Owners Manual
727 Autopilot

Cetrek™

AutoPilots

INDEX

WARNINGS

A. ALL EXPOSED MOVING PARTS RELATING TO THE STEERING GEAR AND AUTOPILOT MUST BE SUFFICIENTLY GUARDED TO PREVENT ACCIDENTAL CATCHING OF EXTREMITIES AND/OR CLOTHING.

B. THE USE OF AN AUTOPILOT DOS NOT AVOID THE NEED FOR NORMAL WATCH-KEEPING.

C. INCORRECT WIRING UP (E.G. POLARITY REVERSAL) CAN CAUSE IRREPARABLE DAMAGE TO SOME EQUIPMENT AND IS NOT COVERED BY THE CETREK WARRANTY AGREEMENT. PLEASE CHECK ALL CONNECTIONS CAREFULLY BEFORE SWITCHING ON.

CETREK LIMITED has prepared this manual for use by CETREK personnel and distributors as a guide to the proper installation, operation and maintenance of CETREK LIMITED equipment.

CETREK LIMITED reserves the right to make changes without notice in the specifications and materials contained herein and shall not be responsible for any damages (including consequential) caused by reliance on the materials presented including but not limited to typographical errors, company policy and pricing information.

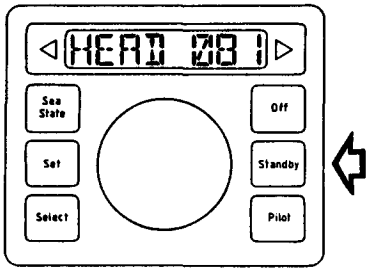
N.B. CETREK LIMITED is a subsidiary of MARINEX INDUSTRIES LIMITED.

PILOT OPERATION

A. COMPASS CONTROL

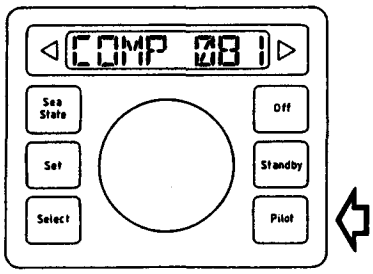
(a) To engage on vessel's heading (Autofollowing)

1. To Turn Pilot On:
   Press 'Standby'.



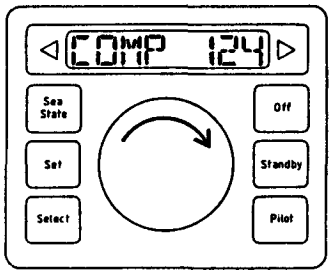
Pilot will self-test; Display indicates heading (if error code see fault section page 22).

2. To Engage Drive:
   Press 'Pilot'.



Vessel under pilot cont 'Comp' indicates compass control. Both red and green LEDs on indicate on course.

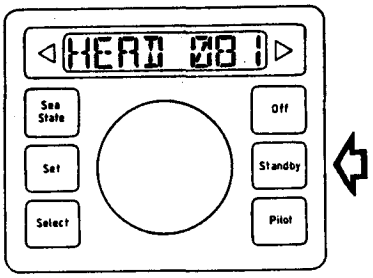
3. To Change Course:
   Rotate Course Selector.



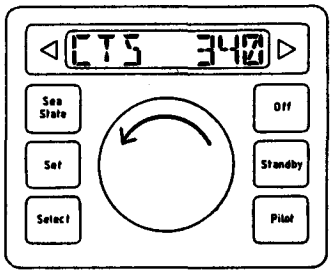
Display indicates course selected; vessel turns on to new course; both red and green LEDs on indicate on course.

(b) To preselect course (Course Select)

1. To Turn Pilot On:
   Press 'Standby'.

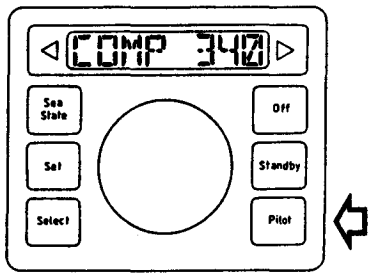


2. To Preselect Course:
   Rotate Course Selector.



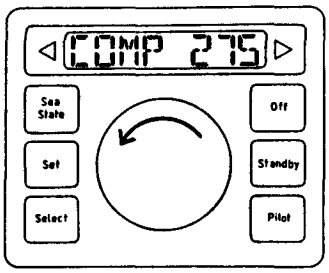
Pilot displays course selected (CTS = Course To Steer).

3. To Engage Pilot:
Press 'Pilot'.



Vessel under pilot control. 'Comp' indicates compass control. Both red & green LEDs on indicates on course.

4. To Change Course:
Rotate Course Selector.

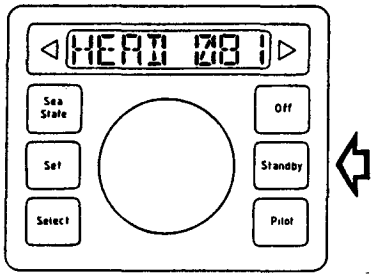


Display indicates course selected; vessel turns on to new course. Red & green LEDs on indicate on course.

B. WINDVANE CONTROL

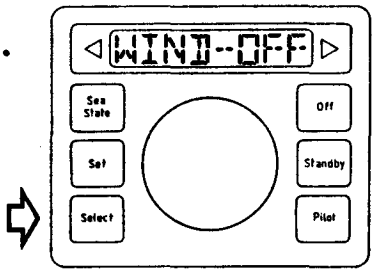
(a) With Pilot off

1. To Turn Pilot On:
Press 'Standby'.

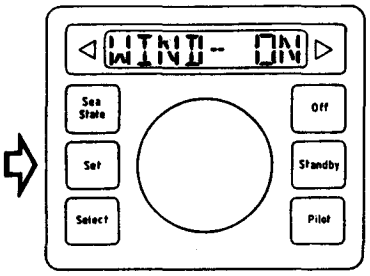


Pilot will self-test. Display indicates heading (if error code see fault section page 22).

2. To Select Windvane Control:
Press 'Select' twice.

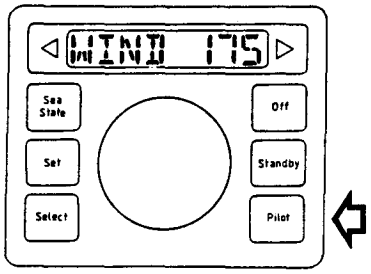


Press 'Set'.



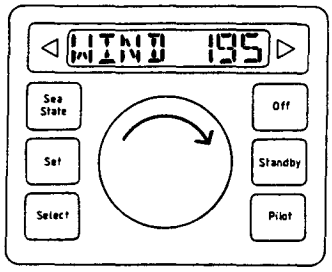
Windvane Control selected.

3. To Engage Pilot:
Steer vessel on required heading.
Press 'Pilot'.



Wind indicates vessel under Windvane Control. Display indicates compass heading. Red & green LEDs on indicate vessel on course.

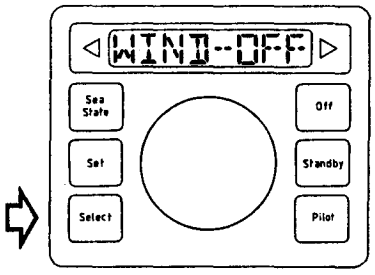
4. To Change Course:
Rotate Course Selector.



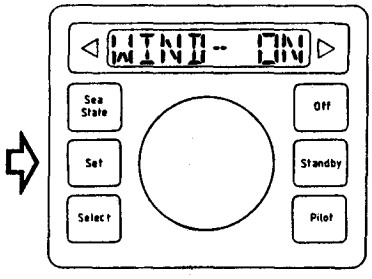
Vessel turns on to new heading. Red & green LEDs on indicate vessel on course.

(b) With Pilot in drive

1. To Select Windvane Control:
Press 'Select' twice.

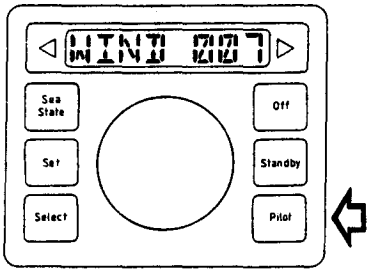


Press 'Set'.



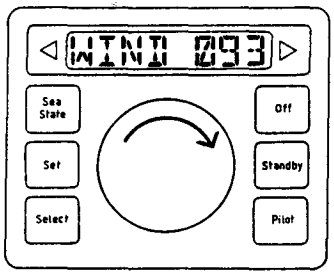
Windvane control selected. Vessel under windvane control. Red & green LEDs on indicate vessel on course.

2. To Display Heading:
Press 'Pilot'.



Heading displayed.

3. To Change Course:
Rotate Course Selector.



Display indicates course selected. Vessel turns on to new course. Red & green LEDs on indicates vessel course.

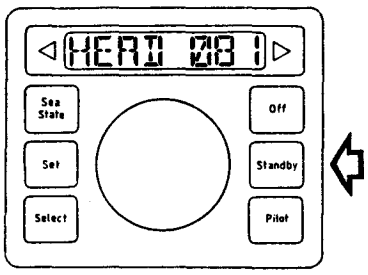
C. NAVIGATOR CONTROL

See Principles of Navigator Control (Page 24)

(a) For Navigators with NMEA 0180

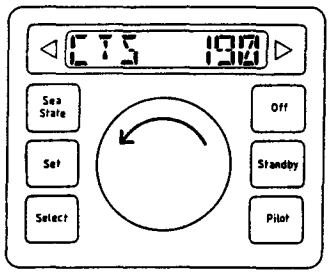
Programme Navigator with required waypoints. Select display on navigator to show course to next waypoint.

1. To Turn Pilot On:
   Press 'Standby'.



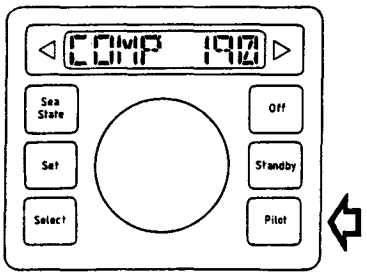
Pilot will self-test
Display indicates heading
(if error code, see fault section page 22).

2. To Select Required Course:
   Rotate Course Selector to course indicated on Navigator.



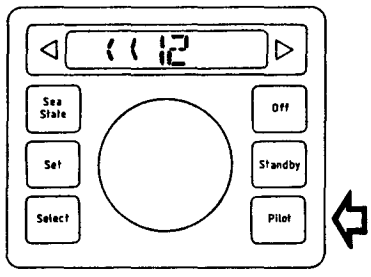
Display indicates course selected.

3. To Engage Pilot:
   Press 'Pilot'.



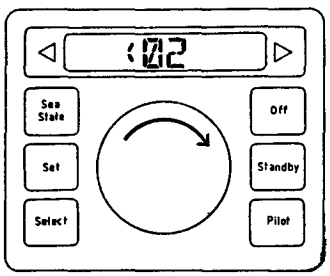
Vessel will turn on to course. Both red and green LEDs on indicates on course.

4. To Check Cross Track error:
   Press 'Pilot' twice.

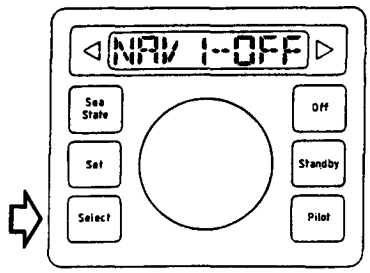


Displays cross track error in hundreth of mile.

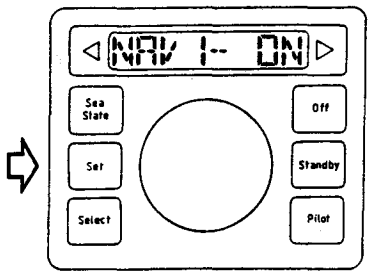
If Cross Track greater than 04, reduce by steering vessel using rotary course control.
Return vessel to approximate heading to way point.



5. To Engage Navigator Control:
Press 'Select' three times to select Nav 1 or four times to select Nav 2.

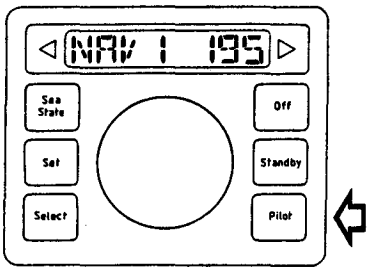


Press 'Set'.



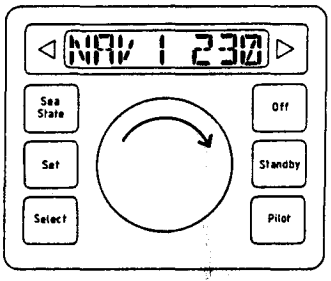
Vessel under Navigator control. Red & green LEDs on indicate vessel on required heading.

Press 'Pilot'.



Pilot displays vessel's heading.

6. To Select Next Waypoint:
When first waypoint reached, observe course to next waypoint. Rotate Course Selector to course required.

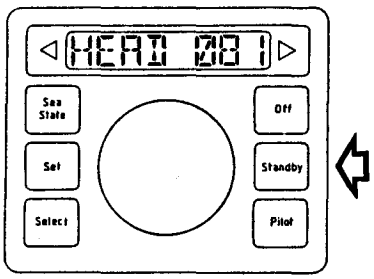


Vessel turns on to new course.

(b) <u>For Navigators with NMEA 0182 or 0183 with no output of waypoint number</u>

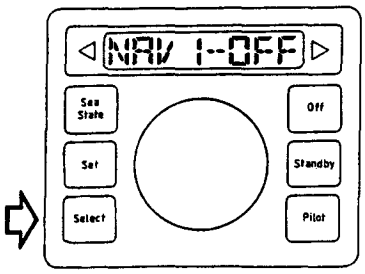
Programme Navigator with required waypoints.

1. To Turn Pilot On:
Press 'Standby'.

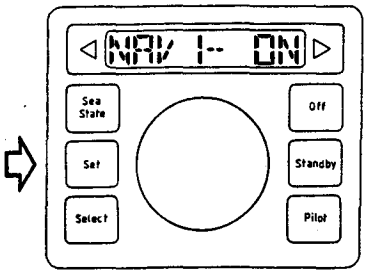


Pilot will self-test. Display indicates heading (if error code see fault section page 22).

2. To Select Navigator Control:
Press 'Select' three times for Nav 1
four times for Nav 2.

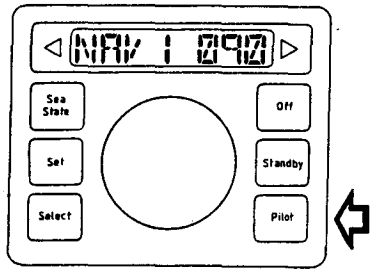


Press 'Set'.



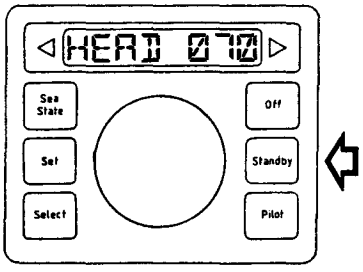
Navigator control selected.

3. To Engage Pilot:
Press 'Pilot'.

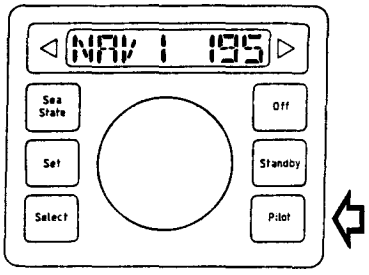


Vessel will turn on to course, pilot under navigator control.
Note: it is recommended that the vessel's heading should be within 30° of course before engaging drive.

4. To Select Next Waypoint:
When next waypoint selected, press 'Standby'.



Press 'Pilot'.

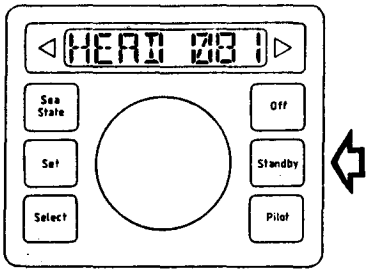


Vessel turns on to new course.

(c) <u>For Navigators with NMEA 0183 with waypoint number output</u>

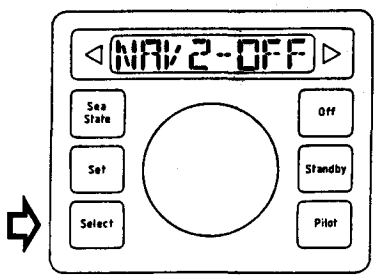
Programme Navigator with required waypoints.

1. To Turn Pilot On:
Press 'Standby'.

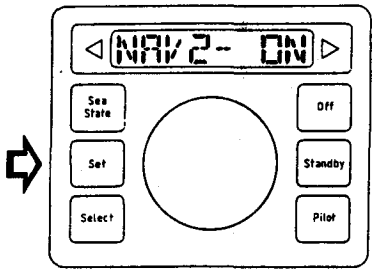


Pilot will self-test.
Display indicates heading (if error code see fault section page 22).

2. To Select Navigator Control:
Press Select three times for Nav 1 or four times for Nav 2.

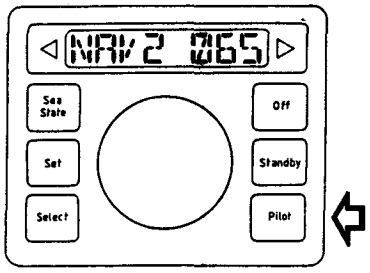


Press 'Set'.



Navigator Control selected.

3. To Engage Pilot:
Press 'Pilot'.



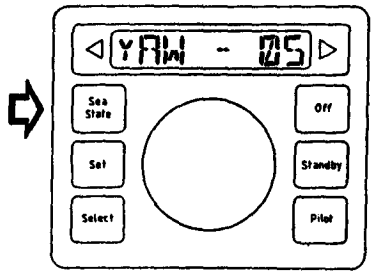
Vessel will turn on to course under Navigator Control. Note: it is recommended that the vessel heading should be within 30^{o} of course before engaging drive.

NOTE: Vessel will automatically turn to next waypoint on reaching waypoint.

D. SEASTATE CONTROLS

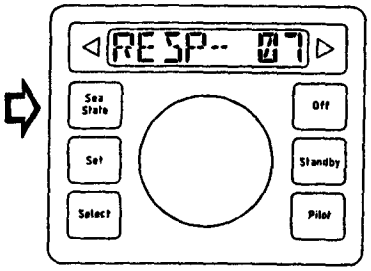
(a) To Select Sea State Adjustments

Press 'Sea State' once for yaw.



Yaw (Rudder Ratio) selected.

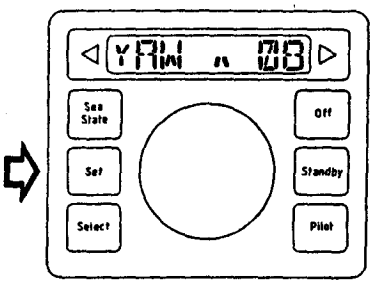
Press 'Sea State' again for response.



Response (Deadband) selected.

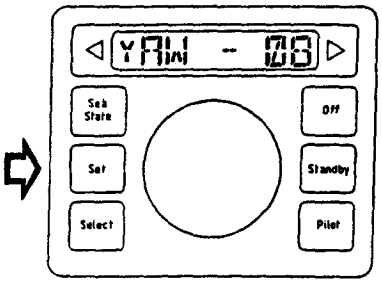
(b) To change Sea State settings

Press 'Set' once.



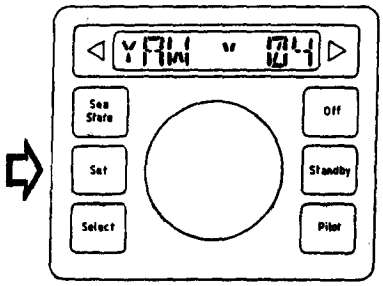
Setting increases.

Press 'Set' again.



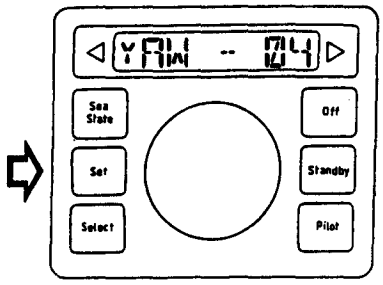
Setting stopped.

Press 'Set' again.



Setting decreased.

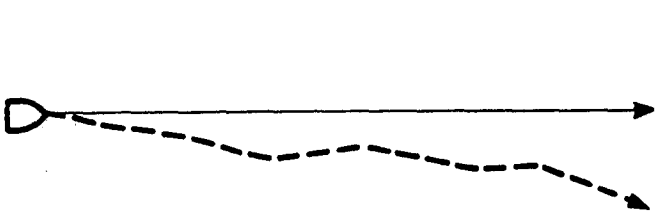
Press 'Set' again.



Setting stopped.

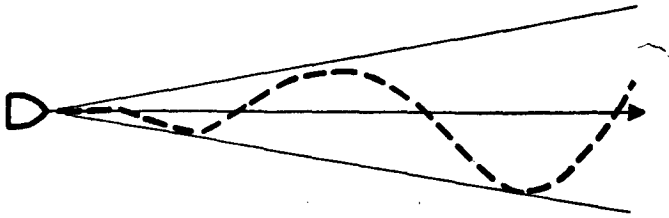
(c) Adjustments

YAW



BOAT UNDERSTEERING
Vessel repeatedly drifts off course to one side and is only loosely controlled by pilot.

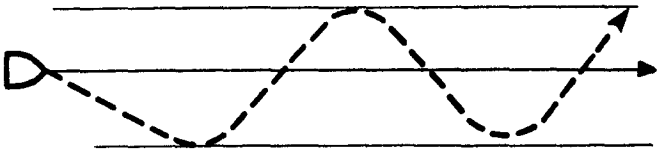
REMEDY: Increase yaw setting.



BOAT OVERSTEERING
Vessel builds up oscillations from side to side of required course.

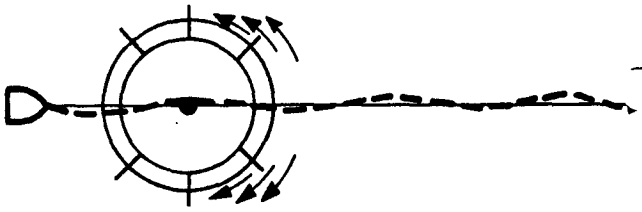
REMEDY: Decrease yaw setting.

RESPONSE



Boat wanders over course
Vessel moves over a wide deadband.

REMEDY: Decrease response setting.



Excessive helm movements
Vessel holds course but helm switches rapidly back and forwards.

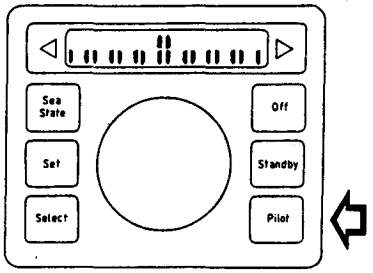
REMEDY: Increase response setting.

This is the pilot's "weather" control. You will need to open the "deadband" (i.e. increase) in heavy seas, and close it (i.e. decrease) in calm seas. N.B. Proper setting of this control has a marked effect on steering system wear and tear and in sailing craft also upon battery life. Aim to set this control so that the autopilot-controlled helm movements are of roughly the same frequency and magnitude as those performed by hand when steering manually.

E. TO DISPLAY RUDDER POSITION

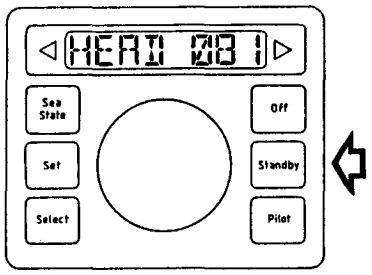
(a) With pilot in standby

Press 'Standby'.



Rudder position indicated.

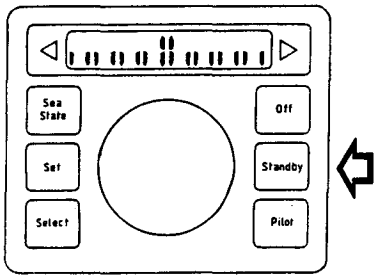
Press 'Standby'.
Note: if pilot in navigator mode, press twice.



Display returns to heading.

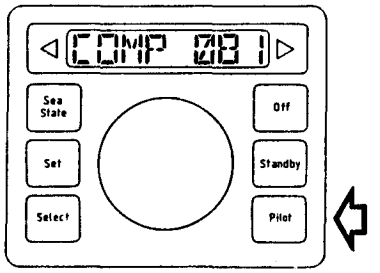
(b) With pilot in drive

Press 'Pilot'.



Rudder position indicated.

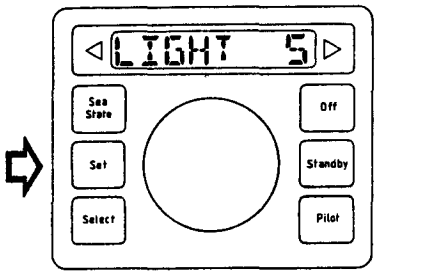
Press 'Pilot'.
Note: if pilot in navigator mode, press twice.



Display returns to heading.

F. TO ADJUST LIGHTING LEVEL

With standby or pilot selected, repeatedly press 'Set'.



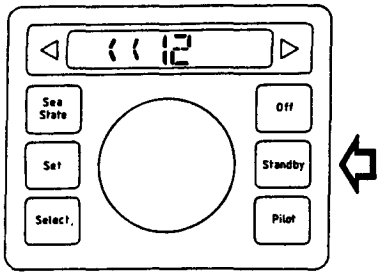
Light level increases from 0 - 7 then decreases from 7 - 0.

G. TO DISPLAY CROSS TRACK ERROR

Pilot will only display cross track error if pilot in navigator mode.

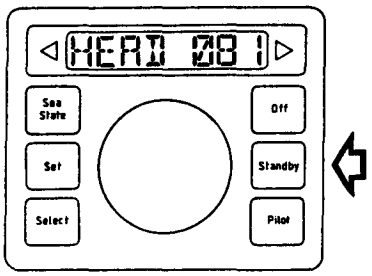
(a) With pilot in standby

Press 'Standby' twice.



Cross track displayed.

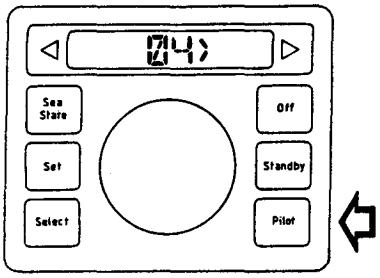
Press 'Standby'.



Vessel's heading displayed.

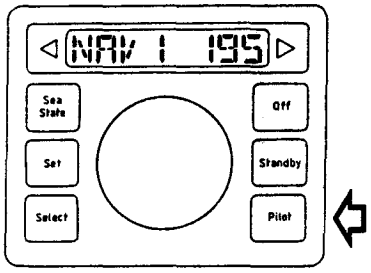
(b) With pilot in drive

Press 'Pilot' twice.



Cross track displayed.

Press 'Pilot'.



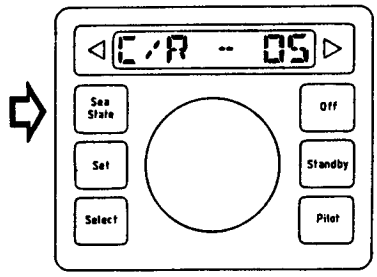
Vessel's heading displayed.

INSTALLATION ADJUSTMENTS

A. PILOT ADJUSTMENTS

(a) To access installation adjustments

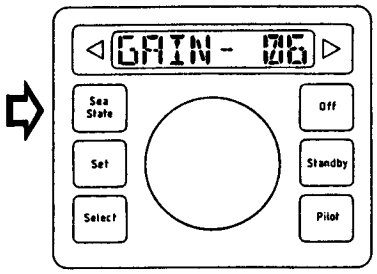
Hold 'Sea State' until C/R displayed (approx 3 seconds).



Installation adjustments available.

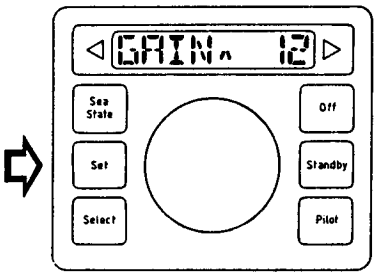
(b) To display adjustments

Press 'Sea State' to select required adjustment.



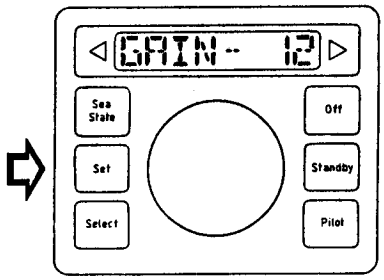
(c) To adjust setting

Press 'Set'.



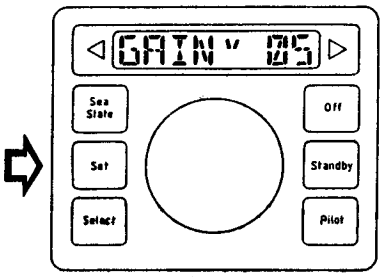
Setting increases.

Press 'Set'.



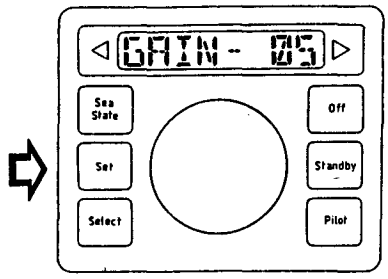
Adjustment stops.

Press 'Set'.



Setting decreases.

Press 'Set'.



Adjustment stops.

WARNING: PILOT DATA WILL NOT BE STORED UNLESS PILOT IS TURNED OFF FROM 727 'OFF KEY.

(d) Displays

See Pre-Trial Checks and Sea Trials (page 37) for actual adjustments.

DISPLAY	DESCRIPTION	EFFECT	RANGE
C/R	Counter rudder	Rudder movement against rate of change of course.	00-20
TRIM	Trim	Sets rate at which standing helm is reduced.	00-20
GAIN	Yaw gain	Adjusts the gain of the Sea State 'Yaw' adjustments.	01-10
RDB	Rudder Deadband	Sets minimum rudder displacement from required position. (Range 0^{o} to 2^{o})	00-20
RLIM	Rudder Limit	Sets maximum rudder limits. (Range 3^{o} to 30^{o})	01-10
DAMP	Compass damping	Damps the input received from heading sensor.	01-10
PSG1 PSG2	Power steer Gain 1 and 2	Adjusts the sensitivity of power steer units fitted to inputs 1 or 2.	01-10
CONFIG	Configuration	Selects preset pilot adjustments for planing, semi-displacement and displacement craft.	N/A
AUTO-DEV	Automatic Deviation	To access the auto-deviation correction procedure for heading sensor.	N/A

(e) To select preset pilot adjustments

The pilot is programmed to enable the Installation Adjustments and Sea State settings to be preset for Planing, Semi Displacement or Displacement craft. These settings can be preselected as below. In addition there is also a 'Restore' function which allows the settings to be returned to those existing when the pilot was previously turned off. The restore function is useful when, having tried various adjustments resulting in deterioration of pilot performance, it is wished to return to previous settings.

The preset levels are:-

Planing

Yaw	05
Response	01
Counter rudder	02
Trim	04
Gain	01
Rudder Deadband	02
Rudder Limit	10
Damp	01
Power Steer Gain	05

Semi Displacement

Yaw	08
Response	01
Counter rudder	04
Trim	04
Gain	01
Rudder Deadband	02
Rudder Limit	10
Damp	01
Power Steer Gain	05

Displacement

Yaw	10
Response	01
Counter rudder	08
Trim	04
Gain	01
Rudder Deadband	02
Rudder Limit	10
Damp	01
Power Steer Gain	05

To select preset pilot adjustments:-

	ACTION	DISPLAY
1.	Press 'Standby' if pilot in drive.	HEAD--00
2.	Select configuration (see page 16).	CONFIG
3.	Press 'Set'.	PLAN - OFF
	If vessel planing craft press 'Set'. Planing presets selected.	PLAN - ON

4.	Press 'Sea State'.	SEMI - OFF
	If vessel semi displacement craft press 'Set'. Semi displacement presets selected.	SEMI - ON
5.	Press 'Sea State'.	DISP - OFF
	If vessel displacement craft press 'Set'. Displacement presets selected.	DISP ON
6.	Press 'Sea State'.	RESTORE
	If it is required to select preset adjustments existing when pilot last switched on press 'Set'.	

B. AUTOMATIC DEVIATION CORRECTION

The automatic deviation correction procedure enables deviation coefficients 'B' and 'C' to be calculated automatically, based on a Starboard turn of 360° at constant rate of turn.

To operate, select AUTO-DEV (page 17). If compass has been previously corrected automatically or manually through sensor keyboard, CORRECT will be displayed. In order to proceed with calibration, clear correction by pressing 'Set' twice when the display will indicate CLEAR. If system has not been calibrated previously, it will automatically display CLEAR.

The actual correction routine starts when the vessel passes North and continues through 360°. A smooth turn should be carried out lasting between one and two minutes. With twin engine craft, spin the boat using the engine controls. With single engine craft, fix wheel or tiller in position and adjust engine speed to give a circle approximately 50 metres in diameter at a speed of 5 knots. Allow the vessel to make at least one complete turn before commencing calibration. This ensures the vessel is being turned at constant speed.

Maintaining a constant turn rate is essential for good results (constant helm and engine speed) as are reasonably calm conditions. Tide will not affect the results, but excessive wind or swell can cause large errors.

When the vessel is settled on course and is between West and North, press 'Set' twice. Display will indicate INIT'D. When the vessel passes north display changes to live digital heading and RUNNING indication is lit. On completion of circle, if unit accepts measurements for correction CORRECT is displayed. Errors in measurement are indicated by an error code on the digital display, which can be cleared by pressing 'Set' key. To repeat calibration, repeat as above.

ERROR CODE

1 Not between 180° and 359° at start of calibration.

2 Turn rate of vessel too slow

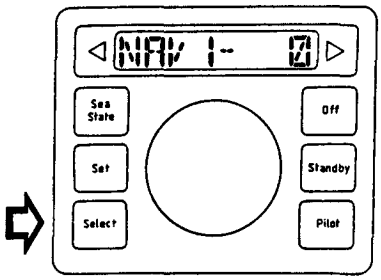
3 Turn rate of vessel too fast

4 Deviation too large for correction

C. NAVIGATOR/WIND INSTALLATION ADJUSTMENTS

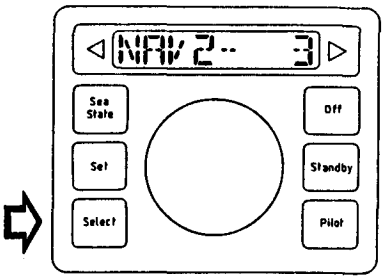
(a) To access navigator/ wind adjustments

Hold 'Select' until Nav 1 appears (approx 3 secs).



Navigator/wind adjustments selected.

Press 'Select' to page through adjustments.



To set adjustments, set as per Installation Adjustments (page 16) using 'Set' key.

(b) Displays

DISPLAY	FUNCTION	SETTINGS
NAV1-- 0	Select input data format for navigator input 1	NAV1-- 0 (NMEA 0180) NAV1-- 1 (NMEA 0182) NAV1-- 2 (NMEA 0183A) NAV1-- 3 (NMEA 0183B)
NAV2-- 0	As NAV1 for input 2.	
WIND-- 0	Select digital or analogue wind input	WIND-- 0 (Digital) WIND-- 1 (Analogue)
NMG1--01	To set gain for navigator 1 input	01-10
NMG2--01	To set gain for navigator 2 input	01-10
VAR--W00	To set local variation to give true compass heading	W45-W00-E45
XALM-OFF	To disable external alarm	ON-OFF

(c) Adjustments

1. Select NAV1-- 0.
   Set for data format received from navigator.

2. If second navigator fitted, select NAV2-- 0.
   Set for data format received from navigator.

3. If windvane connected, select WIND-- 0.
   Set for digital or analogue data.

4. Navigator gains NMG1--01 and NMG2--01 should be set during sea trials.
   If the navigator gain control is set too high, the vessel when under navigator control will make large step corrections to return vessel to track. The gain of the navigator should be set as high as possible without this effect being induced.

5. If navigator is outputting NMEA 0182 or 0183, select VAR--W00 and enter local variation. This ensures vessel turns to correct heading when selecting next waypoint.

D. POWER STEER GAIN ADJUSTMENTS

When 930 716 or 930 717 remote power steer units are fitted, the power steer gain adjustment allows the sensitivity of the steering to be adjusted (see Pilot Installation Adjustment page 16). It is suggested that initial trials are carried out with the power steer gain set at 05 (this is the level selected by the preset pilot adjustments page 18) and then increase or decrease sensitivity as required.

E. ALARM AND FAULT DISPLAYS

Certain alarms are indicated as follows:-

DISPLAY	FAULT	ACTION
BATT ALM	Low battery voltage	To clear alarm press any key except 'Set' or 'Off'. Check ship's battery charger system.
PWR FAIL	Intermittent power disconnection	To clear alarm press any key except 'Set' or 'Off'. Note: data changes to pilot memory since pilot last keyed 'Off' could be erased.
NAV DATA	Navigator Alarm Condition	Switch off pilot. Navigator control can only be resumed when alarm condition removed.
NAV READ	Incorrect Navigator Message	To clear alarm press any key except 'Set' or 'Off'. (Will not affect pilot operation.)
NAV OVFL	Data Overflow	To clear alarm press any key except 'Set' or 'Off'. (Will not affect pilot operation.)

Certain system faults are indicated on the 930 727 keyboard and an audible alarm activated. If system faults are displayed:-

(a) Press any key except 'Off' or 'Set'. This can clear the fault condition if it is only a temporary fault. If this fails to clear, proceed to (b).
(b) Press 'Set'. A "help" message will be displayed indicating the action to be taken.

The system faults are indicated by numbers indicated below. Faults with a number greater than 128 will result in the pilot being switched automatically to 'Standby'

	DISPLAY	FAULT
	SFLT 002	Back-up memory fault
→	032	Timeout for port read ←
*	033	Console fault. No RTS on asigned port.
*	034	Console fault. No valid data received.
@	035	Attempt to reconfigure while in drive.
	036	Compass message fault; bad format.
	037	Compass message fault; status word error.
	064	Internal malfunction.
	065	Message over run of port input buffer.
	066	Port message checksum error.
	128	Ram memory error.
	129	Eprom checksum error.
	160	Compass timeout.
	161	Timeout. No message received. Start up.
	162	Bad message after 10 trys.
	163	Command length error.
	164	Compass error. No RTS.
	165	Compass error. No valid data.
	192	Internal malfunction.
	193	ADC timeout for rudder reference.
	195	Internal fault. Failure to engage FW for MS read.
	196	ADC clock overrun error. Clock elapsed before ADC read complete.
	197	Ghost rudder requested on a spool valve system.

* This error occurs when one 930 727 keyboard in a multi-keyboard installation fails. It can be temporarily cleared by disconnecting the faulty keyboard.
@ This error occurs if one tries to reset the Configuration presets whilst the pilot is in drive. This action can only be carried out with the pilot in 'Standby'.

PRINCIPLES OF NAVIGATOR CONTROL

Problem
Between #27 + G12 but dist control box Cabling
not receiving

Principles of Navigator Control

The autopilot can be controlled with data received from a radio navigator (Sat Nav, Loran or Decca) which has a compatible output. The marine industry has generally adopted the data output formats as specified by the National Marine Electronics Association of North America (NMEA). There are three data formats in common use for autopilot control:-

NMEA 0180
NMEA 0182
NMEA 0183

The data format available from your navigator will affect the method in which your 727 autopilot can be operated with your navigator. In order for the navigator to output the required information, it first has to be programmed with your required destination or waypoints. The basic information used for autopilot control is:-

1. Cross track error. This is expressed in units of one hundreth of a nautical mile (60 feet) and whether the error is to port or starboard of track.

2. Alarm condition. This indicates if information received from the navigator is valid.

3. Heading to next waypoint.

4. Next Waypoint Number.

The data available for your set depends on the data format.

	0180	0182	0183
Cross Track Error	X	X	X
Alarm Condition	X	X	X
Heading to Waypoint		X	X
Waypoint No.			X

Note: Some implementations of 0183 do not output Waypoint number or Heading to Waypoin (see section headed NMEA 0183 Message Formats).

In order to get full use of the interface facility from your equipment, it is imp n to understand the principles of control used. It would of course be very simple to us the heading to the next waypoint calculated by the navigator. However, this would be dangerous method to use when in the proximity of land as a stray tidal offset could pu the vessel in a position when it will run aground (see drawing opposite).

The use of the Cross Track Error to control autopilot heading enables the vessel to be held on track to the reset waypoint. The autopilot is actually controlled by the autopilot's own compass outputs and the Cross Track error information is used to calculate the Trim (change of compass heading) required to keep your craft on track.

When the waypoint is reached (provided the navigator is programmed for the next waypoint) Cross Track Error would not be sufficient information to turn the vessel on to the next track. To do this it is necessary for the navigator to output the heading to the next waypoint and indicate that a new waypoint has been selected. Because of this, the operation, when waypoints are reached, will depend on the type of data received from your navigator.

NMEA 0180

Unless there is only a small (say 15° or less) change in required track, it is necessary to turn vessel to the new track using the course select control or by placing pilot in standby mode and manually steering to the new track.

NMEA 0182

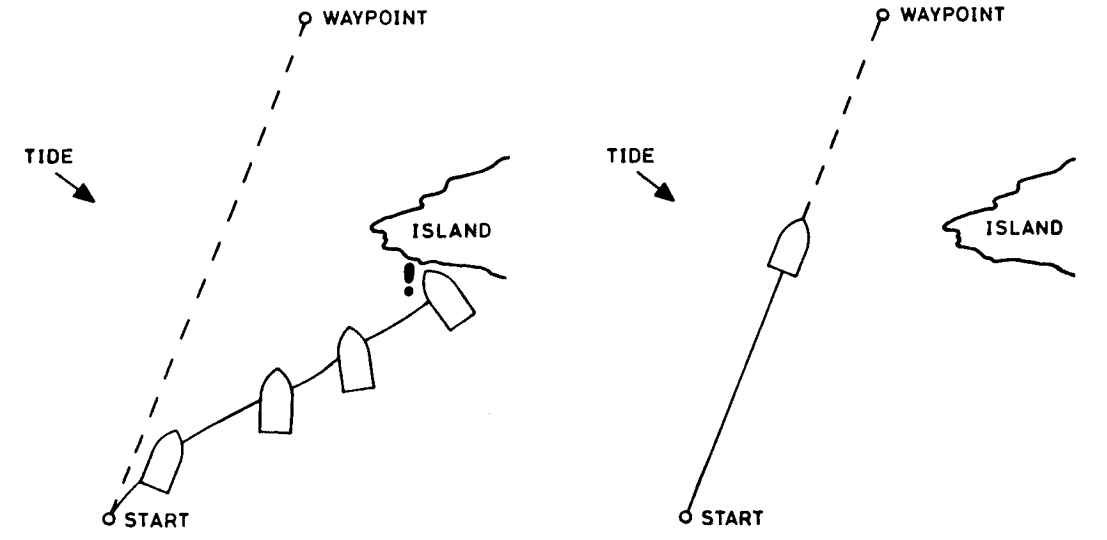
This data will indicate the new heading required but does not indicate that a new waypoint has been selected. Simply place pilot in standby and return to drive immediately. The craft will then turn on to the new track and proceed to next waypoint.

NMEA 0183

Most 0183 data outputs have all the information required for the craft to turn automatically on to the next track without any action on your part. If your craft does not do this, check with the supplier of your navigator to see if the data contains one of the sentences containing Heading to Waypoint and Waypoint Number. If not, operate as described under NMEA 0180 or 0182 depending on data available..

In the event of the navigator indicating an alarm condition, the 727 will display NAV DATA. The 727 will hold the vessel on its present heading and will not accept any further changes until this error is cleared. (Note the navigator will also indicate this alarm condition.) To clear above from 727, press any key except 'Set' or 'Off'. If alarm clears, pilot will accept data. If above condition still exists, turn pilot off and then resume pilot control under compass heading or manually steer vessel.

Navigators with 0182 and 0183 output True or Magnetic Heading or both True and Magnetic. If only True heading is available the local variation should be entered into the 727 (see installation instructions, navigator section, page 20).



AUTOPILOT CONTROLLED BY HEADING

AUTOPILOT CONTROLLED BY CROSS TRACK ERROR

A4/2470/D

NMEA 0183 MESSAGE FORMATS

The 727 Autopilot is capable of processing the following NMEA 0183 messages. To obtain full use of the interface at least one message containing Cross Track Error, Heading to Waypoint and Waypoint number must be present in the data received from the Navigator.

MESSAGE	CROSS TRACK ERROR	HEADING TO WAYPOINT	WAYPOINT NUMBER
AAM	-	-	-
APA	X	X	X
APB	X	X	X
BEC	-	X	X
BOD	-	X	X
BWC	-	X	X
BWW	-	X	X
CTS	-	X	-
DTG	-	-	X
NAV	-	X	-
VTG	-	-	-
WBD	-	X	X
WCV	-	-	-
XTD	X	-	-
XTE	X	-	-
XTR	X	-	-
ZTG	-	-	-

'X' indicates that the data should be present in the given message according to the NMEA 0183 specification.

However, please note that not all manufacturers provide all the data required by a given message.

CHOOSING AND INSTALLING THE CORRECT AUTOPILOT SYSTEM

A. CHOOSING THE CORRECT SYSTEM FOR YOUR BOAT

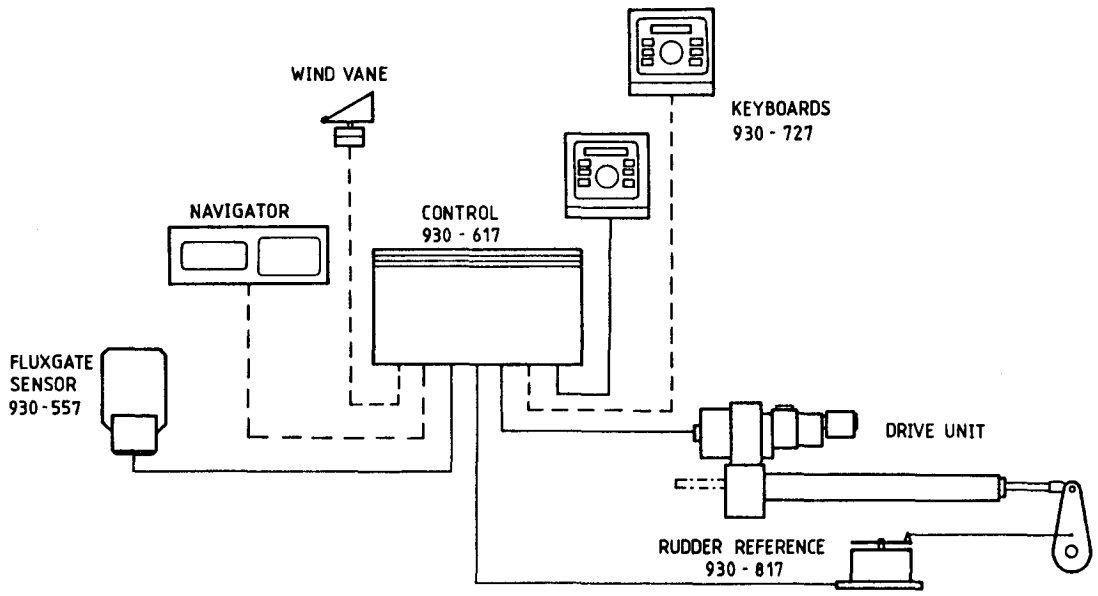
Drive Unit Is the steering mechanical or hydraulic? If mechanical choose according to vessel size and rudder torque to be expected; if hydraulic choose to match the cylinder displacement capacity first, then rudder torque and vessel size. An experienced dealer will usually be able to assess the correct system without going into detailed calculations, but Cetrek are always happy to advise in cases of doubt. It goes without saying that any steering system should itself be in good order before a pilot is connected; steering that is too heavy or which snags up should be put right, and hydraulic systems must be free of leaks or contamination.

Application Guide				Drive Unit	Voltage	Drive Output
Planing		Displacement Sail				
Metres	Ft	Metres	Feet			
Mechanical Steering Rotary Drives						
12	37	10.5	33	930 402 930 412	12 24	90 lb. ins. (1.04 kgm) at 20 rpm
22	70	19	60	930 404 930 414	12 24	300 lb. ins. (3.5 kgm) at 19 rpm
29	90	25	80	930 413	24	360 lb. ins. (4.2 kgm) at 25 rpm
Mechanical Steering Linear Actuator						
21	65	17.5	55	930 108 930 118 930 128	12 24 32	770 lb. ins. (350 kg) thrust
Hydraulic Steering						
17.5	55	14	45	930 106	12	1.4 cu. ins.
Maximum Ram Size				930 116	24	(23 cc) per second
220 cc		450 cc				
19	60	15	50	930 105	12	1.8 cu. ins.
Maximum Ram Size				930 115	24	(29 cc) per second
280 cc		575 cc				
27	90	22	70	930 102	12	3 cu. ins.
Maximum Ram Size				930 112	24	(49 cc) per second
490 cc		980 cc		930 122	32	

Accessories Any of the following may be coupled into the basic system:- Full Remote Control; Power Steer Control on wander lead; Proportional Power Steer; Digital and Analogue Compass Repeaters;

Interfacing The 727 system includes as standard the ability to interface with navigators having NMEA 0180, 0182 or 0183 data outputs.

TYPICAL SYSTEM LAYOUT

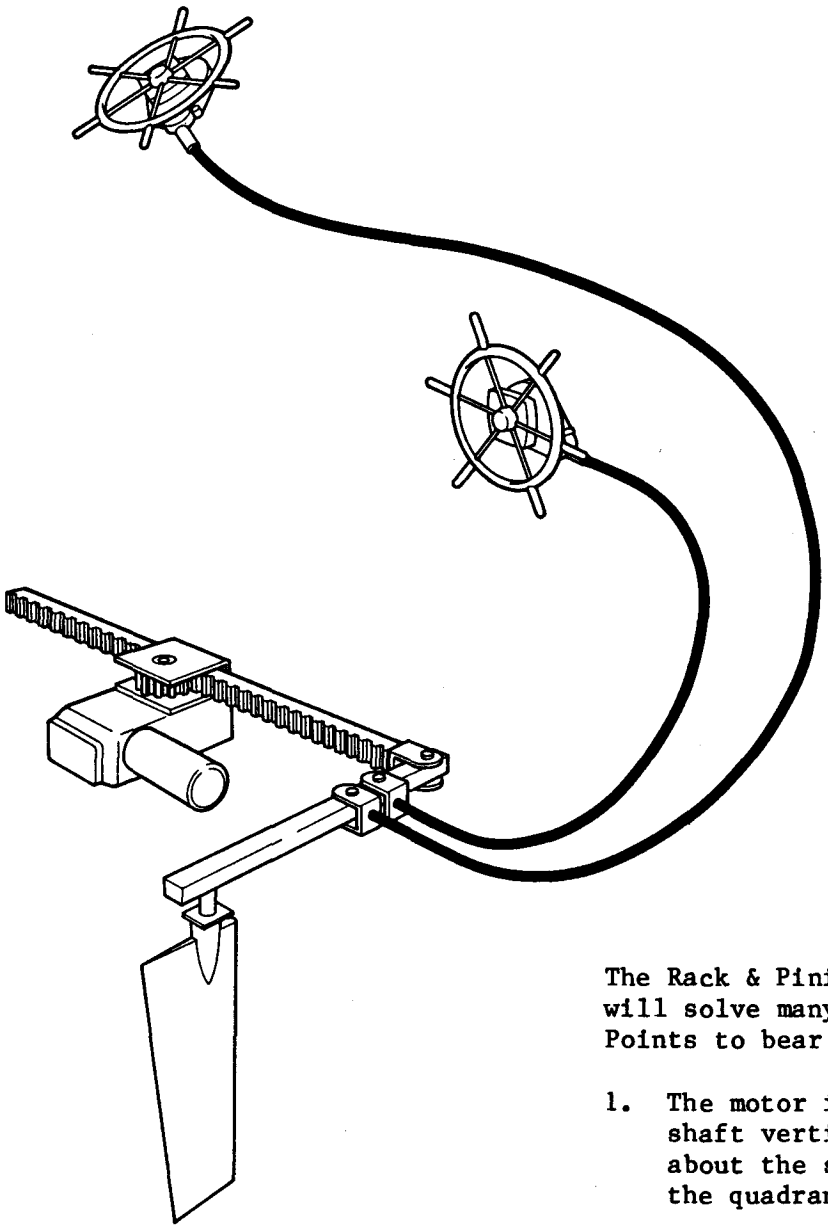


HYDRAULIC LINEAR DRIVE

Many modern mechanical steering systems fitted to power and sailboats do not allow the easy installation of a conventional rotary autopilot drive. The hydraulic linear drive is designed to be connected directly to the steering quadrant or tiller arm.

By using hydraulic instead of mechanical actuation, it is possible to produce a very compact unit with minimum backdrive loading and an adjustable drive speed. The illustrated unit is designed for easy and simple installation and is supplied complete with hydraulic fluid, purged ready for instant operation. Where there is a very restricted installation space, the hydraulic pump can be mounted remote from the hydraulic cylinder.

An added bonus to using a linear actuator is that in the event of the normal steering system failing, a back-up system through the autopilot control is available.



A typical mechanical installation using the 930 215 Rack & Pinion

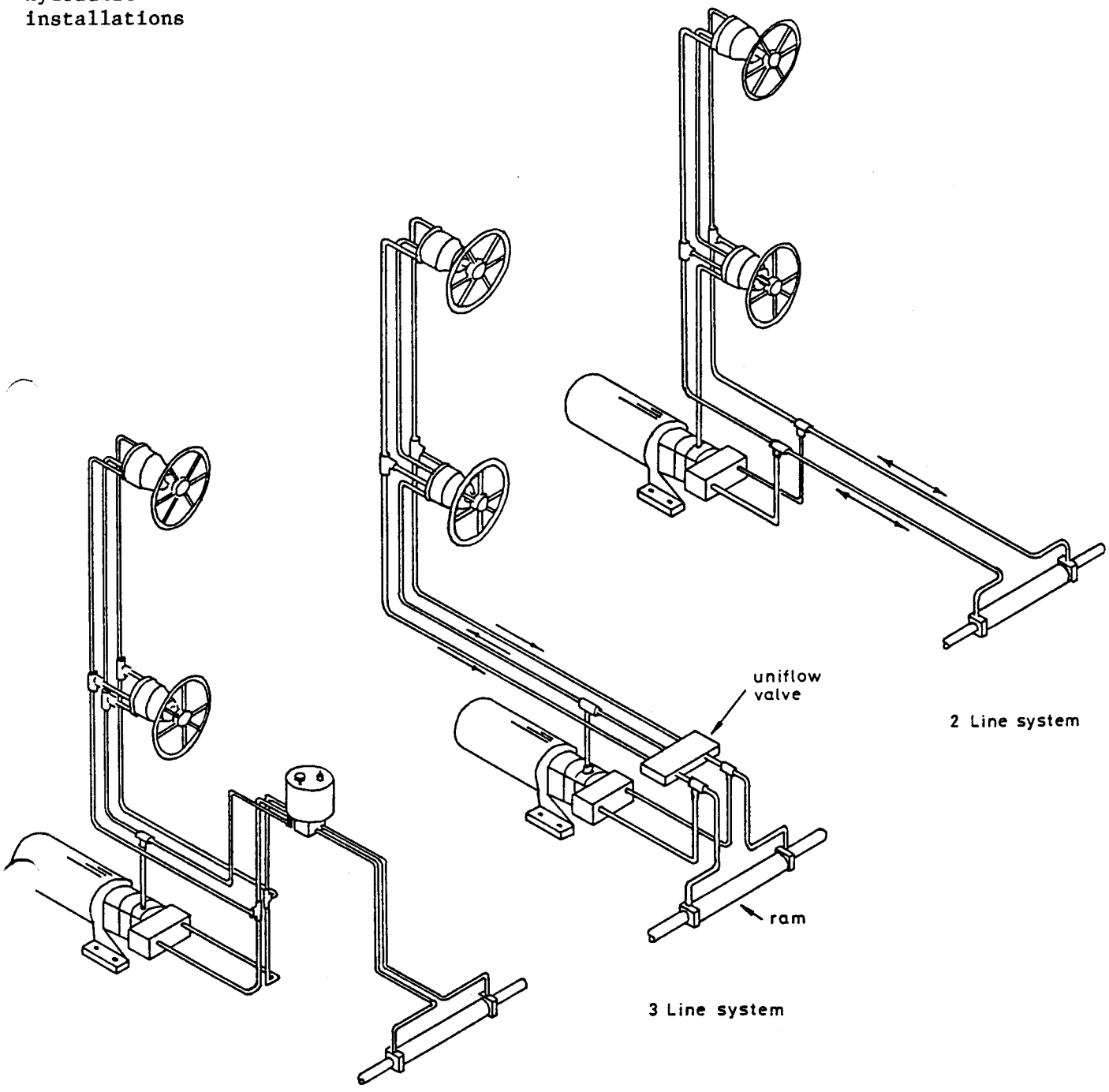
The Rack & Pinion is a versatile unit that will solve many installation problems. Points to bear in mind are:-

1. The motor is mounted with its output shaft vertical so the rack can swing about the shaft freely, and so move with the quadrant or tiller arm.

2. The 'starting point' in determining tiller arm length is 390 mm (15 1/2"). This gives a total rudder angle from hard-over to hard-over of 80°; the 930 404 motor will drive the rack through this angle in 13 1/2 seconds when loaded to its maximum thrust of 53.7 Newtons (240 lb.f.).

3. Reducing tiller arm length increases load on the motor, slowing it down, but reduces the distance the rack has to travel from hard-over to hard-over. These two effects roughly cancel each other over a range of + or - 50%, so there is considerable latitude in tiller arm length.

Some typical hydraulic installations



2 Line system

3 Line system

Pressurised system

(A4 / 2441 / D)

B. GENERAL INSTALLATION PRACTICE

Boats differ widely in their layouts and steering systems, but there are nevertheless certain guidelines applicable to all installations:-

1. Check that you have units of the correct voltage for the boat.

2. The compass safe distances must be observed. You will find each unit's compass safe distance quoted in its specification in the Unit Data Sheets at the end of this manual.

3. All signal circuit cables must be kept as clear as possible from cables carrying RF or pulsed signals. At least 1m (3ft) clearance is advised.

4. DC supply cables should be kept as short as possible, and should be taken directly from the battery via a switch/fuse or overload trip of a suitable rating for the system being installed.

   Under no circumstances should a cable be used to supply both the autopilot and also some other equipment: switching transients can be very troublesome and there is always the possibility of stray RF interference.

5. Where it is necessary to extend the length of any cable, the same type must be used with a splashproof connector box of suitable type mounted in an accessible place. The cables to the motor drive unit or hydraulic pump unit should not be lengthened unless absolutely essential, as the extra voltage drop can degrade the pilot's performance (especially on 12 volt systems). If in doubt use a heavier cable.

6. Any outer screening on a cable should be left isolated except where it is specifically indicated on a drawing that an earthing connection is required.

7. The metal cases of all units are isolated from the ship's DC supply. It is to be preferred that the power supply should not be connected to the metal hull or engine frame, but if you are presented with a boat so wired make sure that the pilot is connected to the power supply only at the main distribution point to reduce the possibility of RF interference to a minimum.

8. It is good practice to cleat all cables to fixed points at no less than 0.5 m spacing, and where cables pass through bulkheads protection by way of a suitable grommet or sleeve should be provided and make sure that any unused cable glands at the distribution box have their blanking plates fitted to avoid moisture ingress.

9. When deciding on mounting locations for the various units try to bear in mind the needs of any future service engineer (it might be you!). There is seldom much choice where the motor drive unit is concerned, but distribution boxes sometimes get put - particularly in newbuilds - in places which are easy to get at at the time but which are almost impossible to get at later, when other fittings have been installed in front of them, etc.

10. The environmental classification of each unit will be found on its data sheet at the end of the manual. Very few items are completely waterproof and it is only common sense to give as much protection as possible even to those which are.

11. There must always be a pilot control within easy reach of the helmsman.

C. CONNECTION INSTRUCTIONS

Introduction

The wiring connections to the 727 system are made in the 930 617 distribution unit. The distribution PCB is accessed by removing the front cover of the 930 617. To remove the cover release the three screws holding the front cover and lift clear. The connections to the 930 617 are printed clearly on the distribution PCB (see page 35).

Power Supply Connections

Your autopilot needs the following power supplies:

Two separately switched and fused power supplies are connected to the 930 617 Distribution Box. The light primary supply and the heavy duty secondary supply should be separately fused. The light duty supply should be fused at 5 amps.

HEAVY DUTY SUPPLY FUSED SWITCH OR OVERLOAD TRIP			
12V		24V	
100/101/105 106/108	30A ANTISURGE	110/111/115 116/118	20A ANTISURGE
402	15A ANTISURGE	412	10A ANTISURGE
404	30A ANTISURGE	414	20A ANTISURGE

Heavy duty power supplies are connected directly to the 930 102 hydraulic drive unit. Refer to Data Sheets for wiring details.
Details of power supply connections are given on page 34.

Connection Schedule

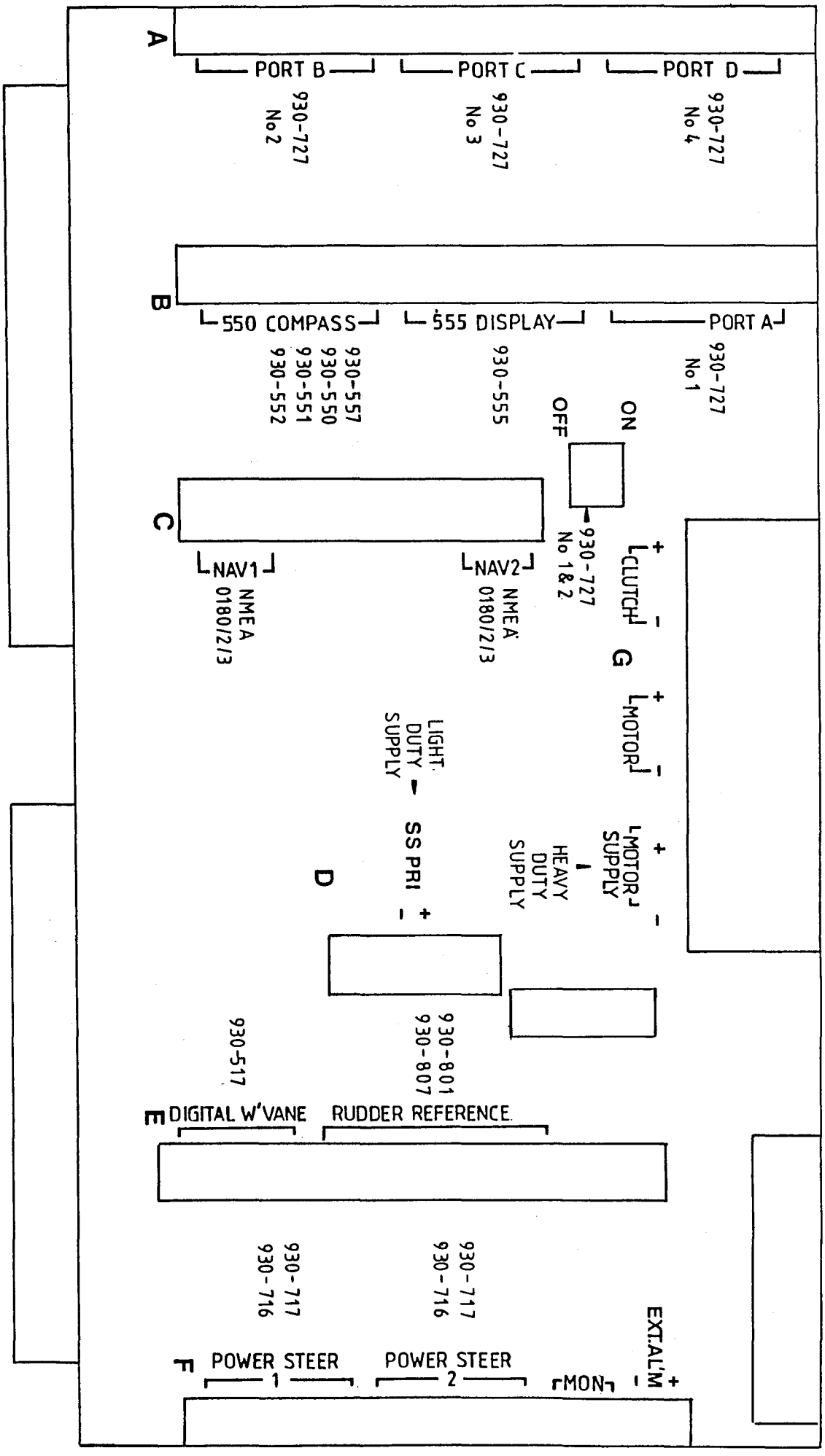
The cables are already fitted to the units supplied by CETREK, the colour coding is given. A key to the abbreviations used for the colours is given below.

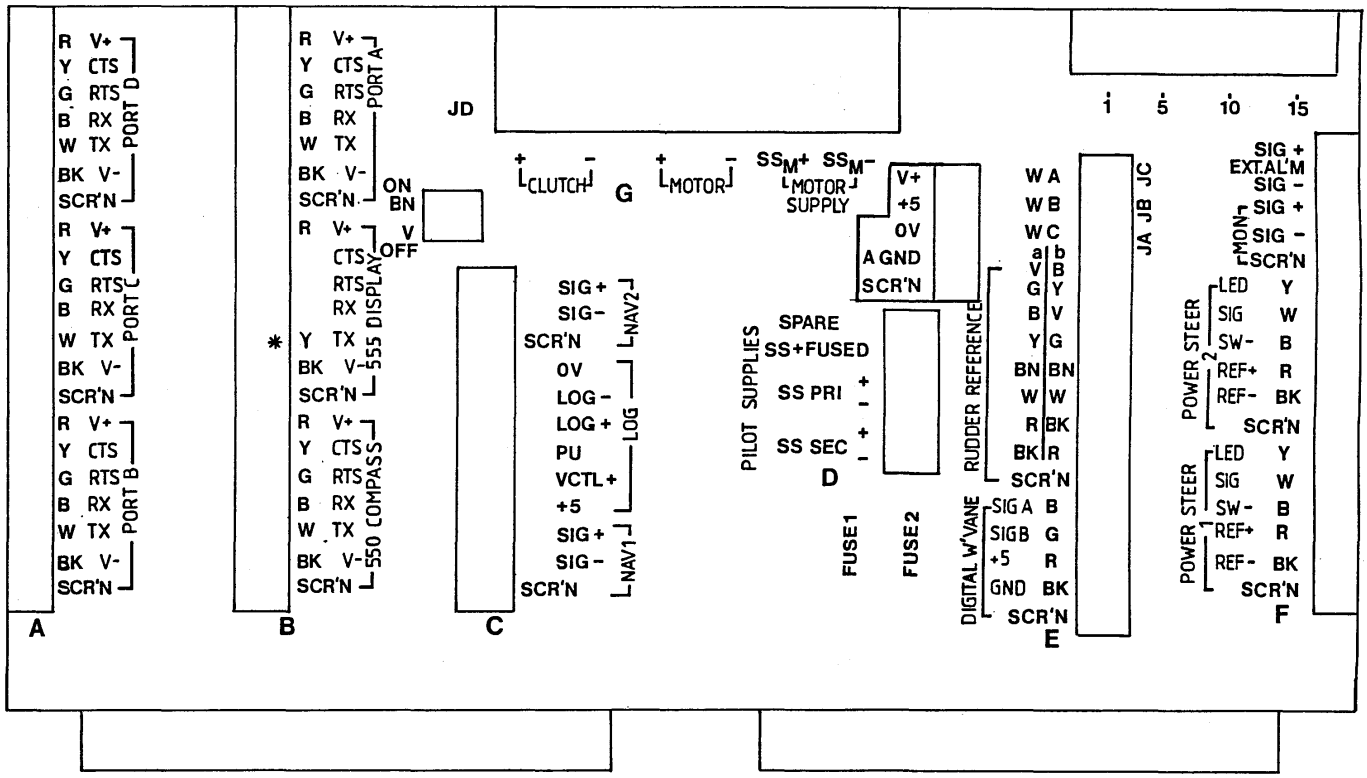
The connections from items such as navigators are also indicated clearly on the distribution PCB (drawing page 35).

Key to Colour Coding

R	Red	Rouge	Rot	Rojo
B	Blue	Bleu(e)	Blau	Azul
BK	Black	Noir(e)	Schwarz	Negro
BN	Brown	Brun(e)	Braun	Marron
V	Violet	Violet(te)	Violett	Mokado
G	Green	Vert(e)	Grun	Verde
W	White	Blanc(he)	Weiss	Blanco
GY	Grey	Gris(e)	Grau	Gris
Y	Yellow	Jaune	Gelb	Amarillo

UNIT CONNECTIONS





* 930 - 555 CONNECTIONS ARE NOT CORRECT ON THE SILK-SCREEN.

DETAIL CONNECTIONS

Motor connection table

UNIT	MOTOR		CLUTCH	
	+	-	+	-
Rotary Drives				
930 402	Green/Yellow	Blue	Black	Brown
930 412	Green/Yellow	Blue	Black	Brown
930 404	Green	Yellow	Black	Red
930 414	Green	Yellow	Black	Red
930 413	Green	Yellow	Black	Red
Linear Drives				
930 108	Green/Yellow	Blue	Black	Brown
930 118	Green/Yellow	Blue	Black	Brown
Hydraulic Drives				
930 100	Red	Black		
930 110	Red	Black		
930 101	Red	Black		
930 111	Red	Black		
930 102				
930 112				
930 105	Red	Black		
930 115	Red	Black		
930 106	Red	Black		
930 116	Red	Black		

D. CHECKING THE SYSTEM

General

1. Check that all units are installed as detailed on individual data sheets.

2. Check that correct size fuses or circuit breakers are fitted and that the ship supplies are up to voltage.

3. Check that the steering moves freely from lock to lock without undue stiffness.

4. Check all system connections before switching power on.

Pre-Trial Checks

1. Select preset pilot settings to suit type of vessel - displacement, semi-displacement or planing - as per installation adjustments.

2. Manually turn rudders. Ensure that the steering is free to move to its full travel without the 930 801/807 linkage arms fouling the steering.

3. Manually turn rudders amidships.

4. Switch on power supplies to autopilot and switch pilot on by pressing 'Standby' (if steering operates switch off at once and recheck connections). Pilot will self test. If system fault shown check under Fault Display section (page 22).

5. Press 'Standby' to display rudder position (page 13). Check that the steering is free to move manually. Turn rudder to port. Rudder indicator should move to the left. If meter moves to right the 930 801/807 is phased incorrectly. Remove power from the system and reconnect the 930 801/807 as per schedule for opposite phasing.

6. Move rudder to position normally required to steer vessel in a straight line. If rudder meter indicator does not read centre scale rotate 930 801/807 rudder reference unit until centre indicated.

7. 930 801 only. Manually turn rudder from lock to lock and check that both port and starboard limit switches in the 930 801 operate before full lock is reached (say 5^{o} before). These limit switches are set in the factory to operate at 30^{o} of rudder movement either side of centre. They can be adjusted if necessary as per instructions in the 930 801 data sheet. Normally it is possible to hear the micro switches operate, if not see data sheet for method of checking electrical operation.

   930 807 only. The 930 807 has electronic rudder limits. These are preset as described in the Installation Adjustments section page 16. When these limits are reached the rudder position display on the 727 will flash. Check that the limits are set to operate before the end of rudder movement is reached. If not, reset as per Installation Adjustments.

8. Ensure it is safe for the steering gear to start automatically. Set rudder to amidships using normal steering. Ensure pilot presets set to suit type of vessel (page 18). Press 'Pilot'. Very little or no rudder movement should occur. If rudder drives continuously to one side, switch off at once. If rudder continuously hunts about amidships, increase the rudder deadband setting. Move course control clockwise, motor should drive and rudder should move to starboard. Anticlockwise movement of course control should cause rudder to drive to port. If rudder moves in the incorrect direction switch off at once, isolate supplies and reverse the connections to the drive unit or solenoid valves at terminals in the 930 617 distribution box. Restore supplies and repeat test. If rudder drives continuously, switch off at once and restart general checks.

9. With pilot still in Drive mode and before compass sensor is aligned and corrected for deviation, move the compass sensor clockwise. The rudder should move to starboard. Moving the compass anti-clockwise will move the rudder to port.

10. If additional 930 727 control units are fitted check that the 'Off' and 'Standby' keys operate.

11. Check that any remote power steering units operate in the correct direction and are unable to drive past the limit switches.

12. Check that any remote disengage switches operate correctly and check any compass repeaters.

Sea trials can now be carried out to determine the best settings for the optimum autopilot performance.

Sea Trials

1. It is advised that these trials are not executed in restricted or busy waters.

2. It is preferable to perform sea trials in average sea conditions.

3. Select preset pilot adjustments to suit type of craft (see page 18).

4. It is recommended that the sea trial adjustments are carried out in the following order (see pages 16 and 17):-

   (a) Yaw and Yaw gain adjustment:- If the vessel is understeering (i.e. too little rudder correction being applied) increase Yaw setting. If too much rudder is being applied and the vessel is oversteering, decrease the setting. If the setting for your vessel is between 15 and 20, increase the Yaw gain and reset Yaw so that for average conditions you are operating in the region of 05 to 10. If the Yaw setting is between 00 and 05, decrease Yaw gain to obtain setting as above, between 05 and 10.

   (b) Counter Rudder adjustment:- Using Course Selector to turn pilot through 90^{o} with vessel moving at normal cruising speed, the Counter Rudder should be adjusted to give approximately 10^{o} of overshoot before returning to preselected course. If larger overshoot occurs, increase setting of Counter Rudder. If vessel approaches preset course very slowly then decrease Counter Rudder setting until overshoot occurs. After carrying out this adjustment, repeat (a) above.

   (c) Trim adjustment:- On single screwed vessels or sailing yachts it is only possible to check the Trim setting when prevailing conditions or use cause the vessel to steer with offset rudder and therefore the correct Trim adjustment setting for these types of vessel is best found by experience.

   To check the Trim adjustment with twin engine vessels, run the boat under pilot command with both engines running, then close down one engine. The vessel will initially go off course but should return to course in less than 60 seconds. If vessel takes longer period of time to return to course, increase the value set for Trim.

   (d) Damping adjustment:- The Damping adjustment allows the signal from the compass sensor to be damped. This would not be an operation normally required on craft other than those with the compass sensor mounted high above the water (i.e. steel boats with the sensor on mast). If pilot becomes overactive in rough weather, increase the Damping setting.

(e) Automatic Deviation Correction:- If unacceptable compass deviation exists, it is recommended that the Automatic Deviation Correction procedure (as explained on page 19) is carried out during initial sea trials. If Automatic Deviation Correction cannot be completed due to the size of vessel and restricted water, then the compass sensor should be corrected manually (see data sheets).

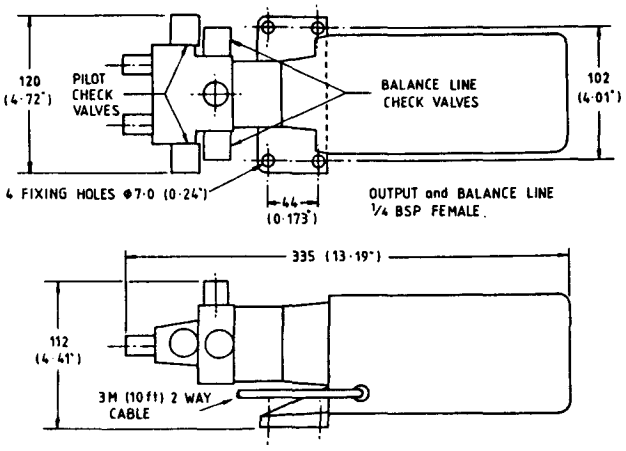
(f) Navigator Control:- If Navigators are interfaced to the autopilot, adjustments for Navigator Control should be carried out at this point (see page 20 for Navigator Installation Adjustments).

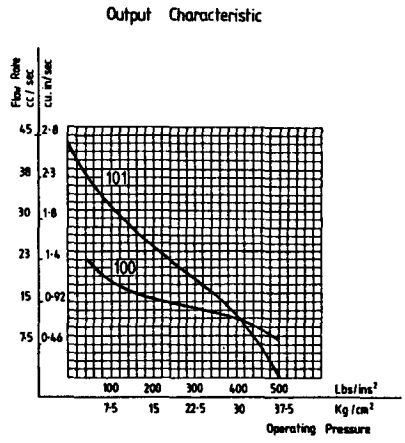
NOTE: After completing these initial sea trials, the data will be stored in the microprocessor memory until future adjustments are made. It is also advised that these settings are recorded in case they are accidentally changed at any time by an operator. If it is required to return to the pilot adjustments existing when the pilot was last switched off, these can be selected through the preset pilot adjustments by selecting RESTORE.

WARNING: PILOT DATA WILL NOT BE STORED UNLESS PILOT IS TURNED OFF BY 727 'OFF' KEY.

DATA SHEETS

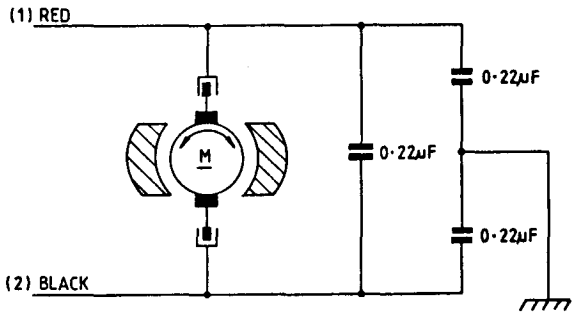
930 100 SERIES AND 930 101 SERIES HYDRAULIC POWER UNITS





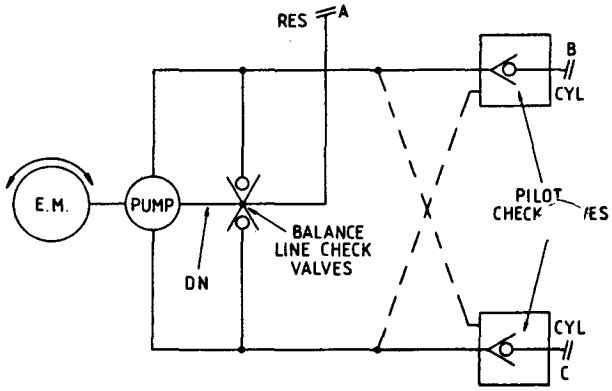
Supply Voltage	:	12/24/32V
Weight	:	4.1 KG
Cable supplied	:	3m 2 way x 28/0.3 mm
Compass Safe Distance	:	Grade 1 (0.25^{o}) 2300 mm (90")
		Grade 2 (1^{o}) 1850 mm (72")
Environmental Classification	:	Not waterproof

MOTOR CIRCUIT



Connect direct to distribution unit
N.B. Case to be bonded to ships metal hull or frame

HYDRAULIC SCHEMATIC



Technical Description

The unit comprises a small high speed gear pump driven by a permanent magnet electric motor. Internal check valves are fitted which, together with the balance line, ensure that the pump is always primed and ready to run in either direction. The hydraulic output of the pump also flows through pilot check valves which allow free flow and return whenever the pump is running, but which at other times remain tightly closed and prevent any leakage through the pump.

930 100 SERIES AND 930 101 SERIES HYDRAULIC POWER UNITS (continued)

The 930 100 and 930 101 pumps are identical in all respects other than the capacities of their pump chambers, that of the 930 101 being exactly double the size of the 930 100.

Installation

The pump should be placed conveniently to the hydraulic delivery lines and as near to the ram cylinder as possible. It should be mounted on a solid base with a minimum of vibration. Ensure that the helm units are fitted with check valves as otherwise the pilot pump will simply drive the helm round and not the ram. (Model 930 213 check valve block is available from Cetrek if necessary.)

Empty the existing oil by releasing a coupling at the lowest point, normally at the ram cylinder. Fit T pieces in the main delivery lines and couple by flexible hose minimum 10 mm bore, 210 kg/cm^2 test pressure. Outlet B is fitted to the starboard line and outlet C to the port line.

Couple the balance pipe (outlet A) to the compensating coupling on the helm pump. This may need running some distance, and should rise gradually with no down turns. This line can be low pressure (35 kg/cm^2) and preferably transparent to assist in visually clearing the system.

Make absolutely sure there is no dirt or swarf left at the joints or anywhere in the system. Check all unions are tight, the emergency valve is closed (if fitted), and then proceed to refill the system, preferably with new, clean oil. The steering gear manufacturer's own recommendation should always be followed when deciding on the choice of the correct oil for the system. Take care not to enclose any air in the system, and do not pour oil carelessly into the helms and frantically wind the wheel back and forth. This will be a waste of time and probably spray oil in all directions. If manufacturer's directions are not available proceed as follows:-

Disconnect the hoses from the cylinder or cylinders and fill each cylinder at each end with oil. Reconnect the hoses and pour oil into the helm pump until it is within 2 cm of the top. Now turn the wheel slowly back and forth about two turns. Top up the helm unit as oil is pushed down into the system. On no account allow the oil level to drop below the rotor which can be seen through the top filler hole in the helm pump. Next turn the helm as far as it will go in one direction and apply moderate pressure, then repeat in the other direction, keeping the oil level topped up at all times. When the system will accept no more oil it may be considered full.

Run the pump unit to move the rudder in either direction; this will release further air. After a while the action will become positive; the ram cylinder must move instantly the pump is run. Leave the helm unit with the oil level about 2 cm from the top.

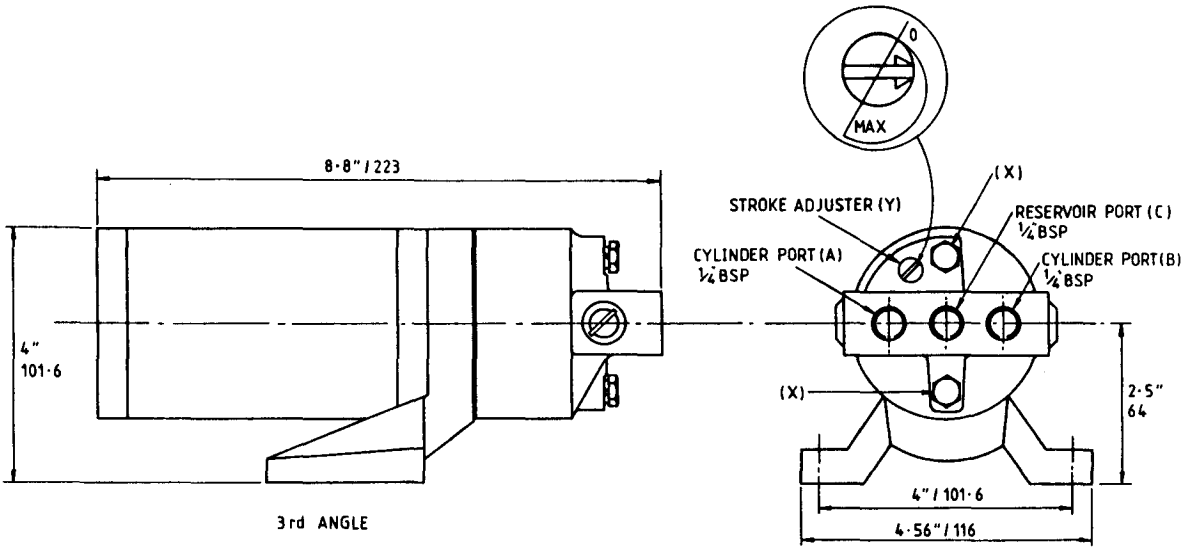
Finally, after the system is filled, apply pressure to each side of the system in turn by pulling the wheel hard against each rudder stop. Check every joint and length of tube for leaks. Fasten all tubing down to prevent fracture due to vibration.

Make the electrical connection to the distribution box as per the schedule.

Wiring Connection

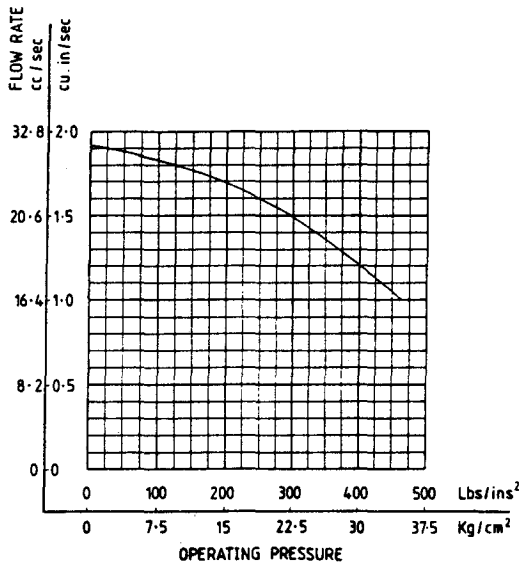
The connections are detailed in the appropriate connection schedule. To reverse drive direction reverse connections.

930 105/115 SERIES HYDRAULIC POWER UNITS



Supply Voltage	:	12/24V
Weight	:	3.5 kg
Cable supplied	:	3m 2 way x 28/0.3mm
Compass Safe Distance	:	Grade 1 (.25°) 2300 mm (90")
		Grade 2 (1°) 1850 (72")
Environmental classification	:	Not waterproof

Output Characteristic of 930-105 & 115
at Maximum Flow Setting



Description

The unit comprises a small high speed piston pump driven by a permanent magnet electric motor. The displacement of the pump can be adjusted by a simple screw adjustment. This enables the pump to be set to suit a range of cylinder sizes and hardover to hardover times.

930 105/115 SERIES HYDRAULIC POWER UNITS (continued)

Installation

The pump should be placed conveniently to the hydraulic delivery lines and as near to the ram cylinder as possible. It should be mounted on a solid base with a minimum of vibration. Ensure that the helm units are fitted with check valves as otherwise the pilot pump will simply drive the helm round and not the ram. (Model 930 213 check valve block is available from Cetrek if necessary.)

Empty the existing oil by releasing a coupling at the lowest point, normally at the ram cylinder. Fit T pieces in the main delivery lines and couple by flexible hose minimum 10 mm bore, 210 kg/cm^2 test pressure. Outlet B is fitted to the starboard line and outlet C to the port line.

Couple the balance pipe (outlet A) to the compensating coupling on the helm pump. This may need running some distance, and should rise gradually with no down turns. This line can be low pressure (35kg/cm^2) and preferably transparent to assist in visually clearing the system.

Make absolutely sure there is no dirt or swarf left at the joints or anywhere in the system. Check all unions are tight, the emergency valve is closed (if fitted), and then proceed to refill the system, preferably with new, clean oil. The steering gear manufacturer's own recommendation should always be followed when deciding on the choice of the correct oil for the system. Take care not to enclose any air in the system, and do not pour oil carelessly into the helms and frantically wind the wheel back and forth. This will be a waste of time and probably spray oil in all directions. If manufacturer's directions are not available proceed as follows:-

Disconnect the hoses from the cylinder or cylinders and fill each cylinder at each end with oil. Reconnect the hoses and pour oil into the helm pump until it is within 2 cm of the top. Now turn the wheel slowly back and forth about two turns. Top up the helm unit as oil is pushed down into the system. On no account allow the oil level to drop below the rotor which can be seen through the top filler hole in the helm pump. Next turn the helm as far as it will go in one direction and apply moderate pressure, then repeat in the other direction, keeping the oil level topped up at all times. When the system will accept no more oil it may be considered full.

Run the pump unit to move the rudder in either direction; this will release further air. After a while the action will become positive; the ram cylinder must move instantly the pump is run. Leave the helm unit with the oil level about 2 cm from the top.

Finally, after the system is filled, apply pressure to each side of the system in turn by pulling the wheel hard against each rudder stop. Check every joint and length of tube for leaks. Fasten all tubing down to prevent fracture due to vibration.

Make the electrical connection to the distribution box as per the schedule.

Adjustment

To adjust flow of pump release the two bolts (X), which hold the pump body to the support casting, one half turn. Turn screw (Y) in pump body anti-clockwise to decrease flow, clockwise to increase flow (see marks on pump casting for maximum and minimum settings).

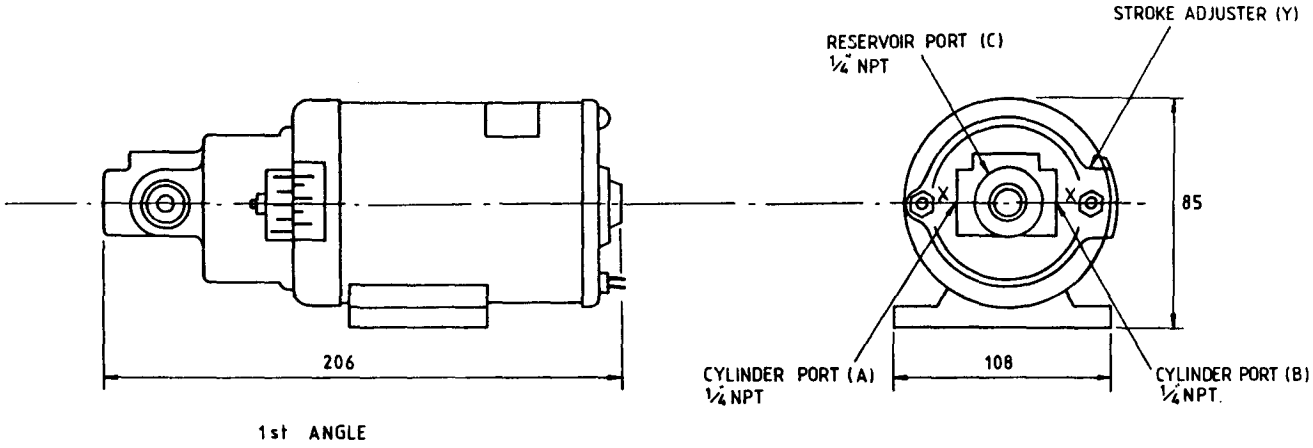
Recommended hardover times:-

Fast planing craft	:	9-12 seconds
Displacement power craft 9 knots plus	:	12-15 seconds
Displacement power craft under 9 knots	:	15-20 seconds
Sailboats	:	15-18 seconds

Wiring Connection

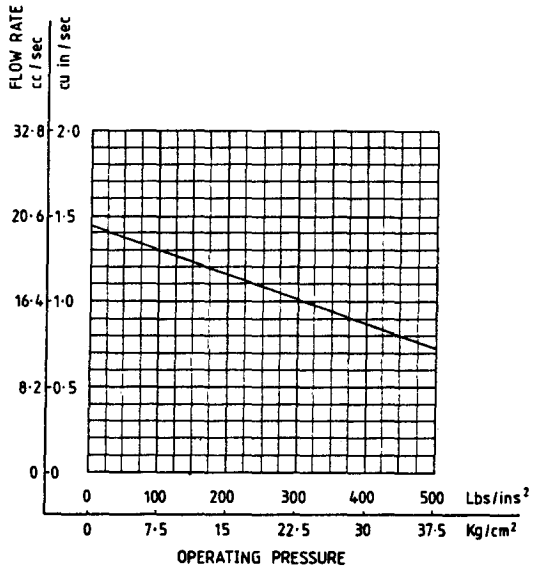
The connections are detailed in the appropriate connection schedule.
To reverse drive direction reverse connections.

930 106/116 SERIES HYDRAULIC POWER UNITS



Supply Voltage	:	12/24V
Weight	:	3.5 kg
Cable supplied	:	150mm 2 core
Compass Safe Distance	:	Grade 1 (.25°) 2300 mm (90")
		Grade 2 (1°) 1850 mm (72")
Environmental classification	:	Not waterproof

Output Characteristic of 930-106 & 116
at Maximum Flow Setting



Description

The unit comprises a small high speed pump driven by a permanent magnet electric motor. The displacement of the pump is variable, it is easy to adjust and a visible vernier reading of the pump setting is given. This allows the pump to be adjusted to cope with different cylinder capacities and hardover to hardover times.

Installation

The pump should be placed conveniently to the hydraulic delivery lines and as near to the ram cylinder as possible. It should be mounted on a solid base with a minimum of vibration. Ensure that the helm units are fitted with check valves as otherwise the pilot pump will simply drive the helm round and not the ram.

Empty the existing oil by releasing a coupling at the lowest point, normally at the ram cylinder. Fit T pieces in the main delivery lines and couple by flexible hose minimum 10 mm bore, 210 kg/cm^2 test pressure.

Couple the balance pipe to the compensating coupling on the helm pump. This may need running some distance, and should rise gradually with no down turns. This line can be low pressure (35kg/cm^2) and preferably transparent to assist in visually clearing the system.

The pumps have threaded ports with 1/4 inch female NPT Taper connections.

Make absolutely sure there is no dirt or swarf left at the joints or anywhere in the system. Check all unions are tight, the emergency valve is closed (if fitted), and then proceed to refill the system, preferably with new, clean oil. The steering gear manufacturer's own recommendation should always be followed when deciding on the choice of the correct oil for the system. Take care not to enclose any air in the system, and do not pour oil carelessly into the helms and frantically wind the wheel back and forth. This will be a waste of time and probably spray oil in all directions. If manufacturer's directions are not available proceed as follows:-

Disconnect the hoses from the cylinder or cylinders and fill each cylinder at each end with oil. Reconnect the hoses and pour oil into the helm pump until it is within 2 cm of the top. Now turn the wheel slowly back and forth about two turns. Top up the helm unit as oil is pushed down into the system. On no account allow the oil level to drop below the rotor which can be seen through the top filler hole in the helm pump. Next turn the helm as far as it will go in one direction and apply moderate pressure, then repeat in the other direction, keeping the oil level topped up at all times. When the system will accept no more oil it may be considered full.

Run the motor of the pump whilst turning the steering wheel in both directions. The pump should purge immediately and start to drive the rudder. Once the pump is running well in both directions check the oil level in the system and top up if required.

Finally, after the system is filled, apply pressure to each side of the system in turn by pulling the wheel hard against each rudder stop. Check every joint and length of tube for leaks. Fasten all tubing down to prevent fracture due to vibration.

Make the electrical connection to the distribution box as per the schedule.

930 106/116 SERIES HYDRAULIC POWER UNITS (continued)

Adjustment

To adjust the flow of the pump release the two nuts (X) which hold the pump body to the motor flange, turn screw (Y) in the pump body to increase or decrease flow as required. See vernier markings on pump body giving maximum and minimum settings.

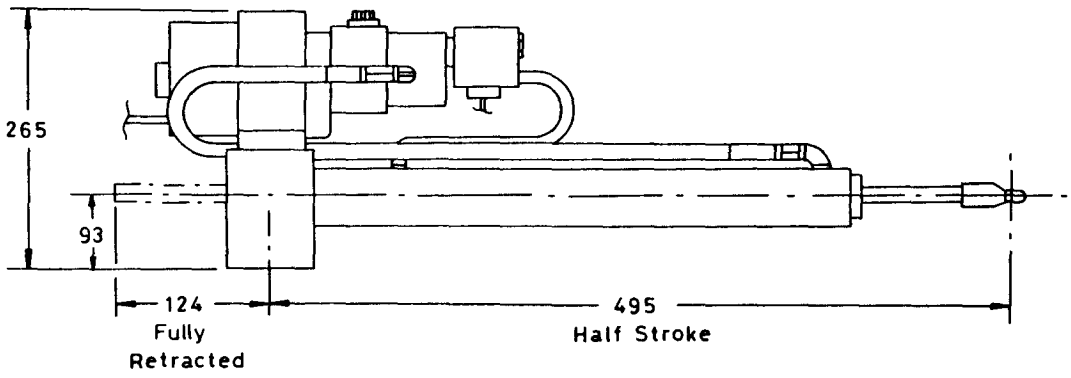
Recommended hardover times:

Fast planing craft	:	9-12 seconds
Displacement power craft 9 knots plus	:	12-15 seconds
Displacement power craft under 9 knots	:	15-20 seconds
Sailboats	:	15-18 seconds

Wiring Connection

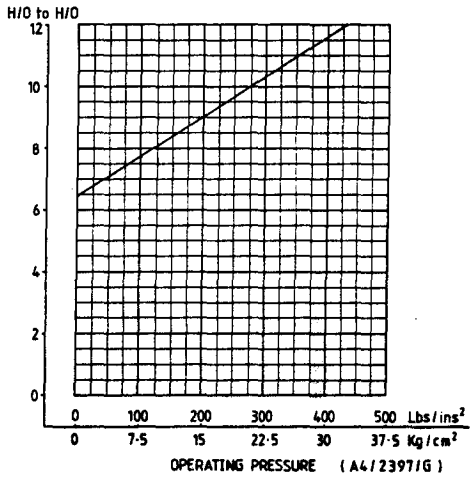
The connections are detailed in the appropriate connection schedule. To reverse drive direction reverse connections.

930 108/118 SERIES HYDRAULIC LINEAR ACTUATOR



Supply Voltage	:	12/24V
Weight	:	5.5 kg
Cable supplied	:	3m x 4 Way; 24 x 0.2
Environmental Classification	:	Not splashproof, mount under cover
Maximum torque	:	60 KgM

Hydraulic Linear Actuator 930-108/118
Hardover Time at Maximum Flow Setting



Description

Many modern mechanical steering systems fitted to power and sailboats do not allow the easy installation of a conventional rotary autopilot drive. The Hydraulic Linear Drive is designed to be connected directly to the steering quadrant or tiller arm.

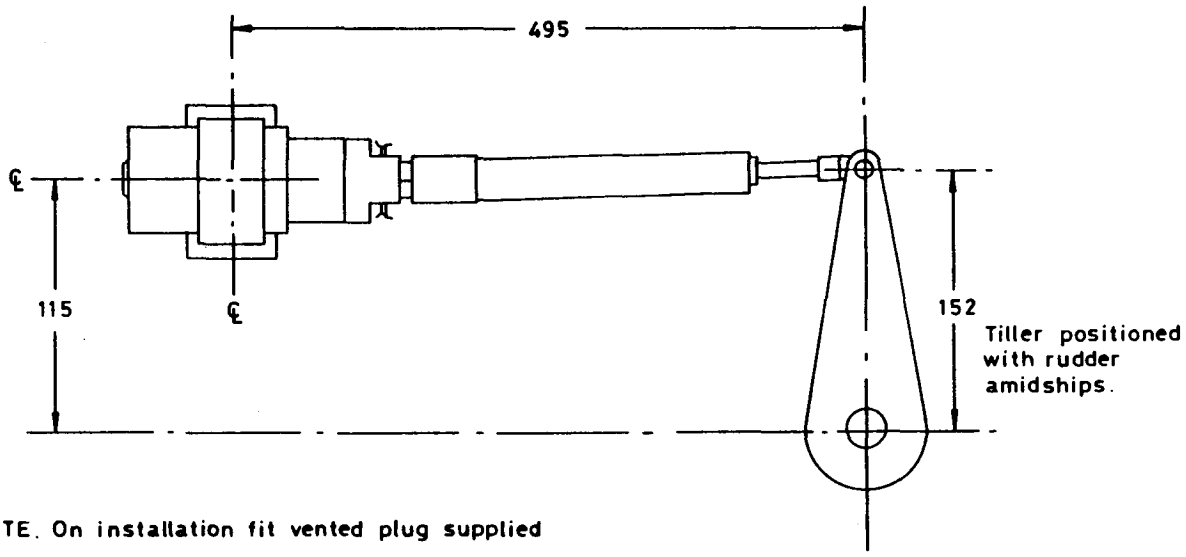
Description (continued)

By using hydraulic instead of mechanical actuation, it is possible to produce a very compact unit with minimum backdrive loading and an adjustable drive speed. The unit is designed for easy and simple installation and is supplied complete with hydraulic fluid, purged ready for instant operation. Where there is a very restricted installation space, the hydraulic pump can be mounted remote from the hydraulic cylinder.

An added bonus to using a linear actuator is that in the event of the normal steering system failing, a back-up system through the autopilot control is available.

Installation

The unit is mounted directly to the tiller arm or quadrant at the rudder head as per drawing below.



NOTE. On installation fit vented plug supplied

The hardover to hardover speed of the system can be adjusted as described in data sheets for 930 106 series hydraulic pump. This speed should be adjusted to suit type of craft:-

Fast planing craft	:	9-12 seconds
Displacement power craft 9 knots plus	:	12-15 seconds
Displacement power craft under 9 knots	:	15-20 seconds
Sailboats	:	15-18 seconds

Wiring Connection

Connections are detailed in the connection schedule. To reverse drive direction, reverse connections.

930 402, 930 403 and 930 404 MOTOR DRIVE UNITS

	930 402/412	930 413	930 404/414
Voltages available	12,24	24,32	12,24
Weight (kg)	5.8	13.3	7
Compass Safe Distance (mm) G1	2900	2900	2900
Compass Safe Distance (mm) G2	1800	1800	1800
Cable supplied	3m 4 way 24/0.2	3m 4 way 2 x 16/0.2 2 x 56/0.3	3m 4 way 2 x 16/0.2 2 x 56/0.3

Environmental Classification: Not splashproof & must be mounted under cover.

INSTALLATION

Installation usually involves fitting a sprocket to a convenient point in the steering system (with less than 5% backlash) and coupling the drive motor to it with a length of good quality chain. Observe the compass safe distance carefully as magnetic clutches produce strong fields when engaged. Count the number of turns of the steering system from hardover to hardover at the chosen attachment point, and select the sprocket size from the table below.

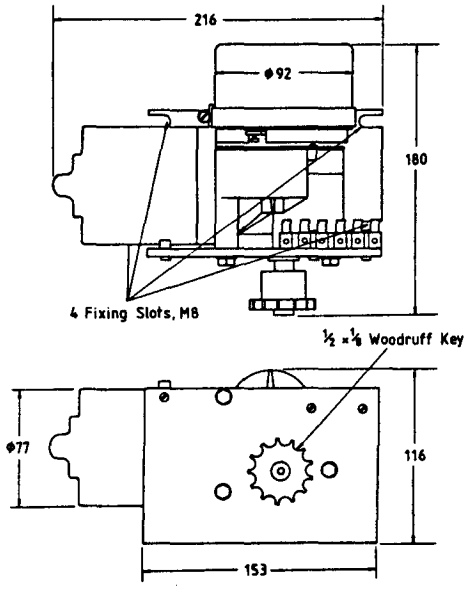
Number of teeth on steering sprocket for variety of circumstances

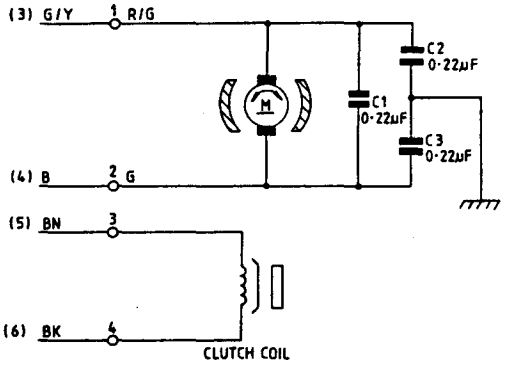
Turns HO/HO at Steering Sprocket	Planing Hull HO/HO time 8-12 sec				Displacement Hull HO/HO time 12-20 sec			
	402 12V	412 24V	413 24V	404 414	402 12V	412 24V	413 24V	404 414
2	19	38	25	25	25	57	38	38
3	13	25	19	19	19	38	25	25
3.5	13	19	19	19	19	38	25	25
4		19	19	19	19	25	19	19
5					13	19	19	19

NB: 930 402 motors are supplied complete with a 13 tooth sprocket and 930 404 motor with a 19 tooth sprocket. 930 403 motors are not supplied with a sprocket as some craft will need heavier chain than others, but the table assumes a 19 tooth size will be fitted. If for reasons of space, etc, the sprocket sizes above are not practicable, the motor sprocket may be changed to give an overall ratio as close as possible to that obtained from the table. Sprockets (where fitted) are of 3/8" pitch.

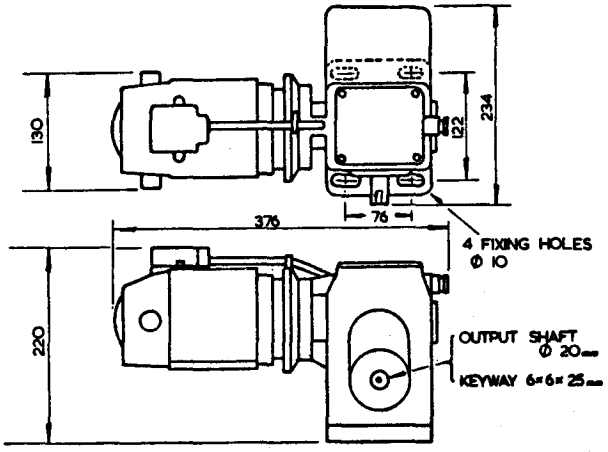
MOTOR DRIVE UNITS

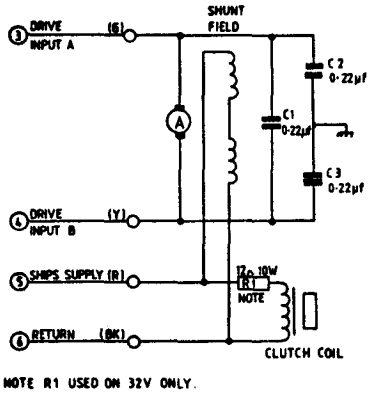
402





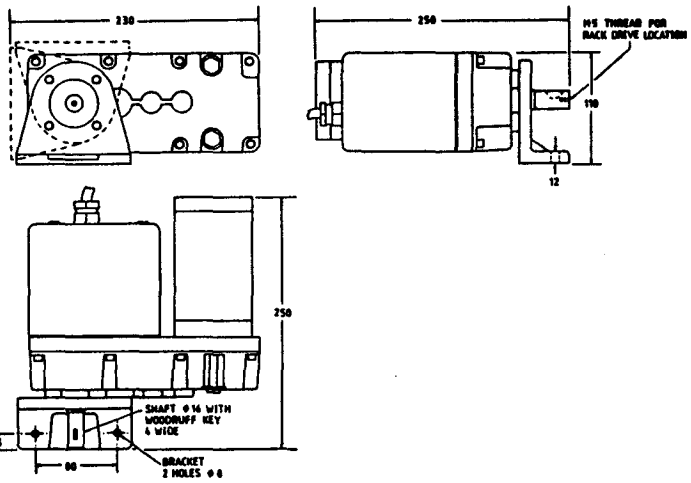
403

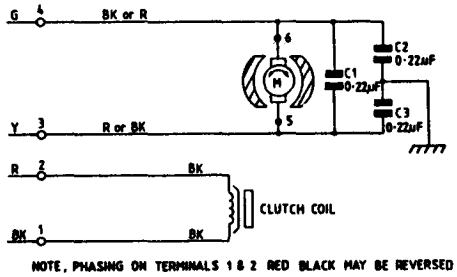




NOTE R1 USED ON 32V ONLY.

404





NOTE, PHASING ON TERMINALS 1 & 2 RED BLACK MAY BE REVERSED

Rotating rod steering systems will usually accept a sprocket with a minimum of difficulty; Teleflex cable systems using helm units 260 or 261 may be fitted with the Cetrek sprocket adaptor unit 930 211; wire-and-quadrant systems usually involve taking out a length of the wire and replacing it by a similar length of chain, which can of course then be driven by the motor sprocket. Remember to make provision for future chain adjustment.

In difficult cases where none of these methods seems easily achievable, the Cetrek rack and pinion (930 215) may well be the answer. Note that if the drive motor is mounted with its output shaft vertical the rack can swing freely about its vertical axis. (All Cetrek motor drive units may be mounted in any plane; there are no problems of oil spillage.)

Allen screws locking the sprocket keys should be tightened using Locktite when everything has been carefully aligned.

CONNECTION

With the drive motor in place and everything moving smoothly, apply starboard rudder and observe the motor output shaft: if it turns clockwise wire up as per schedule; if it turns anti-clockwise reverse the connections marked thus*.

	CABLE COLOUR		
930 402/412	930 413	930 404/414	FUNCTION
Green/Yellow	Green	Green	Drive Input*
Blue	Yellow	Yellow	Drive Input*
Brown	Red	Red	Clutch
Black	Black	Black	Clutch

930 550 SERIES

SENSOR INSTALLATION INSTRUCTIONS

The sensor can be placed anywhere in the vessel where magnetic interference is least. The optimum compass location is as close as possible to the vessel's centre of pitch and roll. On steel vessels, the sensor may need to be mounted on the mast and should be between one metre and three metres from the main structure.

1) Locate a suitable installation area, free from magnetic interference.

2) Transit Screw. This locks the gimbal at the base of the sensor. Ensure transit screw (white nylon screw at centre of base) is withdrawn five full turns to allow full mechanical movement of coil assembly. If fitting unit externally remove screw, shorten by 10 mm (3/8"), replace and tighten.

3) Fix the sensor to a vertical bulkhead using brass or stainless steel screws.

4) Alloy Casing

   Adjust case of the sensor so the pointer on the top leading edge is in fore and aft direction. Tighten main bracket bolt to lock sensor in place. To re-align through 90 or 180 degrees, remove sensor lid (4 screws), release printed circuit board (PCB) by removal of four pillars and gently rotate PCB assembly until it is fore and aft. Replace pillars and lid with arrow facing forward.

   Moulded plastic housing

   To re-align sensor if required, remove front cover and release clamp holding coil PCB by undoing the two locking screws. Rotate PCB until long line with dot is aligned with the fore and aft line of the vessel. Note: the sensor is normally supplied with the coil positioned so that if the casing is mounted on the front face of an athwartship's bulkhead or the front of a mast, it will be correctly aligned.

5) Install junction box in any convenient place to allow system connection.

6) It is advisable to connect the system through a fused supply, either from existing switch panel or separately. Always connect via the junction box. As the current drain is low, the compass can be left on with very little battery drain.

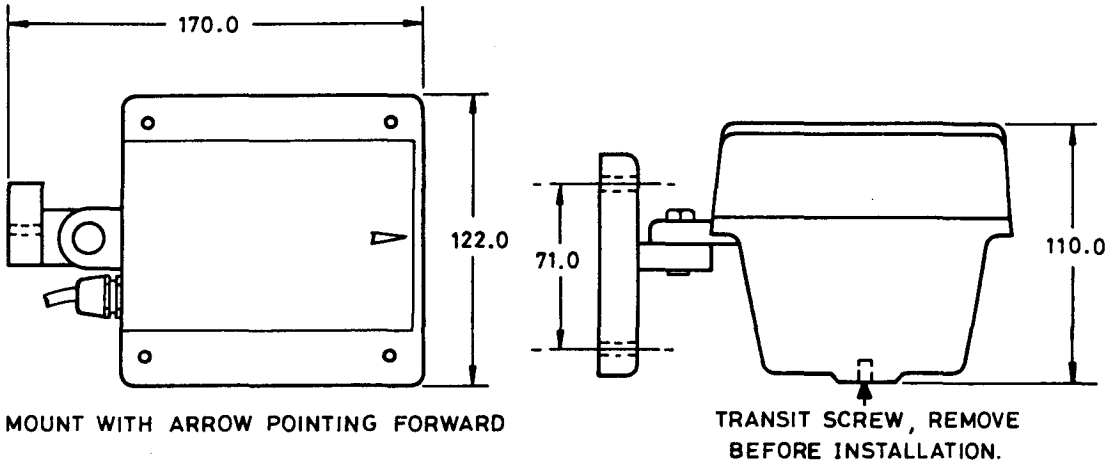
Minimum Mounting Distances

Radios, RDF, Depth Recorders etc:	1 metre
Power cables carrying more than 0.5 amp:	1 metre
Radar Magnetrons:	3 metres
Ship's engines, large mass steel (soft iron) etc:	1 metre

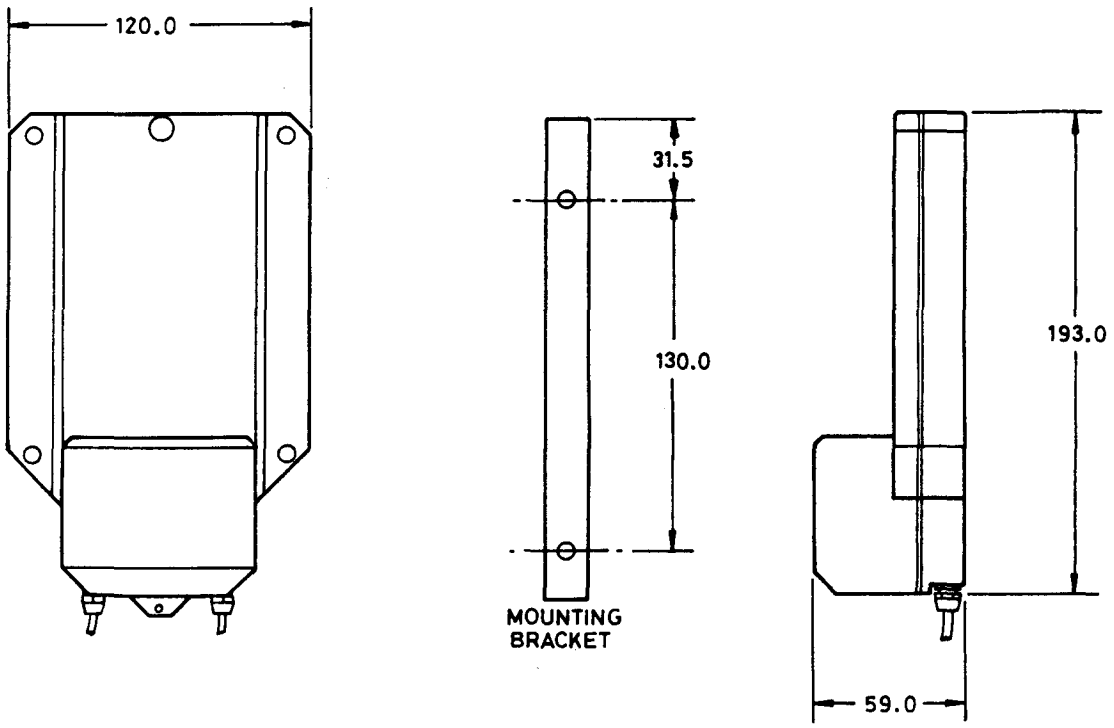
HEADING DISPLAY REPEATERS INSTALLATION INSTRUCTIONS

The repeaters can be mounted in the most convenient position for the helmsman or navigator. Ideally the repeater face should be at right angles to the line of vision. Dimensions for the analogue displays (and the sensor) are given on the next page. The analogue displays are designed for flush fitting while the digital repeater is supplied with an adjustable bracket for surface mounting. All repeaters are illuminated for night use.

930 550/1 SENSOR



ALLOY HOUSING



PLASTIC HOUSING

PROGRAMMING AND ADJUSTING THE 930 550/1 SENSOR Issue C

Remove lid from sensor by releasing the four retaining screws. Programming is performed using the following components (see drawing):

1) 2 x 10 position rotary switch for data entry (SWA and SWB)
2) 16 position rotary switch for Function Select (SWC)
3) 2 position Jumper for data polarity (J2)
4) Key
5) Red and Green LEDs

SWITCH SWC

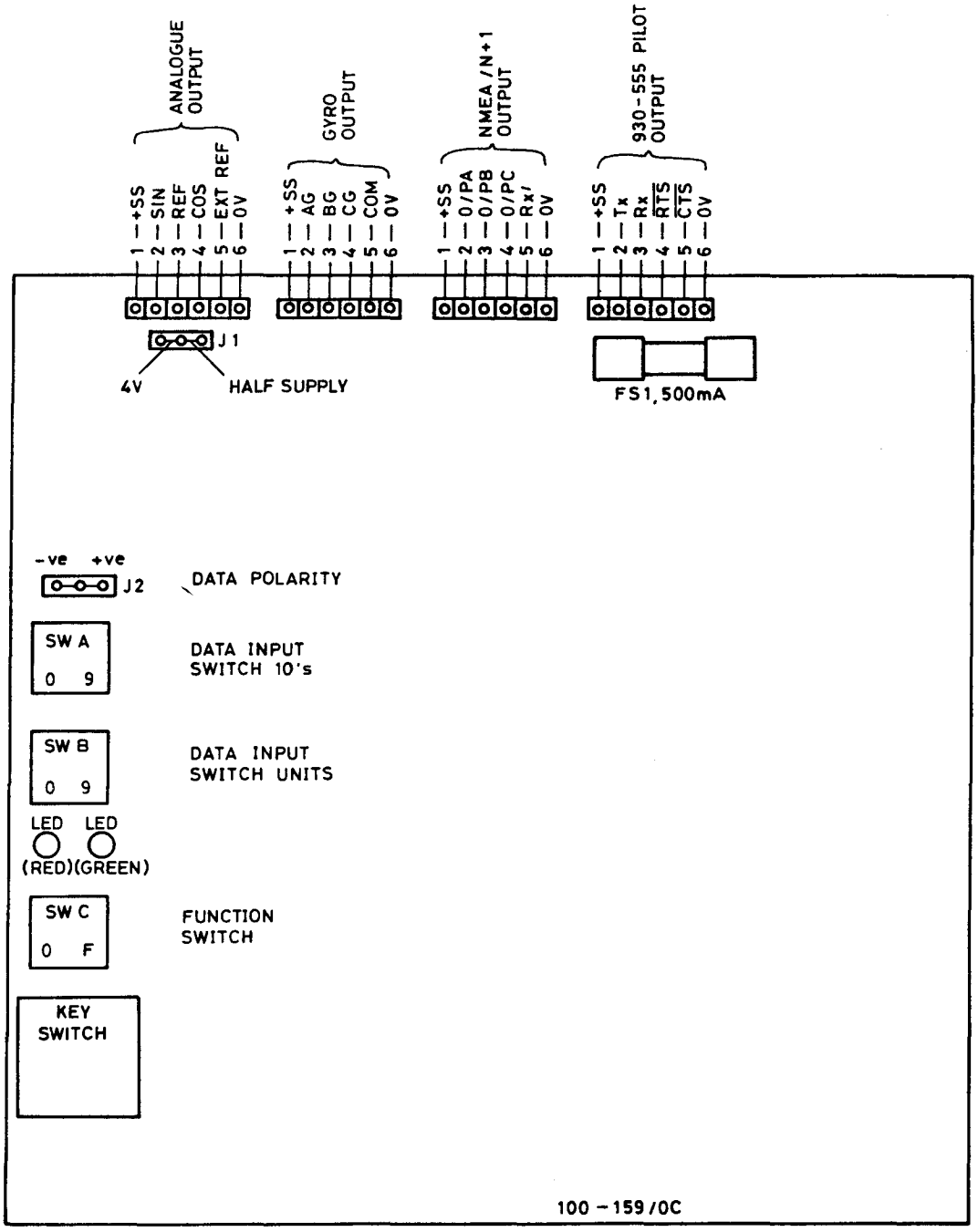
This switch selects the function to be activated.

To enter selected function

- Set switch to required position
- Set SWA and SWB if necessary
- Press KEY switch

SWITCH POSITION	FUNCTION	ACTION
0	Keyboard OFF	Leave switch in this position after adjustments completed.
1	Calibrate mode (Cetrek initial calibration)	(Note: 555 repeater will not operate if switch is in this position)
2	Deviation error clear	
3	Spare	
4	Spare	
5	555/727 input	ON SWA-0 SWB-1 OFF SWA-0 SWB-0
6	Sin/Cos 45° offset	ON SWA-0 SWB-1 OFF SWA-0 SWB-0
7	Read data from Nov-ram	
8	Spare	
9	Set variation	Set JR, SWA, SWB to required value see below
A	Set deviation coefficient A	Set JR, SWA, SWB to required value see below
B	Set deviation coefficient B	Set JR, SWA, SWB to required value see below
C	Set deviation coefficient C	Set JR, SWA, SWB to required value see below
D	Set damping rate	Set SWA-0, set SWB to select required level 0 = minimum damping 7 = maximum damping
E	Start auto deviation procedure	
F	Set data output format	Set SWA, SWB to select required data as table below

930 550/551 100-159 pcb - Switch Jumper & Pin Connections - Version '0C'



STANDARD COLOUR CABLE CODING

Pin 1	Red
Pin 2	Blue
Pin 3	White
Pin 4	Green
Pin 5	Yellow
Pin 6	Black

TO SET OUTPUT FORMAT

This version of the sensor has a maximum of four separate outputs available:-

1) Analogue output - sin/cos output - 930 550, 552 and 551
2) Gyro output - stepper gyro output- 551 version only
3) Data output - selectable data - 930 550, 552 and 551
4) Cetrek data - 930 555 and Cetrek - all versions

To select required output data

- Set switch SWC to position 'F'
- Set switches SWA, SWB as per table below
- Press key switch to enter

The green light will go out momentarily to indicate data has been stored. If no further changes are to be made at this stage, turn SWC to position '0'.

SWA	SWB	Data	Sensor Type
0	0	RS232 4800 bauds	930 551
0	1	RS232 2400 bauds	
0	2	RS232 1200 bauds	
0	3	RS232 300 bauds	
0	4	SER BIN 1	
0	5		
0	6	SER BCD 1	
0	7		930 552
0	8	NMEA 0183A	
0	9	NMEA 0183B	930 550
1	1	NMEA 0183C	
1	4	N + 1	
1	5	STEPPER GYRO	

SWITCH SWA, SWB

These switches are used to input numerical data for deviation, variation and also to select output formats as described above.

To enter numerical data

- Set SWC to function required
- Set SWA, SWB to required value
- Set J2 for polarity

+ve for NORTH or WEST
-ve for SOUTH or EAST

Each unit selected SWA, SWB is equal to 0.352^{o}.

$$\text{SWA, SWB setting} = \frac{\text{Correction required } ^{o}}{0.352}$$

Example: to enter a B coefficient correction of W17^{o}

$$\frac{17^{o}}{0.352} = 48$$

Set Jumper J2 +ve
Set SWA to 4
Set SWB to 8
Set SWC to B
Press KEY switch

TABLE FOR QUICK SELECTION OF SWA, SWB SETTINGS

Degrees	SWA	SWB	Degrees	SWA	SWB
1	0	3	14	4	0
2	0	6	15	4	3
3	0	9	16	4	5
4	1	1	17	4	8
5	1	4	18	5	1
6	1	7	19	5	4
7	2	0	20	5	7
8	2	3	21	6	0
9	2	6	22	6	3
10	2	8	23	6	5
11	3	1	24	6	8
12	3	4	25	7	1
13	3	7			

COMPASS COMPENSATION

After fitting, the installation should be checked and corrected for deviation. Ensure the sensor transit screw is adequately loosened before compensating.

The main co-efficients in the removal of deviation are:

A Alignment of the compass with the fore and aft line (keel line) of the vessel.

B Deviation due to permanent magnetism in fore and aft line.

C Deviation due to permanent magnetism in the athwartships line.

D Deviation due to induced magnetism in fore and aft and athwartships lines (commonly steel hull and/or wheelhouse type vessels), correct by soft iron quadrantal corrector spheres or plates athwart the compass.

H Heeling Error (or Vertical Force) appers when the vessel rolls or pitches moving a magnetic mass, normally below the compass, to one side or the other. The magnetic mass may be an iron keel, engine block, steel-ferro hull or even some steering gear.

AUTO DEVIATION CORRECTION

The automatic deviation correction procedure enables deviation coefficients B and C to be calculated automatically based on a starboard turn of 360° at constant rate of turn with the vessel heading somewhere West of North. The procedure is as follows.

The actual correction routine starts when the vessel passes North and continues through 360°. A smooth turn should be carried out lasting between one and two minutes. With twin engine craft spin the boat using the engine controls. With single engine craft, fix wheel or tiller in position and asjust engine speed to give a circle approximately 50 metres in diameter at a speed of 5 knots. Allow the vessel to make at least one complete turn before commencing calibration. This ensures the vessel is being turned at constant speed.

Maintaining a constant turn rate is essential for good results (constant helm and engine speed) as are reasonably calm conditions. Tide will not affect the results, but excessive wind or swell can cause large errors.

Procedure

- Turn switch SWC to position E
- Set vessel turning as described above
- Press KEY switch when vessel head between WEST and NORTH, green light will go off
- Green light will flash during calibration
- Red and green light together will indicate error
- Green light constant indicates correct calibration

Following a satisfactory correction, the calculated coefficients B and C will be entered into memory and coefficient A will be set to zero. If the sensor has not been previously aligned along the fore and aft line of the vessel then there may be a constant offset in heading remaining to be corrected. This will be the same for all headings and can be removed by rotating the sensor manually so that correct reading is obtained or alternately be entering the required correction in coeff. A. (See below under Variation Adjustment).

If any error is sensed during the run, the procedure is aborted and the red and green lights will come on permanently (see error reset procedure below).

The following conditions will cause an error:

1. Vessel not West or North at start of run.
2. Port turn.
3. Rate of turn too fast or too slow.
4. Deviation correction too large (maximum deviation correction is $\pm 22\frac{1}{2}°$)

If an error occurs, the previous deviation correction entries are retained.

If no more adjustments are required, turn SWC to position '0'.

MANUAL DEVIATION CORRECTION

If preferred, or if it is not possible to carry out the controlled turn required in the auto deviation correction, then it is possible to manually correct for A, B and C deviation using switches SWA, SWB and SWC.

Procedure

- Head vessel NORTH (magnetic), enter B correction required for compass to read correct heading
- Head vessel WEST (magnetic), enter C correction required for compass to read correct heading
- Head vessel SOUTH (magnetic), enter B correction to remove half of remaining heading error
- Head vessel EAST (magnetic), enter C correction to remove half of remaining heading error
- Align vessel on any known heading, enter A correction required to obtain correct heading display

To enter A, B or C corrections

- Set SWC to A, B or C as required
- Set J2 to -ve, or +ve as required
- Set SWA, SWB to the value required (see table above)
- Press KEY switch

VARIATION ADJUSTMENT

If the sensor is required to output the TRUE heading, the local variation can be entered. Turn SWC to position '9', select the correct combination of J2, SWA and SWB from the table above to give the correct value required, depress key switch. Green light will flash for correct entry. If no more adjustments are required, turn SWC to position '0'.

OUTPUT CONFIGURATIONS

Sine/Cosine reference level

- The Sine/Cosine reference level can be set using jumper J1
- J1 set at 4V gives 4 volts reference level
- J1 set at half supply gives reference of half volts supplied to PIN 5, plug 1 (maximum permissible input 35V)

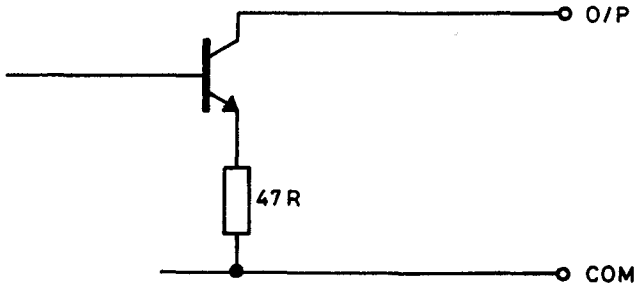
Digital Outputs (PL3)

- Signals are 5V logic levels
- Max current for each output is 20 MA

Gyro Outputs (PL2)

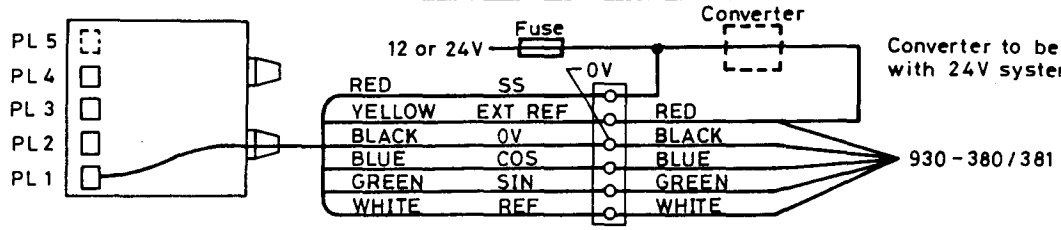
- Outputs are open collector
- 100 MA max current for each output
- Emitters of each output transistor are connected to common (PL2/5)

Typical Output



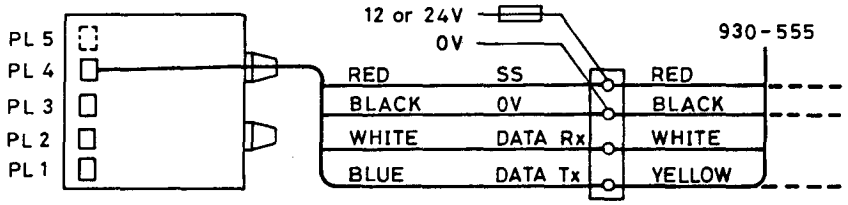
930 550 Connections Version 'OC

CONNECTIONS TO 930-380/381 ANALOGUE REPEATER



Converter to be used with 24V system.

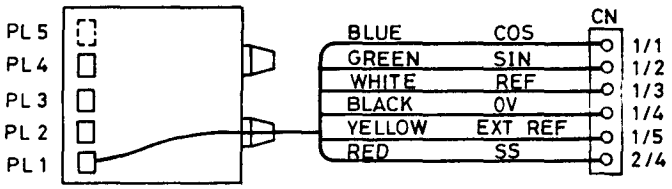
CONNECTIONS TO 930-555 DIGITAL DISPLAY



ADDITIONAL REPEATERS

(Do not connect white from additional stations).

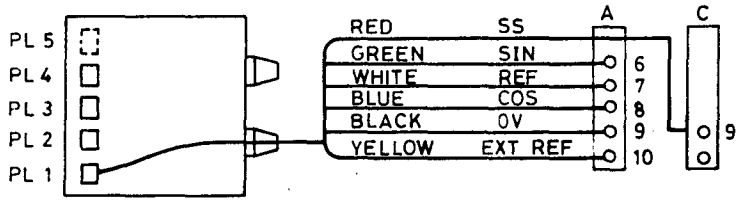
CONNECTIONS TO 701 SYSTEM



930 - 507 INTERFACE

12 or 24V system only.

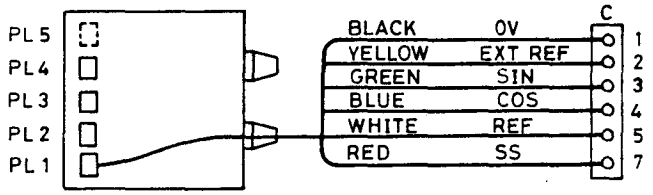
CONNECTIONS TO 721 SYSTEM



930 - 600 DISTRIBUTION BOX

12 or 24V system only.

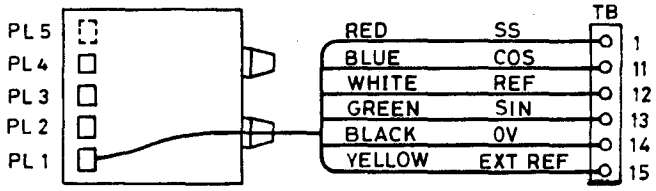
CONNECTIONS TO 7000 SYSTEM



930 - 608 CONTROLLER PCB 100 - 149

12 or 24V system only.

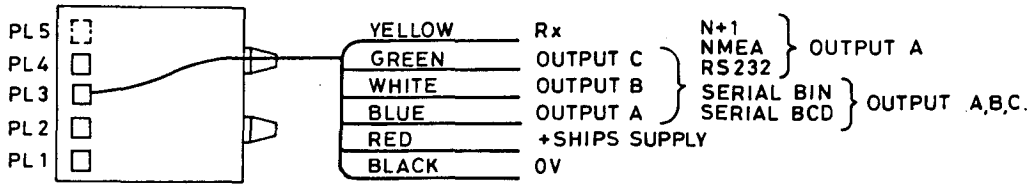
CONNECTIONS TO 9000 SYSTEM



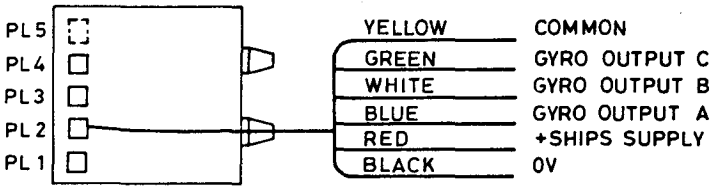
930 - 008 9000 CONTROL UNIT

12 or 24V system only.

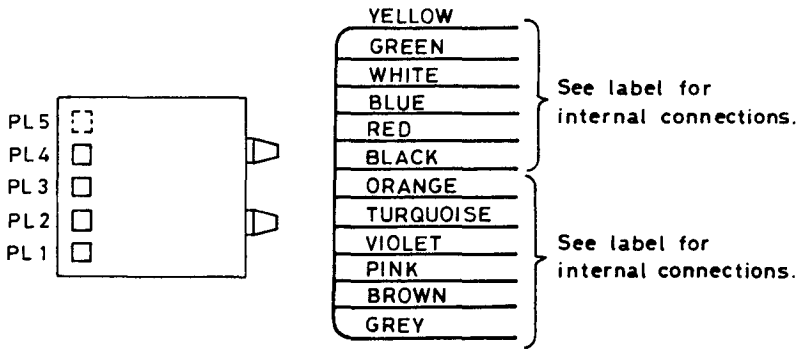
CONNECTIONS TO DIGITAL OUTPUT



CONNECTIONS FOR GYRO OUTPUT (551 ONLY)

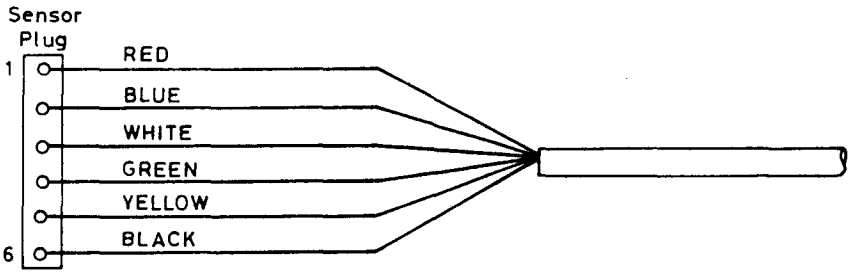


CONNECTIONS FOR 12 WAY CABLE

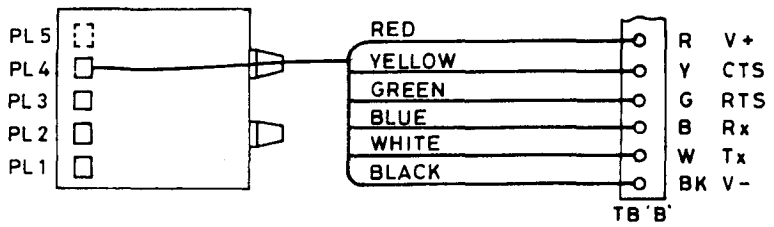


The 12 Way cable is only fitted when more than 3 outputs are required.

CABLE CONNECTIONS

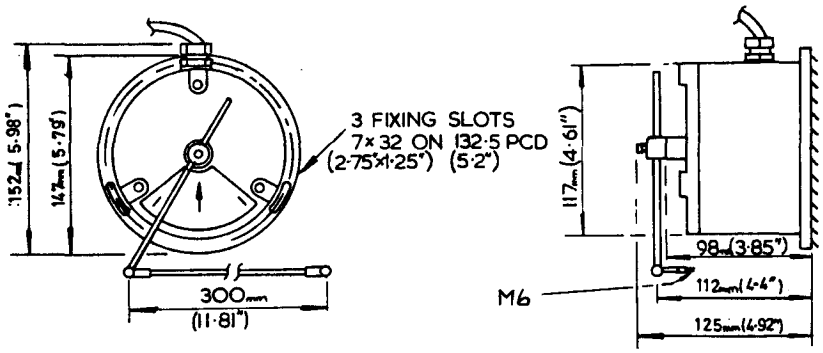


CONNECTIONS TO 727 SYSTEM



930 - 617
DISTRIBUTION BOX

930 801 RUDDER FEEDBACK UNIT



Voltage Supply	:	10.5V stabilised
Weight	:	2.1kg
Cable supplied	:	14m 8 way x 7/0.2 mm
Compass safe distance	:	Grade 1 (0.25^{o}) 300 mm (12")
		Grade 2 (1^{o}) 300 mm (12")
Environmental Classification	:	Waterproof, may be mounted in exposed positions.

DESCRIPTION

The 930 801 rudder feedback unit comprises a robust metal casting, environmentally sealed against bilge water etc, and having a linkage assembly for connection to the rudder tiller arm or tie bar. Inside the casting are a military specification potentiometer and a limit switch assembly comprising two micro-switches and an actuating cam.

INSTALLATION

The unit should be mounted near the rudder in such a way that when the linkage arm is connected the movement of the 930 801 shaft will be a faithful copy of the movement of the rudder stock (see diagram). The sense of the rotation is unimportant as this will be taken care of when wiring-up, but the distances D1 and D2 must be as nearly as possible the same, so that the rudder and the 930 801 arm move in parallel with each other. The Allen screw surmounting the 801 shaft may be slackened to allow the arm length to be adjusted. A platform of some kind will usually have to be made to support the body of the unit, which should be mounted in such a way that the red spot on the rotating shaft lies on the same side as the label. The unit will not work if this is reversed.

Before wiring-up, determine whether you should use Phasing A or Phasing B by applying starboard rudder and observing the movement of the 930 801 shaft from directly above the unit. If the shaft moves clockwise wire as Phasing B, and if it moves anti-clockwise wire as Phasing A. Connections are shown in the wiring schedule.

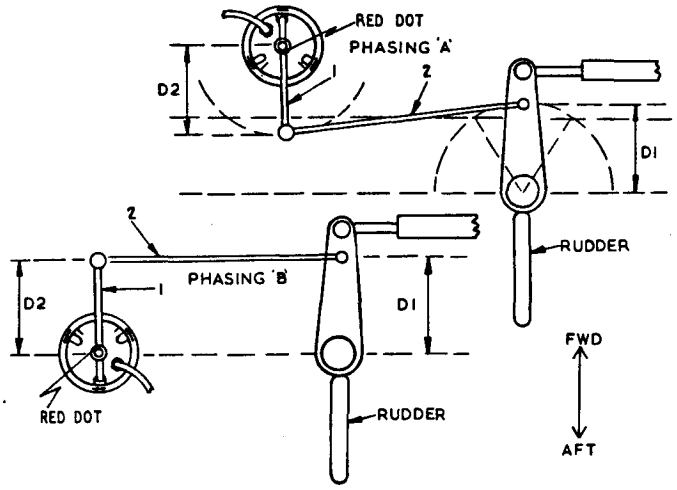
930 801 RUDDER REFERENCE UNIT (continued)

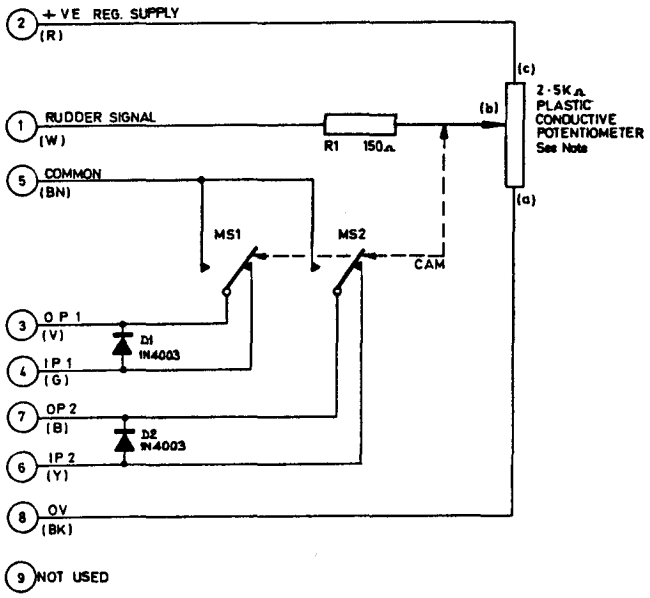
When the rest of the system is installed, switch to STANDBY and check that the rudder meter moves into the green sector with starboard helm applied and into the red with port helm. If it doesn't, re-check your phasing (not forgetting the limit switches).

Use a multimeter to check that the limit switches operate before the rudder arm reaches its end stops. The approximate points of operation are marked on the silver label. Adjust if necessary by removing the top of the unit and moving the actuating cams on their shaft.

930 - 801

RUDDER REFERENCE INSTALLATION DIAGRAM





NOTE: The conductive plastic track of the potentiometer may be destroyed by the passing of currents greater than 10 milliamperes through the wiper when set to extremes of track travel. Therefore the usual multimeters must not be used for resistance continuity testing

Technical Queries
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