Hercules

SYSTEM 190

BROOKES & GATEHOUSE LTD

Owner's Handbook
for
Hercules System 190

Introduction

The Hercules System 190 has brought the technology of the micro-processor to the field of yacht instrumentation in the most significant way. Full use is made of the potential of this device by offering a system which is capable of expansion. The flexibility of the system is such that each installation can (and should) be 'tailor-made' to the owner's requirements.

Please keep this book handy for reference in order that the maximum benefit may be obtained.

Happy sailing!

Note

It is strongly advised that this handbook be read carefully. Both the accuracy and reliability of this instrument are dependent upon correct installation, calibration and operation.

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1 DESCRIPTION

1.1 GENERAL

The Hercules System 190 is a yacht instrumentation system which is capable of being expanded from a basic speedometer/log and wind instrument to a comprehensive system displaying navigational and performance information.

This handbook deals with the component parts that make up the Hercules and how the system is built up, but due to the built-in flexibility of the system it does not attempt to cover all the possible variations which might result.

The heart of the system is a computer unit which accepts inputs from various sensors, such as the masthead unit and underwater unit. It provides outputs for certain analogue indicators and for digital displays. The computer unit has a microprocessor which is programmed to carry out a variety of calculations on the inputs and then present the results or the various displays.

The computer unit has no operator controls other than internal calibration switches which must be correctly set (see para 3.3). Control of certain functions is carried out at a separate master keyboard which is normally installed at the chart table. A second keyboard may be installed externally if required.

The multi-function display (MFD) is a digital display unit controlled by four push buttons. Any one of four pre-selected functions may be displayed at the touch of a button. A liquid crystal display with back lighting is employed to give good legibility under all conditions of ambient light. The pre-selection of the four functions required is made by selector switches inside the unit.

1.2 CAPABILITY OF THE HERCULES 190 SYSTEM

The outputs available from a Hercules system fitted with a masthead unit and underwater unit are described briefly below. **Details of how to obtain any of the information channels are given in Section 2 of this book.**

1.2.1 Boat speed and log

Boat speed is available on both analogue and digital indicators. If speeds in excess of 12 knots are normally required to be displayed, the underwater unit should be fitted with a red impeller and a 50 knot analogue indicator installed in place of the 12 knot meter. A special switch setting in the computer unit is required should a red impeller be used (see Section 3.3.1).

The log readings are available on digital displays only. The reset log reading can be brought back to zero either by switching off the power to the system or by operating a push button at the master keyboard. The accumulating log is maintained when power to the system is switched off by means of an automatically re-charged battery in the computer unit.

1.2.2 Wind speed and direction

The Hercules System 190 presents apparent wind speed and angle on both analogue and digital displays, and the computed values of true wind angle and true wind speed on digital displays. The analogue indicators consist of a 0-50 knot linear scale wind speed indicator, 360° apparent wind angle indicator, and a magnified direction indicator which operates within a 45° arc either side of the bow or stem.

Wind speeds up to 100 knots are shown on the digital displays.

1.2.3 Timing functions

The timing functions are presented on digital displays only. They comprise a five minute count-down/elapsed time indicator, and as a separate channel, a stopwatch.

The five minute count-down/elapsed time facility is provided for racing purposes and is controlled by the master keyboard. This is arranged so that when the five minute counter is started all the computed ('linked-data') channels, which are banned for racing under RORC rules, stop displaying their data. At the end of the five minute count-down the display starts to show elapsed time. The 'linked-data' channels remain inhibited until the timer is stopped and then reset at the end of the race.

The stopwatch operates independently of the 5 min/elapsed time function and has the normal features of start-stop-reset.

1.2.4 Performance measurement

The computer unit is programmed to accept boat speed, apparent wind speed and apparent wind angle inputs, and to process this information to provide three channels of yacht performance data. Automatic correction is made for typical errors on input data of wind speed and direction.

Reaching

The computer compares the measured boat speed with the maximum which could be obtained by a typical boat of the same rating with the same apparent wind speed and angle. The indication is the measured boat speed expressed as a percentage of this maximum. The sail trim and other adjustments can be varied to obtain the highest percentage possible.

Tacking

Tacking performance is concerned with the speed made good (Vmg) which can be defined as the component of the speed of the yacht in the direction of (or away from) the true wind. However if Vmg alone were to be displayed, this would still require further interpretation before it could be used as a measure of performance.

The Hercules 190 computer unit continuously calculates Vmg from the input data of boat speed, apparent wind speed and apparent wind angle, and then compares the result with the maximum obtainable by a typical boat of the same rating sailing under the same conditions. The comparison is displayed as a percentage of this maximum.

Speed made good (Vmg)

This can be used for navigation purposes and for monitoring performance during a tack.

1.2.5 Battery voltage

A highly accurate measurement of battery voltage is available on a digital data channel. With the aid of discharge curves (see para 2.15) an estimate can be made of the number of hours remaining before the ship's battery needs to be re-charged.

1.3 FURTHER FACILITIES WHEN THE HALCYON COMPASS IS ADDED

With the addition of a Halcyon electronic compass the following additional facilities become available:

(a) Dead reckoning (D.R.)

(b) Ship's head

(c) Wind direction (magnetic)

(a) The D.R. channel, having been reset by the master keyboard, displays distance and course made good on a digital display. This information is continuously up-dated and may be transferred to the chart. Corrections for drift and tidal set etc. must be made when determining the position of the ship as these are not calculated by the Hercules computer.

(b) The ship's heading with respect to magnetic north is available on one digital display channel.

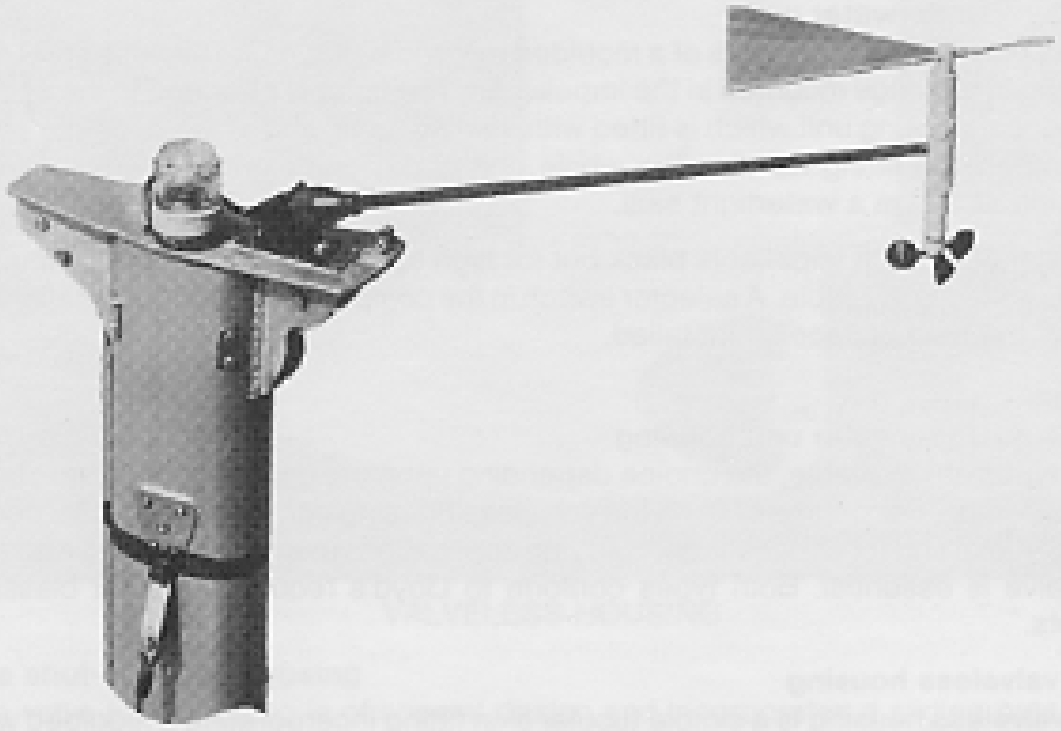
(c) The direction of the wind with respect to magnetic north is also available on one digital channel.

1.4 SENSORS

1.4.1 Masthead units

(a) Mini masthead unit

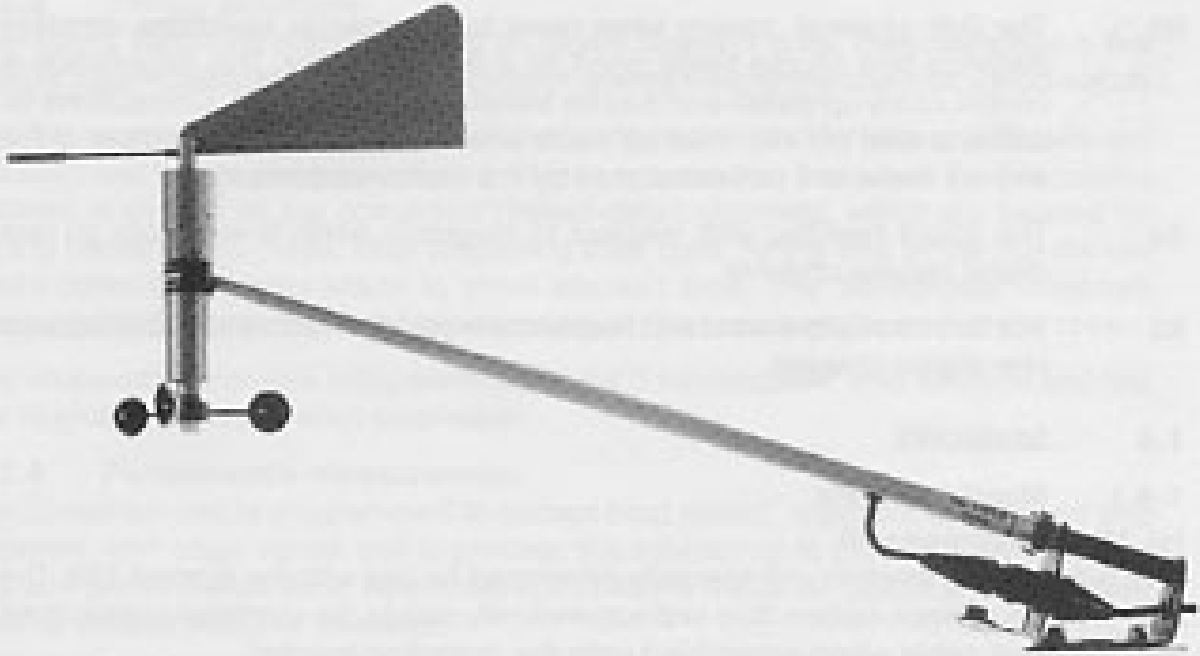
This is a small lightweight unit specially developed for use with the System 190. The spar is made of black carbon fibre and automatically makes the electrical connections with the mast cable when assembled onto the mounting bracket.



MINI MASTHEAD UNIT

(b) 'C' type masthead unit

The metal spar 'C' type masthead unit is available as an alternative to the mini-masthead unit. A switch in the computer unit must be set to correspond with the type of masthead unit fitted (see para 3.3.2).



'C' TYPE MASTHEAD UNIT

1.4.2 Underwater unit

The underwater unit consists of a moulded nylon impeller on a stainless steel shaft running in bearings mounted in the impeller fin. The latter is attached to the end of a cylindrical sensing unit which is fitted with sealing rings, and at the opposite end to the impeller, a lifting handle. The whole unit is designed to be inserted into the housing and form a watertight seal.

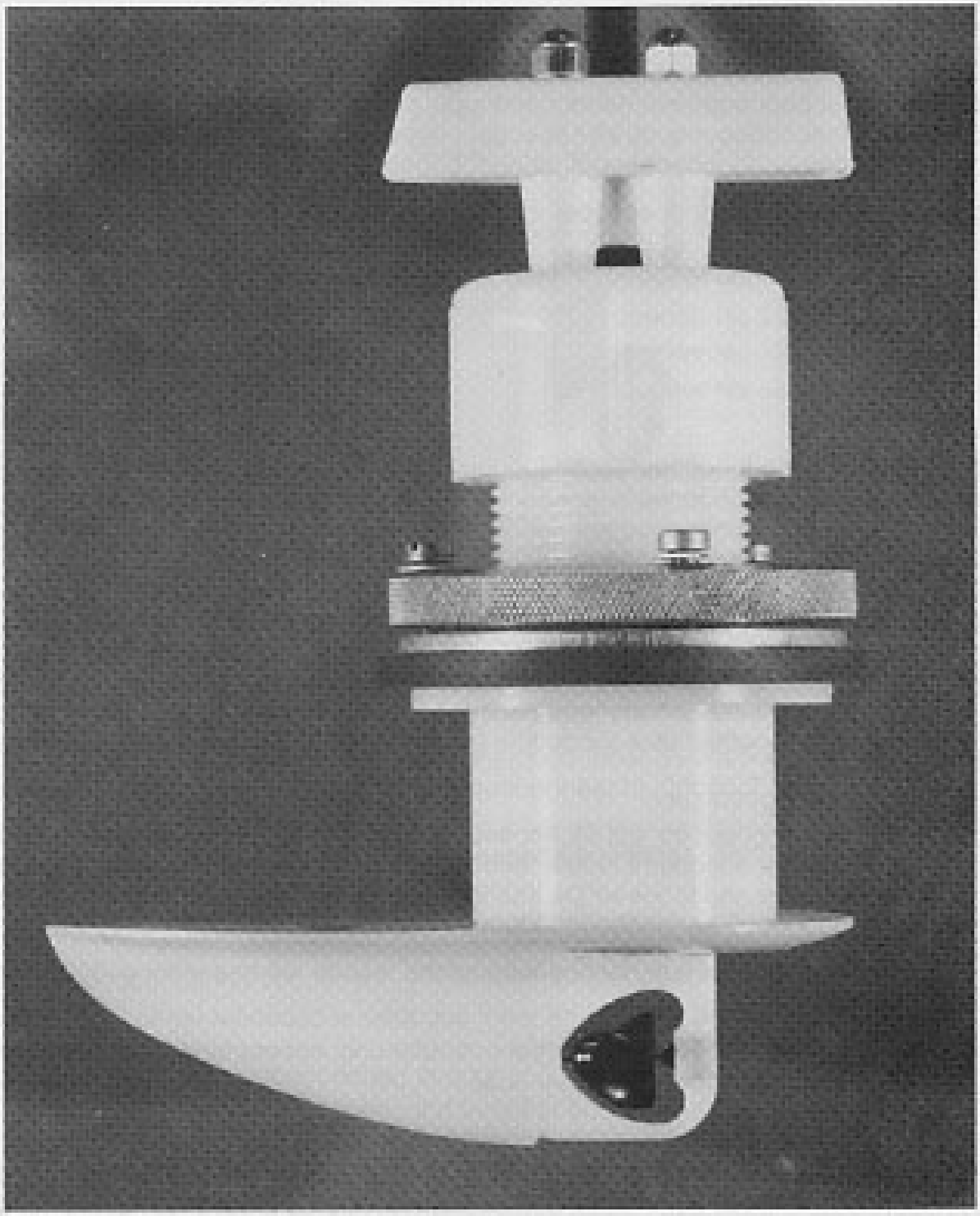
The standard pitch impeller is black but for high speed use a longer pitch impeller coloured red is available. A selector switch in the computer unit alters the calibration to suit the type of impeller installed.

1.4.3 Underwater unit housing

Two types are available, the choice depending upon the depth of installation below the waterline. For depths of 0–4ft the valveless housing can be used, but for deeper installations and for all passenger-carrying applications use of the housing with shut-off valve is essential. Both types conform to Lloyd's requirements for classified yachts.

The valveless housing

The valveless housing is a simple tubular skin fitting incorporating a moulded weed deflector. It is closed by means of a sealing cap after removal of the underwater unit. Alignment of the deflector fin with the direction of water flow is achieved by rotating the housing within its outer sleeve, which is fixed to the hull, and then locking it in position by means of its retaining ring-nut (see Section 3.2). Alignment of the impeller fin with the deflector occurs automatically on lowering the underwater unit into its operating position. The plunger of the underwater unit contains two neoprene sealing rings and a bronze piston ring, the purpose of which is to scrape marine growth from the bore of the housing.



VALVELESS HOUSING

The shut-off valve housing

The valve-type housing is of special design and incorporates a sliding gate valve enabling the tube to be closed when the underwater unit is in the retracted position so that the latter may subsequently be withdrawn without admitting water into the boat. Alignment is maintained by a dowel pin which must be inserted into a hole before the handle can be fully lowered. A locknut is provided to clamp the alignment device once the correct setting has been found. The underwater unit is held down against external pressure by means of a threaded retaining ring.

A separate weed deflector is provided which is fitted ahead of the impeller fin after the alignment procedure has been completed (see Section 3).

SHUT-OFF VALVE HOUSING

1.4.4 Second underwater unit

If required, two underwater units may be installed, one in either bilge. A gravity-operated switch automatically selects the lee-side underwater unit. The switch, which must be mounted on a transverse bulkhead, is fitted with a manual override.

1.5 COMPUTER UNIT

The computer unit carries out all the data processing for the system but has no operator controls. It accepts inputs from the sensors and provides outputs to the analogue displays and to the MFDs. The supply voltage required is a nominal 12 or 24V dc and ON/OFF switching is performed externally at the ship's switchboard.

The system may be expanded by adding the master keyboard to give control facilities (see Section 1.7).

Calibration controls are provided at the computer unit, access to which is available through a rear hatch cover (see para 3.3).

1.6 MULTI-FUNCTION DISPLAY (MFD)

Up to four separate functions can be displayed at any of these units. Each unit consists of a moulded case with a window behind which is a four-digit liquid crystal display. Four push-button selector switches are provided on the front face of the unit to enable a selection of the function to be made. An indicator bar appears on the display adjacent to the appropriate push-button to show which function has been selected. At night an L.E.D. illuminates the appropriate legend. The left-hand channel is always activated at switch-on, and this should be used for primary information.

To set up the four functions required at a particular MFD, channel selector switches are provided inside the unit. Instructions for the setting of these are given in Section 3 of this book 'CALIBRATION AND ADJUSTMENT'.

Up to 32 channels will be available for selection. All MFDs are basically the same, and differ only by the adjustment of the channel selector switches.

Labels are provided to indicate the function of each push-button switch after adjustment of the channel selector switches has been made.

A three-core cable, known as the data-bus, carries the input data and operating power supply to each MFD. A further supply of 12V dc is required to illuminate the display. A dimmer unit with switch is available if required.

Multi-function displays are despatched from Brookes & Gatehouse preset to the following:

1	BOAT SPEED (left hand key-pad)	channel No 1
2	LOG	channel No 2
3	WIND SPEED	channel No 10
4	APPARENT WIND ANGLE	channel No 13

1.6.1 Dedicated Display

A multi-function display can be dedicated to a single function, if required, by setting all four MFD channel selector switches to the same channel. A large label to indicate the selected function is then inserted to cover the push-buttons.

1.7 MASTER KEYBOARD (190/9)

This unit, which is an addition to the basic system, is provided with four key-pads to give the following facilities:

1. 5 MINUTE COUNTDOWN/ELAPSED TIME control. When running, all 'linked data' channels are inhibited.
2. SELECT which enables any of the other 31 channels to be displayed on any MFD which has been pre-set to 'SELECT'.
3. TRIP DATA RESET. A short push resets the RESET LOG. A long push (more than 4 seconds) resets DEAD RECKONING when System 190 has an input from a Halcyon.
4. START/STOP/RESET for the stopwatch.

For further details of the Master Keyboard see Section 2 of this book.

Note: use of the keyboard is essential if the linked data channels are required.

1.8 RACING UNDER RORC RULES

Under RORC rules, functions may not be automatically combined or computed (see RORC general condition 12). Some of the outputs from Hercules are computed and are therefore banned when racing under RORC rules. To inhibit these functions the five-minute count-down and elapsed time measurement programme on the master keyboard is used. Once this programme is started, should any of the banned functions be called up, the word OFF appears on the display. The banned outputs are still being computed but cannot be displayed. When the elapsed time count is stopped at the finish, the total time is maintained in the computer and is proof to an RORC scrutineer that these functions have been inhibited for the duration of the race.

Some races are conducted under other rules which allow the use of the RORC banned functions. In these cases, the five-minute count-down is used in the normal manner but elapsed time is measured using the stop-watch facility. As soon as the five-minute count-down is complete it is reset at the master keyboard and then the 'banned' functions can be displayed.

2 OPERATION

2.1 START UP

i) Ensure that the underwater unit(s) is correctly located in its housing(s) and in the operating position (see para 2.2)

ii) Switch on the supply to the computer unit at the ship's switchboard.

iii) Switch on the display illumination supply if required.

2.2 UNDERWATER UNIT

2.2.1 Valveless housing

Remove the sealing cap from the housing and quickly insert the underwater unit. Once the plunger is in the housing the neoprene rings form a perfect seal. Screw down the retaining ring. Push the handle down to the fullest extent. This is only possible when the fin is in line with a slot in the bottom of the housing. Align the unit with the direction of water flow in accordance with the instructions given in Section 3.2

2.2.2 Shut-off valve housing

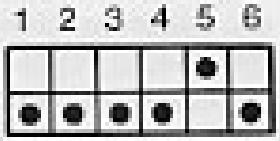
Remove the sealing cap from the housing, insert the underwater unit and screw down the retaining ring. It will be found that the ring cannot be engaged until the peg on the side of the gland casing is located in the slot at the mouth of the housing. Open the valve by turning the handle fully anticlockwise. Lower the lifting handle and rotate it until the dowel pin on the top of the gland casing drops into the hole in the lower nut. Screw down the upper retaining ring.

2.3 READING A MFD

Each MFD is preset to indicate up to four different functions (see para 1.6). The allocation of functions to any one MFD is determined by the setting of switches in the unit (see Section 3.4), after which legend labels are located next to the push-buttons to indicate the function to be displayed.

To call up any channel simply press the appropriate push-button on a MFD at which that function is available. Ensure that the units of the function being observed are known (e.g. wind speed in knots or metres/second).

2.4 BOAT SPEED



Channel No 1

MFD selector switch setting:
(This is the ex-factory standard setting for switch 1 on the MFD.

This is available on a 12 knot analogue indicator as well as a multi-function display. For high speed applications a red impeller is installed in the underwater unit and a switch adjusted in the computer unit (see Section 3.3.1) to suit. A 50 knot analogue indicator is available for this application.

Speed in knots is displayed on a MFD in tens, units and two decimal places. For speeds less than 10 knots the leading zero is not displayed.

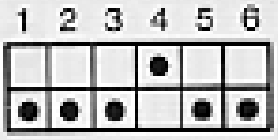
At speeds below 20 knots a small bar appears on the left of the display, as shown below, to indicate increase or decrease in speed.

A special form of damping, known as adaptive damping, has been devised which allows the display to respond slowly to small changes in speed but more rapidly to large changes. In effect this is a combination of light and heavy damping under computer control.

BOAT SPEED SPEED INCREASING SPEED DECREASING

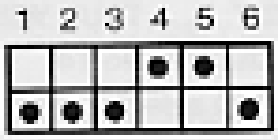
2.5 LOG

2.5.1 Stored log



Channel No 2

MFD selector switch setting:
(This is the ex-factory standard setting for switch 2 on the MFD).

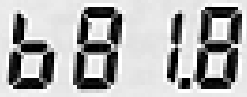


Channel No 3

MFD selector switch setting:

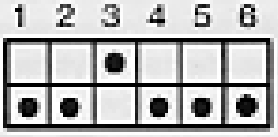
For channel 2 the accumulated distance is shown in nautical miles up to 9999, alternating every two seconds with two decimal places of miles. For instance, if the distance to be displayed were 4681.83 nautical miles, the display would show 4681 and two seconds later .83, and so on at two second intervals. The display is also up-dated at two second intervals.

For channel 3 the distance is displayed in hundreds, tens, units and one decimal place of nautical miles, and is up-dated every two seconds.



For both channels the distance information is stored in the computer memory and is maintained by an internal re-chargeable battery. This is charged automatically whenever the system is being operated. It has sufficient capacity to maintain the log for a whole season without the power being switched on. If completely discharged, the battery requires 10 hours accumulated operating time in order fully to recharge.

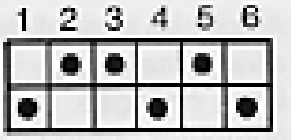
2.5.2 Reset log



Channel No 4

MFD selector switch setting:
Distance in nautical miles is shown up to 9999, alternating every two seconds with two decimal places. The display is up-dated every two seconds and is reset to zero by switching the supply to system off and then on, (if no master keyboard is fitted). If a master keyboard is fitted reset can only be achieved by briefly operating the RESET key (one second or less).

2.6 APPARENT WIND ANGLE

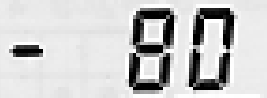


Channel No 13

MFD selector switch setting:
(This is the ex-factory standard setting for switch 3 on the MFD).

This is available on the 360° and magnified direction analogue indicators as well as on a multi-function display.

On the MFD the apparent wind angle is given in degrees from zero to 180. A horizontal bar appears to the left or right of the numerals to indicate port or starboard respectively. For wind angles of less than 100° the zero in the hundreds position is not shown. The display is up-dated every two seconds and is subject to computer-controlled damping.



80° PORT

120° STARBOARD

2.7 TRUE WIND ANGLE

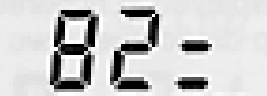
Channel No 14

MFD selector switch setting:

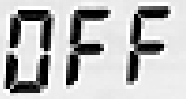
The computer unit continuously resolves the vector triangle consisting of boat speed, apparent wind speed and true wind speed. One of the resultant outputs is True Wind Angle. This is displayed in degrees from 0 to 180 with two horizontal bars either to the left or right to indicate port or starboard. At angles of less than 100° the zero in the hundreds position is not displayed.

As this is a computed function, the display is replaced by the word 'OFF' when the LINKED DATA key-pad on the Master Keyboard is operated, or if no keyboard is fitted, for racing under RORC rules.

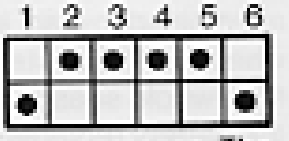
130° PORT



82° STARBOARD



2.8 WIND DIRECTION



Channel No 15

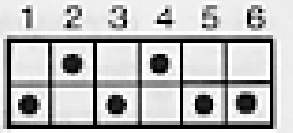
MFD selector switch setting:

Wind direction is computed with the additional data from the Halcyon compass. The display is in degrees related to magnetic north. If the 'LINKED DATA' is inhibited from the Master Keyboard, or if no keyboard is fitted, the display shows the word 'OFF' as shown below.

2.9 WIND SPEED

Note: Wind speed is displayed in knots or metres/sec as selected by a switch in the computer unit. All channels showing wind speed are affected by the one switch and it is not possible to have a combination of knots and metres/sec on different channels.

2.9.1 Apparent wind speed



Channel No 10

MFD selector switch setting:
(This is the ex-factory standard setting for switch 4 on the MFD).

This shows the apparent wind speed to one decimal place up to 9.9 above which it is displayed in tens and units. The display is prefixed by the letter A. Computer-controlled damping is applied.

2.9.2 True wind speed

Channel No 12

MFD selector switch setting:

This is calculated by the computer from apparent wind speed and direction data together with boat speed. The result is displayed in knots or metres/sec, as pre-selected by a switch in the computer unit. True wind speed is subject to heavy (60 second) damping.

When linked data devices are disabled for RORC racing, or if no master keyboard is fitted, the word OFF appears on the display.

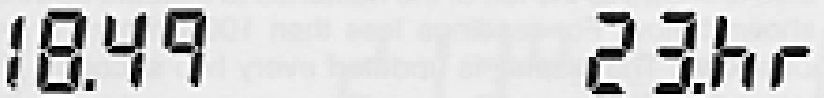
2.10 TIMER

Channel No 30

MFD selector switch setting:
(5 minute countdown/elapsed time)

These functions are principally for use when racing. The timer is first reset by operating the 'Linked Data' key-pad on the Master Keyboard so that the adjacent L.E.D. glows continuously and the display at the MFD shows 5.00. When the 5 minute gun is heard the 'Linked Data' key-pad is operated again, the adjacent L.E.D. flashes on and off continuously and the display counts down.

At the end of the five-minute period the timer stops counting down and starts to display elapsed time. The display shows minutes and seconds for 9 seconds followed by the hours every tenth second as shown below:

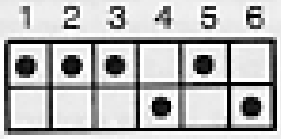


When the 'Linked Data' key-pad is again pressed the elapsed time is 'frozen' and the display alternates between hours and minutes/seconds. The L.E.D. is now extinguished. Further operation of the 'Linked Data' key-pad causes the L.E.D. to glow continuously and the linked data functions are once again operative. The display then shows 5.00 indicating that the timer is reset for 5-minute countdown.

2.11 STOP-WATCH

Channel No 29

MFD selector switch setting:



The stop-watch facility is controlled by the STOP WATCH key-pad on the Master Keyboard. Successive operation of this key-pad takes the display through the sequence START, STOP, RESET.

When the watch has started, the L.E.D. adjacent to the STOP WATCH key-pad on the Master Keyboard flashes on and off continuously. The display shows the time in minutes and seconds up to 59 minutes and 59 seconds for 9 seconds at a time. Every ten seconds the display changes to show the hours as shown below:

When the stop-watch is stopped by the next operation of the STOP WATCH key-pad, the count is stopped and the display is frozen, alternating between hours and minutes/seconds. The L.E.D. is extinguished.

When the STOP WATCH key-pad is again operated the display goes to 00.00 and the L.E.D. at the Master Keyboard glows continuously.

2.12 PERFORMANCE

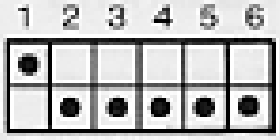
Note: In order to get realistic results on these channels it is important that the IOR rating be correctly set in the computer unit, the log correctly calibrated (see para 3.3), and the masthead unit properly aligned.

There are three channels allocated to performance indication as described in para 1.2.4.

(a) Reaching

Channel No 16

MFD selector switch setting:

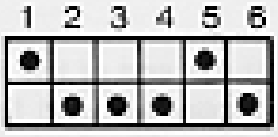


The number displayed is a percentage of the ideal and is up-dated every two seconds. The reading shows the letter P. When the reading is less than 100 the zero in the hundreds column is not shown. This channel is subject to heavy damping.

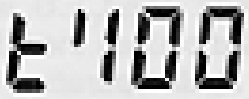
(b) Tacking

Channel No 17

MFD selector switch setting:



This is again a percentage with the letter P appearing to the left of the display. A vertical bar also is shown to the left of the numerals to indicate upwind or downwind tacking as shown below. For readings less than 100% the zero in the hundreds column is not shown. The display is updated every two seconds. This channel is subject to heavy damping.



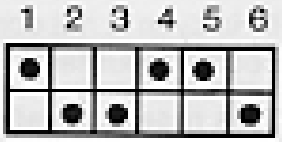
UPWIND

DOWNWIND

(c) Vmg

Channel No 19

MFD selector switch setting:



This is shown in tens, units and one decimal place of knots. For readings of less than 10 the first zero is not displayed. The display is prefixed by a symbol u for upwind or d for downwind. The reading is updated every two seconds.

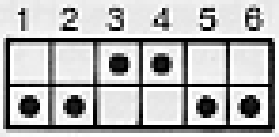
UPWIND

DOWNWIND

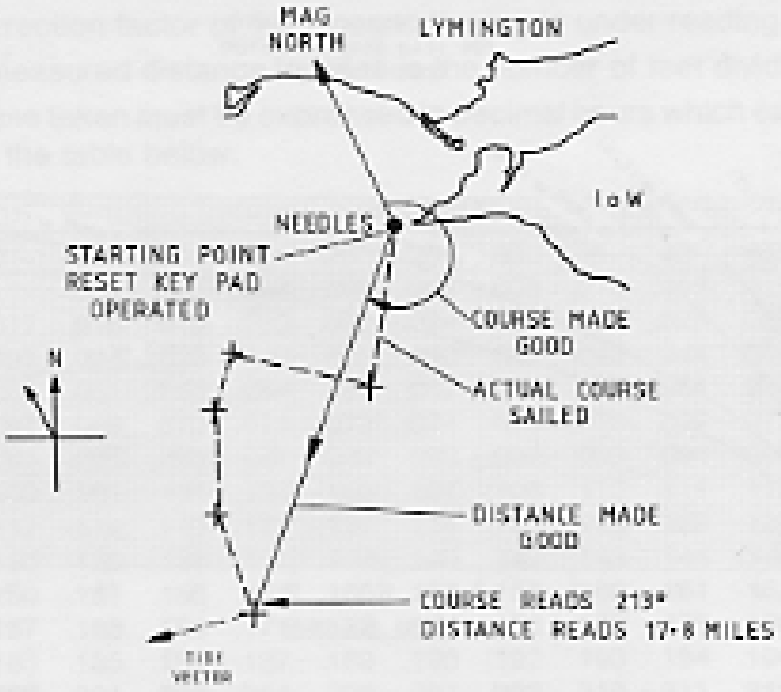
2.13 DEAD RECKONING

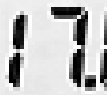
Channel No 6

MFD selector switch setting:

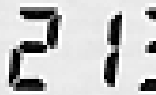


This requires an imput from the B&G Halcyon electronic compass. The course is shown in degrees magnetic and the distance in nautical miles. The two outputs are shown alternately every two seconds. The course and distance are computed continuously from the instant that the function is reset, which is achieved by pressing the RESET key-pad at the master keyboard for at least four seconds. The adjacent L.E.D. lights after four seconds and is extinguished when the key-pad is released. The distance information is shown as hundreds, tens, units and one decimal place. The leading zero is suppressed in all cases. The course angle is displayed with a degrees sign and is with reference to magnetic north.





DISTANCE MADE GOOD



COURSE MADE GOOD

When the linked data functions are inhibited at the master keyboard for racing purposes, or if no keyboard is fitted, the course and distance continue to be computed bu the display shows the word 'OFF'.

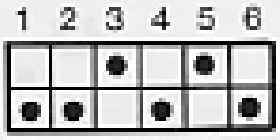
If Halcyon is not connected to the system this channel acts as a Reset Log with the course input taken as 000°.

This reset operation should be the first action of the navigator in the event of there being a MAN OVERBOARD. When the ship is brought about, it is then necessary to steer the reciprocal of course indicated until the distance made good reads zero.

2.14 HEADING

Channel No 5

MFD selector switch setting:

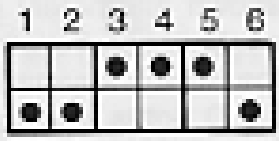


This requires a Halcyon input also. The heading is displayed on the MFD in degrees from 000° to 359° and is related to magnetic north. The display is updated every two seconds and is subject to damping over a period of 10 seconds.

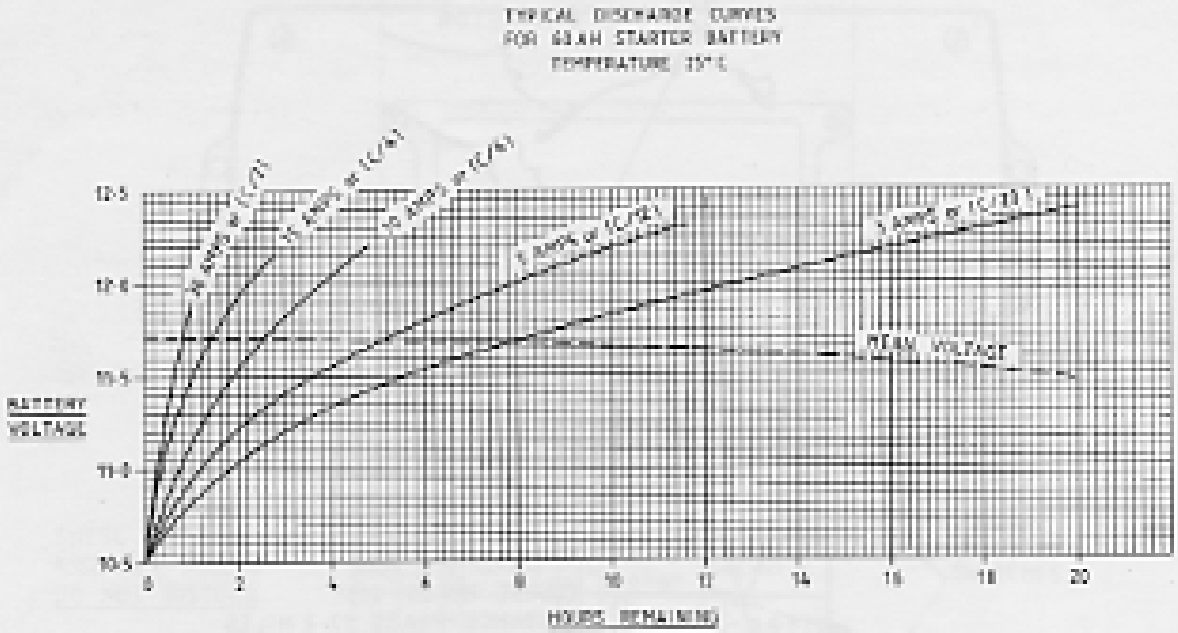
2.15 BATTERY VOLTAGE

Channel No 7

MFD selector switch setting:



This is a very accurate measurement of the ship's battery voltage, from which the state of discharge of the battery can be ascertained. A forecast of remaining hours at any known discharge rate can be made with the aid of the curves shown below.



DISCHARGE IN AMPS SHOWN FOR NOMINAL 60 AH BATTERY
FOR OTHER CAPACITIES USE FIGURES IN BRACKETS (WHERE
CAPACITY = C) TO CALCULATE DISCHARGE RATE

NOTE 1. DO NOT DISCHARGE BELOW 10·5 VOLTS
2. LOWER TEMPERATURES GIVE REDUCED CAPACITY

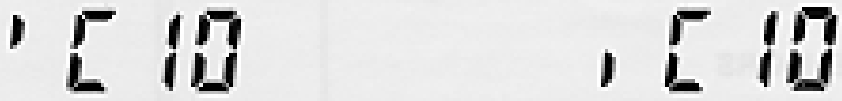
The voltage is given to two decimal places up to 32V maximum and is updated every two seconds.

2.16 SELECT

MFD selector switch setting:

The SELECT facility enables any channel to be displayed on any MFD that has a channel allocated to 'SELECT'.

Upon operating the 'SELECT' push-button at the MFD, data appears in the display. To identify the channel on display, operate the 'SELECT' key-pad at the MASTER KEYBOARD for a period of less than three seconds. The channel number is then displayed.



If the 'SELECT' key at the MASTER KEYBOARD is released within a period of 3 seconds, the data returns to the display. If the 'SELECT' key continues to be pressed, however, successive channel numbers are displayed at 0.8 second intervals. The vertical bar on the left of the display indicates count down (,) or count-up (') through the channel numbers. To reverse the direction of count, release the 'SELECT' key and press again. This feature is particularly useful in the event of overshoot. When the required channel number is observed, the key can be released and the data for that channel is displayed. (Un-allocated channels display their channel number in place of data) e.g.:

To check that the correct channel has been selected, the 'SELECT' key on the MASTER KEYBOARD can be again operated briefly (less than 3 seconds) and the channel number is displayed. The data returns to the display on release of the key.

An adhesive label is provided for easy identification of channel numbers.

3 CALIBRATION AND SETTING UP

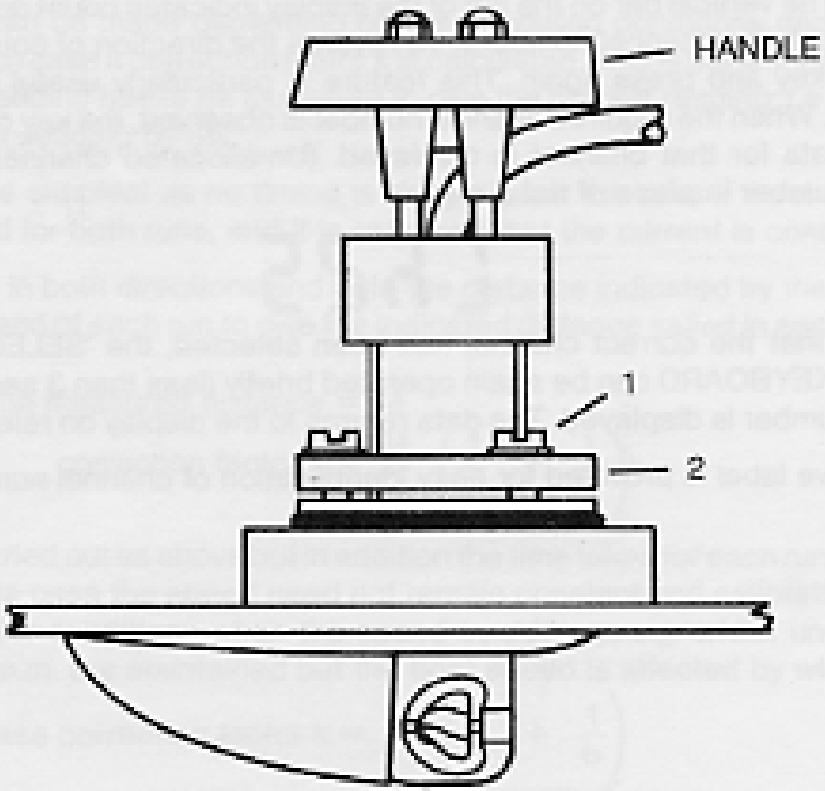
3.1 GENERAL

All calibration adjustments in the computer unit are achieved by setting switches inside the computer unit itself. In the event of the necessity to exchange a computer unit, the switch settings can be duplicated on the new unit thus avoiding the necessity to re-calibrate.

Alignment of the sensors must be carried out before calibration adjustments are made.

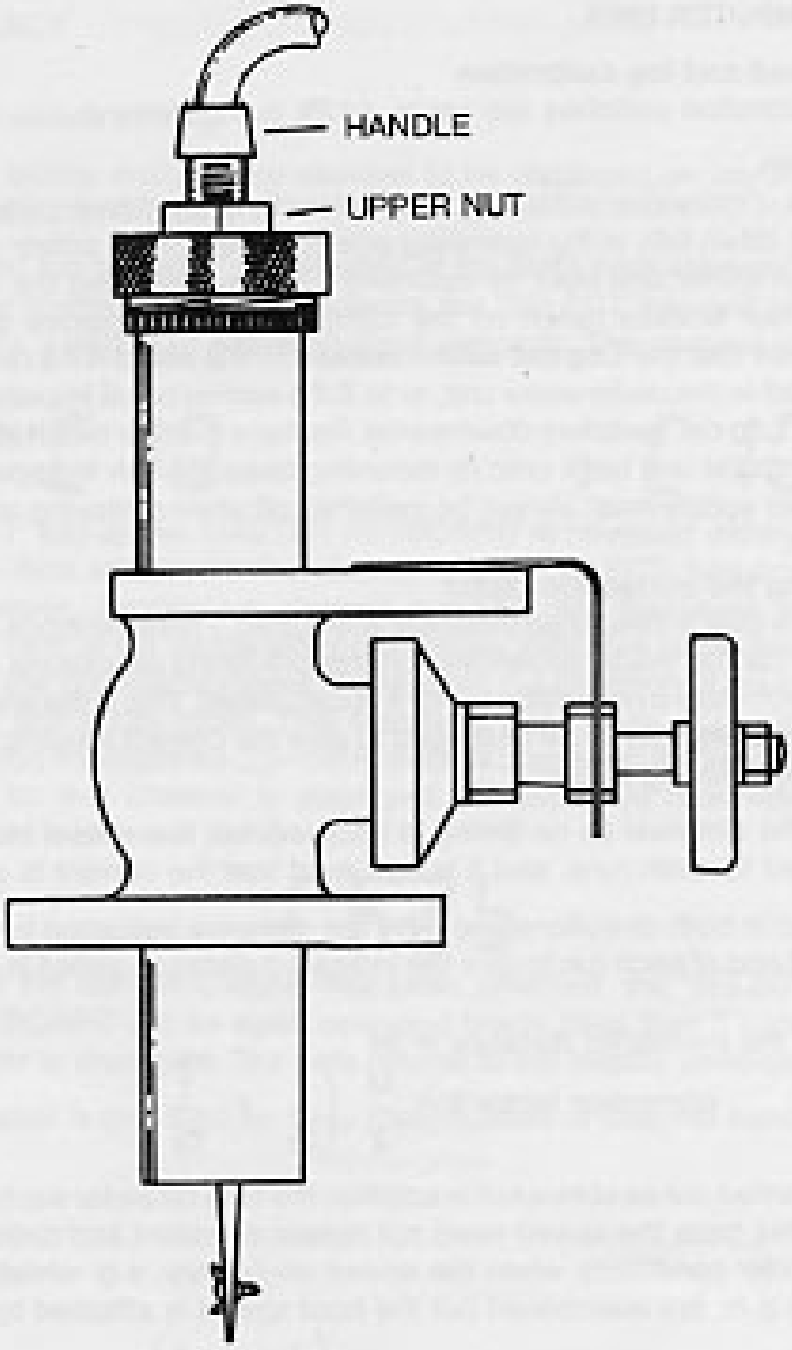
3.2 SENSORS

3.2.1 Underwater unit alignment



VALVELESS HOUSING

With the valveless housing slacken off the three locking screws (1) fully by means of a screwdriver and then slacken the ring-nut (2) if necessary so that the housing is free to rotate. With the boat making constant speed under power, or running under sail, turn the handle slowly through a small angle on either side of the fore-and-aft line until a maximum reading is shown on the speed indicator. (The flow-lines beneath the hull are not necessarily parallel with the boat's fore-and-aft line). Then re-tighten the ring-nut by hand and screw down screws (1) fully, ensuring that their heads 'bottom' on to the shakeproof washers on the ring-nut (2). Subsequent re-alignment after removal of the underwater unit for cleaning is obtained automatically when the unit is lowered fully into its operating position.



SHUT-OFF VALVE HOUSING

With the shut-off valve housing the upper nut should be slackened whilst the handle is turned to obtain maximum speed indication. The nut should then be re-tightened whilst holding the handle firmly to prevent rotation.

3.2.2 Masthead unit alignment

The masthead unit spar should be visually aligned with the fore-stay. Two locking nuts at the mounting bracket can be slackened to permit this adjustment, after which they must be re-tightened. Small errors in alignment can be corrected by switches in the computer unit (see para 3.3.3).

3.2.3 Halcyon compass

The calibration instructions given in the Halcyon owner's handbook, section 4, should be carried out. If the Halcyon system is connected into Hercules 190 without an analogue compass indicator, then ship's heading on Channel 5 should be displayed on a MFD during compass adjustment (see para 2.14).

3.3 COMPUTER UNIT

3.3.1 Speed and log calibration

(Note: the calibration switches are set to +12% in the factory)

(a) Preparation

Check that the underwater unit(s) has been correctly aligned as in para 3.2.1 and that the impeller is down fully in the operating position. Switch the power supply off and remove the computer unit from its mounting base by releasing the fixing screws. Remove the rear access hatch on the computer unit to expose the calibration switches. Check that the 'Log cal' switch marked R,B is set to R if a red (high speed) impeller is fitted to the underwater unit, or to B if a normal black impeller is fitted. Set the remaining 'Log cal' switches downwards. Replace the rear hatch and temporarily screw the computer unit back onto its mounting base. Switch the power supply on. Note: the power supply must always be switched off when removing or replacing the computer unit.

(b) Calculating the correction factor

A series of runs over a measured distance is required. Three methods are described and a choice can be made depending on the prevailing conditions and accuracy required. In each case a correction factor k is calculated. This is the amount by which the indicated reading has to be multiplied to give the correct reading; i.e. if k = 1.3, the log is under-reading by 3%.

Method A is the simplest as no timing is involved, but the vessel must maintain a constant speed for both runs, and it is assumed that the current is constant.

Carry out a run in both directions and note the distance indicated by the log at the beginning and end of each run to give the indicated distance sailed in each case: D_1 and D_2.

If the measured distance = M

$$\text{correction factor } k = \frac{M}{2}\left(\frac{1}{D_1} + \frac{1}{D_2}\right)$$

Method B is carried out as above but in addition the time taken for each run t_1 and t_2 is recorded. In this case the speed need not remain constant and calibration can be carried out under conditions when the speed could vary, e.g. whilst under sail or when engine r.p.m. are maintained but the boat speed is affected by windage.

$$\text{In this case correction factor } k = \frac{M\left(\frac{1}{t_1} + \frac{1}{t_2}\right)}{\frac{D_1}{t_1} + \frac{D_2}{t_2}}$$

Method C is the most accurate method requiring three runs over the measured distance. Again there is no necessity to maintain constant speed and the calibration can be carried out, if required, under sail. Current is assumed to be increasing or decreasing at a steady rate. Record times and indicated distances as before.

$$\text{correction factor } k = \frac{M\left(\frac{1}{t_1} + \frac{2}{t_2} + \frac{1}{t_3}\right)}{\frac{D_1}{t_1} + \frac{2D_2}{t_2} + \frac{D_3}{t_3}}$$

Note: for the above calculations M is in nautical miles and t is in decimal hours.

HARRIER 'D' CALIBRATION CHART

RUN 1	RUN 2	RUN 3

M Measured length of run (miles)

Df Log reading at finish of run (miles)

Ds Log reading at start of run (miles)

D (1, 2 or 3) Distance measured (Df – Ds)

Time of run (minutes & seconds)

t Time of run (from table below)

Speed through water $\frac{D}{t}$

Speed over ground $\frac{M}{t}$

Average speed through water — RUNS 1 & 2 (a), RUNS 2 & 3 (b)

Average speed over ground — RUNS 1 & 2 (c), RUNS 2 & 3 (d)

From the recorded results the correction factor k is found as follows:

METHOD A $k = \frac{M}{2}\left(\frac{1}{D_1} + \frac{1}{D_2}\right)$

METHOD B $k = \frac{c}{a}$

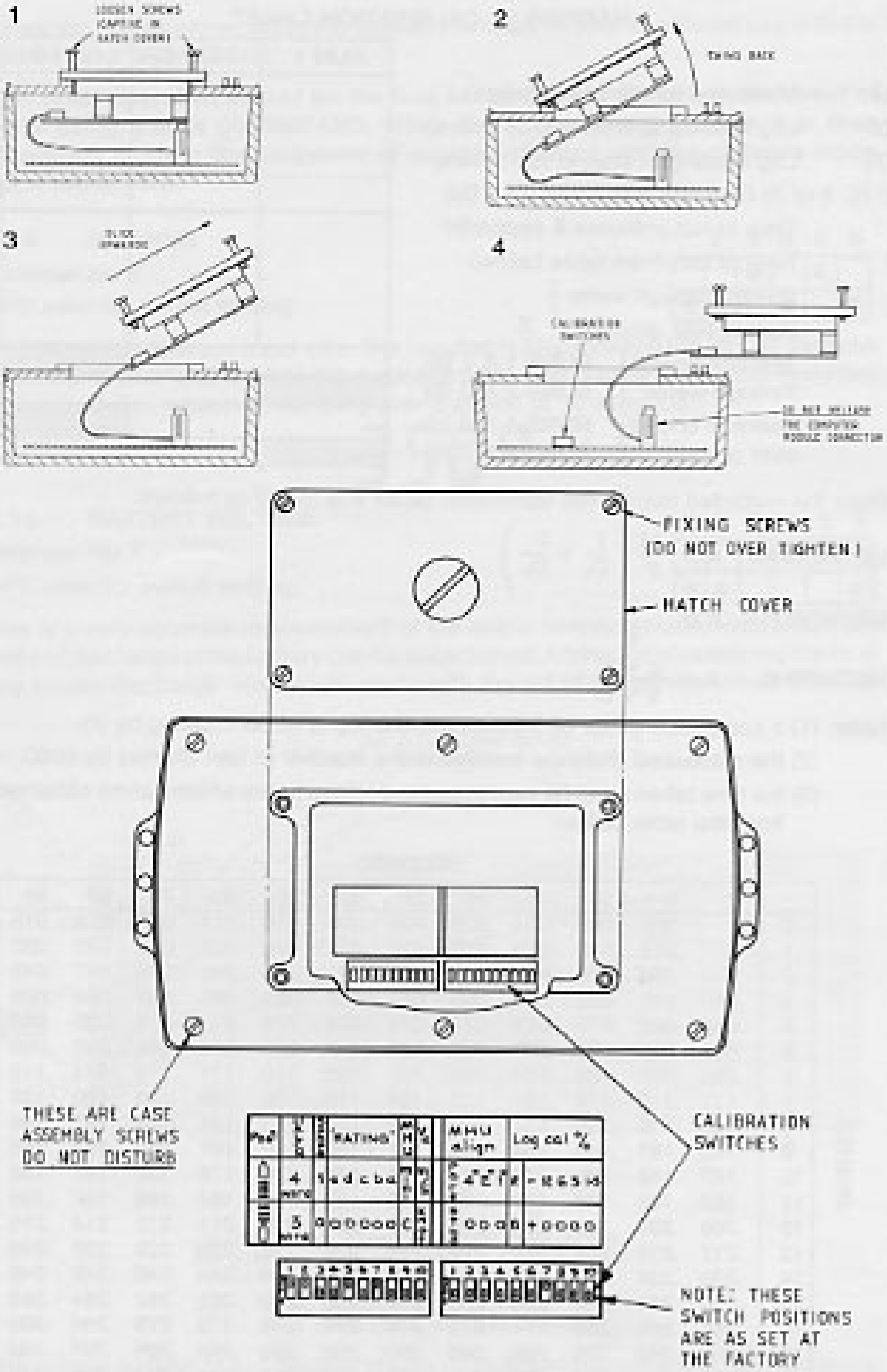
METHOD C $k = \frac{c + d}{a + b}$

Note: (1) a correction factor of 1.03 means the log is under-reading by 3%

(2) the measured distance in miles is the number of feet divided by 6080

(3) the time taken must be expressed in decimal hours which can be obtained from the table below:

MINUTES \ SECONDS	0	5	10	15	20	25	30	35	40	45	50	55
0		.001	.003	.004	.005	.007	.008	.010	.011	.012	.014	.015
1	.017	.018	.019	.020	.022	.024	.025	.026	.028	.029	.030	.032
2	.033	.034	.036	.037	.038	.040	.041	.043	.044	.046	.047	.049
3	.050	.051	.053	.054	.055	.057	.058	.060	.061	.062	.064	.065
4	.067	.068	.070	.071	.072	.074	.075	.076	.077	.079	.080	.082
5	.083	.085	.086	.087	.089	.090	.092	.093	.094	.096	.097	.099
6	.100	.101	.103	.104	.105	.107	.108	.110	.111	.112	.114	.115
7	.117	.118	.119	.121	.122	.124	.125	.126	.128	.129	.130	.132
8	.133	.135	.136	.137	.139	.140	.142	.143	.144	.146	.147	.149
9	.150	.151	.153	.154	.155	.157	.158	.160	.161	.162	.164	.165
10	.167	.168	.169	.171	.172	.174	.175	.176	.178	.180	.181	.182
11	.183	.185	.186	.187	.189	.190	.192	.193	.194	.196	.197	.199
12	.200	.201	.203	.204	.205	.207	.208	.210	.211	.212	.214	.215
13	.217	.218	.219	.221	.222	.224	.225	.226	.228	.229	.230	.232
14	.233	.235	.236	.237	.239	.240	.242	.243	.244	.246	.248	.249
15	.250	.251	.253	.254	.255	.257	.258	.260	.261	.262	.264	.265
16	.267	.268	.269	.271	.272	.274	.275	.276	.278	.279	.280	.282
17	.283	.285	.286	.288	.289	.290	.292	.293	.294	.296	.297	.299
18	.300	.301	.303	.304	.305	.307	.308	.310	.311	.312	.314	.315
19	.317	.318	.319	.321	.322	.324	.325	.326	.328	.329	.330	.332
20	.333	.335	.336	.337	.339	.340	.342	.343	.344	.346	.347	.349



REAR VIEW OF COMPUTER UNIT

(c) Adjusting the calibration

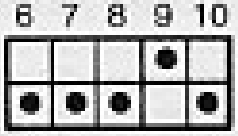
Having obtained the correction factor the percentage error is obtained:

% error = 100 (K-1)

e.g. if K = 1.03 % error = 100 (0.03)

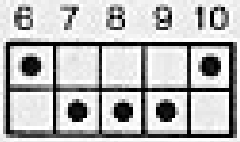
= 3% under-reading.

Set the switches thus:



If K = .98 % error = 100 (–.02) = –2% (over-reading).

Set the switches thus:



All Hercules System 190 calibration adjustments are performed by means of a row of two-position switches located behind the hatch cover on the rear of the computer unit. This hatch cover holds the circuit panel containing the programme memory for the Hercules, which is removed with the hatch cover and remains electrically connected to the computer unit by a flexible multiway cable. This cable is terminated in a plug and socket on the main computer unit circuit panel, and MUST NOT BE DISCONNECTED, or the stored Log reading will be lost.

The calibration switches are marked 12, 6, 3 and 1.5 and represent the percentage correction which can be added. With the switches all set downward as described in para 3.3.1 (a) the % error obtained should always be a positive number representing **under** reading. If the % error is a negative number representing over-reading the log cal switch marked + – should be set to – (upwards) and the other switches adjusted as described above. Set upwards such switches that add up nearest to the percentage error. For example if the percentage error were 3%, set the switch '3' upwards. If the percentage error were 9%, set both '3' and '6' upwards. If the percentage error cannot be corrected exactly, set the switches which most nearly add up to the error, e.g. for 10% error set the switches marked 6, 3 and 1.5 which together give a correction of 10.5%.

3.3.2 Wind speed

Access to the calibration switches is obtained through the rear hatch of the unit as described in para 3.3.1 (a). The switch marked Va should be set upwards if windspeed measurements of the digital displays are required in metres/second or downwards for knots. The switch marked MHU should be set upwards if the mini-masthead unit (black spar) is fitted, or downward for the larger metal-spar type.

3.3.3 Wind direction

If, as a result of trials sailing close to the wind, it is found that the masthead unit is slightly misaligned then a correction can be made by means of the computer unit calibration switches marked 'MHU align'. If the masthead unit is misaligned to port, set the left hand switch to 'port' or set to 'stbd' if the misalignment is to starboard. Then adjust the three remaining switches to correct the estimated error. A switch in the upper position sets in the amount of correction indicated by the label, but in the downward position no correction is applied. For example, if the masthead unit is thought to be 3° to port, the left hand switch is set to 'starboard' (downwards), the 4° switch is set downwards, and the 2° and 1° switches are set upwards.

3.3.4 Halcyon compass

Two switches are provided to cater for a proposed Halcyon compass having a three-wire output. These switches must be left set to '4-wire' for the four-wire system.

3.3.5 Performance rating

To obtain maximum benefit from the performance channels and also so that the adaptive damping employed on boat speed can be properly computed it is necessary to enter the IOR rating into the computer. This is done by means of the five switches marked 'RATING'. Find the rating in the table below which most closely corresponds with the yacht's official rating, and set the switches accordingly. If a yacht is not rated, the water line length **in feet** should be used as a first approximation. Note: 1 metre = 3.28 feet.

Rating	Switches e d c b a	Rating	Switches e d c b a
20.45	● ● ● ● ●	32.07	○ ● ● ● ●
21.19	● ● ● ● ○	34.6	○ ● ● ● ○
21.78	● ● ● ○ ●	37.1	○ ● ● ○ ●
22.40	● ● ● ○ ○	39.7	○ ● ○ ○ ○
23.11	● ● ○ ● ●	42.5	○ ● ○ ● ●
23.80	● ● ○ ● ○	45.3	○ ● ○ ● ○
24.50	● ● ○ ○ ●	48.2	○ ● ○ ○ ●
25.21	● ● ○ ○ ○	51.3	○ ● ○ ○ ○
25.93	● ○ ● ● ●	54.4	○ ○ ● ● ●
26.66	● ○ ● ● ○	57.6	○ ○ ● ● ○
27.41*	● ○ ● ○ ●	60.9	○ ○ ● ○ ●
28.18	● ○ ● ○ ○	64.2	○ ○ ● ○ ○
28.93	● ○ ○ ● ●	67.7	○ ○ ○ ● ●
29.64	● ○ ○ ● ○	71.3	○ ○ ○ ● ○
30.47	● ○ ○ ○ ●	74.9	○ ○ ○ ○ ●
31.27	● ○ ○ ○ ○	78.7	○ ○ ○ ○ ○

*Standard ex-factory setting

3.4

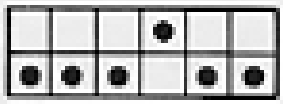
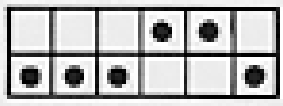
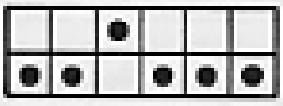
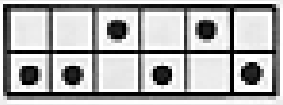
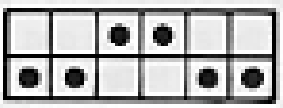
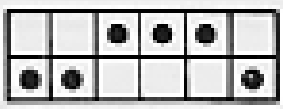
SETTING UP A MULTI-FUNCTION DISPLAY

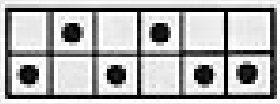
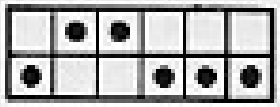
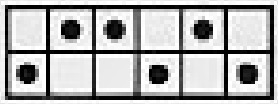
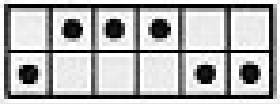
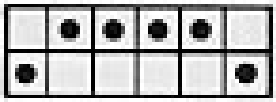
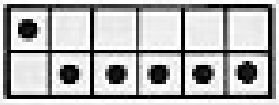
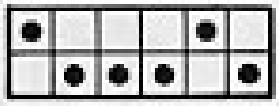
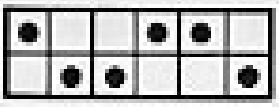
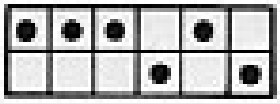
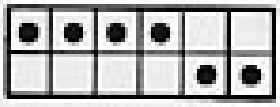
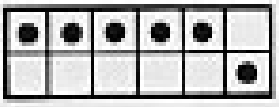
The allocation of channels is performed with the MFD removed from its mounting box, preferably in a clean, dry environment. If the unit has already been installed see para 4.4 for removal instructions.

Release the eight screws at the rear of the MFD. Note: these screws are retained by small rubber 'O' rings and so no attempt should be made to remove them completely. The two parts of the MFD can then be separated to expose the four groups of selector switches S1 S2 S3 and S4.

S1 selects the channel to appear when the left hand push-button is operated, S2 sets the channel related to middle-left push-button, S3 selects the channel for the middle-right push-button whilst S4 is for the channel selected by the right hand push-button.

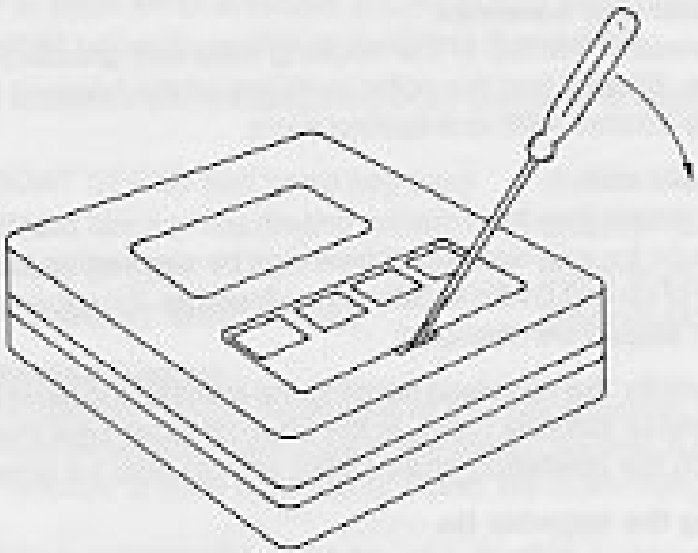
The following table summarises the available channels and shows how the selector switch group should be set to obtain that channel:

Channel	*Function*	*Format*	*Selector Switch Setting* 1 2 3 4 5 6
0	Reserved for Future Output		
1	Boat Speed	21.35 or '10.00 or ,10.00	
2	Stored Log	4681 alternating with .83	
3	Stored Log	681.8	
4	Reset Log	4681 alternating with .83	
5	Heading	350°	
6*	Dead Reckoning	468.1 alternating with 350° or OFF	
7	Battery Voltage	12.57	
8 & 9	Reserved for Future Outputs		

			1 2 3 4 5 6
10	Apparent Wind Speed	A 9.9 or A 49	
11	Reserved for Future Output		
12*	True Wind Speed	†20 or OFF	
13	Apparent Wind Angle	– 80 or 120 –	
14*	True Wind Angle	= 130 or 82 = or OFF	
15*	Wind Direction	350° or OFF	
16*	Reaching Performance	P 102 P96	
17*	Tacking Performance	t°100 t,100	
19*	Vmg	u 5.2 or d 3.7	
20-28	Reserved for Future Outputs		
29	Stop Watch	18.57 23.hr (every 10th second)	
30	Timer	3.59 (count-down) or 18.49 (elapsed time) 23.hr (every 10th second)	
	Select		

*Linked data channels.

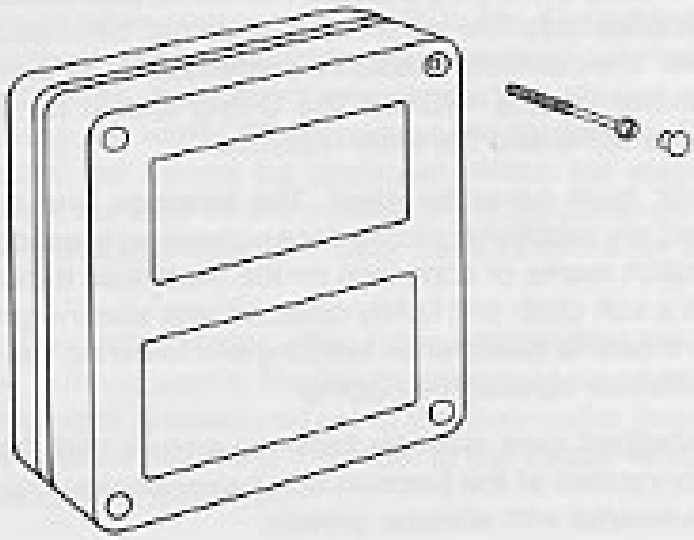
When the switches have been set as required, the push-buttons on the front of the MFD must be labelled. This is achieved by springing the lens frame from the face of the MFD using a small screwdriver in the slot provided.



The clear plastic lenses are removed from the rear of the clip and appropriate water-proof self-adhesive labels attached to the outer face of each lens. Re-assemble the lenses in their correct positions and press the frame into position using finger pressure only. Re-assemble the two parts of the MFD and tighten the eight screws.

CAUTION
All Hercules System 190 cases are precision mouldings which seal effectively under very light pressure. **Care must be taken when re-assembling to tighten the screws evenly to a moderate torque only.**

The unit is now ready to be installed on its mounting box. Carefully locate the MFD on its mounting box ensuring that the connector pins engage correctly, and secure with the four screws provided. When the system has been tested and the channel selection proved, the four plastic plugs provided should be inserted to cover the screw heads.



4 MAINTENANCE

4.1 ROUTINE MAINTENANCE

4.1.1 Underwater unit housings

Keep the screw thread at the top of the housing tube well greased with silicone or water-pump grease. Ensure that the outer surfaces of the housing and underwater unit fin are properly coated with anti-fouling paint.

4.1.2 Underwater unit

The impeller must be kept free from marine growth using a stiff brush. The impeller is removable from the fin for examination of bearings by slackening the aft-end screw. A bearing side-play of up to 0.015in (0.38mm) is allowable. If it exceeds this figure the screw and impeller should be changed.

In the underwater unit for the valveless housing the sealing ring must be kept liberally greased (water-pump or silicone type). In the shut-off valve type the rubber sealing gland through which the operating shaft slides should also be greased.

4.1.3. Replacing the impeller fin

In the event of damage, a defective impeller fin is removed by releasing the two screws. It is recommended that a spare impeller fin, complete with impeller and screws, is kept on board. When fitting the new impeller fin ensure that the peg on the plunger engages with the recess in the fin before tightening the screws.

4.1.4 Desiccators

Should any window show signs of moisture having penetrated the seals e.g. misting of the glass or condensation, the desiccator should be unscrewed from the rear of the instrument and re-activated by placing in an oven or drying cupboard for approximately 2 hours at a temperature of 270°F (130°C). Plug the desiccator hole and keep the indicator in a dry place during re-activation.

4.2 WINTER STORAGE/LAYING UP

4.2.1 Masthead unit

Storage of the masthead unit when the yacht is laid up afloat will increase the life of the transmitters. It should always be removed from the masthead before the mast is unstepped. It should be stored in its packing box with the vane and cups removed. The exposed plug at the top of the mast must be protected with the plastic cup supplied with it. The body of the plug should be smeared with silicone grease such as MS4 (Midland Silicones Ltd). The transmitting units can be unplugged by removing the locking screws. The contacts should be inspected for cleanliness and sprayed with a water-inhibitive oil (e.g. WD40). The O-ring should be greased (e.g. with silicone grease type MS4) and the units replaced.

The masthead unit must never be oiled. The bearings are of the sealed self-lubricating type and any additional oil may cause chemical breakdown of the existing lubricant. Any scratch marks or corrosion on the masthead transmitters should be rubbed clean with a soft cloth and lightly covered with silicone grease. This should not be necessary if care is taken when hoisting and lowering the masthead unit, to protect it from collisions against the rigging.

If the mast is unstepped care must be taken to ensure that the cable is not cut through, but disconnected at the junction box below decks. The bare ends of the cable should be smeared with silicone grease.

4.2.2 Underwater unit

Remove underwater unit(s) from housing(s) and grease the sealing rings and threads. Place the sealing cap on the housing. Carry out the maintenance instructions given in 4.1.2.

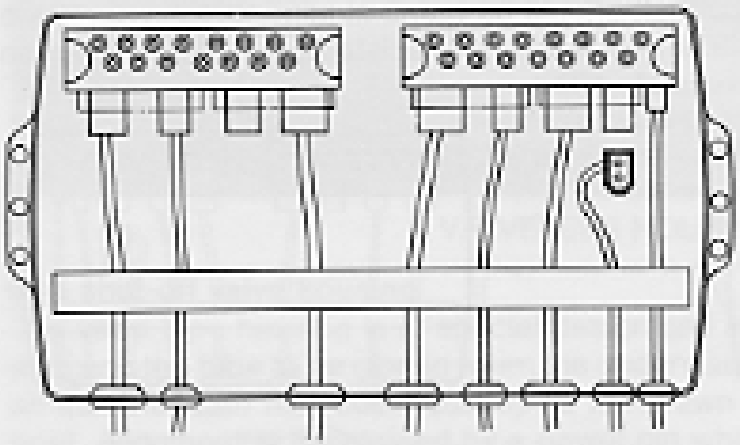
4.3 FAULT FINDING

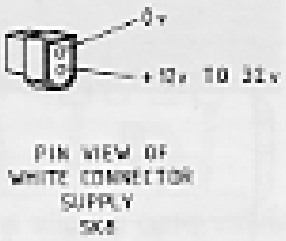
In the event of a fault occurring certain simple checks can be made by the owner. Identify the symptoms in the left-hand column of the table below and carry out the tests shown in the right. Test details are given in the following paragraphs:

Fault Symptoms	*Test*
No display on any indicator, digital or analogue	Check the power supply (para 4.3.1)
No display on all MFDs (Analogue indicators operating correctly)	Check the MFD data bus wiring (para 4.3.2)
One or more analogue indicators not working but equivalent digital channel works correctly	Check analogue indicator wiring (para 4.3.3)
One or several MFDs (but not all) fail to operate	MFD substitution check (para 4.3.4)
Keyboard functions incorrectly	Master Keyboard check (para 4.3.5)
Boat speed and log channels faulty	Check underwater unit and cables (para 4.3.6)
Wind speed or direction channels faulty	Check masthead unit and cables (para 4.3.7)
Compass channels faulty	Check operation and calibration of Halcyon (See Halcyon Owner's Handbook)

4.3.1 Check the power supply

With the computer unit removed from its mounting box check that the supply voltage of 11V to 32V dc is present at the connector and of correct polarity as indicated below:





CAUTION:
Do not try to make connection with the connector block pins. Continuity should be checked from the unplugged connector (to avoid the danger of bending connector block pins).

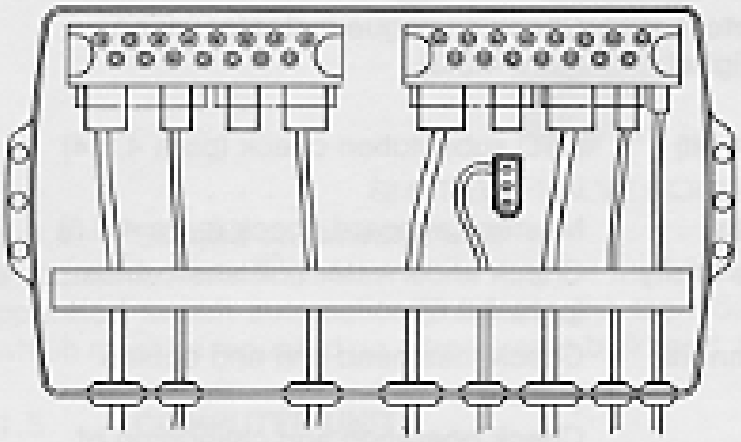
THE COMPUTER UNIT MUST **NEVER** BE REMOVED FROM, OR REPLACED ON, ITS MOUNTING BOX WITH THE POWER APPLIED. **ALWAYS** SWITCH OFF AT THE SHIP'S SWITCH PANEL. Failure to observe this precaution can result in faulty operation of the computer unit programme.

As an additional precaution, always locate the computer unit firmly on its mounting box and TIGHTEN THE TWO SECURING SCREWS before applying power.

4.3.2 Check MFD databus wiring

Remove the computer unit and **all** multi-function displays from their mounting boxes (see para 4.4) and check continuity on each of the three cores of the databus cables.

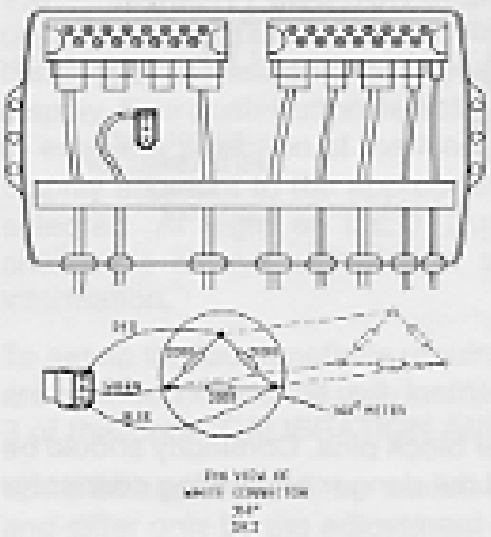
The red core should connect to red at every location, the blue cores should interconnect, and similarly the green cores should also be electrically continuous. There should be no continuity from red to blue, red to green or green to blue. The connector pins at the MFD and computer unit are indicated below:

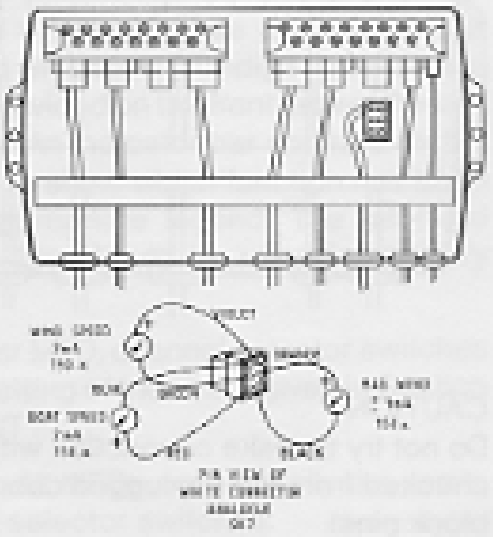


PIN VIEW OF
RED CONNECTOR
DATA BUS
SKT

4.3.3 Check analogue indicator wiring

Remove the computer unit from its mounting box and check the appropriate wiring for continuity through the indicator. Do not pass a current exceeding 2mA through an indicator. The appropriate connections are indicated below. The wind speed, boat speed and magnified direction indicators have a resistance of 150Ω, but it should be remembered that duplicate indicators are wired in series. The 360° meter has three windings connected in delta(Δ) and the resistance measured between any two of the three wires should be around 200Ω. It should be borne in mind that if a duplicate indicator is fitted this is connected in parallel and the resistance measured between any two wires should be approximately 100Ω.





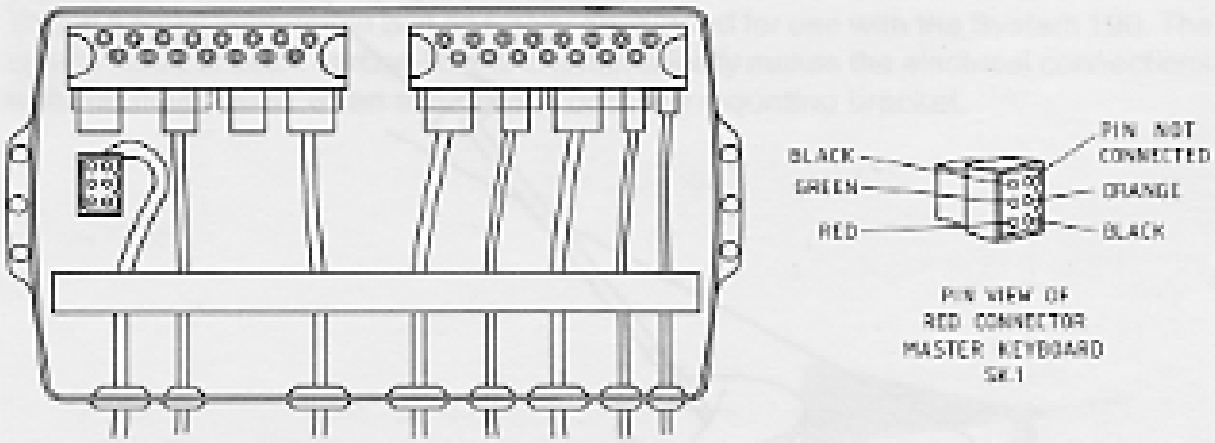
4.3.4 MFD substitution check

Remove the suspect MFD from its mounting box (see para 4.4) and also remove a MFD which is working correctly from its mounting box.

Mount the two MFDs in each other's mounting box. If the suspect MFD continues to display fault symptoms it is proved to be faulty, but if the fault symptoms now appear on the MFD which was previously working, the fault lies in the databus wiring (see para 4.3.2).

4.3.5 Master Keyboard check

Remove the computer unit and master keyboard from their mounting boxes and disconnect the red connector at the computer unit mounting box. Continuity may be checked on the wiring as indicated below. There should be no continuity from red to blue, red to green or green to blue.

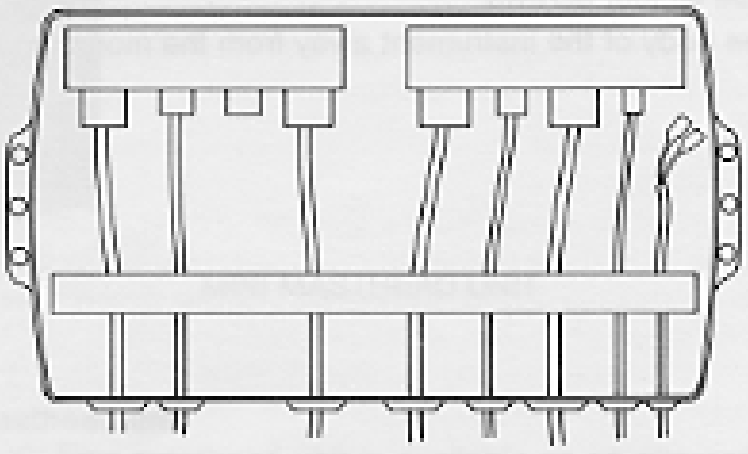


PIN VIEW OF
RED CONNECTOR
MASTER KEYBOARD
SK1

4.3.6 Underwater unit and cable

Withdraw the underwater unit from its housing and screw the sealing cap onto the housing. Blow on the impeller to cause it to spin and observe the speed indication

If no speed indication is obtained, check the underwater unit and cable for continuity. Remove the computer unit from its mounting box to gain access to the cables. Remove the two underwater unit spade connectors and test the resistance of the underwater unit (approximately 7–10kΩ). Polarity of the spade connectors when replacing is unimportant.



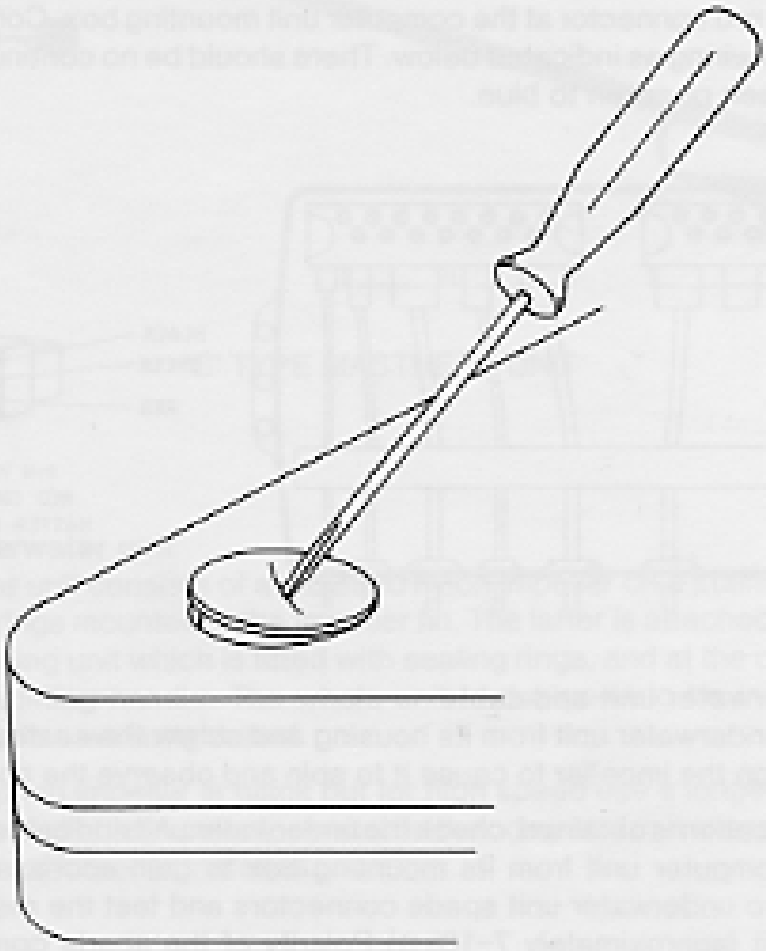
SPADE CONNECTORS
UNDERWATER UNIT

4.3.7 Masthead unit and cables

The mini-masthead unit should be tested using a special B&G test set. The only simple test is to substitute a known working masthead unit for the suspected one. If the fault persists there is probably a cable fault.

4.4 REMOVING A MFD OR MASTER KEYBOARD FROM ITS MOUNTING BOX

(1) Using a small screwdriver prise the four plastic plugs which cover the fixing screws from the screw holes. It is best to pierce the plug to do this and fit new plugs after re-assembly.



(2) Release all four screws.

(3) Pull the body of the instrument away from the mounting box.

5 PARTS LIST

5.1 BASIC SYSTEM PACK PARTS

	Part No.
Computer unit	190–45
Power cable (3m)	135–73
Masthead unit	178–2
Mast cable and bracket (19m)	178–1
Computer to junction box cable (9m)	135–68
Underwater unit (10m)	117–120
Hull housing	117–46
Multi-function display (MFD)	190–42
MFD cable (9m)	135–71
Lighting cable (9m) with connectors	135–74
Mast junction box	WI 187

5.2 SYSTEM EXTRAS

System cabling (9m) and connectors	135–75
360° analogue indicator	0011 L
Cable for 360° indicator	135–70
Magnified direction indicator	4510 L
Ship's speed, 12 knots	12501 L
Ship's speed, 50 knots	
Wind speed, 50 knots	50002 L
Analogue display cable (9m) for meters	135–67
Gravity changeover switch	190–100
Gravity changeover switch cable (4m)	135–79
Master Keyboard	190–88
Master Keyboard cable (4m)	135–66
Master Keyboard extension cable (9m)	135–80
Lighting dimmer and cable	162–3
Extension cable for additional meters (360°) (9m)	135–75
Extension cable for additional meters (magnified wind direction, wind speed or boat speed) (9m)	135–74

5.3 SYSTEM EXTRAS FOR COMPASS

Halcyon input cable to computer unit (9m)	135–78
Halcyon 4in compass indicator	151–6
Compass indicator cable (10m)	135–51
Compass indicator extension lead (10m)	135–52
Junction box to connect 135–51 to 135–78	WI 187

5.4 MASTHEAD UNIT

5.4.1 Mini-masthead unit

Mast cable with plug (less bracket)	135-72
Masthead bracket	178-36
Wind direction potentiometer	178-26
Wind speed aneomometer	178-27
Wind vane	178-28
Anemometer cup	178-03

5.4.2 'C' type masthead unit

Masthead cable and bracket	137-19
Wind vane and counterweight	178-28
Anemometer cups	WI 140
Wind direction potentiometer	D 7250
Wind speed anemometer	D 8102

5.5 UNDERWATER UNIT

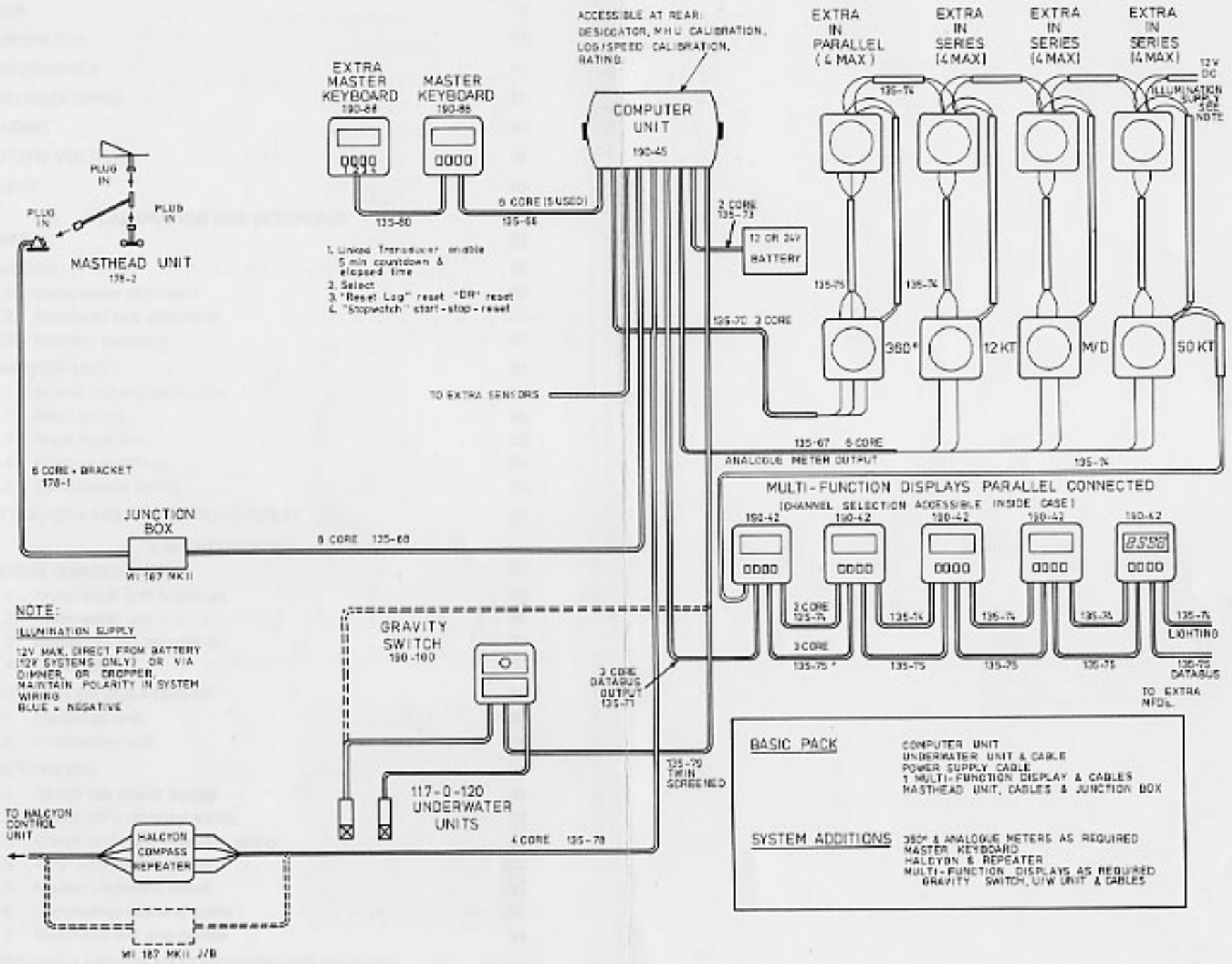
Hull housing with shut-off valve and weed deflector	155-25
Underwater unit for shut-off valve housing	117-124
Stainless steel weed deflector for shut-off valve housing	LG 11
Rotator fin unit (with impeller)	110-21
Impeller	110-18
Replacement valveless housing with weed deflector	117-132
Insulating kit for shut-off valve housing for metal hull	155-17

5.6 MISCELLANEOUS ITEMS

Desiccator for System 190	190-46 item 17
Owner's Handbook	

5.7 MOUNTING AND FITTING ITEMS

Plastic plugs for mounting holes (100 per set)
Spade connectors for cabling
Labels for MFD push-buttons
Channel and function chart
Cable cleats and screws (100 per set)
Crimps (100)
Installation kit of crimps
Installation kit of plastic plugs
Crimping tool



HERCULES SYSTEM 190 CONNECTIONS DIAGRAM