Autohelm Inboard Autopilots
(ST6000 and ST7000 systems)

Service Manual

Autohelm

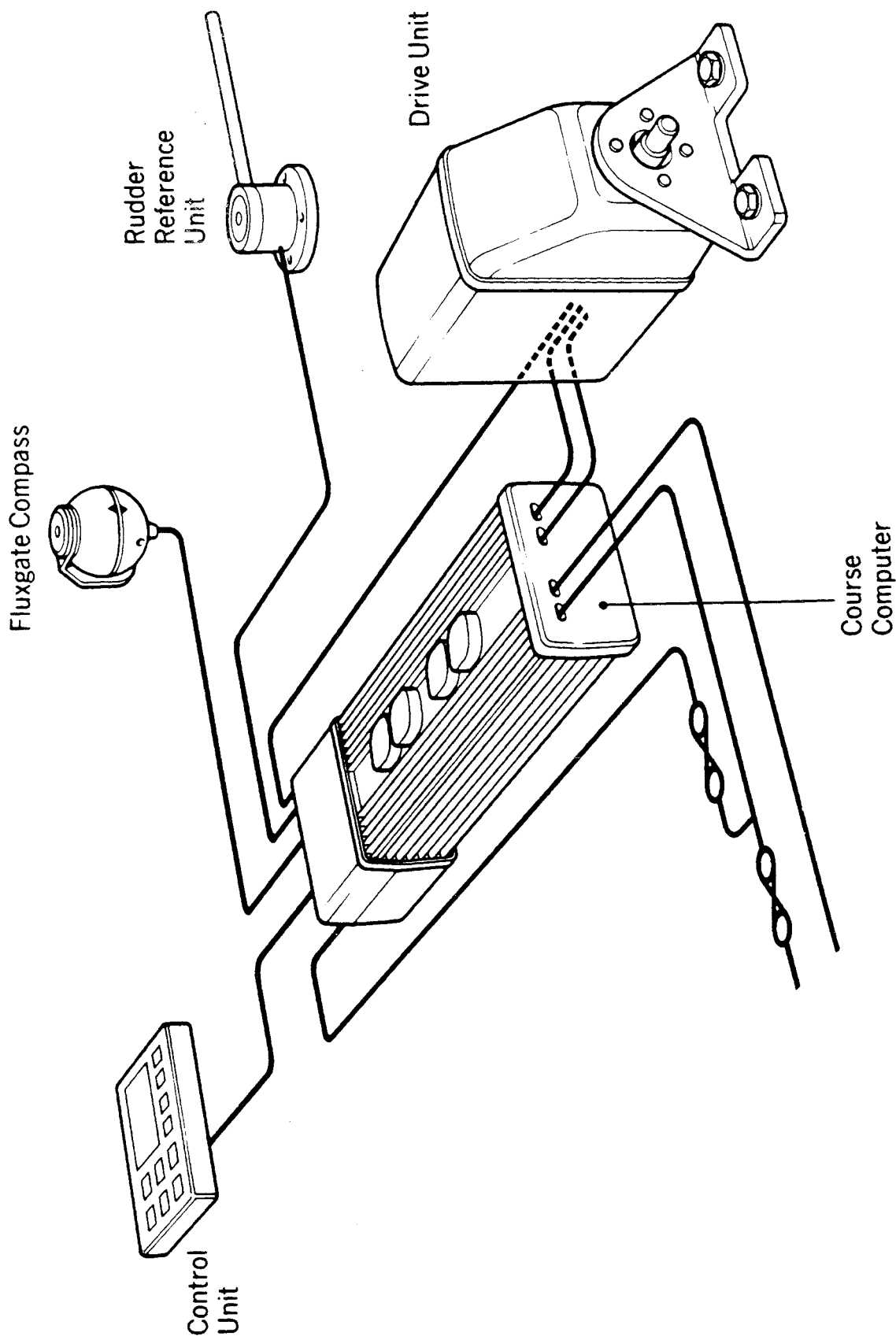# Master Table of Contents

ST7000 Basic System

1. Service Procedures

Rudder
Reference
Unit

Drive Unit

Fluxgate Compass

Course
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Unit

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ST7000 System Index

1. Introduction

The ST7000 system section of this manual contains full system operating instructions and service procedures for the installed autopilot. Further indepth diagnostics are available for each module in the relevant product sections.

2. System Description

The ST7000 is a modular autopilot system that can be built up to match the individual requirements of all vessels. A range of high efficiency Rotary, Linear, Inboard/Outboard and Hydraulic drive units are available to match all types of steering systems.

The ST7000 is SeaTalk compatible providing full data sharing with the Autohelm range of SeaTalk Instruments.

Early systems (pre March 90) were supplied with Z060, Z105 Rudder Reference and Fluxgate transducers. Later systems use the Z131 and Z130 transducers.
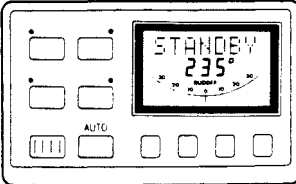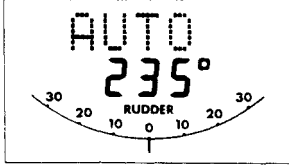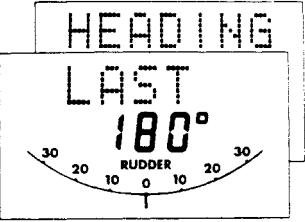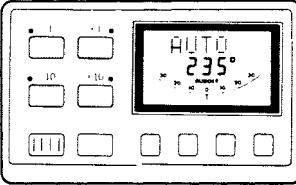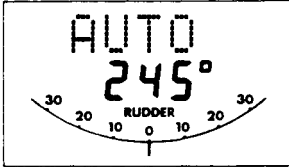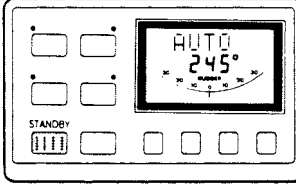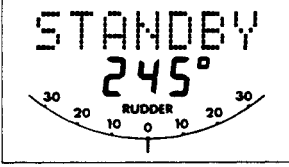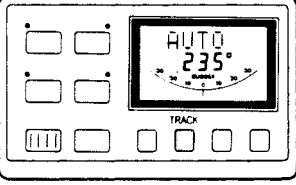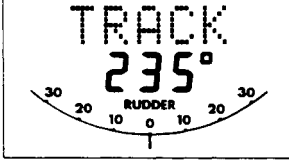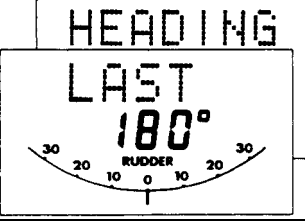
The ST7000 course computer can be used with all Seatalk compatible control units and will operate all of the following drive units:

Z039	Linear Drive Type 1
Z037	Rotary Drive Type 1
Z041	Hydraulic Pump Type 1
Z081	Hydraulic Pump Type 0
Z088	I/O Sterndrive
Z029	Linear Drive Type 2 (1 2v)
Z058	Linear Drive Type 2 (12v) Short Stroke
Z032	Linear Drive Type 2 (24v)
Z059	Linear Drive Type 2 (24v) Short Stroke
Z028	Rotary Drive Type 2 (12v)
Z031	Rotary Drive Type 2 (24v)
Z030	Hydraulic Pump Type 2 (1 2v)
Z033	Hydraulic Pump Type 2 (24v)
Z064	Type CR 3L/min (1 2v) via Z085 Interface Box
Z065	Type CR 3L/min (24v) via Z085 Interface Box
Z066	Type CR 4.5L/min (12v) via Z085 Interface Box
Z067	Type CR 4.5L/min (24v) via Z085 Interface Box

Autohelm

3. Operating/Calibration instructions

3.1 Operation

Auto		Automatic Heading
	Push to engage automatic steering and maintain current heading.	AUTO 235°
	OR Push and hold down for 1 second to return to previous automatic heading. (Display returns to Auto after 10 seconds).	**Previous Automatic Heading** HEADING LAST 180°
Course Changes (—1, +1, —10, +10)		**New Automatic Heading**
	Push to alter course to port (—) and starboard (+) in increments of 1 and 10 degrees.	AUTO 245°
Standby		**Current Heading**
	Push to disengage the autopilot for manual steering. (The previous automatic heading is memorised).	STANDBY 245°
Track (see operating hints)		**Automatic Heading**
	Push to select track control from Auto. Push again to return to automatic steering. OR Push and hold down for 1 second to select previous track control heading from Auto or Track.	TRACK 235° HEADING LAST 180°
(Display returns to Track after 10 seconds).		

Response

- **Response Level Adjustment** (see Operating Hints)

Push to increase (▲) or decrease (▼) response level. To display response level without changing it push both **Response** keys together briefly.

Response Level

```
LEVEL
  1
```

- **Rudder Gain Adjustment** (see Operating Hints)

Push and hold down for 1 second both **Response** keys together to display rudder gain level.

Rudder Gain Level
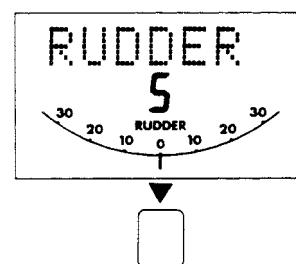
```
RUDDER
  5
```

▼

Within 10 seconds push once to increase (▲) or decrease (▼) rudder gain.

Rudder Gain Level

```
RUDDER
  4
```

(Response and Rudder levels are displayed for 10 seconds only)

Illumination

Push and hold down **Display** for 1 second to switch on illumination.

Within 10 seconds push **Display** to select illumination level.

Illumination Level

```
LAMP
  3
```

3	=High
2	=Medium
1	=Low
OFF	=Off

(Illumination level is displayed for 10 seconds only)

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Display Key Sequence
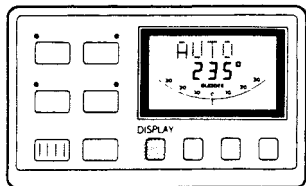
- **Cross Track Error***
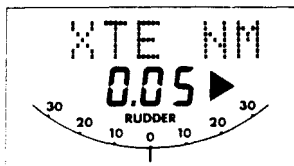
◄ or ► indicates direction to steer

DISPLAY

- **Bearing to Waypoint***
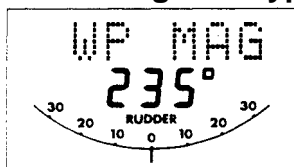
DISPLAY

- **Distance to Waypoint***

DISPLAY

- **Watch Alarm** (not available in Standby)

*Only displayed when waypoint information is transmitted to the control unit by a Radio Navigation System.
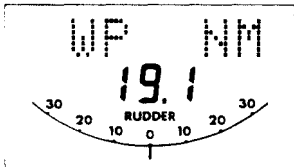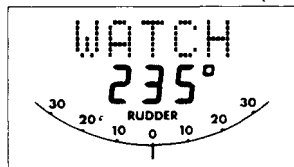
Watch Alarm (not available in Standby)
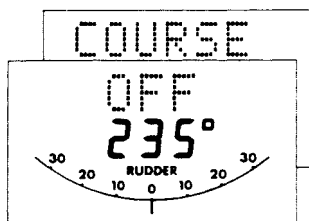
- To select Watch alarm push **Display** repeatedly until Watch appears.

The 4 minute timer is now running:
—After 3 minutes 'Watch' flashes on all control units.
—After 4 minutes the alarm sounds on all control units.

- Push **Auto** at any time to reset the timer to 4 minutes and silence the alarm.
- To cancel the Watch alarm at any time push **Display**.

Warning Messages
• **Off Course Alarm**

```
COURSE
  OFF
 235°
30  RUDDER  30
 20  10 0 10 20
```

—Sounds if the vessel deviates from the automatic heading by more than the selected amount for over 20 seconds.

• **Low Battery Alarm**

```
BATTERY
  LOW
 235°
30  RUDDER  30
 20  10 0 10 20
```

—Sounds if the course computer supply voltage falls below 11 volts for over 20 seconds.

• **Track Mode Alarms**

```
DATA
 NO
235°
30  RUDDER  30
 20 10 0 10 20
```

—Sounds if no waypoint data is received from the Radio Navigation System for over 20 seconds.

```
ERROR
DATA
235°
30  RUDDER  30
 20 10 0 10 20
```

—Sounds if the data has the incorrect format or if an invalid flag is set.

```
XTE
LARGE
 235°
30  RUDDER  30
 20  10 0 10 20
```
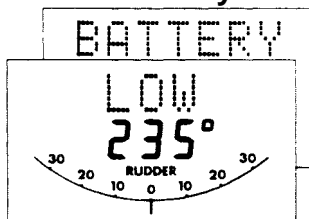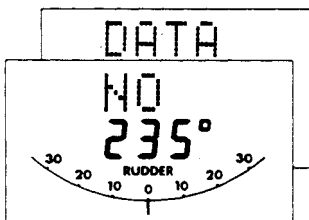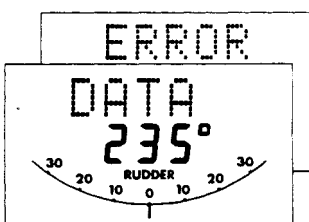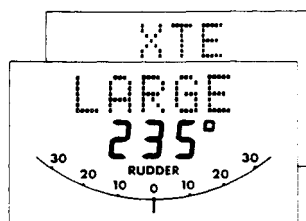
—Sounds if the cross track error exceeds 0.30n.m.

Note: Push **Standby** to silence an alarm and select **Standby** mode.

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3.2 Operating Hints

Response Level Adjustment

The ST7000 has three response levels which enable tighter course keeping to be achieved in certain cases:-

Level 1—   Automatic Sea State Control
Level 2—   Automatic Sea State Inhibit
Level 3—   Automatic Sea State Inhibit and counter rudder.

When the autopilot is switched on, the response level is set to 1. This provides the best compromise between power consumption and course keeping accuracy and is suitable for nearly all situations.

Increasing Response level provides tighter course keeping at the expense of increased power consumption and general wear and tear. It is advisable to use the minimum response level necessary to achieve the desired course keeping accuracy. On larger power vessels level 3 can improve slow speed steering where the natural yaw damping of the vessel is reduced.

Note: Level 3 is not recommended for use at planing speeds or in rough seas.
+
Track

To make full use of Track control the following simple points should be observed:-

• Always steer the vessel to within 0.1n.m. of track and bring the heading to within 5° of the bearing to the next waypoint before selecting Track.

• Always check that there are no navigational hazards either side of the intended track.

• Always maintain an accurate log with regular plots to verify the computed position read from the Radio Navigation Receiver.

• Maintain a proper lookout at all times.

Automatic Trim

If Automatic Trim has been selected during calibration the 5T7000 will correct for trim changes. This correction can take up to three minutes to apply the rudder offset necessary to restore the set automatic heading. Large course changes which change the apparent wind direction can produce large trim changes. In these cases the autopilot will not immediately

assume the new automatic heading, and only settle onto course when the Automatic Trim has been fully established.

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

• Note required new heading.
• Select **Standby** and steer manually.
• Bring vessel onto new heading.
• Select **Auto** and let vessel settle onto course.
• Bring to final course with 1° increments.

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

Rudder Gain Adjustment

The rudder gain level selected during initial sea trials will normally provide excellent steering performance over a wide range of conditions. However, it may be noticed that the autopilot tends to be a little less stable on northerly headings in the higher latitudes of the northern hemisphere (and conversely southerly headings in the southern hemisphere). This is caused by the increasing angle of dip of the earth's magnetic field at higher latitudes, which has the effect of amplifying rudder response on northerly headings. The tendency towards northerly heading instability is usually more obvious in higher speed craft and when it occurs can be corrected by reducing the rudder control setting. At speeds in excess of 30 knots, a reduction of two levels can often be required on headings between 315° and 045° (northern hemisphere) or 135° and 230° (southern hemisphere).

CAUTION

On planing vessels improved course keeping at displacement speeds can sometimes be achieved by increasing the rudder gain level. If this is done, it must be decreased again before opening the throttle as oversteer can be extremely violent at planing speeds.

Unsatisfactory Steering Performance

If the 5T7000 has been installed and set up in accordance with the instructions in the Installation Manual it will provide excellent steering performance over a wide range of conditions.

If performance drops but the autopilot is still working correctly, the following simple checks should find the fault:-

• Has a magnetic influence been introduced near the fluxgate compass? i.e. anchor, chain, radio equipment, loudspeaker, tools, generator etc. Check that the autopilot compass heading still corresponds with the steering compass.

• Are all fuses intact, circuit breakers engaged?

• Are all screw connections tight and free of corrosion.

• If the autopilot fails to hold course check the Rudder Gain level. Has it been changed from the initial sea trials level (check in Installation Manual)?

• If the vessel wanders check that the Rudder Reference Transducer linkage is secure with no free play.

Hydraulic Drive Units only:-

• Check that all unions are tight and bleed system to remove air.

Safety

Passage making under autopilot is a very pleasant experience which can lead to the temptation of relaxing permanent watch. This must always be avoided no matter how clear the sea may appear to be.

It is the responsibility of the skipper to ensure the safety of his vessel at all times by careful navigation and that all crew members are familiar with the procedures required to engage and disengage the autopilot.

When searoom is restricted, a crew member must be close to a control unit at all times if under Autopilot control.

On Power craft permanent watch should be maintained at the steering station when at speed with the Autopilot engaged.

Failure to Disengage

The mechanical drive actuators of the ST7000 are designed to 'Fail Safe' — When power is disconnected the drive unit will disengage leaving the steering system free for manual control.

When Standby is selected the actuator will Disengage leaving the steering free.

It is remotely possible that a fault could develop which could cause the actuator to remain engaged even when Standby is selected. If this happens:-

• DISCONNECT THE MAIN CIRCUIT BREAKER TO THE AUTOPILOT — THE STEERING WILL IMMEDIATELY BE FREE. or

• IN AN EMERGENCY THE ACTUATOR CLUTCH CAN NORMALLY BE OVERRIDDEN BY TURNING THE STEERING WHEEL HARD.

It is emphasised that this fault is extremely unlikely and can be immediately corrected as described.

If preferred a separate **Override** switch can be fitted close to the steering position which will break the actuator clutch drive for **Emergency Use**.

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3.3 Additional Information for Sailing Vessels

Autotack

The ST7000 has a built in Autotack function which will turn the vessel through 100°. This operates in both compass and vane modes as follows:-

Vane
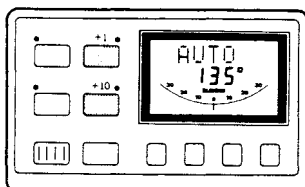
Push +1 and -1 -10 keys together to initiate a tack turning to Starboard.
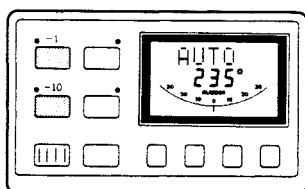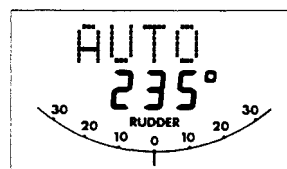
Push -1 and —10 keys together to initiate a tack turning to Port.
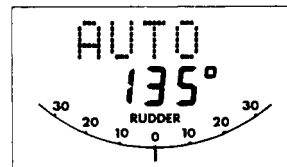
Note: It is important that the rudder angle transducer is accurately aligned as the Autotack function mirrors standing helm and any offset will change the initial tack angle.

Wind Trim

Wind Trim allows the autopilot to be supervised by apparent wind direction. The wind direction is read either:-
—From the SeaTalk bus (requires Autohelm ST50 wind).
OR

—Directly from a Masthead Transducer (Z080).
OR
—   From an NMEA 0183 input on the control unit.
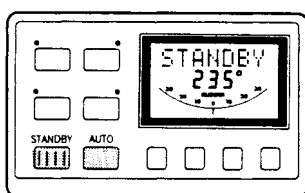
Push both red keys together to select Wind Trim and maintain the current apparent wind angle.
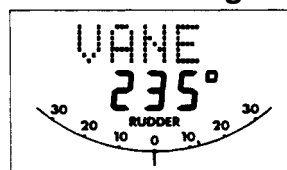
Automatic Heading

Push and hold down for 1 second both red keys together to return to the previous apparent wind angle.

Previous Automatic Heading

Wind Change Alarm

Wind Trim uses the fluxgate compass as the primary heading reference and automatically adjusts the compass heading to maintain the original apparent wind angle. If changes in apparent wind angle adjust the original automatic heading by more than 15° the wind change alarm will sound.

```
CHANGE
WIND
235°
30  20  RUDDER  20  30
   10  0  10
```

—The alarm is silenced by pushing both red keys together briefly.

Display of Wind Angle

If the wind angle information is supplied using the NMEA 0183 input or SeaTalk bus, the apparent wind angle and tack sense (P & S) is added to the display menu and accessed via the Display button.
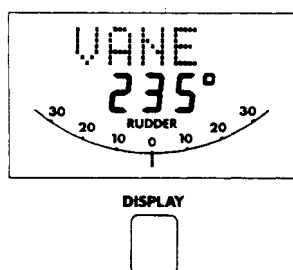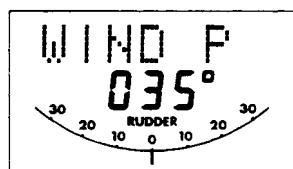
```
VANE
235°
30  20  RUDDER  20  30
   10  0  10
```

DISPLAY

- **Apparent Wind Angle**

```
WIND P
035°
30  20  RUDDER  20  30
   10  0  10
```

Using Wind Trim

It is important to understand that "Wind Trim" prevents over-reaction to gusts or sudden wind shifts. One minute is required to change the heading in response to a permanent change in apparent wind angle. Do not attempt to override the automatic sequence with the course change buttons. In gusty conditions sail a few degrees off the wind and pay frequent attention to sail trim and helm balance using the rudder angle indication.

Performance will normally be improved by reefing headsail and mainsail a little early rather than too late.

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3.4 Calibration

Recommended Settings
As supplied the ST7000 can be switched on and tested safely without any adjustments to the factory calibration settings.
The table below lists the suggested settings for sailing and power displacement and planing power vessels. These will provide good performance for initial sea trials and can be fine tuned later to optimise performance.

	Vessel Type	
	Displacement	**Planing**
	Factory preset	**Set to**
Rudder Gain (level)	5	2
Rate Gain (level)	2	1
Rudder Angle Limit (degrees)	30	30
Turn Rate Limit (degrees/sec)	20	5
Cruise Speed (knots)	8	25
Off Course Alarm (degrees)	20	20
Trim Level	1	1

	Autopilot Drive Unit Type	
	Mechanical	**Hydraulic**
	Factory preset	**Set to**
Drive Type	3	4
Rudder Position Deadband (level) See 3.7	1	1

Selecting and Exiting from Calibration Mode
To select calibration mode:-
• Push Standby.
• Push and hold down for 2 seconds, Track and Display together.
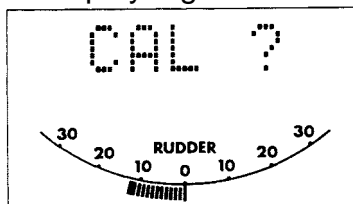
• Repeat push and hold down for 2 seconds, **Track** and **Display** together to enter calibration mode.
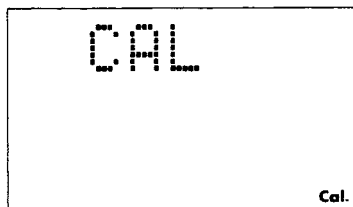
To exit calibration mode at any point.
a) **Saving** any changes made:-
• Push and hold down for 2 seconds, **Track** and **Display** together.
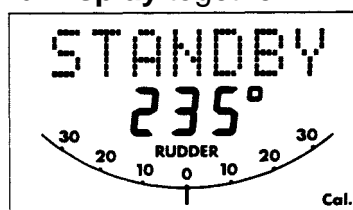
b) Ignoring any changes made:
• Push **Standby.**
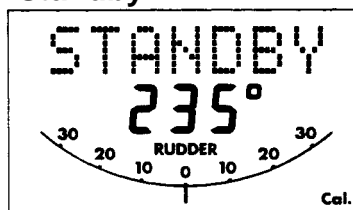
Adjusting Calibration

In calibration mode, the **display** button is used to scroll through the menu. The displayed value is adjusted using the **Response** buttons (hold button down for fast scroll).

- Rudder Angle Limit, 15 to 40 (see 3.6).

DISPLAY

DISPLAY
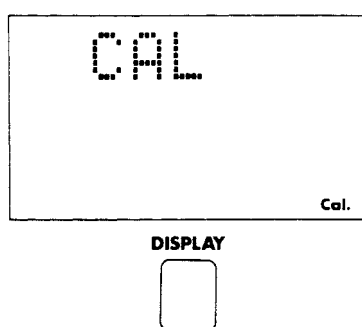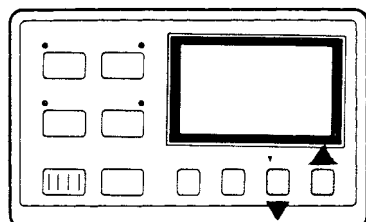
- Rudder Gain, levels 1 to 9, (see 5.5)

- Rate of Turn Limit, 2 to 20°/sec.
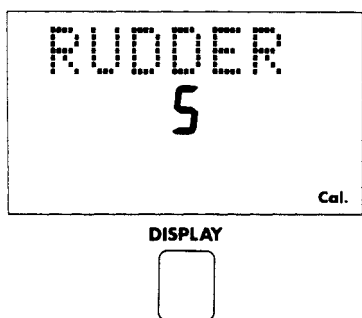
DISPLAY

DISPLAY

- Rate Gain, levels 1 to 9, (see 5.6) (Counter Rudder).
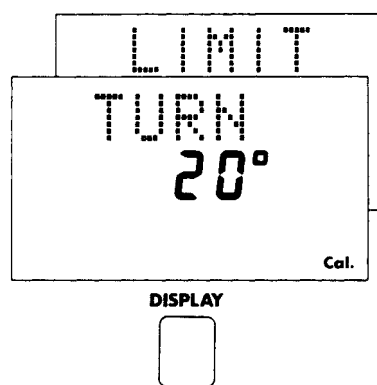
- Cruise Speed, for **Track** mode operation, 4 to 60 knots.
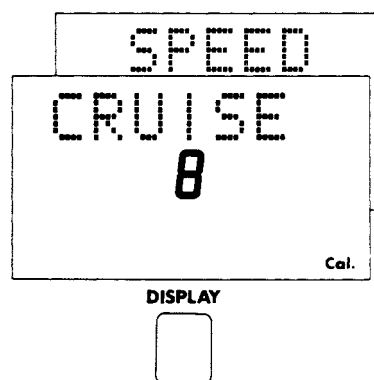
DISPLAY

DISPLAY

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- Off-Course Alarm, 15 to 40° angle.

```
COURSE
 OFF
  20°
        Cal.
```
DISPLAY

- Automatic Trim, (see 5.4).

```
TRIM
 1
        Cal.
```
1 = on
0 = off

DISPLAY

- Remote Control Identifier. (For Future Use).

```
REMOTE
  1
        Cal.
```
DISPLAY

- Manual Steering Lever Type.
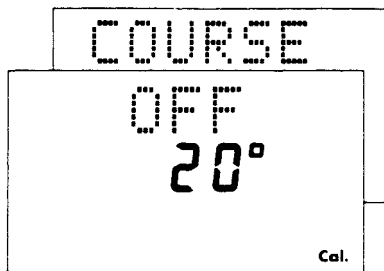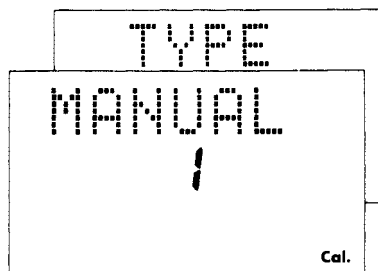
```
TYPE
MANUAL
  1
        Cal.
```
1 = Proportional (Follow up)
2 = Bang Bang (Drive left, Drive right)
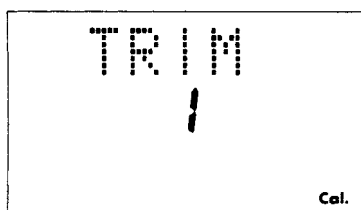
DISPLAY

- Autopilot Drive Unit Type.
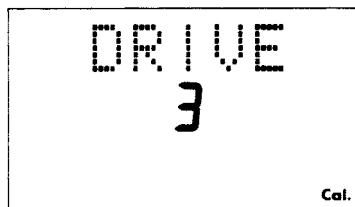
```
DRIVE
  3
        Cal.
```
1 = Future Use
2 = Future Use
3 = Mechanical
4 = Hydraulic

DISPLAY

- Rudder Position Deadband (levels 1 to 9), (See 3.7).
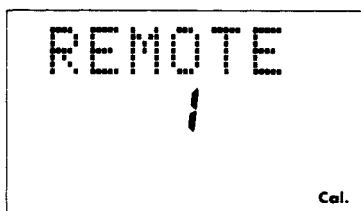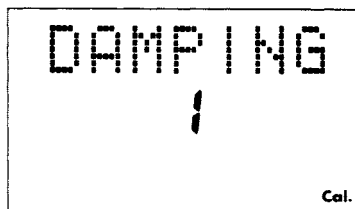
```
DAMPING
  1
        Cal.
```
DISPLAY

3. 5 Automatic Deviation Correction

The ST7000 will correct the fluxgate compass for any deviating magnetic fields. This should be carried out in calm conditions preferably in flat water.

* To select compass adjust Push and hold **Standby** for 1 second.

```
  ADJUST
 COMPASS
                    Cal.
```
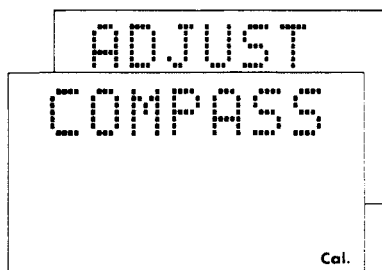
* Keeping boat speed below 2 knots, turn the vessel slowly so that it takes at least 3 minutes to complete 360°. Keep turning until the display changes to show the amount of deviation the autopilot has corrected:-
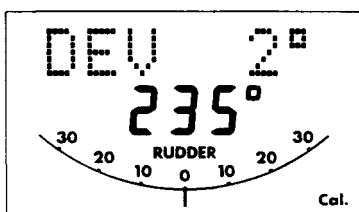
```
 DEV    2°
      235°
  30          30
    20  RUDDER  20
      10  0  10
              Cal.
```

Note: If the amount exceeds 15°, it is recommended the fluxgate should be re-sited.

* Use the course change buttons to adjust the displayed heading until it agrees with the steering compass or a known transit bearing.
Note: 000° is always followed by OFF. This will suppress the display of compass and automatic headings on the control unit.
* To exit compass adjust and store the compass settings push and hold Standby for 1 second.
* To exit compass adjust without saving any new settings push Standby momentarily.

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4. Common System Problems

Problem	Cause.	Solution.
System displays 'Manual' mode instead of 'Standby' on power up.	Early systems had poor colour definition on terminal boards. Blue and Green connections to the Fluxgate are reversed.	Reverse Blue and Green connections on Fluxgate.
System will not pick up N.M.E.A. data from a suitable receiver.	Early systems with software issues prior to 66E (Z083/084) and 66C (Z082) were not fitted with Nav software.	Replace software in both Course Computer and Control unit with latest versions if pre 66E or 65C (Both software issues can easily be checked by pressing +10 and -10 degree course change keys together for 2 seconds.
System displays ST 7000 for 2 sec's followed by 'NO LINK'.	Seatalk Bus non operational.	Cabling error between control units and Course Computer.
System displays 'GYRO' mode instead of 'STANDBY' on power up.	Wind Anemometer connected to pilot.	Remove yellow connection from AUX 1.
System displays maximum rudder angle on power up regardless of rudder position.	Early systems had poor colour definition on terminal boards. Blue and green connections to the rudder reference are reversed.	Reverse Blue and Green connections on rudder reference.
System displays 'ST7000' or 'STANDBY' when Auto is engaged.	Inrush currents on the power amplifier reset either the Control unit or the Course Computer Microprocessor.	Add C6 (100uF capacitor) to the power amplifier PCB. Systems from S/N 890040 on have this mod incorporated.

5. Track Control interfacing.

In most cases interfacing the ST7000 to either a GPS, Decca, Loran or Satellite Navigation system is a simple and straight forward task, so long as the requirements set out in section 6 of the installation manual are met. There are however a few exceptions:

5.1 Inverted Data.

Some receivers, notably some of the Furuno range and early Navstar models, transmit data in an inverted format with respect to 5V. This is easily seen as the data line will idle high with respect to 0V in between data transmissions. In these cases the NMEA cable on the rear of the control unit must be wired with the red wire connected to 5V, (this is normally available on the receiver terminal block), and the blue wire connected to the data line.

5.2 Conversion of Units.

The Control Unit will convert all units of distance to Nautical Miles. Therefore, any receivers displaying Cross Track Error or Distance To Waypoint in either Kilometres of Statute miles etc will have their data displayed on the Control Unit in Nautical Miles.

5.3 Alarm Messages.

Track mode has 3 alarm messages:-

1.	No Data	If a standard N.M.E.A sentence is not received by the ST7000.
2.	Data Error	The ST7000 has recognised the incoming data as N.M.E.A but has detected an invalid flag. This is normally due to poor signal strength at the receiver.
3.	Large XTE	Cross Track Error greater than O.3NM.

Errors 1 and 2 can provide valuable information as to where an installation problem might lie. The 'NO DATA' message indicates the ST7000 is not receiving N.M.E.A data due to either the receiver output not being enabled or more likely a wiring error between the receiver and the pilot. The 'DATA ERROR' message indicates the ST7000 is receiving data recognised as N.M.E.A but has an invalid flag set. This is normally due to the receiver having a low signal strength or a high noise figure.

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5.4 Autohelm 7000 N.M.E.A 0183 Data input Format.

The 7000 must receive Cross Track Error data at least once every 30 seconds.
If a display of Waypoint bearing and distance is required then this information must
be received at least once every 30 seconds. All N.M.E.A data is read into a buffer
thus enabling the 7000 to cope with delays between characters and delays between
sentences. All Talker Identifier characters, i.e. RA, DE, LC etc. are ignored allowing
interface with any type of equipment so long as the sentence type is one of the
following:-

Track Control	Bearing to Waypoint	Distance to Waypoint	Apparent Wind Speed & Direction
XTE	APB	WDR	VWR
XTR	BPI	WDC	
APA	BWR	BPI	
APB	BWC	BWR	
RMB	BER	BWC	
	BEC	BER	
	RMB	BEC	
		RMB	

Apparent Wind Speed and Angle can be received from any external equipment
transmitting the N.M.E.A. VWR header. The ST7000 will only display apparent wind
direction but will convert and retransmit both apparent wind speed and apparent wind
direction on the Seatalk bus. This information can then be displayed on an ST50 wind
instrument acting as a repeater.

6. Special functions.

6.1 Display of Software Version
It is possible to display the version number of both Course Computer and Control Unit software installed in a particular system. This is achieved by pressing both the +10 and -10 keys together for 2 seconds and releasing. The display will show the Control Unit Version (65 followed by Issue Level) for 10 seconds, followed by Course Computer Version (66 followed by Issue Level). The pilot must be in standby mode at the time. Each version is displayed for 10 seconds before the pilot reverts to standby. A software history for each product is shown in the relevant Service Section.

6.2 Permanent Watch Alarm Mode.
The ST7000 autopilot can be set up in a permanent watch alarm mode, as required by the Sea Fish Industry Authority (S.F.I.A).
It must be stressed that the selection of this mode is permanent and can only be reversed by returning the Course Computer to Nautech.
Permanent Watch Alarm is achieved by first entering the calibration menu. Once in calibration, regardless of display message, press the Auto, Standby, and Track keys together for 1 second before releasing. The display will now show 'SELECT WATCH'. The user now has 10 seconds to select permanent watch alarm mode by again pressing Auto, Standby and Track together for 1 second. The display will then show 'WATCH ON' for 10 seconds before reverting back to 'CAL'. A normal exit from calibration mode must now be executed.

6.3 Display Test Mode.
All display segments on the control unit can be switched on by pressing the +10, -10, Standby and Display keys together. This mode can only be accessed after the unit has been powered up with the yellow SeaTalk data wire open circuit. (This is best disconnected in the Course Computer Connector box (Bus 1 and Bus 2).)

6.4 LCD Contrast Ratio Adjustment.
In certain circumstances, it may be necessary to adjust the contrast ratio of the Z082 Control Unit LCD. This procedure is detailed in Section 4 of the ZO82 Control Unit Section.

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7. Service visit to a vessel.

When a service visit to a vessel is made the most common fault en-countered is likely to be poor connections or inadequate power supplies. These should be thoroughly checked before the Service visit diagnostic procedure is carried out.
When trying to locate a fault it should be remembered that most failures will occur in the Course Computer with the Control Units as the next most likely.
It should be noted that the calibration variables and auto deviation correction will require re-setting if the Course Computer, Course Computer Software or its PCB are exchanged. A procedure for carrying out this operation is given in section 3. Always note the Course Computer calibration settings before removing from the vessel.

7.1 Service Visit - Diagnostic Procedure

On arrival check for bad connections (corroded connector pins, loose connectors etc) and for inadequate power supplies. If the system still exhibits a fault, then use the diagnostic procedure outlined below. Once the faulty module has been detected refer to the relevant Product Section for detailed service information.

```
                        ┌─────────────┐
                    YES │  SeaTalk    │
        ┌───────────────│ instruments │
        │               │   fitted    │
        │               └──────┬──────┘
        │                      │ NO
┌───────┴────────┐            │
│     Bypass     │            ▼
│  Instruments   │      ┌─────────────┐
└───────┬────────┘      │   Only 1    │
        └──────────────▶│ control unit│ NO
                        │   fitted    │────────────┐
                        │      ?      │            │
                        └──────┬──────┘            │
                               │ YES               │
  FAIL  ┌──────────────────────┴──────┐            │
    ◀───│     Test Control Unit       │            │
   ┌────┴───┐          └───────┬──────┘            ▼
   │ Faulty │                  │ PASS       ┌─────────────┐
   │Control │                  ●◀───── NO ──│ Does fault  │
   │  Unit  │                  │            │ occur in    │
   └────────┘                  │            │1 Control Unit only│
                               ▼            │      ?      │
  FAIL  ┌─────────────────────────────┐     └──────┬──────┘
    ◀───│      Test Drive Unit        │            │ YES
   ┌────┴───┐          └───────┬──────┘            ▼
   │ Faulty │                  │ PASS       ┌─────────────┐
   │ Drive  │                  │            │Faulty Control Unit│
   │  Unit  │                  ▼            └─────────────┘
   └────────┘               ┌──────┐
                            │  A   │
                            └──────┘
```

Autohelm

A

Test Fluxgate

FAIL

PASS

Faulty
Fluxgate

Test Rudder Reference

FAIL

Rudder
Reference
Faulty

Faulty Course Computer
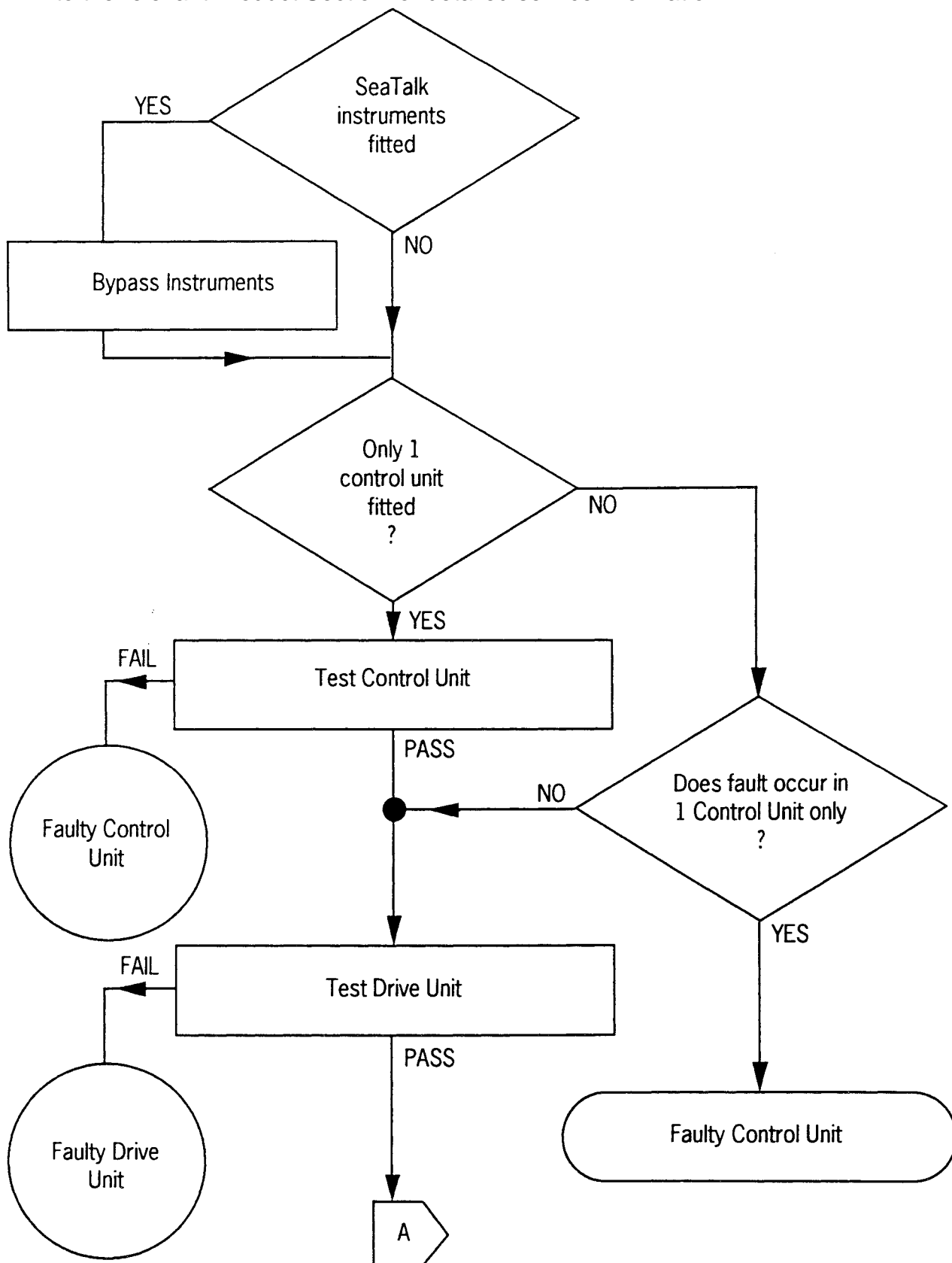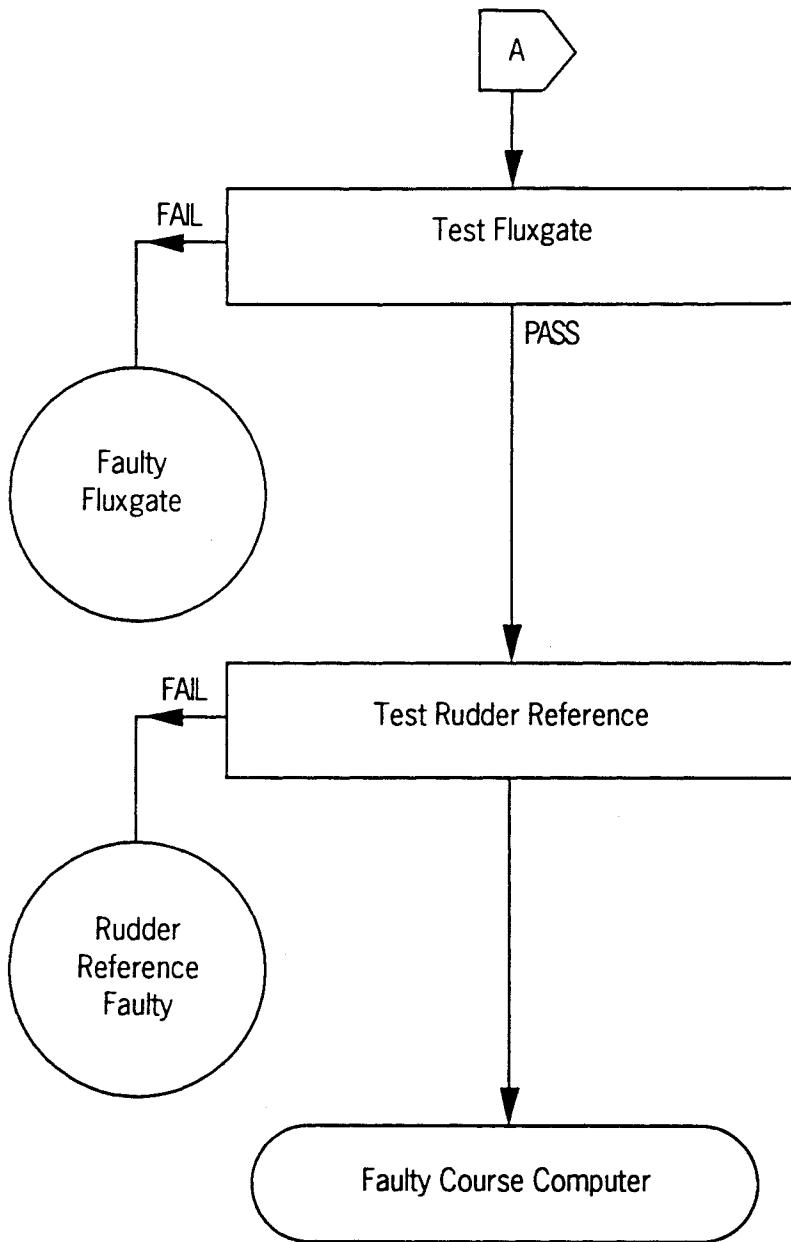
Z082 Control Unit

1. Service Procedures

Autohelm

Contents

Illustrations

1. Description

The Z082 Control Unit is SeaTalk compatible and consists of a single PCB built using surface mount technology. It can be used with both 12V and 24V SeaTalk Course Computers. The unit can also be functionally tested without the use of special equipment using the procedure outlined in figure 3.

2. Dismantling (ref fig 1.)

Note: To prevent damage to the printed face of the unit all work should be carried out on a flat surface covered in foam rubber. A conductive surface will prove beneficial in helping to prevent dust accumulation caused by static on the workbench.

1. Unscrew and remove the 6 case securing screws from the rear cover. Push each cable loom assembly back through its grommet so as to obtain working clearance to the PCB (fig 1).

Note: Failure to push the cables back to ease removal may damage the cable to PCB assembly. If cables are very tight in grommets apply a small smear of silicon grease to outer sheath, (grease can be wiped off after reassembly).

If removing the PCB assembly, it will be necessary to de-solder the cables from the PCB. Great care should be exercised when de-soldering so as not to damage the pads on the PCB.

2. Unscrew and remove the 10 screws which secure the PCB to the facia.

Note: Do not at this stage remove the screws which secure the LCD assembly to the PCB. (fig 2.).

3. Before removing the LCD ensure that lint free and preferably anti static finger cots are worn to prevent the LCD or elastomers getting dirty or greasy.

4. Unscrew and remove the 8 LCD housing retaining screws, (fig 2.). Be careful to hold the LCD surround, LCD, and diffuser when dismantling. Lift away from the PCB and store carefully.

3. Reassembly

Reassembly is a straight reversal of the above procedure but note the following points:

1. Note the correct orientation of the various looms and core colours to the PCB pads (fig 1).

2. Ensure the LCD is correctly orientated relative to the PCB (fig 2).

3. Ensure the diffuser is correctly orientated relative to the LCD and PCB (fig 2).

4. Always ensure the board is tightened down sequentially to ensure the load is evenly spread.

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5. When finally refitting the cover to the facia ensure that the cover is in the correct position relative to the cables and pull the cables back through the grommets as the cover is lowered onto the facia. Wipe off any excess grease from the cable sheaths.
6. Use only hand screwdrivers for reassembly to ensure screws are not over tightened and elastomers are compressed uniformly. Rotate screws anticlockwise to locate in the thread before tightening.
7. Re-check for full function after reassembly to check the LCD has not been damaged or looms incorrectly soldered.

4. Display Contrast Adjustment

The Display Contrast on the Z082 Control Unit can be manually adjusted to suit installations where the LCD is normally viewed from significantly above or below, or when a replacement LCD with different drive characteristics has been fitted.
1. Remove power from the unit.
2. Unscrew the mounting thumb nuts and ease the Control unit forward from its mounting position.
3. Unscrew and remove the 6 case screws from the rear cover. Push each cable loom back through its grommet so as to obtain working clearance to the PCB (fig 1). Note: If cables are tight in grommets then apply a small smear of grease to the outer sheath, (grease can be wiped off after reassembly).
4. Re-connect power.
5. View Control unit from normal operating angle.
6. Adjust vrl, (see figure 1 for location) to obtain optimum display legibility.
7. Refit the cover to the facia ensuring correct positioning relative to the cables. Pull the cables back through the grommets as the cover approaches the facia.
8. Secure Control unit in its original position.
Note: Use only hand screw drivers to reassemble to ensure screws are not over tightened.

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Control Unit General Assembly (Z082)

Fig. 1.

Labels on exploded assembly diagram:

- CABLE ASSY.
- CABLE ASSY.
- CABLE ASSY.
- SCREW (x6)
- COVER
- CASE SEAL
- SCREW (x10)
- P.C.B. ASSY. Q004
- KEYPAD INSERTS 20 x 12 (x6)
- GREY KEYPAD 20 x 12 (x4)
- RIBBED KEYPAD 20 x 12
- RED KEYPAD 20 x 12
- GREY KEYPADS 10 x 12 (x4)
- KEYPAD INSERTS 10 x 12 (x4)
- FACIA

Labels on reverse view of P.C.B.:

- I.C. M091
- SCREEN (0V)
- RED (12V)
- YELLOW (DATA)
- YELLOW (DATA)
- RED (12V)
- SCREEN (0V)
- YELLOW PL 2/2 R/NAV 0V
- RED PL 2/1 R/NAV RX
- VR1 (DISPLAY CONTRAST ADJUSTMENT)
- REVERSE VIEW OF P.C.B SHOWING LOOM WIRING CONNECTIONS

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LCD Display Assembly

LCD RETAINING SCREW (x8)

PCB ASSEMBLY 7000 CONTROL UNIT

DIFFUSER

NOTE ORIENTATION OF PIP ON LCD

LCD HOLDER

PCB ASSEMBLY

ELASTOMER (x2)

LCD

Fig. 2.

5. Functional Test

```
┌─────────────────────────────┐
│  Connect 0v to Screen       │
│  Connect 12v to Red Core    │
│  Yellow Core open Circuit   │
└─────────────────────────────┘
```

Tone sounds at Switch On ? — NO → Faulty PCB assembly

YES

Does display show ST7000 followed, after 2 seconds with NO LINK — NO → Faulty PCB assembly

YES

Do all pushbuttons sound when pressed ? — NO → Faulty pushbutton

YES

```
┌─────────────────────────────┐
│  Press +10, -10, Standby    │
│  and Display together       │
└─────────────────────────────┘
```

A

Fig 3.

Autohelm

A

Do all LCD segments come on

NO → Faulty PCB assembly

YES

Control Unit correct

6. Product History (Z082)

Change	Serial Number	Comments
Production Start	290001	
Track Compatibility	690075	When used with a Track Compatible Course Computer
White Back Light diffuser introduction	890007	
Protective Cover supplied with unit	100001	
SeaTalk Cable supplied with unit	300056	

7. Software History (Z082)

Version	Change	Course Computer Compatibility
B	Initial release (S/No. 290001)	All versions
C	Track function added, Rudder Angle display updates at a faster rate. (S/No. 690075)	All versions but must be used with a track compatible Course Computer if the track function is required.

8. Spares Numbers - Control Unit (Z082)

Item	Catalogue No	Comments
Double Skin mounting kit	Q003	Allows Control Unit to be mounted on up to 4" thick bulkheads
PCB Assembly	Q004	No LCD included
LCD	Q026	
White Backlight Diffuser	Q023	
Protective Cover	D122	

Autohelm

2. Technical Information

Contents

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1. Control Unit PCB Circuit Description
Circuit Diagram Fig. 1.
PCB Assembly/Parts List Fig. 2.

1.1 Power Supply
Incoming power is routed to the PCB via PL1 and SKT1. D4 and D20 protect against reverse connection of the supply. IC1 is a 5V regulator and can also reset the microprocessor, via TR1, should the supply voltage fall below approximately 6V.

1.2. Microprocessor and Program Memory
IC6 is an Intel 80C32 microprocessor. It can access up to 32k bytes of program memory (IC5) via the latch IC4. A clock signal for the microprocessor is provided by an 1 1MHz ceramic resonator (XL1), and associated capacitors C7 and C8. Capacitors C6, C9 and C10 provide decoupling.

1.3. LCD and Display Driver
The LCD is a Nautech custom part. The display is driven by a Hitachi LCD driver (IC3) deriving its drive voltages from resistor chain R24-R27 and VR1. Communication to the microprocessor is via a 4 bit parallel bus (DB4 to DB7) and the three control lines E, R/W and RS. Capacitors C18 and C22 provide decoupling and resistor R44 the clock signal for IC3.

1.4. Negative Rail Generator
A negative voltage rail is required by the LCD display and is generated by a switching regulator formed by TR11, D10 and D21. A 4.8KHz waveform is generated from the microprocessor P3.4 (pin no. 16). This drives a charge pump, via transistorTR11, pumping charge from C19 via D1O and C20. The negative rail is then stabilised by D21 and R60.

1.5. N.M.E.A Interface
NMEA data is fed to the control unit via PL2 and isolated from the rest of the circuit using the opto-isolator (IC7). Diode D1 provides input reverse connection protection and resistor R35 is tuned to give the desired bandwidth of operation. The output from IC7 is connected to the microprocessor Port P3.2 (pin 14). Capacitor C21 provides decoupling.

1.6. SeaTalk Bus Transmit and Receive
SeaTalk transmit and receive circuitry consists of TR5, 6, 7, 8, 9, 14 and 15 and their associated components. Data transmission is at 4800 band with a low start bit and line idling high. TR7 and TR8 provide high and low drive respectively, whilst TR14 and R57 give overload protection to TR8 in the event of misconnection. TR5 and TR6 allow the microprocessor to monitor its own transmissions and also to receive data from other units on the bus.

1.7. Keypad Operation

The 10 button key pad is configured in a 4*3 matrix and connected to the microprocessor P1.0 and P1.6 (pins 2 to 8). Each key is diode isolated to enable multiple key presses to be decoded.

1.8. Buzzer Operation

TR2 and TR3 are configured as an astable multivibrator with a nominal frequency of 2.7KHz. TR4 is used to switch the buzzer with TR13 acting as an invertor to turn the buzzer off during a micro-processor reset.

1.9. Illumination Drive

TR10, 12 and 16 provide a constant current drive for lamps LP1, LP2, LP3 and LP4. The current is set by resistors R56 and R62. TR12 is an inverting buffer to turn off the lights during a microprocessor reset. Illumination levels are given by pulse width modulation of drive line P3.3 (pin 15 of IC6).

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Fig. 1. **Z082 Control Unit Circuit Diagram** ISS C

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NOTES

1. ALL SURFACE MOUNT CAPACITORS AND RESISTORS TO HAVE NICKEL BARRIER SOLDER PLATED TERMINATIONS

2. ITEM 4 (15036) TO BE SANDWICHED BETWEEN ITEM 5 (15039) AND PCB TO INSULATE HEATSINK FROM 5V TRACK CONNECTED TO IC 1 (PIN 2)
3. ITEM 6 15085) TO LIE FLAT ON P.C.B. AS SHOWN.

ITEMS	DRG/PART N*	QTY	DESCRIPTION	
47	OR	1	LCD DISPLAY DRIVER KS0062 (SAMSUNG)	IC3
46	EITHER	1	LCD DISPLAY DRIVER HD44780 (HITACHI)	
			AND	
45	OR	1	TRANSISTOR BC337 NPN (TO BE ASSEMBLED WITH	
			MAXIMUM LEAD LENGTH =4MM)	
44	EITHER	1	TRANSISTOR SOT89 BCX68 NPN	TR16
			PLUS	
43		10	CONTACT CLICKER 00K-73470 S1, S2, S3, S4, S5, S6, S7, S8, S9, S10	
42		1	CHIP TRIMMER RESISTOR 1K MURATA RVG 4F03A-102VM	VR1
41		1	OPTO ISOLATOR 6N139 LEADS TO BE FORMED FOR	
			BUTT JOINT CONNECTION (ie HPs OPTION 100)	IC7
40		1	MICRO ROM LESS 80C32 12MHz PLCC	IC6
39		1	HCMOS LATCH 74HC373	IC4
38		1	VOLTAGE REGULATOR LM2925	IC1
3?		1	TRANSISTOR SOT 23 BC807 PNP	TR7
36		14	TRANSISTOR SOT 23 BC817 NPN	TR1, TR2, TR3, TR4, TR5, TR6, TR8, TR9, TR10, TR11, TR12, TR13, TR14, TR15
35		5	DIODE SOT 23 BAW56	D6, D7, D8, D15, D16
34		3	DIODE SOT 23 BAV99	D2, D10, D21
33		1	DIODE SOT 23 BAS 16	D12
32		3	DIODE SOT23 BAS19	D1, D4, D20
31		2	CAPACITOR SOLID TANT. 10UF ±20% 6V3(SIZE C)	C19, C20
30		1	1206 CAPACITOR 1000pF ± 10% 5OV X7R	C11
29		2	1206 CAPACITOR 33pF ±5% 50V COG	C7, C8
28		3	1206 CAPACITOR 22pF ±5% 50V X7R	C2, C4, C5
27		1	1206 CAPACITOR 0.1µF ±20% 50V X7R	
26		1	ELECTROLYTIC CAPACITOR 100uF ±20% 6.3V MIN 5.5 MAX C3	
25		1	1206 RESISTOR 100K 5% 0. 125W	R35
24		4	1206 RESISTOR 1K0 2% 0.125W	R24.R25R26R27
23		1	1206 RESISTOR 220R 5% 0. 125W	R42
22		1	1206 RESISTOR 680R 5% 0 125W	R60
21		1	1206 RESISTOR 10R0 1% 0.125W	R56
20		1	1206 RESISTOR 91K 2% 0.125W	R44
19		1	1206 RESISTOR 8R2 5% 0.125W	R34, R47, R57, R59
18		3	1206 RESISTOR 39K 5% 0.125W	R10, R11, R19
17		1	1206 RESISTOR 22K 5% 0.125W	R21
16		1	1206 RESISTOR 15K 5% 0. 125W	R12
15		9	1206 RESISTOR 12K 5% 0. 125W	R1, R2, R6, R7, R9, RZ2, R23, R50, R55
14		4	1206 RESISTOR 4K? 5% 0.125W	R13R32R54R58
13		3	1206 RESISTOR 2K2 5% 0.125W	R3, R14, R20
12		3	1206 RESISTOR 1K2 5% 0.125W	R31, R51, R52
11		2	1206 RESISTOR 470R 5% 0 . 125W	R5, R8
10		1	1206 RESISTOR 390R 5% 0. 125W	R18
9		1	1206 RESISTOR 13R0 1% 0.125W	R62
8		1	BUZZER KBS-27DB~3T	
7	26006	1	RIVSCREW 1712-3507 (AVDEL)	
6	15085	1	CERAMIC RESONATOR 11MHz (CSA 11.0MT)	XL1
5	15039	1	HEATSINK REDPOINT TV58	
4	15036	1	TRANSISTOR MOUNTING PAD	
3	07164	1	28 PIN IC SOCKET	
2	3015-028	1	7000 CONTROL UNIT PCB DETAIL	
1	3010-036	10	CLICKER SEAL	
ITEMS	DRG/PART N*	QTY	DESCRIPTION	

TOP SIDE

COMPONENT SIDE
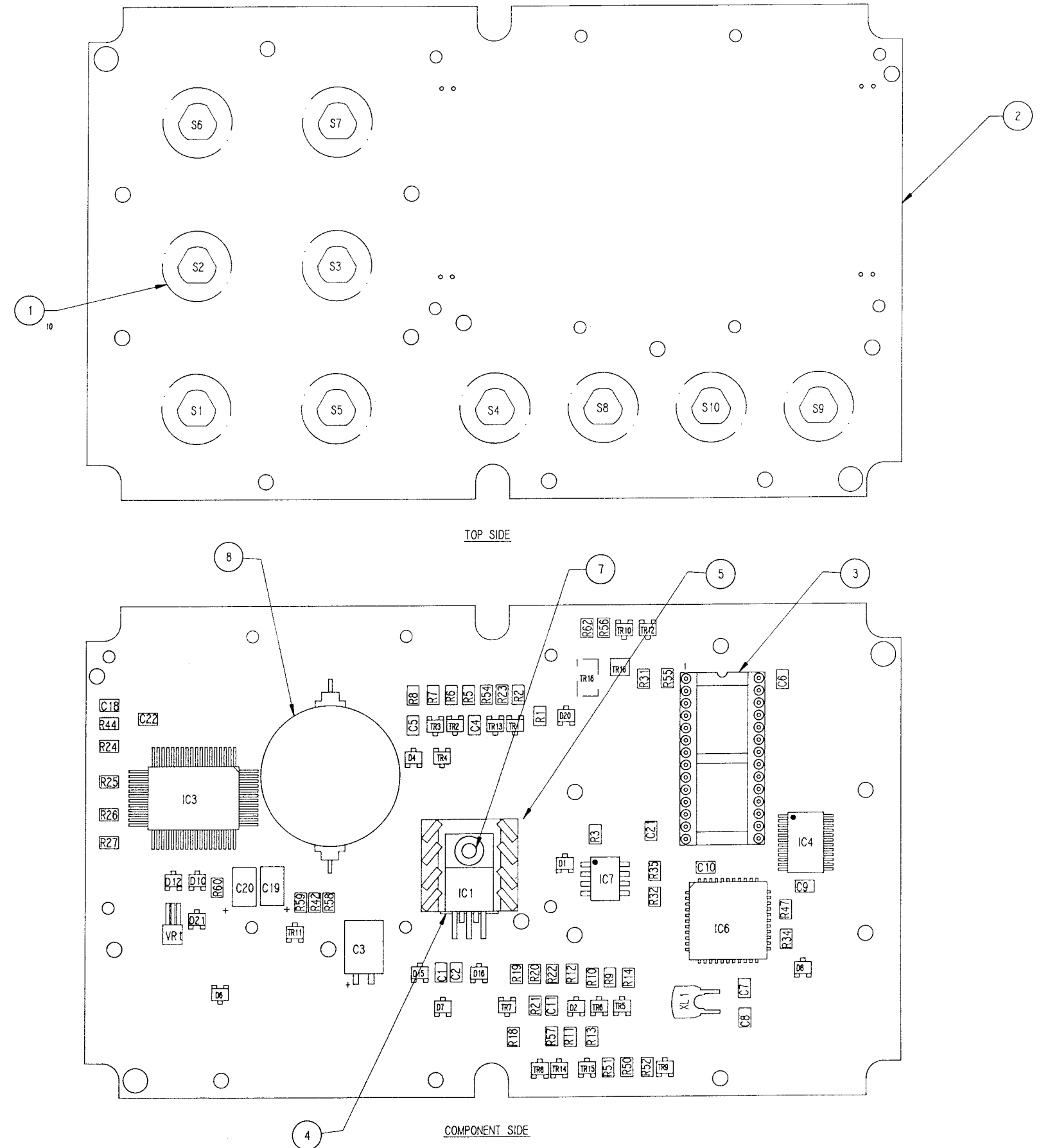
Fig. 2 . **Z082 Control Unit PCB Assembly/Parts List** ISS S

SeaTalk Service Manual

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Z084 Course Computer (24V) & Z083 Course Computer (12V)

1. Service Procedures
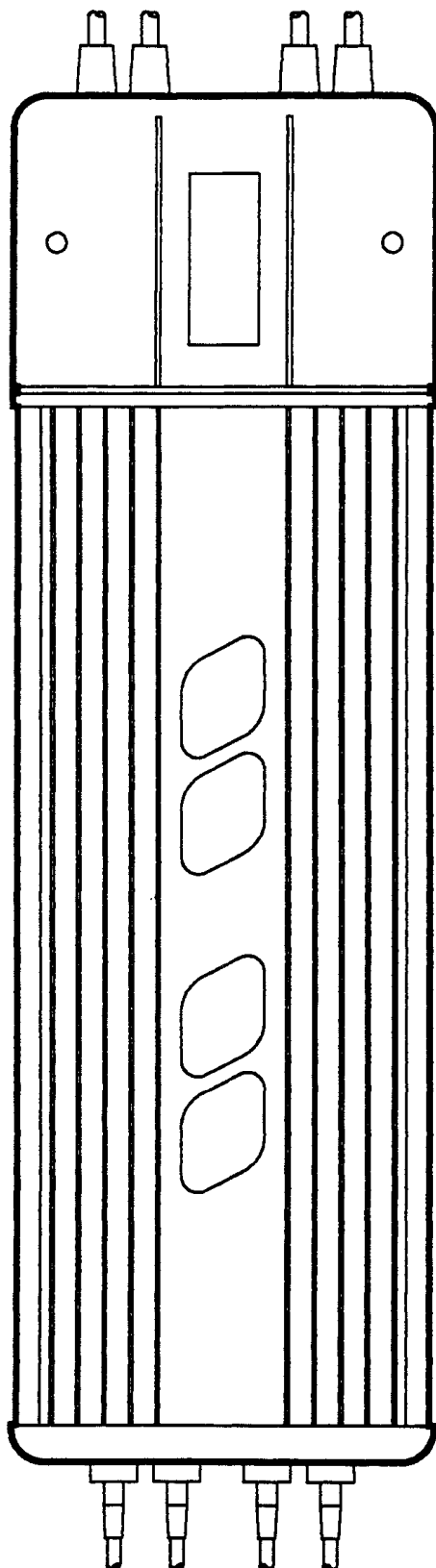
Z083 COURSE COMPUTER (12V)
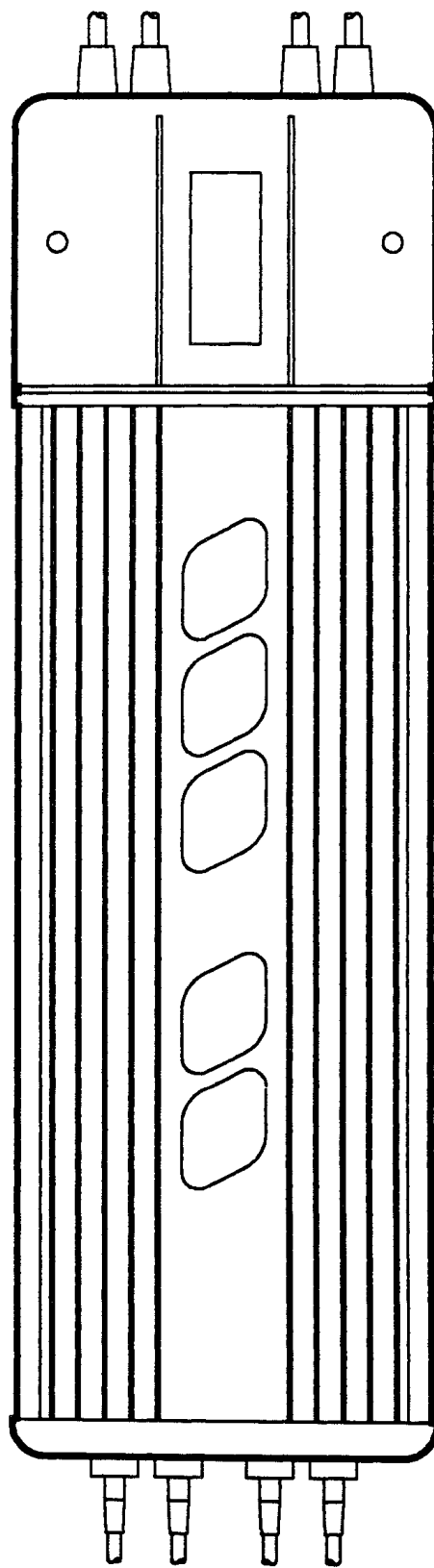
Z084 COURSE COMPUTER (24V)

Autohelm

Contents

Illustrations

1. Description

The ST7000 course computer is SeaTalk compatible and consists of 2 PCB's, a course computer and power amplifier. The course computer, which is built using surface mount technology, contains a microprocessor and various analogue interface circuitry. The power amplifier provides the motor drive, protection relays and 24V to 12V regulator (24V systems). This PCB is identical to that used on the Autohelm 6000 type 2 pilots (Z051 and Z052) and uses conventional through hole components. The two PCB's are connected together via a 16 way ribbon cable. The same computer PCB is used on both 12V and 24V systems. The power amplifier PCB is built to two standards, one for 12V systems, and a second, which includes a 24V to 12V regulator, for 24V systems. A single design of terminal board is used for all drive applications. This PCB has no active components and should be visually checked if suspected faulty. Note:

If the course computer or its PCB are replaced, calibration values previously altered from the factory settings will require re-setting. Also the Fluxgate Compass will require re-linearising (auto deviation correction). Both of these procedures are outlined in the 7000 system section.

2. Dismantling (reference figures 1 & 2)

1. Unscrew and remove 2 countersunk screws securing lid on terminal box section and lift off.

2. Unscrew and remove 2 thumb nuts securing extrusion assembly to terminal box unit and pull extrusion assembly away from terminal box.

3. Course Computer PCB

If servicing course computer PCB, unscrew and remove 4 pan head screws securing the connector cover moulding to the extrusion and slide out cover and PCB assembly. Disconnect power amp PCB loom and lift away the PCB assembly. If necessary, remove the PCB from the moulded cover by unscrewing the 2 countersunk screws and nuts which fix the 'D' connector flange to the moulding.

4. Power Amplifier PCB

Repeat steps 1 to 3 but do not remove the computer PCB from the cover. Disconnect the 16 way loom from the computer PCB and remove the plastic covers from the power transistors. Unscrew all pan head screws and retain the shakeproof washers where fitted. Lift out all transistors. Slide PCB out of extrusion from the open end. Retain the insulators and caps fitted to the securing lugs on the PCB.

5. If servicing the terminal PCB, repeat steps 1 and 2. Remove the terminal PCB from the terminal box by removing the 2 nuts securing the 'D' connector to the terminal box, and the 2 securing screws at the front of the PCB, and remove the PCB assembly.

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3. Re-assembly

In all cases re-assembly is a reversal of the dismantling procedures above, but note;-

1. Ensure correct orientation of power amp PCB loom when reconnecting to the computer PCB. Ensure a loom clip is fitted to the ribbon cable connector.

2. Ensure that insulating caps are all in place before sliding the power amp PCB back into the extrusion. Ensure that the silpads are fitted between the transistors and the extrusion.

3. Ensure that the correct transistor type is placed at each location. (Fig. 2).

4. Ensure that transistor/PCB securing screws are not loose, but do not over tighten.

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ST7000 Course Computer General Assembly Z083-12V and Z084-24V

Cover Securing Screws

Switch Cover

Extrusion

Course Computer ROM (M092)

PCB Assembly Q007

ST 7000 Ident Dot

Power Amp PCB Loom Connection

Computer PCB Assembly Q007

Cover Securing Screw

Connector Cover

Securing Studs

Course Computer Label

Terminal Box

Securing Screws

Terminal Box Cover

Thumb Nut

Terminal PCB Assembly Q006

Terminal Box Pillars

Fig. 1.

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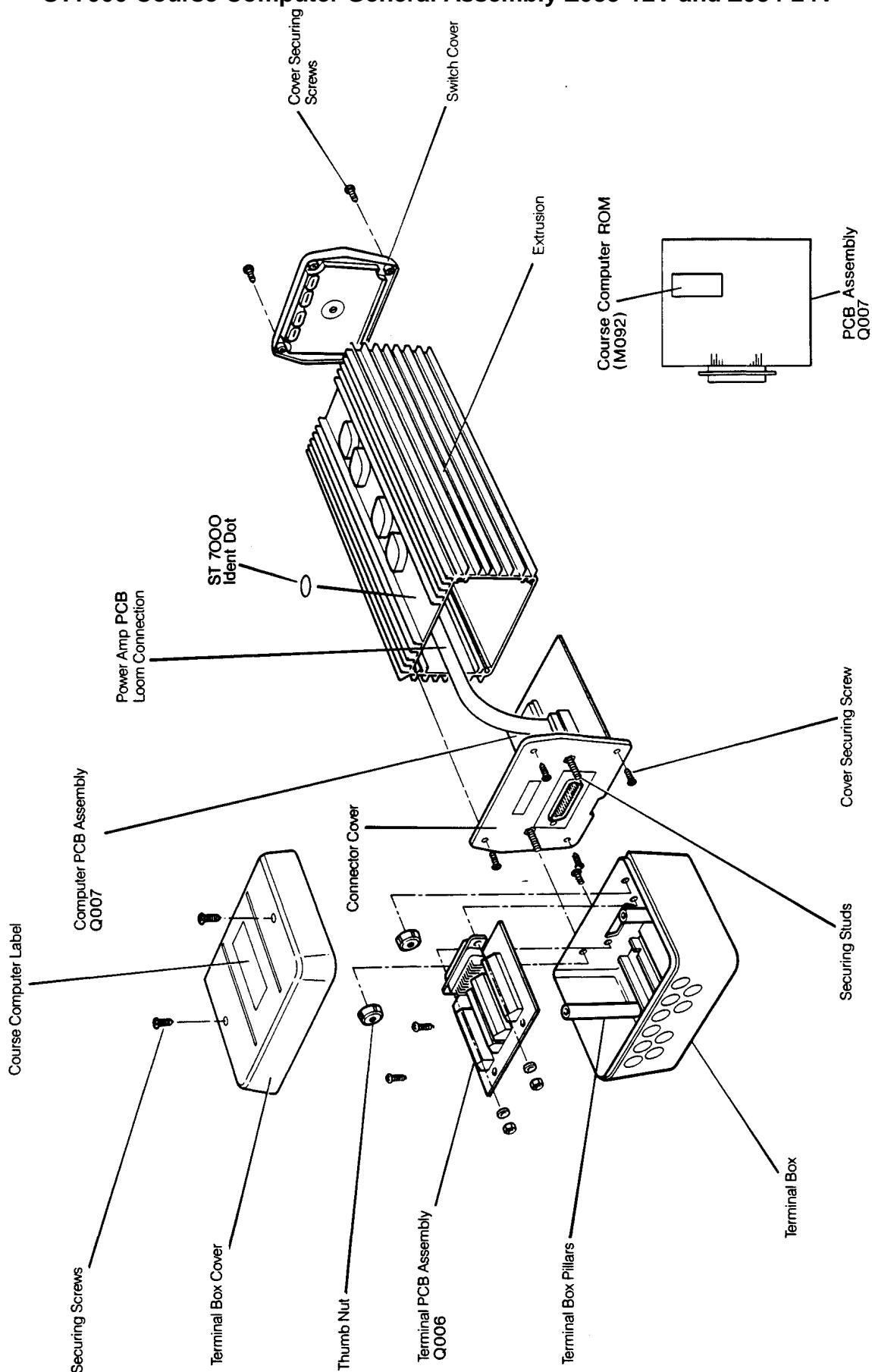
ST7000 Course Computer (Z083, Z084) - Power Amp PCB Assembly

Transistor Cover (Screwed Fixing Type)

Transistor Sitpad Part of L009 or L010

24V Power Amp PCB Assembly M063

Transistor Insulator

Transistor Insulator

Insulator Cap

Insulator Cap

12V Power Amp PCB Assembly M062

Transistor Kit L010 (MJ11029)

Transistor Kit L009 (MJ11028)

ST7000

Transistor Kit L010 (MJ11029)

Transistor Kit L009 (MJ11028)

ST7000
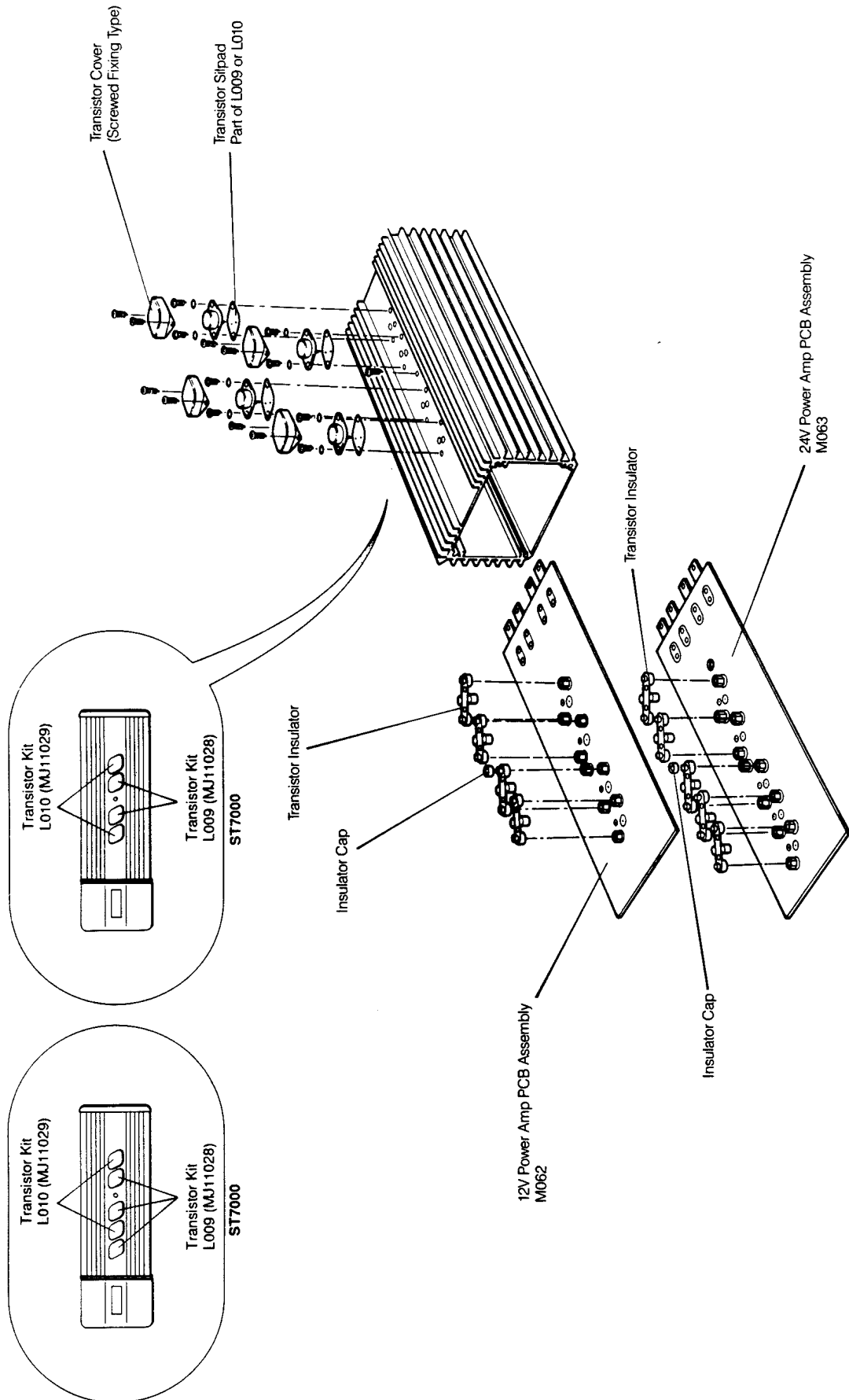
Fig. 2.

4. Functional Test

The Course Computer can be functionally checked by using the following procedure.
Pre checked equipment required;-

SeaTalk Control Unit (Z082)
Fluxgate Compass (Z105)
Pushpit Vane Transducer (Z087)
Rudder Reference Transducer (Z060)
Terminal PCB (Q006)
Terminal Block
Multimeter
Motor for Z083 (12V) (N002)
Motor for Z084 (24V) (N003)
Power Supply (min rating 20A)
SeaTalk Cable (D131)

Procedure:
a) Connect all units to course computer and terminal board PCB.
b) Position the rudder reference transducer arm diametrically opposite the cable gland.
c) Connect 12V (Z083), 24V (Z084) electronic and heavy duty supplies (do not switch on).
d) Start at Bench Test Stage 1. The procedure will determine if the course computer is faulty or correct and in most cases will also identify the nature of the fault and corrective action required. Some faults require further investigation and this is covered in stage 2 and stage 3.

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4.1 Course Computer Bench Testing (Stage 1)

Fig. 4.

A

Press 'Auto'

Does meter read >10v ? — NO → Replace Computer PCB

YES

Press 'standby'. Select Drive level 1 via the calibration menu. Press 'Auto'

Press +10° three times

Motor runs ? — NO → Go to stage 3

YES

Motor stops within 10 seconds ? — NO → Replace Computer PCB

YES

B

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B

Press -10° three times

Motor
runs
?

NO → Go to stage 3

YES

Motor
stops within
10 seconds
?

Replace Computer
PCB

YES

Press 'Standby'.
Select Drive level 3
via the calibration menu

Press 'Standby' and 'Auto'
together

Does
Display indicate
windvane mode
?

NO → Replace computer
PCB

YES

C

```
          ┌───┐
          │ C │
          └─┬─┘
            │
            ▼
┌───────────────────────────┐
│       Press 'Standby'      │
└─────────────┬─────────────┘
              │
              ▼
┌───────────────────────────┐
│  Move rudder reference arm │
│      30° anti-clockwise    │
└─────────────┬─────────────┘
              │
              ▼
           ╱     ╲
         ╱  Does   ╲
       ╱  rudder     ╲              NO
     ╱  angle display  ╲ ──────────────────────┐
     ╲ show approximately30° ╱                  │
       ╲ starboard rudder  ╱                    │
         ╲               ╱                      │
           ╲     ╱                              │
             │ YES                              │
             ▼                                  │
┌───────────────────────────┐                  │
│  Move rudder reference arm │                  │
│       60° clockwise        │                  │
└─────────────┬─────────────┘                  │
              │                                 │
              ▼                                 │
           ╱     ╲                              │
         ╱  Does   ╲                            │
       ╱  rudder     ╲              NO          │
     ╱  angle display  ╲ ──────────────────────┤
     ╲ show approximately30° ╱                  │
       ╲   port rudder   ╱                      │
         ╲             ╱                        │
           ╲   ╱                                │
             │                                  │
             │ YES                              ▼
             │                    ┌───────────────────────┐
             │                    │       Replace          │
             │                    │    computer PCB        │
             │                    └───────────────────────┘
             ▼
          ┌───┐
          │ D │
          └───┘
```

Autohelm

```
        ┌───┐
        │ D  ⟩
        └─┬─┘
          │
          ▼
┌─────────────────────────────┐
│      Disconnect motor.       │
│ Connect meter across alarm output │
└──────────────┬──────────────┘
               │
               ▼
┌─────────────────────────────┐
│         Press 'Auto'         │
└──────────────┬──────────────┘
               │
               ▼
          ╱─────────╲
         ╱  Does meter ╲        NO
        ╱   read Ov?    ╲──────────────────┐
         ╲             ╱                   │
          ╲───────────╱                    │
               │ YES                        │
               ▼                            │
┌─────────────────────────────┐            │
│      Press +10 4 times       │            │
└──────────────┬──────────────┘            │
               │                            │
               ▼                            ▼
           ┌───┐            ┌─────────────────────────┐
           │ E  ⟩           │         Replace          │
           └───┘            │      computer PCB        │
                            └─────────────────────────┘
```

E

Does meter read >10v
after 120 secs.
?

NO

Repeat previous test with
meter connected across alarm 2

Replace
computer PCB

Course computer, OK

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4.2 Course Computer Bench Testing (Stage 2)

1. Proceeding from stage 1 bench testing, remove the four screws retaining the computer PCB cover assembly and slide the PCB clear of the extrusion. Do not disconnect the loom.

```
┌─────────────────────────────┐
│   Connect meter +ve to       │
│   Bus 1 or Bus 2 (Red Dot).  │
│   Connect meter -ve to -ve output │
│   on Bus 1 or Bus 2 (White Dot). │
└─────────────────────────────┘
              │
              ▼
           ╱Does╲         YES
          ╱ meter read ╲──────────────►
          ╲   12v?    ╱
           ╲       ╱
              │ NO
              ▼
┌─────────────────────────────┐
│  Connect meter +ve to PL2/16 │
│  Connect meter -ve to PL2/6  │
└─────────────────────────────┘
              │
              ▼
           ╱Does╲         YES
          ╱ meter read ╲──────────────►
          ╲   12v?    ╱
           ╲       ╱
              │ NO
              ▼
┌──────────────────┐        ┌──────────────────┐
│  Power Amp PCB    │        │  Computer PCB     │
│  faulty replace   │        │  faulty replace   │
└──────────────────┘        └──────────────────┘
```
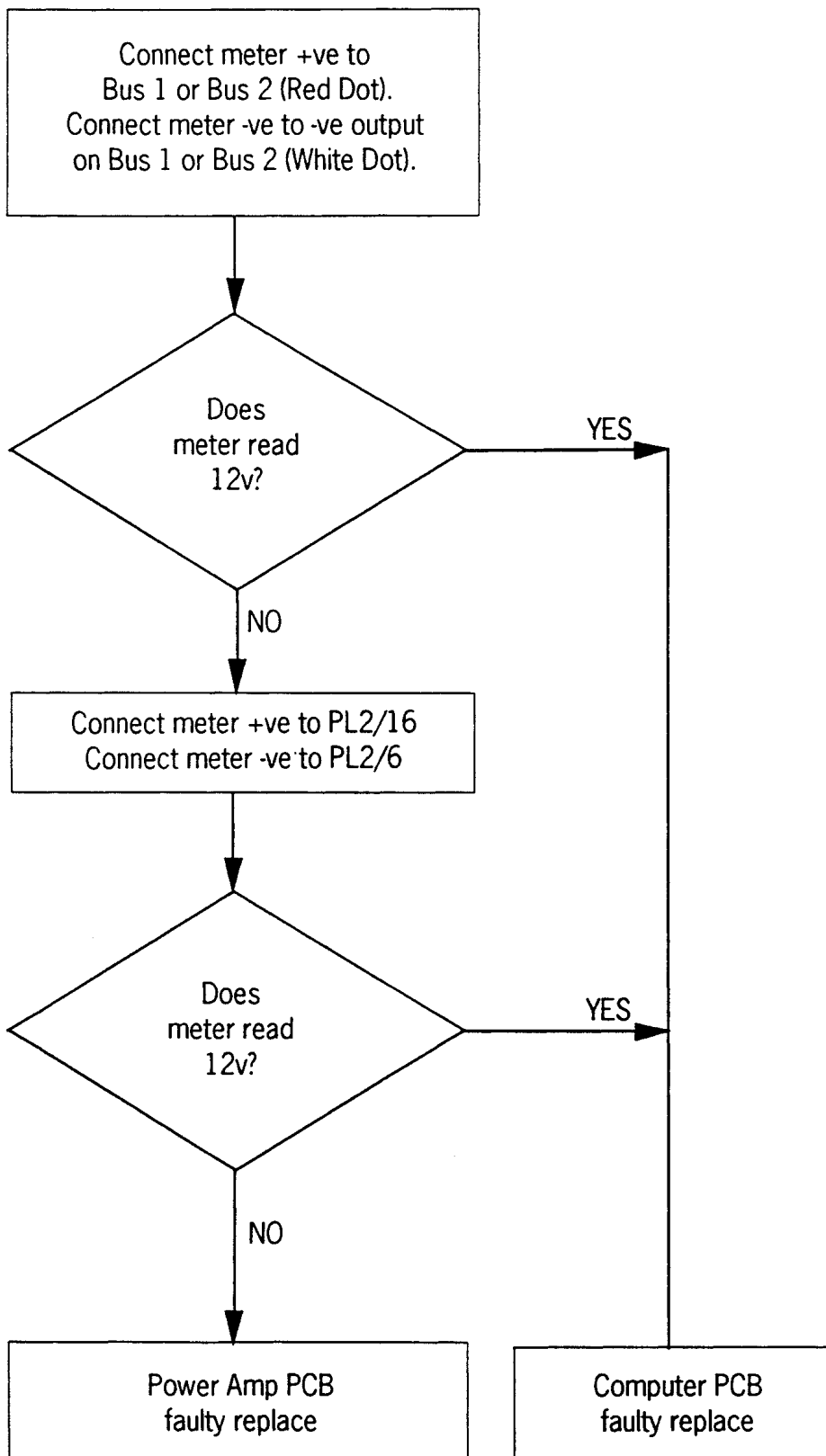
4.3 Course Computer Bench Testing (Stage 3)

Proceeding from stage 1 bench testing, remove 4 screws retaining the computer PCB cover assembly and slide the PCB clear of the extrusion. Do not disconnect the loom.

```
┌─────────────────────────────────────┐
│   Press 'Standby' Connect meter      │
│  across PL2/1 and PL2/3. Check drive │
│   level in calibration menu is set to 1 │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│    Press 'Auto' then press '+10'     │
└─────────────────────────────────────┘
                  │
                  ▼
          ◇ Does motor run ? ◇ ───NO───►
                  │                      │
                 YES                     ▼
                  │              ◇ Does meter read > +/-0.25v ◇
                  ▼                      │
   ◇ Does motor stop ◇ ◄─NO── NO─►      YES
   ◇ within 10 secs  ◇                   │
                  │                      ▼
                 YES          ┌──────────────────────┐
                  │           │ Connect meter +ve to │
                  ▼           │ PL2/5. Connect meter │
   ┌──────────────────────┐   │    -ve to PL2/6      │
   │ Repeat test, but     │   └──────────────────────┘
   │ driving motor in the │              │
   │ other direction      │              ▼
   │ by pressing '-10'    │     ◇ Does meter read >10v ? ◇
   └──────────────────────┘     │                  │
                           NO ◄─┘                 YES
                            │                      │
                            ▼                      ▼
                ┌──────────────────┐  ┌──────────────────┐
                │ Computer PCB     │  │ Power Amplifier  │
                │ faulty. Replace  │  │ PCB faulty. Replace │
                └──────────────────┘  └──────────────────┘
```
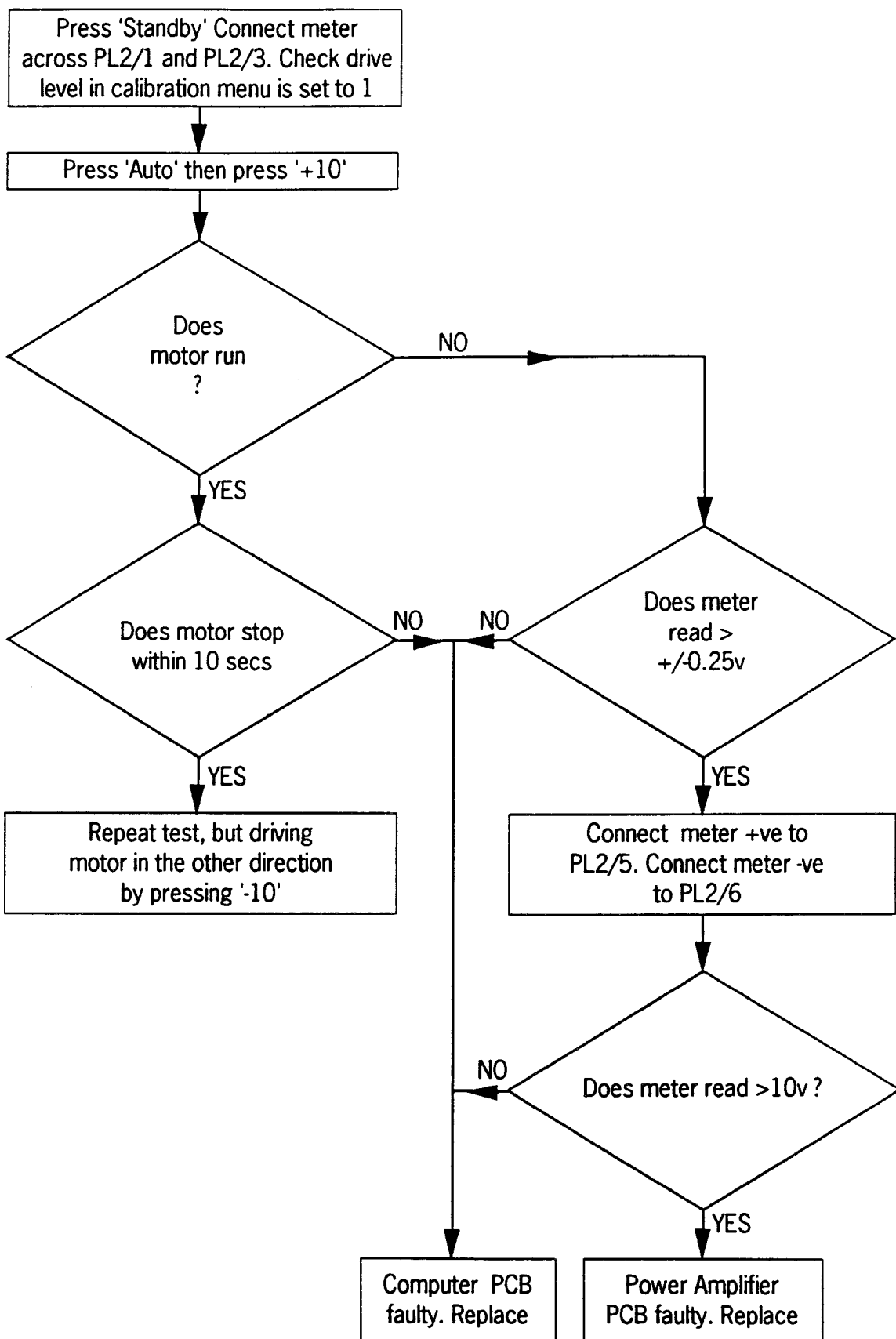
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5. Product History Course Computer (Z083 & Z084)

Change	Serial Number	Comments
Production Start	290001	
Track Function Introduced	590206	Must be used in conjunction with a Control Unit capable of supporting the Track function
Capacitor 'C6' (100µf) fitted to power amplifier board	890040	Cures occasional system reset to Standby mode when initially engaging Auto after power up.

6. Software History (Z083 & Z084)

Version	Change	Control Unit Compatibility	S/No
C	Initial release	All versions	290001
D	Auto Seastate problem cured	All versions	490081
E	Track function added	All versions. If Track keeping algorithm is required then control unit must also be Track Compatible	590206
G	Trim function Improved	All versions	500256

7. Spares Numbers - Course Computers (Z083 & Z084)

Item	Catalogue No.	Comments
Connector Unit terminal PCB assembly	Q006	
Course Computer PCB assembly	Q007	
Power Amplifier PCB assembly (Z083)	M062	12v version
Power Amplifier PCB assembly (Z084)	M063	24v version
PNP Power Transistors (2offMJ11029)	L010	
NPN Power Transistors (2offMJ11028)	L009	

2. Technical Information

Contents

Illustrations

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1. Course Computer PCB Circuit Description;-
Circuit diagram Fig. 1.
PCB assembly/parts list Fig. 2.

1.1. Power Supplies
Incoming power is routed to the PCB via the 'D' connector plug PL1. VI provides suppression against any voltage spikes present on the incoming DC supply whilst D6 protects against reverse connection of the supply. 1C 1 is a 5V regulator and can also reset the microprocessor, via TR9, should the supply voltage fall below 6V. TR17, C19, D13, R92 and R91 form an 8V regulator to supply the windvane.

1.2. Microprocessor and Program Memory
IC2 is an Intel 80C32 microprocessor. It can access up to 32k bytes of program memory (IC7) via the latch IC6. A clock signal for the microprocessor is provided by an 11 MHz ceramic resonator (XL1) and associated capacitors C15 and C16. C14, 18 and 17 provide decoupling.

1.3. Analogue to Digital Converter
IC3,4,5 and 9 form a software driven analogue to digital converter. IC3 and IC9 are 8 channel multiplexed analogue switches routing all analogue signals, (see table below), through to IC4 which is configured as an integrator. C9 is discharged at a constant rate triggering the comparator IC5 as it reaches a level of approximately 0.53V. The output of the comparator is connected to the microprocessor thus measuring the discharge time which is proportional to the analogue input.

Analogue Channels;-

IC3	Channel 0	Reset integrator
	Channel 1	Integrator discharge signal
	Channel 2	Fluxgate sense A
	Channel 3	Fluxgate sense B
	Channel 4	Motor Feedback 1
	Channel 5	Motor Feedback 2
	Channel 6	Windvane sense 1
	Channel 7	Windvane sense 2
IC9	Channel 0	Alarm sense 1
	Channel 1	Alarm sense 2
	Channel 2	Rudder Reference
	Channel 3	Supply Monitor
	Channel 4	Rate Gyro sense
	Channel 5	Gyro Compass sense
	Channel 6	Joystick
	Channel 7	Not used

1.4. Clutch Drive
TR10, 11 and 12 switch a nominal 12V onto the actuator clutch whenever pin 15 of the microprocessor (IC2) is low at 0V.

1.5. SeaTalk Bus Transmit and Receive
SeaTalk transmit and receive circuitry consists of TR1, 2, 3,4, 5, 18 and 19 and their associated components. Data Transmission is at 4800 baud with a low start bit and line idling high. TR1 and TR2 provide high and low outputs respectively, whilst TR3 and RI give overload protection to TR2 in the event of misconnection. TR4 and TR5 allow the microprocessor to monitor its own transmissions and also to receive data from other units on the bus.

1.6. Fluxgate Drive
IC2 produces a series of 8KHz pulses on pin 2 which are then fed through TR6, 7 and 8 and AC coupled to the fluxgate via C3.

1.7 E^2 Prom
IC8 is an e^2 PROM (Electrically Erasable and programmable Read Only Memory) which allows calibration values to be stored and recalled each time after power up. Data is written to the e^2 PROM on pin 3 and read back on pin 4.

1.8 Supply Voltage Monitor
R53 and R54 scale down the supply voltage and feed it through to the analogue to digital convertor. This enables the microprocessor to transmit a warning on the SeaTalk bus if the supply voltage drops below 11.2V (12V system) or 22.4V (24V system) for 10 seconds or more.

1.9. Alarm Drive
The two main warning alarms are driven via TR13, 14, 15 and 16. Components R41,42, 79,80 and D7 and 8 are used to detect any tampering with the alarm connections, as required by the SFIA.

2. Power Amplifier PCB Circuit Description;-
Circuit diagram 12V-figure 3
Circuit diagram 24V - figure 3
PCB layout 12V-figure 4
PCB layout 24V-figure 5

The power amplifier electronics consist of three main areas;-

1. Voltage regulator 24V-12V. (Not present on 12V boards).
2. Reverse connection protection.
3. Current amplifier bridge.

2.1. Voltage Regulator (24V systems only)
TR13 and TR14 together with associated components form a 24-12V regulator routing 12V to the course computer board via PL1.

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2.2. Reverse Connection Protection

TR1 and TR2 along with RL1,2 and 3 ensure that external misconnection of Heavy duty V+, Heavy duty 0V and M1 and M2 will not damage the unit.

2.3. Bridge Amplifier

TR6, 7,8 and 9 form a bridge amplifier to control the actuator motor. Four modes of operation are possible, each selectable with a binary code on drive A and drive B.

Mode 1 - Drive A and drive B both a logic 1. The motor is shorted via TR7 and TR9. This mode is used for stopping the motor quickly.

Mode 2 - Drive A and drive B both at logic 0. The motor is open circuit and therefore may run as a generator allowing measurement of motor back emf. R14 and R16 in combination with R25 and R28 on the computer PCB scale down the back emf.

Mode 3 - Drive A is at logic 1. Drive B is at logic 0. The motor will rotate clockwise.

Mode 4 - Drive B is at logic 1, drive A at logic 0. The motor will rotate anti-clockwise.

TR4 and TR10 are interlocks, switching off TR8 and TR6 when both drives are switched high in mode 1. C3 and C20 suppress motor brush noise.
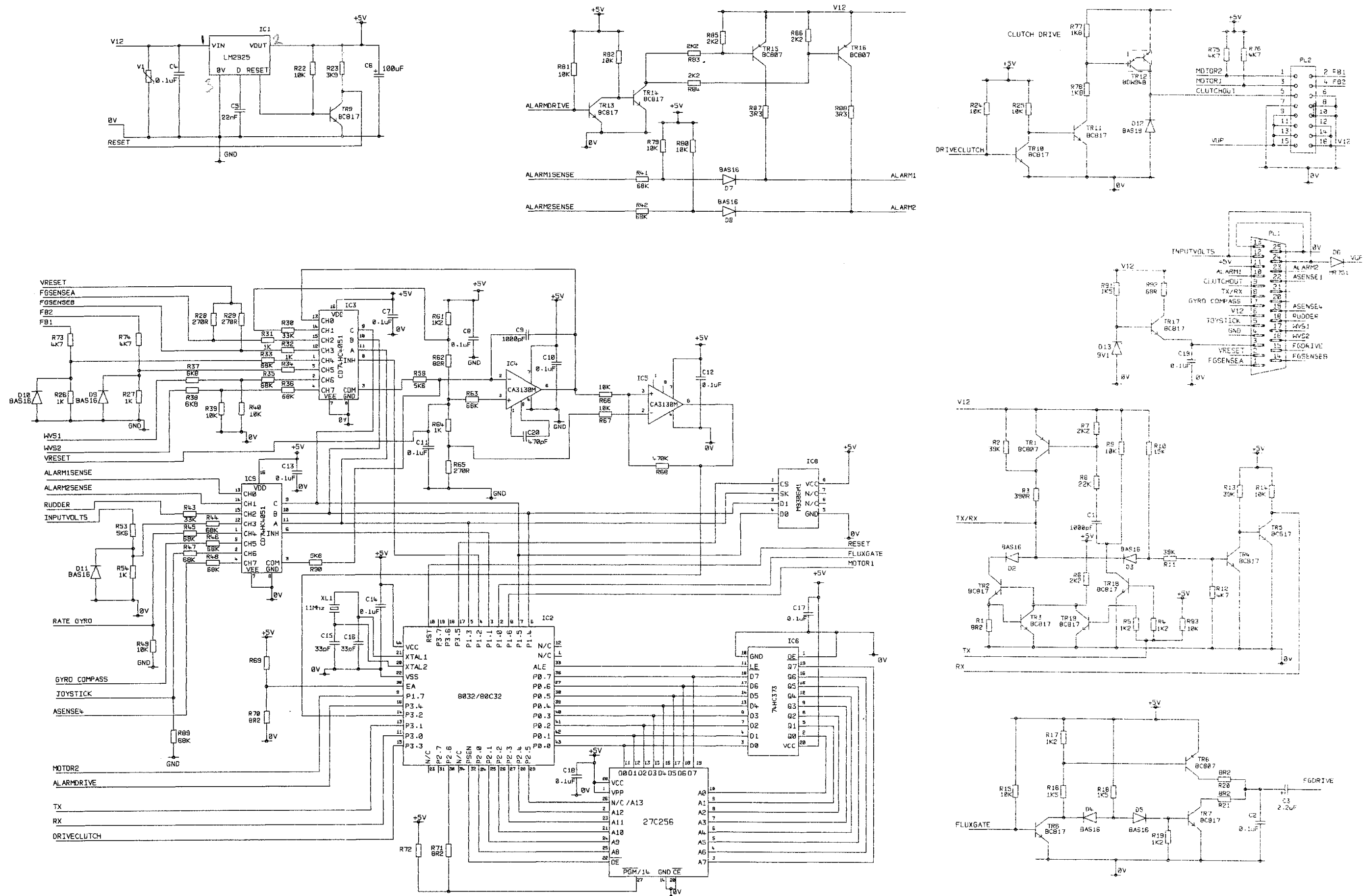
Fig. 1.   **ST7000 (Z083 and Z084) Course Computer Circuit Diagram**   ISS B

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ITEMS	DRG/PART N°	QTY	DESCRIPTION	
51	91063K9	1	WCR 1206 3K9 5X .125W	R23
50	940093061	1	EEPROM 16 x 16 M9306M 1 (SURFACE MOUNT)	IC8
49				
48	940374373	1	LATCH 74HC373	IC6
47	9400CA3130	2	F.E.T. OP. AMP CA3130M (SURFACE MOUNT)	IC4, 5
46	94024051	2	ANALOGUE SWITCH CD74HC405 1M1SURFACE MOUNT)	IC3, 9
45	940680C32	1	MICRO ROM LESS 8032 12MHz PLCC NMOS OR 80C32 12MHz PLCC CMOS	IC2
44	04049	1	5v REGULATOR LM2925	IC1
43	05035	1	TRANSISTOR PNP BDW94B	TR12
42	9500BC817	14	TRANSISTOR SOT23 NPN BC817	TR2, 3, 4, 5, 6, 7, 9, 10, 11, 13,14, 17, 18, 19
41	9500BC807	4	TRANSISTOR SOT23 PNP BC807	TR1, 8, 15, 16
40	03067	1	CAPACITOR TANTALUM 100uF ±20% 6V3 2.5 PITCH C6	
39	93102U2	1	CAPACITOR CASE A 2.2uF ±20X 6V3MIN	C3
38	9307470P	1	CAPACITOR 1206 470pF ±201 50v	C20
37	931233P	2	CAPACITOR 1206 33pF ±5$ 50v	C15, 16
36	93070U1	12	CAPACITOR 1206 0.1µF ±20* 50v	C2, 4, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19
35	93161000P	2	CAPACITOR 1206 1000pF ±2% COG 50v	C1, C9
34				
33	02031	1	DIODE MR751 (MOTOROLA)	D6
32	9200BAS19	1	DIODE SOT23 BAS19	D12
31	9200BAS16	9	DIODE SOT23 BAS16	D2, 3, 4, 5, 7, 8, 9, 10, 11
30				
29	91063R3	2	WCR 1206 3R3 5% .125W	R87, 88
28	9106470K	1	WCR 1206 470K 5% .125W	R68
27	910382R	1	WCR 1206 82R 5% .125W	R62
26	91035K6	3	WCR 1206 5K6 5% .125W	R53, 59, 90
25	910368K	13	WCR 1206 68K 5% .125W	R33, 34, 35, 36, 41, 42, 44, 45, 46, 47, 48, 63, 89
24	9103270R	3	WCR 1206 270R 5% .125W	R28, 29, 65
23	91031K	6	WCR 1206 1K 5% .125W	R26, 27, 31, 32, 54, 64
22				
21	91061K5	3	WCR 1206 1K5 5% .125W	R16, 18, 91
20	91034K7	2	WCR1206 4K7 5% .125W	R73, 74
19	91064K7	3	WCR 1206 4K7 5% .125W	R12, 75, 76
18	910615K	1	WCR 1206 15K 5% .125W	R10
17	910610K	13	WCR 1206 10K 5% .125W	
16	910622K	1	WCR 1206 22K 5% .125W	R8
15	91062K2	6	WCR 1206 2K2 5% .125W	R6, 7, 83, 84, 85, 86
14	91061K8	2	WCR 1206 1K8 5% .125W	R77, 78
13	91031K2	5	WCR 1206 1K2 5% .125W	R4, 5, 17, 19, 61
12	91061K2			
11	9106390R	1	WCR 1206 390R 5% .125W	R3
10	910639K	3	WCR 1206 39K 5% .125W	R2, 11, 13
9	91068R2	5	WCR 1206 8R2 5% .125W R1, 20, 21. (691,70,71, (72)	SEE NOTE
8	01051	1	VAR1STOR ZNR TYPE D ERZC07DK270	V1
7	26005	2	RIVSCREW (1712-35091	
6	15085	1	CERAMIC RESONATOR 11MHz CERALOCK CSA 11.OMT	XL1
5	15033	2	HEATSINK	
4	07164	1	1C SOCKET (28 PIN)	SKT1
3	07155	1	16 WAY HEADER	PL2
2	07118	1	'D 'CONNECTOR 25 WAY	PL1
1	3015-030	1	7000 COMPUTER P.C.B DETAIL	
ITEMS	DRG/PART N°	QTY	DESCRIPTION	

52	910333K	2	WCR 1206 33K 1% .125W	R30.43
53	91036K8	2	WCR 1206 6K8 1% .125W	R37 38
54	910310K	3	WCR 1206 10K 1% .125W	R39.40.49
55	910668R	1	WCR 1206 68R 5% .125W	R92
56	930522N	1	CAPACITOR 1206 22nF ±5% X7R 50V	C5
57	9203BZX9V1	1	ZENER DIODE SOT23 BZX 84C9V1	D13
58	15036	1	TRANSISTOR MOUNTING PAD	

ITEM 58 TO BE FITTED BETWEEN HEATSINK ANB PCB

NOTE:-
RESISTORS SHOWN IN BRACKETS R69, R72 ARE FOR FUTURE USE AND ARE NOT INCLUDED IN QUANTITY COLUMN.
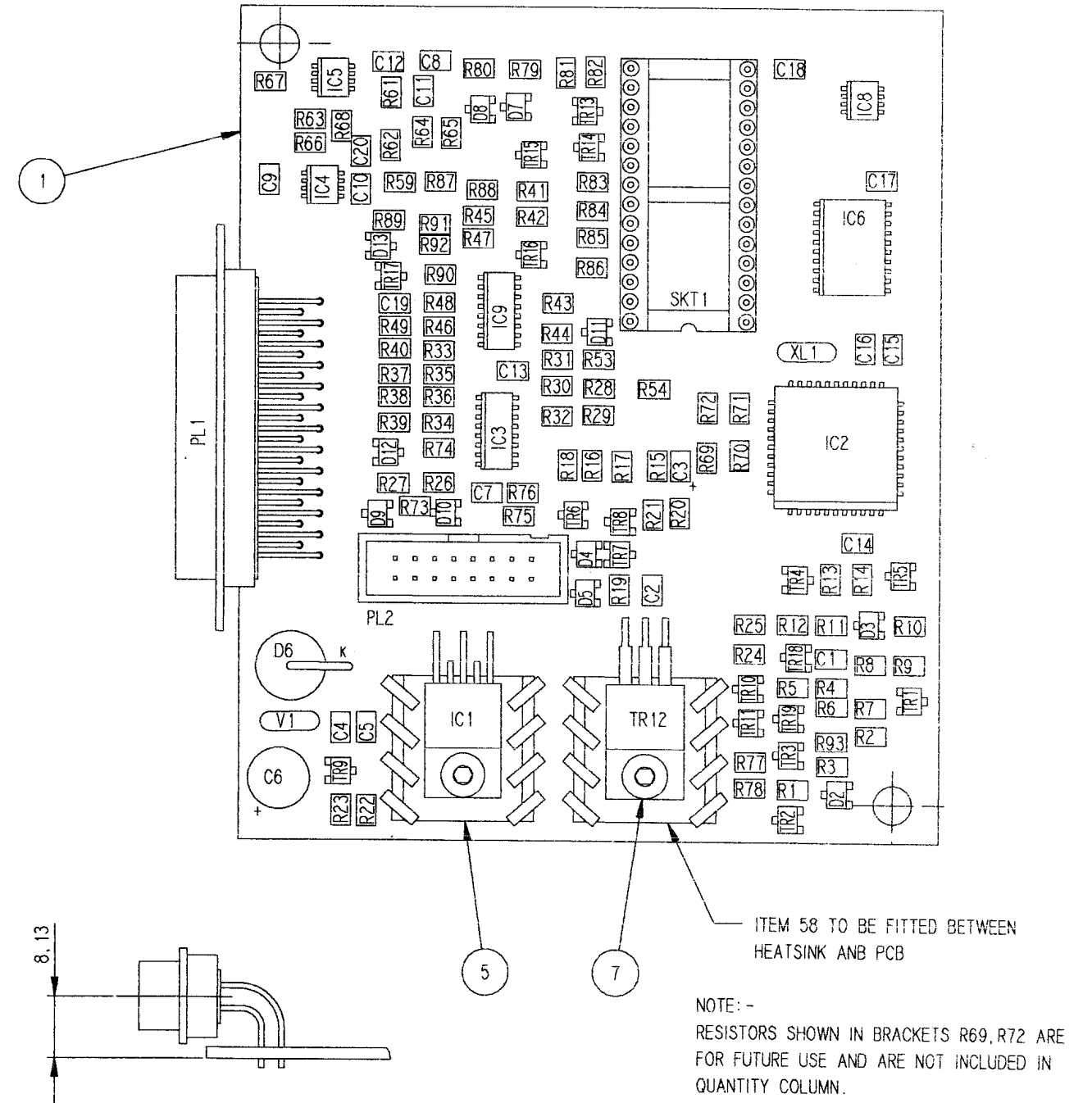
Fig. 2.   **Z083 and Z084 Course Computer PCB Assembly/Parts List**   ISS G

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Z083 Power Amplifier Circuit Diagram 12V
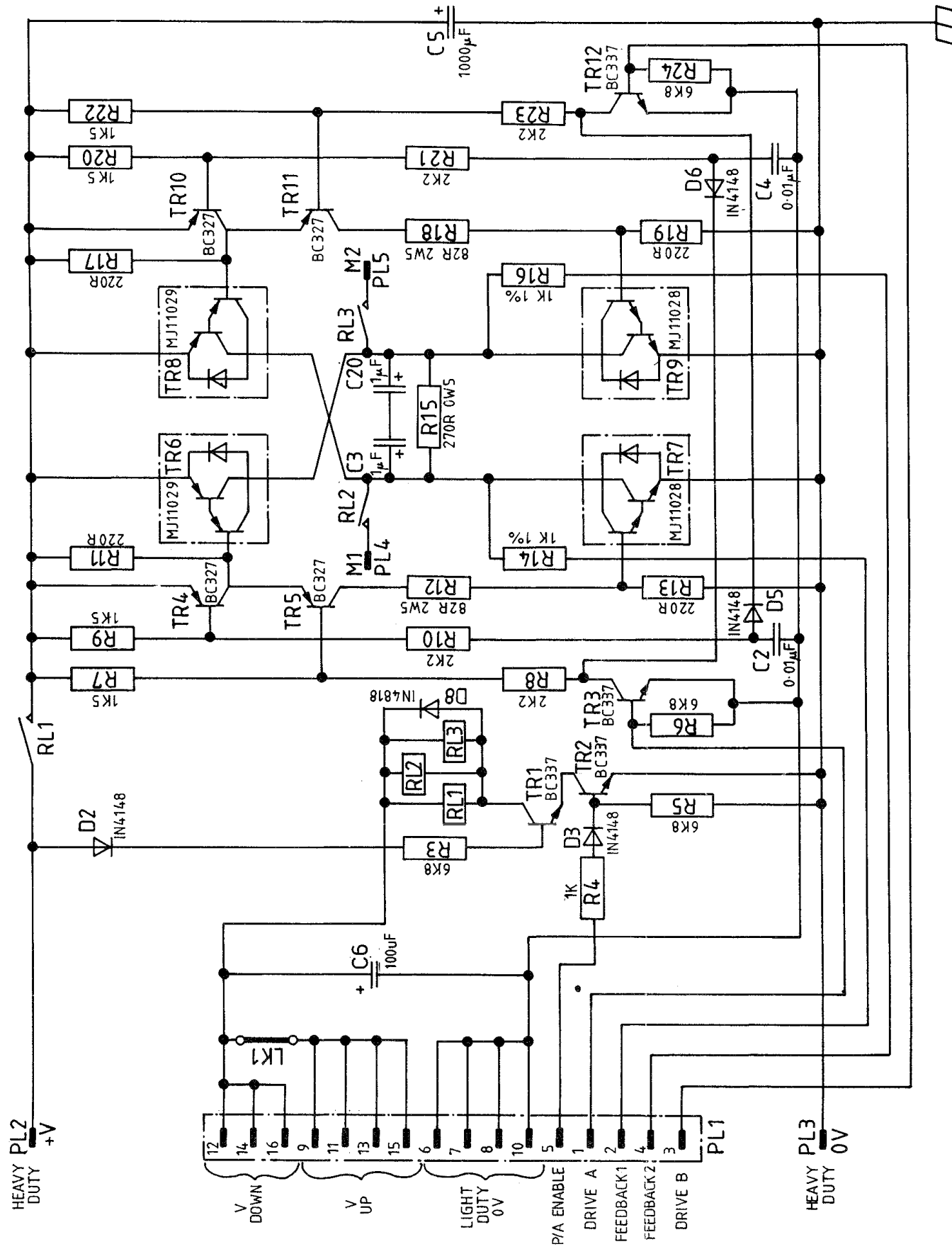
Z084 Power Amplifier Circuit Diagram 24V
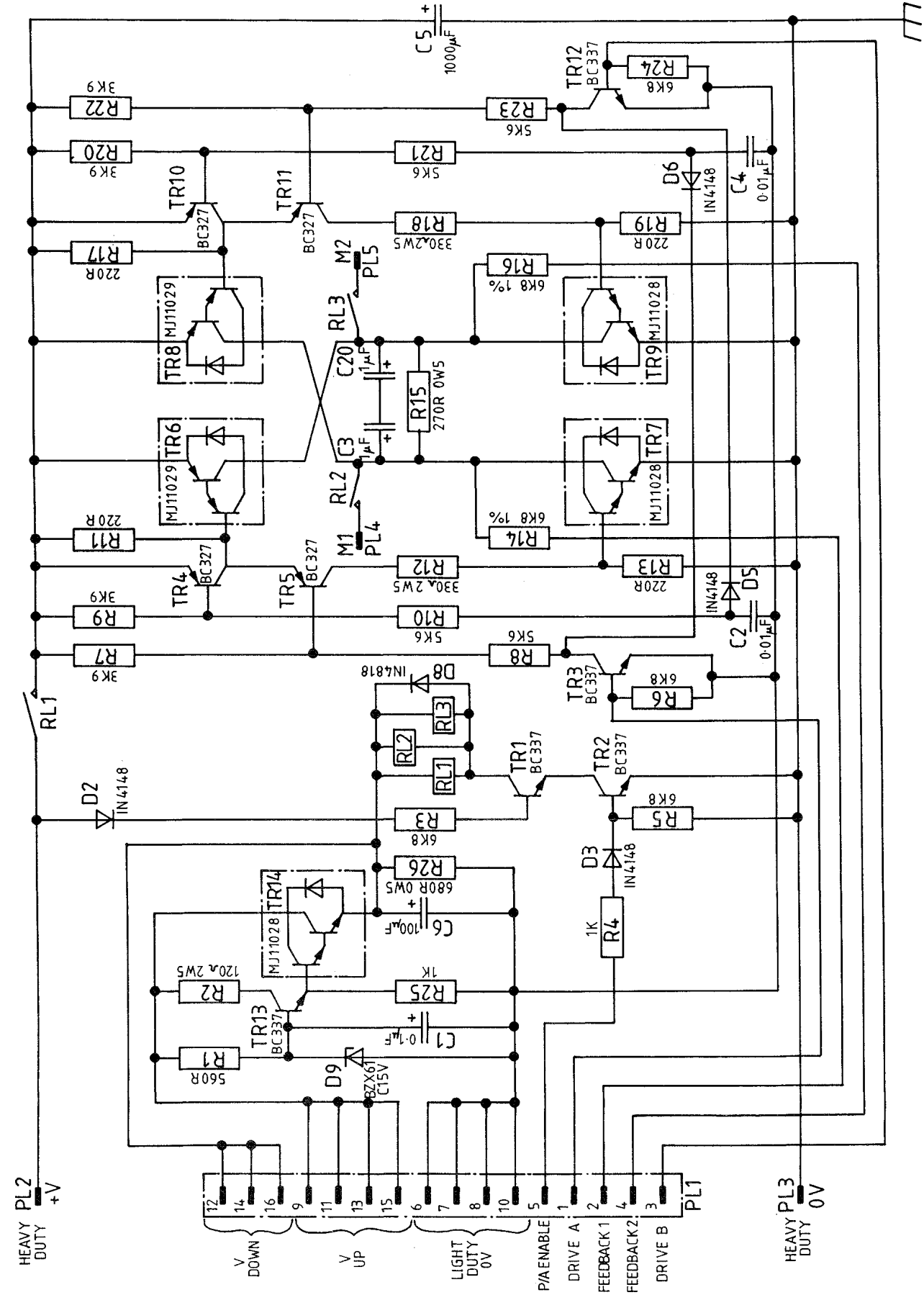
Fig. 3.

Autohelm
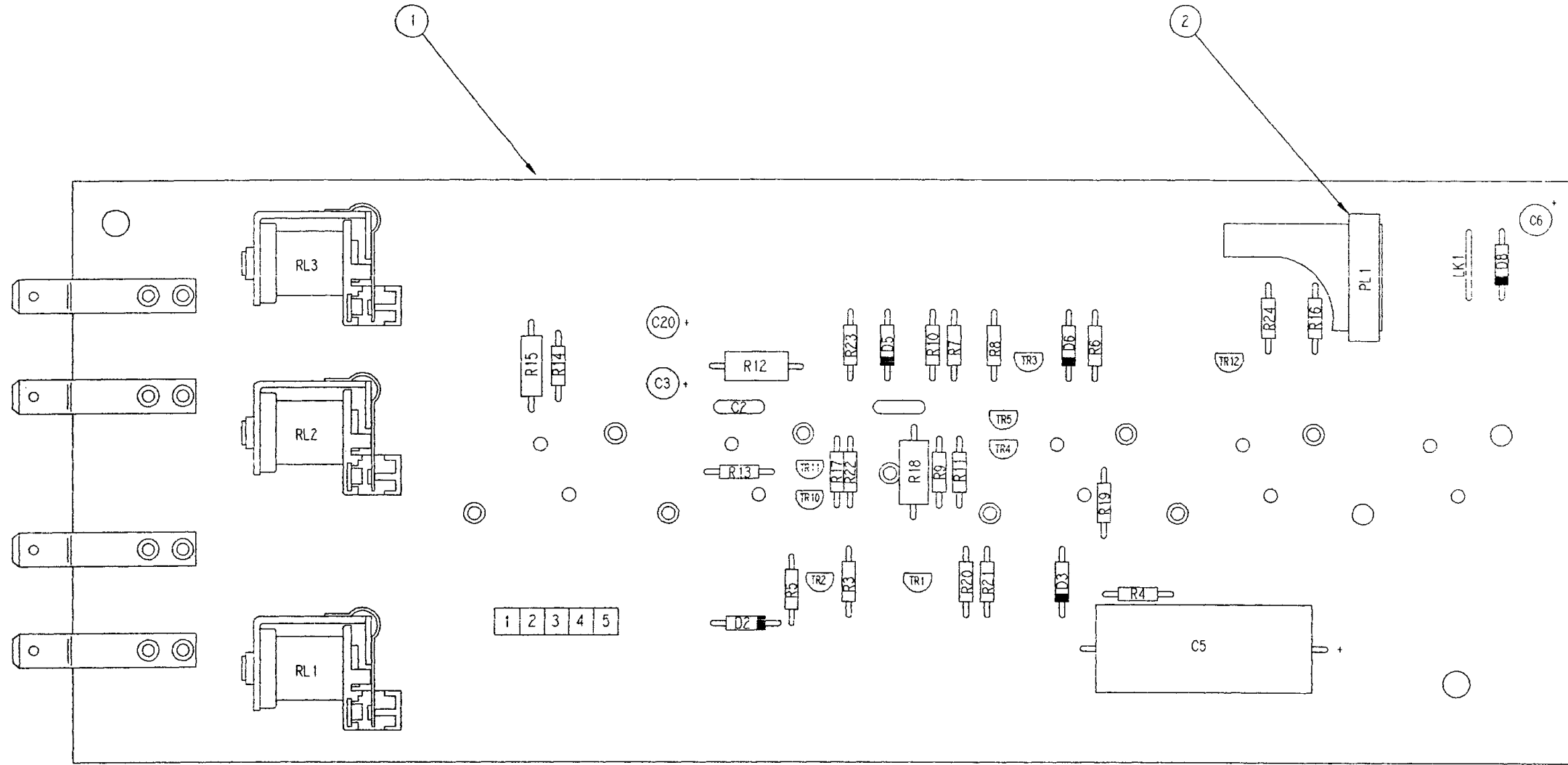
21	03031	f	CAPACITOR ELECTROLYTIC 100uF +80% -20% 25VMIN C6
20	01083	1	RESISTOR C'FILM 3K9 .25W ±5% R3
19	15057	3	RELAY T90.30A RL1, 2, 3
18	13024	1	LINK LK1
17	05019	4	TRANSISTOR PNP BC 327 TR4, 5, 10, 11
16	05018	4	TRANSISTORS BC 337 TR1, 2, 3, 12
15	03036	2	CAPACITOR TANTALUM 1µF ±20% 25vmin C3, 20
14	03023	1	CAPACITOR ELECTROLYTIC 1000µF +80% -20% 60vmin C5
13	03020	2	CAPACITOR CERAMIC 0.01µF ±20% 25vmin C2, 4
\?	02004	4	DIODE IN 4148 D2, 3, 5, 6
11	02002	1	DIODE IN 4818 D8
10	01158	4	RESISTOR CTILM 1K5 .25W ±5% R7, 9, 20, 22
9	01157	2	RESISTOR WIREWOUND 82R 2.5W ±5% R12. 18
8	01102	?	RESISTOR CTILM IK .25W ±1% R14. 16
7	01061	3	RESISTOR CTILM 6K8 .25W ±5% R5, 6, 24
6	01055	t	RESISTOR CTILM 270R .5W ±5% R15
5	01045	4	RESISTOR CTILM 220R .25W ±5% R11, 13, 17, 19
4	01032	4	RESISTOR CTILM ZK2 .25W ±5 R8, 10, 21, 23
3	01003	1	RESISTOR CTILM IK .25W ±5% R4
2	4021-024	1	LOOM S'ASSY
1	4021-023	1	POWER AMP. S'ASSY 1st STAGE
ITEMS	DR'G/PART N*	Q'T'Y	DESCRIPTION

Fig. 4.   **Power Amplifier PCB Assembly/Parts List (Z083)**   ISS B

Autohelm
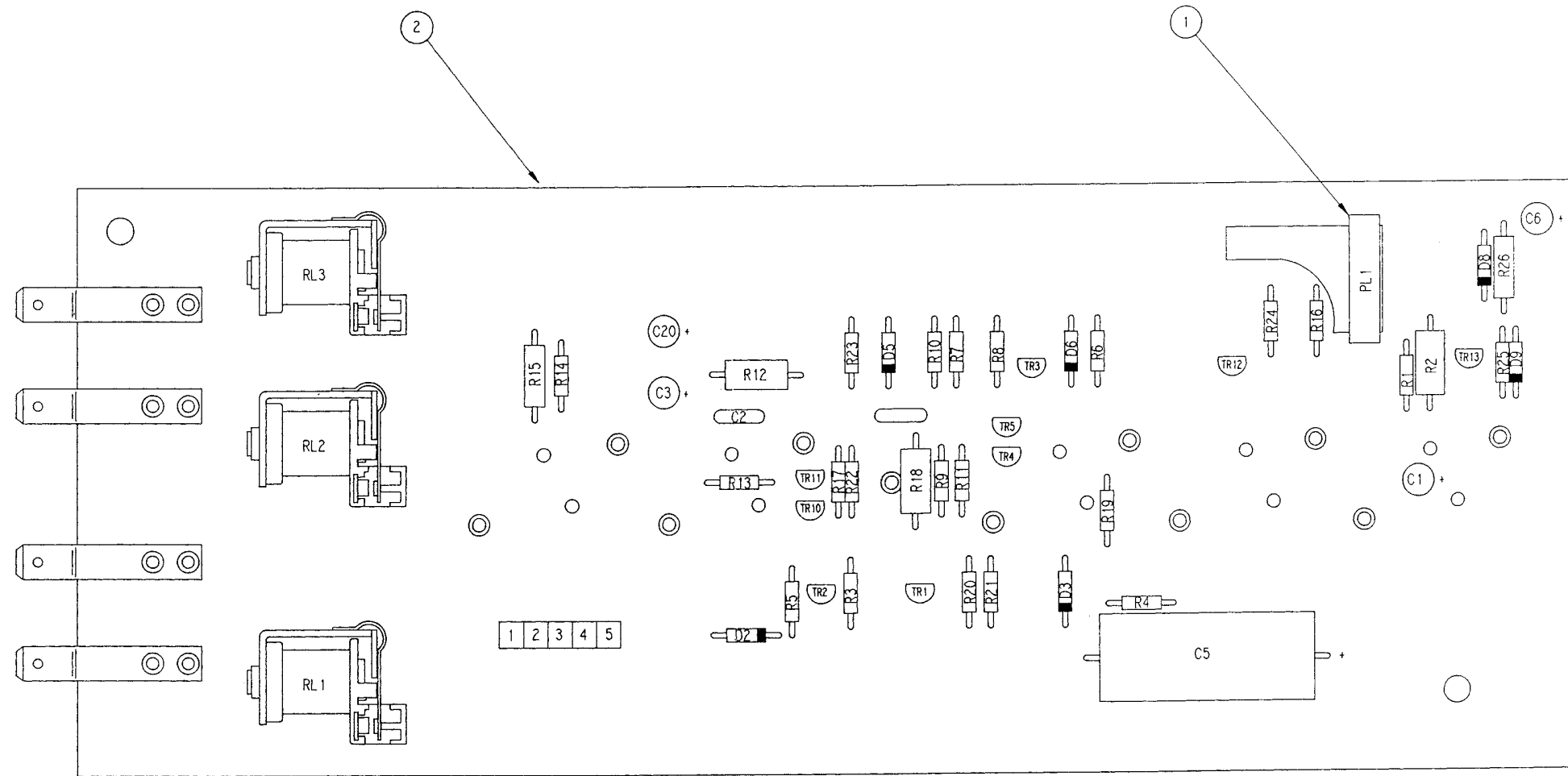
ITEMS	DR'G/PART Ne	QTY	DESCRIPTION	
24	15057	3	RELAY T90 30A	RL1, 2, 3
23	05019	4	TRANSISTOR PNP BC 327	T4, 5, 10, 11
22	05018	5	TRANSISTOR NPN BC 337	T1, 2, 3, 12, 13
21	03036	2	CAPACITOR TANTALUM 1µF±20% 25vmin C3, 20	
20	03031		CAPACITOR ELECTROLYTIC 100% 525vmin C6	
19	03023		CAPACITOR ELECTROLYTIC 1000µF	60vmin C5
18	03020		CAPACITOR CERAMIC 0.01µF ±20%	25vmin C2.4
17	03007		CAPACITOR CERAMIC 0.1µF ±20% 25vmin C1	
16	02025		ZENER DIODE BZX 6 1C 15V	D9
15	02004		DIODE IN 4148	D2, 3, 5, 6
14	02002		DIODE IN 4818	D8
13	01162		RESISTOR WIREWOUND 330R 2.5W+5% R12, 18	
12	01140		RESISTOR C'FILM 120R 2.5W ±10%	R2
11	01139		RESISTOR C'FILM 680R .5W ±5%	R26
10	0112?	2	RESISTOR C'FILM 6K8 .25W +1%	R14, 16
9	01083	5	RESISTOR C'FILM 3K9 .25W ±5%	R3, 7, 9, 20, 22
8	01061	3	RESISTOR C'FILM 6K8 .25W ±5%	R5, 6, 24
7	01055	1	RESISTOR C'FILM 270R .5W ±5%	R15
6	01045	4	RESISTOR C'FILM 220R .25W ±5%	R11, 13, 17, 19
5	01031	i	RESISTOR C'FILM 560R .25W ±5%	R1
4	L01006	4	RESISTOR C'FILM 5K6 .25W ±5%	R8, 10, 21, 23
3	01003	2	RESISTOR C'FILM 1K .25W ±5%	R4, 25
2	4021-028	1	POWER AMP. S'ASSY 1st STAGE	
1	LJ402 1-024	1	LOOM S'ASSY	
ITEMS	DR'G/PART Ne	QTY	DESCRIPTION	

Fig. 5.   **Power Amplifier PCB Assembly/Parts List (Z084)**   ISS B

Autohelm

Colour code

Sc	White
R	Red
G	Green
Y	Yellow
B	Blue
Br	Brown

SK1

Fluxgate

Sk1/13	0V	Sc
Sk1/2	V Reset	R
Sk1/1	FGSA	G
Sk1/14	FGSB	Y
Sk1/15	FG Drive	B

Aux 1

Sk1/4	GND	Sc
Sk1/3	0V	R
Sk1/17	WVS1	G
Sk1/16	WVS2	B
Sk1/7	Asense2	Y

TB1

Rudder Reference

Sk1/13	Sc	0V
Sk1/11	R	5V
Sk1/4	G	GND
Sk1/18	B	Rudder

Alarm 2

Sk1/13 —	B	0V
Sk1/23 + Br		Alarm 2

Aux 2

Sk1/13	Sc	0V
Sk1/11	R	5V
Sk1/4	G	GND
Sk1/5	B	Asense3

TB2

Bus 1

Sc		0V
R		V12
Y		Tx/Rx

Bus 2

Sc		0V
R		V12
Y		Tx/Rx

Bus 3

Sc		0V
R		5V
G		GND
B		Asense4

TB3

Sk1/13	
Sk1/6	
Sk1/8	
Sk1/13	
Sk1/6	
Sk1/8	

Aux 3

Sk1/13	
Sk1/11	
Sk1/4	
Sk1/19	

Sk1/13	
Sk1/12	
Sk1/13	
Sk1/9	Clutch out
Sk1/13	
Sk1/10	Alarm 1
Sk1/13	
Sk1/11	
Sk1/6	
Sk1/22	

Power

0V		B —
VS		Br +

Clutch

0V		B —
		Br +

Alarm 1

		B —
		Br +

Aux 4

0V		Sc
5V		R
V12		G
Asense1		B

TB4

Autohelm

Autohelm

ITEMS	DR'G/PART N*	QTY	DESCRIPTION
3	07163	4	TERMINAL BLOCK
2	07119	1	'D' CONNECTOR
1	3015-029	1	PCB DETAIL

Fig. 7.   **Connector PCB General Assembly**   ISS C

Autohelm

ST6000 System

1. Service Procedures

Rudder
Reference
Unit

Drive Unit

Fluxgate Compass

Course
Computer

Power
Supply

Control
Unit

Autohelm

Contents

1. Introduction

The ST6000 system section of this manual contains full system operating instructions and service procedures for the autopilot. Further in depth diagnostics are available for each module in the relevant product sections.

2. Systems description

The ST6000 is a modular Seatalk compatible autopilot system that can be built up to match the individual requirements of most vessels and steering systems.

The ST6000 course computer can be used with all Seatalk compatible control units and ST50 instruments and will operate the following drive units:
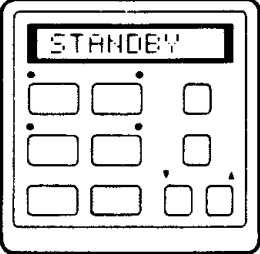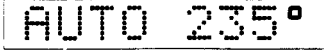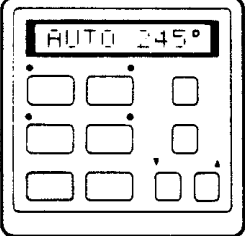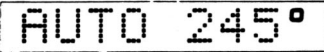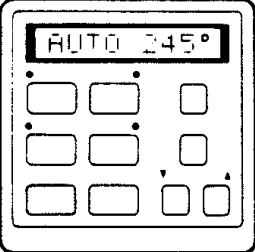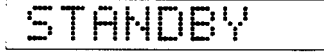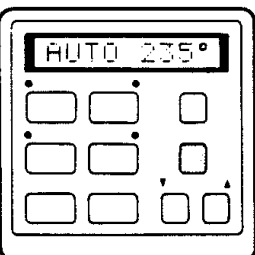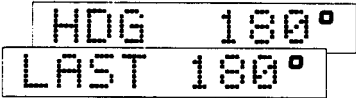
Z039 Linear drive type 1
Z037 Rotary drive type 1
Z041 Hydraulic pump type 1
Z081 Hydraulic pump type 0
Z088 I/O Sterndrive
Z064 Type CR 3L/min (via Z085 Interface)
Z066 Type CR 4.5L/min (via Z085 Interface)

Autohelm

3. Operating/Calibration Instructions

3.1 Operation

<table>
<tr>
<td colspan="2">Auto</td>
<td>Automatic Heading</td>
</tr>
<tr>
<td>

STANDBY
</td>
<td>Push to engage automatic steering and maintain current heading.
OR
Push and hold down for 1 second to return to previous automatic heading. (Display returns to Auto after 10 seconds).</td>
<td>
AUTO 235°

Previous Automatic Heading

HDG 180°
LAST 180°
</td>
</tr>
<tr>
<td colspan="2">Course Changes (-1, +1, -10, +10)</td>
<td>New Automatic Heading</td>
</tr>
<tr>
<td>
AUTO 245°
</td>
<td>Push to alter course to port (-) and starboard (+) in increments of 1 and 10 degrees.</td>
<td>
AUTO 245°
</td>
</tr>
<tr>
<td colspan="2">Standby</td>
<td>Current Heading</td>
</tr>
<tr>
<td>
AUTO 245°
</td>
<td>Push to disengage the autopilot for manual steering (The previous automatic heading is memorised).</td>
<td>
STANDBY
</td>
</tr>
<tr>
<td colspan="2">Track (see operating hints)</td>
<td>Automatic Heading</td>
</tr>
<tr>
<td>
AUTO 235°
</td>
<td>Push to select track control from Auto.
Push again to return to automatic steering.
OR
Push and hold down for 1 second to select previous track control heading from Auto or Track.</td>
<td>
TRACK

HDG 180°
LAST 180°
</td>
</tr>
<tr>
<td colspan="3">(Display returns to Track after 10 seconds).</td>
</tr>
</table>

Response

- **Response Level Adjustment** (see Operating Hints)

  Push to increase (▲) or decrease (▼) response level.

  To display response level without changing it push both **Response** keys together briefly.

Response Level

```
LEVEL   1
```

- **Rudder Gain Adjustment** (see Operating Hints)

  Push and hold down for 1 second both **Response** keys together to display rudder gain level.

  Within 10 seconds push once to increase (▲) or decrease (▼) ruddergain.

Rudder Gain Level

```
RUDDER 5
```

Rudder Gain Level

```
RUDDER 4
```

(Response and Rudder levels are displayed for 10 seconds only)

Illumination

Push and hold down **Display** for 1 second to switch on illumination.

Within 10 seconds push **Display** to select illumination level.

Illumination Level

```
LAMP    3
```
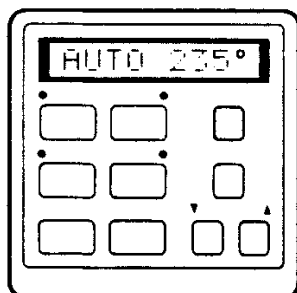
3	= High
2	= Medium
1	= Low
OFF	= 0ff

(Illumination level is displayed for 10 seconds only)

Autohelm

Display Key Sequence

The Display pushbutton is used to cycle through additional information menus. These menus depend on the autopilot mode and if navigation information is available.

Standby Mode

- **Main Display**

```
STANDBY
```
DISPLAY

- **Compass Heading**

```
HDG    359°
```
DISPLAY

- **Rudder Angle**

```
HELM  ▶ 30°
```
DISPLAY
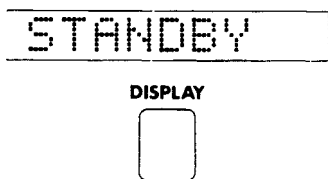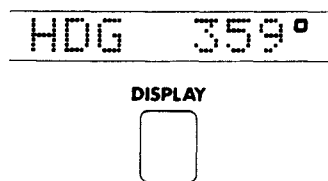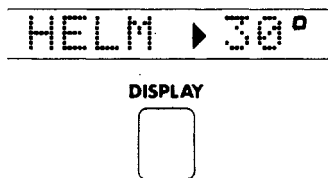
- **Navigation Displays**
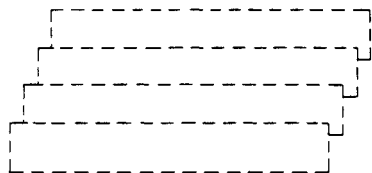
See section on Navigation Displays.

Auto Mode

- **Main Display**
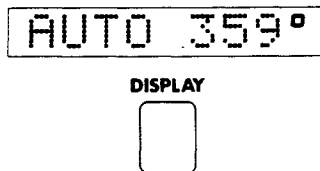
```
AUTO  359°
```
DISPLAY

- **Rudder Angle**

```
HELM  ▶ 30°
```
DISPLAY

- **Navigation Displays**

See section on Navigation Displays.

DISPLAY

- **Watch Alarm**

```
WATCH
```
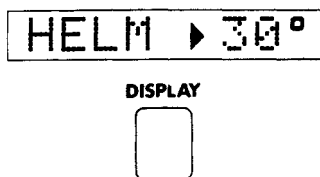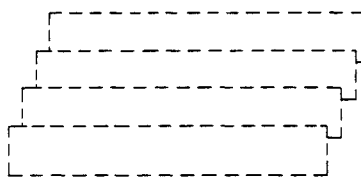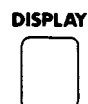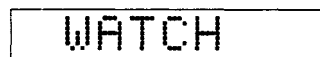
Track Mode

- **Main Display**

```
┌──────────────────┐
│    TRACK         │
└──────────────────┘
```

DISPLAY

- **Locked Course**

```
┌──────────────────┐
│  HDG    359°     │
└──────────────────┘
```

DISPLAY

- **Rudder Angle**

```
┌──────────────────┐
│  HELM  ▶ 30°     │
└──────────────────┘
```

DISPLAY

- **Navigation Displays**
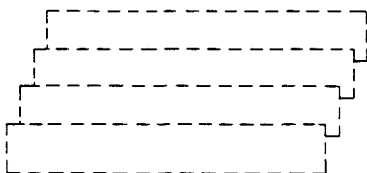
See section on Navigation Displays.

DISPLAY

- **Watch Alarm**

```
┌──────────────────┐
│     WATCH        │
└──────────────────┘
```

Navigation Displays

With the Navigation Receiver operating in waypoint mode, the following information can be displayed (provided that the Navigation Receiver transmits the appropriate information - see Installation Handbook).

- **Cross Track Error**

```
┌──────────────────┐
│  XTE  0.05▶      │
└──────────────────┘
```

DISPLAY

The arrows show the direction to steer to rejoin the desired Track:
▶ Starboard
◀ Port

- **Bearing to Waypoint**

```
┌──────────────────┐
│  WP  M  235°     │
└──────────────────┘
```
- **Magnetic**

or

```
┌──────────────────┐
│  WP  T  235°     │
└──────────────────┘
```
- **True**

DISPLAY

- **Distance to Waypoint**

```
┌──────────────────┐
│  WP  19.1NM      │
└──────────────────┘
```

DISPLAY

- **Waypoint Number**

```
┌──────────────────┐
│  WP         4    │
└──────────────────┘
```

Autohelm

Watch Alarm (not available in Standby)

• Engage the Autopilot in Auto Track Windvane mode.
• To select Watch alarm push **Display** repeatedly until Watch appears.

```
WATCH
```

The 4 minute timer is now running:-
— After 3 minutes 'Watch' flashes on all control units.
— After 4 minutes the alarm sounds on all control units.

• Push **Auto** at any time to reset the timer to 4 minutes and silence the alarm.
• To cancel the Watch alarm at any time push **Display**.

```
AUTO 235°
```

Warning Messages

• **Off Course Alarm**

```
COURSE
OFF
```

— Sounds if the vessel deviates from the automatic heading by more than the selected amount for over 20 seconds.

• **Low Battery Alarm**

```
BATTERY
LOW
```

— Sounds if the course computer supply voltage falls below 11 volts for over 20 seconds.

• **Track Mode Alarms**

```
DATA
NO
```

— Sounds if no waypoint data is received from the Radio Navigation System for over 20 seconds.

```
ERROR
DATA
```

— Sounds if the data has the incorrect format or if an invalid flag is set.

```
XTE  0.31▶
LARGE0.31▶
```

— Sounds if the cross track error exceeds 0.30n.m.

```
   PORT     o
WP M 235°
```
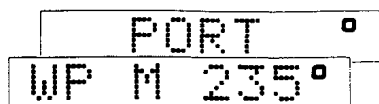
— Sounds when the target waypoint number changes. The displayed bearing is to the new waypoint. PORT or STBD indicates in which direction the autopilot will turn onto the new waypoint bearing.
Push **Track** to silence the alarm and automatically steer onto the new bearing to waypoint.

- **Manual Override Alarm**

(Installations with stern drive actuators only).

```
RELEASE
```

— Sounds for 10 seconds when the autopilot is manually overridden at the steering wheel. After 10 seconds the autopilot will return to **Standby** automatically.

Note: Push **Standby** to silence an alarm and select **Standby** mode (unless indicated otherwise).

Autohelm

3.2 Additional information for Sailing Vessels

Autotack

The ST6000 has a built in Autotack function which will turn the vessel through 100°. This operates in both compass and vane modes as follows:-

Vane
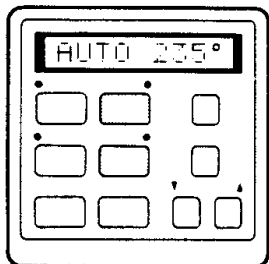
Push **+1** and **+10** keys together to initiate a tack turning to Starboard.

```
AUTO 335°
```
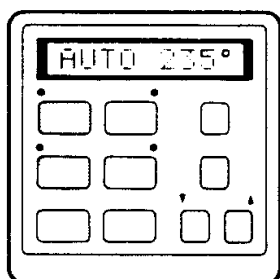
Push **–1** and **–10** keys together to initiate a tack turning to Port.

```
AUTO 135°
```

Note: It is important that the rudder angle transducer is accurately aligned as the Autotack function mirrors standing helm and any offset will change the initial tack angle.

Wind Trim (Windvane Operation)

Wind Trim allows the autopilot to be supervised by apparent wind direction. The wind direction is read either:-

— From the SeaTalk bus (requires Autohelm ST 50 unit).
OR
— From an NMEA 0183 input on the control unit.
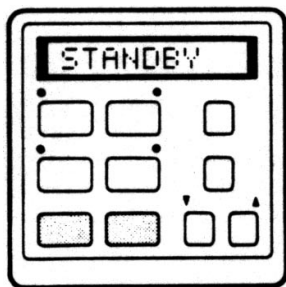
Push both red keys together to select Wind Trim and maintain the current apparent wind angle.

Automatic Heading

```
VANE 235°
```

Push and hold down for 1 second both red keys together to return to the previous apparent wind angle.

Previous Automatic Heading

```
HDG    180°
LAST 180°
```

Wind Change Alarm

Wind Trim uses the fluxgate compass as the primary heading reference and automatically adjusts the compass heading to maintain the original apparent wind angle. If changes in apparent wind angle adjust the original automatic heading by more than 15° the wind change alarm will sound.

```
CHANGE
WIND
```
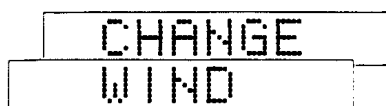
— The alarm is silenced by pushing both red keys together briefly.

Display of Wind Angle

If the wind angle information is supplied using the NMEA 0183 input or SeaTalk bus, the apparent wind angle and tack sense (◄ for port, ► for starboard) is added to the display menu and accessed via the Display button.

```
VANE 235°
```

DISPLAY

- **Apparent Wind Angle**

```
WIND ▶ 35°
```
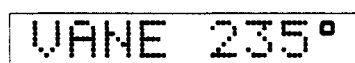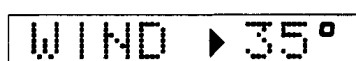
— The apparent Wind Angle is 35° — Starboard Tack.

- **Adjust Apparent Wind Angle**

```
AUTO 235°
```
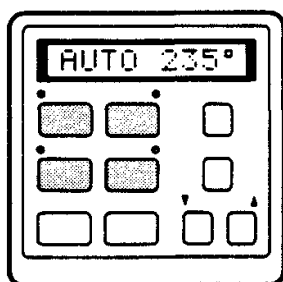
Use the ±1 or ±10 degree buttons to change heading and hence adjust the apparent wind angle.

```
AUTO 245°
```

Using Wind Trim

It is important to understand that "Wind Trim" prevents over-reaction to gusts or sudden wind shifts. One minute is required to change the heading in response to a permanent change in apparent wind angle. Do not attempt to override the automatic sequence with the course change buttons. In gusty conditions sail a few degrees off the wind and pay frequent attention to sail trim and helm balance using the rudder angle indication.

Performance will normally be improved by reefing headsail and mainsail a little early rather than too late.

Autohelm

3.3 Operating Hints

Response Level Adjustment
The ST6000 has three response levels which enable tighter course keeping to be achieved in certain cases:-
Level 1 - Automatic Sea State Control
Level 2 - Automatic Sea State Inhibit
Level 3 - Automatic Sea State Inhibit and counter rudder.
When the autopilot is switched on, the response level is set to 1. This provides the best compromise between power consumption and course keeping accuracy and is suitable for nearly all situations.
Increasing Response level provides tighter course keeping at the expense of increased power consumption and general wear and tear. It is advisable to use the minimum response level necessary to achieve the desired course keeping accuracy. On larger power vessels level 3 can improve slow speed steering where the natural yaw damping of the vessel is reduced.
Note: Level 3 is not recommended for use at planing speeds or in rough seas.

Track
To make full use of Track control the following simple points should be observed:-
- Always steer the vessel to within 0.1nm of track and bring the heading to within 5° of the bearing to the next waypoint before selecting Track.
- Always check that there are no navigational hazards either side of the intended track.
- Always maintain an accurate log with regular plots to verify the computed position read from the Radio Navigation Receiver.
- Maintain a proper lookout at all times.
-

Waypoint Advance
If the navigation receiver is transmitting the waypoint number to the ST6000 the waypoint alarm will sound whenever a new target waypoint is selected (see Page 9). When the alarm is sounding the ST6000 will maintain the current heading and automatic track control is suspended. Check the displayed new bearing to waypoint and when it is safe to turn onto it, resume automatic track control by simply pushing **Track**.

This accepts the new target waypoint and will steer the vessel onto the new bearing to waypoint.
The tidal offset may be very different on the new bearing, and it is good practise to check the cross track error after a couple of minutes. If the cross track error continues to increase make a course adjustment of say 10 degrees in the direction of the arrow. This will help the Track control correct more quickly for the new tidal vector.

Automatic Trim
If Automatic Trim has been selected during calibration the ST6000 will correct for trim changes. This correction can take up to one minute to apply the rudder offset necessary to restore the set automatic heading. Large course changes which change the apparent wind direction, can produce large trim changes. In these cases the autopilot will not immediately assume the new automatic heading, and only settle onto course when the Automatic Trim has been fully established.
To minimise the inherent time delay the following procedure may be adopted for large course changes.
- Note required new heading.
- Select **Standby** and steer manually.
- Bring vessel onto new heading.
- Select **Auto** and let vessel settle onto course.
- Bring to final course with 1° increments.
It is sound seamanship to make major course changes only whilst steering manually. In this way any obstructions or other vessels may be cleared properly and due account taken of the changed wind and sea conditions on the new heading prior to engaging the autopilot.

Rudder Gain
The rudder gain level selected during initial sea trials will normally provide excellent steering performance over a wide range of conditions. However, it may be noticed that the autopilot tends to be a little less stable on northerly headings in the higher latitudes of the northern hemisphere (and conversely southerly headings in the southern hemisphere). This is caused by the increasing angle of dip of the earth's

magnetic field at higher latitudes which has the effect of amplifying rudder response on northerly (southerly) headings.

Rudder Gain Adjustment (Sail) It is not normally necessary to adjust the autopilot gain setting once the correct level has been established during initial sea trials.

Depending on the yachts individual steering characteristics a change of one level may improve course keeping accuracy when going from northerly to southerly (increase) or southerly to northerly (decrease) headings.

The effect may be judged by carrying out a sea trial in smooth water conditions and observing the results.

Note: The effect is reversed for the southern hemisphere.

Rudder Gain Adjustment (Powercraft) The tendency towards northerly (southerly) heading instability is more obvious in high speed craft and can be corrected by a reduction in the rudder gain setting. At speeds in excess of 30 knots a reduction of two levels can be required on headings between 315° and 045° (northern hemisphere) or 135° and 230° (southern hemisphere).

Two options are available to control this:-

• **Manual** (Low speed and displacement craft) The rudder gain control may change by one level when going from northerly to southerly (increase) or southerly to northerly (decrease) headings.

The effect may be judged by carrying out a sea trial in smooth water conditions and observing the results.

Note: The effect is reversed for the southern hemisphere.

• **Autoadapt** (High speed planing craft) The ST6000 can be set to automatically reduce the effects of Northerly heading instability. This feature is selected in calibration mode by entering the Latitude (see Installation Handbook, Calibration, section on 'Auto Adapt'). When selected the ST6000 automatically adjusts the Rudder Gain depending on the compass heading, removing the need for manual adjustment.

Rudder Gain/Speed Adjustment (Powercraft)

High speed planning craft exhibit very different steering characteristics when on and off the plane. As a result it is generally necessary to adjust the Rudder Gain setting when going from displacement speed to planing speed or vice versa. Two options are available to achieve this:-

• **Automatic**

When the ST 6000 is used with an Autohelm ST50 Speed Instrument or Tridata. Rudder Gain is adjusted automatically with boat speed. There should be no need for any manual adjustment.

• **Manual**

(No ST50 Speed/Tridata) The Rudder Gain setting may be increased by one or two levels when dropping from planing speed to cruise speed and decreased by the same amount when returning to planing speeds,

Note: It is important to make the gain adjustment after dropping to displacement speed and before returning to planing speed.

Note: The adjustment of Gain with boat speed is normally only required for high speed planing powercraft.

Unsatisfactory Steering Performance

If the ST6000 has been installed and set up in accordance with the instructions in the Installation Manual it will provide excellent steering performance over a wide range of conditions.

If performance drops but the autopilot is still working correctly, the following simple checks should find the fault:-

• Has a magnetic influence been introduced near the fluxgate compass? i.e. anchor, chain, radio equipment, loudspeaker, tools. generator etc. Check that the autopilot compass heading still corresponds with the steering compass.

• Are all fuses intact, circuit breakers engaged?

• Are all screw connections tight and free of corrosion.

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- If the autopilot fails to hold course check the Rudder Gain level. Has it been changed from the initial sea trials level (check in Installation Manual)?
- If the vessel wanders check that the Rudder Reference Transducer linkage is secure with no free play.

Hydraulic Drive Units only:-

- Check that all unions are tight and bleed system to remove air.

Failure of Drive Unit to Disengage

The mechanical drive actuators of the ST6000 are designed to fail Safe1 - When power is disconnected the drive unit will disengage leaving the steering system free for manual control.

When Standby is selected the actuator will Disengage leaving the steering free.

It is remotely possible that a fault could develop which could cause the actuator to remain engaged even when Standby is selected. If this happens:-

- DISCONNECT THE MAIN CIRCUIT BREAKER TO THE AUTOPILOT - THE STEERING WILL IMMEDIATELY BE FREE, or
- IN AN EMERGENCY THE ACTUATOR CLUTCH CAN NORMALLY BE OVERRIDDEN BY TURNING THE STEERING WHEEL HARD.

It is emphasised that this fault is extremely unlikely and can be immediately corrected as described.

If preferred a separate **Override** switch can be fitted close to the steering position which will break the actuator clutch drive for **Emergency Use.**

Stern Drive Actuator
(Manual Override Option)

Manual override is selected during calibration using the **Auto Release** option. It must only be used on installations fitted with the stern drive actuator. When it has been selected, the ST6000 can be overridden to allow hand steering by turning the steering wheel. This will return the ST6000 to **Standby** and sound the control unit buzzer for 10 seconds. There is a slight delay before the ST6000 will return to Standby. **Excessive force is not required and will not reduce this delay.**

With the ST6000 in **Auto** and clear of obstruction turn the steering wheel to observe the manual override. Repeat two or three times until you are confident with its operation.

The manual override is intended for emergency use only. The ST6000 should normally be disengaged by pushing the Standby button on the control unit.

3.4 Calibration
Recommended Settings

As supplied the ST6000 can be switched on and tested safely without any adjustments to the factory calibration settings.

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

	Vessel Type	
	Displacement	**Planing**
	Factory preset	**Set to**
Rudder Gain (level)	5	2
Rate Gain (level)	2	1
Rudder Angle Limit (degrees)	30	30
Turn Rate Limit (degrees/sec)	20	5
Cruise Speed (knots)	8	25
Off Course Alarm (degrees)	20	20
Trim Level	1	1
Auto Adapt	OFF	ON

	Autopilot Drive Unit Type		
	Mechanical	**Stern Drive**	**Hydraulic**
	Factory preset	**Set to**	**Set to**
Drive Type	3	3	4
Rudder Position Deadband (level) See 3.8	1	1	1
Auto Release	OFF	ON	OFF

Selecting and Exiting from Calibration Mode

To select calibration mode:-
- Push **Standby**.
- Push and hold down for 2 seconds, **Track** and **Display** together.

```
CAL  ?
```

- Repeat push and hold down for 2 seconds, **Track** and **Display** together to enter calibration mode.

```
CAL          Cal.
```

To exit calibration mode at any point;

a) **Saving** any changes made:-
- Push and hold down for 2 seconds, **Track** and **Display** together.

```
STANDBY
```

b) **Ignoring** any changes made:-
- Push **Standby**.

```
STANDBY
```

Autohelm

3.4.1 Adjusting Calibration

In calibration mode, the Display button is used to scroll through the menu. The displayed value is adjusted using the Response buttons (hold button down for fast scroll).
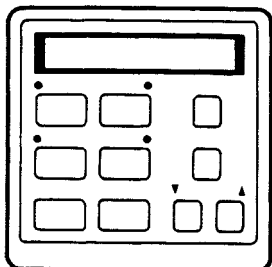
```
CAL          Cal.
```

DISPLAY

- Rudder Gain, levels 1 to 9, (see 5.6)

```
RUDDER  5 Cal.
```

DISPLAY

- Rate Gain, levels 1 to 9, (see 5.7) (Counter Rudder).

```
RATE    4 Cal.
```

DISPLAY

- Rudder Angle Limit, 15° to 40° (see 3.6).

```
LIMIT  26° Cal.
RUDDER 26° Cal.
```

DISPLAY

- Rate of Turn Limit, 5° to 20°/sec.

```
LIMIT  20° Cal.
TURN   20° Cal.
```

DISPLAY

- Cruise Speed, for **Track** mode operation, 4 to 60 knots.

```
SPEED   6 Cal.
CRUISE  6 Cal.
```

DISPLAY

- Off-Course Alarm, 15° to 40° angle.

```
COURSE 20° Cal.
OFF    20° Cal.
```

DISPLAY

- Automatic Trim, (see 5.4).

```
TRIM     1 Cal.
```

0 = OFF
1 = ON   **DISPLAY**

- Remote Control Identifier. (For Future Use).

```
REMOTE  1 Cal.
```

DISPLAY

Autopilot Drive Unit Type.

```
DRIVE   3 Cal.
```

1 = Future Use
2 = Future Use
3 = Mechanical with Rudder Reference
4 = Hydraulic with Rudder Reference

DISPLAY

```
[ ]
```

• Rudder Position Deadband (levels 1 to 9), (See 3.7).

```
DAMPING5 Cal.
RUDDER  5 Cal.
```

DISPLAY

```
[ ]
```

• Northerly/Southerly Heading Instability

```
ADAPTOFF Cal.
AUTO OFF Cal.
```

Select Hemisphere

N (North)
S (South)

DISPLAY

```
[ ]
```

```
LAT N   0° Cal.
```

Enter Local Latitude using Response Keys. Atypical display in the Northern Hemisphere would be:

```
LAT N  50° Cal.
```

and in the Southern Hemisphere.

```
LAT S  35° Cal.
```

• Auto Release (see 3.8).

```
AUTO     0 Cal.
RELEASE0 Cal.
```

0 = OFF
1 = ON

The Auto Release facility is designed to provide Emergency Manual Override when used with the Autohelm Stern Drive Actuator.
For all other Drive Systems Auto Release must be selected "OFF" (0).

3.4.2 Display Contrast Adjustment

The LCD Contrast can be adjusted to suit a wide range of control unit viewing angles.
• Push display and track together momentarily.
• Push response ▲ to increase contrast (suits viewing from below),
• Push response ▼ to decrease contrast (suits viewing from above).
• Adjust the display for optimum viewing.
• Push display and track together momentarily to store selection and return to previous operating mode.

Decrease Contrast Ratio

Normal Viewing Position

Increase Contrast Ratio
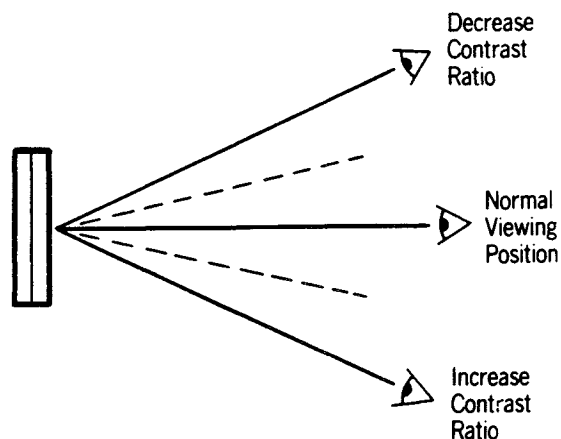
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3.5 Automatic Deviation Correction

The ST6000 will correct the fluxgate compass for operation in most deviating magnetic fields. This should be carried out in calm conditions preferably in flat water.

* To select compass adjust **Push** and hold **Standby** for 1 second.

```
 ADJUST     Cal.
 COMPASS    Cal.
```
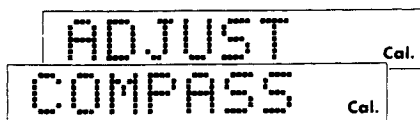
Keeping boat speed below 2 knots, turn the vessel slowly so that it takes at least 3 minutes to complete 360°. Keep turning until control unit beeps, and the display changes to show the amount of deviation the autopilot has corrected:-
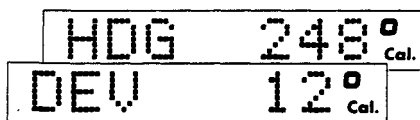
```
 HDG   248°  Cal.
 DEV    12°  Cal.
```

Note: If the amount exceeds 15°, it is recommended the fluxgate should be re-sited.

* Use the course change buttons to adjust the displayed heading until it agrees with the steering compass or a known transit bearing.
Note: 000° is always followed by OFF. This will suppress the display of compass and automatic headings on the control unit.
* To exit compass adjust and store the compass settings push and hold **Standby** for 1 second.
* To exit compass adjust without saving any new settings push **Standby** momentarily.

4. Common system problems

Problem	Cause	Solutions
To be updated as necessary		
		"
		"
		"
		"

5. Track control interfacing

In most cases interfacing the ST6000 to either a GPS, Decca, Loran or Satellite Navigation system is a simple and straight forward task so long as the requirements set out in section 6 of the installation manual are met. There are however a few exceptions.

5.1 Inverted Data

Some receivers, notably some of the Furuno range and early Navstar models, transmit data in an inverted format with respect to 5V. This is easily seen as the data line will idle high with respect to 0V in between data transmissions. In these cases the NMEA cable on the rear of the control unit must be wired with the red wire connected to 5V (this is normally available on the receiver terminal block), and the blue wire connected to the data line.

5.2 Conversion of Units.

All data containing units of distance will be converted to Nautical miles by the Control Unit. Therefore any receivers displaying Cross Track Error or Distance To Waypoint in either Kilometres of Statute miles etc will have their data displayed on the control unit in Nautical miles.

5.3 Alarm Messages

Track mode has 3 alarm messages:-

1. No data — If a standard NMEA sentence is not received by the ST6000

2. Data error — The ST6000 has recognised the incoming data as NMEA but has detected an invalid flag. This is normally due to poor signal strength at the receiver.
3. Large XTE — Cross track error greater than 0.3NM.

Errors 1 and 2 can provide valuable information as to where an installation problem might lie. The 'No data' message indicates the ST6000 is not receiving NMEA data and carries a high probability of a wiring error between the receiver and the pilot. The 'data error'

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message indicates the ST6000 is receiving data recognised as NMEA but has an invalid flag set. This is normally due to the receiver having a low signal strength or a high noise figure.

5.4 Autohelm 6000 NMEA 0183 data input format

The 6000 must receive Cross Track Error data at least once every 30 seconds.

If a display of Waypoint Bearing, Distance or Number or the Waypoint advance facility is required then this information must be received at least once every 30 seconds.

All NMEA data is read into a buffer thus enabling the 6000 to cope with delays between characters and delays between sentences.

All Talker identifier characters, ie RA, DE, LC etc. are ignored allowing interface with any type of equipment so long as the sentence type is one of the following :-

Apparent wind speed and angle can be received from any external equipment transmitting the N.M.E.A VWR header. The ST6000 will only display apparent wind angle but will convert and retransmit both apparent wind speed and direction on the seatalk bus. This information can then be displayed on an ST50 wind instrument acting as a repeater.

Track Control	Bearing to Waypoint	Distance to Waypoint	Waypoint Number	Apparent Wind Speed and Direction
XTE	APB	WDR	APB	VWR
XTR	BPI	WDC	APA	
APA	BWR	BPI	BPI	
APB	BWC	BWR	BWR	
RMB	BER	BWC	WDR	
	BEC	BER	BWC	
	RMB	BEC	WDC	
		RMB	RMB	
			BOD	
			WCV	
			BER	
			BEC	

6. Special Functions

6.1 Display of Software Version

It is possible to display the version number of both course computer and control unit software installed in a particular system. This is achieved by pressing both the +10 and -10 keys together for 2 seconds and releasing the display will show the control unit version (65 followed by version number) for 10 seconds followed by the course computer version (66 followed by version number). The pilot must be in standby mode at the time. Each version is displayed for 10 seconds before the pilot reverts back to standby. A software history for each product is shown in the relevant service sections.

6.2 Permanent Watch Alarm Mode

The ST6000 autopilot can be set up with a permanent watch alarm mode, as required by the Sea Fish Industry authority (SFIA).
It must be stressed that the selection of this mode is permanent and can only be reversed by returning the course computer to Nautech.
Permanent watch alarm is achieved by first entering the calibration menu. Once in calibration, regardless of display message, press the Auto, Standby, and Track keys together for 1 second before releasing. The display will now show 'SELECT WATCH'. The user now has 10 seconds to select permanent watch alarm mode by again pressing Auto, Standby and Track together for 1 second. The display will then show 'WATCH ON1 for 10 seconds before reverting back to 'CAL1. A normal exit from calibration mode must now be executed.

6.3 Display Test Mode

All display segments on the control unit can be switched on by pressing the +10, -10, Standby and Display keys together. This mode can only be accessed after the unit has been powered up with the yellow data wire open circuit.

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7. Service visit to a vessel

When a service visit to a vessel is made the most common fault encountered is likely to be poor connections or inadequate power supplies. These should be thoroughly checked before the service visit diagnostic procedure is carried out. When trying to locate a fault it should be remembered that most failures will occur in the Course Computer with the Control Units as the next most likely.

It should be noted that the calibration variables and auto deviation correction will require re-setting if either the course computer, its PCB or its Software are exchanged. Similarly if the Control Unit PCB is exchanged the display contrast will require re-setting. Procedures for carrying out both these operations are given in section 3.

Always note the course computer calibration settings before removing from the vessel.

7.1 Service Visit - Diagnostic Procedure

On arrival check for bad connections and for inadequate power supplies. If the system still exhibits a fault, then use the diagnostic procedure outlined below.

```
                              ┌─────────────────┐
               YES            │    SeaTalk       │
         ┌────────────────────┤   instruments    │
         │                    │     fitted       │
         │                    └────────┬─────────┘
         │                             │ NO
  ┌──────┴──────────┐                  │
  │ Bypass Instruments│                 │
  └──────┬──────────┘                  │
         │                             │
         └──────────►──────────────────┤
                                       ▼
                              ┌─────────────────┐
                              │     Only 1       │
                              │   control unit   │         NO
                              │     fitted       ├──────────────────┐
                              │       ?          │                  │
                              └────────┬─────────┘                  │
                                       │ YES                        │
                  FAIL       ┌─────────┴─────────┐                  │
              ┌──────────────┤ Test Control Unit │                  │
              │              └─────────┬─────────┘                  │
         ┌────┴─────┐                  │ PASS                       ▼
         │ Faulty   │                  │          NO      ┌─────────────────┐
         │ Control  │                  ●◄─────────────────┤ Does fault occur│
         │ Unit     │                  │                  │ in 1 Control Unit only
         └──────────┘                  │                  │       ?         │
                                       ▼                  └────────┬────────┘
                  FAIL       ┌─────────┴─────────┐                 │ YES
              ┌──────────────┤  Test Drive Unit  │                 │
              │              └─────────┬─────────┘                 ▼
         ┌────┴─────┐                  │ PASS          ┌─────────────────────┐
         │ Faulty   │                  │               │  Faulty Control Unit │
         │ Drive    │                  ▼               └─────────────────────┘
         │ Unit     │               ╱ A ╲
         └──────────┘               └─────┘
```

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```
        ┌─────┐
        │  A   │
        └──┬──┘
           │
           ▼
FAIL   ┌─────────────────────────────┐
◀──────┤       Test Fluxgate         │
       └─────────────┬───────────────┘
  ┌────────┐      PASS
  │ Faulty │        │
  │Fluxgate│        │
  └────────┘        ▼
       ┌─────────────────────────────┐
       │      Rudder Reference        │
       │          Fitted?             │──────┐
       └─────────────┬───────────────┘      │
                     │                        │
                     ▼                        │
FAIL   ┌─────────────────────────────┐       │
◀──────┤     Test Rudder Reference    │◀──────┘
       └─────────────┬───────────────┘
  ┌────────┐         │
  │ Rudder │         │
  │Reference│        │
  │ Faulty │         ▼
  └────────┘  ┌──────────────────────┐
              │ Faulty Course Computer│
              └──────────────────────┘
```
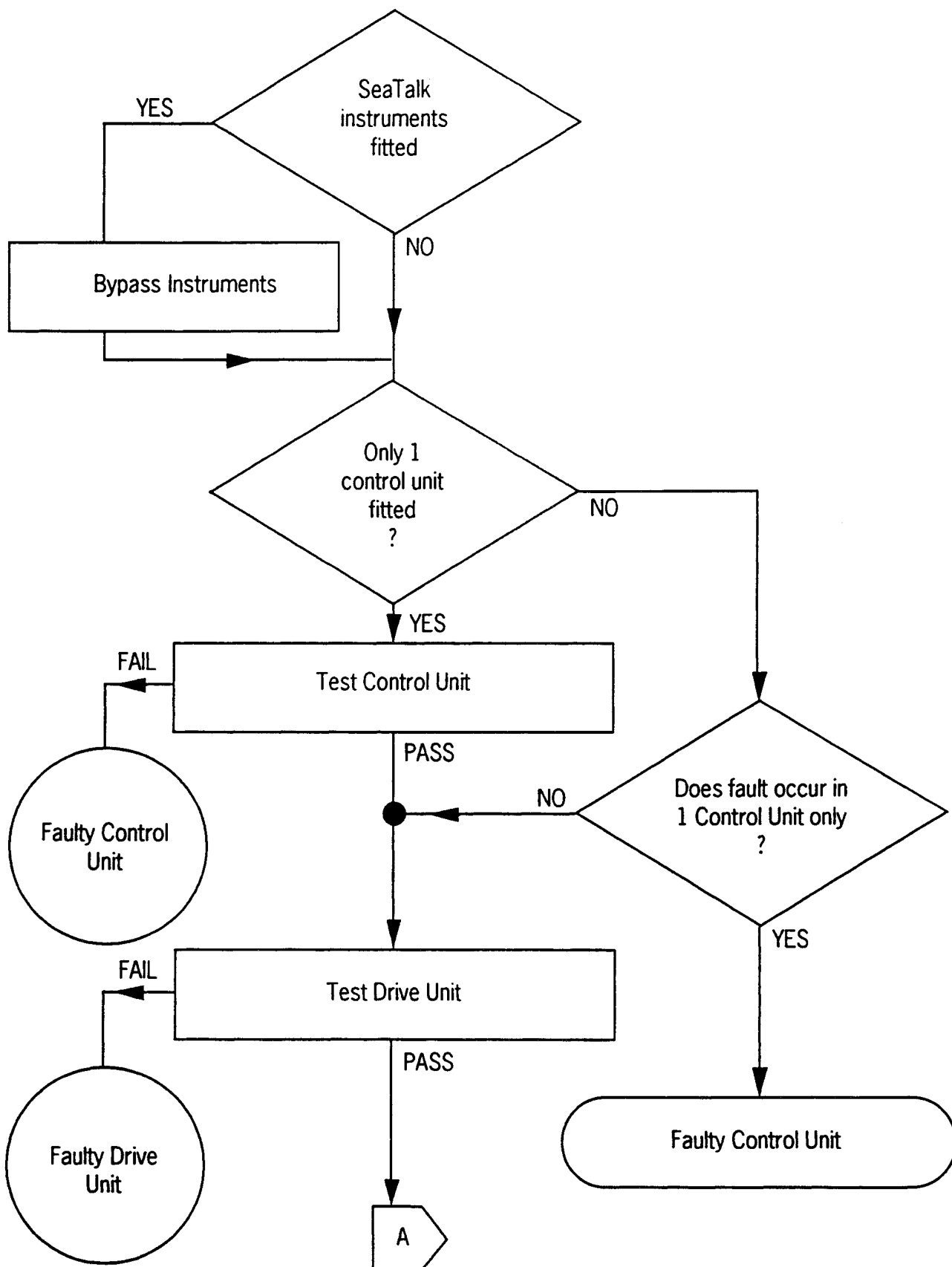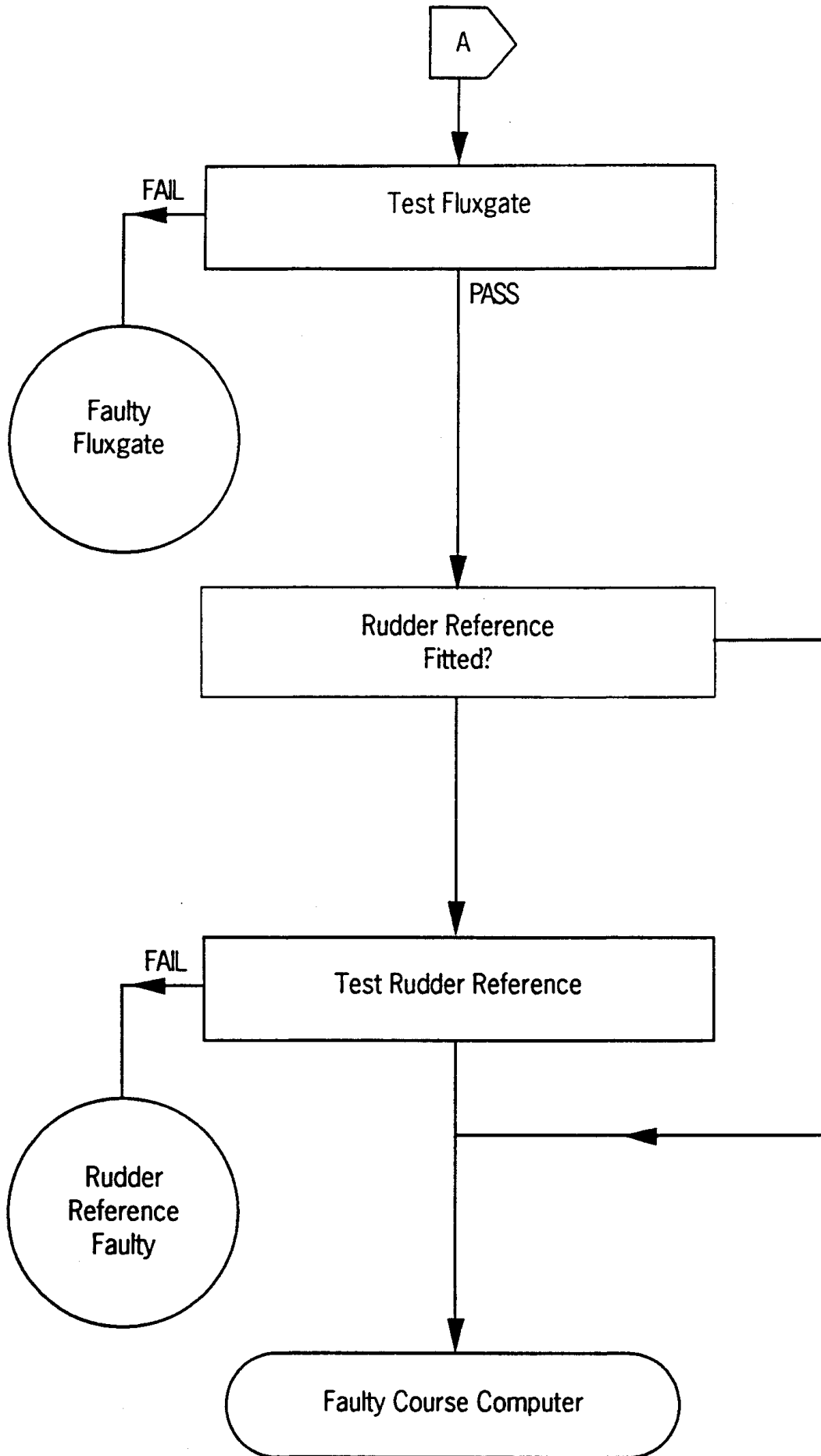
ST6000 Control Unit (Z124)

1. Service Procedures

2. Technical Information
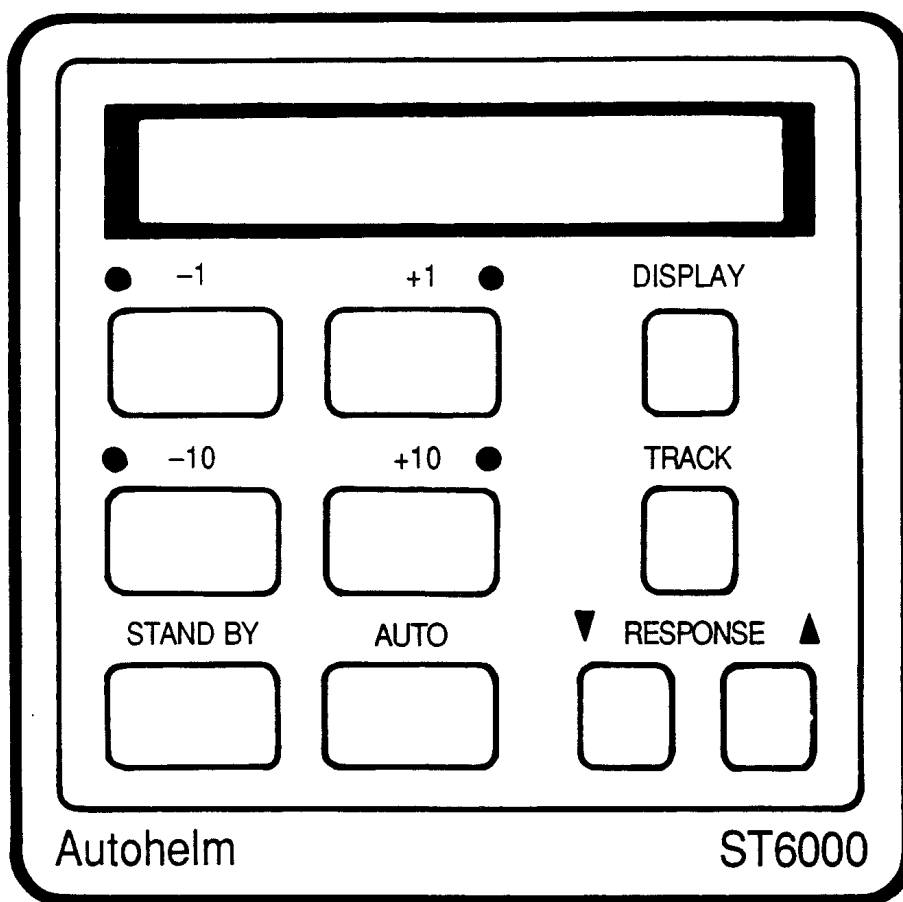
Autohelm

1. Service Procedures

Contents

Illustrations

1. Description

The Z124 control unit is Seatalk compatible and consists of a single PCB built using surface mount technology. The unit can be functionally tested (figure 3) without the use of special equipment other than a seatalk cable with a seatalk plug at one end and bared cores at the other.

If a control unit or its PCB are replaced the display contrast will require re-setting. This should be carried out aboard the vessel following the instructions given in section 3.

2. Dismantling

After removing the unit from the boat and returning to the service centre. Place face down on a clean, light foam surface. Preferably conductive.

1. Unscrew and remove the 4 case securing screws from the rear cover. Push each cable loom assembly back through its grommet so as to obtain working clearance to the PCB (fig 1)

Note: if cables are very tight in grommets apply a small smear of silicon grease to outer sheath, (grease can be wiped off after reassembly).

If removing the PCB assembly it will be necessary to de-solder the cables from the PCB. Great care should be exercised when de-soldering so as not to damage the pads on the PCB.

2. Unscrew and remove the 9 screws which secure the PCB to the facia.

Note: Do not at this stage remove the screws which secure the LCD assembly to the PCB. Refer to figure 1 to clarify which screws to remove.

3. Before removing the LCD ensure that lint free and preferably anti static finger cots are worn to prevent the LCD or elastomers getting dirty or greasy.

4. Unscrew and remove the 3 LCD housing retaining screws (fig 1). Be careful to hold the LCD surround, LCD, and diffuser when dismantling. Lift away from the PCB and store.

3. Re-assembly

Re-assembly is a straight reversal of the above procedure but note the following points:-

1. Ensure the LCD is correctly orientated relative to the PCB (fig 1).

2. Ensure the diffuser is correctly orientated relative to the LCD and PCB (fig 1).

3. Note the correct orientation of the various looms and core colours to the PCB pads (fig 1).

4. Ensure that the board is tightened down sequentially to ensure the load is evenly spread.

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5. Pull the loom assemblies back through the grommets when lowering the cover to ensure that the cables do not bunch up inside the cover and foul the PCB on re-assembly.

6. Refit the cover.

7. Re-check for full function after re-assembly to check the LCD has not been damaged or looms incorrectly soldered. Adjust LCD contrast if necessary.

4. Display Contrast adjustment

The LCD Contrast can be adjusted to suit a wide range of control unit viewing angles.

Push display and track together momentarily.

Push response ▲ to increase contrast (suits viewing from below).

Push response ▼ to decrease contrast (suits viewing from above).

Adjust the display for optimum viewing.

Push display and track together momentarily to store selection and return to previous operating mode.

Autohelm

YELLOW
RED

YELLOW
RED
SCREEN

YELLOW
SCREEN
RED

NMEA
CONNECTOR

COVER

CASE SEAL

SEATALK
CABLES

COVER
SCREWS
(x4)

CABLE
TIE (x2)

PCB RETAINING
SCREW (x9)

SPRING
WASHER
(x9)

PCB ASSEMBLY
Q027

NOTE POSITION
OF PIP

LCD
ASSEMBLY
Q028

KEYPAD
(x4)

KEYPAD
RED
RIBBED

KEYPAD
INSERT
(x6)

KEYPAD
RED

KEYPAD
INSERT
(x4)

KEYPAD
(x4)

FASCIA

SEATALK
SCREEN

SEATALK
RED

EPROM
Q029

SEATALK
SCREEN

SEATALK
RED

SEATALK
YELLOW

NMEA DATA
GROUND
YELLOW

NMEA DATA
RED
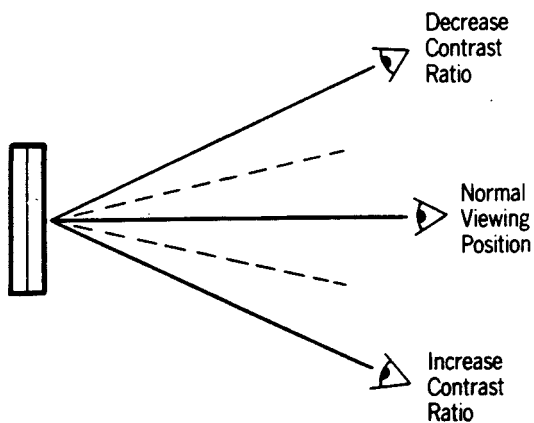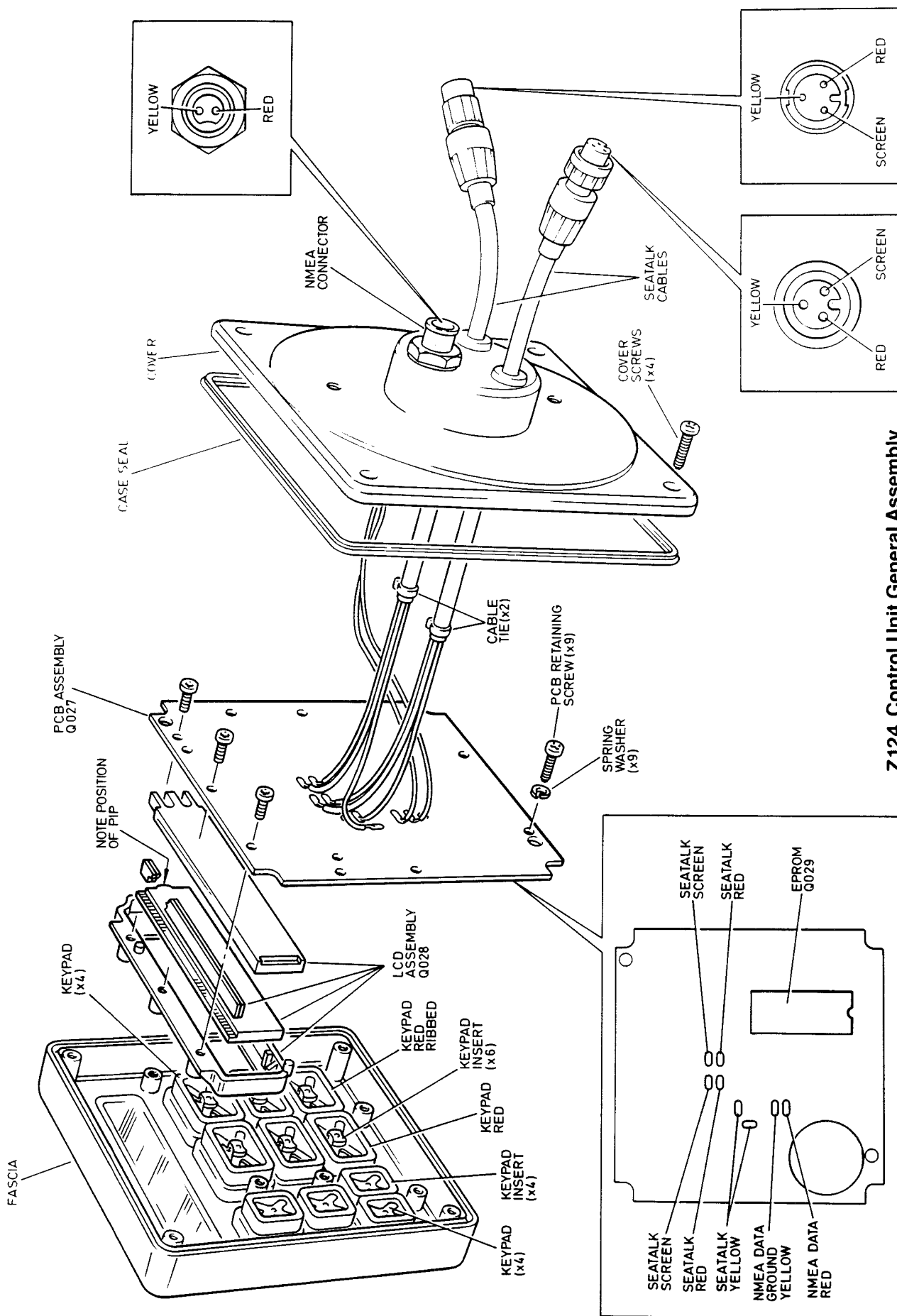
Z124 Control Unit General Assembly

Fig. 1.

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4. Z124 Control Unit Functional Test

Disconnect Control Unit
from the seatalk bus

Connect Test lead as follows:
Screen to 0V - Red to +12V
Yellow open circuit

Tone sounds at
Switch On
?

→ NO → Faulty PCB

YES

Does display show
ST6000 followed,
after 2 seconds with
NO LINK

→ NO → Faulty PCB

YES

Do all pushbuttons
sound when
pressed
?

→ NO → Faulty PCB

YES

Press **-1**, **+10**, **Standby** and
Display keys together

A

A

All display segments
and illumination
switched on ?

NO → Faulty
PCB

YES

Control Unit
OK

Autohelm

5. Product History - Control Unit (2124)

Change	Serial number	Comments
	030001	production start

6. Software History - Control Unit (Z124)

Version	Change	Serial No
65E	Product launch	030001

7. Spares numbers - Control unit (Z124)

Item	Catalogue no	Comments
Double skin mounting kit	Q003	allows fixing to up to 4" thick bulk heads
PCB assembly	Q027	
LCD	Q028	
Protective cover	D123	

2. Technical Information

Contents

Illustrations

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1. Control Unit PCB Circuit description
Fig. 4. Circuit Diagram
Fig. 5. PCB Assembly/Parts List

1.1 Power supply
Incoming power is routed to the PCB via PL1 and SKT1. Dl and D2 protect against reverse connection of the supply. IC1 is a 5v regulator and can also reset the microprocessor, via TR1, should the supply voltage fall below 6V.

1.2 Microprocessor and program memory
IC6 is an Intel 80C32 microprocessor. It can access up to 32k bytes of program memory (IC5) via the latch IC4. A clock signal for the microprocessor is provided by an 11MHz ceramic resonator (XL1), and associated capacitors CIS and C16. Capacitors C17, C18 and C19 provide decoupling.

1.3 LCD and Display driver
The LCD is a Nautech custom part. The display is driven by a Hitachi Led driver (IC3) deriving its drive voltages from resistor chain R27-R30 and VR1. Communication to the microprocessor is via a 4 bit parallel bus (DB4 to DB7) and the three control lines E,R/W and RS. Capacitors C8 and C10 provide decoupling and resistor R26 the clock signal for IC3.

1.4 Negative Rail Generator
A negative voltage rail is required by the LCD display and is generated by a switching regulator formed by TR6,D5 and D6. A 4.8kHz waveform is generated from the microprocessor P3.4 (pin no. 16). This drives a charge pump, via transistor TR16, pumping charge from C20 via D6 to C21. The negative rail is then stabilised by D5 and R49.

1.5 N.M.E.A Interface
NMEA data is fed to the control unit via PL2 and isolated from the rest of the circuit using the opto-isolator (IC7). Diode D3 provides input reverse connection protection and resistor R15 is tuned to give the desired bandwidth of operation. The output from IC7 is connected to the microprocessor Port P3.2 (pin 14). Capacitor C7 provides decoupling.

1.6 Seatalk Bus Transmit and Receive
Seatalk transmit and receive circuitry consists of TR9, 10, 11 ,12, 13, 14 and 15 and their associated components. Data transmission is at 4800 baud with a low start bit and line idling high. TR9 and TR13 provide high and low output respectively, whilst TR14 and R45/46 give overload protection to Trl3 in the event of misconnection. TR10 and TR11 allow the microprocessor to monitor its own transmissions and also to receive data from other units on the bus.

1.7 Keypad operation
The 10 button keypad is interfaced to the microprocessor via 2 dual input multiplexer IC's.

Each key is read in turn when the relevant channel is selected via pins p3.5 and p3.6.

1.8 Buzzer Operation

TR2 and TR3 are configured as an astable multivibrator with a nominal frequency of 2.7kHz. TR7 and 8 are used to switch the buzzer with TR7 acting as an inverter to turn the buzzer off during a microprocessor reset.

1.9 Illumination Drive

TR10, 12 and 16 provide a constant current drive for lamps LP1 and LP2. The current is set by resistors R11 and R12. TR6 is an inverting buffer to turn off the lights during a microprocessor reset. Illumination level's are given by pulse width modulation of drive line P3.3 (pin 15).

Autohelm
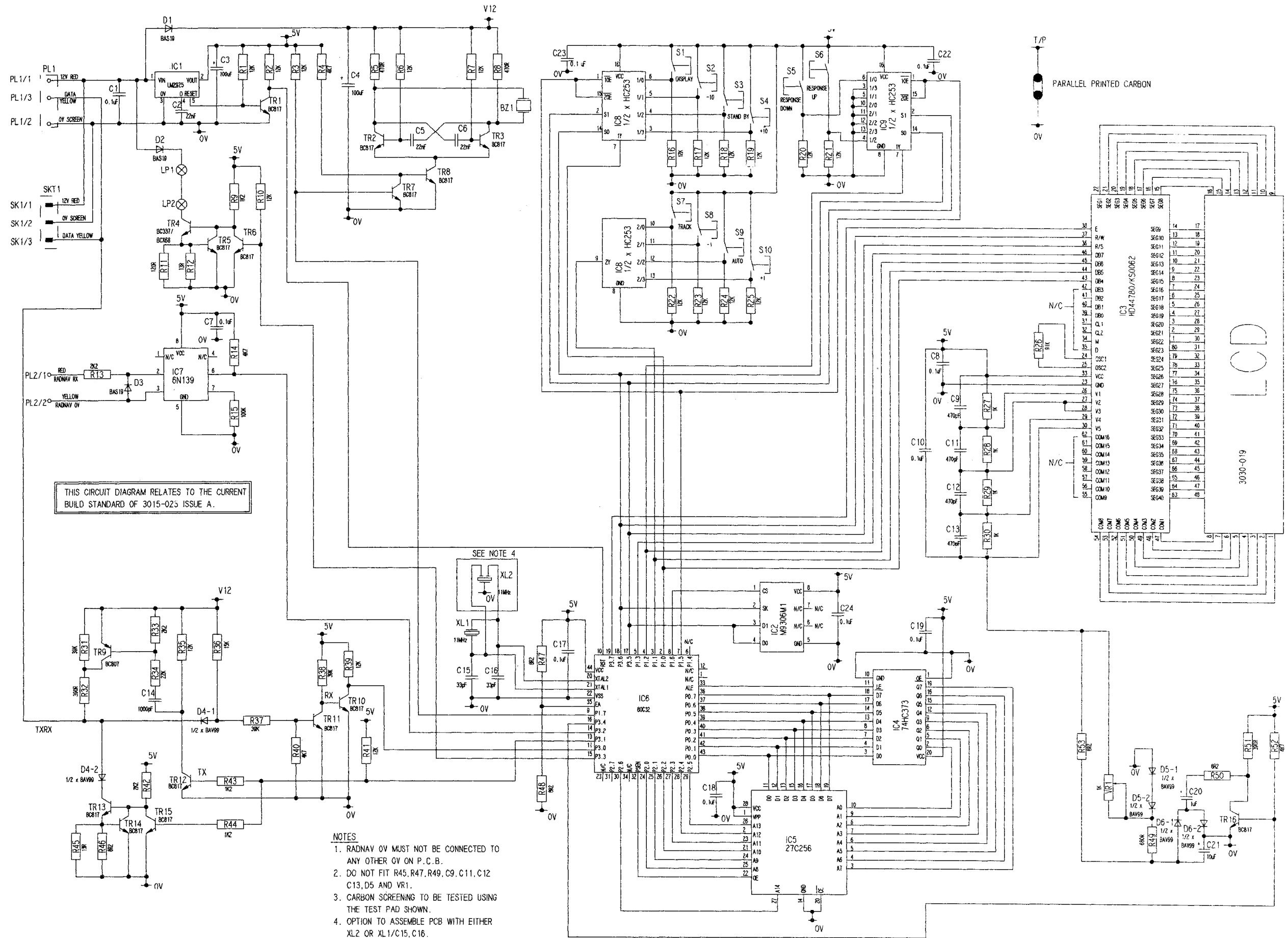
NOTES
1. RADNAV OV MUST NOT BE CONNECTED TO ANY OTHER OV ON P.C.B.
2. DO NOT FIT R45,R47,R49,C9,C11,C12 C13,D5 AND VR1.
3. CARBON SCREENING TO BE TESTED USING THE TEST PAD SHOWN.
4. OPTION TO ASSEMBLE PCB WITH EITHER XL2 OR XL1/C15,C16. XL2 IS THE PREFERRED OPTION.

THIS CIRCUIT DIAGRAM RELATES TO THE CURRENT BUILD STANDARD OF 3015-025 ISSUE A.

ST6000 (Z124) Control Unit Circuit Diagram

ISS E

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NOTES
1. ALL SURFACE MOUNT CAPACITORS AND RESISTORS TO HAVE NICKEL BARRIER SOLDER PLATED TERMINATIONS.
2. ITEM 47 (15085) & ITEM 49 (15127) TO LIE FLAT ON PCB.
3. DO NOT FIT COMPONENTS R45,R47,R49,C9,C11 C12,C13,D5 AND VR1.
4. OPTION TO ASSEMBLE PCB WITH EITHER XL2 OR XL1/C15.C16.
XL2 IS THE PREFERRED OPTION
5. THIS ITEMS LIST HAS NOT BEEN RATIONALISED FOR 'IN HOUSE' BUILD. ITEMS 93041000P.91051K AND 91061K2 ARE NON PREFERRED SURFACE MOUNT COMPONENTS.

ITEMS	DR'G/PART N°	QTY	DESCRIPTION		
47	15127	1	CERAMIC RESONATOR (CERALOCK) BUILT IN LOAD		
			CAPACITANCE CST 11.0MT (3 PINS)	XL2	
	OR				
46	9303G3P	2	0805 CAPACITOR 33pF ±5% 50V COG	C15,C16	
	&				
45	15085	1	CERAMIC RESONATOR 11Mhz (CSA 11.0MT) XL1		
	EITHER				
			AND		
44	9408HD44780	1	LCD DISPLAY DRIVER HD44780 (HITACHI) OR KS0062 (SAMSUNG) IC3		
		1	AND		
43	05018		TRANSISTOR BC337 NPN (TO BE ASSEMBLED WITH TR4)		
		1	MAXIMUM LEAD LENGTH OF 4MM).		
	OR				
42	9501BCX68	1	TRANSISTOR SOT 89 BCX68 NPN	TR4	
	EITHER				
			PLUS		
41	940274253	2	HCMOS (DUAL 4 TO 1 MULTIPLEXER) 74HC253 IC8, IC9		
40	94006N139	1	OPTO ISOLATOR 6N139 LEADS TO BE FORMED FOR IC7		
			BUTT JOINT CONNECTION (i.e. HPS OPTION 100)		
39	940680C32		MICRO ROMLESS 80C32 12MHz PLCC	IC6	
38	940374373		HCMOS LATCH 74HC373	IC4	
37	940093061		EEPROM 16x16 M9306M1 [SGS] OR NATIONAL SEMICONDUCTOR IC2		
36	04049		VOLTAGE REGULATOR LM2925	IC1	
35	9500BC807		TRANSISTOR SOT 23 BC807 PNP	TR9	
34	9500BC817	14	TRANSISTOR SOT 23 BC817 NPN	TR1,3,5,6,7,8,10,11,12,13,14,15,16	
33	9200BAV99	2	DIODE SOT 23 BAV99	D4,(D5),D6	# - SEE NOTE 3
32	9200BAS19	3	DIODE SOT 23 BAS19	D1,D2,D3	
31	93041000P	1	0805 CAPACITOR 1000pF ±10% 50V X7R	C14	
30	930522N	3	1206 CAPACITOR 22µf 5% 50V X7R	C2,C5,C6	
29	93070U1	10	1206 CAPACITOR 0.1µF ±20% 50V X7R	D1,7,8,10,17,18,19,22,23,24	
28	931470P	0	0805 CAPACITOR 470pF ±20% 50V X7R	(C9,C11,C12,C13)	# - SEE NOTE 3
27	931110U	1	CAPACITOR SOLID TANT 10µF ±20% 6V3 (SIZE 0) C21		
26	03063	2	CAPACITOR ELECTROLYTIC 100µF ±20% 25V MIN 0.75 MAX C3,C4		
25	93091U	1	CAPACITOR SOLID TANT 1µF ±20% 16V (SIZE A) C20		
24	9106100K	1	1206 RESISTOR 100K 5% 0.125W	R15	
23	9105K	4	1206 RESISTOR 1KO 2% 0.125W	R27,R28,R29,R30	
22	9106680R	0	1206 RESISTOR 680R 5% 0.125W	(R49)	
21	9106120R	1	1206 RESISTOR 120R 5% 0.125W	R11	
20	910591K	1	1206 RESISTOR 91K2% 0.125W	R26	
19	91068R2	4	1206 RESISTOR 8R2 5% 0.125W	R46,(R47),R48,R50,R53	# - SEE NOTE 3
18	910639K	3	1206 RESISTOR 39K 5% 0.125W	R31,R37,R38	
17	910622K	1	1206 RESISTOR 22K 5% 0.125W	R34	
16	910615K	1	1206 RESISTOR 15K 5% 0.125W	R36	
15	910612K	19	1206 RESISTOR 12K 5% 0.125W R1,2,3,6,7,10,16,17,18,19,21,22,23,24,25,35,39,41		
14	91064K7	4	1206 RESISTOR 4K7 5% 0.125W	R4,R14,R40,R52	
13	91062K2	3	1206 RESISTOR 2K2 5% 0.125W	R13,R33,R42	
12	91061K2	3	1206 RESISTOR 1K2 5% 0.125W	R9,R43,R44	
11	9106470R	2	1206 RESISTOR 470R 5% 0.125W	R5,R8	
10	9106390R	2	1206 RESISTOR 390R 5% 0.125W	R32,R51	
9	910313R	1	1206 RESISTOR 13R0 1% 0.125W	R12,(R45)	# - SEE NOTE 3
8	9107K	0	CHIP TRIMMER RESISTOR 1K MURATA RVG 4F03A-102VM (VR1)		# - SEE NOTE 3
7	15087	1	BUZZER KBS-27DB-3T	BZ1	
6	06025	10	CONTACT CLICKER OOK-73470	S1,S2,S3,S4,S5,S6,S7,S8,S9,S10	
5	26006	1	RIV SCREW 1712-3507 (AVDEL)		
4	15039	1	HEATSINK REDPOINT TV58		
3	07164	1	28 PIN SOCKET		
2	3015-025	1	6000 CONTROL UNIT PCB DETAIL		
1	3010-036	10	CLICKER SEAL		
ITEMS	DR'G/PART N°	QTY	DESCRIPTION		
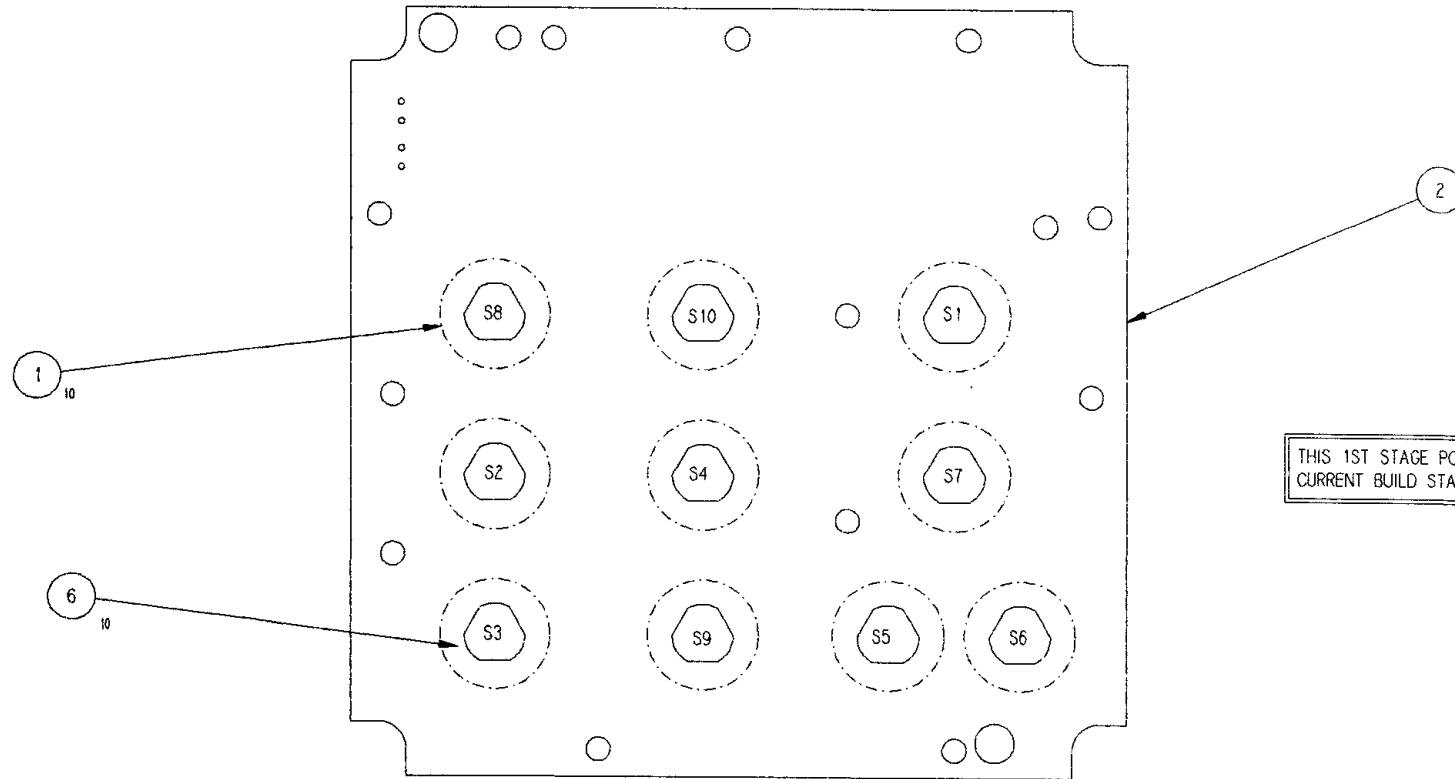
THIS 1ST STAGE PCB S'ASSY RELATES TO THE CURRENT BUILD STANDARD OF 3015-025 ISSUE A.

TOP SIDE

SEE NOTE 4

COMPONENT SIDE
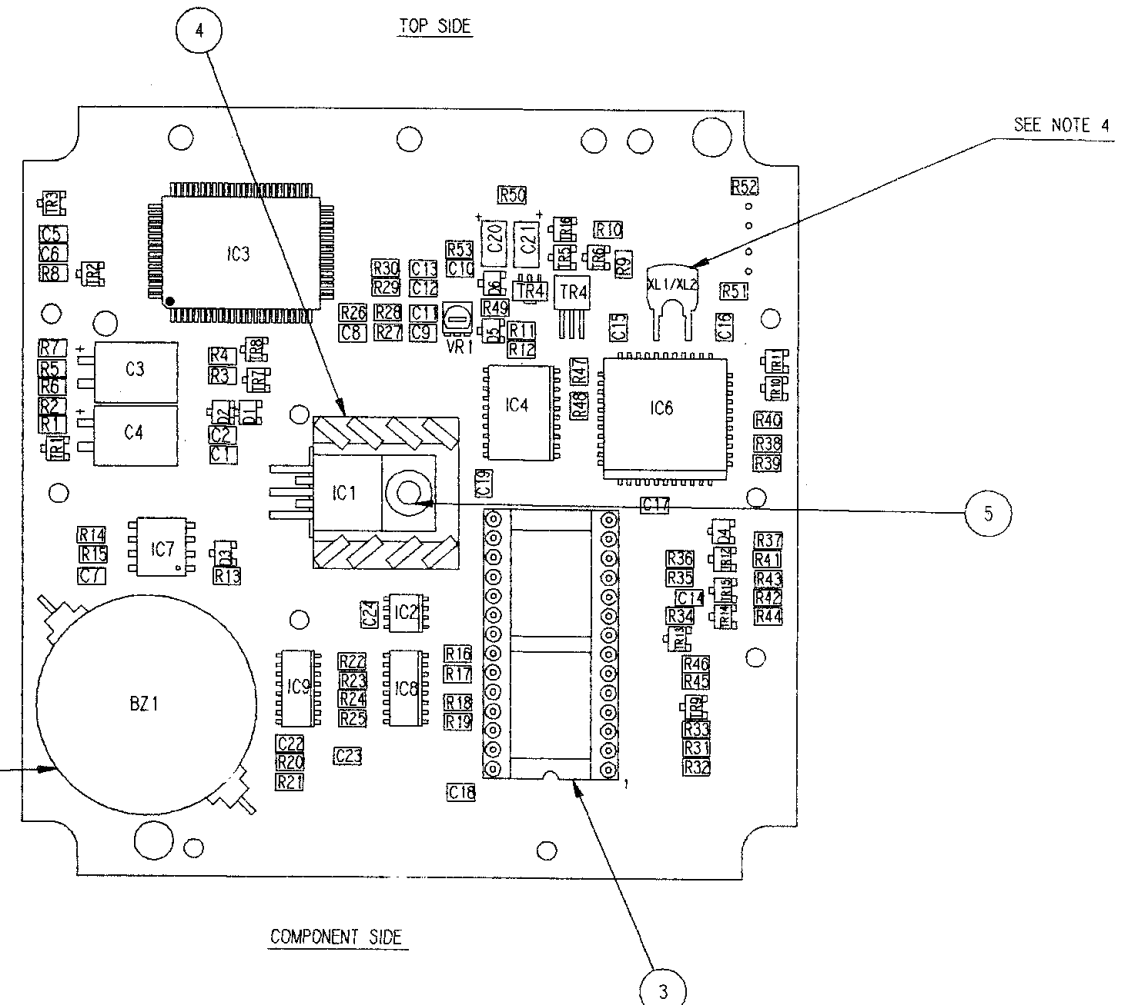
ST6000 (Z124) Control Unit PCB Assembly

Autohelm

ST6000 Course Computer (Z123)

1. Service Procedures
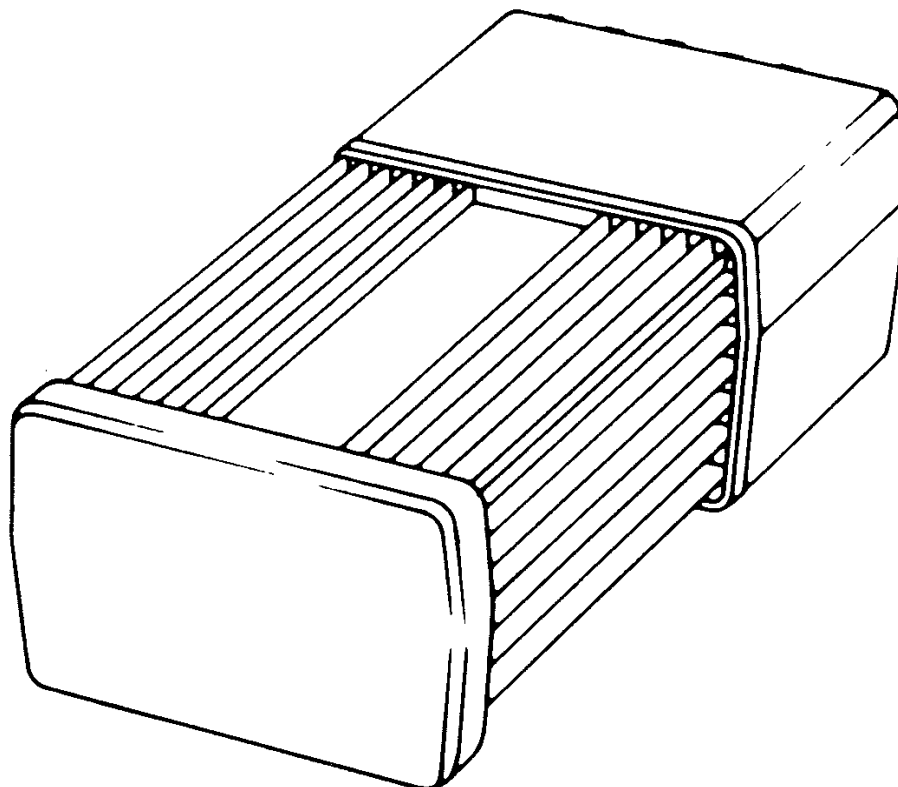
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Contents

1. Description

The ST6000 course computer is SeaTalk compatible and consists of a single PCB containing both the course computer and power amplifier circuitry. It is built using surface mount technology and available for 12v operation only.

Note: If the course computer or its PCB are replaced, calibration values previously altered from the factory settings will require resetting. Also the Fluxgate Compass will require re-linearising (auto deviation correction). Both of these procedures are outlined in the ST6000 system section.

It is essential the cable used for the single DC supply is of adequate gauge otherwise the system may reset back to standby mode when the drive motor operates.

The table below gives a guide to cable size required. The length quoted is the total cable length from the main distribution panel to the course computer, plus the length from the course computer to the drive unit.

Drive Unit and Power Supply Cable Size

Cable length	Cable type	Copper area	Cable gauge
up to 7m	50/0.25	2.5mm^2	12 awg
up to 10m	56/0.3	4.0mm^2	10 awg
up to 16m	54/0.3	6.0mm^2	8 awg

2. Disassembly

1. Unscrew and remove the 2 countersunk screws securing lid on terminal box section and lift off lid.

2. Unscrew and remove the 2 thumb nuts securing extrusion assembly to terminal box unit and pull extrusion assembly away from terminal box.

3. Unscrew and remove the 8 pan head screws securing both the connector cover and extrusion end cap mouldings.

4. Remove the two heatsink location screws (ensure associated nuts and washers are recovered).

5. Carefully withdraw the PCB assembly.

3. Re-assembly

In all cases re-assembly is a reversal of the dismantling procedure but note the following:-

Apply a small amount of loctite 270 (or equivalent) to the threads of the two heatsink location screws after they have been installed.

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Course Computers (Z083, Z084) - General Assembly

COVER SECURING SCREWS

COVER

EPROM Q032

COMPUTER PCB ASSEMBLY PLAN VIEW

EXTRUSION

COMPUTER PCB ASSEMBLY SECURING SCREWS

COMPUTER PCB ASSEMBLY Q031

SECURING STUDS

CONNECTOR COVER

COVER SECURING SCREWS

IDENTIFICATION LABEL

TERMINAL BOX

COURSE COMPUTER LABEL

SECURING SCREWS

TERMINAL BOX COVER

THUMB NUT

TERMINAL PCB ASSEMBLY Q030

TERMINAL BOX PILLARS
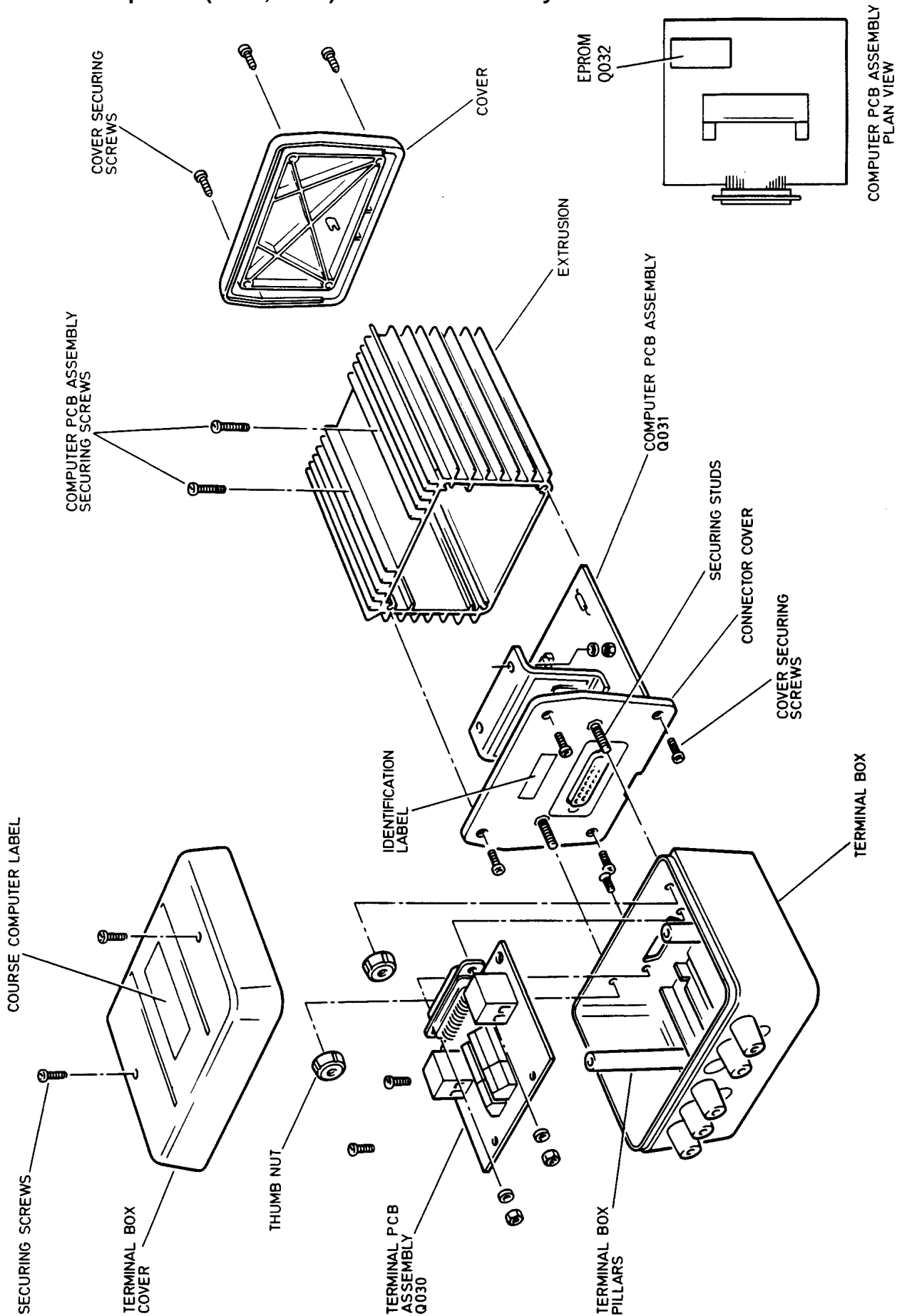
4. Functional Test

The course computer can be functionally checked as follows; Pre-checked equipment required:

SeaTalk Control Unit   (Z124)
Fluxgate Compass   (Z105 or Z130)
Pushpit vane transducer   (Z087)
Rudder Reference Transducer   (Z060)
Terminal PCB   (Q030)
Terminal Block
Multimeter
Motor (small AH1000 type)   (M080)
Power Supply   (Min rating 10A)
SeaTalk Cable   (D131)

Procedure

1. Connect all units to course computer and terminal PCB.
2. Position the rudder reference transducer arm diametrically opposite the cable gland.
3. Connect the 12v supply (do not switch on) and refer to the bench testing (stage 1) procedure that follows.

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4.1 Course Computer Bench Testing (Stage 1)

```
                    ┌──────────────┐
                    │  Switch on   │
                    └──────┬───────┘
                           │
                           ▼
                         ◇◇◇◇◇
                    Does control unit      NO
                    sound tone ?      ──────────────►  ┌──────────┐
                         ◇◇◇◇◇                          │ Faulty   │
                           │ YES                        │ PCB      │
                           ▼                            └──────────┘
                         ◇◇◇◇◇
                    Does control
                    unit display ST6000 for 2s     NO
                    and then display 'Standby' and  ─────────►
                    Current compass heading
                         ◇◇◇◇◇
                           │ YES
                           ▼
                         ◇◇◇◇◇
                    Does compass reading
                    change as compass        NO
                    is rotated ?         ──────────►
                         ◇◇◇◇◇
                           │ YES
                           ▼
         ┌────────────────────────────────────┐
         │ Connect meter +ve to clutch +ve     │
         │ Connect meter -ve to clutch -ve     │
         └──────────────┬─────────────────────┘
                        │ YES
                        ▼
                      ◇◇◇◇◇
                 Does meter          NO
                 read 0v ?       ──────────►
                      ◇◇◇◇◇
                        │ YES
                        ▼                          ┌──────────┐
                      ╱ A  ╲                        │ Replace  │
                      ╲────╱                        │ PCB      │
                                                    └──────────┘
```

Fig .4.

```
    ┌──────┐
    │  A   ╲
    └──────╱
        │
        ▼
┌──────────────────┐
│   Press 'Auto'   │
└──────────────────┘
        │
        ▼
      ╱────╲
    ╱        ╲           NO
  ╱  Does meter ╲ ──────────────────────►┐
  ╲  read >10v  ╱                        │
    ╲    ?    ╱                          │
      ╲────╱                             │
        │ YES                            │
        ▼                                ▼
┌──────────────────────┐      ┌──────────────────┐
│ Press 'standby'. Select Drive│      │   Replace        │
│ level 1 via the calibration  │      │   PCB            │
│ menu. Press 'Auto'           │      └──────────────────┘
└──────────────────────┘
        │
        ▼
┌──────────────────────────┐
│ Press +10° three times   │
└──────────────────────────┘
        │
        ▼
      ╱────╲
    ╱        ╲           NO
  ╱   Motor   ╲ ──────────────────────►┐
  ╲   runs ?  ╱                        │
    ╲        ╱                         │
      ╲────╱                           │
        │ YES                          │
        ▼                              │
      ╱────╲                           │
    ╱        ╲         NO              │
  ╱   Motor   ╲ ──────────────►┐       │
  ╱ stops within╲              │       │
  ╲ 10 seconds  ╱              │       │
    ╲    ?    ╱                │       │
      ╲────╱                   ▼       ▼
        │ YES          ┌──────────────────┐
        ▼              │   Replace        │
    ┌──────┐           │   PCB            │
    │  B   ╲           └──────────────────┘
    └──────╱
```

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B

Press **-10°** three times

Motor runs ? → NO → Replace PCB

YES

Motor stops within 10 seconds ? → NO → Replace PCB

YES

Press **'Standby'**.
Select Drive level 3
via the calibration menu

Press **'Standby'** and **'Auto'**
together

Does
Display indicate
windvane mode
? → NO → Replace PCB

YES

C

```
        ┌──────────┐
        │    C     ⟩
        └────┬─────┘
             ▼
  ┌────────────────────────┐
  │   Press 'Standby'      │
  └───────────┬────────────┘
              ▼
  ┌────────────────────────┐
  │  Move rudder reference arm │
  │     30° anti-clockwise  │
  └───────────┬────────────┘
              ▼
          ◇ Does rudder
            angle display
            show approximatly 30°      ───── NO ──────┐
            starboard rudder                          │
              │ YES                                    │
              ▼                                        │
  ┌────────────────────────┐                          │
  │  Move rudder reference arm │                      │
  │     60° clockwise       │                          │
  └───────────┬────────────┘                          │
              ▼                                        │
          ◇ Does rudder
            angle display
            show approximatly 30°      ───── NO ──────┤
            port rudder                               │
              │ YES                                    │
              ▼                                        ▼
     ┌──────────────┐                        ┌──────────────┐
     │   Course     │                        │   Replace    │
     │ Computer OK  │                        │     PCB      │
     └──────────────┘                        └──────────────┘
```

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5. Product History - Course Computer (ST6000)

Change	Serial No	Comments
Production start	030001	

6. Software History - Course Computer (ST6000)

Version	Change	Serial No
66F	Product launch	030001
66G	Improved Trim function	500571

7. Spares numbers - Course Computer (ST6000)

Item	Catalogue No	Comment
PCB Assembly	Q031	Main course computer PCB
PCB Assembly	Q030	Terminal box PCB

2. Technical Information

Contents

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1. ST 6000 Course Computer Circuit Description
Circuit diagram Fig. 1.
PCB Assembly/Parts List Fig. 2

1.1 Power Supply
Incoming power is routed to the PCB. via the 'D' connector socket SKI. VI provides suppression against any voltage spikes present on the incoming DC supply whilst D15 protects against accidental reverse connection of the supply. 1C 1 is a 5v regulator with an integral reset function which resets the microprocessor, via Tr9, should the supply voltage be insufficient to maintain regulation.

1.2 Microprocessor and Program memory
IC2 is an Intel 80C32 microprocessor with 256 bytes of on board Ram. It can access up to 32K bytes of programme memory in IC7, via the latch IC6.
A Clock Signal for the microprocessor is provided by an 11MHz ceramic resonator (XL1) and C15 & C16. Alternatively. XL2 can be used which combines all three components in one package.

1.3 Power Amplifier
TR23, 24, 25 and TR26 are configured to form a power amplifier capable of driving a motor in four modes:-
1. Drive right
2. Drive left
3. Short circuit motor (Brakes Motor)
4. Open circuit motor

Mode 3 is used to stop the motor quickly by switching Tr23 and 25 On and TR24 and 26 Off. Mode 4 allows the motor speed to be measured by switching off all of the power transistors.
All four modes are controlled via pins 8 and 9 of the microprocessor IC2.

1.4 Analogue to digital Converter
IC3.4 and 9 form a software driven analogue to digital Converter. IC3 and 9 are 8 channel multiplexed analogue switches routing all analogue signals, (see table below), through to IC4 which is configured as an integrator. C9 is discharged at a constant rate triggering the comparator IC5 as it reaches a level of approximately 0.53v. The output of the comparator is connected to the microprocessor allowing measurement of the discharge time which is directly proportional to the analogue input. Analogue channels:-

IC3	Channel 0	Reset integrator
	Channel 1	Integrator discharge signal
	Channel 2	Fluxgate sense A
	Channel 3	Fluxgate sense B

	Channel 4	Feedback 1 (FB1)
	Channel 5	Feedback 2 (FB2)
	Channel 6	Not used
	Channel 7	Not used
IC9	Channel 0	Not used
	Channel 1	Not used
	Channel 2	Rudder Reference (RUDDER)
	Channel 3	Supply Monitor (INPUT VOLTS)
	Channel 4	Not used
	Channel 5	Not used
	Channel 6	Joystick
	Channel 7	Not used

1.5 Clutch Drive

TR10, 11 and 12 switch a nominal 12v onto the actuator clutch whenever pin 15 of the microprocessor (IC2) is low at 0v.

1.6 Seatalk Bus Transmit and Receive

Seatalk transmit and receive circuitry consists of TR1,3,4,5,18 and 19 and their associated components. Data transmission is at 4800 baud with a low start bit and line idling high. TR1 and Tr2 provide high and low drive respectively, whilst TR3 and R1 give overload protection to Tr2 in the event of misconnection. Tr4 and Tr5 allow the microprocessor to monitor its own transmissions and also to receive data from other units on the bus.

1.7 Fluxgate drive

IC2 produces bursts of 8KHz pulses on pin 2 which are then fed through Tr6,7 and 8 and AC coupled to the fluxgate via C3.

1.8 E2 prom

IC8 is an E^2 PROM which allows calibration values to be stored and recalled each time after power up. Sequential data is written to the e2 prom on pin 3 and read back on pin 4.

1.9 Supply voltage monitor

R53 and R54 scale down the supply voltage and feed it through to the A/D converter to enable the microprocessor to transmit a warning on the Seatalk bus if the supply voltage drops below 11.2v for 10 seconds or more.

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ST6000 (Z123) Course Computer Circuit Diagram   ISS A
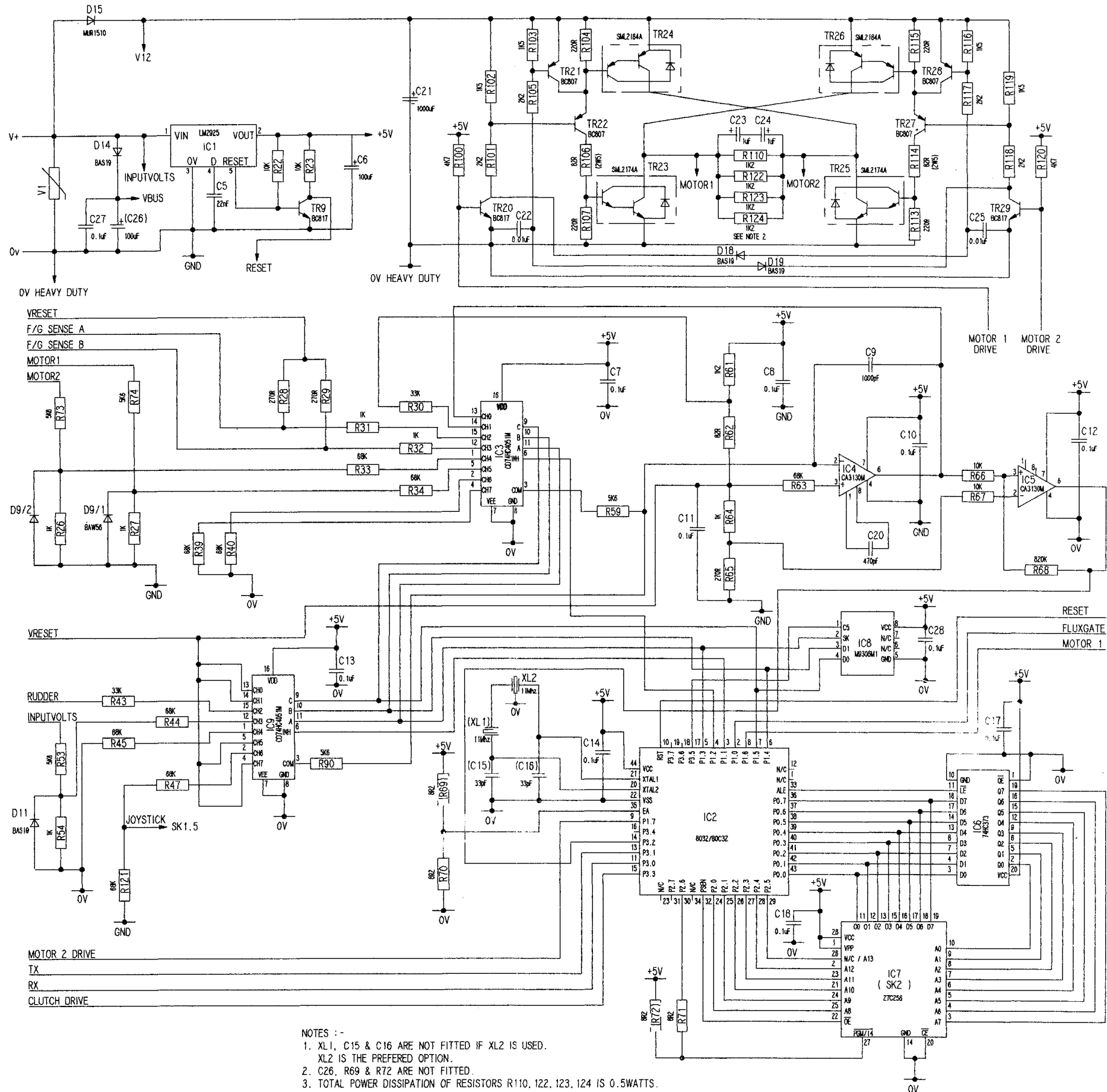
NOTES :-
1. XL1, C15 & C16 ARE NOT FITTED IF XL2 IS USED. XL2 IS THE PREFERED OPTION.
2. C26, R69 & R72 ARE NOT FITTED.
3. TOTAL POWER DISSIPATION OF RESISTORS R110, 122, 123, 124 IS 0.5WATTS.

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NOTE:-THIS 1st STAGE PCB ASSY RELATES TO CURRENT BUILD STANDARD OF 3015-040 ISSUE D
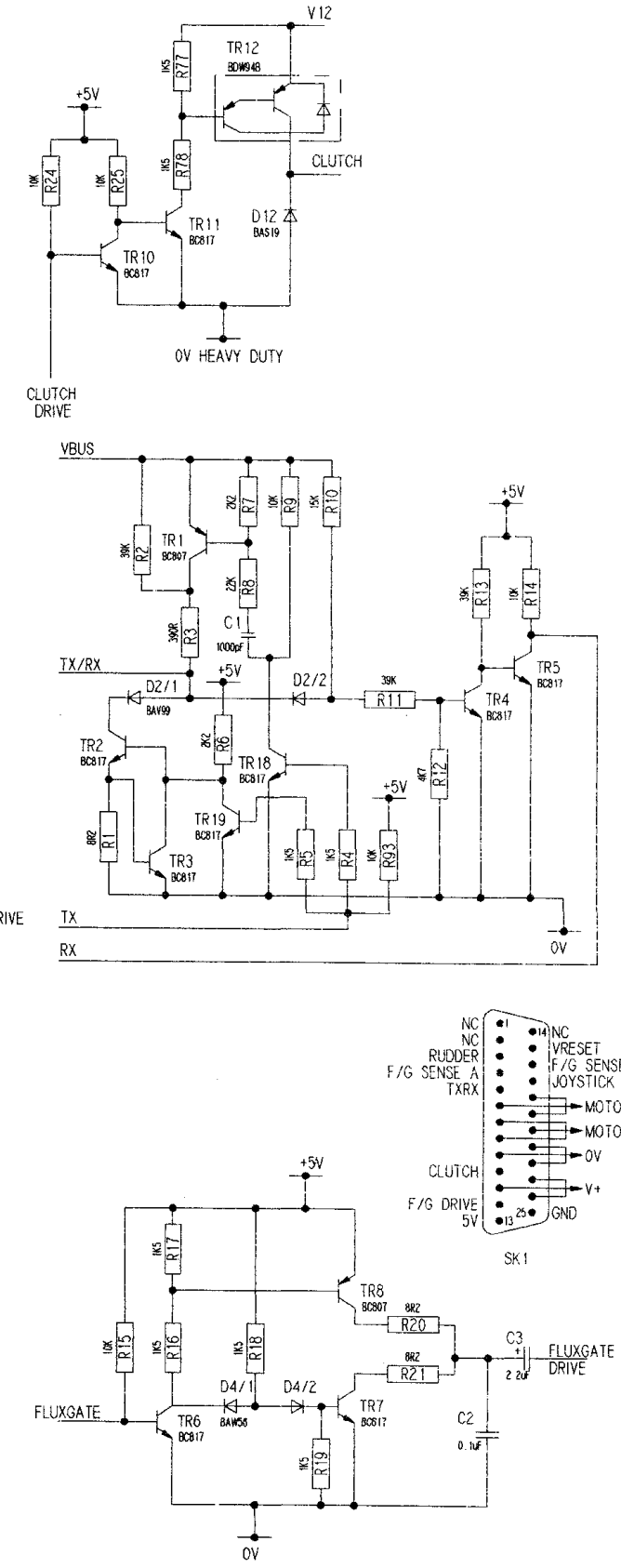
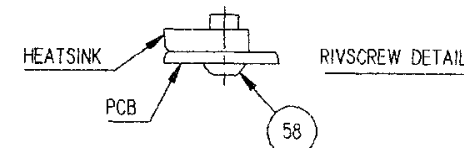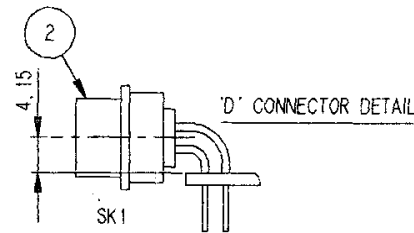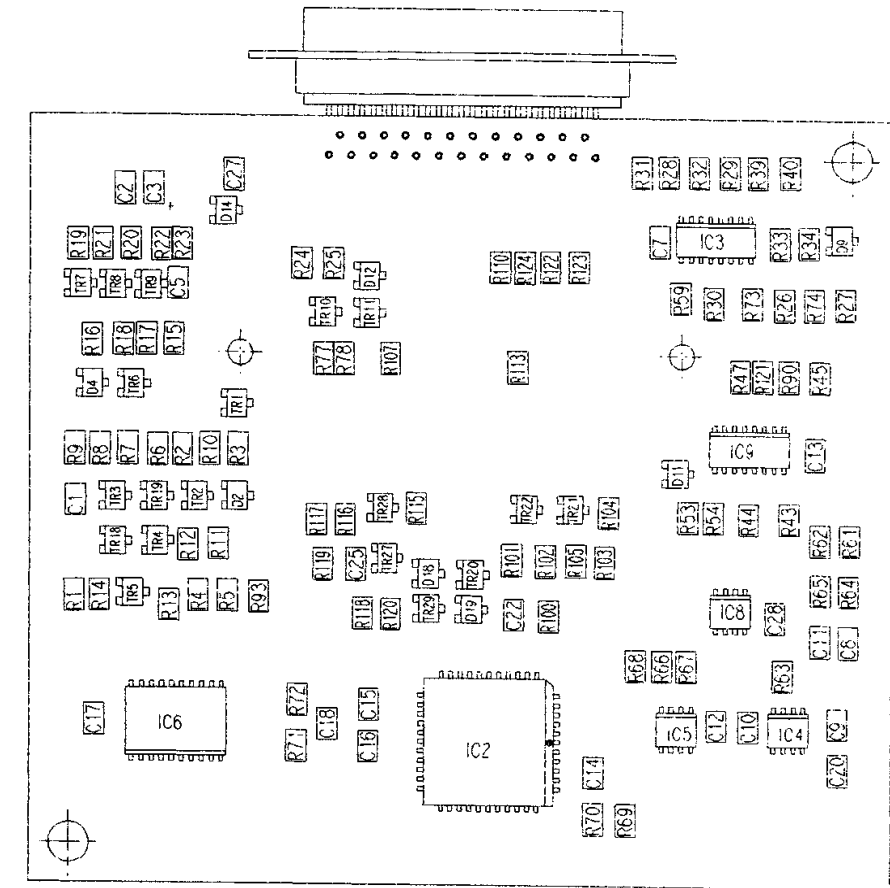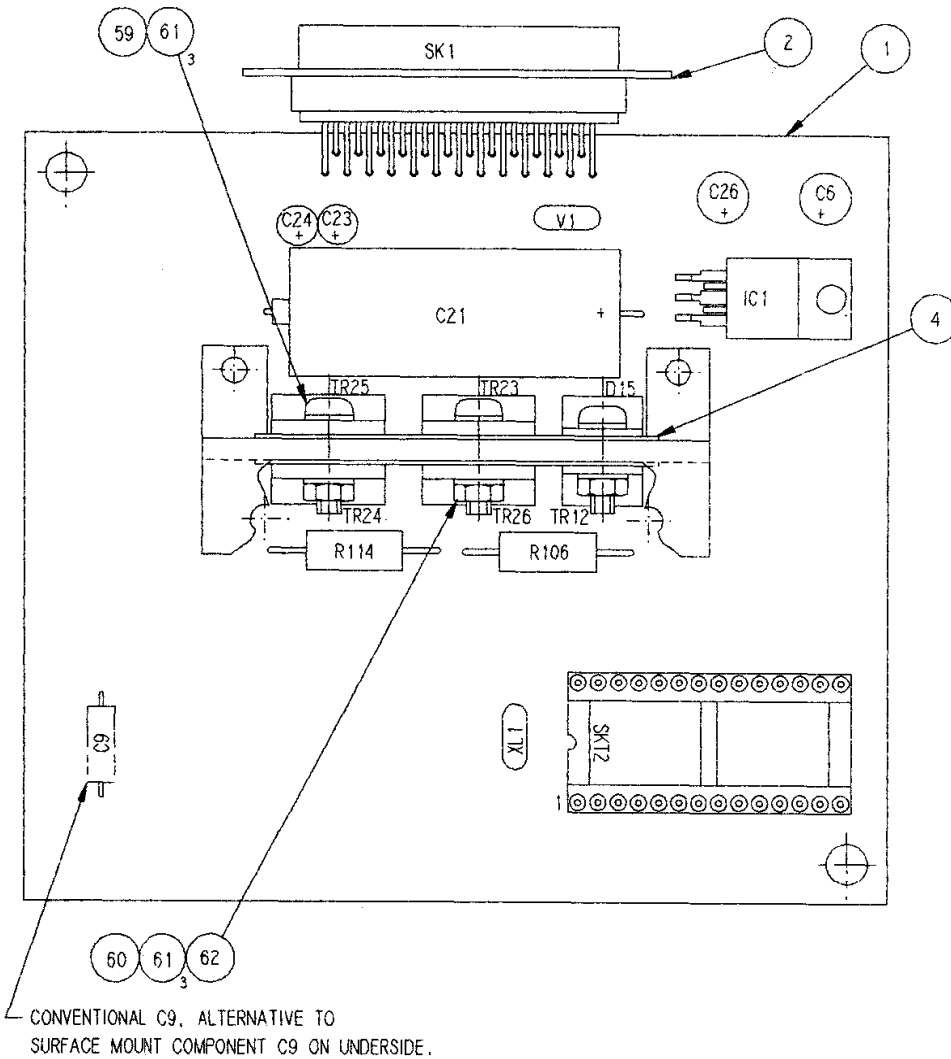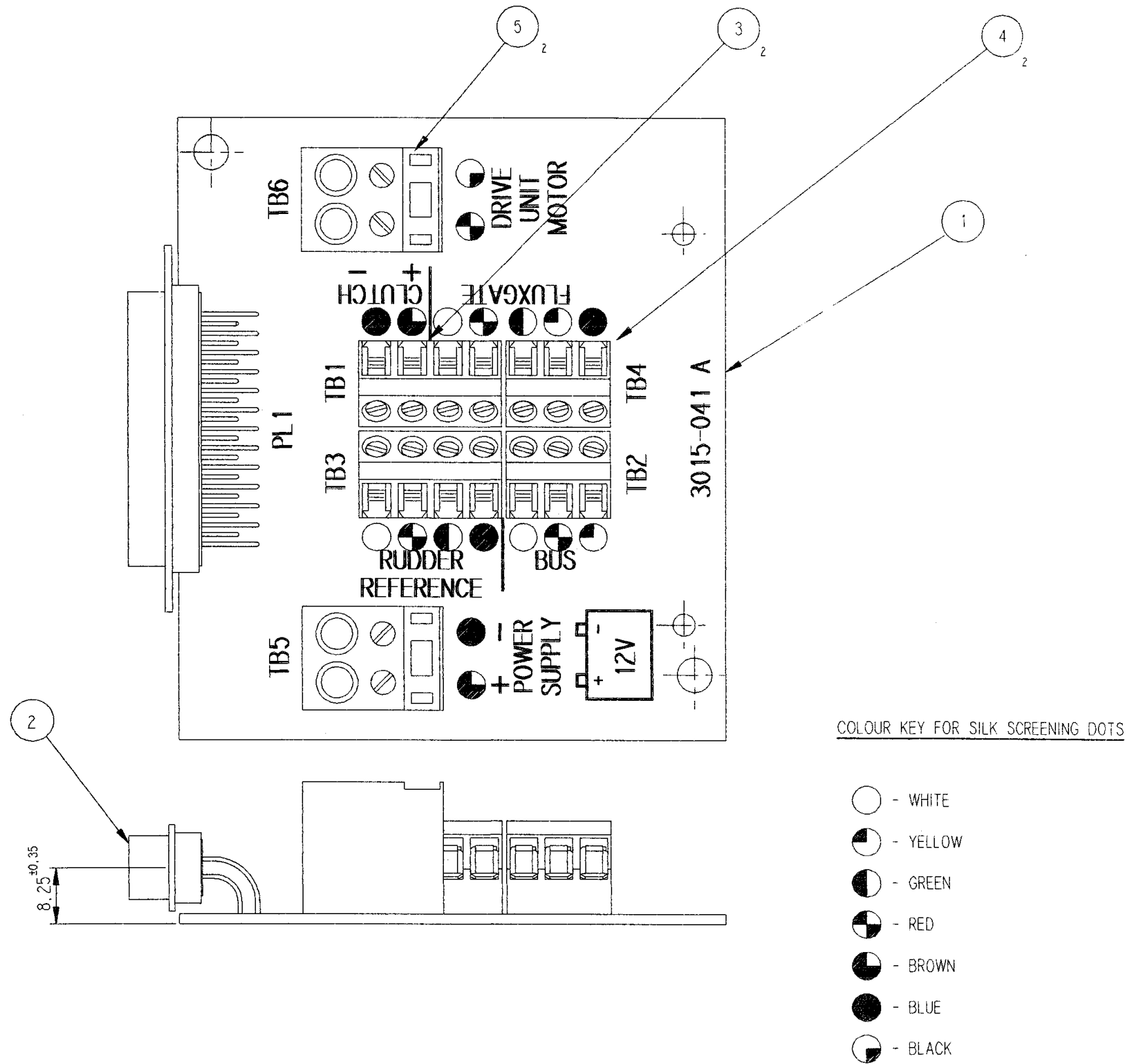| ITEMS	DRG/PART N°	QTY	DESCRIPTION	
65	EITHER	1	CERAMIC RESONATOR 11MHz CERALOCK CSA 11.0MT	XL 1
64		2	CAPACITOR 1206 33pF ±5* 50V	C15, 16
63	OR	1	CERAMIC RESONATOR CERALOCK CST 11.0MT(3 LEGS)	XL 1
			AND	
62	22016	3	NUT	
61	15014	6	INSULATING BUSH	
60	23029	3	WASHER	
59	21114	3	SCREW	
58	26005	2	RIVSCREW (1712-3509)	
57	02032	1	DIODE MUR1510	D15
56	05028	2	TRANSISTOR SM2174A	TR23,25
55	05029	2	TRANSISTOR SM2184A	TR24,26
54	03036	2	CAPACITOR 1µF ±m 25V MIN TANTALUM BEAD	C23,24
53	03023	1	CAPACITOR 1000µF 3 60V M1N	C21
52		1	CAPACITOR 1206 22nF ±20$ X7R 50V	C5
51		1	EEPROM 16 x 16 M9306M1 (SURFACE MOUNT)	IC8
50		1	LATCH 74HC373 (SURFACE MOUNT)	IC6
49		2	F.E.T.OP.AMP CA3130M (SURFACE MOUNT)	IC4,5
48		2	ANALOGUE SWITCH CD74HC4051M (SURFACE MOUNT) IC3,9	
47		1	MICRO ROMLESS 80C32 12MHz PLCC CMOS IC2	
46		1	5v REGULATOR LM2925	IC1
45	05035	1	TRANSISTOR PNP BDW94B	TR12
44		13	TRANSISTOR SOT23 NPN BC817	
43		6	TRANSISTOR SOT23 PNP BC807	TR1, 8, 21, 22, 27, 28
42		2	CAPACITOR 1206 0.01µF ±20% 25V MIN C22.25	
41	03031	2	CAPACITOR ELECTROLYTIC 100µF +80% -20% 5V MIN RADIAL 10DIA C6.26	
40		1	CAPACITOR CASE A 2.2µF ±20% 6V3MIN TANTALUM C3	
39		1	CAPACITOR 1206 470pF ±20% 50v	C20
38				
37		12	CAPACITOR 1206 0. 1µF ±20% 50v	C2,7,8,10,11,12,13,14,17,18,27,28
36		1	CAPACITOR 120 100pF ±20% COG 50v OR CAPACITOR POLYSTYRENE 1000pF ±1% 10v MIN (03053)	C9
35		1	CAPACITOR 1206 1000pF ±20% 50v C1	
34		2	DIODE SOT23 BAW56	D4,9
33		5	DIODE SOT23 BAS 19	D11,12,14,18,19
32		1	DIODE SOT23 BAV99	D2
31	01157	2	RESISTOR WIRE-WOUND 82R ±5% 2.5W R106, 114	
30				
29		2	WCR 1206 (FUTURE USE)	R69,72
28		2	WCR 1206 33K 1% 0.125W	R30,43
27		1	WCR 1206 3K9 5% 0.125W	R23
26		1	WCR 1206 470K 5% 0.125W	R68
25		1	WCR 1206 82R 1% 0.125W	R62
24		5	WCR 1206 5K6 1% 0.125W	R53, 59,73,74,90
23		9	WCR 1206 68K 1% 0.125W	
22		3	WCR 1206 270R 1% 0.125W	R28,29,65
21		6	WCR 1206 1K 1% 0.125W	R26,27,31,32,54,64
20		6	WCR 1206 1K5 5% 0.125W	R16,18,102,103,116,119
19		4	WCR 1206 220R 5% 0.125W	R104,107,113,115
18		3	WCR 1206 4K7 5% 0.125W	R12,100,120
17		1	WCR 1206 15K 5% 0.125W	R10
16		9	WCR 1206 10K 5% 0.125W	R9,14,15,22,24,25,66,67,93
15		1	WCR 1206 22K 5% 0.125W	R8
14		6	WCR 1206 2K2 5% 0.125W	R6,7,101,105,117,118
13		2	WCR 1206 1K8 5% 0.125W	R77.78
12		1	WCR 1206 1K2 1% 0.125W	R61
11		8	WCR 1206 1K2 5% 0.125W	R4,5,10,110,122,123,124
10		1	WCR 1206 390R 5% 0.125W	R3
9		3	WCR 1206 39K 5% 0.125W	R2,11,13
8		5	WCR 1206 8R2 5% 0.125W	R1,20,21,70,71
7		1	VARISTOR ZNR TYPE D ERZC07DK270 V1	
6				
5	3022-003	1	HEATSINK	
4	3010-073	2	CUSTOM SIL PAD	
3	07164	1	1C SOCKET (28 PIN)	SK2
2	07119	1	'D' CONNECTOR 25 WAY (FEMALE) SK1	
1	3015-040	1	ST6000 COMPUTER PCB DETAIL	

CONVENTIONAL C9, ALTERNATIVE TO SURFACE MOUNT COMPONENT C9 ON UNDERSIDE.

'D' CONNECTOR DETAIL

HEATSINK   RIVSCREW DETAIL
PCB

ST6000 (Z123) Course Computer PCB Assembly   ISS D

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TB6

DRIVE UNIT MOTOR

CLUTCH − +

FLUXGATE

PL1

TB1

TB3

TB2

TB4

3015-041 A

RUDDER REFERENCE

BUS

TB5

− POWER SUPPLY +

− 12V +

8.25 ±0.35

COLOUR KEY FOR SILK SCREENING DOTS

- WHITE
- YELLOW
- GREEN
- RED
- BROWN
- BLUE
- BLACK

ITEMS	DR'G/PART N°	Q'T'Y	DESCRIPTION	
5	07212	2	TERMINAL BLOCK (2 WAY)	TB5,6
4	07108	2	TERMINAL BLOCK (3 WAY)	TB2,4
3	07109	1	TERMINAL BLOCK (4 WAY)	TB1,3
2	07118	1	'D' CONNECTOR	SK1
1	3015-041	1	PCB DETAIL	

ST6000 (Z123) Terminal PCB Assembly   ISS A1

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Type CR Interface Box (Z085)

1. Service Procedures
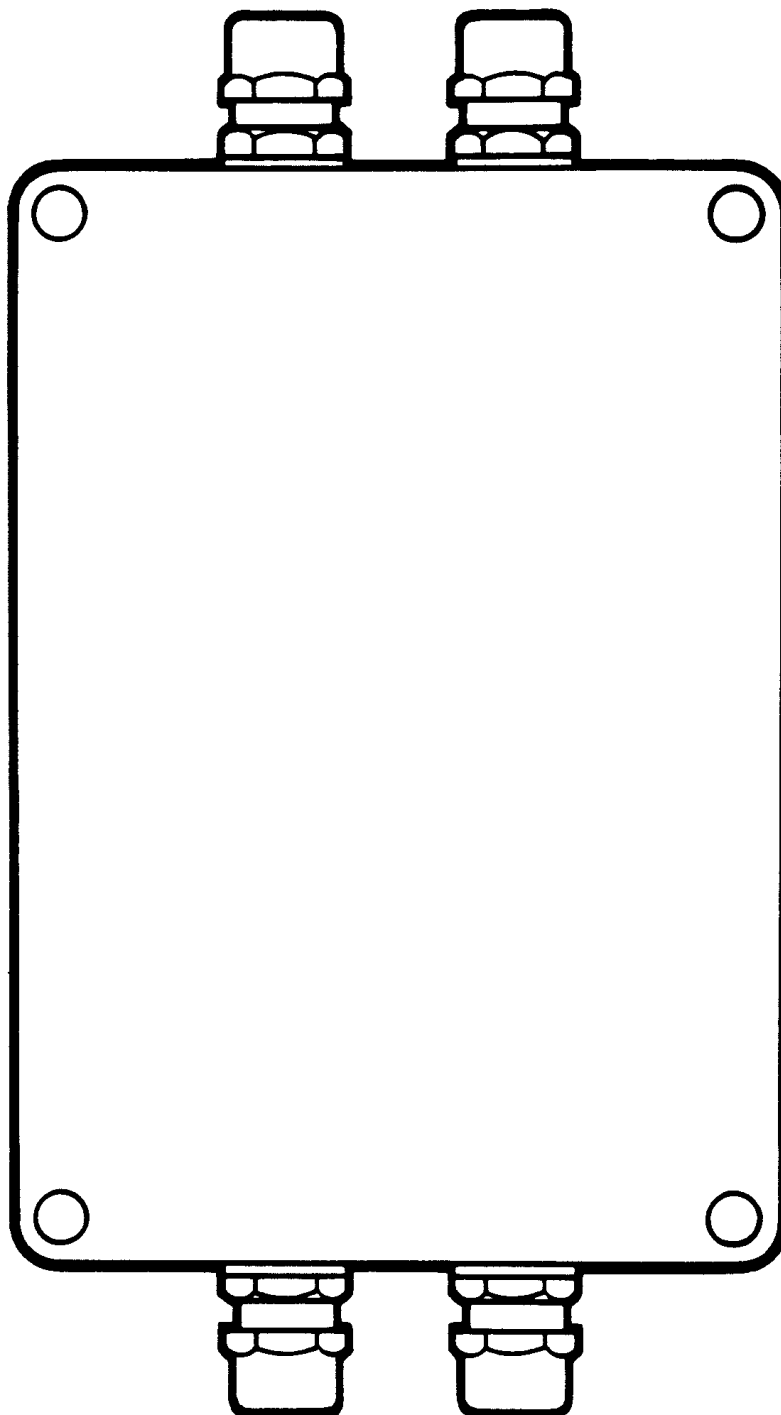
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Contents

Service Procedures Type CR Interface Box (Z085)

Course Computer
Power Supply

12V — 20 Amp
24V — 10 Amp

Main Breaker

Supply

5 Amp

3L (12V) 50A
4.5L (12V) 70A
3L (24V) 30A
4.5L (24V) 40A

Clutch
Drive

ST7000
Course Computer

To Bypass
Valve

Type CR
Interface Unit

Power Pack
Motor Supply

Solenoid 'A'
Cable
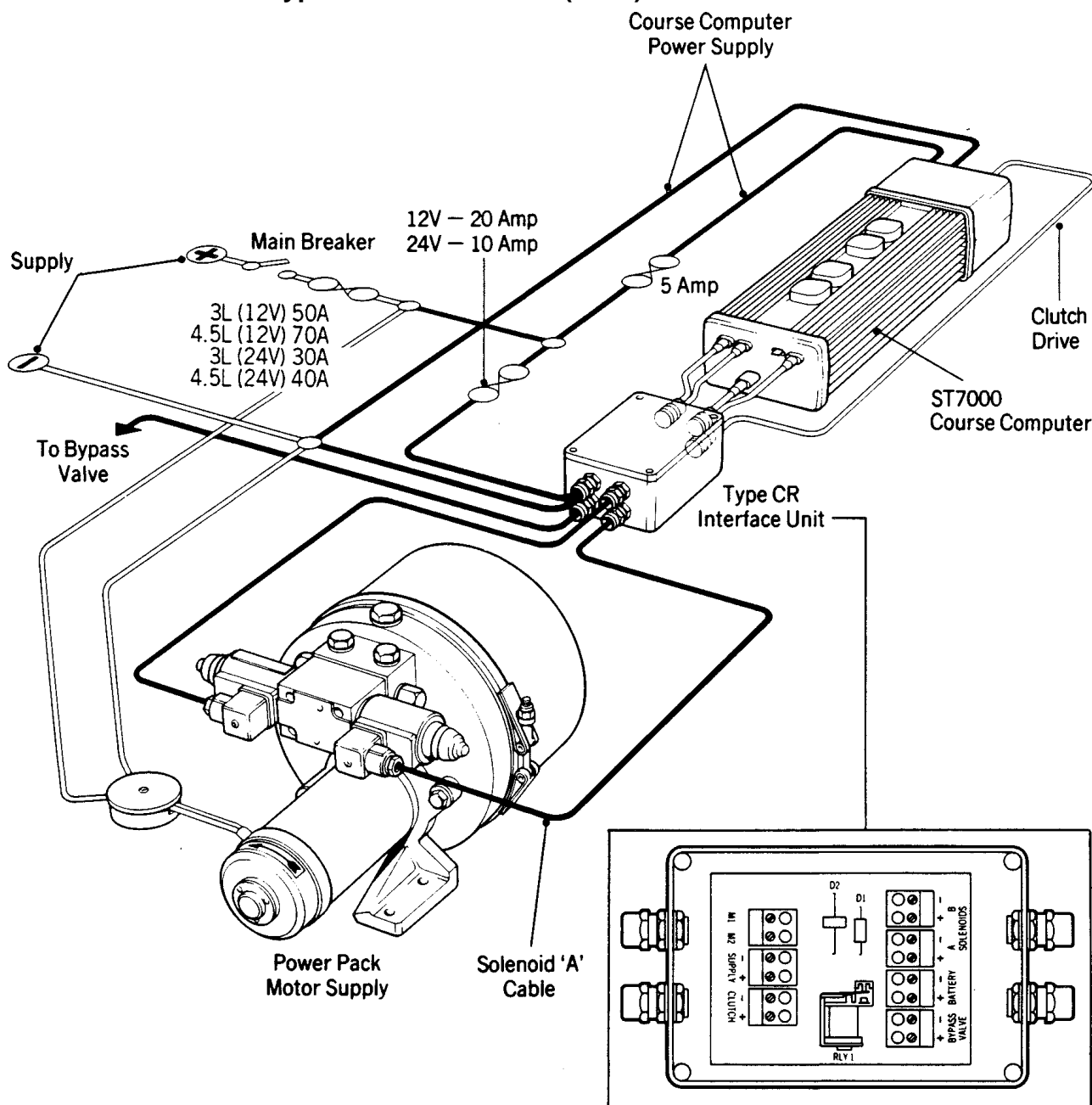
1. Description

All type CR systems are driven with a standard course computer and terminal board which interfaces to a type CR interface box (Z085). The same interface box is used for both 12V and 24V systems and can be functionally tested by using the following procedure.

2. Functional Test

Connect + 12V to clutch (+) and battery (+). Connect 0V to clutch (-) and battery (-). Confirm with a multimeter that 12V is present across the bypass connections. Remove the +12V from clutch (+) and confirm that 0V is present across the bypass connections.

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3. Operation with non Autohelm Power Packs

If the Type CR Interface Box is to be used to drive non-Autohelm power packs the following points should be noted:

1. Solenoid pull-in voltage <8V (16V for 24V systems).
2. Solenoid drop-out voltage >2V.
3. Solenoid nominal operating voltage should be the same as the pilot.

2. Technical Information

Contents

Illustrations

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1. Type CR Interface Box PCB Circuit Description

The course computer clutch signal activates RLY1 which in turn supplies current to a bypass valve, if fitted. D1 suppresses any inductive spikes produced when the valve is switched and D2 protects against supply misconnection.

Each solenoid drive is derived by connecting one side of the solenoid to a motor terminal and the other side to 0V.
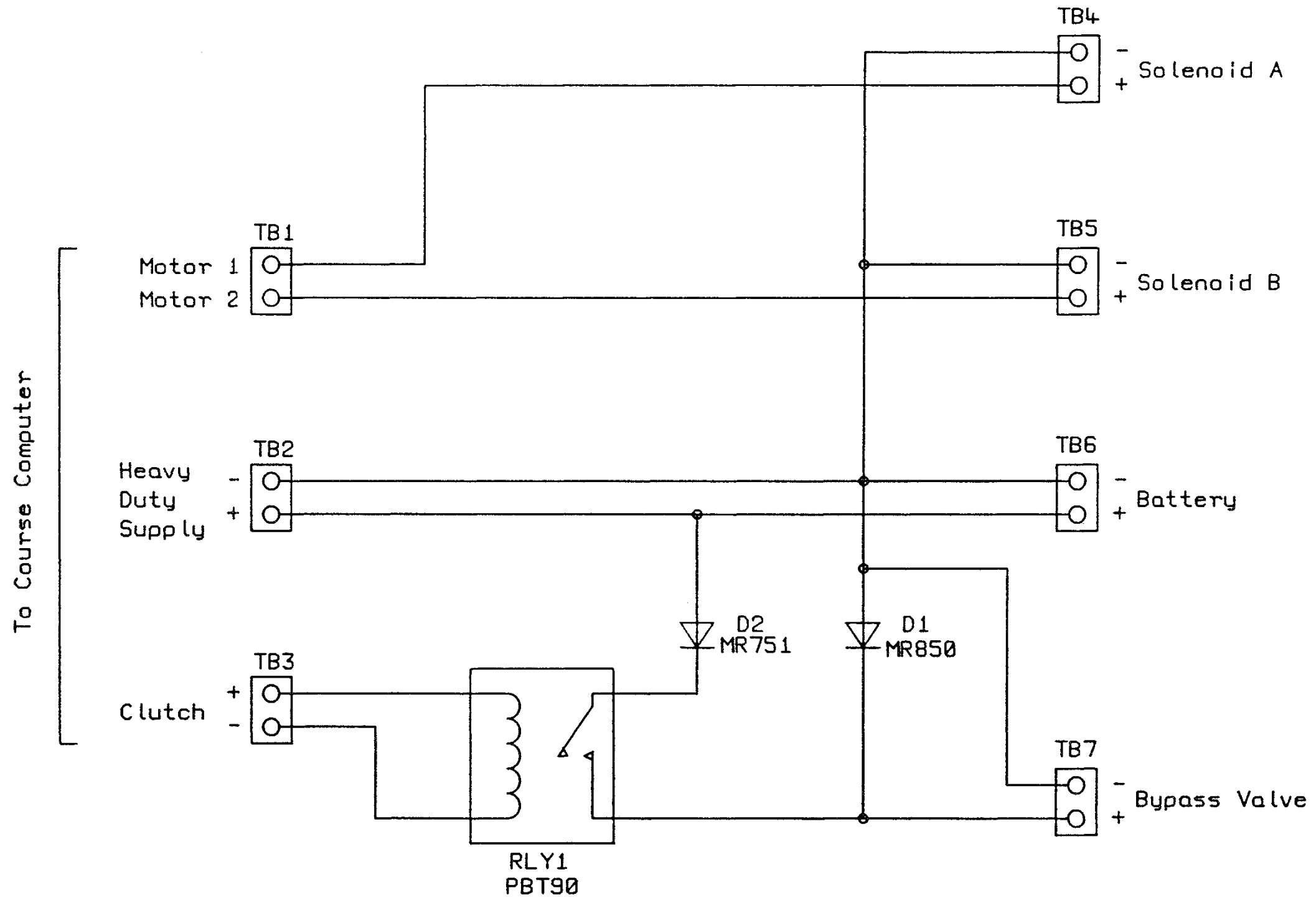
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Fig. 2.
SeaTalk Service Manual

Z085 Type CR Interface Box PCB Assembly

ISS B
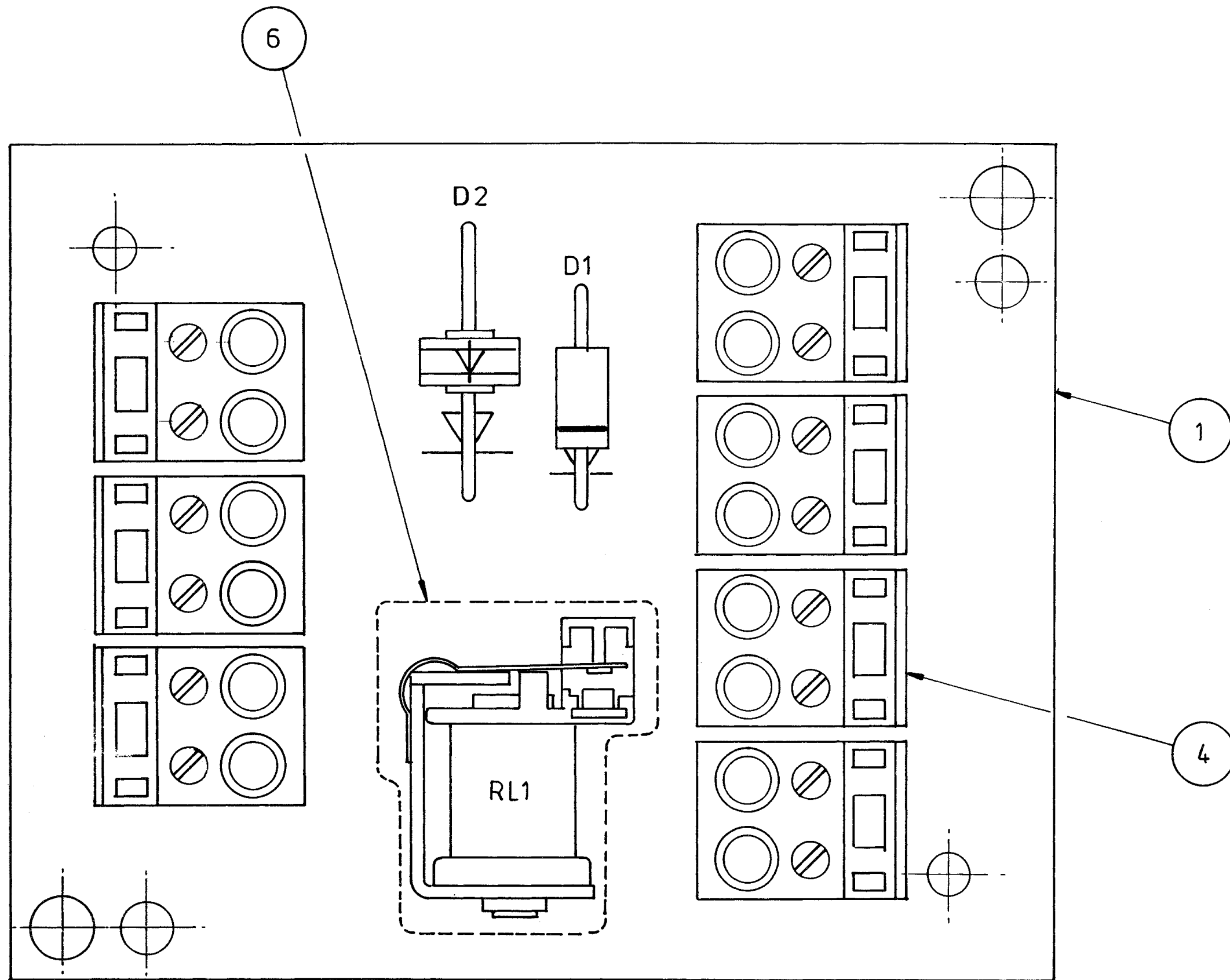
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7000 Type CR Parts List

Item	DR'G/Part No
PCB detail	3015-038
Diode MR751 D1	02031
Diode (Fast Recovery) MR850 D1	02036
PCB Connector	07-212
Relay T9030A RL1	15057
Dust Cover	15111

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Rudder Reference Transducer (Z131)

Service Procedures

Autohelm

Contents

Illustration

1. Description

The Z131 Rudder Reference contains a single turn 5k ohm plastic potentiometer to provide the autopilot with rudder position information. When replacing, correct installation is vital if optimum steering performance is to be achieved. The Rudder Reference unit arm movement is limited to +/-60 degrees. Care must be taken to ensure that the arm is opposite the cable entry when the rudder is amidships. Failure to do this could result in damage to the Rudder Reference if the arm is driven into its end stops by the steering system. Once detected as faulty the Rudder Reference unit should be replaced as a complete unit.

2. Functional Test

The Rudder Reference unit, when disconnected from the autopilot, can be functionally tested by checking the following resistance measurements:-

Cable colour	Arm position	Resistance
Green/Red	Any position	5k ohm +/-5%
Blue/Green	Anticlockwise stop	1.66k ohm +/-10%
Blue/Green	Clockwise stop	3.33k ohm +/-10%

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Z131 Rudder Reference Body Assembly

GROMMET

SCREW(x3)

BODY

'O' RING

SPACER

POTENTIOMETER SUB-ASSY.
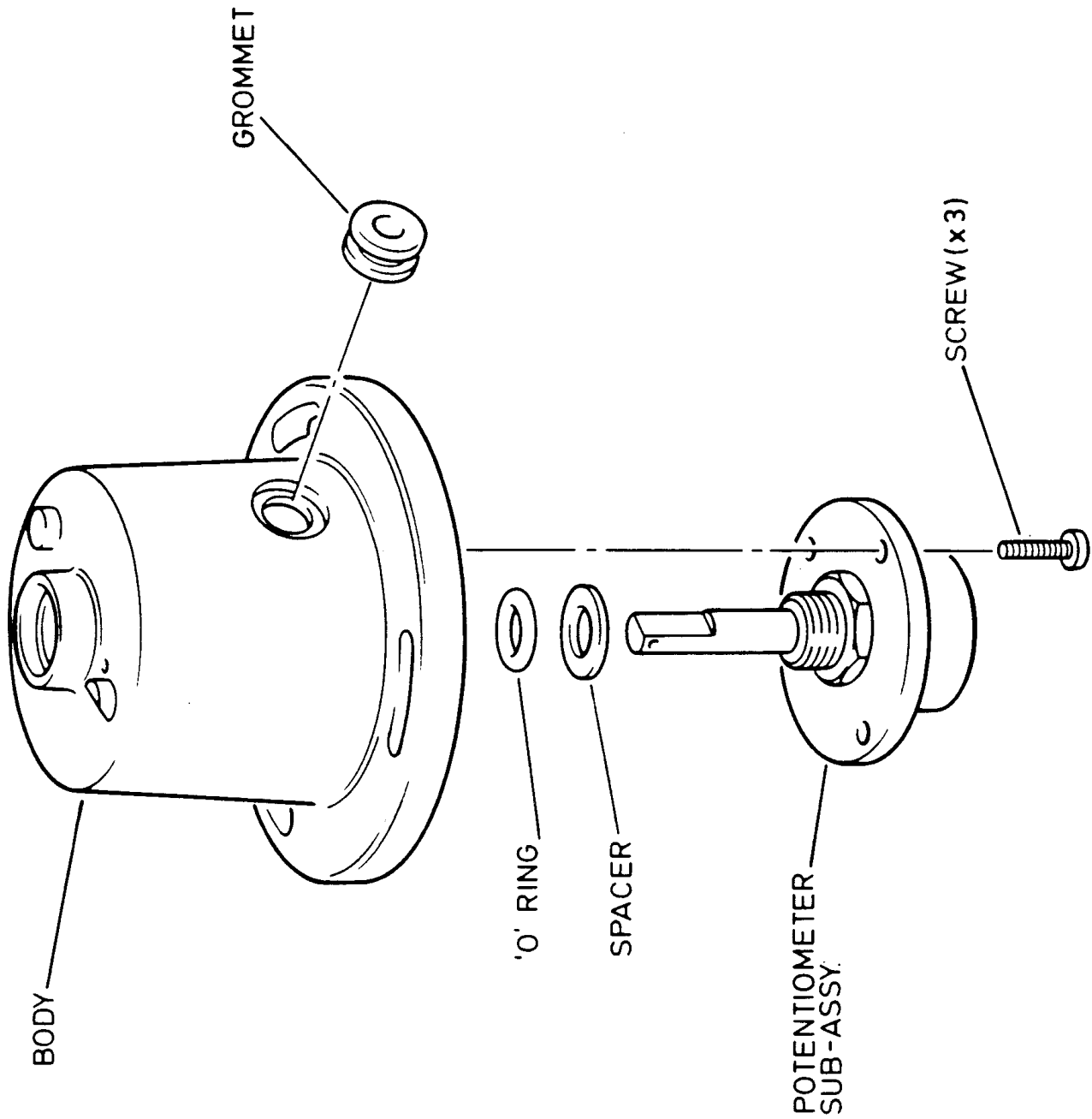
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Z131 Rudder Reference General Assembly

CAP SUB-ASSY.

TORSION SPRING

'O' RING

SPIROL PIN

BODY SUB-ASSY.

CABLE TIE

CABLE DETAIL

'O' RING

PLUG

SCREW (x3)

GREEN

RED

BLUE

BOURNE POTENTIOMETER

RED

GREEN

BLUE

COLVERN POTENTIOMETER
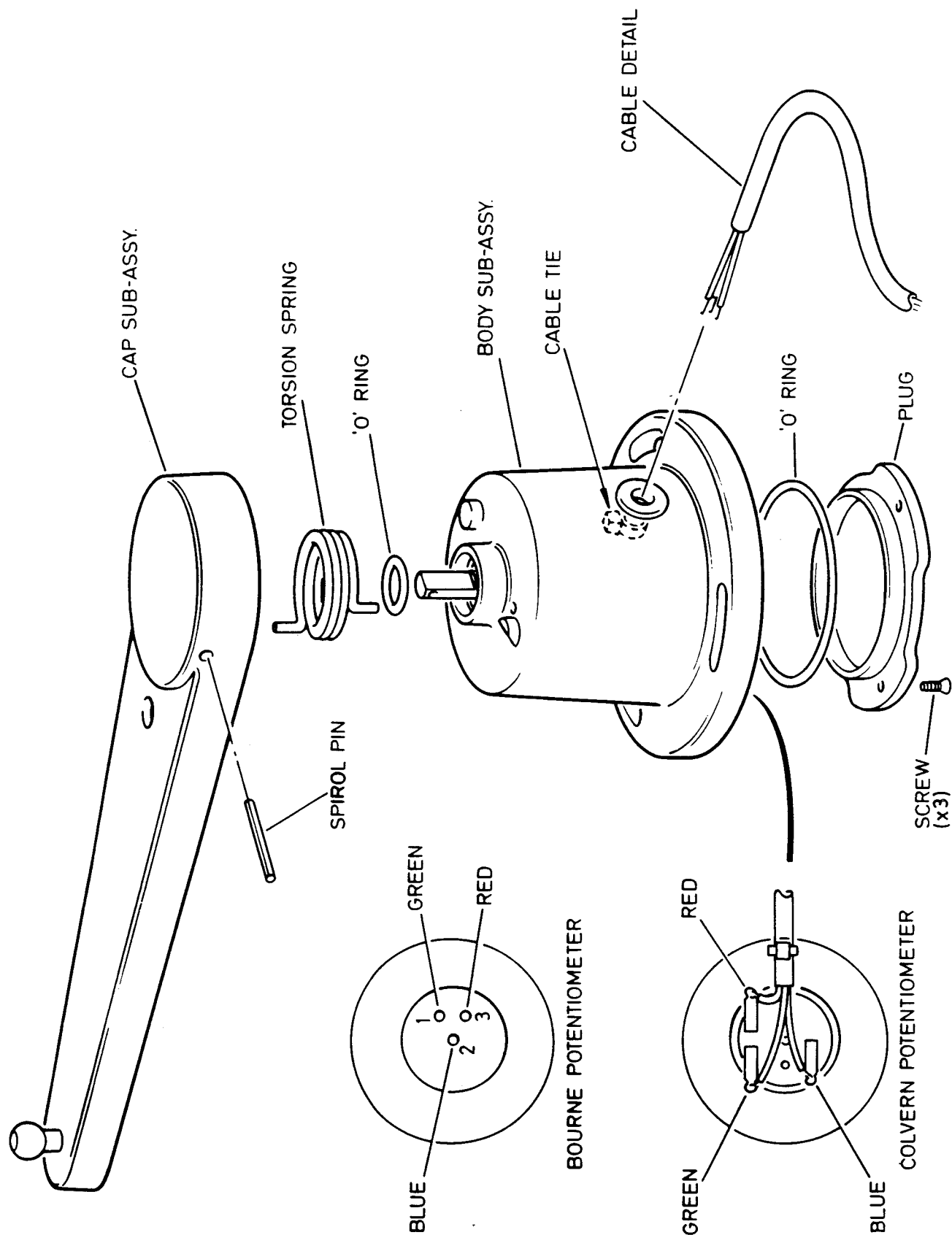
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Fluxgate Compass Transducer (Z130)

Service Procedures

Autohelm

Contents

Illustrations

Fluxgate Compass Transducer (Z130)

1. Description

The Z130 Fluxgate Compass Transducer contains a precision Fluxgate sensor. This can be replaced by following the procedures in Section 5.

Some early models (pre Serial No 600001 were susceptible to damage in transit (fluxgate sensor springing free from gimbal assembly). If received for service these units should be modified using the gimbal support bracket (see section 4).

2. Functional Test

Disconnect the Fluxgate from the autopilot and check continuity as follows:-

Cable Colour	Connector pin no	Resistance
Screen to Blue	2/4	< 10 ohms
Red to Green	3/5	< 5 ohms
Red to Yellow	3/6	< 5 ohms
Red to Screen	3/2	Open circuit

3. Magnetic Deviation

The Z130 Fluxgate Compass requires careful siting if optimum autopilot performance is to be achieved. The SeaTalk Course Computers are able to correct the compass for any deviating magnetic fields present when the linearisation procedure is carried out. Any further deviation, introduced after linearisation, will introduce an error between the Fluxgate and the ships compass. This can be removed by carrying out the linearisation procedure again. If the displayed deviation is greater than +/-15 degrees the Fluxgate should be re-sited.

Note:

The linearisation procedure should always be carried out if the fluxgate has been exchanged, removed or moved from its original mounting position.

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Z130 Fluxgate General Assembly

BLUE

SCREEN

GREEN

YELLOW

RED

CONNECTOR WIRING DETAIL

PIN 2 SCREEN
PIN 3 RED
PIN 4 BLUE
PIN 5 GREEN
PIN 6 YELLOW

BODY

CONNECTOR

SCREW (x2)

INNER GYMBAL SUB-ASSY.

PIVOT SUB-ASSY.(x2)

CABLE TIE

GROMMET

CABLE SUB-ASSY.

4. Gimbal Support Bracket installation (Spares Kit M096)

This kit comprises of a back case, cable assembly, pivot blocks, support bracket and pivot retaining screws.

1. Remove the four case screws and take off the front cover and seal.
2. Carefully remove the flexible circuit from the connector in the rear moulding.
3. Remove and discard the pivot block mounting screws and lift away fhe fluxgate assembly.
4. Build the Fluxgate assembly into the new back case as shown in fig. 1. Use the new screws supplied to retain the pivot mounting blocks and support bracket. Use only hand screw drivers for re-assembly to ensure screws are not over tightened. Rotate screws anticlockwise to locate in the thread before tightening.
5. Carefully insert the flexible circuit tail into the connector in the rear moulding. Ensure the tail is not twisted and passes over the support bracket (see fig. 1.)
6. Before installing the cover check the gimbal action of the new assembly by tilting the case in all directions and observing the fluxgate movement.
7. Refit the front cover and seal (again rotating the screws anticlockwise to locate and tightening with a hand screw driver).
8. Functionally check the Fluxgate with a D.V.M. as follows:

Cable Colour	Connector Pin no.	Resistance
Screen to Blue	2/4	<10ohms
Red to Green	3/5	< 5 ohms
Red to yellow	3/6	< 5 ohms
Red to Screen	3/2	Open circuit

5. Fluxgate Sensor replacement (Spares kit M022)

1. Remove the four case screws and take off the front cover and seal.
2. Carefully remove the flexible circuit from the connector in the rear moulding.
3. Remove the pivot block mounting screws and lift away the fluxgate assembly.
4. Build the Fluxgate assembly into the back case as shown in fig. 1. Use only hand screw drivers for re-assembly to ensure screws are not over tightened. Rotate screws anticlockwise to locate in the thread before tightening.
5. Carefully insert the flexible circuit rail into the connector in the rear moulding. Ensure the tail is not twisted and passes over the support bracket (see fig. 1.)

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6. Before installing the cover check the gymballing action of the new assembly by tilting the case in all directions and observing the fluxgate movement.

7. Refit the front cover and seal (again rotating the screws anticlockwise to locate and tightening with a hand screw driver).

8. Functionally check the Fluxgate with a D.V.M. as follows:

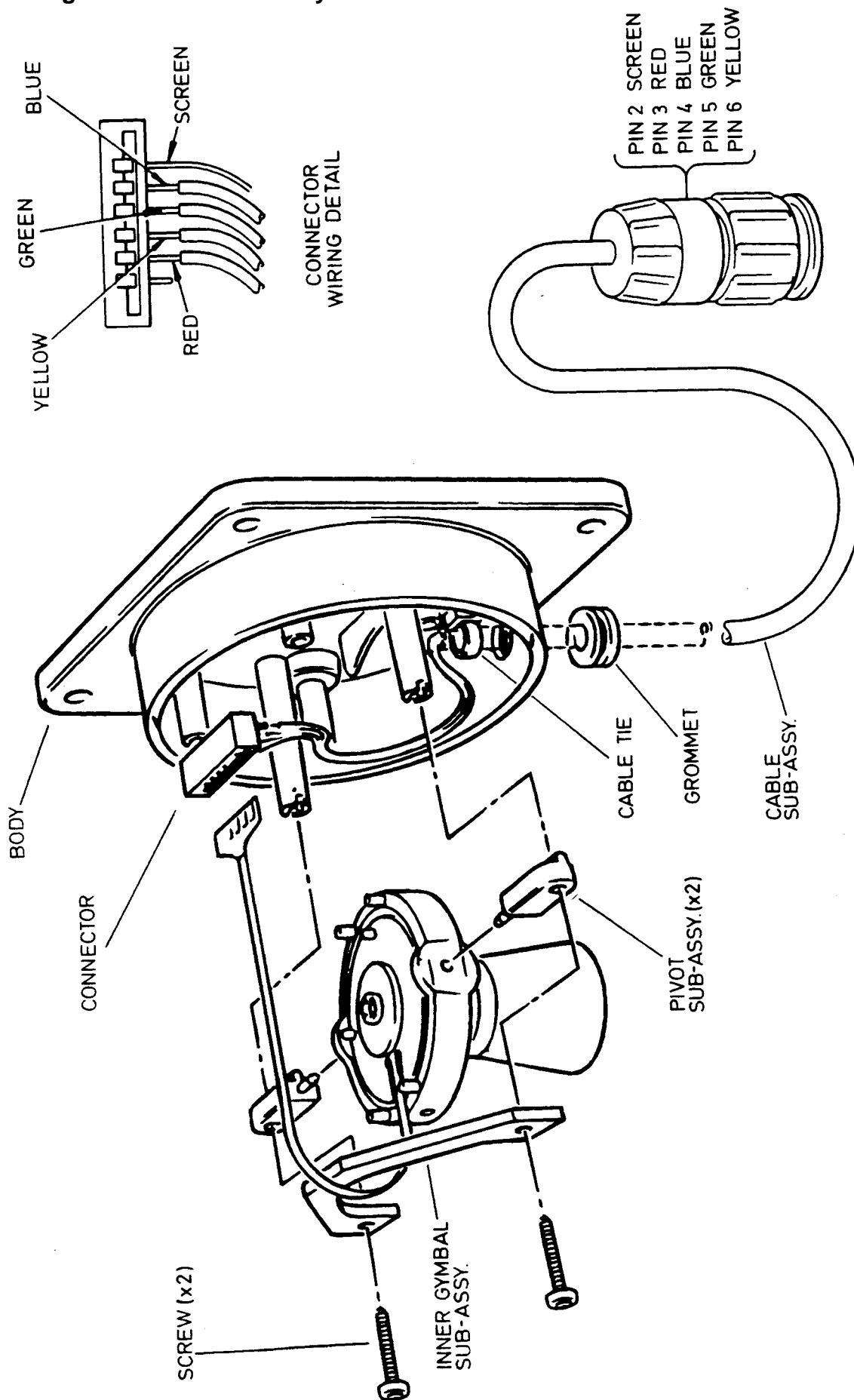| Cable Colour	Connector Pin no	Resistance
Screen to Blue	2/4	<10ohms
Red to Green	3/5	< 5 ohms
Red to yellow	3/6	< 5 ohms
Red to Screen	3/2	Open circuit

6. Product history - Fluxgate Compass (Z130)

Change	Serial No	Comments
Production Start	400001	
Gimbal Support bracket added	600001	Reduces risk of fluxgate assembly becoming dislodged during transit.

7. Spares Numbers - Fluxgate Compass (Z130)

Item	Catalogue No.	Comments
Fluxgate bobbin & Gimbal Assembly	M022	Includes inner gimbal sub-assembly and 2 x pivot assemblies.
Support bracket	M096	Includes back case cable assembly pivot blocks, support bracket and pivot retaining screws, (fitted as standard to units built after Serial No 600001.

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Fluxgate Compass (Z105)
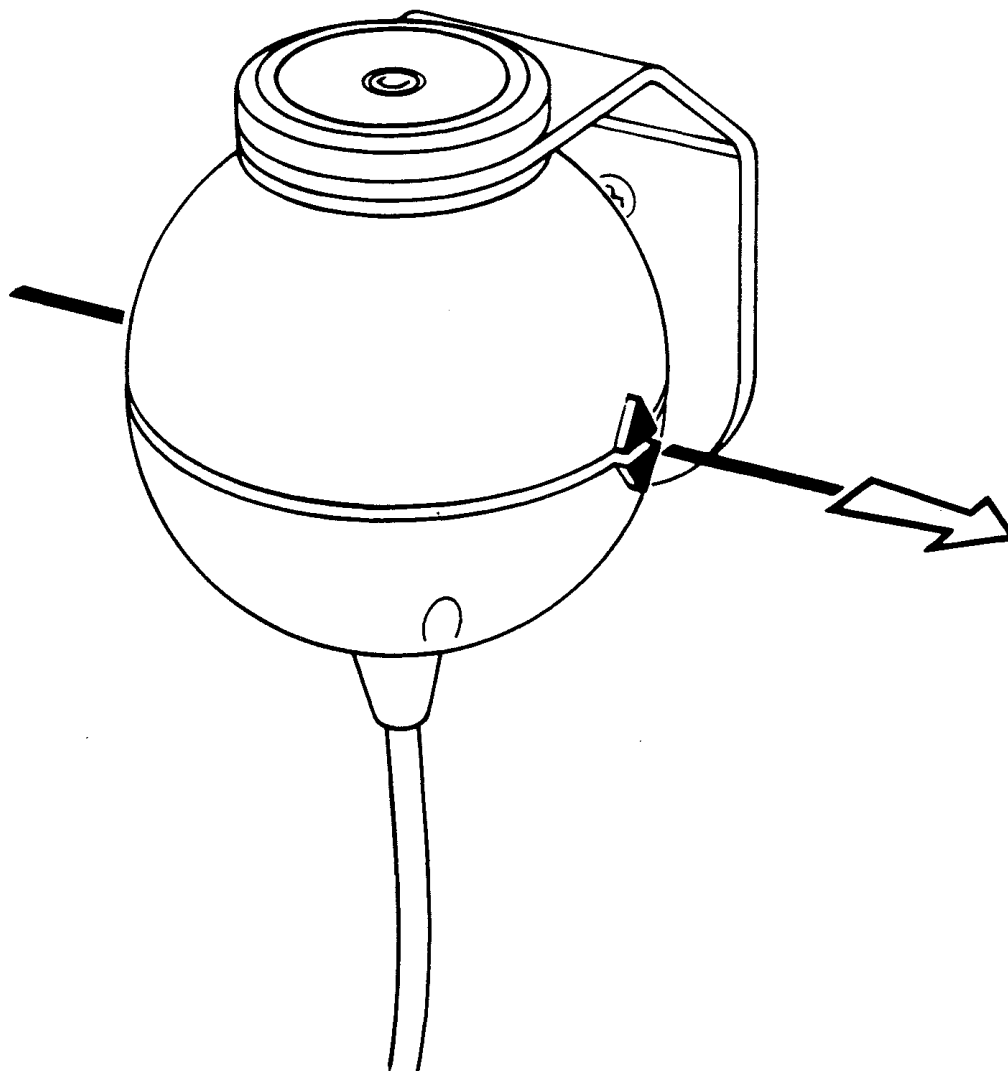
Autohelm

Contents

Fluxgate Compass (Z105)

1. Description
The Z105 Fluxgate Compass Transducer contains a precision Fluxgate sensor and, once detected as faulty, should be replaced as a complete unit.

2. Functional Test
Disconnect the Fluxgate from the autopilot and check continuity as follows:-

Cable Colour	Resistance
Screen to Blue	< 10 ohms
Red to Green	< 5 ohms
Red to Yellow	< 5 ohms
Red to Screen	Open Circuit

3. Magnetic Deviation
The Z105 Fluxgate Compass requires careful siting if optimum autopilot performance is to be achieved. The SeaTalk Course Computers are able to correct the compass for any deviating magnetic fields present when the linearisation procedure is carried out. Any further deviation, introduced after linearisation, will introduce an error between the Fluxgate and the ships compass. This can be removed by carrying out the linearisation procedure again. If the displayed deviation is greater than +/-15 degrees the Fluxgate should be re-sited. Note:

The linearisation procedure should always be carried out if the fluxgate has been exchanged, removed or moved from its original mounting position.

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Rudder Reference Transducer (Z060)
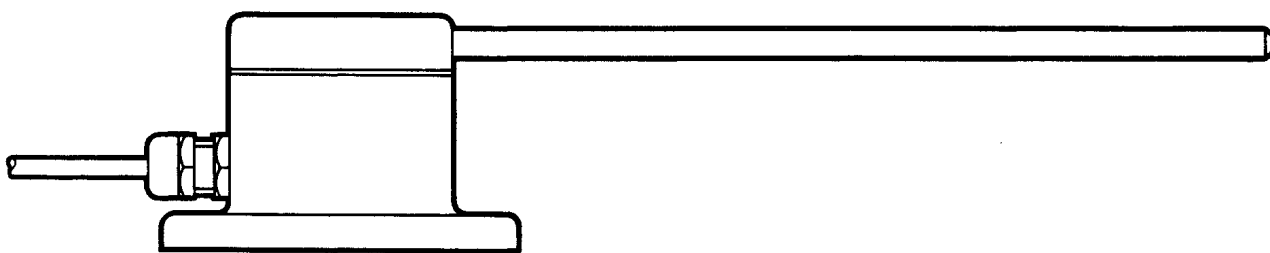
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Contents

Illustrations

1. Description and Functional Test

The rudder reference transducer contains a single turn plastic potentiometer to provide the course computer with rudder position information.

With the rudder reference transducer disconnected from the connector unit, its operation can be checked as follows:-

a) Connect an Ohmeter across the blue and red wires.

b) Position the rudder reference transducer arm diametrically opposite the cable gland and check the reading is between 2.2 and 2.8K ohm.

c) Slowly rotate the arm in both directions and check that the resistance increases and decreases smoothly according to arm movement.

A faulty rudder reference transducer is replaced as a complete unit.

2. Resetting Centre Position

It is important that the rudder reference transducer is correctly centred to ensure that the potentiometer output remains within the working range of the Analogue to Digital converter (1.0V to 4.0V). During assembly, the unit is set up to ensure that when the rudder reference transducer arm is diametrically opposite the cable gland, the wiper is at its mid position. The installation instructions then direct the installer to mount the transducer so that with the rudder amidships the arm is diametrically opposite the cable gland (see figure 31). Should it be necessary to install the transducer with its arm in an alternative position to the cable gland, the centre position of the potentiometer must be reset as follows (see figure 32).

1. When the rudder is amidships, determine the orientation of the rudder reference transducer arm to the cable gland.

2. Remove the plastic base plug from the underside of the transducer and connect an ohmeter across the red and blue wires.

3. Remove the plastic cap from the top of the unit to gain access to the locking nut of the taper collet.

4. Slacken the locking nut until the potentiometer shaft can be turned within the rudder reference transducer cap.

5. Position the arm as determined in 1. and rotate the potentiometer shaft with a screwdriver until the meter reads between 2.4 and 2.6k ohm.

6. While pressing the potentiometer and potentiometer mounting plate into the rudder reference transducer body, tighten the locking nut to clamp the potentiometer shaft to the cap.

7. Confirm the meter still reads between 2.4 and 2.6k ohm.

8. Check that the total vertical movement at the end of the transducer arm is less than 1.5mm. If it is greater, steps 4. to 8. must be repeated ensuring that the potentiometer and mounting plate are fully pressed into the transducer body.

9. Finally, replace the plastic plug into the base and the cap into the tap.

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Fig. 1. Rudder Reference Unit Standard Installation
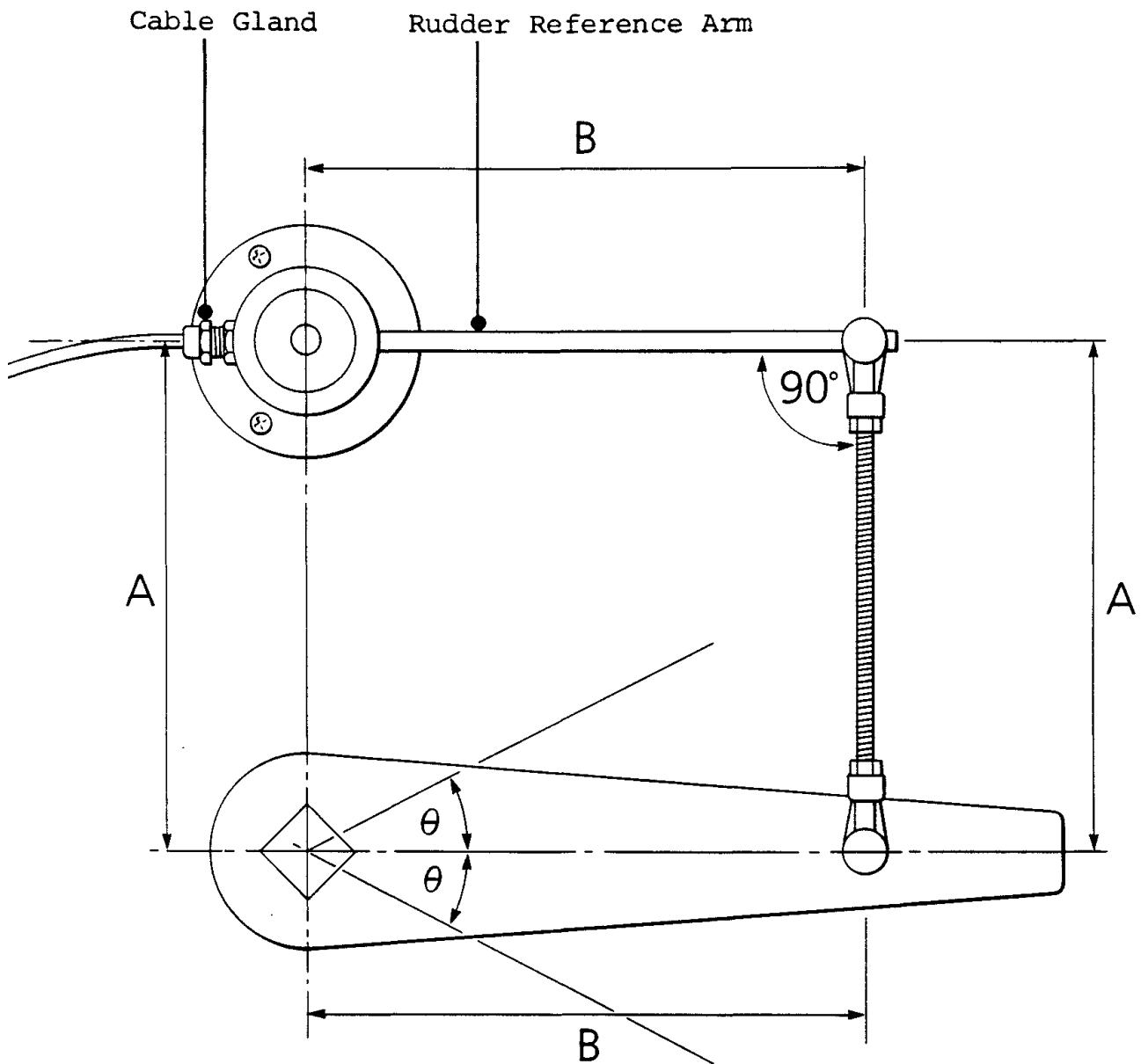
Fig. 2. Adjusting Centre Position

Locking Nut

Taper Collet

Potentiometer Shaft

Plastic Cap

Rudder Reference Tranducer Cap

Plastic Base Plug

to tighten locking nut
use tool SOO8
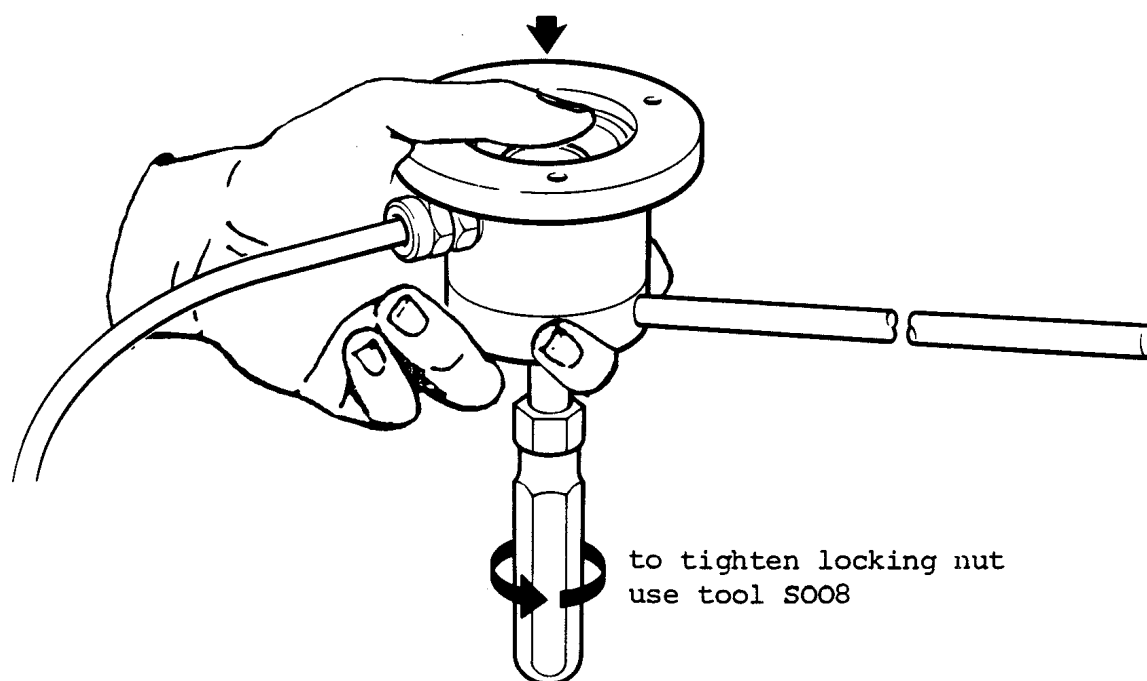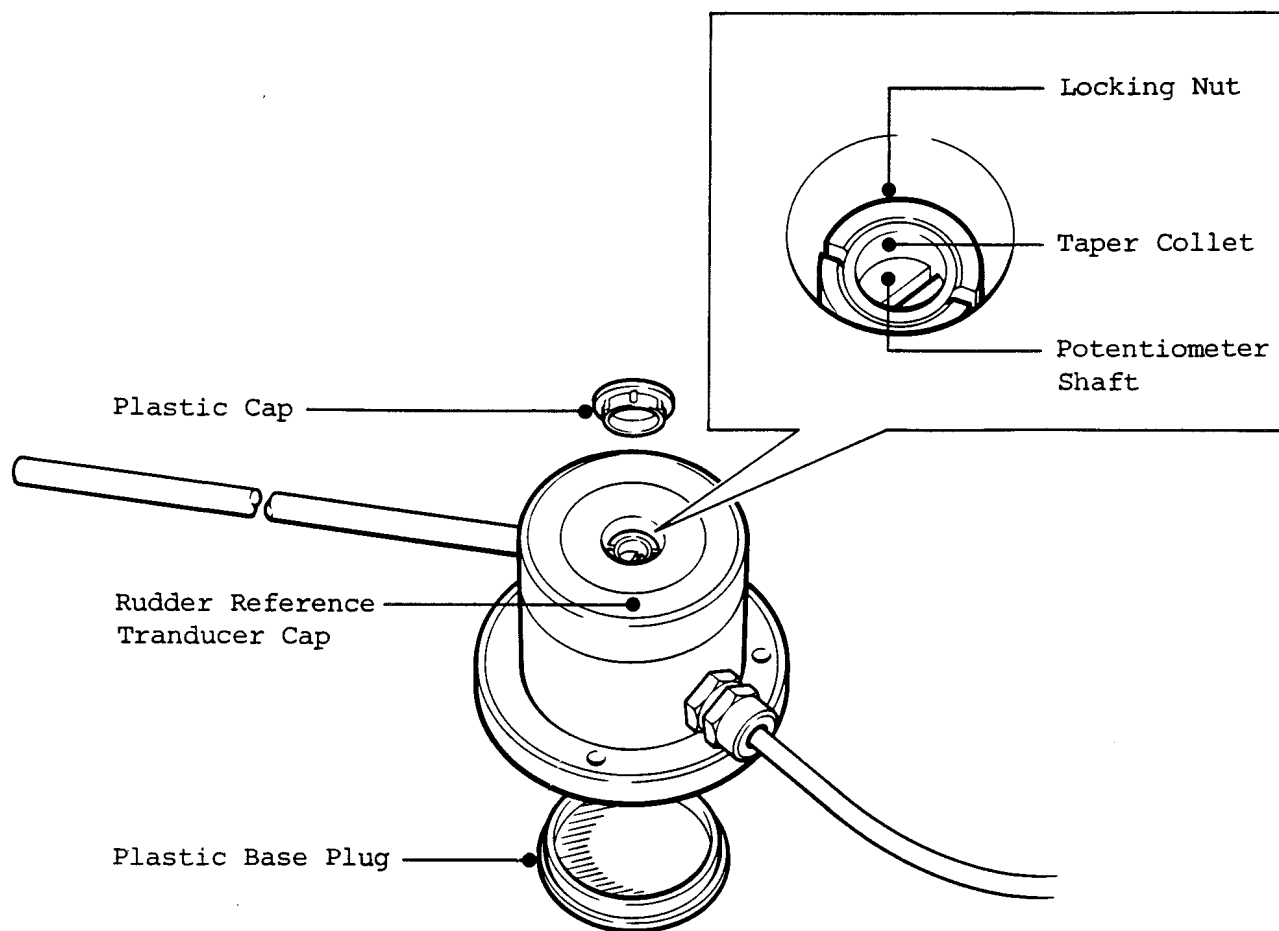
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3. Product History Rudder Reference (Z060)

Change	Serial Number
Slotted mounting holes introduced	980001
Stainless Steel fittings introduced	290001
Stainless Steel studding introduced	K90001

Pushpit Windvane Transducer (Z087)
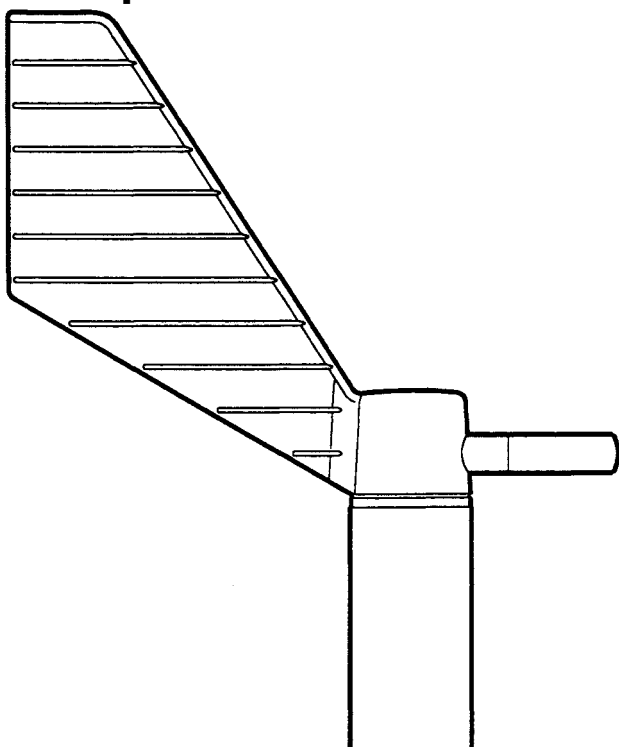
Masthead Windvane Transducer (Z080)

Service Procedures

Autohelm

Contents

1. Description

The Z080 and Z087 Windvane transducers are only compatible with Autohelm Seatalk products. The push pit transducer (2087) is identical to the Vane transducer in the Masthead Unit (Z080). When connecting a masthead Transducer (Z080) to an Autohelm ST7000 Autopilot do not connect the yellow core into the Aux 1 connector in the connector box. Simply connect the other four cores and trim the yellow back short.
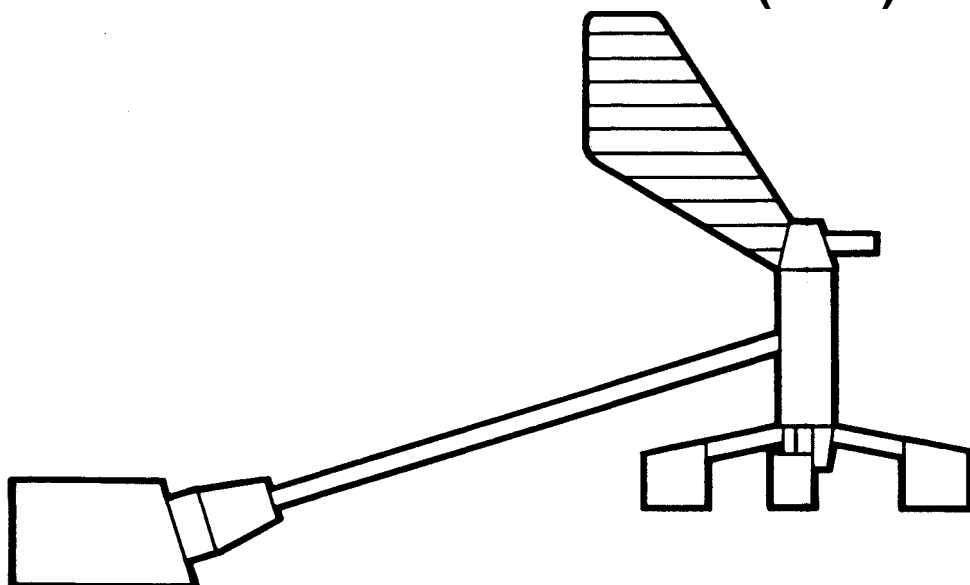
2. Functional Test (Z080 Masthead Transducer)

The operation of the Z080 masthead mounted windvane can be checked using the following procedure:-
1. Connect +8V dc to the red core and 0V to the screen.
2. Connect a digital volt meter across the screen and the green core.
3. Rotate vane head through 360 degrees and check that the meter reading oscillates sinusoidally. The maximum reading must be between 6V and 5.5V. The minimum reading must be between 2V and 2.5V.
4. Repeat section 3 with the meter connected across the blue core and screen.
The anemometer transducer can not easily be tested and a replacement pod should be fitted if suspected faulty.

3. Functional Test (Z087 Pushpit transducer)

The pushpit vane transducer can be functionally checked by following the Masthead test procedure.

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4. Product History (Z080 Masthead Transducer)

Change	Serial No.	Comments
Production Start	590001	
Drain hole added to anemometer boss	K90001	
Connector housing length increased	K90164	Allows mast arm assembly to be located tighter onto mast socket
Self cut grub screws replace brass inserts in vane and anemometer bosses	L90000	Tighter location of vane and cups onto respective transducer shafts

5. Spares Numbers (Z080 Masthead Transducer)

Item	Catalogue No.	Comments
Vane transducer pod	Q001	Used on both Z080 and Z087 transducers
Anemometer transducer pod	Q002	
Masthead transducer arm	Q025	Mast arm and pod housing without transducer pods
Masthead socket and cable	Q026	
Vane and Cups	D139	

Z080 Masthead Transducer General Assembly

VIEW 'A'

BLACK (0V)
GREEN (COS)
RED (+12V)
BLUE (SIN)

ANOMOMETER HEAD
GRUB SCREW(x2)
YELLOW (ANEM)
RED (+12V)
BLACK (0V)
VIEW 'B'

SLEEVE(x3)
BODY SUB-ASSY.

A
B

SLEEVE (x3)

TUBE
'O'RING
TUBE CONNECTOR
CONNECTOR HOUSING
GRUB SCREW
HEATSHRINK TUBE
CONNECTOR
SLEEVE(x2)

BALANCE WEIGHT

VANE HEAD

CONNECTION DETAILS

GREEN PIN 3
BLUE PIN 4
YELLOW PIN 5
RED + RED PIN 2
BLACK + BLACK PIN 1
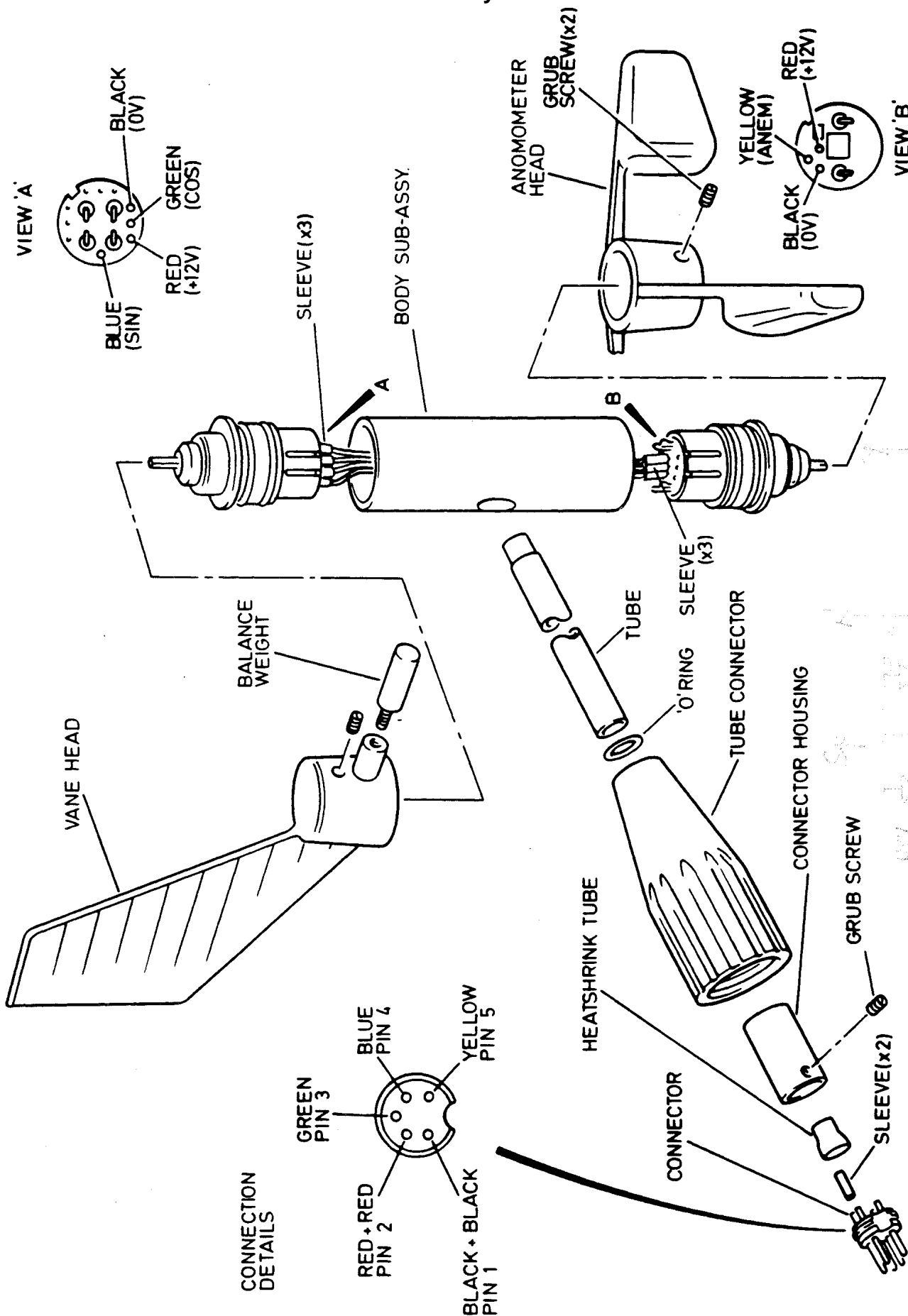
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Z050 Mount Assembly

CABLE

SLEEVE

BACKSHELL

SPOOL

CABLE GRIP

GROMMET

CONTACT (x5)

PLUG BODY

RED

SCREEN

YELLOW

GREEN

BLUE

MOUNT

SLEEVE(x5)

CONNECTOR

'O' RING

HEATSHRINK TUBE

SET SCREW

BLUE

GREEN

RED

YELLOW

SCREEN
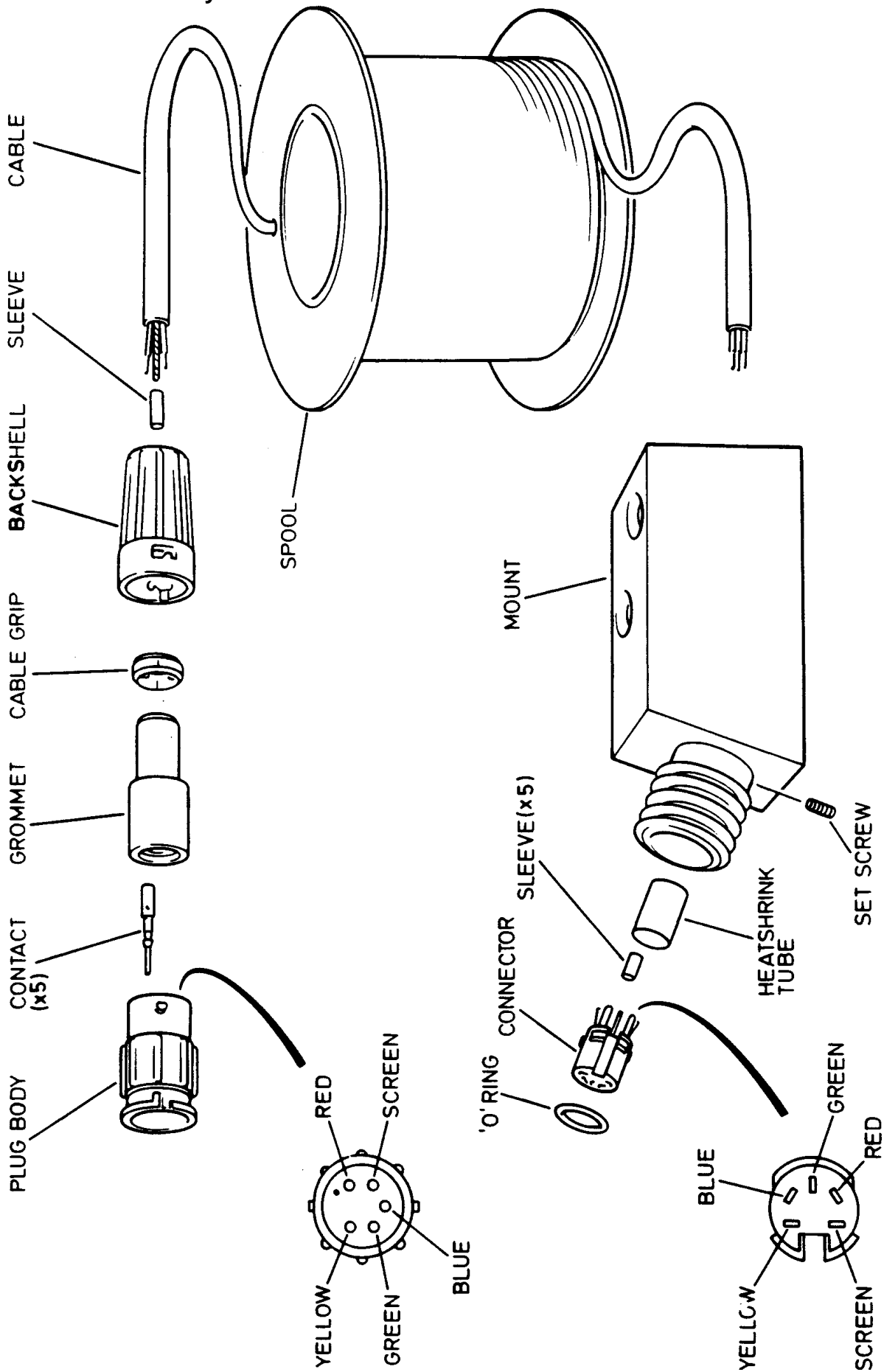
Linear Drive Units

Service Procedures
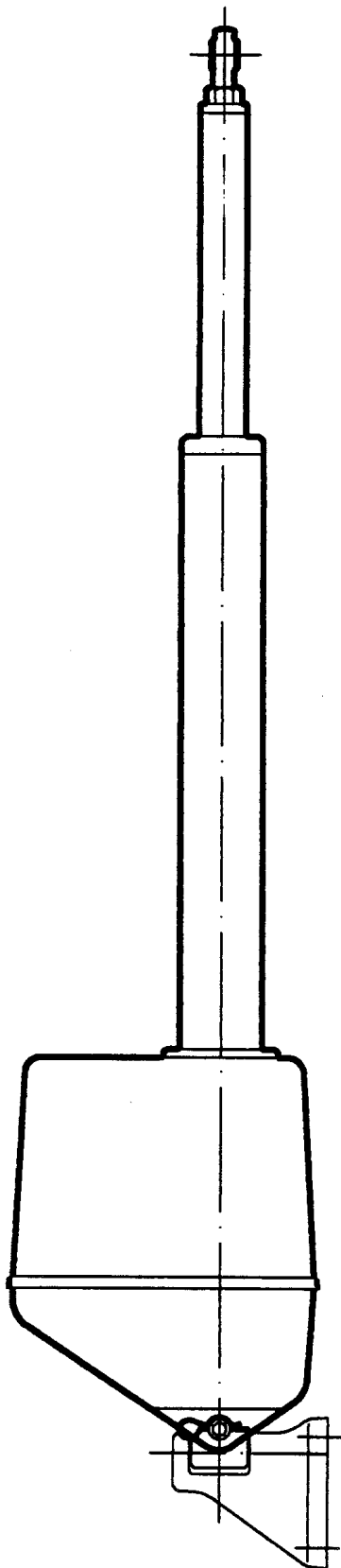
Linear Drive Unit (Z029, Z032)
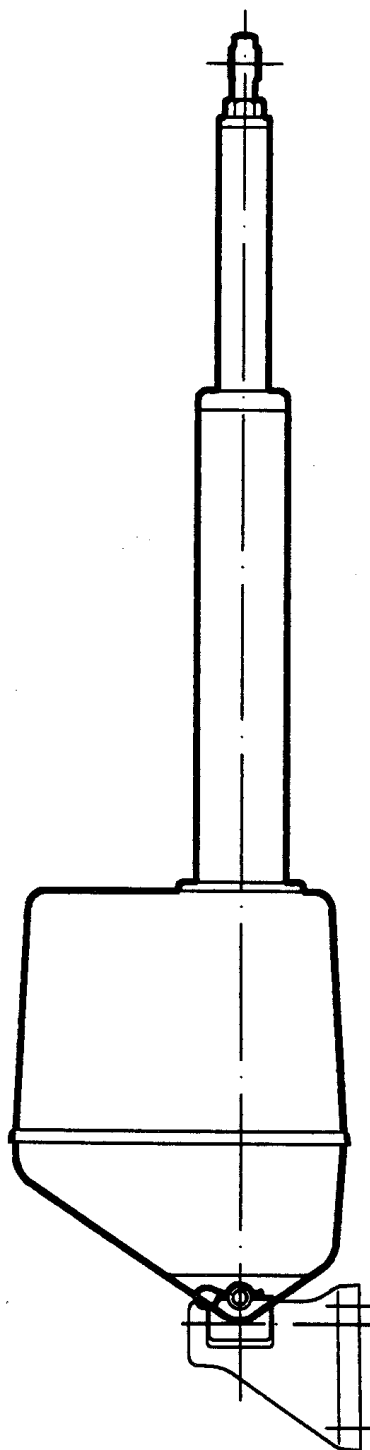
Linear Drive Unit (Z029, Z058, Z059)

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Contents

1. Linear Drive Unit

The linear drive unit comprises a belt drive reduction stage from the motor, a single epicyclic gearbox and a two start recirculating-ballscrew to provide linear motion. An electromagnetic clutch locks the outer ring of the epicyclic gearbox when drive is required. The drive is unique in providing efficient drive combined with very smooth backdrive at extremely low loads.

2. Inspection

Before stripping down or testing the drive unit, a close visual inspection should be made to establish if the cause of the problem is external.

Poor mechanical installation where the unit can foul obstructions, particularly at the end of stroke, can distort the drive module and lead to rough operation and high backdrive loads. The drive module is assembled at Nautech in a dirt free environment to precise limits. If disturbed, rough operation and high backdrive loads will result.

3. Dismantling

After removing the unit from the boat and to gain access to drive motor, drive belt, clutch rotor or drive module the following steps apply:

a) Unscrew and remove the two caphead screws which secure the plastic dust cover to the main unit (use 'M3' alien key). Slide the dust cover off the girdle tube.

b) Unscrew and remove the four M6 caphead screws with washers and the two long hexagonal studs at the centre-sides of the master plate. Separate the mounting cover assembly from the master plate assembly, after feeding the cables through the grommet.

c) If servicing the clutch rotor assembly, remove it from the mounting plate by unscrewing the central caphead screw which secures the assembly to the casting. Note that the assembly is sprung loaded and care should be taken when removing.

d) If replacing the drive belt, loosen the three M6 caphead screws with washers which secure the motor to the masterplate. With the tension taken off the belt it can be slipped off both pulleys.

e) If replacing the drive motor unscrew and remove the three M6 caphead screws as above and take the weight of the motor as it is released. Note that the power cables are extended and passed through grommets in the masterplate. Remove the drive belt.

f) If servicing the drive module, follow steps a) b) d) and e) above. Then remove the circlip at the front of the clutch plate/ring gear assembly and withdraw the assembly. Locate the leadscrew journal and carrier on a firm block to prevent bending the journal and drive out the roll pin securing the carrier to the leadscrew (general assembly).

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Slide off the carrier assembly and the four planet gears. Finally withdraw the driven pulley assembly from the drive module.

4. Re-assembly

In all cases rebuilding the unit is a straight reversal of the above procedures, but the following points should be noted:-

a) If replacing a drive motor, first ensure that the drive pulley is fitted in the correct orientation (general assembly). Ensure that the motor spindle is degreased and dried thoroughly before bonding the pulley to the shaft with Loctite 601 or equivalent anaerobic adhesive. After bonding, the unit should not be put under power for at least one hour.

b) If replacing the clutch rotor assembly, ensure the rotor can be pulled forward along the two dowels against the spring and when released returns hard against the mounting cover. If this is not done, the assembly will jam the drive train when the unit is rebuilt. Also after the unit is completely rebuilt check for a metallic click when the clutch voltage is applied and removed showing the clutch is operating correctly.

c) When rebuilding from the drive module stage, ensure that the driven pulley, planet gears, washers and carrier are all correctly located and turning freely before and after the roll pin securing the carrier to the leadscrew is refitted. Note that extreme care must be taken to fully support the leadscrew journal when driving the roll pin back into the carrier. This prevents the leadscrew journal from being bent. Check for free movements of the ram tube in and out before proceeding further. When refitting the clutch plate assembly ensure that it is engaged correctly with the planet gears before refitting the washer and circlip. Check again for free ram tube movement before refitting the mounting cover.

d) Ensure that all cables are correctly routed, secured and pulled through away from moving parts.

e) Check the correct length drive module, drive motor and product label have been used.

5. Operation with non Autohelm Autopilots (24v systems)

It should be noted that the 24V version of the Autohelm linear drive requires a 12V clutch signal. If used with other manufacturers autopilots, steps should be taken to limit the voltage supplied to the clutch.

6. Functional Test

Having reassembled the drive unit the following functional test (Fig.2) must be completed.

Linear Drive Unit - Functional Test Procedure (Z029, Z032, Z039, Z085, Z059)

```
        ┌───────────────────────┐
        │  Connect multimeter   │        NO      ┌──────────────────────────┐
        │  to clutch cable and  │───────────────▶│ Check connections to     │
        │  check impedance is   │                │ clutch winding. Check for│
        │  between 25Ω and 35Ω  │                │ damage to winding.       │
        └───────────────────────┘                └──────────────────────────┘
                    │ YES
                    ▼
        ┌───────────────────────┐
        │ Connect to AH 7000     │
        │ System Switch on.      │
        └───────────────────────┘
                    │
                    ▼
        ┌───────────────────────┐
        │ Press Auto then Standby│
        │ a few times            │
        └───────────────────────┘
                    │
                    ▼
        ┌───────────────────────┐
        │ Clutch operation       │        NO      ┌──────────────────────────┐
        │ audible on each press ?│───────────────▶│ Check clutch housing is  │
        └───────────────────────┘                │ free to move. Re-check   │
                    │ YES                         │ electrical connections.  │
                    ▼                             └──────────────────────────┘
        ┌───────────────────────┐
        │ No load current within │        NO      ┌──────────────────────────┐
        │ limits * ?             │───────────────▶│ Too low:- check supply   │
        └───────────────────────┘                │ voltage. Check correct   │
                    │ YES                         │ motor is fitted. Too     │
                    ▼                             │ high:- slacken motor     │
                  ┌─────┐                         │ bolts and tighten with   │
                  │  A  ▷                         │ the belt pinched.        │
                  └─────┘                         └──────────────────────────┘
```

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```
        ┌──────┐
        │  A   >
        └──┬───┘
           │ YES
           ▼
         ╱─────╲
        ╱ Drive ╲        NO      ┌─────────────────────┐
       ╱  cuts    ╲────────────▶ │ Clutch slipping :-  │
       ╲ out on end╱             │ strip down and clean│
        ╲ stops   ╱              │ with alcohol and    │
         ╲   ?   ╱               │ re-test.            │
          ╲────╱                 └─────────────────────┘
           │ YES
           ▼
         ╱──────────╲
        ╱  Backdrive  ╲     NO    ┌─────────────────────┐
       ╱ less than 7 lbs╲────────▶│ Replace mechanical  │
       ╲ when pulling    ╱        │ drive module        │
        ╲thrust tube out ╱        └─────────────────────┘
         ╲at normal      ╱
          ╲operating    ╱
           ╲ speed ?   ╱
            ╲────────╱
               │ YES
               ▼
        ┌─────────────────┐
        │  Drive unit  O.K.│
        └─────────────────┘
```

* No load current limits :-		Minimum (A)	Maximum (A)
Type 1	(Z039)	2.0	3.0
Type 2 12V	(Z029, Z058)	2.5	3.5
Type 2 24V	(Z032, Z059)	1.0	2.5

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Fig. 1. Linear Drive Unit (Z029, Z032, Z039, Z058, Z059) General Assembly

Dust Cover Securing Screw (x 2)

Grommet

Dust Cover

Linear Drive Module
N 004: Type 1, Type 2S
N 005: Type 2

Cover Pillars (x 2)

Mounting Cover Fixing Screw (x 4)

Drive Motor Sub-Assy. (includes drive pulley)
N 001: 12v Type 1
N 002: 12v Type 2
N 003: 24v Type 2

Washer (x 4)

Drive Pulley

Drive Belt
N 006

Washer (x 3)

Driven Sprocket Sub-Assy.

Motor Fixing Screw (x 3)

Spacer (x 4)

Planet Gear (x 4)

Carrier Sub-Assy.

Pin

Spacer

Ring Gear Sub-Assy.

Circlip

Centre Sleeve

Screw

Clutch Coil Sub-Assy.
N 007

Spring

Mounting Cover Sub-Assy.

Grommet

Motor Cables

Clutch Cable

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7. Product History Type 2 Linear Drive Actuators (Long Stroke) (Z029 & Z032)

Change	Serial Number	Comments
Introduction	470001	
Fracmo Motors introduced	780042	
Girdle Buffer/Stop material changed	790045	Extended high temperature use caused rubber buffer to swell giving higher back drive
Rockford Leadscrew introduced	100002	

8. Product History Type 1 Linear Drive Actuators (Z039)

Change	Serial Number	Comments
Introduction	470003	
Fracmo Motors introduced	680086	
Girdle Buffer/Stop material changed	790068	Extended high temperature use caused rubber buffer to swell giving higher back drive
Rockford Leadscrew introduced	100002	

9. Product History Type 2 Linear Drive Actuators (Short Stroke) (Z058 & Z059)

Change	Serial No.	Comments
Introduction	470001	
Fracmo Motors introduced	780042	
Girdle Buffer/Stop material changed	790045	
Rockford Leadscrew introduced	100002	Extended high temperature use caused rubber to swell giving higher backdrive.

10. Spares Numbers - Linear Drive Unites (Z029, Z032, Z039 Z058 & Z059)

Item	Catalogue No.
Drive Motor (Z039)	N001
Drive Motor (Z058 & Z029)	N002
Drive Motor (Z032 & Z059)	N003
Short Stroke drive module	N004
Long Stroke drive module	N005
Drive Belt	N006
Clutch/Rotor	N007

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Rotary Drive Units (Z028, Z031 & Z037)
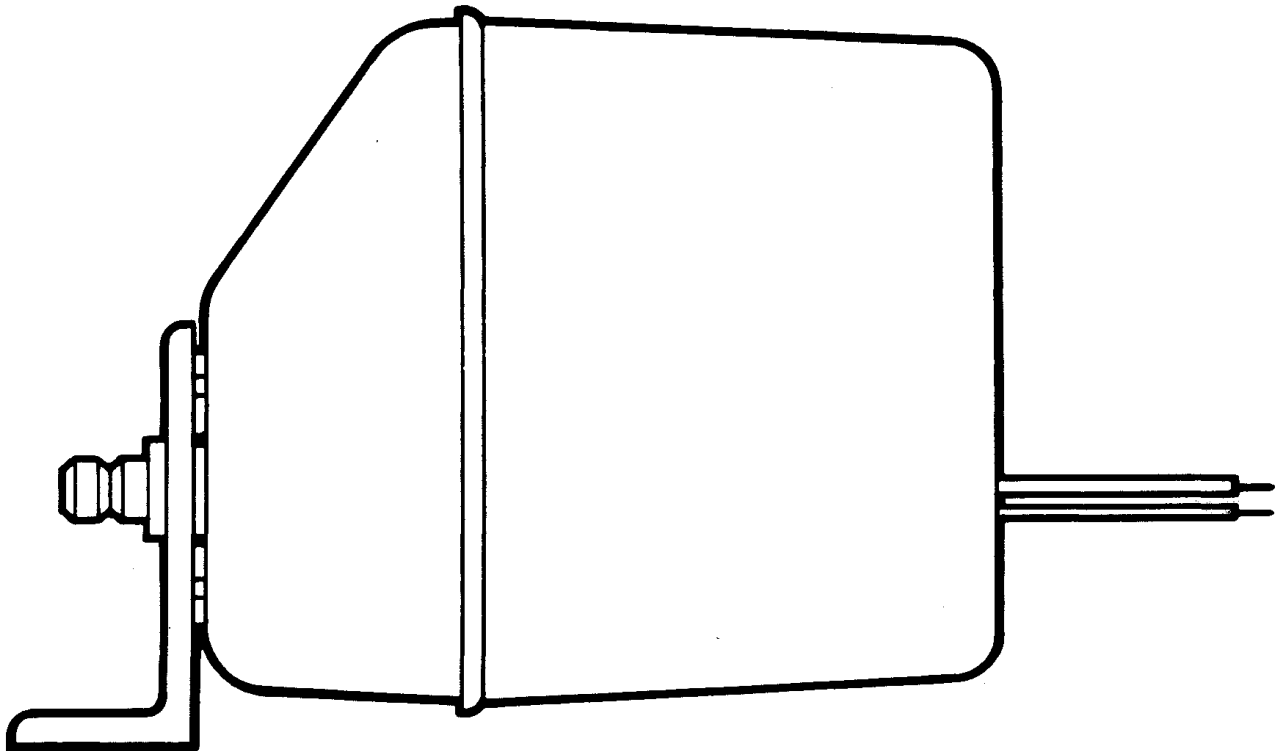
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Illustrations

1. Rotary Drive Unit

The rotary drive unit comprises a belt drive reduction stage from the motor, and a two stage epicyclic gearbox. An electro-magnetic clutch locks the outer ring of the first stage gearbox when drive is required. This arrangement provides very quiet operation with low backdrive torques.

2. Dismantling

After removing the unit from the boat and to gain access for drive motor, drive belt or clutch replacement, the following steps apply:-

a) Unscrew and remove two caphead screws using M3 alien key. These screws secure the plastic cover to the main unit. Ease the power supply and clutch cables through the grommet whilst removing the plastic cover and finally remove the cover altogether.

b) If servicing the clutch assembly remove the dust cover as above then unscrew and remove the two caphead screws which secure the clutch rotor and plate assembly to the two pillars holding it off the main assembly (use a M3 alien key).

c) The clutch rotor is fixed to its plate by one caphead screw through the centre which is spring loaded. Therefore, care should be taken to hold the clutch rotor as the screw is removed.

d) If servicing the drive motor assembly, remove the dust cover as above then unscrew and remove the 4 x 6mm caphead screws with washers and also the two long hexagonal studs at the centre sides of the main assembly. The mounting cover assembly can now be removed from the master plate. Care must be taken when removing the cover assembly to ensure the drive gear disengages without damage. This is best done with the mounting cover placed down on the bench and the drive motor facing uppermost so that the planet gears within the mounting cover will stay in place. If they become dislodged keep them safely ready for reassembly.

e) Support the motor, unscrew and remove the three M6 caphead screws and washers securing the motor to the master plate and slip the drive belt off the pulley.

f) If replacing the drive belt it will only be necessary to loosen the three screws that secure the motor to take the tension off the belt whilst it is slipped off both pulleys.

3. Reassembly

In all cases rebuilding the unit is a straight reversal of the above procedures, but the following points should be noted:-a) When refitting a drive motor ensure that the drive pulley is fitted to the motor shaft in the correct orientation (general assembly). Note also that the motor shaft should be degreased with a suitable solvent and dried off thoroughly before bonding the pulley in place using Loctite 601 or equivalent anaerobic adhesive. Following bonding the unit should not be placed under full power for at least one hour.

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b) When rebuilding the clutch rotor and plate assembly ensure the rotor can be pulled forward along the two dowels against the spring and when released it returns hard against the mounting plate. If this is not done, the assembly will jam the drive train when the unit is rebuilt. Also, check it pulls in and releases when a voltage is applied and removed.

c) When refitting the mounting cover to master plate assembly, firstly ensure that all four planet gears are correctly fitted and freely rotate when the drive shaft is rotated. Secondly, when lowering the master plate onto the mounting cover it will help to locate the gear train if the drive shaft is rotated slightly to engage the geared shaft with the planet gears. Ensure the drive train rotates freely before refitting and tightening all the screws.

d) When refitting the dust cover ensure that all leads are either secured to the hexagonal pillars or pulled uptight through the grommet so that they are kept clear of any moving parts.

e) Ensure that the correct drive motor (and product label) is fitted by a simple voltage and current test checked against the serial number.

4. Operation with non Autohelm Autopilots (24v systems)

It should be noted that the 24V version of the Autohelm rotary drive requires a 12V clutch signal. If used with other manufacturers autopilots, steps should be taken to limit the voltage supplied to the clutch.

5. Functional Test

Having reassembled the drive unit, the following functional test (Fig.2) must be completed.

Without stalling the output shaft it is impossible to check for clutch slip and so care must be taken when handling the drive unit to ensure that no grease is allowed onto the clutch surfaces.

Rotary Drive Unit - Functional Test Procedure (Z028, Z031, Z038)

```
    ┌─────────────────────┐
    │  Connect            │        NO    ┌──────────────────────┐
    │  multimeter to      │ ───────────> │ Check connections to │
    │  clutch cable and   │              │ clutch winding. Check│
    │  check impedance is │              │ for damage to winding│
    │  between 25Ω and 35Ω│              └──────────────────────┘
    └─────────────────────┘
            │ YES
    ┌─────────────────────┐
    │ Connect to course   │
    │ computer. Switch on.│
    └─────────────────────┘
            │
    ┌─────────────────────┐
    │ Press Auto then     │
    │ Standby a few times.│
    └─────────────────────┘
            │
    ┌─────────────────────┐
    │ Clutch operation    │  NO   ┌──────────────────────┐
    │ audible on each     │ ────> │ Check clutch housing │
    │ press ?             │       │ is free to move.     │
    └─────────────────────┘       │ Re-check electrical  │
            │ YES                 │ connections.         │
                                  └──────────────────────┘
    ┌─────────────────────┐
    │ No load current     │  NO   ┌──────────────────────┐
    │ within limits * ?   │ ────> │ Too low:- check      │
    └─────────────────────┘       │ supply voltage. Check│
            │ YES                 │ correct motor is     │
    ┌─────────────────────┐       │ fitted. Too high:-   │
    │   Drive Unit O.K.   │       │ slacken motor bolts  │
    └─────────────────────┘       │ and tighten with the │
                                  │ belt pinched.        │
                                  └──────────────────────┘
```

*No load current limits:-		Minimum (A)	Maximum (A)
Type 1	(Z037)	2.0	3.0
Type 2 12V	(Z028)	2.5	3.5
Type 2 24V	(Z031)	1.0	2.5

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Securing Screw (x 2)

Clutch Cable

Dust Cover

Motor Cables

Screw (x 2)

Pillar (x 2)

Clutch Body/Plate Sub-Assy.

Cover Pillars (x 2)

Cable Tie (Secure Clutch Cable to Pillar)

Spring

Drive Motor Sub-Assy. (includes drive pulley)
N 001: 12v, Type 1
N 002: 12v, Type 2
N 003: 24v, Type 2

Centre Sleeve

Screw

Circlip

Spacer

Drive Pulley

Ring Gear Sub-Assy.

Spacer

Screw (x 4)

Pin

Carrier Sub-Assy.

Washer (x 4)

Planet Gear (x 4)

Spacer (x 4)

Washer (x 3)

Driven Sprocket Sub-Assy.

Spacer

Motor Fixing Screw (x 3)

Spacer

Master Plate/ Bearing Sub-Assy.

Belt N 006

Drive Shaft

Screw (x 4) (Locktite 222)

Ring Gear

Washer (x 4)

Planet Gear (long)

Output Shaft

Mounting Cover Sub-Assy.

Spacer

Circlip

Spacer (Black)

6. Spares numbers - Rotary Drive Units (Z028, Z031, Z037)

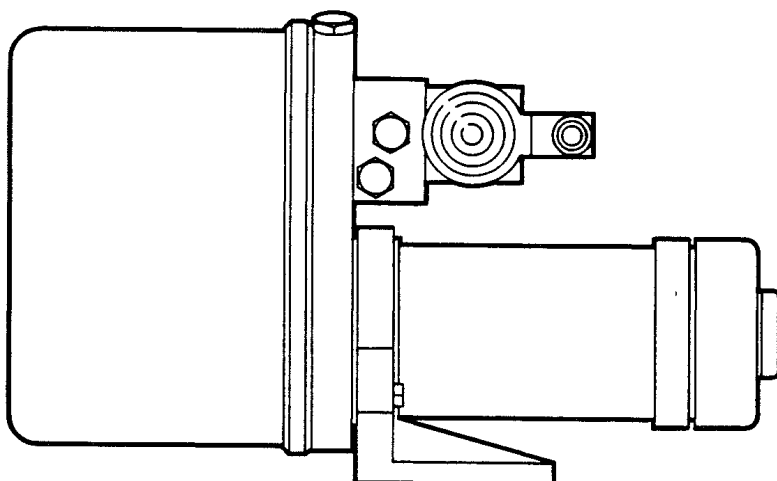| Item	Catalogue No.
Drive Motor (Z037)	N001
Drive Motor (Z028)	N002
Drive Motor (Z031)	N003
Drive Belt	N006
Clutch/Rotor	N007

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Hydraulic Drive Units Service Procedures
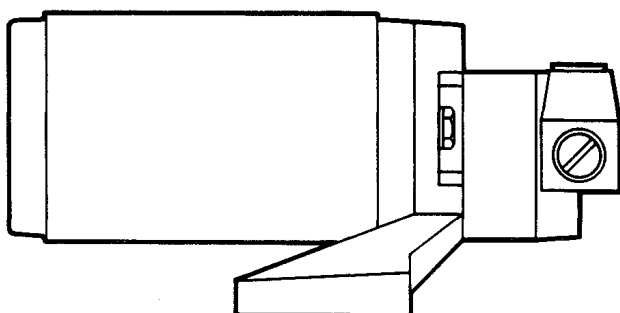
Type '0' Piston Pump (Z081)
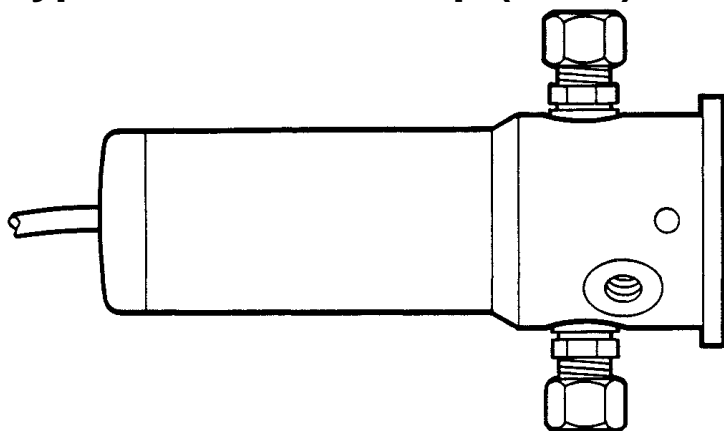
Constant Running Power Pack (Z064, Z065, Z066, Z067)

Reversing Gear Pump (Z030, Z033, Z041)

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Contents

1. Hydraulic Drive Units

Three types of hydraulic drive units are covered, the constant running power pack, the reversing gear pumps and the type '0' piston pump. The most common cause of problems is trapped dirt in the valve assemblies between the balls and their seats. This provides a short circuit path for the oil, which will greatly reduce the pressure generated to move the steering cylinder. It is important to observe absolute cleanliness at all times during dismantling and reassembly. If it is necessary to service the drive units when installed the following points should be observed:-
- Hydraulic pressurised systems must be depressurised before work is started.
- The drive unit should be isolated from the main steering system to minimise fluid loss.

2. Constant Running Power Pack (Z064, Z065, Z066, Z067)

The constant running hydraulic power pack provides a drive unit for larger vessels with steering cylinder displacements above 400cc. The power pack motor is switched independently of the autopilot and runs continuously. When rudder movement is required, the solenoid valves are energised by the course computer to direct the flow to the steering cylinder.

The servicing information allows replacement of the solenoid valve assembly, inspection and cleaning of the check valve and relief valve assembly and seal replacement. It is not possible to service the pump and filter assembly which are contained within the reservoir as the reservoir seal requires special assembly techniques.
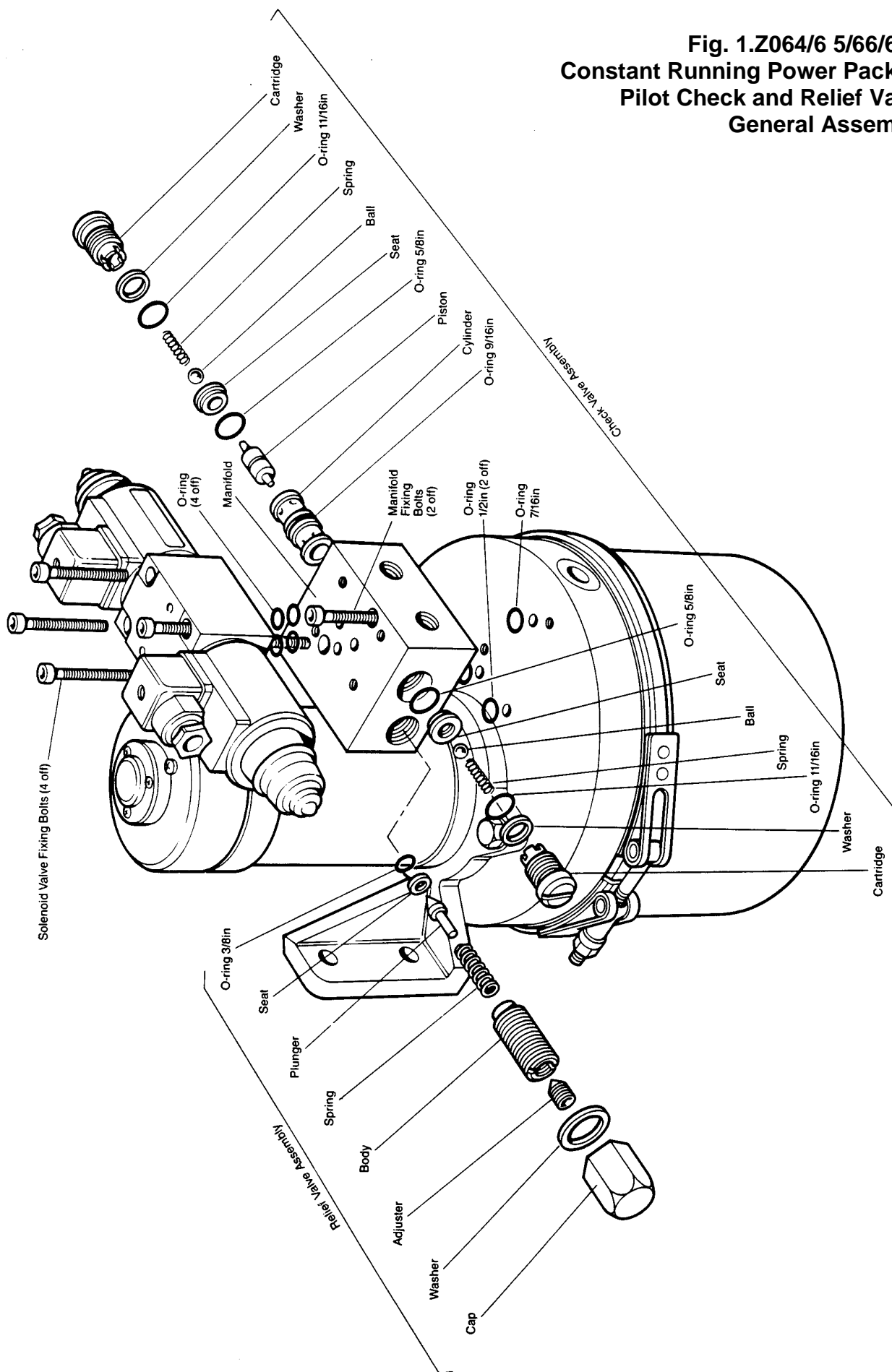
2.1 Dismantling and Reassembly

a) To remove the solenoid valve, undo the four caphead bolts securing it to the manifold. Remove the valve carefully to ensure the 0 ring seals are not lost. Reassembly is a simple reversal of this procedure.

b) To clean the check valve assembly, unscrew the cartridge and remove it along with the washer and 0 ring seal. The spring and ball can then be taken out. The seat and 0 ring will probably remain in position and oil from the reservoir is likely to wash out any dirt that could have been causing problems. If the check valve assembly is further dismantled, care must be taken when reassembling to prevent damage to the 0 rings. The best method is to place the 5/ Sin. 0 ring and seat in the manifold and screw in the cartridge (without the ball or spring) to position the seat within its sealing ring. The cartridge can then be removed and the ball and spring positioned within the cartridge. Some grease may be used to retain them whilst the cartridge with its 0 ring and washer is screwed into position.

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c) If the relief valve assembly is removed, the relief valve setting should be checked after reassembly. The factory pre-set is 750 psi.

d) Ensure all parts are reassembled in the current sequence and nothing is missed out during reassembly.

**Fig. 1.Z064/6 5/66/67 –
Constant Running Power Packs –
Pilot Check and Relief Valve
General Assembly**

Cartridge
Washer
O-ring 11/16in
Spring
Ball
Seat
O-ring 5/8in
Piston
Cylinder
O-ring 9/16in

Check Valve Assembly

O-ring (4 off)
Manifold
Manifold Fixing Bolts (2 off)
O-ring 1/2in (2 off)
O-ring 7/16in

O-ring 5/8in
Seat
Ball
Spring
O-ring 11/16in
Washer
Cartridge

Solenoid Valve Fixing Bolts (4 off)

O-ring 3/8in
Seat
Plunger
Spring
Body
Adjuster
Washer
Cap

Relief Valve Assembly

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3. Reversing Gear Pumps (Z030f Z033, Z041)

Reversing Gear Pumps are fitted with a single check valve assembly which allows operation with unbalanced rams.

To clean the valve assemblies, it is usually only necessary to remove the cap, spring and ball. The dirt will in most cases be washed out with oil from the reservoir.

If the seats and 0 ring seals are removed, these are best replaced by using the cap (without the spring) to position them. The cap may then be removed, and reassembled with the spring in position. Ensure all parts are reassembled in the correct sequence and nothing is missed out.

Fig. 2. Z041, Z030, Z033 - Reversing Gear Pump
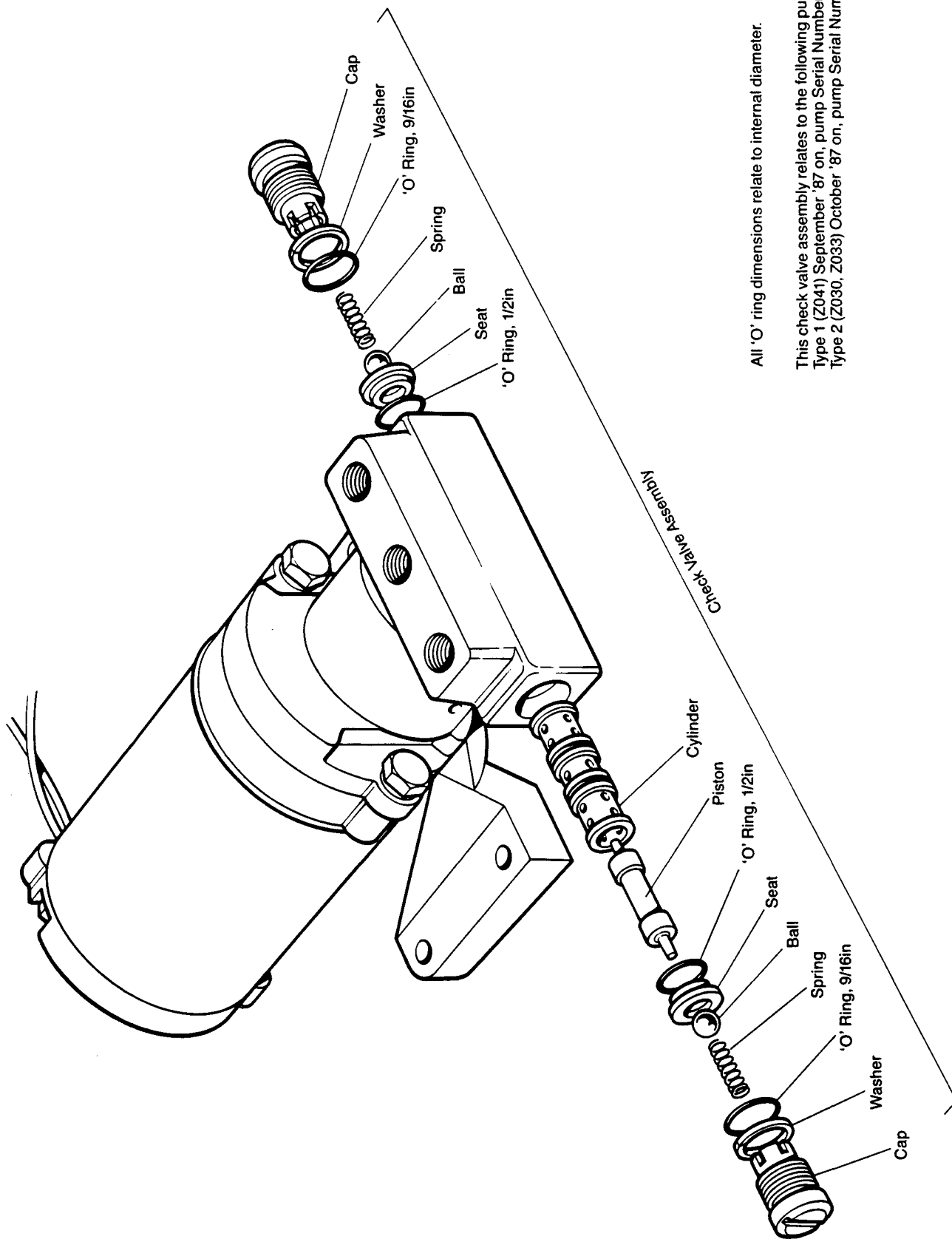
All 'O' ring dimensions relate to internal diameter.

This check valve assembly relates to the following pumps:-
Type 1 (Z041) September '87 on, pump Serial Number DF873197 on.
Type 2 (Z030, Z033) October '87 on, pump Serial Number EF871419 on.

Cap
Washer
'O' Ring, 9/16in
Spring
Ball
Seat
'O' Ring, 1/2in

Check Valve Assembly

Cylinder
Piston
'O' Ring, 1/2in
Seat
Ball
Spring
'O' Ring, 9/16in
Washer
Cap

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4. Type'0'Piston Pump (Z081)

A faulty type '0' pump should be replaced as a complete item. Care should be taken when removing the pump, not to introduce any dirt into the hydraulic system.

The type '0' pump is sensitive to trapped air and care should be taken to remove it during installation and commissioning.

4.1 Type '0' Pump Reinstallation

When a faulty pump is replaced new sealing washers should always be installed between the fittings and the pump body. Connect the reservoir line to the pump leaving the two drive pipes disconnected at points A and B (Fig.3). Temporarily blank off the two tee unions to the steering system to avoid fluid loss. The pump should then be bled using the following procedures:-

1. Fill pipe B with oil.

2. Connect pump drive cable to a 12V dc supply via a 10 ohm 50W resistor. This allows the pump to rotate slowly without cavitating.

3. Continue adding oil to pipe B as the level drops. Note: If oil is expelled from pipe B then reverse the connections to the pump.

4. Stop the pump when oil appears out of pipe A. Reconnect A to the steering system and repeat steps 2 and 3 until the steering ram moves.

5. Observe the movement of the ram and turn the helm pump in the opposite direction to keep the rudder stationary. This will cause any remaining air in pipe A to be drawn up to the helm pump and vented.

6. When all the air in pipe A is cleared stop the pump and reconnect pipe B to the steering system.

7. Reverse the polarity of the pump and repeat from section 5.

Note: This type of positive displacement pump is sensitive to trapped air. It should be thoroughly bled before using the autopilot.
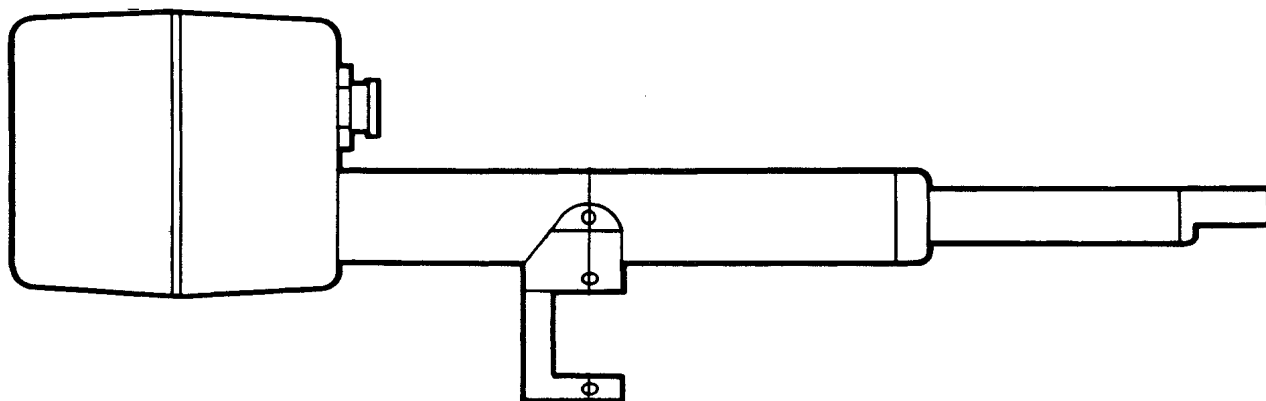
Fig. 3. Type '0' Piston Pump Bleeding

Reservoir Line

B

A
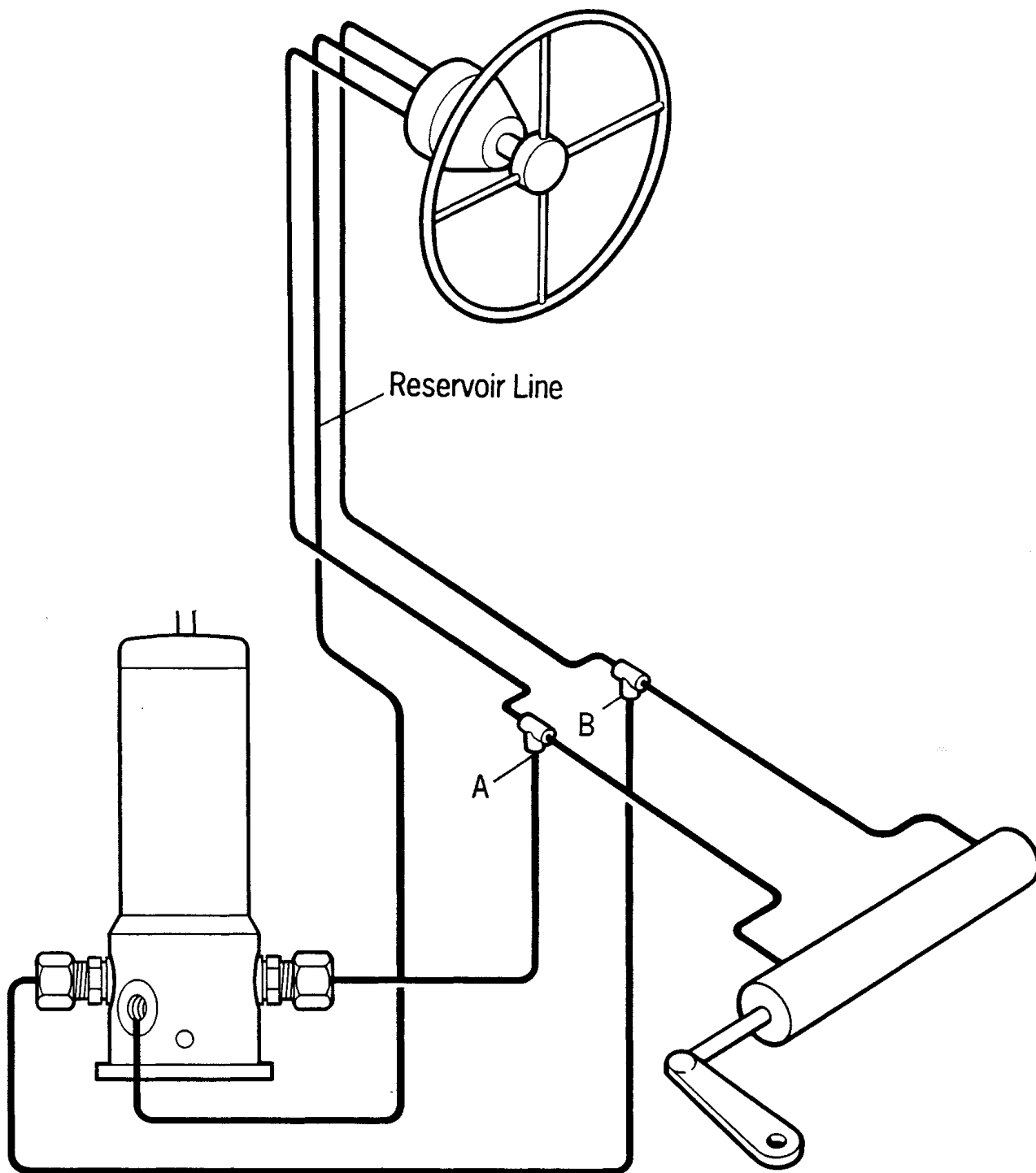
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Inboard/Outboard Drive Unit (Z088)

Service Procedures

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Illustrations

Fig. 1. I/O Drive Unit - Exploded View (Z088)

Screws (2)

Dust Cover

Screws (4)

Washer

Support Plate Sub-Assy.

Idler Gear Sub-Assy.

Clutch (gear) Core Sub-Assy.

Spring

Spacer

Screw

Washer

Clutch Shaft

Plastic Bearing

Master Plate Sub-Assy.

Pin No 1 Red

Clutch Leads

Pin No 2 Black

View on Arrow **A**
Showing Wire End
of Connector

Pin No 4 Brown

Motor Leads

Pin No 3 blue

Front Dust Cover

Screws (2)

Cover pillars

Motor Sub-Assy. NO17

Connector

A

Locknut

Girdle Tube Sub-Assy.

Thrust end

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4. Spares numbers - I/O Sterndrive Unit (Z088)

Item	Catalogue No.
Drive Motor	N017
Drive Assembly	N018
Mercruiser Installation Kit	D137
Volvo Installation Kit	D129

1. I/O Drive Unit

The I/O drive unit comprises a motor with a two-stage spur reduction gearbox.

A single toothed clutch transmits the torque to a recirculating ball screw. The clutch is held apart by a small spring to ensure the clutch tooth does not 'ratchet1 when disengaged. The I/O drive unit may be used with all 610 versions of the AH6000 power pilot and both the

SeaTalk ST6000 and ST7000 Autopilots.

Servicing is restricted to motor replacement.

Great care must be taken when servicing to ensure all screws are fully tightened. The I/O Drive Unit is subjected to high vibration levels and loose screws will quickly work free.

2. Motor Replacement (No 17)

2.1 Dismantling

- Unscrew the 2 off rear dust cover retaining screws and remove the dust cover.
- Unscrew the 4 off support plate retaining screws complete with washers.
- Carefully remove the support plate sub-assembly complete with Idler gear sub-assembly and 2 off spacers. Ensure that the support plate is held square during removal to prevent damage to clutch shaft. It is now possible to remove the clutch/gear core sub-assembly, spring and plastic bearing from clutch shaft.
- Undo the lock nut of the 4 pin connector and remove.
- Unscrew 2 off front dust cover retaining screws and push connector out of front dust cover.
- Slide dust cover along girdle tube sub-assembly to provide access to motor sub-assembly No. 17.
- Desolder the wires from the motor.
- Unscrew the 2 off motor retaining screws complete with washers and remove. Pull motor away from master plate sub-assembly.

2.2 Reassembly

-Assemble motor sub-assembly (No.17) to master plate sub-assembly and secure with 2 off screws complete with washers. (Fully tighten).
- Solder the wires to the new motor.
- Assemble connector to front dust cover and secure with lock nut.
- Slide dust cover along girdle tube and assemble to master plate.
Check that the motor and clutch leads are not trapped during assembly.
- Fully tighten the 2 off screws to secure dust cover.
- Reassemble the plastic bearing spring and clutch (gear) core sub-assembly to clutch shaft.
- Assemble the Idler gear sub-assembly complete with 2 off washers to support plate sub-assembly.

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- Position the support plate sub-assembly on clutch shaft and ensure Idler shaft and support plate pillars engage correctly, the support plate must be held square during assembly to prevent damage to the clutch shaft.
- Fully tighten the 4 off screws complete with washers to secure support plate.
- Assemble rear dust cover to master plate sub-assembly and fully tighten the 2 off securing screws.

3. Functional Test

It is important to check the clutch operation to make sure it will disengage even under load. Failure of the clutch to disengage is probably \ due to a damaged clutch tooth in which case the drive unit must be replaced.

The spur reduction gearbox is noisy compared to the epicyclic gearboxes on other drive units. This is normal. The no load motor running current with the clutch engaged should be less than 1.5A.

The clutch current at 10V should be between 0.7 and 10A. Connect the drive unit to an ST7000 system and switch on power. Set rudder gain to maximum.

- Press 'Auto'
- Press '+10' 7 times to drive the unit fully out.
- Check that clutch holds on end stops without any ratcheting.
- Press 'Standby'
- Check that clutch disengages.
- Press 'Auto'
- Press -10 7 times to drive unit fully in.
- Check that clutch holds.
- Press 'Standby'
- Check that clutch disengages.