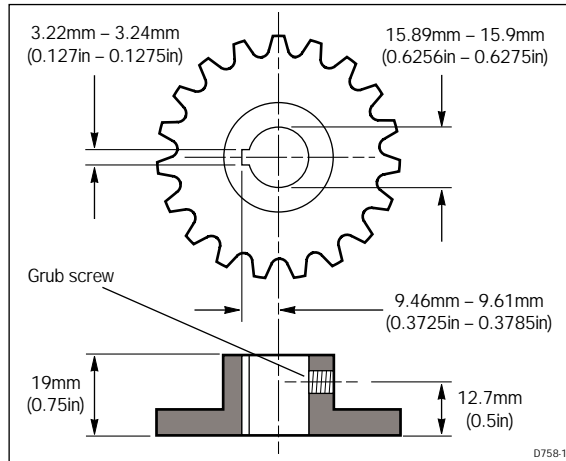
Having selected the position for attachment of the autopilot drive chain, it is necessary to determine the chain reduction ratio.

Count the number of turns of the steering gear shaft (driven sprocket) when the rudder is driven from hardover to hardover. Determine the sprocket sizes required from the following table.



These ratios provide good steering performance for most vessels. If the vessel is thought to have unusual steering characteristics, contact our Product Support Department, or an authorised representative, for advice.

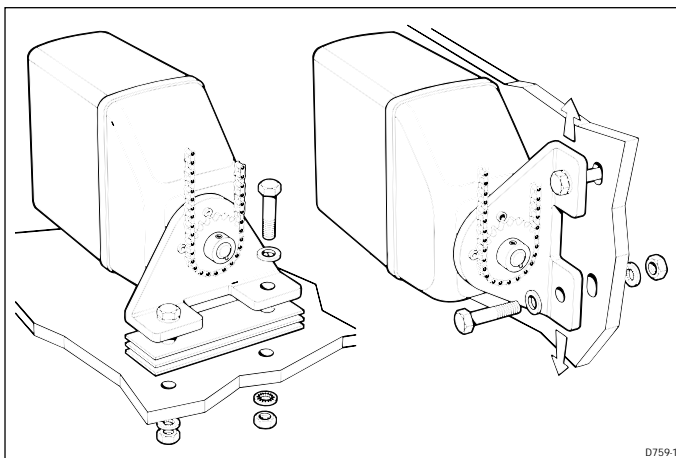
A standard 3/8in. or 1/2in. pitch chain is recommended for the chain drive and, ideally, the drive sprocket should not have less than 15 teeth. Bore and keyway dimensions for the drive unit sprocket are detailed in the following illustration. It is essential that these bore and keyway dimensions are strictly adhered to. All sprockets must be keyed, set screwed to their shaft and finally secured with loctite.



The drive unit must be bolted to a substantial frame member. The mounting foot is secured to the drive unit by four equally spaced allenhead screws and it may be rotated through 90 degrees to provide a more convenient mounting position, if required. 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 500 lb (230Kg) and, therefore, an extremely rigid mounting structure is vital to maintain good chain alignment. Installation failures can occur in this area and over-engineering is strongly recommended for drive unit mounting. All fastenings should be secured with lock washers.

Provisions must also be made for chain adjustment. This is achieved by removable shims placed under the mounting foot or, alternatively, by elongated clearance holes in the mounting frame.



Both sprockets must be accurately aligned to run in the same plane. Correct alignment must be carefully checked by means of a straight edge.

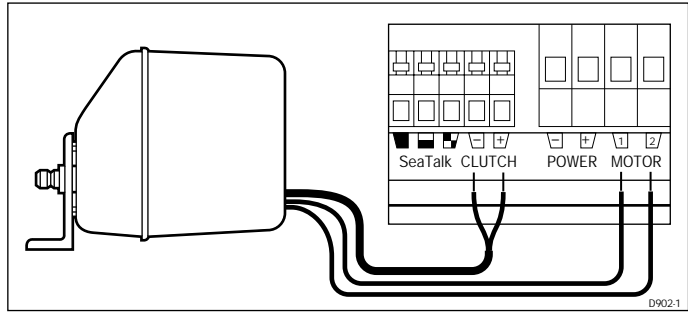
The gearbox can be mounted in any position. Additionally, the drive sprocket may face in any direction as the steering sense can, by reversing the polarity of the drive motor connection, be corrected when installation is complete.

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

Having completed installation of the drive unit, turn the steering wheel from hardover to hardover and check that the chain and sprockets driving the actuator move freely and are in alignment.

## Cabling

The rotary actuator has electrical connections for both the drive motor (red/black cores) and clutch (twin cable with blue/red cores). Using a suitable size cable (see tables), route back to the course computer and connect to the clutch and motor terminals.



### Type 1 Drive Unit

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

### Type 2 Drive Unit (12V)

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-06

### Type 2 Drive Unit (24V)

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

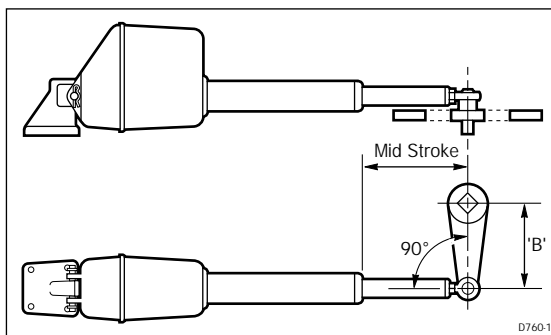
### Linear Drive Unit

The linear drive unit connects directly on to the rudder stock at the tiller arm radius (shown below).

Drive Unit	Tiller Radius (B)
Type 1	250mm (10in)
Type 2S	250mm (10in)
Type 2L	360mm (14in)

81004-09

It is preferable to couple the linear drive unit to the rudder stock via an independent tiller arm (Edson and Whitlock 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.

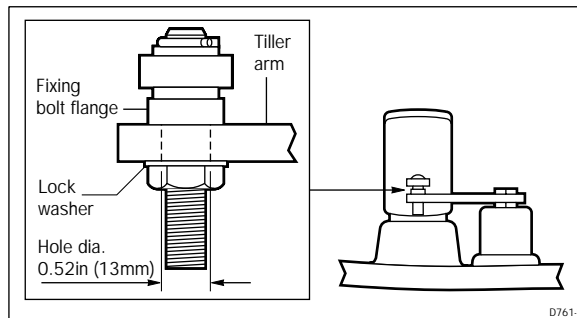


**Caution:** The linear drive system can exert a thrust of over 1000lb. (450Kg). The steering gear manufacturer must be consulted if any doubt exists about the strength of the existing tiller arm or rudder quadrant.

## Mounting

When siting the linear drive unit, the following points should be noted:

- The drive unit mounting bracket can be attached to any horizontal or vertical surface. Also, the drive unit can be mounted upside down if required.
- The ball end fitting will allow up to 5 degrees misalignment between the pushrod and tiller arm plane of rotation. Accurate angular alignment is extremely important and, therefore, under no circumstances should this limit be exceeded.
- The drive unit must be at right angles to the tiller arm when the rudder is amidships.
- The drive is clear of any bilge water.



- The mounting bracket should be bolted to a substantial frame member.  
**Always over-engineer to ensure reliability and maintenance of correct alignment.**

The pushrod ball end must be attached to the tiller arm, using the adaptor pin (supplied), with its flange positioned between the ball end and the tiller arm. It is vitally important that the lock washer (supplied) is used and that the nut is tightened fully.

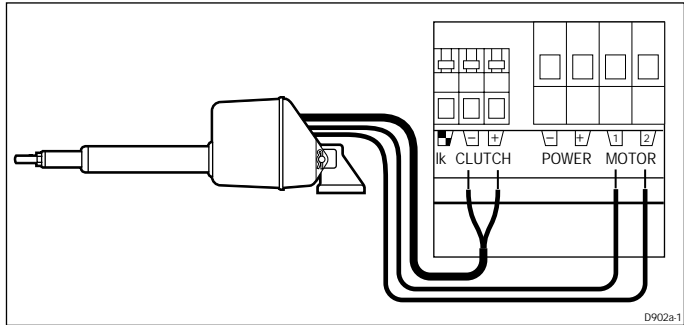
The mounting bracket should be attached with four stainless steel 3/8in. bolts and locknuts/lock washers.

Having installed the drive unit, turn the steering wheel from hardover to hardover and check that:

- no part of the drive unit fouls the vessels structure.
- the mechanical limit stop on the vessels steering system is reached before the actuator reaches its mechanical limit.
- angular movement of the ball end fitting is less than 5 degrees.

## Cabling

The linear drive unit has electrical connections for both the drive motor and clutch. Using a suitable size cable (see tables), route back to the course computer and connect to the clutch and motor terminals as shown.



### Type 1 Drive Unit

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

### Type 2 Drive Unit (12V)

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 5m (16ft)	8 AWG	6 mm
Up to 7m (23ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-06

### Type 2 Drive Unit (24V)

Cable Length (Drive Unit to Course Computer)	Cable Gauge	Copper Area
Up to 3m (10ft)	12 AWG	2.5 mm
Up to 5m (16ft)	10 AWG	4 mm
Up to 7m (23ft)	8 AWG	6 mm
Up to 10m (32ft)	6 AWG	10 mm
Up to 16m (52ft)	4 AWG	16 mm

81004-05

### Stern drive Actuator

The stern drive actuator can be fitted to power assisted Stern drive systems made by Volvo-Penta, Mercruiser, OMC and Yamaha. Different installation kits are available to cover most of these installations.

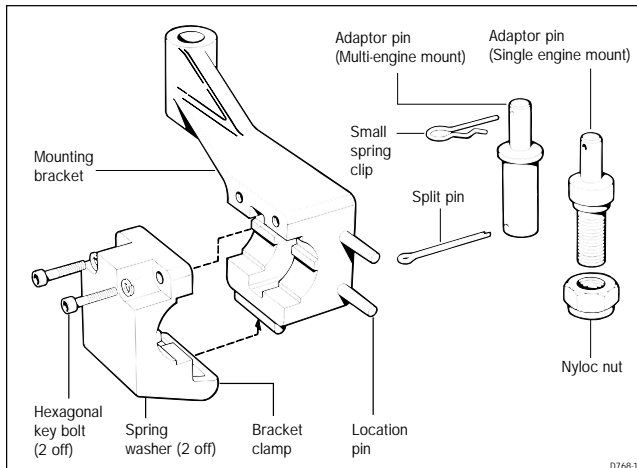
**Note:** Older Volvo steering systems (Pre type 872215) require an adaptor bracket (D129).

### Mounting

#### Volvo (Pre type 872215)

Fitting to this type of engine requires an adaptor bracket (M81139).

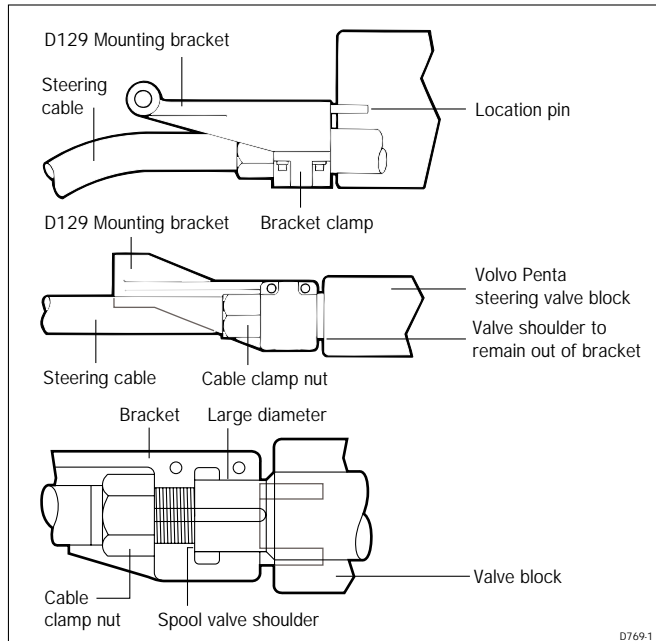
The stern drive actuator should be connected to the centre hole on the tiller arm. On twin engine installations, this is the position used to connect the engine tie bar to link the two tiller arms.



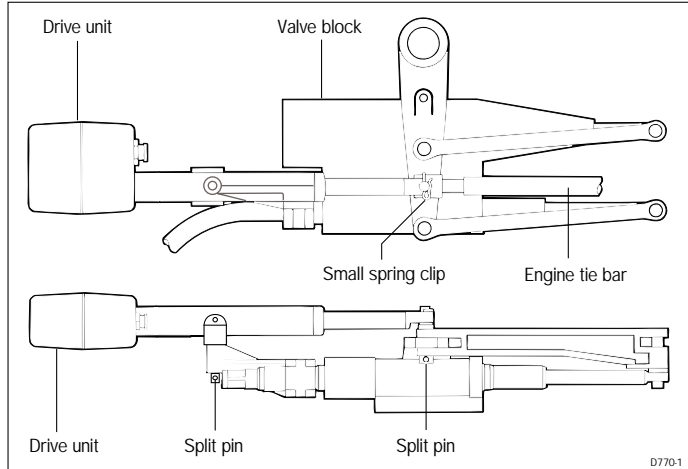
07681



1. Push the mounting bracket behind the steering cable, sliding the location pins either side (top and bottom) of the Volvo power steering block.
2. The bracket clamp hinges onto the mounting bracket and is located using the two allenhead key bolts. Tighten the two bolts evenly until the bracket is securely located.



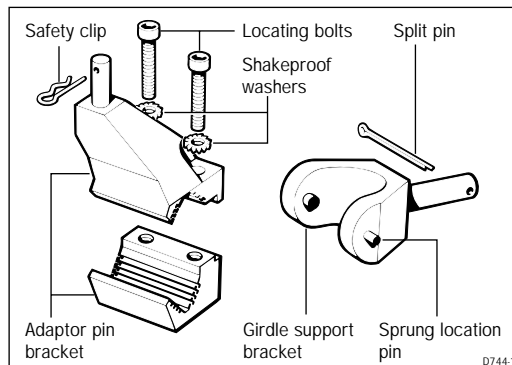
3. Uncouple the engine tie bar from the outdrive tiller arm by bending back the locking tabs and removing the cotter pin. This should be replaced with the multi-engine adaptor pin. Make sure that it is secured properly with a split pin (on single engine installations, fit the single engine adaptor pin in the vacant middle hole in the tiller arm).

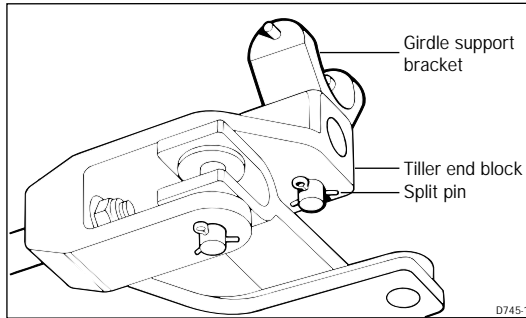


4. Attach the drive unit to the mounting bracket as shown above and secure split pin provided. The small spring clip can then be used to attach the drive unit to the adaptor pin.
5. Slowly turn the steering system from hardover to hardover. It is most important that the drive unit and the adaptor pin bracket do not touch any part of the engine or steering system.

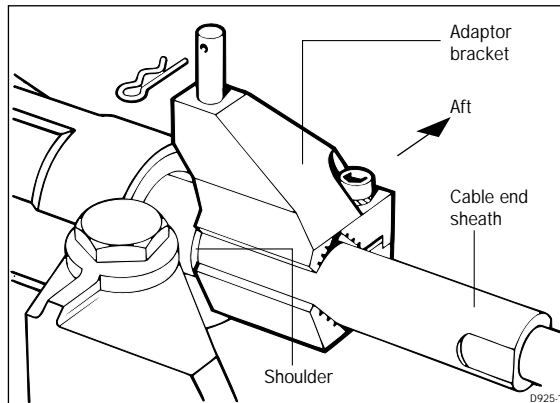
### **Volvo (Post type 872215)**

1. Remove the locating pin that attaches the cable rod to the tiller end block and replace with the girdle support bracket as shown.



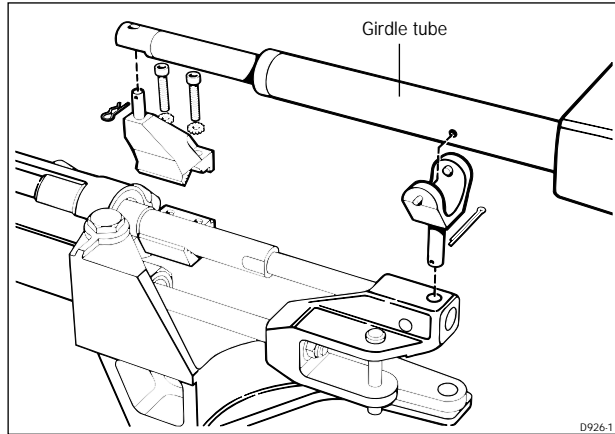


2. Secure the assembly with the split pin (supplied).
3. Install the adaptor pin bracket to the cable end sheath.



**Note:** The adaptor pin bracket must sit against, but not on, the shoulder of the cable end sheath. Also, it is important that the securing bolts are sternside of the steering cable end sheath.

4. Ensure that the bracket remains vertical and tighten the locking bolts.
5. Rotate the girde support bracket so that locator pin is facing forwards.
6. Position the stern drive actuator so as to locate the fixed support pin on the girde support bracket into the hole in the girde tube.



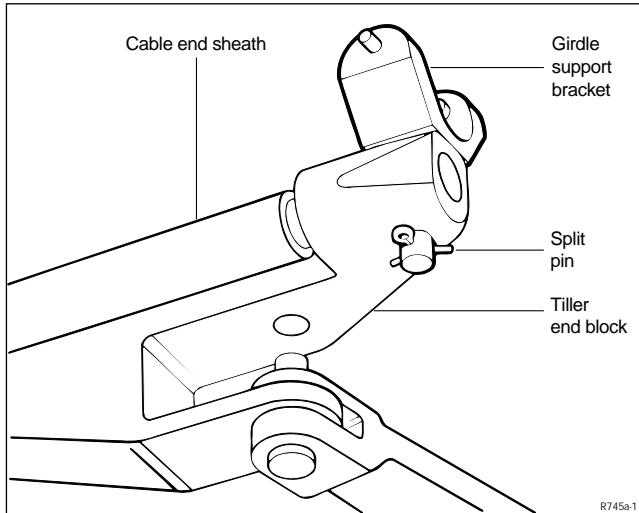
7. Carefully twist and lower the actuator into the girdle support bracket until the spring pin locates into the opposite side of the girdle tube.

**Caution:** It is most important that both the solid and spring location pins are fully engaged in the actuator girdle tube. Failure to do so will result in autopilot failure and possible steering system damage.

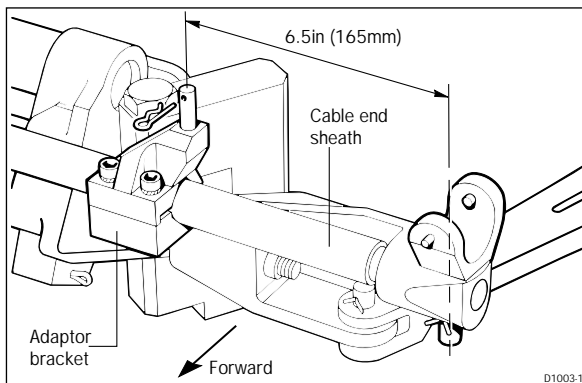
8. Position the drive unit pushrod over the top of the adaptor pin and secure with the safety clip.
9. Slowly turn the steering system from hard-over to hard-over. The drive unit and the adaptor pin bracket must not touch any part of the engine or steering system. This includes any engine hoses that may have only passing contact with the autopilot actuator; **after a time these will wear and ultimately fail.**

**Mercruiser/OMC/Yamaha**

1. Remove the locating pin that attaches the cable end sheath to the tiller end block.
2. Replace the locating pin with the girdle support bracket as shown.

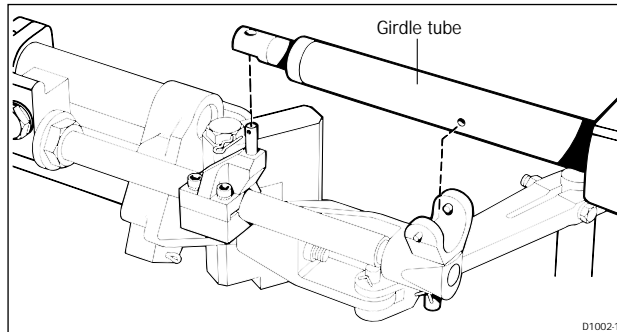


3. Secure the assembly with the split pin (supplied).
4. With the helm turned hard to port, assemble the adaptor pin bracket to the cable end sheath as shown.



**Note:** The securing bolts must be on the front or bow of the boat side cable end sheath. Also, the bracket should be positioned 6.5in (165mm) from the girdle support bracket.

5. Make sure that the bracket remains vertical and tighten the two locating bolts.
6. Rotate the girdle support bracket so that the spring locator pin is facing forwards.
7. Position the stern drive actuator so as to locate the fixed support pin on the girdle support bracket into its location hole in the girdle tube.



8. Carefully twist and lower the actuator in to the girdle support bracket until the spring pin locates into the opposite side of the girdle tube.

**Note:** Both the solid and spring location pins must be fully engaged in the actuator girdle tube; **failure to do so will result in autopilot failure.**

9. Position the drive unit pushrod over the top of the adaptor pin and secure with the safety clip.
10. Slowly turn the steering system from hard-over to hard-over.

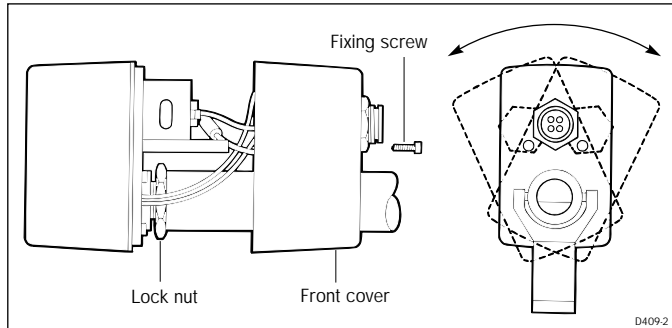
**Note:** It is most important that the drive unit and the adaptor pin

bracket do not touch any part of the engine or steering system. This includes any engine hoses that may have a passing contact with the autopilot actuator; after a time these will wear and ultimately fail.

### ***Mounting in a Restricted Area***

If an obstruction prevents installation of the drive unit as supplied, the main body can be rotated relative to the mounting bracket as follows:

1. Remove the two fixing screws and carefully slide the cover forwards, ensuring that the four cables do not pull away from the plugs inside the cover.
2. Loosen off the lock nut and rotate the main body as required.
3. Re tighten the lock nut securely, making sure that the lock nut is no more than one turn from the start of the thread.
4. Replace the cover taking care not to crimp any cables.
5. Using the steering wheel, move from hard over to hard over and check that no part of the drive unit contacts any part of the vessel/ fittings.

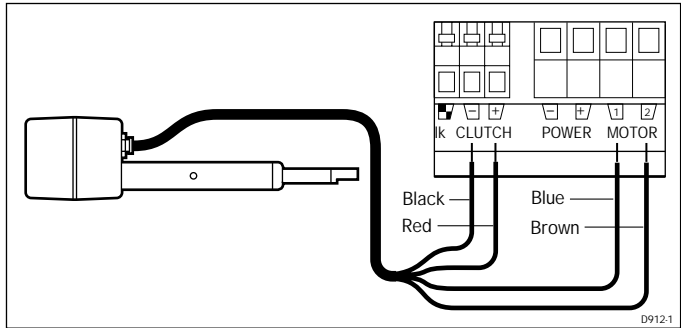


## Cabling

1. Plug in the power cable, supplied with the drive unit, making sure that the connector is locked in place by turning the locking ring clockwise.
2. Run the cable back to the course computer. Secure the cable close to the drive unit but allowing sufficient free length to accommodate the drive unit movement.
3. Once again using the steering wheel to move the rudder from hard over to hard over, check that the cable does not catch on any part of the vessel/fittings.
4. The actuator cable has electrical connections for both the drive motor and the clutch. Connect to the course computer terminals



labelled clutch and motor as shown.



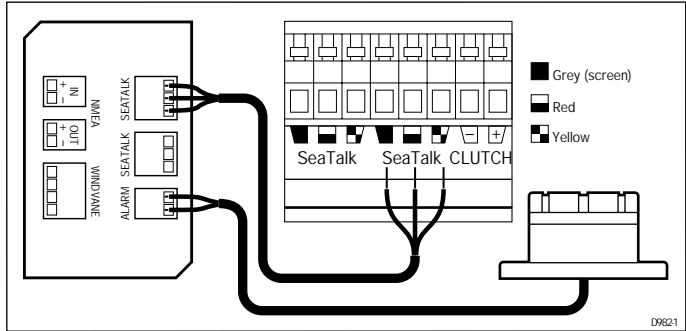
## 2.9 Auxiliary Alarm

The auxiliary alarm is waterproof and, therefore, can be mounted in any position. A foam seal on the mounting flange ensures a watertight joint to the mounting surface.

The auxiliary alarm must be connected to the system via an NMEA interface.

1. Drill a 7/8in (22mm) diameter hole through the mounting panel as shown.
2. Pass the two way connector block and cable through the drilled hole.
3. Mount the auxiliary alarm in position using the four self tapping screws (supplied).

## Cabling

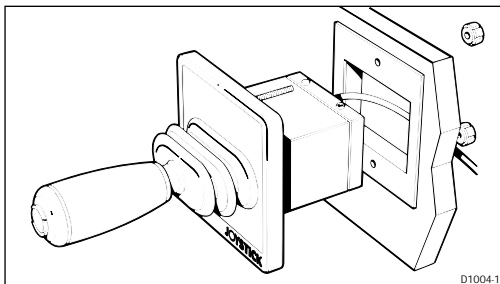


Connect the NMEA interface to the alarm and course computer as shown.

## 2.10 Joystick

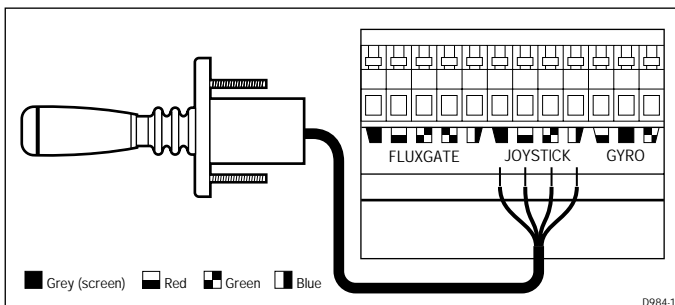
The mounting surface must be smooth and flat to ensure that there is adequate waterproofing.

1. Use the template provided to mark the centers for the two fixing holes and outline of the body aperture.
2. Drill the fixing holes and cut-out the aperture for the body.
3. Remove the mounting template and peel off the protective paper from the rear of the weather gasket and fix to the mounting surface.
4. Pass the signal cable through the body aperture and secure the Joystick with the thumb nuts provided.



## Cabling

The Joystick is supplied with 26ft (8m) of cable which should be connected to the course computer as shown.



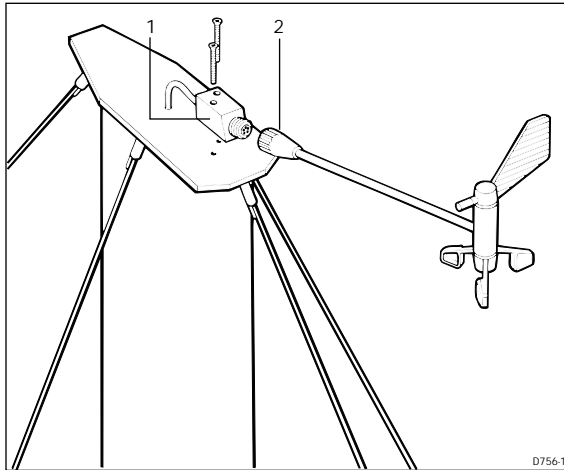
**Note:** Only one joystick can be connected.

## 2.11 Masthead Transducer (sail only)

To enable wind information to be made available to the SeaTalk system, the wind transducer must be connected to the NMEA interface box.

## Mounting

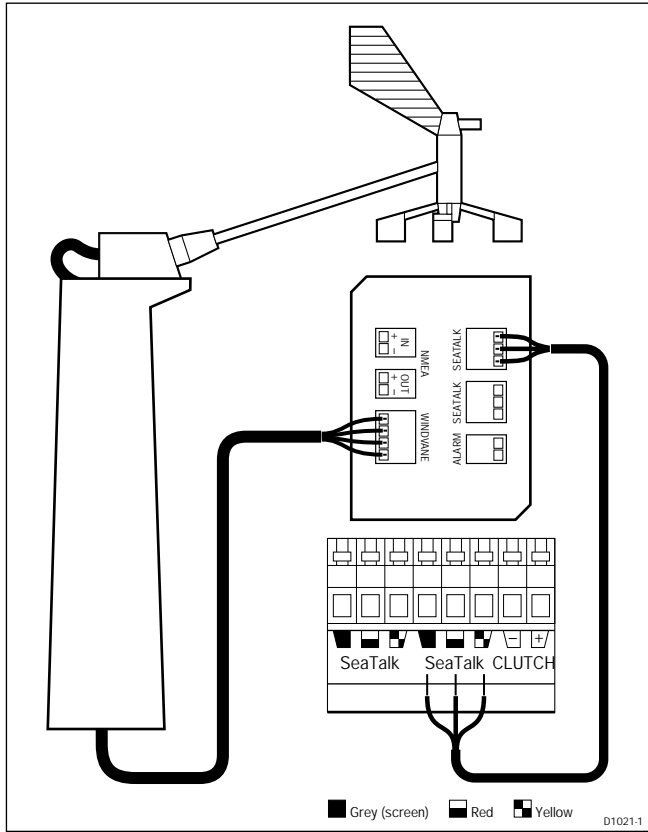
1. With the threaded end of the mounting block facing forwards, mark the position for the self tapping screws.
2. Drill the holes using the supplied 4.0mm (5/32in.) drill.
3. Attach the mounting block to the mast using a suitable sealing compound.
4. Tighten the locking ring securely.



1 Mounting block 2 Locking ring

## Cabling

1. Cut the cable with sufficient length to run from the mounting block to the NMEA interface box.
2. Feed the cable down the mast.  
**Note:** If the mast is deck stepped the cable should be passed through the deck and sealed using a proprietary gland fitting.
3. Connect the cable to the NMEA interface box as shown.



**Note:** The yellow connection from the mast head transducer is not connected at the NMEA interface.

## 2.12 Interfacing to other manufacturer's equipment (NMEA)

### Course Computer NMEA ports

The type 100 and 300 course computers have NMEA 0183 input and output ports. Sentances decoded are as follows.

#### *Input Port*

NMEA 0183 Data	NMEA Header Received
Cross Track Error	APA, APB, RMB, XTE, XTR
Bearing to Waypoint	BPI, BWR, BWC, BER, BEC, RMB, APB
Distance to Waypoint	BPI, BWR, BWC, BER, BEC, RMB, WDR, WDC
Waypoint Number	APB, BPI, BWR, BWC, BER, BEC, RMB, APA, WDR, WDC, BOD, WCV
Water Speed (through the water)	VHW
Apparent Wind Angle	VWR
Latitude/Longitude	GGA, GLL, GXA, RMA, RMC, GXP, GDF, GDP, GDA, GOF, GOP, GLF, GLP, GLA, GOA, IMA, GXF
COG/SOG	VTG, RMA, RMC, VTA
Variation	HDG, RMA, RMC, HVD, HVM

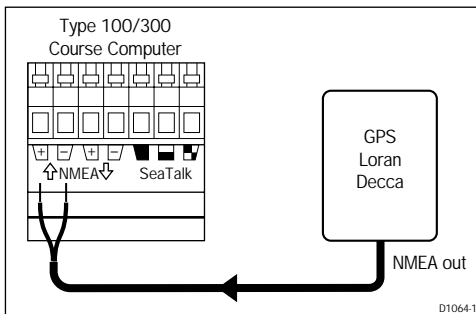
#### *Output Port*

NMEA 0183 Data	NMEA Header Transmitted
Cross Track Error	XTE
Bearing to Waypoint	BWC
Distance to Waypoint	BWC
Waypoint Number	BWC
Latitude and Longitude	GLL
Magnetic Heading	HDG, HDM, HDT
True Heading	HDT
Locked Autopilot Heading	HSC
Course Over Ground	VTG
Speed Over Ground	VTG
Fix/No Fix	GLL

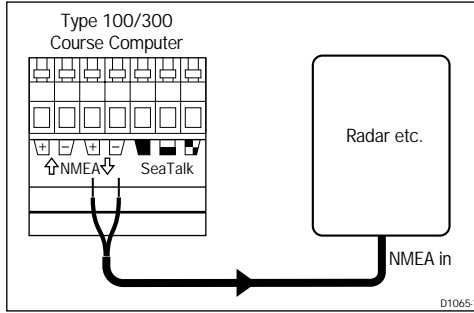
81004-11

### Cabling

Connect the NMEA output from a GPS, Loran, Decca etc. to the NMEA input terminals on the course computer.



Connect the NMEA input on the radar etc. to the NMEA output terminals on the course computer.



### ST6000/ST7000 Control Unit NMEA Input

The ST6000/ST7000 control units are fitted with an NMEA input port. sentences decoded are as follows.

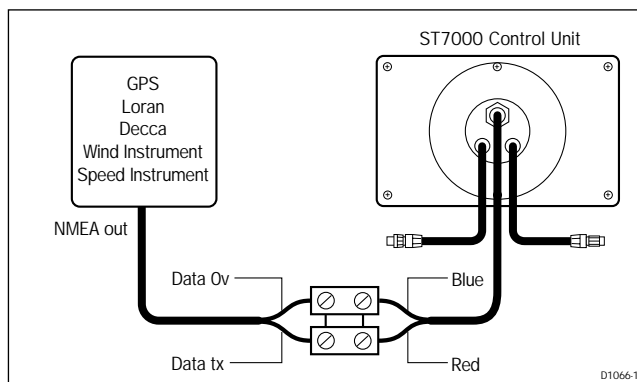


NMEA 0183 Data	NMEA Received Header
Bearing to Waypoint	APB, BPI, BWR, BWC, BER, BEC, RMB
Distance to Waypoint	WDR, WDC, BPI, BWR, BWC, BER, BEC, RMB
Waypoint Number	APB, APA, BPI, BWR, WDR, BWC, WDC, RMB, BOD, WCV, BER, BEC
Speed (through water)	VHW
Apparent Wind Speed and Direction	VWR
Latitude and Longitude	GLL
COG and SOG	VTG
Cross Track Error	XTE, XTR, APA, APB, RMB

81004-12

### Cabling

Connect the NMEA output from either a GPS, Loran, Decca, Speed or Wind instrument to the NMEA input on the control unit.



### NMEA Interface

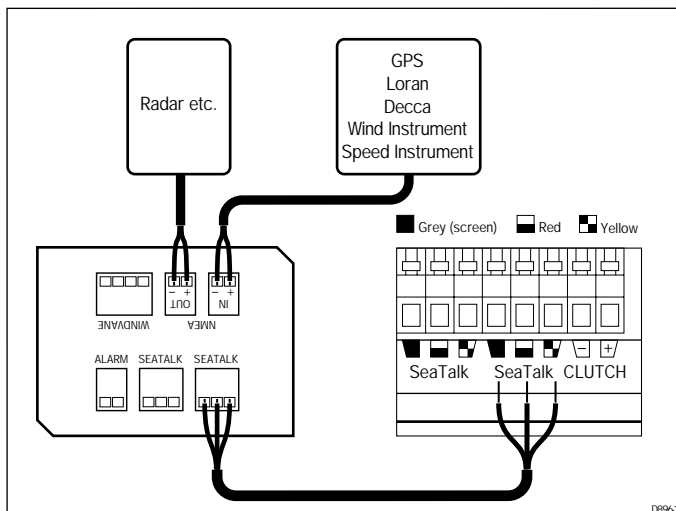
The NMEA interface is primarily designed to allow operation with other manufacturers equipment by providing conversion between SeaTalk and NMEA 0183 data format. Sentances decoded and transmitted are as follows:

<b>Data</b>	<b>SeaTalk instrument required</b>	<b>Transmitted NMEA Header</b>
Cross Track Error	Navcenter or Navdata or GPS	APB
Bearing to Waypoint	Navcenter or Navdata or GPS	BWC
Distance to waypoint	Navcenter or Navdata or GPS	BWC
Waypoint Number	Navcenter or Navdata or GPS	BWC
Apparent wind speed and direction	Wind	VWR
Boat Speed (Through water)	Speed or Tridata	VHW
Water Depth	Depth or Tridata	DBT
Longitude and Latitude	GPS or Navcenter or Navdata	GLL
Magnetic Heading	Compass or SeaTalk Autopilot	HDM, HDG, VHW
True Heading	Compass or SeaTalk Autopilot	HDT, VHW
Locked autopilot heading	SeaTalk Autopilot	HSC
Water Temperature	Speed or Tridata	MTW
Course over the	GPS or Navdata or	VTG

NMEA 0183 Data	NMEA Header Transmitted
Cross Track Error	XTE
Bearing to Waypoint	BWC
Distance to Waypoint	BWC
Waypoint Number	BWC
Latitude and Longitude	GLL
Magnetic Heading	HDG, HDM, HDT
True Heading	HDT
Locked Autopilot Heading	HSC
Course Over Ground	VTG
Speed Over Ground	VTG
Fix/No Fix	GLL

81004-11

## Cabling



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- Connect the NMEA interface box to the course computer SeaTalk connection or alternatively any other SeaTalk product using one of the available interface cables.
- Other manufacturer's equipment can now be connected to the NMEA in or NMEA out connections.

**Note:** Only one transmitter should ever be connected to an NMEA

## Chapter 3: Functional Test

This section provides detailed information related to complete system testing, equipment calibration and initial sea trials.

### 3.1 System test

The steering system and drive unit/rudder reference transducer should be carefully inspected and the following points checked using the steering wheel to drive the vessels steering from hardover to hardover.

- the steering system reaches the rudder end stops before the drive actuator reaches its end stops (Linear/Stern Drive).
- no part of the autopilot drive system fouls any part of the steering system or vessels structure through full travel.
- the mechanical alignment of the drive unit is as specified in this handbook.
- the mechanical alignment of the rudder reference transducer is as specified in this handbook.
- all connecting wires are secured clear of the bilge and cannot foul any part of the steering system. All connectors are tightly secured.
- all securing bolts are fully tightened and mechanical locking arrangements as specified are in place.

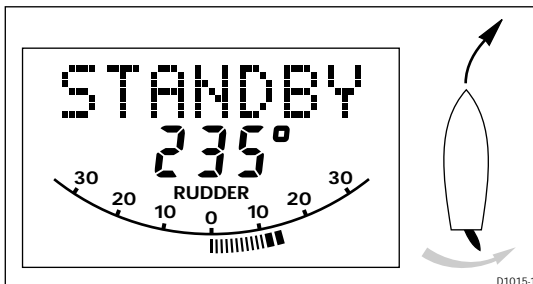
### 3.2 Switch-on

Switch on the electrical supply from the main panel. All control units will emit a short beep and display the autopilot type: either ST6000 or ST7000. Within 2 seconds **Standby** will be displayed to indicate that the autopilot is in Standby mode.

### 3.3 Rudder angle sense

#### ST7000 control unit

Move the wheel to produce a starboard turn. The rudder angle display should move to the right.

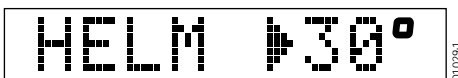


If the display moves to the left the red and green wires from the rudder reference transducer must be reversed.

#### ST6000 control unit

Press **Display** twice.

Move the wheel to produce a starboard turn. The rudder angle should increase and the direction indicator (▶) be displayed.



If the (◀) rudder angle indicator is displayed the red and green wires from the rudder reference transducer should be reversed.

### 3.4 Rudder angle alignment

With the rudder amidships, see if the rudder angle display reads zero. Misalignment up to +/- 7 degrees can be removed in the calibration sequence which is explained later in this section. If the misalignment is greater than 7 degrees the rudder reference should be mechanically adjusted to be within the +/- 7 degree limit.

### 3.5 Operating sense

The operating sense of the autopilot can be checked as follows:

1. Push **AUTO**.
2. Press the **+10** degree key. This should move the rudder a few degrees to produce a turn to starboard. If the rudder moves hardover to port, the motor connections at the course computer should be reversed.

### 3.6 Rudder deadband

The factory preset rudder deadband level will provide stable rudder positioning on most steering systems. On some steering systems, where a rotary or hydraulic drive unit is sited a long way from the rudder, slight instability may occur. This can be removed by increasing the 'rudder damping' level in calibration. Any increase should be minimised as it will reduce the autopilots course keeping accuracy.

### 3.7 Mechanical test (Linear, Rotary & Hydraulic Drives)

**WARNING: When the steering system is being moved manually, or under drive from the autopilot, do not touch any part of the system. The forces exerted are considerable and could cause injury.**

1. Push **AUTO**.
2. Press the **+10** degree key to drive the rudder hardover onto the end stops

**Note:** This may require increasing the rudder limit in the calibration mode.

3. Make sure the drive unit mounting shows no sign of movement.
4. For hydraulic systems, make sure there is no seepage of hydraulic fluid and that the steering ram moves smoothly.

**Caution: If the installation is a non Autohelm Constant Running Pump, firstly check that the system includes a pressure relief valve. Failure to do this could cause damage to the steering system.**

5. Repeat driving the rudder hardover to the opposite end stop.

#### Current limit and cutout

When the rudder is driven onto the end stops the power to the drive will be cut out after a few seconds - this is normal. Drive will only be restored if the rudder moves away from the end stop or if drive is required in the opposite direction.

### 3.8 Mechanical Test (Stern Drive)

It is recommended that the Auto Release facility is used when a Autohelm mechanical stern drive actuator is installed. This should be switched on in calibration.

1. Manually drive the steering hardover to starboard
2. With the engines running, engage **Auto** and, with repeated presses of the **-10** degree key, drive the steering to the opposite lock (port).
3. The autopilot should drive the steering onto the end stops, sound an alarm, display the 'Release' message and then revert to 'Standby'.
4. Re-engage the autopilot (Auto) and repeat the driving the steering hardover to starboard using the **+10** degree key.
5. The autopilot should again drive onto the end stop, sound an alarm, display 'Release' and return to 'Standby'.

**Note:** If the unit sounds the alarm and displays Release before reaching the opposite lock, carefully check the vessel's steering system for any stiffness or mechanical jamming.

If the condition persists, set the Auto Release function to "off" (0) in calibration and contact the Product Support Department at Autohelm for further advice.

**Note:** The Auto Release function should always be set to "off" (0) in calibration if using any drive unit other than a stern drive actuator.

### 3.9 Setting the Autopilot Rudder Limit (All drives)

Having checked the correct functioning of the drive unit and the appropriate End Stop Cutout/Auto Release function the programmable rudder angle unit should be set.

The rudder angle limit sets the maximum angle to which the autopilot will move the rudder. This should be set to just less than the vessel's mechanical limit stop to avoid putting the steering system under unnecessary load.

Using the rudder angle display whilst manually moving the helm, record maximum rudder angle in both directions. Set up the rudder angle limit in calibration mode (see page 82) to 5 degrees less than the minimum angle recorded.

### 3.10 GyroPlus Offset and Drift Compensation

The GyroPlus uses the latest generation solid-state rate gyro to enhance steering performance at response level 3 (see Calibration for details). Like all rate gyro's the GyroPlus is subject to offset and drift. However, this is automatically compensated for whenever the autopilot is in **AUTO** mode.

When the GyroPlus is initially installed, it is important that offset and drift compensation ( a once-only operation) is carried out before selecting response level 3 - failure to carry out this procedure will result in rapid course changes when level 3 is selected.

#### Procedure

Compensation for offset and drift is achieved by simply using the autopilot in response level 1 or 2 for at least 5 minutes before you select level 3.

Alternatively, if you want to use response level 3 as soon as you engage **AUTO**, then the following procedure must be carried out.

1. Moor the vessel so that the heading remains constant.
2. Press **AUTO** and leave for at least 5 minutes.
3. After 5 minutes, press **STANDBY** to return to "standby" mode. The autopilot will now have stored the compensation value for future use.



## Chapter 4: Calibration

### 4.1 Recommended Settings

As supplied the ST7000 can be switched on and tested safely without any adjustments to the factory calibration settings.

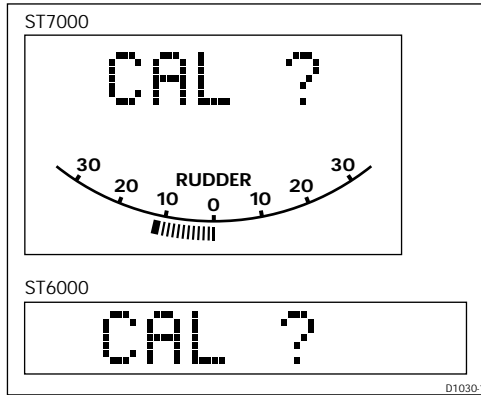
The table below lists the suggested settings for sailing/power displacement and planing power vessels. These will provide good performance for initial sea trials and can be fine tuned later to optimise performance.

	Vessel Type			
	Displacement Factory Preset	Planing Set to		
Rudder Gain (level)	5	4		
Rate Gain (level)	7	4		
Rudder Angle Limit (degrees)	30	30		
Turn Rate Limit (degrees/sec)	20	12		
Cruise Speed (knots)	8	25		
Off Course Alarm (degrees)	20	20		
Trim Level	1	3		
Auto Adapt	off	on		
Autopilot Drive Unit Type				
	Mechanica Drive	Stern Drive	Hydraulic Drive	Hydraulic Linear
	Factory Preset	Set to	Set to	Set to
Drive Type	3	3	4	3
Rudder Position Deadband (level)	1	1	1	3
Auto Release	off	on	off	off

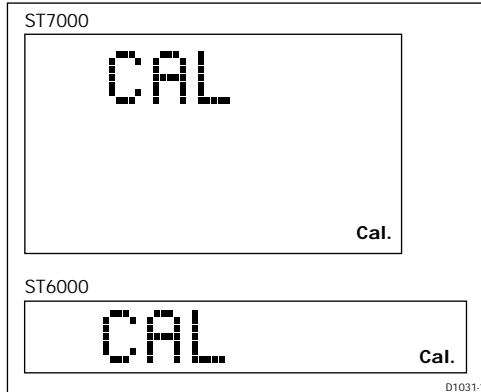
## 4.2 Selecting calibration

To select calibration:

- Press **Standby**.
- Press and hold **Track** and **Display** for 2 seconds to access the following display.



- Press and hold **Track** and **Display** for a further 2 seconds to access the following display.



## 4.3 Adjusting calibration

In calibration the **Display** key is used to scroll through the menu. The displayed value is adjusted using the **Response** keys (hold down for fast scroll).

**Note:** If the 'CAL' display reappears at any time during calibration, press **Display** to advance to the next menu level.

Once calibration has been carried out, further adjustment can be made at any time.

### Rudder Gain

Rudder Gain controls the amount of rudder the pilot will apply to turn onto a new heading. A correctly set rudder gain will, for example, turn the vessel crisply onto the new heading with an overshoot of no more than 2 to 5 degrees for a 40 degree course change. A high rudder gain setting will result in oversteer, recognized as an overshoot of more than 5 degrees.

A rudder gain level that is too low will result in understeer giving poor steering performance.

**WARNING: It is most important that the rudder gain is correctly set on planing craft. Incorrect adjustment will lead to poor steering performance and is dangerous at high speeds.**

The settings available are as follows:

Range	1 to 9
Recommended setting	5 (Displacement) 5 (Semi displacement) 4 (Planing) 3 (Stern drive)

### Rate Level

Rate level controls the amount of rudder the pilot will apply to reduce the speed at which the vessel is turning. This is also known as counter rudder, and is only used in response level 3.

The settings available are as follows:

Range	1 to 9
Recommended setting	7 (Displacement) 7 (Semi displacement) 7 (Planing) 5 (Stern drive)

81004-18

### Rudder Offset (Helm Adjust)

Rudder Offset sets the control head to read zero degrees of rudder when the helm is positioned amidships.

The range available is as follows:

Range	-7 to +7 degrees
Default Setting	0

81004-19

### Rudder Limit

Rudder Limit restricts autopilot rudder movement to just less than the steering systems mechanical stops. This avoids putting the steering system under unnecessary load.

The range available is as follows:

Range	15 to 40 degrees
Default setting	30 degrees

81004-20

## Turn Rate

Turn Rate is the rate in degrees per second at which the vessel will turn when course changes are made via the autopilot.

The settings available are as follows:

Range	5 to 20 degrees per second
Default setting	20 degrees (Displacement) 15 degrees (Semi displacement and planing) 8 degrees (Stern drive)

81004-21

Turn Rate limit does not apply in power steer or joystick modes.

## Cruise Speed

Cruise Speed should be set to the vessel's normal cruising speed and is used in track mode.

**Note:** If boat speed is available on either the SeaTalk bus or via the NMEA input this will be taken and used in preference to the Calibration Cruise Speed.

The range available is as follows:

Range	4 to 60 knots
Recommended setting	6 (Displacement) 8 (Semi displacement) 20 (Planing) 20 (Stern drive)

81004-22

## Off Course Limit

Off Course Limit warns you if the autopilot is unable to maintain its set course and has subsequently strayed more than the set limit for more than 20 seconds.

The off course alarm settings available are as follows:

Range	15 to 40 degrees
Default setting	20 degrees

81004-23

## Trim Level

Trim Level sets the level for automatic trim which applies additional rudder to correct for unbalanced propeller torque on twin engine installations, or weather helm.

The Trim Level settings available are as follows (rate of trim increases with trim level):

Range	0 to 4
Default setting	2 (Displacement) 3 (Semi displacement, planing and stern drive)

81004-24

## Joystick Mode (Manual Type)

Power steer selects the Joystick mode of operation: Proportional or 'Bang-Bang'.

Proportional applies rudder in proportion to Joystick movement - the further the Joystick is held over the greater the applied rudder.

Bang-Bang applies continuous rudder drive in the direction of lever movement. To improve control the speed of rudder movement changes with the angle of the lever. For maximum speed push the lever hardover. If the lever is returned to the center position the rudder will remain in its current position.

The settings available are as follows:

Range	0 OFF 1 (Proportional) 2 (Bang-Bang)
Default setting	1

81004-25

## Drive Option

Drive Option sets the type of drive used by your vessel: mechanical with rudder reference or hydraulic with rudder reference.

The settings available are as follows:

Range	1 to 4
Default setting	1 Future use 2 Future use 3 (Displacement and stern drive) 4 (All hydraulic installations)

81004-26

## Rudder Deadband (Rudder Damping)

The factory setting for Rudder Deadband provides stable rudder positioning on most steering systems. However, some steering systems that use a rotary or hydraulic drive unit a long way from the rudder may experience slight instability. This instability can be minimised by increasing the setting.

The settings available are as follows:

Range	1 to 9
Default setting	1

81004-27

## Magnetic Variation

Variation tells other equipment the level of magnetic variation present at the boats current position. Local variation should be entered using the appropriate keys.

The settings available are as follows:

Range	30 degrees West to 30 degrees East
Default setting	Off

81004-28

## Auto Adapt

It may be noticed that the autopilot tends to be a little less stable on northerly headings in higher latitudes of the northern hemisphere and southerly headings in the southern hemisphere. This is caused by the increasing angle of dip of the earth's magnetic field at higher latitudes. This has the effect of amplifying the rudder gain on northerly (southerly) headings, affecting all magnetic compasses and getting worse the further away from the equator you are.

The autopilot is able to compensate for this and provide precise course keeping on all headings by automatically adjusting the gain of the autopilot depending on the heading.

It is recommended that for high speed craft the Auto Adapt facility is selected. This automatically reduces the effects of Northerly/Southerly heading instability.

This feature is selected in calibration by entering the vessel's operating latitude. When selected it automatically adjusts the Rudder Gain depending on heading removing the need for manual adjustment.

**Note:** If Auto Adapt is not selected manual adjustment of rudder gain is normally required when going from Northerly to Southerly headings or vice versa. Failure to do so can lead to poor course keeping.

The settings available are as follows:

---

Range	0: Off 1: North 2: South
Default setting	1: North

---

81004-29

### Latitude

Latitude is used to compensate for Northerly/Southerly headings errors.

The settings available are as follows:

---

Range	0 to 80 degrees
Default setting	0 degrees

---

81004-30

### Wind Trim

Wind trim varies the response of the autopilot in Vane mode.

---

Range	1 -- Fast response 2 -- Slow response
Default setting	1

---

81004-31

### Response Level

This sets the response level when the pilot is switched on.

The settings available are as follows:

---

Range	Level 1: Automatic sea state control Level 2: Automatic sea state inhibit Level 3: Automatic sea state inhibit counter rudder
Default setting	Level 1

---

81004-32



## Auto Release (manual override)

Auto Release provides emergency manual override, should it be necessary, for example, to avoid an obstacle at the last moment. It is used with an Autohelm stern drive actuator. For all other drive systems Auto release should be turned off.

The settings available are as follows:

---

Range	0 = Off 1 = On
-------	-------------------

---

Default setting	N/A (Displacement) N/A (Semi displacement) N/A (Planing) 1 (On) (Stern drive)
-----------------	--

---

81004-33

## 4.4 Saving Calibration Mode

To exit calibration mode and save all changes, press and hold **Track** and **Display** for 2 seconds.

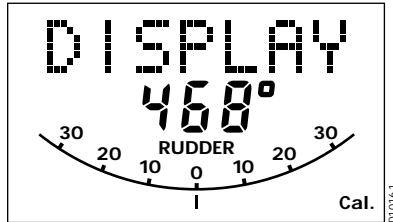
Changes made to calibration settings can, while still in the calibration mode, be cancelled by quitting as follows:

Press **Standby**.

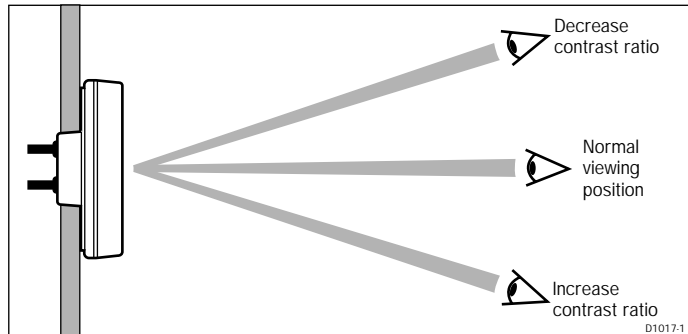
## 4.5 Display Contrast Adjustment (ST7000 only)

The contrast of the LCD display can be adjusted to suit a wide range of viewing angles.

- Press **Display** and **Track** together momentarily.



- Press Response (▲) to increase contrast (suits viewing from below).
- Press Response (▼) to decrease contrast (suits viewing from above).



To store the contrast selection, press **Display** and **Track** together momentarily.

## 4.6 Permanent Watch Alarm (SFIA)

If a permanent watch alarm is required, please contact the Autohelm Product Support Department or an authorised dealer for further information.

## 4.7 Recording Calibration Settings

Having fine tuned the calibration settings during initial sea trials, record them in the following table for future reference.

## Chapter 5: Initial Sea Trials

### 5.1 Initial Sea Trials

Initial sea trials should be carried out in calm conditions with plenty of sea room. As the vessel will be constantly changing heading, it is most important to maintain a constant look out.

Before sea trials:

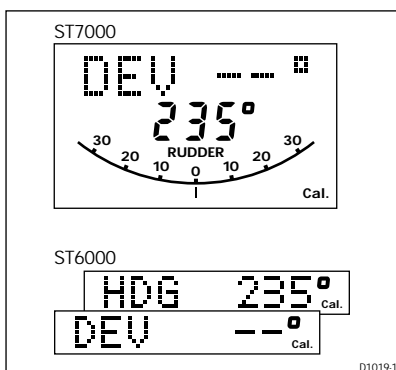
- Read the Operating section of this manual.
- Carry out the system test to verify that the autopilot is operating correctly.

### 5.2 Automatic Compass Heading Alignment and Deviation Correction

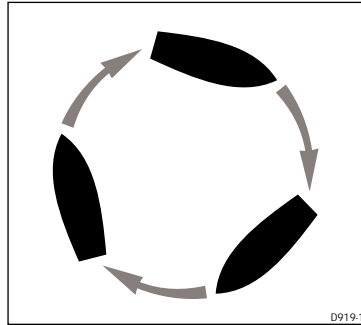
The displayed compass heading requires alignment with the ships compass. Until this procedure is carried out, the autopilot compass display **will not agree** with the ships compass.

The autopilot will correct the fluxgate compass for most deviating magnetic fields. This correction procedure should be carried out in calm conditions preferably in flat water.

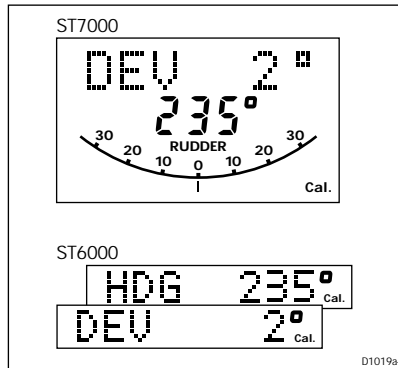
To select compass heading alignment and correction, push and hold **STANDBY** for 2 seconds until the display shows:



1. Press **DISPLAY**
2. Keeping boat speed below 2 knots, turn the vessel slowly so that it takes at least 3 minutes to complete 360 degrees.



Keep turning until the display changes to show the amount of deviation the autopilot has corrected. This can take up to 2 full turns depending on the amount of deviation found.



**Note:** If the deviation exceeds 15 degrees, you should relocate the fluxgate compass.

3. Steady the boat up on one heading and use the course change keys to adjust the displayed heading until it agrees with the steering compass or a known transit bearing.
4. To exit fluxgate alignment/correction and store the settings, push and hold STANDBY for 2 seconds until the pilot returns to 'STANDBY' mode.
5. To exit fluxgate alignment/correction without saving any new settings, push STANDBY momentarily.

### 5.3 Compass Alignment (without deviation correction)

It is possible to change the alignment between the fluxgate and the ship's compass without carrying out the automatic deviation correction. Proceed as follows:

1. Push and hold **STANDBY** for 2 seconds to select fluxgate alignment/correction mode.
2. Use the course change keys to adjust the heading displayed.
3. To exit fluxgate alignment/correction and **store** the new setting push and hold **STANDBY** for 2 seconds until the pilot returns to 'STANDBY' mode.
4. To exit fluxgate linearisation **without saving** the new setting push **STANDBY** momentarily.

### 5.4 First Sea Trials

In clear waters, steer the boat on to the required heading.

1. Hold the course steady for 5 to 10 seconds.
2. Press **AUTO** to lock onto the current heading. In calm conditions a perfectly constant heading will be maintained.
3. Alter course to port and starboard using the course change keys on any control unit. Course changes should be prompt and without any sign of overshooting.
4. Press **STANDBY** to disengage the autopilot for return to hand steering.

## 5.5 Response Control

There are three response levels to provide tighter than normal course keeping when there is restricted sea room. Select each level in turn and observe the autopilot activity.

### Level 1 - Automatic Sea State Control

- This provides the optimum compromise between power consumption and course keeping accuracy and is suitable for most situations.

The automatic sea state control can be observed during the sea trial.

- When the autopilot is initially engaged in Auto mode it will respond to all pitch and roll movements.
- During the first minute of operation, it will be noticed that repetitive movements of the vessel are gradually neglected until finally the autopilot will respond only to true variations in course.
- To ensure precise course adjustments the sea state control is automatically reset whenever the course change knob is adjusted.

### Level 2 - Automatic Sea State Inhibit

- Where increased course keeping accuracy is required the automatic sea state control can be inhibited by moving to response level 2.
- Autopilot activity and therefore power consumption will be increased.

### Level 3 - Automatic Sea State Inhibit and counter rudder

- Where maximum course keeping accuracy is required a Rate Gyro transducer should be fitted. This introduces counter rudder (rate) to increase the natural damping of the vessel. On power craft level 3 is useful at slow speed where the natural damping of the vessel is reduced. Autopilot activity and therefore power consumption will be at a maximum.

The minimum response level necessary to achieve the desired course keeping should be used to reduce power consumption and autopilot wear and tear.

## 5.6 Automatic Trim Control

The autopilot automatically corrects for trim. No adjustment of the pilot is necessary.

After each course change the automatic trim is cancelled and the autopilot will re-establish the correct trim for the new heading. It should be noted that if a large course change is keyed in (greater than 60 degrees) the autopilot will not assume the final selected course immediately. The vessel will come to within say 10 degrees of the desired course and will only settle onto course when the automatic trim has been fully established. This may take up to two minutes.

It is recommended the following procedure is adopted for large course changes:

- Note required heading
- Select **STANDBY** and steer manually
- Bring vessel onto new heading
- Select **AUTO** and let vessel settle onto course
- Bring to final course with 1 degree course change increments

It is sound seamanship to make major course changes only whilst steering manually. In this way any obstructions or other vessels may be cleared properly and due account taken of the changed wind and sea conditions on the new heading prior to engaging the autopilot.

Note: If the autopilot trim control is switched off, regular checks on the vessel's heading should be made as changes in standing helm will change the course steered by the autopilot.

## 5.7 Rudder Gain Adjustment (Displacement Craft)

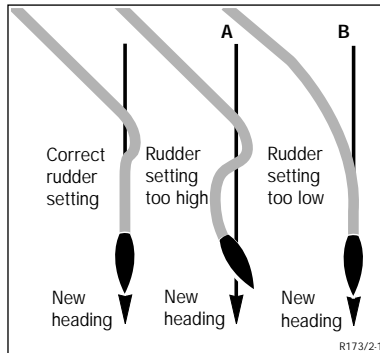
The factory set rudder gain level provides stable control for initial sea trials. However, vessels can vary widely in their response to the helm, and further adjustment to the rudder gain may improve the autopilot's steering characteristics. Rudder gain should be set in Response level 1.

An excessively high rudder control setting will result in oversteer, which can be recognized by the vessel swinging from side to side of the automatic heading, accompanied by excessive rudder movement. In addition, distinct overshoot will be observed when the course is changed. This condition can be corrected by reducing the rudder setting.

Similarly, an insufficient rudder control setting results in understeer which gives sluggish steering performance and is particularly apparent when changing course. This is corrected by increasing the rudder setting. These tendencies are most easily recognized in calm sea conditions where wave action does not mask basic steering performance.

Typically, if at cruising speed a course change of 40 degrees results in an overshoot of between 2 - 5 degrees, the rudder gain is correctly adjusted.

Push either **RESPONSE** key for access to Rudder Gain. Adjust either side of the calibrated setting to provide optimum autopilot steering.



**Note:** Once the optimum setting has been found, the default calibration setting for rudder gain should be changed.

### Adjustment with Response Level 3

Response level 3, by default, automatically sets the gain to 3 settings above the gain at response level 1. This can be adjusted as follows:

Select response level 3 and then scroll to the gain display. Adjust the value as required and save the new value by pressing the up and down response keys together momentarily.



## 5.8 Rudder Gain Adjustment (High Speed Planning Craft)

**Warning: It is particularly important that the Rudder Gain is correctly set on high speed craft. Incorrect adjustment will lead to poor steering performance and is a dangerous condition at high speed.**

Adjust as follows:

- Set to Rudder Gain for optimum steering performance at the vessels normal cruising speed.
- Push either **RESPONSE** key for access to Rudder Gain. Adjust either side of the calibrated setting to provide optimum autopilot steering.

## 5.9 Rudder Gain - Adjustment with Speed

Due to the significant differences in dynamic stability between planing and non-planing conditions, most high speed craft require Rudder Gain adjustment when going from planing to displacement speeds or vice versa. The required adjustment can be achieved automatically or manually.

- When the autopilot is used with the speed input from an Autohelm SeaTalk Speed instrument or is receiving boat speed via its NMEA input. Rudder gain is automatically adjusted with boat speed. After setting the gain at planing speed no further manual adjustment should be required.

**Warning: When speed information is fed to the autopilot via the NMEA input always check the displayed speed is close to the actual boat speed before locking the autopilot onto a heading. Delays in data transmission could result in the 'pilot' applying too much rudder after a large change in vessel speed.**

- If no Speed input or NMEA is available manual adjustment should be carried out to the Rudder Gain setting via the Response keys adjusting as follows:
  1. Speed decreases from planing to displacement
    - Increase gain by 1 or 2 levels.
  2. Speed increases from displacement to planing
    - Decrease gain by 1 or 2 levels.

**Warning: The manual gain adjustment must be made after reducing from planing to displacement speed and before increasing from displacement to planing speed.**

## 5.10 Manual Override (Stern Drive Actuators only)

Manual override should be selected in calibration only on installations fitted with the stern drive actuator. When it has been selected, the autopilot can be overridden to allow hand steering by turning the steering wheel. This will return the autopilot to Standby and sound the control unit buzzer for 10 seconds. There is a slight delay before the autopilot will return to Standby.

**CAUTION: Excessive force is not required and will not reduce this delay.**

With the autopilot in Auto and clear of obstruction, turn the steering wheel to observe the manual override. Repeat two or three times until you are confident with its operation.

The manual override is intended for emergency use only. The autopilot should normally be disengaged by pushing the **STANDBY** button on the control unit.

## Chapter 6: Track Control

Track control allows the autopilot to maintain track between waypoints entered on a GPS, Decca or Loran Navigation System. The navigation system must have a suitable autopilot NMEA output (refer to section 2.13).

If the navigation system transmits the correct NMEA 0183 sentences, the autopilot will receive and display bearing to waypoint, distance to waypoint, waypoint number and cross track error.

If it transmits NMEA 0180 only crosstrack error will be displayed.

Before attempting sea trials, make sure that the control unit is receiving navigation data by using the **Display** key to bring it up on the control unit LCD.

**Note:** If data is not being received it is impossible to select Track Mode.



## **Chapter 7: Windvane Control (Sail Only)**

Windvane control allows the autopilot to maintain an apparent wind angle. There are two methods of supplying wind angle:

1. Using NMEA 0183 output from another manufacturer's instrument system.
2. Using an Autohelm ST50 wind instrument connected using the SeaTalk bus.

The autopilot uses wind trim to eliminate the effects of turbulence and short term wind variations to provide smooth, precise performance under windvane with minimum power consumption. Wind trim uses the fluxgate compass as the primary heading reference, and as changes in the apparent wind angle occur, the compass heading is adjusted to maintain the original apparent wind angle.



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