SM-7707

SYSTEM MANUAL

FOR THE

USBL AND LUSBL SYSTEMS

[INCLUDING DUAL-REDUNDANT LUSBL]

ISSUE B

REVISION 3

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AMENDMENT RECORD

All amendments and additions will be issued with a new copy of this sheet, recording the history of amendments.

Issue	Revision	Date	Comments	Section	Page
A	0	21.09.95	Initial Issue	All	All
B	0	05.07.96	Incorporation of dual-redundant version	All	All
B	1	15.08.96	Correction of minor errors throughout	All	All
B	2	01.09.98	Addition of material for new Monitor Unit	5,6,7	All
B	3	21.12.01	Figure 3.3 in Section 3 updated CN6978	3	All

SECTION 1

1. INTRODUCTION AND OPERATING PRINCIPLES

1.1 STRUCTURE OF MANUALS

The manual is divided into seven sections, each dealing with a different aspect. In general, these seven sections deal with the basic, single channel, version of the system. Although the dual-redundant version of the system behaves in much the same way as the basic version, there are some differences in the areas of installation, operation and maintenance and these are covered in Appendix K. The section content is summarised as follows:

1. INTRODUCTION AND OPERATING PRINCIPLES. Provides a general introduction and a brief description of the operating principles.

2. OPERATING THE SYSTEM SOFTWARE. Describes the operator interface and the procedures to be used to perform any system task.

3. INSTALLATION AND CONNECTIONS - HARDWARE. Contains all necessary procedures and recommendations for installing and connecting up an LUSBL/USBL system.

4. INSTALLATION PARAMETERS SET-UP. Describes the procedures involved in setting-up the system in the installation phase.

5. TECHNICAL SPECIFICATIONS - HARDWARE. Full technical specifications for all of the major LUSBL/USBL components.

6. DESCRIPTION OF SYSTEM COMPONENTS. Detailed technical description of all major LUSBL/USBL components together with dismantling procedures.

7. MAINTENANCE. Description of maintenance principles and trouble-shooting procedures.

1.2 PURPOSE OF THE SYSTEM

The Sonardyne USBL and LUSBL systems are designed for:-

- USBL
  - Remotely Operated Vehicle (ROV) tracking relative to a vessel.
  - Tow fish tracking relative to a vessel.
  - Diver tracking relative to a vessel.
- LUSBL
  - Use as a more accurate and robust position sensor for a vessel Dynamic Positioning (DP) system.
  - Accurate positioning of underwater structures.
  - When used with a RAMS (Riser Angle Monitoring System) system, measurement of BOP/Riser Angle/Differential Angles.

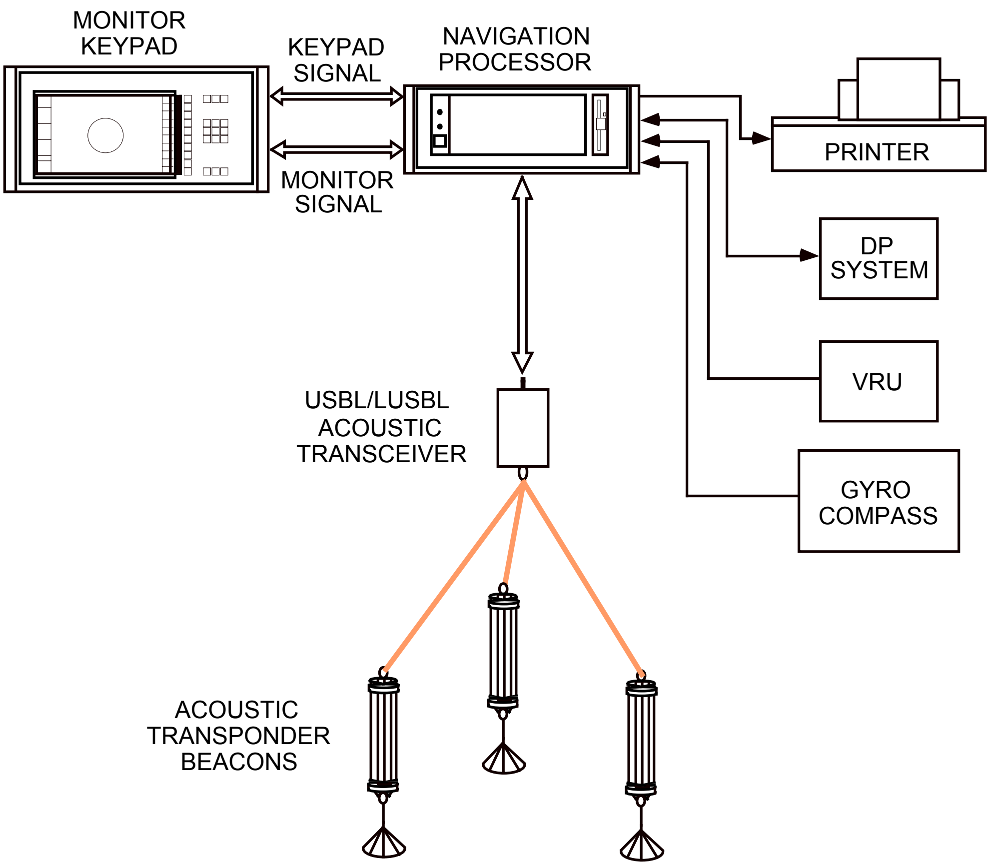
1.3 BRIEF SYSTEM DESCRIPTION

The equipments comprising a typical LUSBL system are illustrated in Fig 1.1 which follows. Note that Fig 1.1 illustrates the older version of the Monitor/Keypad. More recent systems may be supplied with a 17 inch Monitor unit and information relating to this version is covered later in the manual.

The key difference between USBL and LUSBL systems is that the basic USBL system utilises only one transponder beacon on the seabed (or on an ROV, etc) and has less accuracy and more limited functionality as a result.

The dual-redundant version of the system incorporates a second set of Navigation Processor, Monitor/Keypad and Transceiver. These two sub-systems are cross-linked in such a way that, in the event of a failure of any major element, system operation will continue without the need for operator intervention.

FIG 1.1 SCHEMATIC (CONTEXT) DIAGRAM - BASIC SYSTEM



Operation of the system is controlled by the Navigation Processor, once it has been set up and initiated by the operator. The operator uses the Monitor/Keypad unit as his Man/Machine Interface. The Processor commands the Transceiver to emit acoustic signals to the Beacon(s) and then interprets the responses received by the Transceiver.

In a typical system, the Processor receives reference information from a VRU and a Gyro Compass and produces outputs to a DP system and a printer. In other system configurations, the vessel's absolute position may be derived by reference to a Radio Navigation system.

The system measures the range and direction of a beacon relative to the known location and orientation of the Transceiver housing:-

- Beacon range is calculated by measuring the elapsed time between the interrogation signal and the detection of the beacon reply.
- Beacon bearing is calculated by measuring the difference in "time-phase" between signals in a number of pairs of acoustic receiving elements on the front face of the Transceiver. (This is sometimes referred to as the Interferometer method). See Appendix B for more detail.

In the case of an LUSBL system, where a number of beacons are in use, greater accuracy of position fixing is possible than with a basic USBL system because the larger volume of data being gathered enables a greater degree of statistical filtering to be carried out.

In a typical navigation cycle:-

- The Navigation Processor commands the Transceiver to transmit an interrogation signal.
- The Beacon reply (or replies in the case of LUSBL) is detected by the Transceiver which measures the elapsed time and the time-phases. The data is reported to the Navigation Processor. Simultaneously, the Navigation Processor will have received the vessel's attitude (roll, pitch) and, possibly, heading data.
- The Navigation Processor computes the position of the beacon relative to the vessel and reports the data to the DP system.

If heading data is present, the processor can compute the position of the vessel (in a North-referenced grid) relative to a beacon fixed to the seabed. Without heading data, vessel position would only be known in terms of range, bearing and elevation from the beacon.

Subsequent navigation cycles may be used to position other beacons up to a maximum of 10 beacons in total. If the positions of the beacons in an array on the seabed (i.e., relative to each other) have previously been calibrated, the position of the vessel (relative to the array) may be calculated to a high degree of accuracy.

1.4 TYPICAL APPLICATIONS OF A USBL/LUSBL SYSTEM

1.4.1 USBL

1.4.1.1 ROV/Tow Fish Tracking

In this application, a beacon is placed on an ROV or Tow Fish as appropriate. The USBL system will then track the position of the ROV/Tow Fish (in terms of depth and bearing) relative to the vessel.

1.4.1.2 Diver Tracking

As for ROV/Tow Fish tracking except that the beacon is attached to the diver.

1.4.2 LUSBL

1.4.2.1 DP Applications

The most common application of a LUSBL system is as an input to a Dynamic Positioning (DP) system. Dynamic Positioning control of a vessel removes the need to anchor the vessel, which is a time consuming and costly exercise. A DP vessel is fitted with a number of thrusters in addition to the normal main propellers. The thrusters and propellers are managed by a control system to keep the vessel on a constant heading and in a constant position whatever the disturbing forces from wind, current and wave action.

For a DP application, a reference beacon (or an array of beacons in the case of LUSBL) is placed on the seabed and the position of the beacon or array in the vessel frame is reported to the DP control system.

A variation of the method is to place a beacon on an ROV which may be following a line feature such as a pipeline. The LUSBL/DP systems will then control the vessel to follow the ROV. This is sometimes referred to as "The dog on a lead" or “Follow the Sub” principle.

1.4.2.2 Accurate Positioning of Underwater Structures

The greater accuracy afforded by the LUSBL system is valuable when the position of an underwater structure needs to be known more precisely than can be achieved by other means. By deploying more than one beacon, the LUSBL is able to use statistical filtering techniques to reduce the impact of system errors.

1.4.2.3 Riser Angle Monitoring

Setup and control functions for a RAMS (Riser Angle Monitoring System) are built into the LUSBL system. RAMS alarm levels may be displayed on the LUSBL’s screen while in Navigation mode.

SECTION 2

2. OPERATING THE SYSTEM SOFTWARE

The Operator Interface is described in this section together with a description of how to use the system in Navigate mode (see Section 2.2) and how to set up the system for a new job (see Section 2.3). A step by step procedure for setting up a typical new job is given in Section 2.4. A brief description is given also of the other modes accessible from the top level menu - with references to relevant Sections.

In general, the operating procedures described here apply equally to the dual-redundant version of the LUSBL system as well as to the basic system. Any differences in operation which do apply are described in Appendix K.

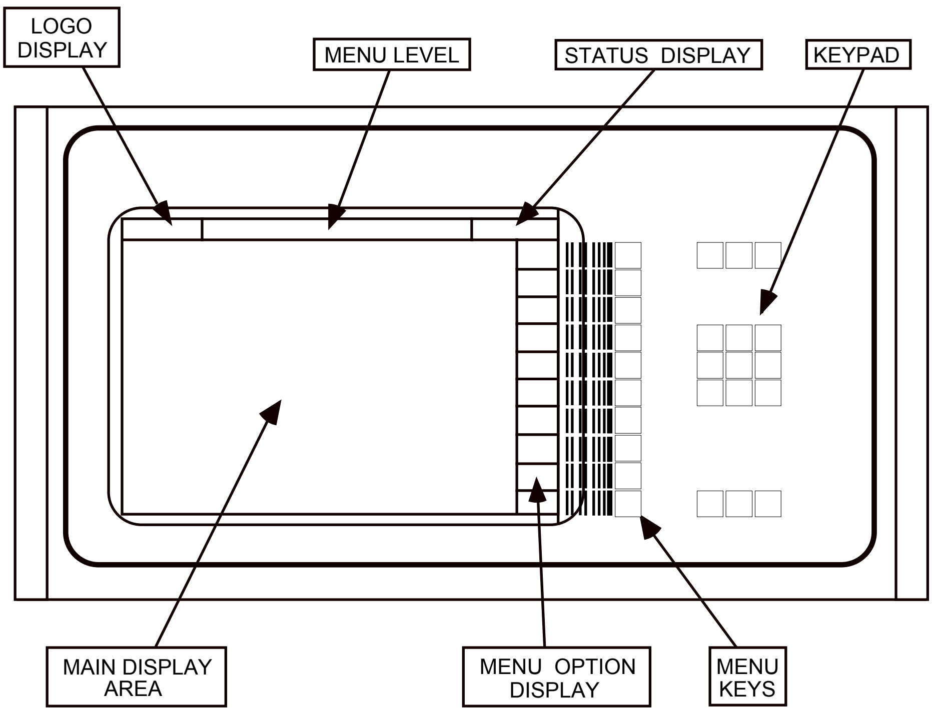
2.1 THE OPERATOR INTERFACE

The operator interface presented on the Type 7783 Monitor/Keypad unit consists of a high resolution colour display and a keypad situated to the right hand side of the display.

The layout of the display and the controls on this unit is illustrated in Fig 2.1 below.

In more recent systems, a Type 7940 Monitor unit may be supplied - in conjunction with a Type 7941 Keyboard unit. The operator interface in this case is illustrated in Fig 2.2 and Fig 2.3, which follow.

FIG 2.1 OPERATOR INTERFACE - TYPE 7783 MONITOR/KEYBOARD UNIT

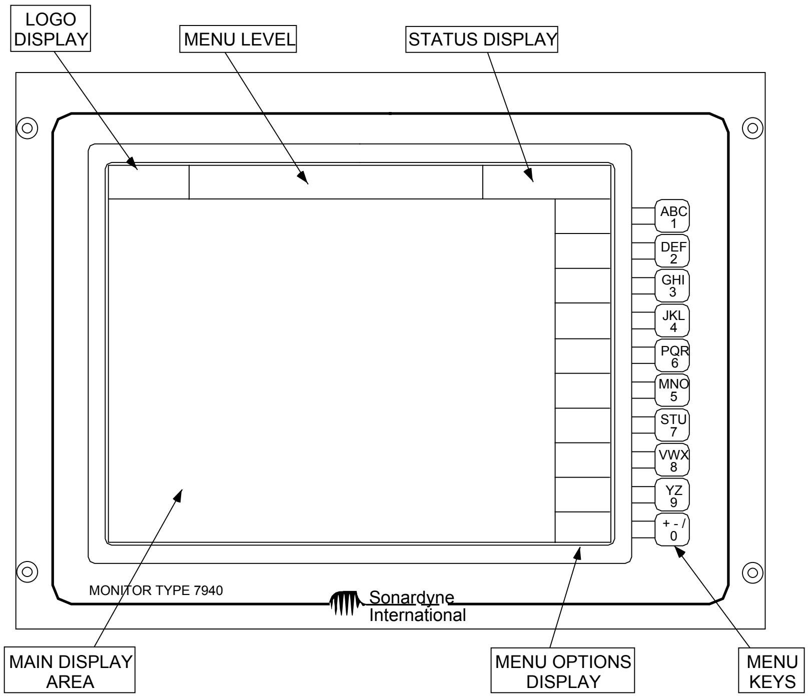


The screen is divided into zones. Across the top are three zones - which are always present.

- The left-hand zone contains the Sonardyne logo.
- The centre zone shows the current position in the menu structure (except in Navigate mode where it is used as a message area).
- The right-hand zone (STATUS DISPLAY) contains three rows of text. The top row shows the current system time and date, the second the current job file name. The third row shows the master/slave status of the local system (always 'master' for a standard system) plus the name of the Transceiver currently being addressed by the local system.

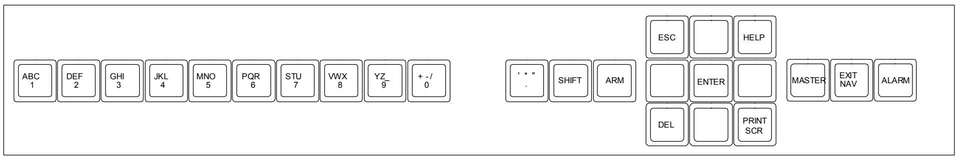
In the case of the more modern version of the system, the operator interface is provided by two units - the Type 7940 Monitor Unit (illustrated in Fig 2.2) with a 17 inch display and the Type 7941 Keyboard Unit (illustrated in Fig 2.3).

FIG 2.2 OPERATOR INTERFACE - TYPE 7940 MONITOR UNIT



As can be seen, the operator interface provided by this unit is similar to that provided by the older Monitor/Keyboard unit. However, the screen is much larger, providing greater display clarity for the detail on some of the LUSBL screens, and only the menu keys are included on this unit now - the keys provided on the keypad of the Type 7783 unit now being provided on the Type 7941 Keyboard Unit.

FIG 2.3 OPERATOR INTERFACE - TYPE 7941 KEYBOARD UNIT



As shown on the left hand side of Fig 2.3, the menu keys are repeated on the Keyboard unit and these may be used interchangeably with those included on the Type 7940 Monitor Unit. The Keyboard unit, however, also includes the keypad keys previously included on the older Monitor/Keyboard unit - as shown on the right hand side of Fig 2.3. In addition, the new Keyboard unit is mounted in a rack drawer which may be pulled out to reveal a PC-compatible AT keyboard. This keyboard may be used to enter longer strings of characters more conveniently than can be achieved with either of the menu key strips. A tilting platform is provided in the drawer, enabling the PC AT keyboard to tilted up at the back for greater ease of use.

Whichever operator interface is being used, the LUSBL system is menu driven - Fig 2.4 which follows shows the top two layers of the menu structure plus the paragraph reference for each item on the menu structure. The full structure of the Navigate menu is given at the end of Section 2 as Fig 2.10.

FIG 2.4 TOP LEVEL MENU STRUCTURE

- **1. Navigate**
  - 1. Nav SETUP 2.3.2
  - 2. Job SETUP
  - 3. Chart DISPLAY 2.2.2.1
  - 4. Monitor BRIGHT 2.2.2.2
  - 5.
  - 6. Chart CENTRE 2.2.2.3
  - 7. Chart SCALE 2.2.2.4
  - 8. Chart Co-ord FRAME 2.2.2.5
  - 9. Trail CONTROLS 2.2.2.6
  - 10. Data BOXES 2.2.2.7
- **2. Job Setup**
  - 1. Navigation Setup 2.3.2
  - 2. Define Watch Circles 2.3.4
  - 3. Sound Velocity 2.3.3
  - 4. Display Units 2.3.1
  - 5. Compatt Commands 2.3.6
  - 6. Ship Ref Points 2.3.7
  - 7. Waypoints 2.3.8
  - 8. Riser Angle Monitoring Setup 2.3.9
- **3. Job File Management** 2.5
- **4. Installation**
  - 1. Acoustic Transceivers 4.2.3
  - 2. DGPS Receiver 4.2.6
  - 3. Attitude Sensors 4.2.4
  - 4. I/O Port Allocation & Setup 4.2.1
  - 5. Set/Change Installation Password 4.2
- **5. System Setup**
  - 1. Set Time and Date 4.1.3
  - 2. Set Display Brightness 4.1.4
  - 3. System Test Programs 4.2.2
- **6. Simulate** 2.8

As illustrated in Fig 2.1 and Fig 2.2, the currently available menu options are displayed down the right hand side of the main Display Area. Upon powering-up, the system will display the top level menu, with “**Navigate**” highlighted. In this state, the system polls for devices connected to it; such as Transceivers, other Navigation Processors, Attitude Sensors, etc. A summary of the system status is then presented in the main Display Area.

Below the three top zones is the main Display Area, with the currently highlighted menu option emphasised. The remaining (not highlighted) menu options are coloured red. Except when in “**Navigate**” mode, the different options on the menu can be highlighted using the UP/DOWN cursor keys. [Note that “highlighting” an object on the display in this way causes no other action to be taken by the system].

Pressing the <ENTER> key (on the Type 7783 Monitor/Keyboard or on the Type 7941 Keyboard unit in the case of the newer system) or the menu key (see Fig 2.1 or Fig 2.2) next to any option activates that option and moves the display to the next level down in the menu structure. [Note that "Activating" an object on the display in this way - as opposed to "highlighting" it - does cause the system to take some action].

To read, enter or modify data the operator progresses through the menu structure until the leaf node (or data page) containing the relevant data is reached. Until a data page of the menu structure is reached, menu options continue to appear on the right of the display. Once the data page has been reached, the whole screen, apart from the three zones at the top, is taken up by the data for display, entry or modification.

A number of RULES apply when entering or modifying data on a data page. These are:-

- A record is a complete horizontal line of individual fields.

- The UP/DOWN cursor keys are used to highlight the required record and the LEFT/RIGHT cursor keys to highlight the required data field for entry or change.

- Once a field is highlighted, pressing <ENTER> will cause a dialogue box to appear displaying the legal or safe options for that field. The cursor keys may then used to highlight an option and the choice confirmed by pressing <ENTER>.

- If alpha characters are allowable in a field (e.g. entering a name for a Beacon), the numeric menu keys may be used in an alpha mode by first pressing a LEFT, RIGHT or UP cursor key (e.g. for "A" press LEFT cursor key followed by the "1" menu key, for "E" press the UP cursor key followed by the "2" menu key, etc). Alternatively, of course, if a Type 7941 Keyboard unit is installed, alpha characters may be keyed in more conveniently using the PC-compatible keyboard.

  In many cases where text options are allowable for a field it will be sufficient merely to type the first character of the required options.

- A record may be deleted by pressing DEL, and answering YES to the confirmation question.

- A new record is created by using the DOWN cursor to highlight a line below the lowest current line and pressing <ENTER>.

- The ESC key is used to go back up the menu tree once data entry is complete. To re-enter the top level menu from the Navigate (or Simulate) mode, press the "ARM" and "EXIT NAV" keys together.

NOTE: TO BECOME FAMILIAR with the system the potential operator should create a "Job" as described in Sections 2.3 and 2.4 and then run the system in SIMULATE mode. As far as possible, the system reacts in the same way as in the NAVIGATE mode.

2.2 NAVIGATE MODE

This is the active mode of the system. Entry to Navigate mode and the operator displays available, are described in some detail first (Section 2.2.1). This is followed by the steps needed to arrange the electronic chart display to suit the current job requirement (Section 2.2.2).

Note that, once in Navigate mode, it is not possible to use the cursor keys to "highlight" a menu option before activating. Instead, the required option is selected by pressing the menu key alongside it and the option is then activated directly.

2.2.1 <u>Entering Navigate Mode</u>

On entering Navigate mode, the display changes to the form shown in Fig 2.5, which follows (Fig 2.5 illustrates the Type 7783 Monitor/Keyboard - the Navigate display on the Type 7940 Monitor unit is the same).

The system may be placed in Navigate mode simply by returning up the menu structure, until the main menu is displayed, highlighting the "**Navigate**" menu option and pressing <ENTER> (or by pressing the menu key alongside the "**Navigate**" option).

2.2.1.1 **Menu Keys**

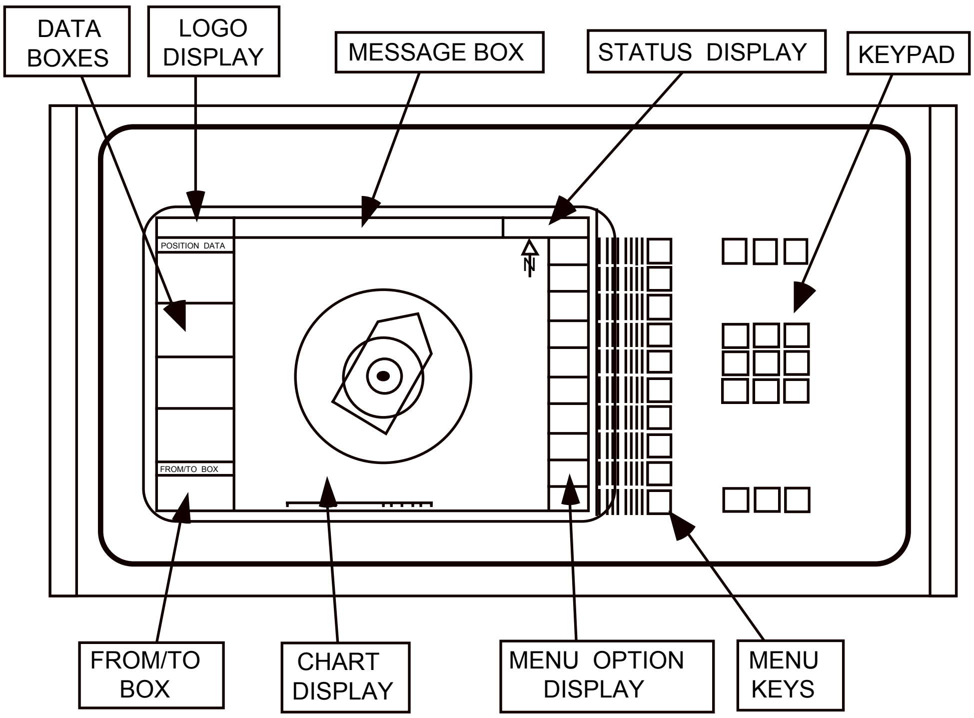
The ten boxes on the right hand side of the Navigate mode display show the current menu option which would be activated by pressing the menu key to the right of the box. (The top two layers of the menu structure are illustrated in Fig 2.4).

2.2.1.2 **The Data Boxes**

To the left of the display are four position data boxes that are available for the display of numeric position data (co-ordinates, error etc.) of up to four objects. The objects may be the ship, any "Mobile" Beacon, the seabed array, attitude sensor data or riser angle data.

The From/To box to the bottom left of the display may be used to display the range and bearing or the relative co-ordinates between any two objects.

FIG 2.5 NAVIGATE MODE DISPLAY



2.2.1.3 **The Message Box**

At the top centre of the display is a message box that is used to display messages generated by the system. There are three levels of alarm or message:-

- Level 1, which is reserved for events critical to the system such as the ship moving outside the watch circle, loss of reliable data to the DP system etc. This level triggers a continuous audible alarm and displays a warning message in the main display area. The audible alarm may be switched off by pressing the “ARM” and “ALARM” keys together, on the Monitor/Keypad - or on the Type 7941 Keyboard unit as appropriate, but the warning message will remain until the fault is cleared.

- Level 2, which is reserved for events that should act as a warning to the operator but are not yet critical. This level triggers a "beep" type of audible alarm. In this case both audible alarm and warning message may be cleared by pressing the “ARM” and “ALARM” keys together.

- Level 3, which is reserved for events that are useful for monitoring or diagnostic purposes but do not warrant the status of a Level 1 or 2 type alarm. Messages of this type are normally triggered by transient conditions and will clear automatically when the condition clears.

To the top right of the display is a box that displays the time/date and the name of the current Job File.

2.2.1.4 **The Electronic Chart**

The centre of the display area is reserved for the electronic chart display.

The chart may be centred on any object. This may be the current ship position, any “Mobile” Beacon position, the seabed reference array position, a ship reference point or any seabed waypoint.

The chart may be re-scaled either by the use of "**Zoom-in**" and " **Zoom-out**" options or to specific scales such as 1/1000 etc.

The charting may be carried out in either a ship-based frame or a seabed-fixed frame.

NOTE: The current operating mode of the chart is displayed on a line at the head of the Data boxes. It also defines the co-ordinate frame used for the data.

There are two other main options for the chart display. These are:-

- A trail display of object motion history.

- Chart Background - see paragraph 2.2.2.1 which follows.

2.2.2 <u>Modifying the Electronic Chart</u>

The menu options available within Navigate mode are illustrated in Fig 2.10 Full Navigate Menu. The ones controlling the appearance of the chart are listed in the following. In all cases, (except that the cursor keys have no effect) the rules which apply to moving through the menu structure and highlighting, or changing, any entry are as described in Section 2.1. The system will remain in Navigate mode throughout all chart display changes. The chart options are:

2.2.2.1 **"Chart DISPLAY" Option**

Under the "**Chart DISPLAY**" option, the operator may choose background features of the chart display:

- "**Circles & Grid OFF**"
- "**Range CIRCLES only**"
- "**GRID only**"
- "**Range CIRCLES & GRID**"
- "**Chart Outline COLOUR**" - a colour menu is displayed and any of the displayed colours may be chosen.
- "**Display RISER ANGLES**" - used for displaying Riser Angle, Alarm Limits and Course to Steer. Note that this option is only available if a Riser Angle Monitoring System has been installed and this option has been enabled by Sonardyne. See Section 2.2.4 for more information on operating the system in this mode.

2.2.2.2 **"Monitor BRIGHT" Option**

This option enables the menu keys to be used to make the display "dimmer" or "brighter".

2.2.2.3 **"Chart CENTRE" Option**

Activation of this option enables the chart to be centred on:

- the Ship
- a "Mobile" Beacon
- a Reference Beacon
- a Ship Reference Point
- a Waypoint.

NOTE:	Activating any of these four options displays a list of items for selection, assuming that more than one item is available for selection. If only one item is available, the selection is activated immediately.

Activate the option required.

2.2.2.4 **"Chart Scale" Option**

This option enables the operator to zoom in or zoom out or choose the specific scale required. Activate Zoom In or Zoom Out options or the scale required by pressing the appropriate menu key.

2.2.2.5 **"Chart Co-ord Frame" Option**

Activate either the "**Ship Frame**" or "**Seabed Frame**" option by pressing the appropriate menu key.

- Under the "**Ship Frame**" option, the ship remains fixed in the centre of the display even if the ship is moving in the real world. If the ship is moving, seabed objects would move across the display relative to the stationary ship. The operator may choose the orientation of the chart in ship terms:
  - Gyro North pointing upwards on the chart
  - Seabed Grid North up
  - Ship's bows up
  - Ship's stern up
- Under the "**Seabed Frame**" option, seabed objects remain in a fixed position on the display. If the ship is moving in the real world, it would move across the display relative to the stationary seabed objects. The operator may choose the orientation of the chart in seabed terms:
  - Gyro North pointing upwards on the chart
  - Seabed Grid North up

Note that the "**Seabed Frame**" option is available only if there is at least one Reference Beacon assigned - or DGPS is enabled. Once activated, the display will remain in Seabed Frame mode (including on powering up again after powering down) provided one or other of these conditions continues to be met. If neither of these conditions is met the display will automatically revert to "**Ship Frame**" mode until such time as one of the conditions is satisfied - at which time the Seabed Frame mode will resume automatically.

2.2.2.6 **"Trail Controls" Option**

Under the "**Trail Controls**" option, the operator may choose either "full line trails" or "dot trails" of object motion. "Full line trails" means that the display shows lines joining the dots representing the fix positions and "dot trails" means that there are no such lines. The previous record of trails on the chart may be cleared (activate **"Clear Trail Histories**") or the trails mode may be switched off completely (activate "**Trails Off**").

2.2.2.7 **"Data BOXES" Option**

Under this option, the operator may organise the data to be displayed in the data boxes which appear down the left-hand side of the display. For any of the four POSITION DATA boxes the operator may elect to clear the box (CLEAR BOX option) or to show any of the following:

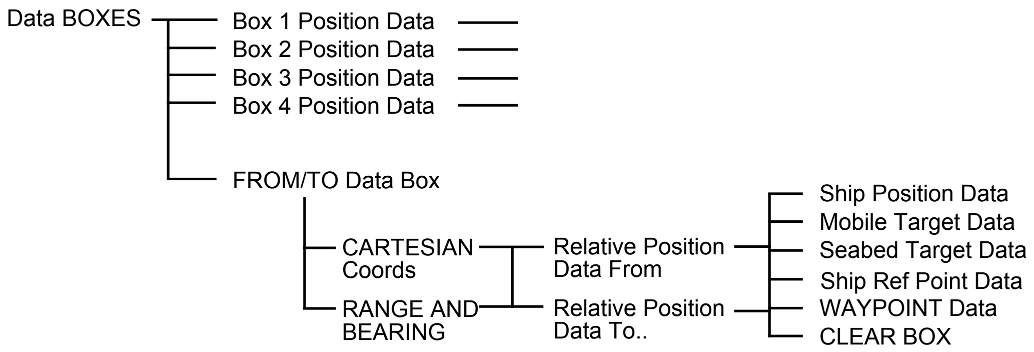
- Ship Position Data

  NOTE: Only selectable if GYRO available or at least two Reference Beacons assigned.
- Mobile Target Data
- Seabed Target Data

  NOTE: If more than one target is available then a menu of the targets is presented.
- Attitude Sensor Data
- Riser Angle Data
- LBL Data

If, instead of activating any of the Position Data Boxes, the operator activates the FROM/TO Data Box, he is first given a choice of co-ordinate type for defining relative position, then a choice of “Position From” or “Position To” before being presented with a list of objects whose relative positions are to be displayed. In many cases, it will only be necessary to change either the “Position From” setting or the “Position To” setting. If both have to be changed, set the “Position From” entry first.

This sequence of menu options is illustrated in the diagram which follows:-



2.2.3 Setup Facilities within Navigate Mode

In addition to enabling access to all the charting options the **Navigate** menu options also allow access to a range of "**Setup**" facilities without halting the operation of the system in Navigate mode.

- By activating the “**Nav SETUP**” option from within the Navigate mode, the operator may access all of the Nav Setup controls - see Section 2.3.2.

- By activating the "**Job SETUP**” option from within the Navigate mode, the operator may continue to navigate whilst accessing the following range of setup controls:

  - “**Display UNITS**”. As in “**Job Setup**” menu - see Section 2.3.1.
  - “**Sound VELOCITY**”. As in “**Job Setup**” menu - see Section 2.3.3.
  - “**Define WATCH CIRCLES**”. As in “**Job Setup**” menu - see Section 2.3.4.
  - “**Compatt Commands**”. As in “**Job Setup**” menu - see Section 2.3.5.
  - “**Ship Ref Points**”. As in “**Job Setup**” menu - see Section 2.3.6.
  - “**WAYPOINTS**”. As in “**Job Setup**” menu - see Section 2.3.7
  - “**Attitude SENSOR CORRECTIONS**”. (Roll, Pitch and Heading). As in “**Installation**” menu -see Section 4.2.4.
  - “**ARCHIVE Job File**”. This option has the same function as “**Archive Job**” in the “**Job File Management**” menu - see Section 2.5.
  - “**Archive log files to disc**”. This option has the same function as “**Archive Logging File to PC disc**” in the “**Job File Management**” menu - see Section 2.5.

2.2.4 Operation Using a Riser Angle Monitoring System

This procedure assumes that a Riser Angle COMPATT (RAC) has already been attached to the BOP (with its longitudinal axis parallel to the vertical axis of the BOP), the External Inclinometer Unit has been attached to the Riser (with its longitudinal axis parallel to the Riser) and that they have been connected to each other, calibrated and deployed on the seabed. Refer to Section 2.3.8 or to MM-7804 (Installation and Maintenance manual for the Riser Angle Monitoring System) if you are not sure of the procedure for doing this.

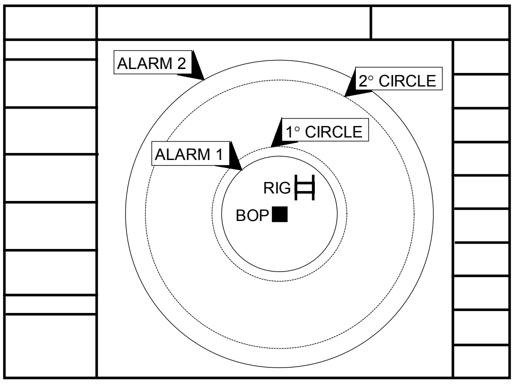
It is first necessary to enter details of the RAC into the database. To do this, enter the "**Navigation Setup**" page as described in Section 2.3.2 and go through the procedure for entering a new Beacon on the Mobile Beacons panel as described in Section 2.3.2.1. Respond to the prompts, selecting "7804 Mk4 Riser Angle COMPATT" as Beacon type and entering a surface offset value, if known, or "0.0", if not.

This will produce a new line of data in the Mobile Beacon panel. Move along this line to edit it, in the usual way, and produce or confirm the following entries:

- ❑ STATUS: Not Set
- ❑ FILTER: 9
- ❑ DP_OUT: DS for DISABLE
- ❑ COLOUR: As appropriate (avoid Bright White)
- ❑ UPDATE: DS for DISABLE
- ❑ INTER: Either appropriate HPR channel or select Sonardyne option (CIF)
- ❑ REPLY: Either appropriate HPR channel or TST if Sonardyne option selected
- ❑ TAT: Allowed values are in steps of 62.5ms (Sonardyne)
- ❑ DEPTH FIXING: None
- ❑ BCN IDX: Tcvr1
- ❑ NUM SAMPLES: 6
- ❑ TX PWR: HIGH
- ❑ DET TH: 14.0
- ❑ VAL TH: 12.0
- ❑ ATTN: 0db
- ❑ BANDWIDTH: ±200
- ❑ RX MODE: LINEAR

Next it is necessary to set up the Alarm Limits and BOP/Riser values following the procedure given in Section 2.3.8.

Having carried out all of these setting-up procedures, enter “**Navigate**” mode and switch the display to “**Display RISER ANGLES**”.



The display will now show the Riser Angle Alarm Limits as illustrated here to the right and the audible alarm functions associated with this mode will come into operation - see Section 2.3.8. On this display, the Alarm Limit circles, and angular scale circles, are centred on the BOP.

The system will monitor the differential angle of the Riser with respect to the BOP and will display the result as a Rig position angle on the chart, as shown in the illustration. By observing the display, it is possible to decide when it is necessary to re-position the Rig and in which direction to steer.

2.3 JOB SETUP MODE

Navigate
Job Setup

- Navigation Setup
- Define Watch Circles
- Sound Velocity
- Display Units
- Compatt Commands
- Ship Ref Points
- Waypoints
- Riser Angle Monitoring Setup

If, prior to entering Navigate mode, it is required to set up a new job configuration or to change an existing one, the Job Setup mode should be used. It may be entered from the top level menu. To set up a completely new job configuration, use the “**Create New Job**” option in the “**Job File Management**” facility (see Section 2.5) to establish a new file as the current job. Then return to this section to set up the configuration required. Having done so, the new configuration can be saved for future use as a job file using the “**Job File Management**” facility again.

A Job Setup task should be started by activating the “**Display Units**“ menu option.

2.3.1 Display Units

On entering this menu option, the user is given a choice between entering and displaying data in metres or feet - the default is metres. [The system, however, will always calculate in metres]. If a change is needed, use the cursor keys to highlight the option required and press <ENTER> to activate it.

2.3.2 Navigation Setup

The "**Navigation Setup**" menu option is an integrated-function page enabling all parameters involving "Mobile" and Reference Beacons to be set into the job file. The volume of data which can be set on this page is too great to be accommodated on a single screen width and a scrolling function is provided to enable the user to move his view of the page sideways as required. Figures 2.6.1 et seq. illustrate the screen views which can be obtained using the scrolling function.

The main "**Navigation Setup**" screen is divided into five panels, as illustrated in Figure 2.6.1. The top (header) panel contains the Sonardyne logo, current menu level and time/date information - as described earlier. This header panel appears on the top of all screens accessed through the scrolling system associated with the "**Navigation Setup**" option.

The remaining four data panels cover the following four headings, starting at the top:

- Beacon Navigation data - for those "mobile" Beacons, and associated transceiver(s), which are in the current Job List but are not allocated as Reference Beacons.
- Object Positioning data - for the system as a whole.
- Calibration Control - for controlling the use of the system in calibrating the Reference Beacons.
- Reference Beacons - for those Beacons, and associated transceiver(s), which have been allocated as Reference Beacons.

The Navigation setup task is described in the following paragraphs by reference initially to Figure 2.6.1.

2.3.2.1 Entering New Beacons on the Data Page

Beacons are known to the system at three different levels:

- Sonardyne Level. This level is expressed as a list of all possible types of beacon with which all Sonardyne systems are capable of working. Sonardyne systems are able to work with a wide range of SONARDYNE Beacons, SONARDYNE SIMRAD-compatible types and SIMRAD-supplied types.
- System Level. This level is expressed as a list (selected from the Sonardyne list during the installation phase) of beacons known to a particular system on board a particular vessel.
- Job Level. This level is expressed as a list (selected from the System list during the Job Setup phase) of beacons deployed on the current job and displayed on this page.

The Beacon Navigation panel of the "**Navigation Setup**" page (see Figure 2.6.1) shows a summary list of "mobile" Beacons on the current Job List.

FIG 2.6 NAVIGATE MODE DISPLAY

Fig 2.6.1 Screen 1

	CURRENT LEVEL: TOP ->NAV MENU ->NAV SETUP	11:50:35 10 MAR 95 FILE: XXXXXXX.XXX MASTER AFT_TCVR

BEACON NAVIGATION	POSITIONING PARAMETERS STATUS	FILTER	DP OUT	COLOUR	UPDATE	SURVEY	BEACON PARAMETERS INTER	REPLY	TAT
ROV-NAV	READY	NONE	YES		0.5	ON	1	9	125.00
WELLHEAD	NOT SET	1 LGHT	NO		99.9	OFF	5	2	
ARRAY 2.1	OFFLINE	5 MED	FLW				H O		
ARRAY 2.2		10 HVY					H □		
ARRAY 2.3							R 1	HΔ	
ARRAY 2.4							H X		

TCVR PARAMS →

OBJECT POSITIONING BY REF BCNS & DGPS	COLOUR	FILTER	DP CTRL	SURVEY OUTPUT	APS UPDATE	DGPS	DGPS ACC.	ACTIVE TCVR
SONARDYNE		NONE	OFF	OFF	1.0	OFF	0.0	AFT_TCVR

CALIBRATION CONTROL	CAL TARGET	
	0.5	COLLECT BASELINES

REFERENCE BEACONS	BEACON CO-ORDS EASTING	NORTHING	DEPTH	ERR	POSITIONING PARAMETERS STATUS	FILTER	DP OUT
ARRAY 1.1	XXXXXXX.X	XXXXXXX.X	XXXX.X	XXX.X	READY	NONE	YES
ARRAY 1.2					UNSET	1 LGHT	NO
ARRAY 1.3					OFFLINE		
ARRAY 1.4							

UNITS IN METRES | POSN PARAMS + BEACON PARAMS + TCVR PARAMS →

NOTE: The header titles in the "**OBJECT POSITIONING BY REF BCNS & DGPS**" panel in Figure 2.6.1 above is shown as it would appear if an HPR 309 Telegram was being used for DP output. If an HPR 418 Telegram is being used, the "**DP CTRL**" header is replaced by "**DP OUT**".

For a new job file, or if it is required to add new Beacons to an existing job file, move the cursor to the next blank line in the Beacon Navigation panel, and press <ENTER>. A small window appears - with the heading "Select Mobile Beacon". In this window is listed all beacons known at the System Level. Follow the on-screen prompts to enter the data required for each new Beacon. On completion of all data entries, the new "Mobile" Beacon data will appear in the list on the Beacon Navigation panel.

NOTE: If, as would be necessary during the installation phase, it is required to enter a new beacon onto the System List from the Sonardyne List, this can be done via the "Add New Beacon" item which will be found at the bottom of the "Select Mobile Beacon" window. More information on this is given in Section 4.

Having entered all required beacons onto the Job List, parameters for any “Mobile” Beacon already listed on this page may be changed either by editing entries in this panel or by editing on a Beacon Summary page (see Figure 2.6.2).

Fig 2.6.2 Beacon Summary Page

	CURRENT LEVEL: TOP ->JOB SETUP ->NAV SETUP->SUMMAR`	11:50:35 10 MAR 95 FILE: XXXXXXX.XXX MASTER AFT_TCVR

BEACON NAME	SERIAL NO.	DESCRIPTION
WELLHEAD	01037	**7200 MK3 MF COMPATT**

ADDRESS	INT CHAN	REPLY CHAN	DEPTH SENSOR OFFSET	TPDR POWER	TAT	TPDR GAIN
0101	**1**	**CRF**	**0.0**	**LOW**	**125.00**	**HIGH**

STATUS	DP OUT	SURVEY OUT	FILTER	COLOUR UPDATE	DEPTH FIXING
READY	**OFF**	**OFF**	**NONE**	**0.5**	**NONE**

NUMBER SAMPLES	TRANSMIT POWER	DETECTION THRESHOLD	VALIDATION THRESHOLD	ATTENUATION	BAND WIDTH	RECEIVE MODE
6	**MED**	**14.0**	**12.0**	**0 DB**	**+-200**	**LINEAR**

	EASTING	NORTHING	DEPTH	STD ERR
CURRENT CO-ORDS	**173.0**	**28.4**	**7.4**	**FIXED**
DROP CO-ORDS	**N/A**	**N/A**	**N/A**	**N/A**

READ BATTERY VOLTS	COUNT **168**	VOLTS **31.60**	LAST MEASURED **11:00:32 23 FEB 96**	
READ TEMPERATURE	TEMPERATURE **11.7**		SET BATTERY OVERRIDE	
READ DEPTH	DEPTH **99.38**		READ POWER STATUS	POWER STATUS **L1 S1 T1 J2 U1 G2 E : 0**
DISABLE BEACON	**ENABLED**		READ STATUS	STATUS **RF 1/125.0 NPEU7.14 E: 0** **CRF R2.5/5.5/0.25 EE E: 0**

A Beacon Summary page for a particular Beacon may be displayed by pressing <ENTER> when the cursor is over one of the existing beacon names. This will cause a new page to appear on which are displayed all parameters associated with the beacon selected. This is a very powerful way of changing Beacon parameters for a particular beacon. However, if it is required to change a particular parameter for several Beacons in the “Mobiles” list then it is more efficient to use the Beacon Navigation panel to do so.

Having opened a Beacon summary page, all parameters except the Beacon Serial No. may be changed using the normal editing rules described in Section 2.1. Three of these parameters, “**Address**”, “**XPDR Power**” and “**XPDR Gain**” may only be changed on this summary page. In order to conserve battery charge and reduce the impact of reverberations, “**XPDR Power**” should be set to LOW if possible and only increased if communication difficulties with this transponder become apparent.

The “buttons” in the lower half of the page may be used to initiate an acoustic update of any of a range of Beacon parameters - “**Battery Volts**”, “**Temperature**” of the sea at Beacon depth, “**Depth**” of the Beacon, Beacon “**Power Status**” and Beacon “**Status**”. Note, however, that the reply from the “**Read Power Status**” and “**Read Status**” buttons will only be displayed on the screen if the appropriate “button” is “pressed” and will be displayed using Sonardyne PAN terminology - see Sonardyne PAN MK2 OPERATING MANUAL (OM-7145).

If it is required to remove a Beacon from a Job List (or from the System List), this may be done by moving the cursor to the Beacon name and pressing <DEL> (or the backspace key if using a PC keyboard). A "**CONFIRM DELETE**" window for the selected Beacon will appear, as illustrated to the right, with the "Cancel Delete " option highlighted. Move the cursor to select the option required and press <ENTER>. If a Beacon is deleted from the Job List, it will remain on the System List. If it is deleted from the System List, it will still be retrievable from the Sonardyne List, as described in Section 4. If the Beacon is a COMPATT, a further window will open giving an operator the option of disabling the Beacon before removing it from a list.

CONFIRM DELETE FOR BEACON XXXXXXXXX
Delete Beacon from Job ?
Delete Beacon from System ?
Cancel Delete

The reply message from the "**Disable Beacon**" button will be either "**Disabled**" or "**Enabled**" depending on the last known status of the Beacon.

As an acoustic update proceeds, progress of the transmissions and replies is reported in the third line of the menu level box at the top of the page.

NOTE: If the Beacon in question is tethered underwater using a release mechanism, the "Set Battery Override" button should only be used with great caution. Once set, the normal power drain safeguards built into a COMPATT, which ensure that it will reserve enough battery power to operate the release mechanism, will be overridden. In such cases, this button should only be used where it is known that outstanding work involving the Beacon can be accomplished with only minimal extra battery drain.

If, on the other hand, it is preferable to change "Mobile" Beacon parameters in the Beacon Navigation panel on the Navigation Setup page, this may be done as follows.

2.3.2.2 Positioning Parameters - "Mobile" Beacons

The following six data entry options are available under the Positioning Parameters heading.

- "**STATUS**". Defines the usability status of a "Mobile" Beacon. If it is required to change the status of a Beacon, move the cursor to the appropriate row of the "STATUS" column and press <ENTER>. A dialogue box will appear offering the following options. Move the cursor to the option required and press <ENTER>.

- **"READY"** - meaning that the Beacon is fully active and will respond normally to any interrogation.

- **"NOT SET"** - applies ONLY to COMPATT Beacon type. The COMPATT requires setup commands before it is ready for use. After these commands have been sent the Beacon status is automatically set to "READY". See Section 2.3.5.

- **"OFFLINE"** - meaning the Beacon will not be interrogated during the Navigation cycle.

- **"REFBCN"** - meaning that the Beacon is to be changed from "Mobile" status to Reference Beacon status. If this option is highlighted (and <ENTER> pressed), the Beacon data will disappear from this list and appear in the Reference Beacon list (see paragraph 2.3.2.7).

  This would be done if the Beacon's position was known with sufficient accuracy and it was in a position relevant to the ongoing operation. The current co-ordinates for the Beacon become the "drop" co-ordinates and thus the starting point for calibration.

  In the Reference Beacon window this menu item is replaced by "MOBBCN" (see paragraph 2.3.2.8).

- "**FILTER**". Defines the level of statistical filtering which will be applied to the Beacon data before use by the system. A "heavy" filter value (e.g., 10) will cause the system to be more selective about the data it accepts, and will therefore lead to a more accurate result. However, too high a filter value could lead to all data values being rejected and the system, therefore, not working at all. For a "Mobile" Beacon which may be subject to unpredictable changes in position (e.g., an ROV), a "light" filter value will be necessary.

  The dialogue box which appears in this case offers a range of 11 options from 1 (identified as LIGHT) to 10 (identified as HEAVY), plus a "NONE" option. Move the cursor to the option required and press <ENTER>. Note that the filtered data is only used internally by the system - any DP output (see next item) will not be filtered if an HPR 309 telegram is being used.

- "**DP OUT**". Determines whether or not the Beacon is being used to provide an output to a DP (Dynamic Positioning) system. The default setting is "**OFF**".

  The position of any of the "Mobiles" or the seabed reference Beacon can be reported to the DP system in "ship frame" rectangular co-ordinates. Any of the "Mobile" Beacons can be allocated as a "DP" Reference Beacon - which does not have to be a fixed seabed Beacon. It may for example be mounted on an ROV - in which case the Ship will follow the ROV. This is sometimes referred to as the "dog on a lead" principle. Option "**FLW**" sets the Reference Beacon to be followed by the DP System.

- "**COLOUR**". Defines the Beacon colour on the system "Navigate" mode display. A range of 15 colours is available.

- "**UPDATE**". Defines at what intervals the Beacon is to be interrogated by the system - in seconds. A range of values from 0.5 to 99 is available. If the update period entered is too short, the system will run as fast as it can but may not comply with the figure specified. Depending on circumstances, a minimum figure of 0.5 seconds should enable the system to comply.

- "**SURVEY**". Determines whether or not the Beacon is being used to provide a survey output from the system. The default setting is "**OFF**".

2.3.2.3 Beacon Parameters - "Mobile" Beacons

There are five data entry options available under this heading - three on the right hand side of the screen illustrated in Figure 2.6.1 and two on the left hand side of the screen illustrated in Figure 2.6.3 which follows.

The three data entry options available on the first screen are:

- "**INTER**". [Interrogate]. This column and the "**REPLY**" column which follows are linked - these two columns define the interrogate and reply channels applicable to this Beacon. If the Beacon is COMPATT type, the two channels may be chosen independently. If it is not, the interrogate and reply channels are either fixed or are presettable before the Beacon is deployed (and are therefore fixed once the Beacon is in the sea). In the non-COMPATT case, the channel entered will appear between the two columns - as illustrated in the HO and HX cases in Figure 2.6.1 - the "H" signifies that the Beacon is using an HPR channel.

When choosing interrogate and reply channels for a COMPATT, choose frequencies which are separated sufficiently to avoid clashing with other Beacons in the vicinity - either associated with the current job or not. For an LUSBL with (say) four COMPATTs, it is safest to pick four separate IIFs and a different four separate IRFs. However, in many cases, it is possible to economise on frequencies and still achieve sufficient discrimination by setting one CIF and four different IRFs together with four different turn-around times - see next. See Appendix N for more information on both SONARDYNE and SIMRAD channel frequencies.

Some Beacons (e.g., Sonardyne Type 7656) may be set into a Responder mode in which the interrogate function is executed electronically via an umbilical cable between the ship and the Beacon. In such a case, the Interrogate Channel is shown as “Rn”, where “R” signifies “Responder” and the “n” is the Responder Trigger value (1 to 4). Note, however, that if the Transceiver is driven from the CPU Card, options 1 to 4 all use the same output channel.

- “**TAT**”. Defines the turn-around time applicable to a Beacon. Beacons "time-out" for a time between detection of the interrogation pulse and transmitting a reply. This may be fixed or, if the Beacon is COMPATT type, may be commanded in increments of 62.5 ms. Even in the case of a fixed-type Beacon, it may be advantageous to enter an exact value if it is known that this particular Beacon is slightly off nominal.

    - SIMRAD Beacons use 31.25 milliseconds as a standard.
    - SONARDYNE HPR types use 62.5 milliseconds as a standard.
    - SONARDYNE MF types use 125 milliseconds as a standard but many types are programmable.

The last two data entry options available under this heading may be accessed by moving to the extreme right-hand column on the initial “Mobile” Beacon panel and pressing the right arrow key again. The “Mobile” Beacon panel will scroll to the left, leaving the rest of the screen unaffected. Figure 2.6.3 illustrates the contents of the new “Mobile” Beacon panel - the rest of the screen is not shown in this illustration.

Fig 2.6.3 Navigation Setup - Screen 2

	CURRENT LEVEL: TOP ->NAV MENU ->NAV SETUP	11:50:35 10 MAR 95 FILE: XXXXXXX.XXX MASTER AFT_TCVR

BEACON NAVIGATION	DEPTH FIXING	BCN IDX	NUM SMPLS	TX PWR	DET TH.	VAL TH.	ATTN	BAND WIDTH	RX MODE
ROV-NAV	NONE	ALL	6	HIGH	14.0	12.0	0 DB	+-100	LINEAR
WELLHEAD	EXT	TCVR 1		MED			10 DB	+-200	LINEAR
ARRAY 2.1	MANUAL	TCVR 2		LOW			20 DB	+-400	LINEAR
ARRAY 2.2	PLS POS						30 DB	+-800	LINEAR
ARRAY 2.3	TELEM								
ARRAY 2.4									

← POSN PARAMS & BEACON PARAMS

These last two Beacon Parameter options are:

- "**DEPTH FIXING**". Defines the depth fixing mode in which the Beacon is to operate. If it is required to change Beacon depth status, move the cursor to the appropriate row of the "DEPTH FIXING" column and press <ENTER>. A dialogue box will appear offering the following options. Move the cursor to the option required and press <ENTER>.

  - **"NONE"** - means depth fixing is not used for this Beacon.

  - **"EXT"** - means the Beacon depth will be input via a serial port on the Navigation Processor. THIS FACILITY IS NOT YET AVAILABLE.

  - **"MANUAL"** - means the Beacon depth is to be entered manually. Activating this option will cause a further dialogue box to appear, enabling the depth value (in Current display Units) to be typed in.

  - **"PLS POS"** - if the Beacon is a depth-monitoring COMPATT type, activating this option will cause the depth data to be transmitted in Pulse Position Telemetry format. THIS FACILITY IS NOT YET AVAILABLE.

  - **"TELEM"** - if the Beacon is COMPATT type, activating this option will result in the Beacon being interrogated for its current depth at regular intervals. A second dialogue box enables the time (in minutes) between depth interrogations to be entered.

- "**BCN IDX**". If two LUSBL/USBL Transceivers are deployed in the system (eg, a dual redundant system), this option determines which combination of Transceivers is to interrogate this Beacon. If it is required to change this, move the cursor to the appropriate row of the "TCVR" column and press <ENTER>. A menu box will appear offering the following options. Move the cursor to the option required and press <ENTER>.

  - **"ALL"** - if both Transceivers are to be used.

  - **"TCVR 1"** - if only TCVR 1 is to be used (or TCVR 2 otherwise).

2.3.2.4 Transceiver Parameters - with Reference to "Mobile" Beacons

The following seven data entry options are available under this heading. These options are available on the screen illustrated in Figure 2.6.3.

- "**NUM SMPLS**". After detection, the system records 8 sets of samples through the received pulse from each of the Transceiver's transducers. Each sample is checked for consistency with its peers in the other transducers and is rejected if it fails this test. Positions are calculated using the remaining data and those position values which are close to the first good one are retained by the system. Provided this number (of retained position values) is more than the values entered as "NUM SMPLS", the system will take the average of these retained position values and use it as the current position fix. If this number of retained position values is less than "NUM SMPLS", a "QA Error" message is displayed.

  This can be useful for noisy or multi-path environments. Any number from 2 to 8 may be entered here. Entering a high number for "NUM SMPLS" minimises the risk of ambiguous results but can cause high rejection rates in noisy underwater conditions. Entering a low number, in noisy conditions, raises the risk of having false position fixes accepted by the system. Generally this should be set to 6.

  Depending on operator experience, it may be necessary to consult Sonardyne for advice before varying this parameter.

- "**TX PWR**". This determines the power level of the interrogate pulse transmitted by the Transceiver. On full power, the "on-axis" or "on-boresight" source level is approximately 193 dB with reference to 1 micro pascal at one metre distant from the transducer face. Consult Sonardyne for advice on the appropriate power level to use in new conditions. A level of "HIGH", "MED" or "LOW" may be chosen. The default level is "HIGH".

  - "Low Power" = - 20 dB on FULL POWER.
  - "Medium Power" = - 10 dB on FULL POWER.
  - "High Power" = FULL POWER.

  In general, it is advisable to use the Full Power setting unless the deployed elements are in a reverberant environment or there is a danger of LUSBL transmissions interfering with users of other acoustic systems in the area.

- "**DET TH.**". [Detection Threshold]. This sets the level (in dB relative to average noise level) at which the system will accept an incoming pulse as being a genuine signal. Any level from 5 dB to 90 dB may be entered. The default level is 14 dB. A level of 10 dB may result in a few false detections but may be necessary in the noisiest conditions.

- "**VAL TH.**". [Validation Threshold]. This sets the level (in dB relative to average noise level) at which the next eight new samples after the Detection sample (as determined by the "DET TH" level) will be accepted by the system. This value will normally be set slightly lower than the Detection Threshold (eg. 12 dB). A level of 8 dB may result in a few false validations but may be necessary in the noisiest conditions.

  The eight samples are those referred to in "**NUM SMPLS**" and are used for computing the bearing of the Beacon relative to the Transceiver.

- "**ATTN**". [Sensitivity]. This, in effect, determines the gain of the receiving circuit in the Transceiver to an incoming acoustic pulse. The gain level is expressed in dB of attenuation. Four levels are available - 0 dB (meaning high gain), 10 dB attenuation, 20 dB attenuation and 30 dB attenuation (meaning low gain). The default level is 0 dB.

- "**BAND WIDTH**". For best range information, the bandwidth should be matched to the duration of the reply (which is a function of the Beacon type). Parameters available are:

  - Bandwidth ±100 Hz (for 8 msec reply)
  - Bandwidth ±200 Hz (for 4 msec reply)
  - Bandwidth ±400 Hz (for 2 msec reply)
  - Bandwidth ±800 Hz (for 1 msec reply)

- "**RX MODE**". Two options are available here:

  - "LINEAR" - means that the system will measure background noise continuously and use this data, together with the Detection and Validation Threshold values, as a basis for deciding if a pulse is valid. In reasonably low noise conditions, this option will allow operation to a 6dB better S/N ratio than with the "LIMITING" mode and yields greater timing accuracy.

  - "LIMITING" - means that the system will not use background noise as a basis for validation but will integrate the pulse signal over the duration of the pulse . If the amplitude of the integrated pulse reaches a level which is greater than 63% of the maximum possible (limiting) amplitude, the pulse will be deemed valid. If signal levels are very high (even with maximum attenuation set) and signal, or noise, is still limiting, limiting mode will give the best results.

2.3.2.5 **Object Positioning by Reference Beacons and DGPS**

This panel is located near the centre of the screen illustrated in Figure 2.6.1 and is used to control the Ship position calculations, the output of position data to other systems and the input, or not, of DGPS data.

Nine categories of data may be controlled, as follows:

- Vessel Name. This is entered in the space below the "**OBJECT POSITIONING BY REF BCNS & DGPS**" box (the vessel name "SONARDYNE" is entered in the example illustrated in Figure 2.6.1).

- "**COLOUR**". Defines the ship display colour on the system "Navigate" mode display. A range of 15 colours is available.

- "**FILTER**". Defines the level of statistical filtering which will be applied to the ship position. The ship position is computed relative to the Reference Beacons.

The dialogue box which appears in this case offers a range of 11 options from 1 (identified as LIGHT) to 10 (identified as HEAVY), plus a "NONE" option. Move the cursor to the option required and press <ENTER>. Note that only raw data is sent in an HPR 309 telegram, whereas in an HPR 418 telegram both raw and filtered data are sent. Detailed information on format and content of HPR 309 and HPR 418 telegrams is given in Appendix F.

- "**DP CONTROL**". For HPR 418 Telegrams, a simple ON/OFF facility is provided for this option. If HPR 309 Telegrams are being used, pressing <ENTER> in this column causes another window (see illustration to the right) to appear enabling three Dynamic Positioning parameters to be controlled. These are:

DP CONTROL		
DP OUT	DP INDEX	DP PERIOD
OFF	0	10.0

  - "**DP OUT**". This determines whether or not the LUSBL System will output ship position data on an HPR 309 telegram to the Ship's DP System. Options available are "NO" (default) or "YES".

  - "**DP INDEX**". This is only used when outputting an HPR 309 telegram to the DP System. The DP index is a pseudo Beacon number used to represent ship position. A value ranging from 1 to 16 may be entered. The DP index should be different from the index of all other beacons in use in the system.

  - "**DP PERIOD**". This determines how often an HPR 309 telegram is output to the DP system.

NOTE: If the value set here means that the HPR 309 telegram is being output more frequently than the position fix update frequency (the APS rate - see later), the system will output repeat values from the most recent fix - provided good fixes are being obtained - up to a maximum of five repeats.

After this, if a fix update is still not available, the system will output "Watchdog" telegrams which signify that the data is invalid but the system is otherwise still working. In the Watchdog telegram, the position data is set to zero but the attitude data continues.

The system will then continue to output Watchdog telegrams until the next fix is obtained.

If good fixes are not being obtained, the system will instead output filtered data up to a maximum of five repeats and then revert to the Watchdog telegram.

- “**SURVEY OUTPUT**”. This determines whether or not the LUSBL System will output position data to a Survey System. Options available are “**OFF**” (default) or “**ON**”. More information on the Survey output from the system is given in Appendix G.

- “**APS UPDATE**”. This determines how frequently the Reference Beacons are interrogated and how often the Ship’s position is re-calculated by LBL means. Entering a value of 0 prevents the Reference Beacons from being interrogated. Otherwise a value ranging from 0.5 seconds to 99 seconds may be entered.

  If a value is not set for this parameter, the system takes the value of the “**UPDATE**” parameter from the first Mobile Beacon transferred into the Reference Beacon category.

- “**DGPS**”. This determines whether or not the LUSBL System will accept position reference data from the Ship’s DGPS System. Options available are “DISABLED” (default) or “ENABLED”.

- “**DGPS ACC**”. This defines the position accuracy level (expressed in current System Display Units) of the data from the DGPS. A value in the range 1.0 (very accurate) to 99.9 (very inaccurate) inclusive may be entered. In the absence of a known value, the default value of 5.0 may be used.

- “**ACTIVE TCVR**”. Displays the name of the Transceiver currently being accessed by the system.

2.3.2.6 Calibration Control

This panel is located near the centre of the screen illustrated in Figure 2.6.1 and is used to define the accuracy target for the position of Reference Beacons.

The value to be entered in the “**CAL TARGET**” box is the radius of the maximum acceptable error circle for the position of the Reference Beacons - in current System Display Units. A value in the range 0 to 99.99 inclusive may be entered. A typical value is 0.5 metres (or 1.64 feet).

A “COLLECT BASELINES” button is available also to start the system collecting baselines once it is judged that enough Reference Beacons are within the position accuracy target [see paragraph 2.3.2.7 for information on <u>how</u> this is judged]. The button is operated by using the arrow keys until the button is highlighted and then pressing <ENTER>.

2.3.2.7 Beacon Co-ordinates - Reference Beacons

The “Reference Beacons” panel is located near the bottom of the screen illustrated in Figure 2.6.1. As with the Beacon Navigation panel, the volume of data which can be set for Reference Beacons is too great to be accommodated on a single screen width and a scrolling function is provided to enable the user to move his view of the page sideways as required.

As for the Beacon Navigation panel, Reference Beacon parameters may be changed either by editing entries in this panel or by editing on the Beacon Summary page (see paragraph 2.3.2.1 and Figure 2.6.2). In this panel on the Navigation Setup page, parameters may be set as follows.

Four data entry options are available under the “BEACON CO-ORDINATES” heading.

- “**EASTING**”. This is the easting co-ordinate of a Reference Beacon in either local or global earth reference plane co-ordinates in current System Display Units. A value between 0 and ±9,999,999.0 may be entered.

- “**NORTHING**”. This is the northing co-ordinate of a Reference Beacon in either local or global earth reference plane co-ordinates in current System Display Units. A value between 0 and ±9,999,999.0 may be entered.

- “**DEPTH**”. The current depth of a Reference Beacon. A value between 0 and 9,999.0 may be entered in the current System Display Units.

- “**ERR**”. [ERROR]. This column displays the calculated value, for each Reference Beacon, of the radius of the Beacon’s position error circle. These values may be used to judge when it is appropriate to signal to the System to measure the baselines. This value slowly reduces with each navigation cycle until it is less than the calibration target.

  Reference Beacons can be “dropped down” from the Mobiles panel, in which case the **EASTING**, **NORTHING**, **DEPTH** and **ERR** parameters are those that applied when the Beacon was last interrogated. All the while the **ERR** value is greater than the calibration target error, the system will continue to calibrate the Beacon - ie, updating the easting northing and depth values. Once the **ERR** value is less than the target error, the calibration process is complete and will cease.

  If a filter setting of 10 is used, then the co-ordinates will never change - unless the target error is reduced to a value less than the Beacon error (in which case calibration is resumed). Setting the filter to a value less than 10 will allow noise to slowly increase the Beacon’s error value and, when it exceeds the target value, calibration resumes. The lower the filter value, the faster this happens. This feature is useful for Beacons whose position can change very slowly (e.g. a Beacon anchored to the seabed on a tether that allows it to sway in a current) and it is desired to keep topping up the calibrated position.

NOTE: The co-ordinates and error value for a Beacon cannot be changed whilst navigating.

2.3.2.8 Positioning Parameters - Reference Beacons

Five data entry items are available under this heading - three (“**STATUS**”, “**FILTER**” and “**DP OUT**”) on this screen and two on the next screen (see paragraph 2.3.2.9). The meaning of the items and the range of entry values which can be made are as described in paragraph 2.3.2.2 for the “Mobile” Beacons except that the “**REF BCN**” option in the “**STATUS**” column is now replaced by “**MOBILE BCN**” - enabling the Beacon concerned to be transferred back to the mobile Beacon panel.

2.3.2.9 Positioning Parameters - Reference Beacons continued

The remaining data entry options available under this heading may be accessed by moving to the extreme right column of the Positioning Parameters panel on the initial screen and then pressing the right arrow key once again. The Reference Beacons window will scroll to the left, leaving the top part of the screen unaffected. Figure 2.6.4 illustrates the contents of the scrolled Reference Beacons window - the rest of the screen is not shown in this illustration.

Fig 2.6.4 Navigation Setup – Screen 3

REFERENCE BEACONS	POSITIONING PARAMETERS STATUS	FILTER	DP_OUT	COLOUR	SURVEY	BEACON PARAMETERS INTER	REPLY	TAT
ARRAY 1.1	READY	NONE	YES		OFF	1	9	125.00
ARRAY 1.2	NOT SET	1 LGHT	NO		NO	5	2	
ARRAY 1.3	OFFLINE	5 MED				H O		
ARRAY 1.4		10 HVY				H □		
						R1	H Δ	
						H X		
	◄ POSN PARAMS & CO-ORDINATES					TCVR PARAMS ►		

The remaining two data entry items under this heading - “**COLOUR**” and “**SURVEY**” - may now be accessed. The meaning of the items and the range of entry values which can be made are as described in paragraph 2.3.2.2 for the “Mobile” Beacons.

2.3.2.10 Beacon Parameters - Reference Beacons

There are five data entry options available under this heading - three on the right hand side of the screen illustrated in Figure 2.6.4 and two on the left hand side of the screen illustrated in Figure 2.6.5. The three data entry options available on the first screen are “**INTER**”, “**REPLY**” and “**TAT**”. The meaning of the items and the range of entry values which can be made are as described in paragraph 2.3.2.3 for the “Mobile” Beacons.

The last two data entry options available under this heading may be accessed by moving to the last column in the Beacon Parameters panel and then pressing the right arrow key once again. The Reference Beacon window will scroll to the left, leaving the rest of the screen unaffected. Figure 2.6.5 illustrates the contents of the fully scrolled Reference Beacon window - the rest of the screen is not shown in this illustration.

Fig 2.6.5 Navigation Screen Setup – Screen 4

REFERENCE BEACONS	DEPTH FIXING	BCN IDX	NUM SMPLS	TX PWR	DET TH.	VAL TH.	ATTN	BAND WIDTH	RX MODE
ARRAY 1.1	NONE	ALL	6	HIGH	14.0	12.0	0 DB	+-100	LINEAR
ARRAY 1.2	EXT	TCVR 1		MED			10 DB	+-200	LINEAR
ARRAY 1.3	MANUAL	TCVR 2		LOW			30 DB	+-400	LINEAR
ARRAY 1.4	PLS POS							+-800	LINEAR
	TELEM								
	◄ BEACON PARAMS & POSN PARAMS & CO-ORDINATES								

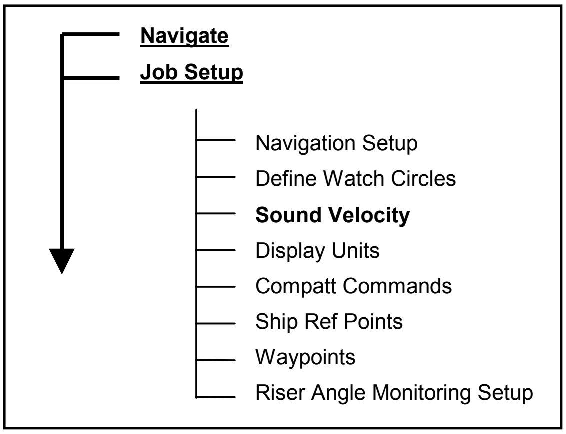
These last two data entry options on this last screen are “**DEPTH FIXING**” and “**BCN IDX**”. The meaning of the items and the range of entry values which can be made are as described in paragraph 2.3.2.3 for the “Mobile” Beacons.

2.3.2.11 **Transceiver Parameters - Reference Beacons**

Seven data entry items are available under this heading -,“**NUM SMPLS**”. “**TX PWR**”, “**DET TH.**”, “**VAL TH.**”, “**ATTN**”, “**BANDWIDTH**” and “**RX MODE**”. The meaning of the items and the range of entry values which can be made are as described in paragraph 2.3.2.4 for the “Mobile” Beacons.

These data entries are the last to be made on the “**Navigation Setup**” page. If, on exiting from this page, the system detects that two or more beacons have been set up with the same frequency, a warning message will be displayed and one of the beacons will have to be set to a different frequency to clear the problem.

2.3.3 Sound Velocity

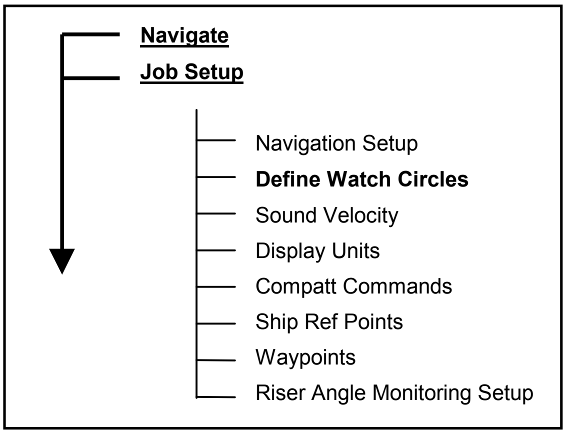


Return through the menu to the “**Job Setup**” menu option and activate “**Sound Velocity**”.

The velocity of sound is necessary to obtain the correct range from the timing measurement and the correct direction or bearing from the "time-phase" measurements.

Four parameters are listed. The water depth value is now only needed by the system if a “**% water depth**” limit is selected in “**Watch Circles**” mode (see Section 2.3.4) and need only be entered if this is to be used. Enter the sound velocity corresponding to the LUSBL Transceiver depth, the mean harmonic sound velocity through the water column between the Transceiver and the Beacon array and the sound velocity on the seabed.

2.3.4 Define Watch Circles



Return through the menu to the “**Job Setup**” menu option and activate “**Define Watch Circles**”.

This function will only operate when a Gyro-Compass input is available and the seabed Beacon array is being used as the DP reference. A watch circle may be set up around the current ship position. When the ship moves outside this circle a level 1 alarm will be generated.

First, the radius of the circle must be defined either in Display Units (metres or feet) or in percentage of water depth (in cases where the angle of deviation of the ship’s position from the vertical at the DP reference point is important and has to be controlled). Note, however, that if % water depth is to be set, then water depth must previously have been set in the Sound Velocity page - see Section 2.3.3.

Next, the centre of the circle needs to be set. [For example, this could be the Ship position displayed in a Ship Data Box]. Finally, the watch circle mode should be enabled using the enable/disable facility.

Once triggered, the alarm will continue unless cancelled by any of the following actions:

- the ship returning within the watch circle
- the operator pressing the "ARM" key and the "ALARM" key together - on the Type 7783 Monitor/Keypad - or on the Type 7941 Keyboard unit as appropriate
- the operator re-centring the watch circle
- the operator disabling the watch circle facility

2.3.5 COMPATT Commands

Return through the menu to the "**Job Setup**" menu option and activate "**Compatt Commands**".

Navigate
Job Setup

- Navigation Setup
- Define Watch Circles
- Sound Velocity
- Display Units
- **Compatt Commands**
- Ship Ref Points
- Waypoints
- Riser Angle Monitoring Setup

This option allows COMPATT commands to be typed in - using the format defined in the Sonardyne PAN MK2 OPERATING MANUAL (OM_7145) - see also Appendix I for a list of PAN commands.

The command is transmitted to the appropriate COMPATT and the telemetered reply is decoded and displayed as defined in the PAN manual. Note that, while the system is waiting for a reply to the command, the cursor is not displayed.

This option is useful for checking COMPATT status, battery count, etc, but a knowledge of Sonardyne PAN terminology is necessary. See also paragraph 2.3.2.1 and Figure 2.6.2.

2.3.6 Ship Ref Points

Return through the menu to the "**Job Setup**" menu option and activate "**Ship Ref Points**". An integrated function page opens. This page is illustrated in Fig 2.7 which follows.

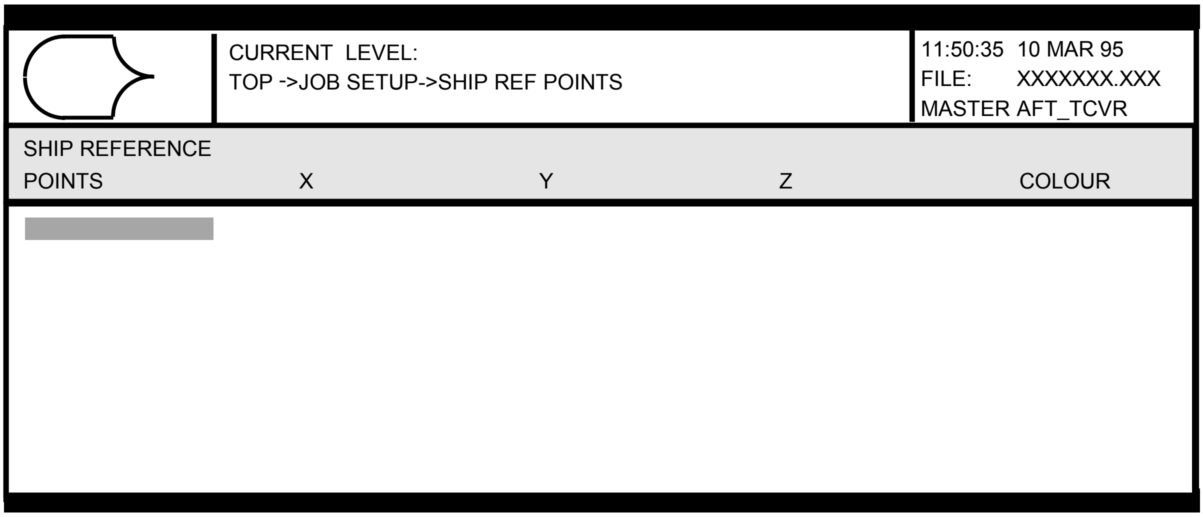
Navigate
Job Setup

- Navigation Setup
- Define Watch Circles
- Sound Velocity
- Display Units
- Compatt Commands
- **Ship Ref Points**
- Waypoints
- Riser Angle Monitoring Setup

Enter the name of the Ship Reference Point in the highlighted box as illustrated in Fig 2.7. Use the right arrow key to move across to the remaining fields, entering the X, Y and Z co-ordinates of the Ship Reference Point (usually the centre of rotation) in the Ship Grid. On entering the colour field, press <ENTER> and a colour menu box appears - choose a display colour and press <ENTER> to confirm.

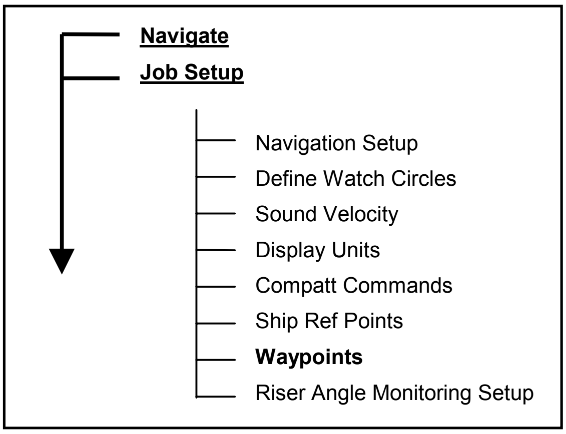
Repeat this procedure for the Transceiver (both Transceivers if a dual-redundant system).

FIG 2.7 SHIP REFERENCE POINTS FUNCTION PAGE DISPLAY



2.3.7 Waypoints

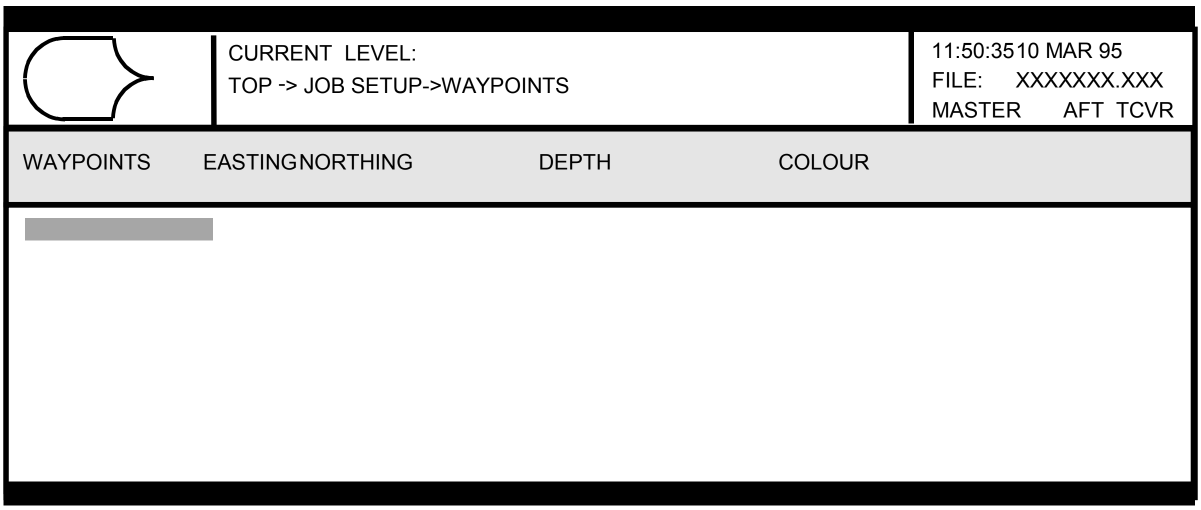
Activating this option enables a range of Ship and other reference points to be defined. An integrated function page opens.



This page is illustrated in Fig 2.8 which follows.

Enter the name of whichever Mobile beacon, Reference Beacon or Seabed Waypoint is to be used as a Waypoint in the highlighted box as illustrated in Fig 2.8. Use the right arrow key to move across to the other fields and enter Eastings, Northings, Depth and display Colour for the Waypoint. Press <ENTER> on conclusion of all data entry.

FIG 2.8 WAYPOINTS FUNCTION PAGE DISPLAY



2.3.8 Riser Angle Monitoring Setup

Return through the menu to the "**Job Setup**" menu option and activate "**Riser Angle Monitoring Setup**".

This option applies only to special purpose Riser Angle COMPATT (RAC) systems designed to make accurate measurements of the Riser Angle. Alarm limits and a range of COMPATT parameters may be set. When this option is activated, the screen changes to show an integrated function page, as illustrated in Fig 2.9 which follows.

Navigate
Job Setup
- Navigation Setup
- Define Watch Circles
- Sound Velocity
- Display Units
- Compatt Commands
- Ship Ref Points
- Waypoints
- **Riser Angle Monitoring Setup**

FIG 2.9 RISER ANGLE COMPATT SETUP DISPLAY

CURRENT LEVEL:
TOP -> NAV SETUP->RISER ANGLE MONITORING

11:50:3510 MAR 95
FILE: XXXXXXX.XXX
MASTER AFT_TCVR

ALARM LIMIT 1	3.00
ALARM LIMIT 2	5.00

	BEACON	INTERNAL/	ROLL	PITCH	BOP STACK	TELEMETRY	
FUNCTION	NAME	ADDRESS	EXTERNAL	OFFSET	OFFSET	BEARING	UPDATE MIN
RISER	RAC BEACON	606	INTERNAL	0.00	0.00		
BOP	RAC BEACON	606	EXTERNAL	0.05	0.12	23.00	20.00

2.3.8.1 **Setting Initial Values**

In the Alarm Limit panel enter the required values for:

- Alarm Limit 1 Angle ("cautionary" limit). The system compares the Riser Angle measured by the Riser Angle COMPATT with this limit value and, if exceeded, triggers a Level 2 System Alarm. This Limit Angle should be set initially to 14°. [Once the offsets - see later - have been collected, this angle is set, typically, to 0.5°].

- Alarm Limit 2 Angle ("failure imminent" limit, triggering a Level 1 System Alarm). Alarm Limit 2 defines the larger of the two Alarm Circles on the display. This Limit Angle should be set initially to 15°. [Once the offsets have been collected, this angle is set, typically, to 1.0°].

Eight other parameters should be entered in the lower panel, as follows. Go through this procedure twice, firstly for the RISER and then for the BOP.

- "**FUNCTION**". This refers to the function being performed by the COMPATT concerned. The entries in this column (RISER or BOP - Blow Out Protector) are fixed by the system.

- "**BEACON NAME**". Move the cursor to the "Beacon Name" column on the RISER row and press <ENTER>. A list of Riser Angle Beacons already defined for positioning via the Nav Setup page will appear. Highlight the Beacon name applicable to this Riser (in some installations, the "Beacon" fitted here will be a slave Inclinometer Unit connected to a COMPATT being used on the BOP).

  On the second pass through this procedure, enter the Beacon name applicable to the BOP - again, it may be a slave Inclinometer Unit in some installations.

- "**ADDRESS**". Enter the Beacon address.

- "**INTERNAL/EXTERNAL**". If the Beacon is a COMPATT, enter INTERNAL. If it is a slave Inclinometer Unit connected to a COMPATT, enter EXTERNAL.

- "**ROLL OFFSET**". Enter a Roll offset value of zero at this stage. Correct values will be entered later once offsets have been collected.

- "**PITCH OFFSET**". Enter a Pitch offset error of zero at this stage.

- "**BOP BEARING**". Leave a blank in the RISER row. In the BOP row, enter the bearing (in degrees) of the Beacon inclinometer Roll axis relative to seabed grid North. Thus, if the Roll axis of the Beacon is pointing to starboard of North, enter a number between 0 and 180 degrees, as appropriate, etc.

- "**TELEMETRY UPDATE MIN**". This is the frequency at which it is required to update the BOP angle - in minutes. Leave a blank in the RISER row. In the BOP row, set this value initially to 1 minute (once offsets have been collected, this value should be increased to at least 20 minutes).

Having set initial values on this page, press <ESC> twice to return to the top level menu. This will save all settings to the job file.

2.3.8.2 Measuring Offsets

Offsets are measured by deploying the BOP and Riser at a sufficient depth (say 250 to 300 feet) below the Rig so as to create a pendulum.

Once this has been done, select "Navigate" from the top level menu and wait for the system to establish communications with the COMPATT. One of the Data Boxes should now be set to display Riser Angle data and offset values recorded, as follows:

- Select "**Data BOXES**" and then (say) "**Box 4 Position Data**" followed by "**Riser Angle Data**".

  - The system will now use telemetry once per minute to collect values for:
  - RR (Riser Roll)
  - RP (Riser Pitch)
  - BR (BOP Roll)
  - BP (BOP Pitch)

- Record thirty sets of values and then take averages of the RR, RP, BR and BP values to form the offsets to be entered on the setup page.

2.3.8.3 **Entering Offsets**

Exit "**Navigate**" and return to the "**Riser Angle Monitoring Setup**" page and make the following entries.

- Change the Alarm Limit values to the required angles (typically 0.5° for Alarm Limit 1 and 1.0° for Alarm Limit 2).
- Enter the calculated average values for the Roll and Pitch offsets for both the RISER and BOP beacons.
- Enter a "**Telemetry Update Min**" value of at least 20 minutes.

The system is now set up ready for use once the BOP and Riser have been fully deployed.

2.4 SETUP PROCEDURE FOR A TYPICAL JOB

The step by step process involved in setting up the system to carry out a typical job is given in this section. Although strictly applicable to one particular job (one or two options are given), it should be possible for an experienced operator to adapt the steps given here to suit a variety of other jobs.

2.4.1 Setting "Units" and "Sound Velocity"

If not already set, these parameters should be set up as described in Sections 2.3.1 and 2.3.3.

2.4.2 DGPS Setup - if Fitted

Ignore this section if no DGPS system is fitted.

This menu option is located in the Installation menu as shown to the right. On selecting the "**DGPS Receiver**" option, an integrated function page opens. All that is necessary in setting up for a job is to set the system to "ENABLED" - see Section 2.3.2.5 for more detail on this.

Installation

- Acoustic Transceivers
- **DGPS Receiver**
- Attitude Sensors
- I/O Port Allocation and Setup
- Set/Change Installation Password

NOTE: If DGPS is already being used by the ship's DP system, use DGPS within the LUSBL system only while achieving absolute calibration of beacons. DO NOT use it when using the LUSBL in "**Navigate**" mode for DP purposes.

2.4.3 Acoustic Beacons

Carry out this setup procedure before deploying beacons to the locations on the seabed (or wherever appropriate) required by the current job.

The Beacon setup procedure is carried out using the "**Navigation Setup**" integrated-function page from in the "**Job Setup**" menu. In carrying out the Beacon setup procedure given in the following, refer to Section 2.3.2 for full detail on how to make entries on this page.

The procedure to be followed in a practical setup operation will depend on circumstances - in particular whether or not DGPS is available and whether or not the beacon positions are known from a survey.

2.4.3.1 Beacon Setup with no DGPS and no Survey

If this is an established installation, there will be a number of Beacons already entered on the "**Nav Setup**" page for this job (there may be Beacons entered on the Ship List as well - see Section 2.3.2). Proceed as follows:

- ❑ Starting with one of the Beacons (the only one if USBL) which is intended to be used as a Reference Beacon, select this Beacon type from the Beacon List (or the Ship List, if not already shown on the Beacon Navigation panel - see Section 2.3.2) and check/enter its details in the Beacon Navigation panel on the "**Nav Setup**" page. For a typical Beacon:

Filter	:	5 (Medium)
DP Output	:	ON
Colour	:	As required
Update Rate	:	2 seconds
Interrogation Channel	:	Beacon IIF (Default)
Reply Channel	:	CRF (Default)
Turn-around Delay	:	250 millisecs
Depth Fixing	:	None (Default)
Number of Samples	:	6 (Default)
Transceiver TX	:	Medium
Threshold Levels	:	14dB & 12 dB (Defaults)
Attenuation	:	30 dB
Band Width	:	200 dB (Default)
Receiver Mode	:	Linear (Default)

- ❑ Change the Beacon Status from "Offline" to "Not Set".
- ❑ Set the system into "**Navigate**" mode - see Section 2.2.1. The system will now calculate the position of the Beacon with reference to the ship.
- ❑ Convert this Beacon to a Reference Beacon and the system will display the Beacon position in the "**Reference Beacons**" panel on the "**Nav Setup**" page (which may be accessed from within Navigation mode).
- ❑ In this panel, set "**Err**" to zero and "**Filter**" to 10.

For a USBL system with one Transceiver and one Beacon, the procedure is now complete.

For an LUSBL system:

- ❑ To set up the rest of the Reference Array, enter the remaining Beacons from the System List (or move them down from the "Mobile" Beacon panel if there already) as Reference Beacons and set their filter values also to 10.
- ❑ In the "**Calibration Control**" panel, set the "**Cal Target**" to a value which is either 0.2% of the slant range to the Beacon furthest away from the ship or to 0.3m (whichever is the greater). The system will then calibrate itself and the "**Err**" values for the remaining Beacons will reduce and stabilise on a value close to or equal to zero.

2.4.3.2 Beacon Setup with no DGPS but with Survey Positions available for the Beacons

For a USBL system, start with the "**Nav Setup**" page in the "**Job Setup**" menu:

- Enter the Beacon, selecting the appropriate type from the System List, as a Reference Beacon (or move it down from the "Mobile" Beacon panel if already there) and change it from "Offline" to "Not Set".

- If the Beacon is to be used as an absolute reference, enter the Eastings, Northings and Depth from the survey data. Set "**Err**" to zero and "**Filter**" to 10. If it is to be used as a relative reference, enter Eastings and Northings as 0,0 (or as 5000, 5000 if it is preferred to avoid negative numbers).

For an LUSBL system, enter the remaining beacons as described in paragraph 2.4.3.1 and set the system to self-calibrate as before.

2.4.3.3 Beacon Setup with DGPS

Set the system into "**Navigate**" mode - see Section 2.2.1.

- As before, start with a Beacon (the only one if USBL) which is intended to be used as a Reference Beacon, select this Beacon type from the System List (or from the "Mobile" Beacon list if already there) and check/enter its details in the Beacon Navigation panel on the "**Nav Setup**" page - accessible from within Navigation.

- Change the Beacon Status from "Offline" to "Not Set". The system will now calculate the beacon position in UTM co-ordinates with reference to the DGPS data.

- Convert this Beacon to a Reference Beacon. The system will display the Beacon in the "**Reference Beacons**" panel on the "**Nav Setup**" page using the UTM co-ordinates calculated whilst it was a "mobile" Beacon.

- Set "**Err**" to zero and "**Filter**" to 10.

For a USBL system with one Transceiver and one Beacon, the procedure is now complete.

For an LUSBL system:

- Enter/select the remaining Beacons as described above for the first Beacon and transfer them to Reference Beacon status once the system has calculated their position with reference to DGPS.

- Set the "**Cal Target**" to 0.2% or 0.3m (whichever is the greater), as before. Set the system to self-calibrate as before.

For an LUSBL system which is required for DP purposes, no further action need be taken.

2.4.3.4 **Beacon Setup for Survey Applications**

For survey applications, or any other application where the highest accuracy is required, all Beacons must be COMPATT type and the LUSBL should be set to measure the array baselines, as follows:

- Set the system into "**Navigate**" mode - see Section 2.2.1.

- Go to the "**Nav Setup**" page from within Navigation, move the cursor down and across until it is over the "**Collect Baselines**" button. Press <ENTER>. The system will now use each COMPATT in the reference array in turn to measure, acoustically, the baseline distances to each of the other COMPATTs. Navigation will continue whilst this is in progress, using the remaining COMPATTs for navigation purposes. As the process continues, the "**Err**" values will decrease and become stable.

- When the process is complete, set "**Err**" to zero and "**Filter**" to 10.

2.4.4 Archiving the Job

Having reached this point in the Job setup process, it is appropriate to archive the settings entered for this job.

Before doing this, however:

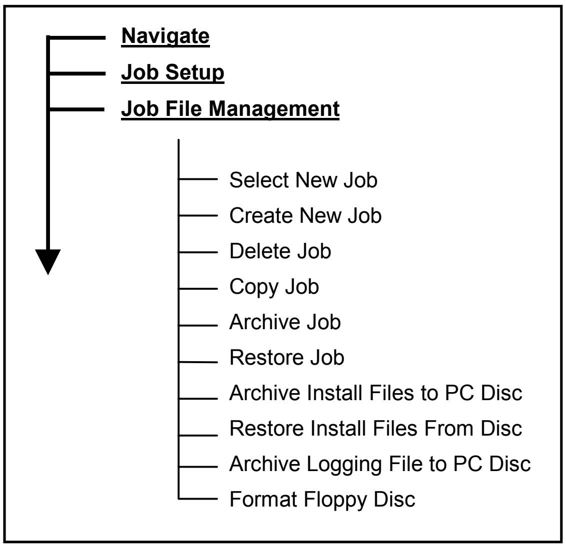
- Enter Sound Velocity data, if not already done - see Section 2.2.3.

- Set up Ship Reference Points, as described in Section 2.3.6. Include the Transceiver(s) as Reference Point(s) as well as one for the ship itself (usually the centre of rotation).

Having done this, return to the top level menu, select "**Archive Job**" from the "**Job File Management**" menu. Follow the on-screen prompts to copy the job details to a floppy disk.

2.5 JOB FILE MANAGEMENT

A "Job" is a piece of work to be done, using a particular system configuration to carry out a particular task. A "Job File" contains the information necessary to set up the system to perform that job. The system stores a number of Job Files on the hard disc. The current Job File is the one currently chosen for the system to perform (i.e., that "belongs to" the current configuration doing the current task).



Management of Job Files (creating a new one, choosing a different one from those stored on the hard disc, etc) is carried out under the "**Job File Management**" menu option, as illustrated here to the right.

Return through the menu to the Top level and activate "**Job File Management**". This main menu option allows the operator to:-

- "**Select New Job**". Choose any stored Job File to be the Current Job File.

- "**Create new Job**". Activate this option if it is required to create a completely new Job File on the hard disc. On activating this option, the user will be prompted for a description. Type in a description and press <ENTER>. Press <ESC> twice to return to the top level menu. The new Job File automatically becomes the current Job File.

- "**Delete Job**". Delete an existing Job File on the hard disc.

- "**Copy Job**". Copy a Job File on the hard disc to another on the hard disc. This allows the operator to save a known working Job before modifying it.

- "**Archive Job**". Archive a Job File by copying a file from the hard disc to a floppy disc in a file format of your choice.

- "**Restore Job**". Restore a Job File by copying a file from a floppy disc to the hard disc. This file automatically becomes the current job file.

- "**Archive Install Files to PC Disc**". Copy Installation File(s) to a floppy **disc** - in PC text format.

- "**Restore Install Files from PC Disc**". Restore Installation File(s) from an external PC format floppy Disc.

- "**Archive logging file to PC disc**". The system continuously logs data to the hard disc. This option copies the most recent data to a PC-formatted floppy disc in CSV (Comma Separated Variable) format. Data in this format is readily imported into, for example, a spreadsheet.

More information on the logging output from the system is given in Appendix H.

- "**Format Floppy Disc**". Formats a floppy disc - either standard or high density format and either OS9 or standard IBM PC format.

NOTE. Archiving and restoring Installation files is best done immediately following a reboot.

2.6 INSTALLATION MODE

This area of the menu is used to configure those system parameters which are likely to be common to all jobs on a particular ship. When appropriate, it may be accessed by returning through the menu to the Top level and activating "**Installation**".

Full details are given in Section 4 of this manual.

2.7 SYSTEM SETUP MODE

This area of the menu is used to set system Time and Date and adjust Display Brightness. A facility is also included here to carry out a range of System Tests. When appropriate, it may be accessed by returning through the menu to the Top level and activating "**System Setup**".

Full details are given in Section 4 of this manual.

2.8 SIMULATE MODE

This section allows the operator to run a Job from a simulation. It has the same menu structure as **Navigate** and is an excellent way of becoming familiar with the way the system operates.

FIG 2.10 FULL NAVIGATE MENU

- Navigate
  - Nav SETUP - as in the main Job Setup menu (see Figure 2.2 and Section 2.3.2)
  - Job SETUP
    - blank
    - Define WATCH CIRCLES
      - Watch Circle RADIUS
      - CENTRE Watch Circle
      - Enable/Disable Watch Circle
    - Sound VELOCITY
    - Display UNITS
    - Compatt Commands
    - Ship Ref Points
    - WAYPOINTS
    - ARCHIVE Job File
    - Archive log files to disk
  - Chart DISPLAY
    - Circles & Grid OFF
    - Range CIRCLES Only
    - GRID Only
    - Range CIRCLES and GRID
    - Chart Outline COLOUR
    - Display RISER ANGLES
  - Monitor BRIGHT
    - Dimmer
    - Brighter
  - blank
  - Chart CENTRE
    - SHIP Centred Chart Display
    - MOBILE Beacon Centred Chart Display
    - REFERENCE Beacon Centred Chart Display
    - Ship Ref Point Centred Chart Display
    - WAYPOINT Centred Chart Display
  - Chart SCALE
    - ZOOM IN
    - ZOOM OUT
    - 1 : 10
    - 1 : 100
    - 1 : 500
    - 1 : 1000
    - 1 : 5000
  - Chart Co-ord FRAME
    - SHIP Frame
      - GYRO North Up
      - Seabed Grid North Up
      - BOWS Up
      - STERN UP
    - SEABED Frame
      - Gyro North Up
      - Seabed Grid North Up
  - Trail CONTROLS
    - Trails Off
    - LINE Trails
    - DOT Trails
    - CLEAR Trail Histories
  - Data Boxes
    - Box 1 Position Data
    - Box 2 Position Data
    - Box 3 Position Data
    - Box 4 Position Data
      - Ship Position Data
      - Mobile Target Data
      - Seabed Target Data
      - ATTITUDE Sensor Data
      - RISER Angle Data
      - Ship Ref Point Data
      - WAYPOINT Data
      - CLEAR BOX
    - FROM/TO Data Box
      - CARTESIAN Coords
      - RANGE AND BEARING
        - Relative Position Data From
        - Relative Position Data To..

SECTION 3

3. INSTALLATION AND CONNECTIONS – HARDWARE

From the user point of view, the installation procedure for an LUSBL system is virtually the same as that for a USBL system. Differences do arise as far as the Installation Setup procedure is concerned (see Section 4) but not in the installation of hardware. In the case of a dual-redundant version of the LUSBL there are hardware installation differences and these are covered in Appendix K.

3.1 INSTALLING THE NAVIGATION PROCESSOR

Error! Reference source not found. is an outline drawing of the Type 7784 Navigation Processor. The unit is a "4U" high 19 inch rack-mounting unit. It is possible to mount the unit in three ways, as follows:-

The first method is to mount the unit on the 4 screws on the 2 outer front sub-panels. The unit is designed to take the weight of the unit on these panels. The screws are supplied with the mounting kit and are M6 posidrive PAN-headed screws with cup washers.

The disadvantage of this method is that it may be difficult to gain access to the top of the unit (in the rare event that the power supply has to be replaced). Similarly, access to the cabling on the rear panel may be awkward unless there is access through the rear of the frame.

To overcome the lack of access, the frame into which the processor is mounted may be hinged. The swinging frame should also allow the bottom tray to hinge down so that easy access is available for the Transceiver power supplies and communications drivers mounted on this tray.

The second method is to place a simple tray below the unit capable of supporting the weight of the unit and securing the unit using the 4 front sub-panel screws as in the first method. This will allow the unit to be withdrawn away from the rack mount for access to the top and rear. However this method does make it extremely awkward to access components in the bottom tray.

The third method is to mount the unit on runners. The unit is designed to take Schroff 69,000 series runners as standard. The Schroff type number is 69,000-131 to 136 depending on the depth of the racking system. This method does allow easy access to all faces of the unit.

A 115V or 240V AC 50/60 Hz power supply is required (see Section **Error! Reference source not found.** for full details).

In some installations, it may be necessary to re-configure some of the hard-wired links fitted to certain of the printed circuit cards in the Navigation Processor. This is described in each sub-section of Section 3. Appendix J contains more information on this.

For units with Type I bottom trays it is necessary to fit a serial cable from the connector on the back of the CPU spreader marked ‘SER2’ (or ‘U.S.B.L. TRANSCEIVER’ on older systems) to the connector on the bottom tray labelled ‘SERIAL’.

3.2 INSTALLING THE TYPE 7783 MONITOR/KEYPAD

The mounting options for the Type 7783 Monitor/Keypad unit are similar to those for mounting the Navigation Processor. An outline drawing of this unit is given as **Error! Reference source not found.**.

Access to the rear panel is required for the cabling (mains lead, video cable and keypad serial I/O - all from/to the Navigation Processor) and for changing a fuse.

Access to the top of the unit is required for servicing the keypad PCB, a 12V power supply, the inverter for a fluorescent back-light and the back-light itself. Replacement of the front panel keypad needs access to the top, front bottom and the front side of the unit. Replacement of the monitor itself requires the whole unit to be withdrawn.

Ideally, the two units (Navigation Processor and Monitor/Keypad) should be mounted within a 5m cable run of each other.

A 115V or 240V AC 50/60 Hz power supply is required (see Section **Error! Reference source not found.** for full details). This is usually from the mains outlet at the back of the Navigation Processor using a monitor mains lead 7783-061 (See Figure 3.9.1.)

The monitor is linked to the Graphics Spreader PCB at the rear of the Navigation processor by an RGB monitor lead 7784-045. (See Figure 3.9.2)

The keypad in the monitor is connected to the CPU spreader board in the rear of the Navigation processor by a 7784-042 Keypad to Keyboard lead. (See Figure 3.9.3. If an external keyboard (7784-148) is fitted, a Twin Keyboard/keypad adapter 7784-131 (see Figure 3.9.5) is used. This is plugged into the CPU spreader and the keyboard and Keypad to Keyboard leads are plugged into it.

Alternatively a standard VGA monitor can be used. For VGA output, remove LK3 from the VME Graphics board and fit LK13 pins 1-2 on the Graphics Spreader board. Use a VGA Monitor cable instead of the RGB Monitor cable (see Appendix J for details of the link change). A 7784-148 keyboard is then used.

3.3 INSTALLING THE TYPE 7940 MONITOR AND TYPE 7941 KEYBOARD UNITS

In the case of the newer units based on the 17 inch display, there are two units to be installed in place of the single Type 7783 Monitor/Keypad unit. Installation dimensions for these units in a 19 inch rack are as follows:

- Type 7940 Monitor unit - 8U
- Type 7941 Keyboard unit - 2U

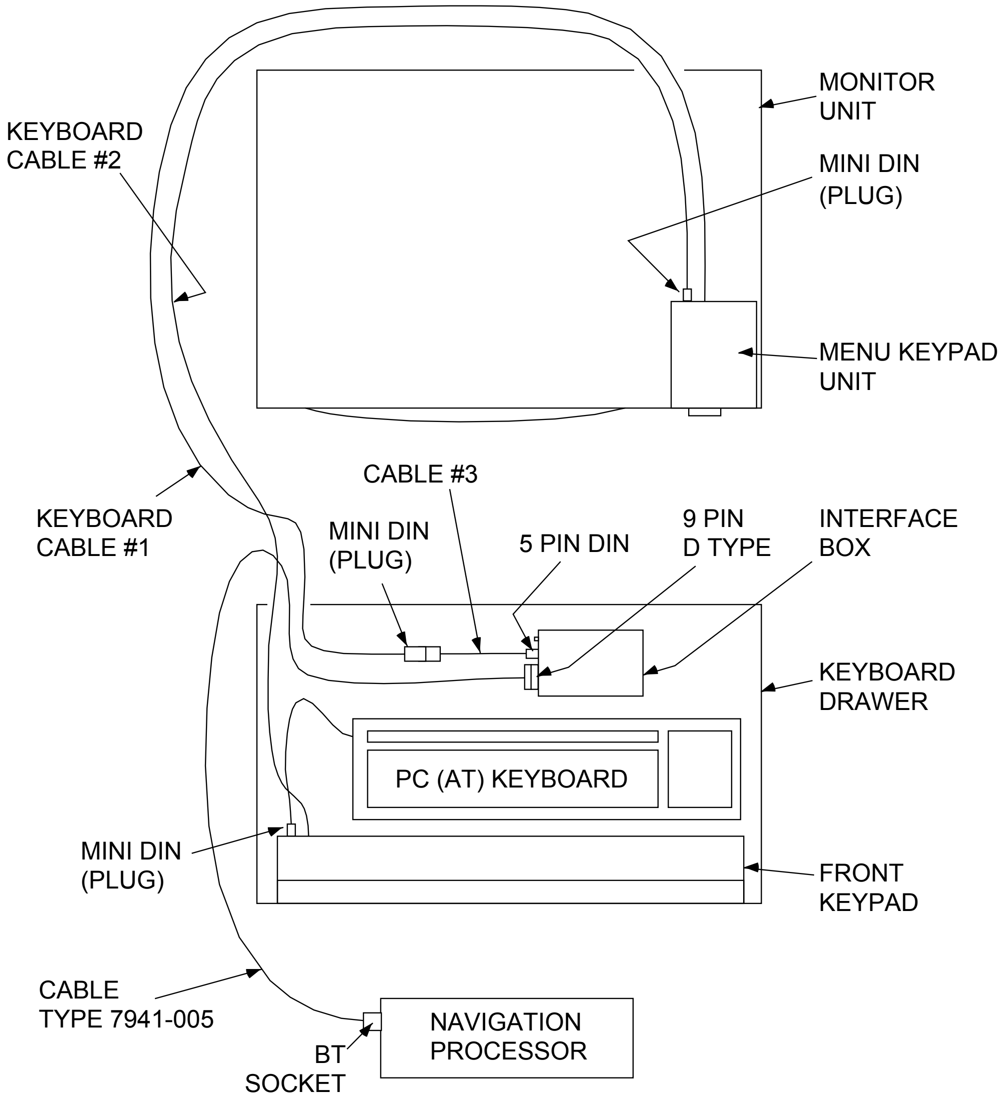
The Monitor unit should be mounted above the Keyboard unit.

Connections to these units are relatively straightforward. Mains input and video (RGB) inputs are as for the Type 7783 Monitor/Keyboard unit and use the same cables.

The PC AT keyboard in the Type 7941Keyboard unit, the front keyboard on the same unit and the keypad on the Type 7783 Monitor/Keypad are all “daisy-chained” together to the Interface Box (Ref: 265 0738), as illustrated in Fig 3.1, which follows. The Interface Box converts the PC standard keyboard signals to the serial TTL format required by the Navigation Processor and outputs these signals via a 9 pin D type connector to the Navigation Processor using a new interface cable (Type 7941-005 - see Figure 3.9.4).

The cables required for the daisy-chaining connections are standard PC keyboard cables using the AT mini DIN connectors. In the case of the cables going to and from to the Type 7940 Monitor unit and the cable to the Navigation Processor, these should be passed through the cable access hole in the back left-hand side of the Type 7941Keyboard unit drawer assembly.

FIG 3.1 KEYBOARD DAISY CHAIN CONNECTIONS



NOTE: SCHEMATIC ONLY

3.4 INTERFACING TO THE VRU

In this issue of the manual it is assumed that the VRU is an analogue type e.g. a Datawell type or a TSS 355 type operating with the analogue ± 10V option.

These units are connected to the rear panel of the SYNC I/O board to any of the "VERTICAL REFERENCE UNITS" connectors using a Type 7784-047 lead - see Fig 3.2 for the connection details. See also Fig 3.4 for details of the lead itself.

Correct functioning of the VRU interface may be checked by switching the Navigation Processor ON and looking at the reading on the top level menu.

3.4.1 Calibrating the VRU.

The VRU inputs may be checked by switching the Navigation Processor on. The monitor should display the Transceiver status, the VRU input values and the Gyro heading.

Two sets of corrections have to be measured for accurate vessel pitch/roll compensation. These are the offsets between the vessel vertical axis and:-

- the VRU vertical axis
- the vertical axis of the Transceiver transducer face when in the normal operating position.

If the VRU is already installed as ship’s equipment then the VRU offsets are usually either already known or zeroed out.

If the VRU is fitted as part of the LUSBL/USBL installation then it should be mounted on a rigid framework as close to the vessel roll axis as possible. This is to reduce the errors caused by lateral accelerations. Consult the particular VRU mounting instructions for details.

3.5 INSTALLING THE TRANSCEIVER

Error! Reference source not found. is an outline drawing of the Transceiver. It should be installed vertically with the connector at the top and the “forward direction” mark pointing forward.

There are several ways of mounting the Transceiver on a ship. The most common are:-

- A vertical tube of at least 228.6 mm or 9 inches internal diameter is let into the ship. This is sometimes referred to as the "mini-moonpool" method.

  The Transceiver is mounted to the end of a flanged pole using a purpose designed flange adapter if necessary (see Fig 3.10 - but consult Sonardyne also). The adapter and any intermediate flanges should employ some mechanical means (the Sonardyne supplied adapter has provision for two dowel pins) to maintain the alignment of the Transceivers lubber line mark with the ship’s lubber line. Alignment should be maintained to within 1 degree - which is similar to the accuracy of a typical Gyro-Compass. The pole will normally have a number of flanges with a compliant outer edge that contacts the inside wall of the tube. The alignment with true vertical is not very critical but the pole should not change its vertical alignment with respect to the ship by more than 0.5 degrees. For critical deep water applications, and if good quality VRUs are available, then this tolerance should be tightened.

  If the mounting flange has the correct fixing holes then the transceiver can be bolted on without the use of the adapter ring (see Fig 3.12), the isolation ring must be used if galvanic corrosion is a possibility

- The second common deployment method is the use of a gate-valve and sea chest assembly that can accommodate the Transceiver. Above this sea chest is a deployment machine that is capable of raising and lowering the Transceiver and stem. The LUSBL Transceiver has been designed to fit directly onto a Fixed Head HPR deployment pole (see Fig 3.11).

  The Transceiver housing is made of 10/5/5 Aluminium Bronze and the common material used for the tube and pole etc. is mild steel. It is good practice to isolate the two systems electrically and acoustically. Sonardyne provide an isolation adapter within the Installation kit (see Fig 3.12 for the correct use of the isolation kit). On no account should the Aluminium Bronze be in contact with a material more noble than itself (electro-chemically) - galvanic corrosion would be the result. A blue connector cover is provided to prevent the accumulation of rust etc. (which may fall off the inside of the deployment pole) from collecting on the top of the transceiver.

3.6 INTERFACING TO THE DP SYSTEM

This is via a 9 way D-type socket on the back of the CPU spreader labelled ‘SER1’ on type II CPU spreaders and ‘DP COMMS’ on Type I spreaders. A cable 7784-132 is shown in Fig 3.3. Either RS232 or current loop is supported with HPR 309, HPR 418 and ATS ASCII formats are supported. The format and baud rate are set up in software (see Section 4.2). The choice of current loop or RS232 is made using links on the CPU spreader board (see Appendix J for diagrams of spreaders and details).

For 7784-054 CPU Spreader

Current Loop	LK9 link, LK10 link (if CPU spreader sources current), LK11 link
RS232	LK9 no link, LK10 no link, LK11 no link

For 7784-141 CPU Spreader

Current Loop	LK5 link, LK6 link (if CPU spreader sources current), LK7 link
RS232	LK5 no link, LK6 no link, LK7 no link

The connections are as follows:-

1	CS2	Current source 2
2	RXD	RS232 in
3	TXD	RS232 out
4	CLOUT -	Current loop output return from transmitter (linked to ground if spreader sources current)
5	GND	Chassis ground
6	CLIN -	Current loop input return from receiver
7	CS1	Current source 1 (output to DP system if CPU spreader sources current)
8	CLOUT+	Current loop input drive to transmitter (input from DP system if CPU spreader sources current.)
9	CLIN+	Current loop input drive to receiver.

3.7 INTERFACING TO THE GYRO COMPASS

3.7.1 Synchro Output Gyro Compasses.

115V 60Hz, 115V 400Hz and 26V 400Hz synchros are supported. This is achieved using different versions of the Navigation Interface board and Sync I/O Spreader.

Options	Nav Interface Board	Sync I/O Spreader Board
Multi Serial / 60 Hz 115V	7693-058-07	7784-057-01
Multi Serial / 400 Hz 26V	7693-058-06	7784-057-02
Multi Serial / 400 Hz 115V	7693-058-06	7784-057-04

N.B. Multiple turn synchro systems e.g. 90:1 are not supported.

Synchro output gyros are connected to the rear panel of the SYNC I/O board to “SYNC/DIG” connectors using a Type 7784-049 lead. See Fig 3.2 for the connection details. See also Fig 3.5 for details of the lead itself.

After connecting the gyro the system needs to be set up to use the gyro compass (see Section 4.2)

Correct functioning of the gyro compass interface may be checked by examining the polling page which is accessed at the top level menu by moving the cursor to Navigate using the arrows keys. (Not selecting Navigate by pressing number 1.)

Consult Sonardyne for a suitable calibration procedure.

3.7.2 Serial Output Gyro Compasses

NMEA and Robertson format serial gyros using Current loop, RS232 and RS422 interfaces are supported at 2400, 4800, 9600 & 19200 Baud. These units are connected to the rear panel of the SYNC I/O board to the connector marked Current Loop Gyro using a 9 way D-type plug.

The connections are as follows:-

1	CS2	Current source 2
2	RXD	RS232 in
3	TXD	RS232 out
4	RS422-	RS422 in negative
5	GND	Chassis ground
6	CLIN-	Current loop input return from receiver
7	CS1	Current source 1
8	RS422+	RS422 in positive
9	CLIN+	Current loop input drive to receiver.

The baud rate and electrical format are set by links:- see Appendix J for diagrams.

Options available:-

7693-058-06/07 Jumper J1	Baud Rate
1 - 2	2400
3 - 4	4800
5 - 6	**9600**
7 - 8	19200

7784-057-01/02/04 Jumper J6	Protocol
1 - 2	RS422
3 - 4	RS232
5 - 6	**Current Loop**

Default values in **bold** type

After connecting the gyro the system needs to be set up to use the gyro compass and set the input format (see Section 4.2).

Correct functioning of the gyro compass interface may be checked by examining the polling page which is accessed at the top level menu by moving the cursor to Navigate using the arrows keys. (Not selecting Navigate by pressing number 1.)

3.8 INTERFACING TO A PRINTER

Interfacing to a parallel printer is done via the PRINTER (parallel) port through the rear panel of the CPU card. A standard Centronics lead is all that is required. Interfacing to a serial printer is described in Section 3.10. The system should be set up as described in Section 4.2 in both cases.

The printers currently supported are:- Epson FX, Epson LQ, HP ThinkJet, HP LaserJet 3 HP DeskJet 320 or Bitmap. Colour printers are not supported unless they can print any of the above file formats which will be in black and white. However colour prints can be produced from the bitmap in a PC. This is a Windows .BMP file which can be read in a program such as Windows paintbrush.

3.9 CONNECTING A RESPONDER

The cable used for responders is shown in Fig 3.5. Tails are provided for connection to ship's wiring.

On systems with a type I base tray and a type I CPU spreader the responder is connected to the 5 way Lemo socket on the rear of the base tray.

On systems with a type I base tray and a type II CPU spreader the responder is normally connected to the 5 way Lemo socket on the rear of the base tray but the links on the CPU spreader can be set to use the socket on the rear of the CPU spreader. (See Appendix J for link details).

On systems with a type II base tray and no serial card the responder is connected to the 5 way Lemo socket on the back of the type II CPU spreader.

On systems with a type II base tray and a serial card there are two possible sources of responder triggers. If there is a single LUSBL transceiver driven from the CPU card then the responder output is the connector on the CPU spreader. If there is more than one LUSBL transceiver or a single transceiver is driven from a serial card then one of the 4 responder ports on the serial board will be used.

3.10 CONNECTING A SERIAL PERIPHERAL

There are 4 serial channels on the CPU card. One of these is a dedicated console port, one is used for the keyboard, and the other two are normally used as the DP output and transceiver communications.

If a serial card and spreader are fitted 6 channels of additional serial I/O are available. The first two of these may be used to drive LUSBL transceivers in systems with Type II bottom trays. The third channel is used as an interconnect in dual-redundant systems. In other circumstances these 3 channels can be used for general purpose I/O and are link configurable for RS232 or RS422 using links on the Serial I/O spreader board. The other 3 channels are general purpose RS232.

Serial peripherals currently supported are serial printers, DGPS systems, surveyor's output and Sonardyne PAN emulation. The serial channel must be configured in software (see Section 4.2).

The cable used for serial I/O is shown in Fig 3.7. Tails are provided for connection to ship's wiring.

3.11 SYSTEM SET-UP

Having completed the installation to this stage, the system should be set up as described in Sections 4.1 and 4.2 and functionally tested as described in Section 4.2.2. See also Appendix E for a complete System Test procedure. On completion of this work, save the INSTALLATION DATABASE as described in Section 2.5.

FIG 3.2 SYSTEM INTERCONNECTIONS

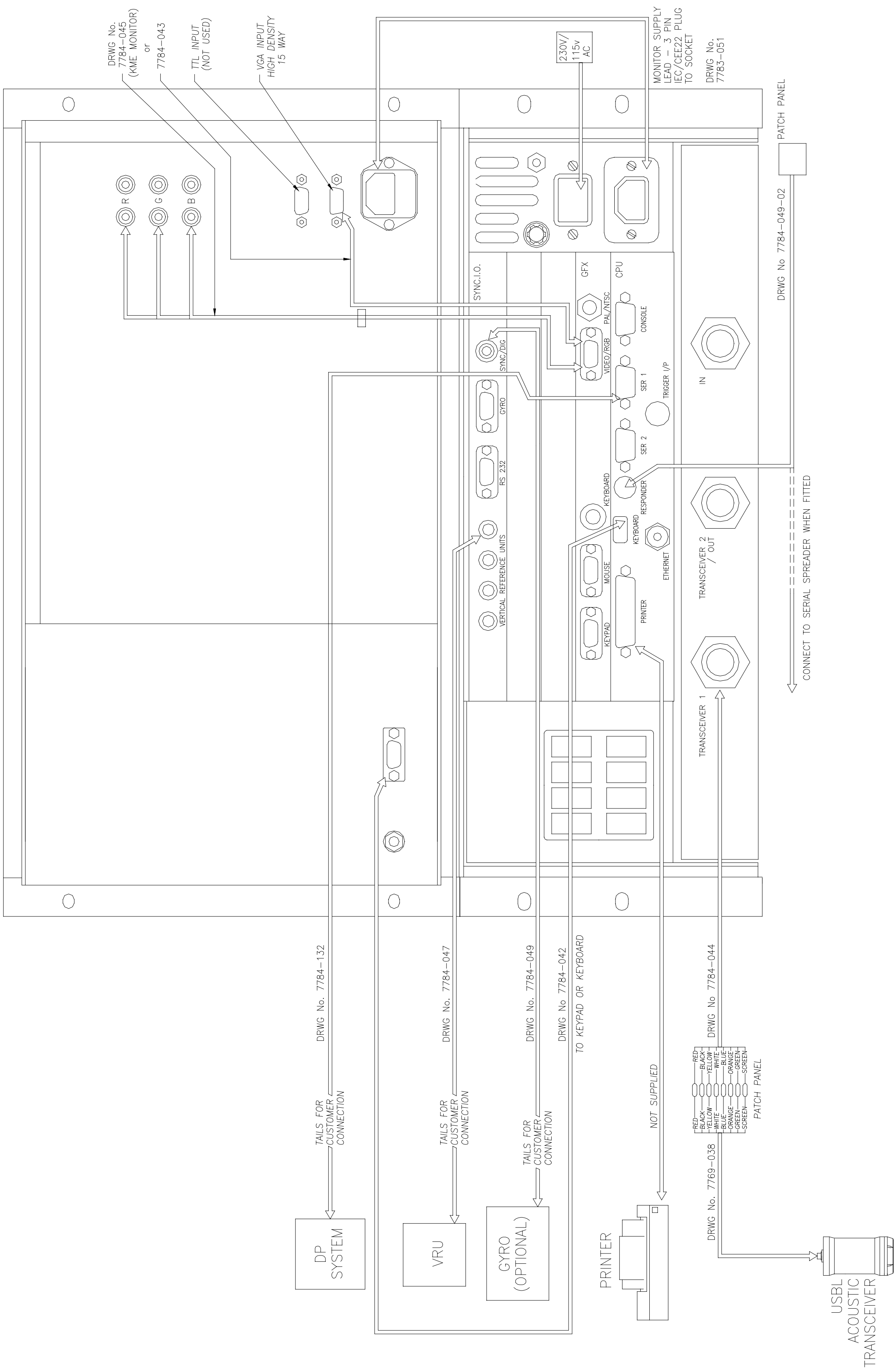
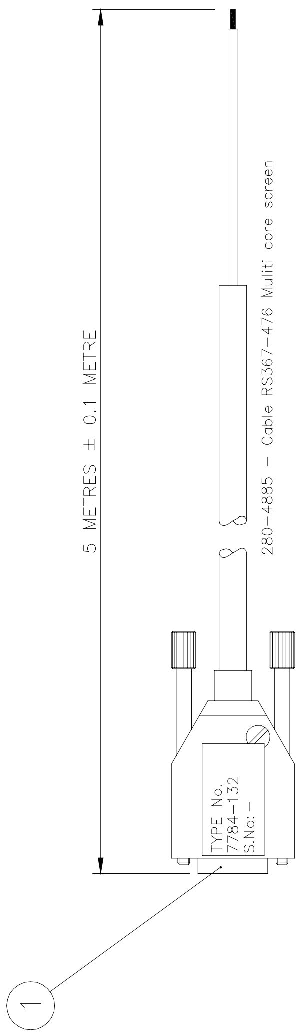


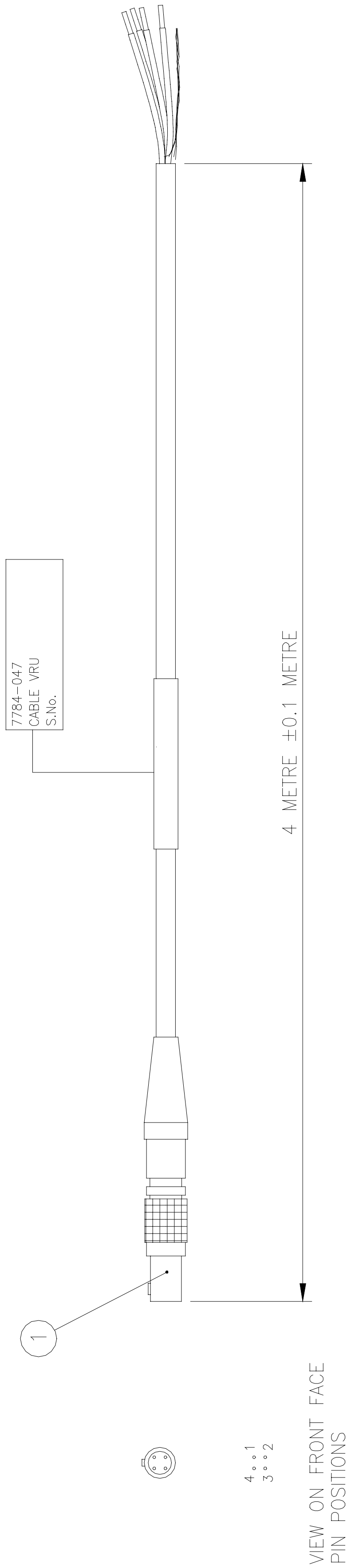
FIG 3.3 CONNECTIONS/LEAD TO DP SYSTEM



Notes:-
1. For RS232 "DP out" connect pins 3 (XT) and 5 (GND).
2. For current loop " DP out" where the Navigation processor sources the current, connect pins 7 (CS1) and 8 (CLOUT +) return. Link 6 on CPU spreader should be made.
3. For Current loop "DP out" where the DP system sources the current, connect pins 8 (CLOUT +) and 4 (CLOUT rtn) Link 6 on the CPU spreader should be open.

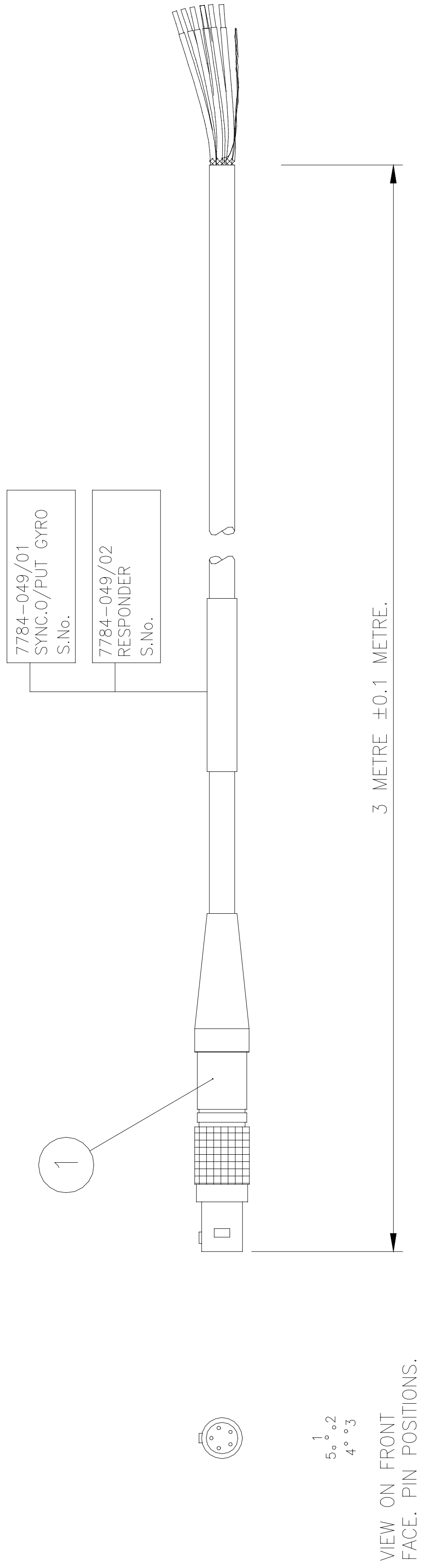
ITEM 1 PIN POSN.	Wire colour	Signal
1	Red	CS2
2	Purple	RS232 RX
3	Brown	RS232 TX
4	Black	CLOUT rtn
5	Screen / Green-Yellow	GND
6	Blue	CLIN-
7	Green	CS1
8	Yellow	CLOUT +
9	White	CLIN +

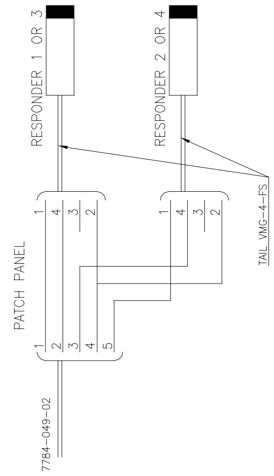
FIG 3.4 CONNECTIONS/LEAD TO VRU



ITEM 1 PIN POSN.	WIRE COLOUR	SIGNAL
1	YELLOW	COM
2	RED	ROLL
3	BLUE	PITCH
4	GREEN	VRUS
SHELL	SCREEN	GND

FIG 3.5 CONNECTIONS/LEAD TO GYRO COMPASS



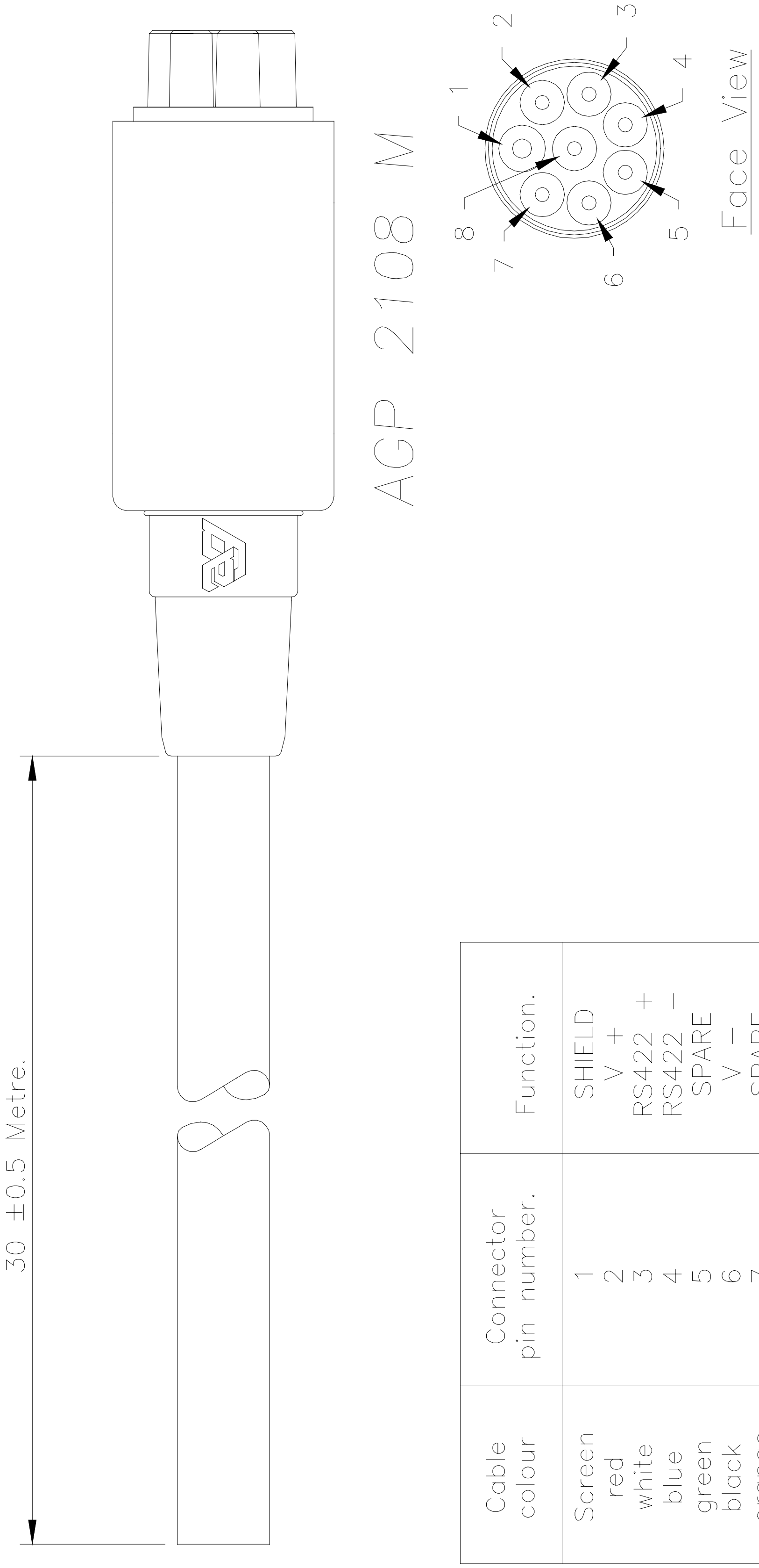


When using 7730 as responder do not connect pin 4 of the VMG-4-FS tail.

ITEM 1 PIN POSN.	WIRE COLOURS	SYNC.OUTPUT-01 SIGNAL	RESPONDER-02 SIGNAL
1	RED	S1	RESPONDER TRIGGER 1/3
5	YELLOW	S2	RESPONDER TRIGGER 2/4
4	GREEN	S3	0V
3	BLUE	26V EXC LO	+24VR 2/4
2	BLACK	26V EXC HI	+24VR 1/3
BODY	GREEN YELLOW	SCREEN	N/C
	SCREEN	N/C	SCREEN

FIG 3.6 CONNECTIONS/LEAD TO TRANSCEIVER

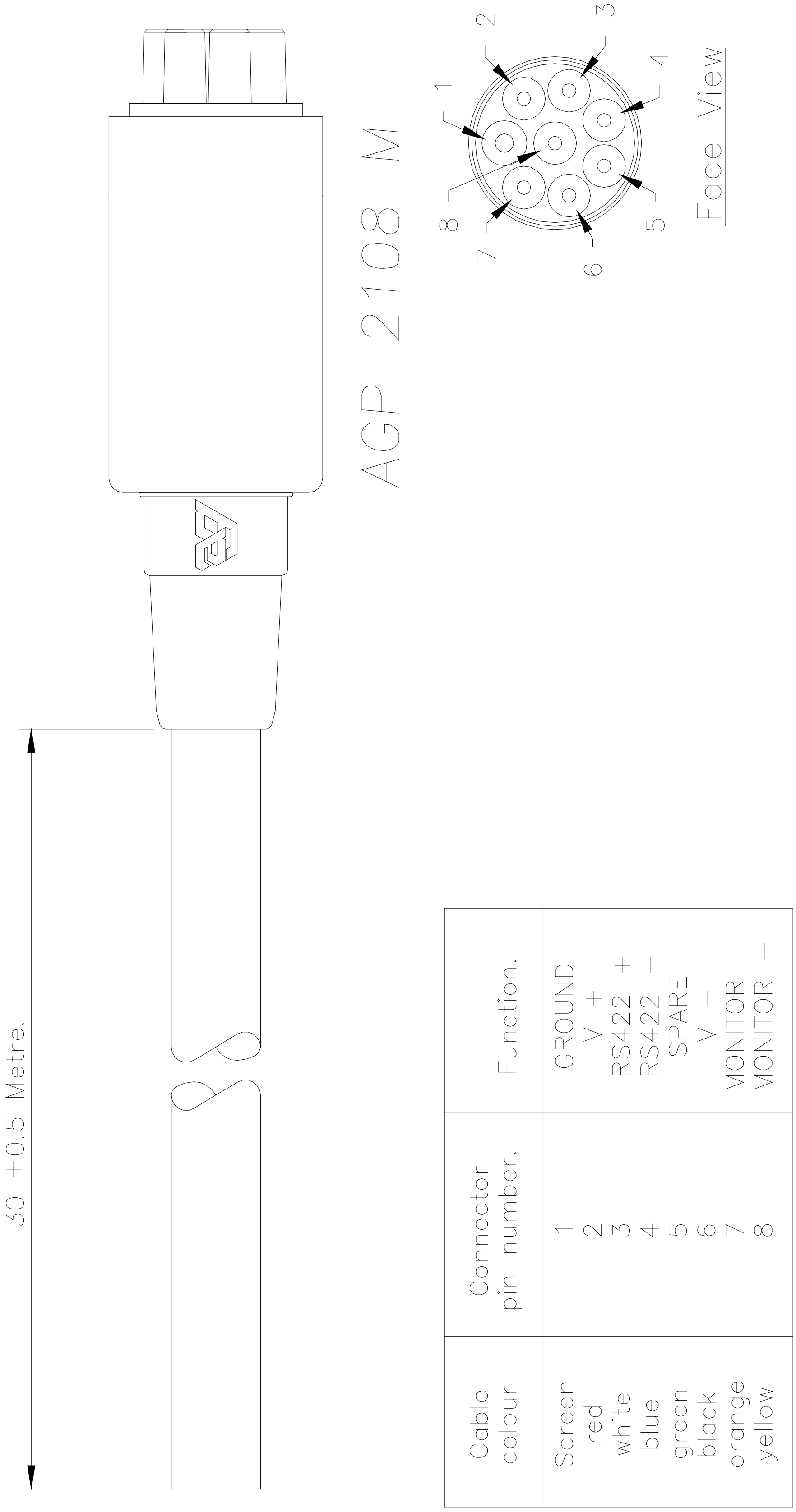
Fig. 3.6.1 - (Subsea – Old Type)



Cable colour	Connector pin number.	Function.
Screen	1	SHIELD
red	2	V +
white	3	RS422 +
blue	4	RS422 –
green	5	SPARE
black	6	V –
orange	7	SPARE
yellow	8	SPARE

FIG 3.6 CONNECTIONS/LEAD TO TRANSCEIVER

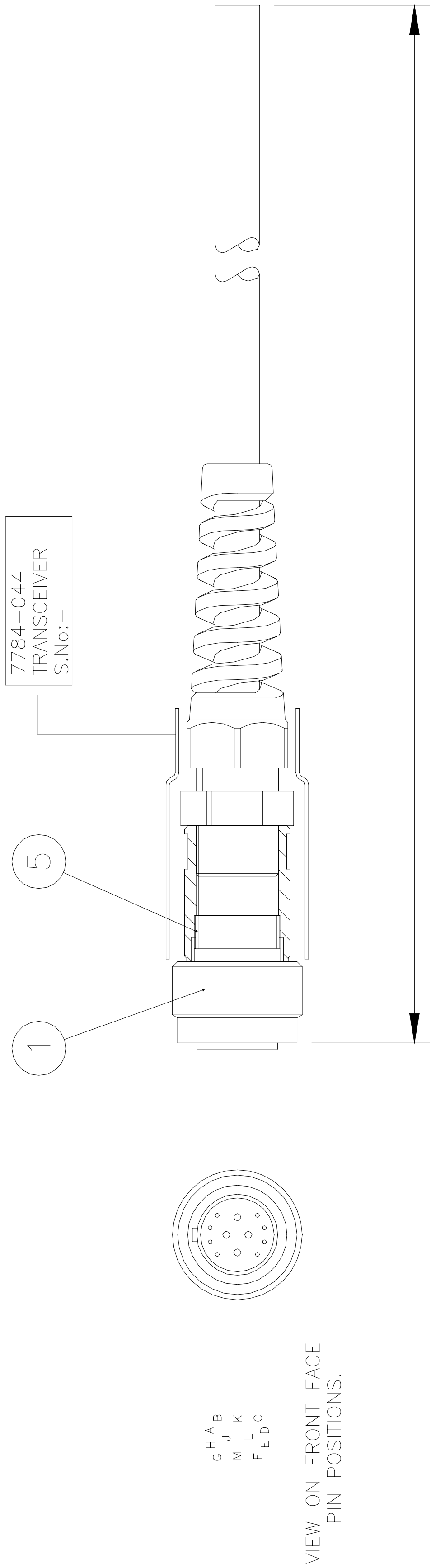
Fig 3.6.2 - (Subsea – New Type)



Cable colour	Connector pin number.	Function.
Screen	1	GROUND
red	2	V +
white	3	RS422 +
blue	4	RS422 –
green	5	SPARE
black	6	V –
orange	7	MONITOR +
yellow	8	MONITOR –

FIG 3.6 CONNECTIONS/LEAD TO TRANSCEIVER

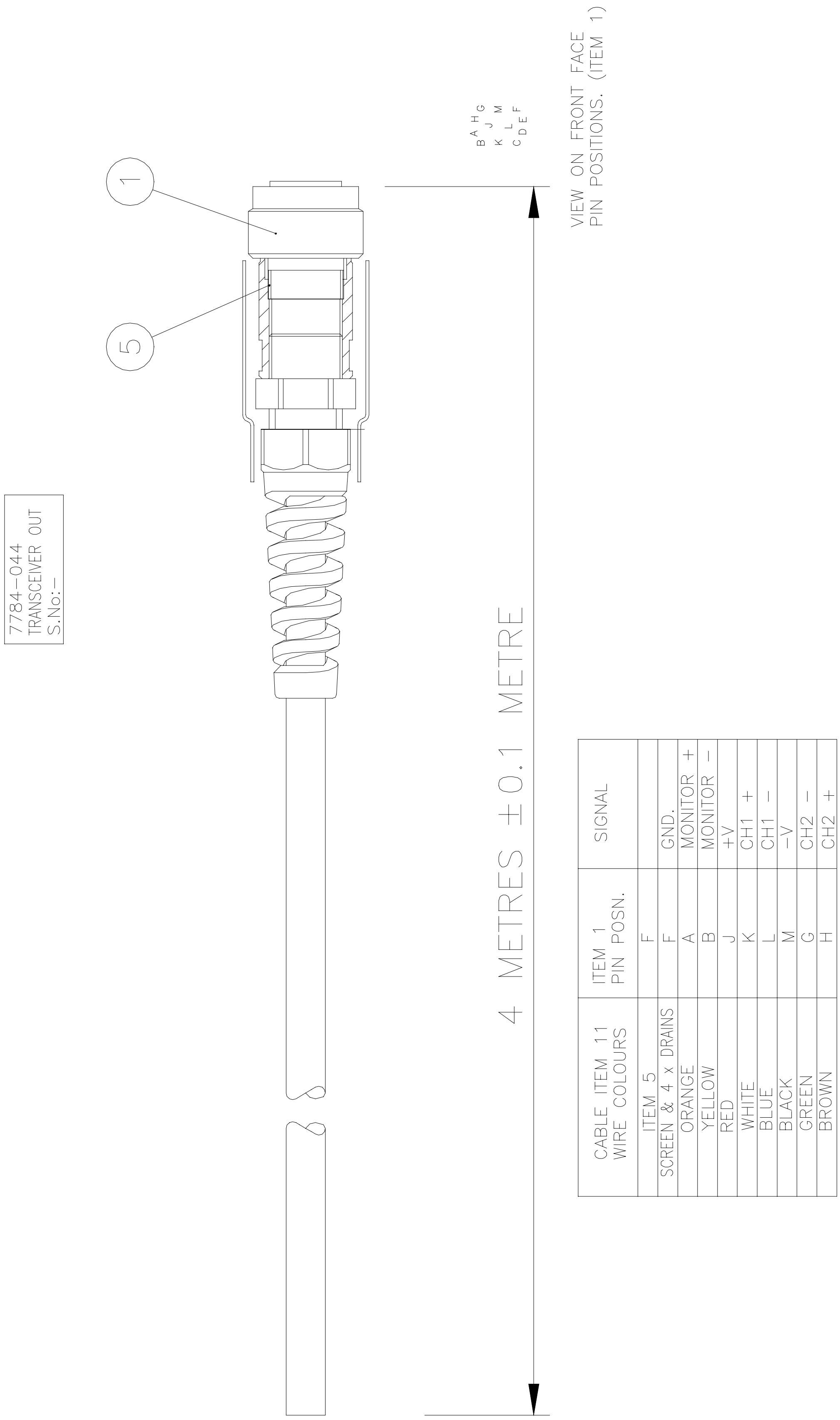
Fig 3.6.3 - Topside – Old Type



ITEM 1 PIN POSN.	CABLE ITEM WIRE COLOURS	SIGNAL
D	ITEM 5	
D	SCREEN	GND.
E	SCREEN	GND.
F	SCREEN	GND.
J	RED	+V
K	WHITE	SIG +
L	BLUE	SIG –
M	BLACK	–V

FIG 3.6 CONNECTIONS/LEAD TO TRANSCEIVER

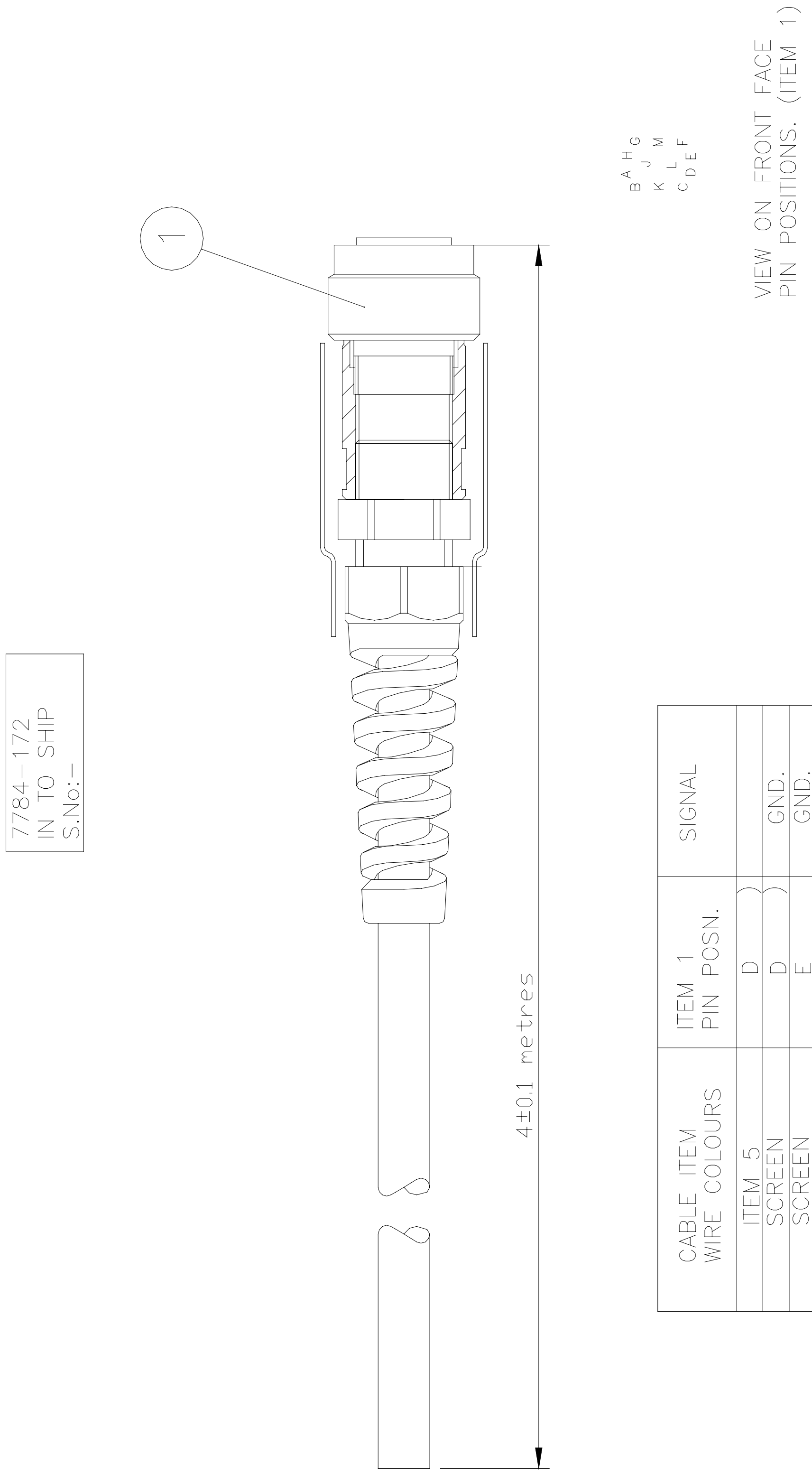
Fig 3.6.4 - Topside – New Type



CABLE ITEM 11 WIRE COLOURS	ITEM 1 PIN POSN.	SIGNAL
ITEM 5	F	
SCREEN & 4 x DRAINS	F	GND.
ORANGE	A	MONITOR +
YELLOW	B	MONITOR −
RED	J	+V
WHITE	K	CH1 +
BLUE	L	CH1 −
BLACK	M	−V
GREEN	G	CH2 −
BROWN	H	CH2 +

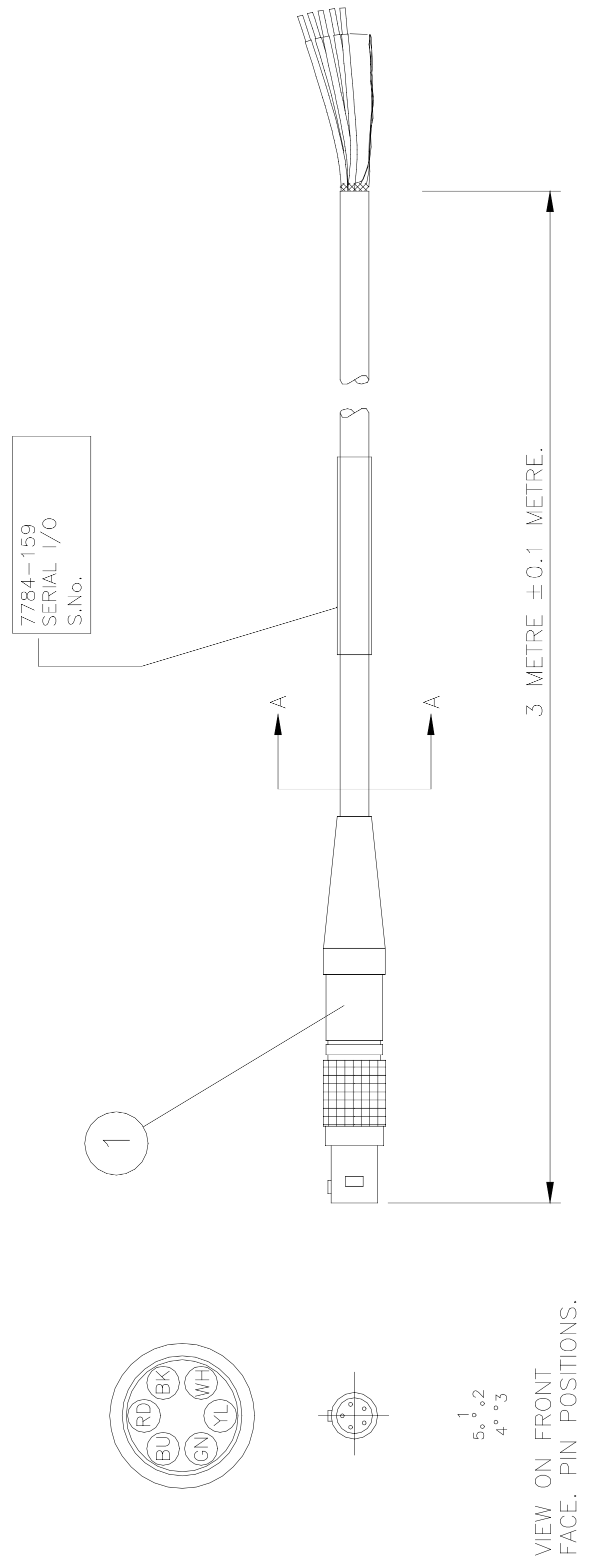
FIG 3.6 CONNECTIONS/LEAD TO TRANSCEIVER

Fig 3.6.5 - Dual-Redundant System



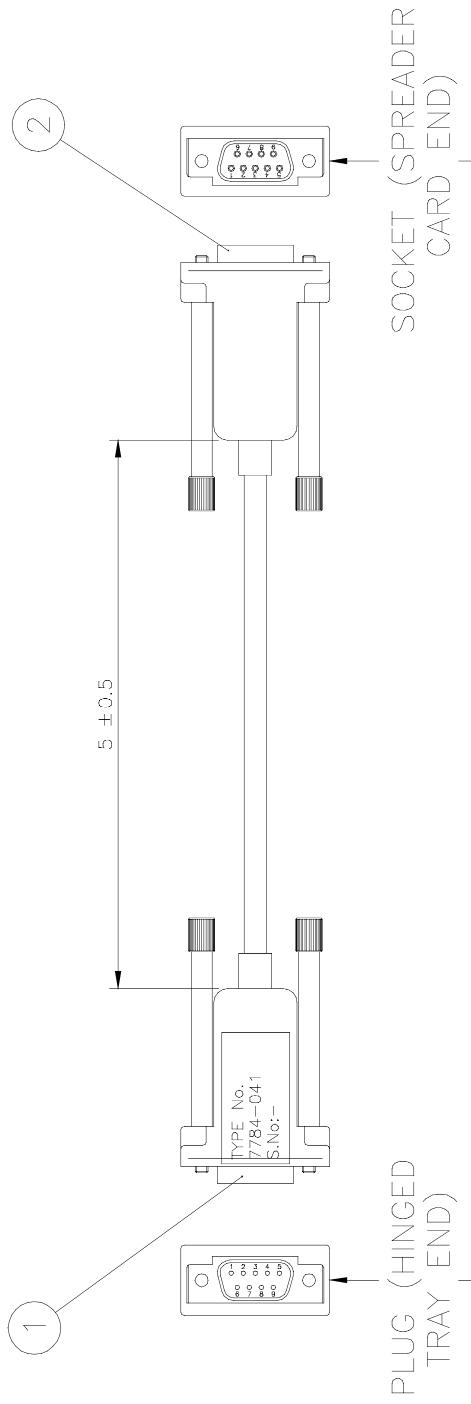
CABLE ITEM WIRE COLOURS	ITEM 1 PIN POSN.	SIGNAL
ITEM 5	D	
SCREEN	D	GND.
SCREEN	E	GND.
SCREEN	F	GND.
ORANGE	G	CH2−
YELLOW	H	CH2+
RED	J	+V
WHITE	K	CH1 +
BLUE	L	CH1 −
BLACK	M	−V

FIG 3.7 CONNECTIONS/LEAD FOR PERIPHERALS CONNECTED TO SERIAL I/O CARD



ITEM 1 PIN POSN.	WIRE COLOURS	Serial I/O RS422 SIGNAL	Serial I/O RS232 SIGNAL
1	RED	TX+	RTS OUT
5	YELLOW	OV1	OV
4	GREEN	RX−	DATA IN
3	BLUE	RX+	CTS IN
2	BLACK	TX−	DATA OUT
BODY	SCREEN	SCREEN	SCREEN

FIG 3.8 CPU TO TRANSCIEVER CABLE



NOTE:- RTS, CTS & DTR ARE NOT USED IN THEIR NORMAL MODE ON THE USBL NAV.PROCESSOR.

SIGNAL w.r.t. HINGED TRAY	ITEM 1 PIN POSN.	WIRE COLOUR	ITEM 2 PIN POSN.	SIGNAL w.r.t. CPU
	1		1	
TXD	2	RED	2	RXD
RXD	3	ORANGE	3	TXD
RTS	4	YELLOW	4	DTR
GND	5	GREEN	5	GND
	6		6	
DTR	7	VIOLET	7	RTS
CTS	8	GREY	8	CTS
	9		9	

HINGED TRAY:-

RTS IS RS422 COMM'S DIRECTION CONTROL.

CTS IS FROM EXTERNAL TRIGGER IN.

DTR IS TRIGGER OUT.

FIG 3.9 LEADS

Fig 3.9.1 - Monitor Mains Lead

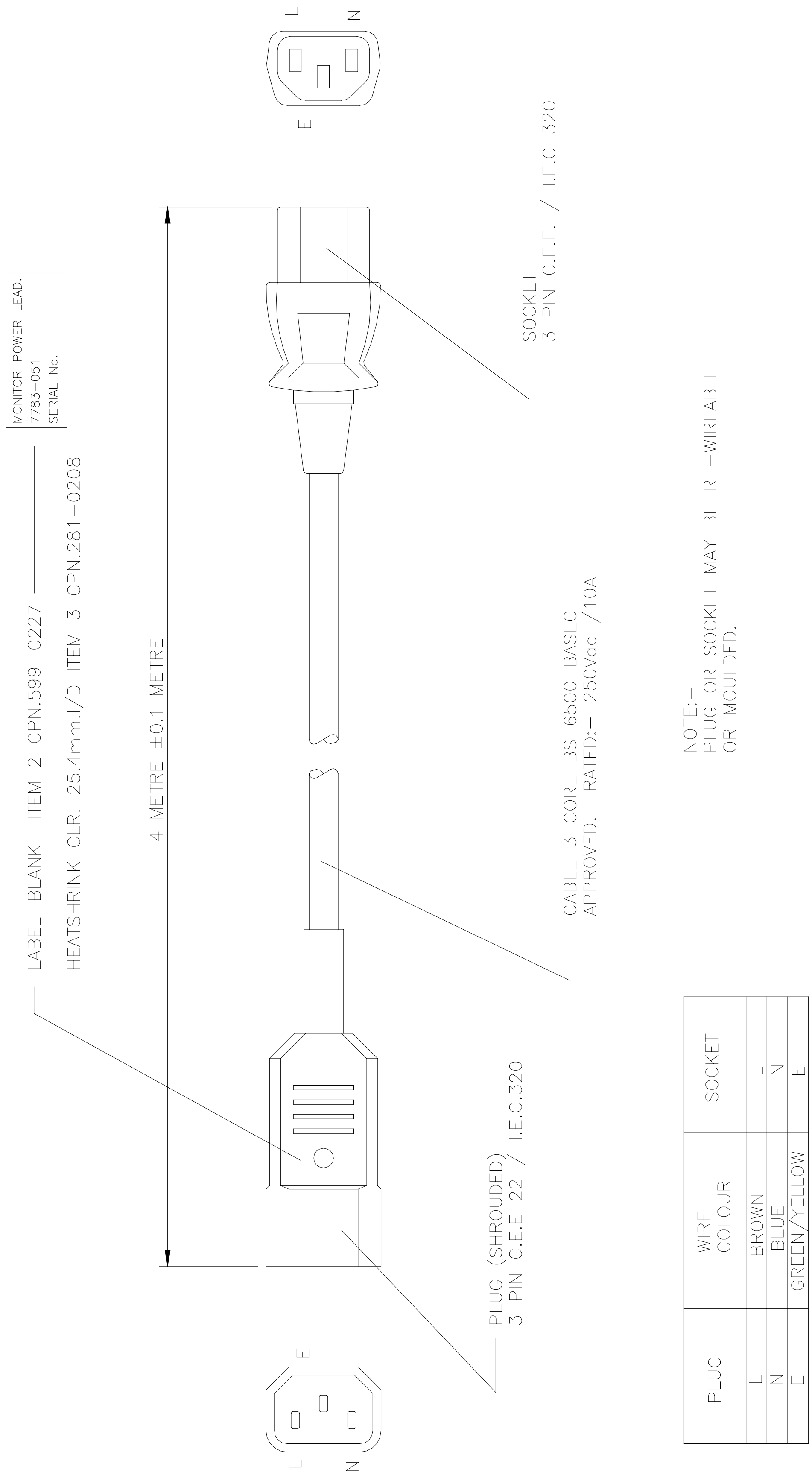
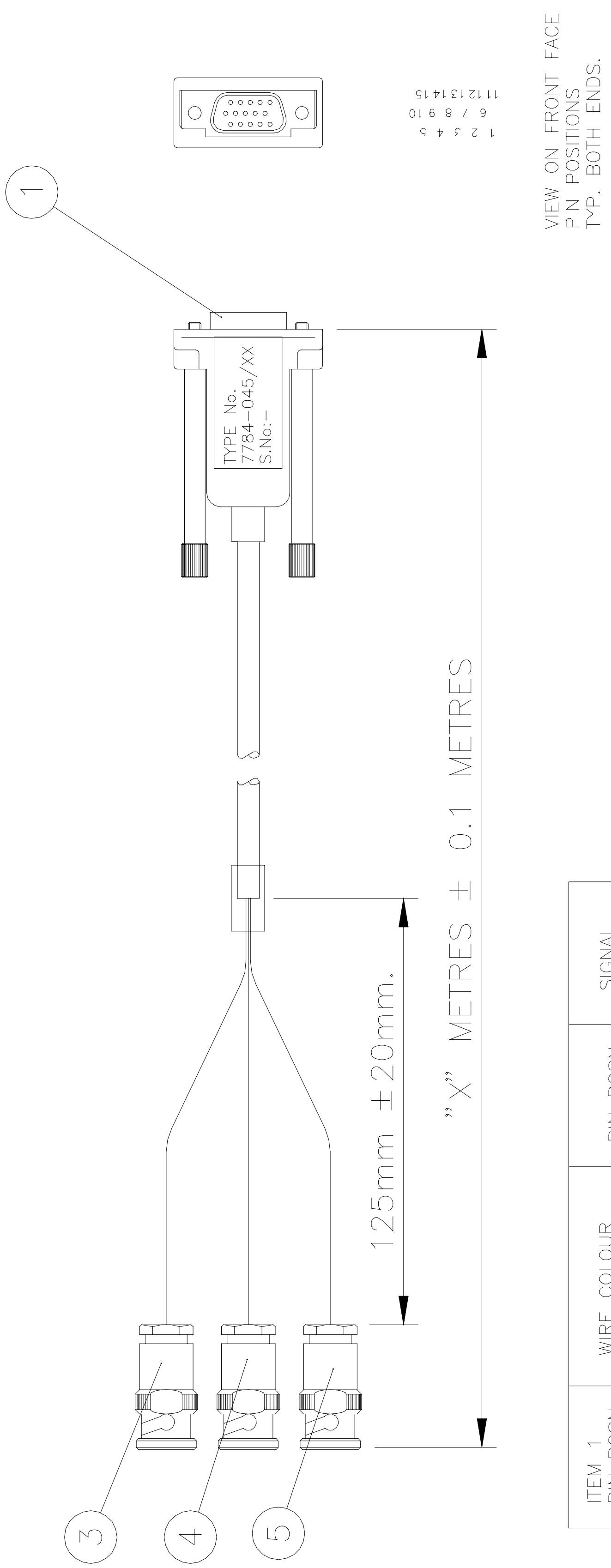


FIG 3.9 LEADS

Fig 3.9.2 - RGB Monitor Lead



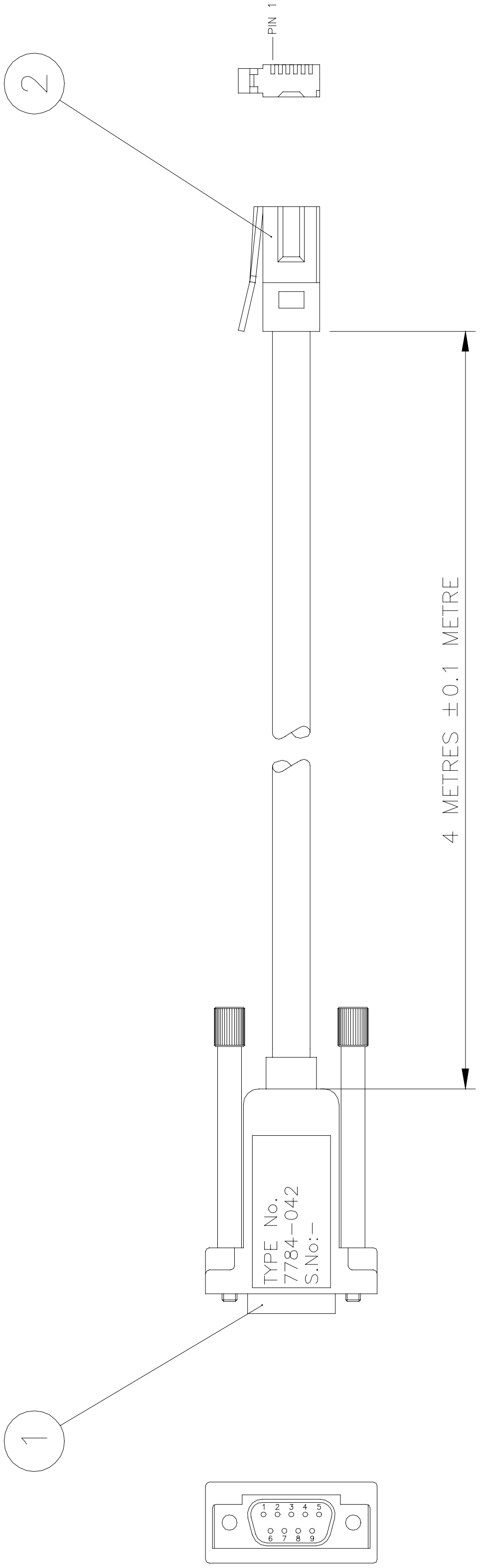
LENGTH "X"	VERSION	CPN.
2 METRES	E3-7784-045-01	820-2885
4 METRES	E3-7784-045-02	820-2892

ITEM 1 PIN POSN.	WIRE COLOUR	PIN POSN.	SIGNAL
1	RED	ITEM 3-PIN	RED
6	SCREEN	BODY	
2	GREEN	ITEM 4-PIN	GREEN
7	SCREEN	BODY	
3	BLUE	ITEM 5-PIN	BLUE
8	SCREEN	BODY	

FIG 3.9 LEADS

Fig 3.9.3 - Type 7784-042 Keypad to Keyboard Lead

(To connect to Type 7783 Monitor Keypad)

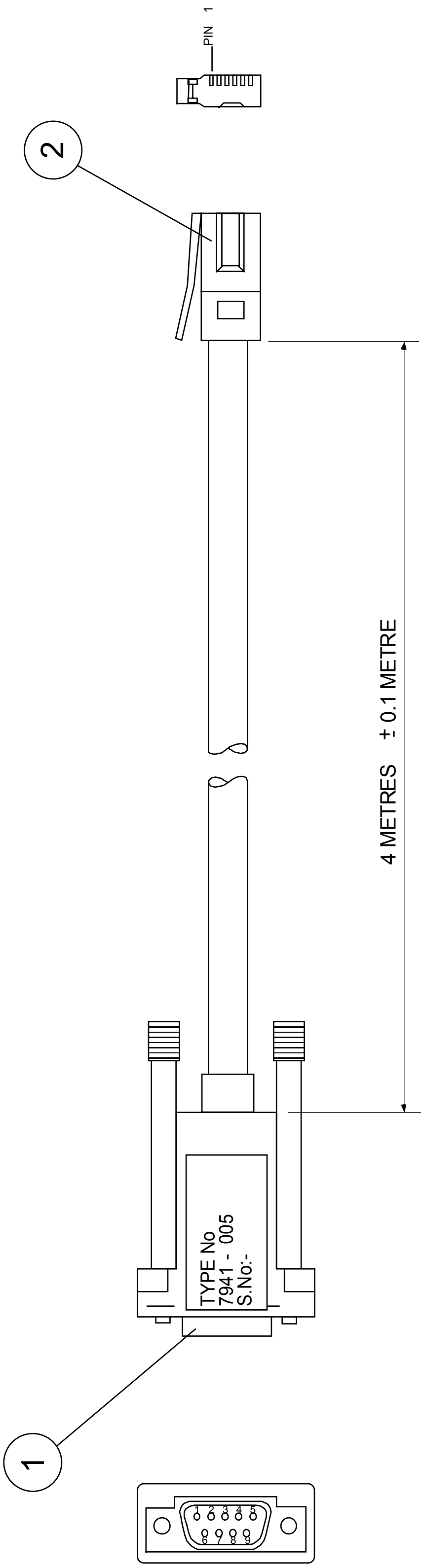


ITEM 1 PIN POSN.	ITEM 2 PIN POSN.	CORE COLOUR TYPE 1 BT CABLE	CORE COLOUR TYPE 2 BT CABLE	SIGNAL
N/C	1	ORANGE	BLUE	
N/C	2	RED	YELLOW	
8	3	BLUE	GREEN	TTL OUT
5	4	GREEN	BLACK	GND
2	5	WHITE	RED	RS232 IN
N/C	6	BLACK	WHITE	

FIG 3.9 LEADS

Fig 3.9.4 - Type 7941-005 Keypad to Keyboard Lead

(For connection to Type 7941-001 Monitor Lead)



ITEM 1 PIN POSN.	ITEM 2 PIN POSN	CORE COLOUR TYPE 1 BT CABLE	CORE COLOUR TYPE 2 BT CABLE	SIGNAL
N/C	1	ORANGE	BLUE	
9	2	RED	YELLOW	+V
2	3	BLUE	GREEN	TXD
5	4	GREEN	BLACK	GND
3	5	WHITE	RED	RXD
N/C	6	BLACK	WHITE	

Note there are different standards of BT cable wiring.
Check wiring of item 2 before connecting item 1.

FIG 3.9 LEADS

Fig 3.9.5 - Twin Keyboard/Keypad Adapter

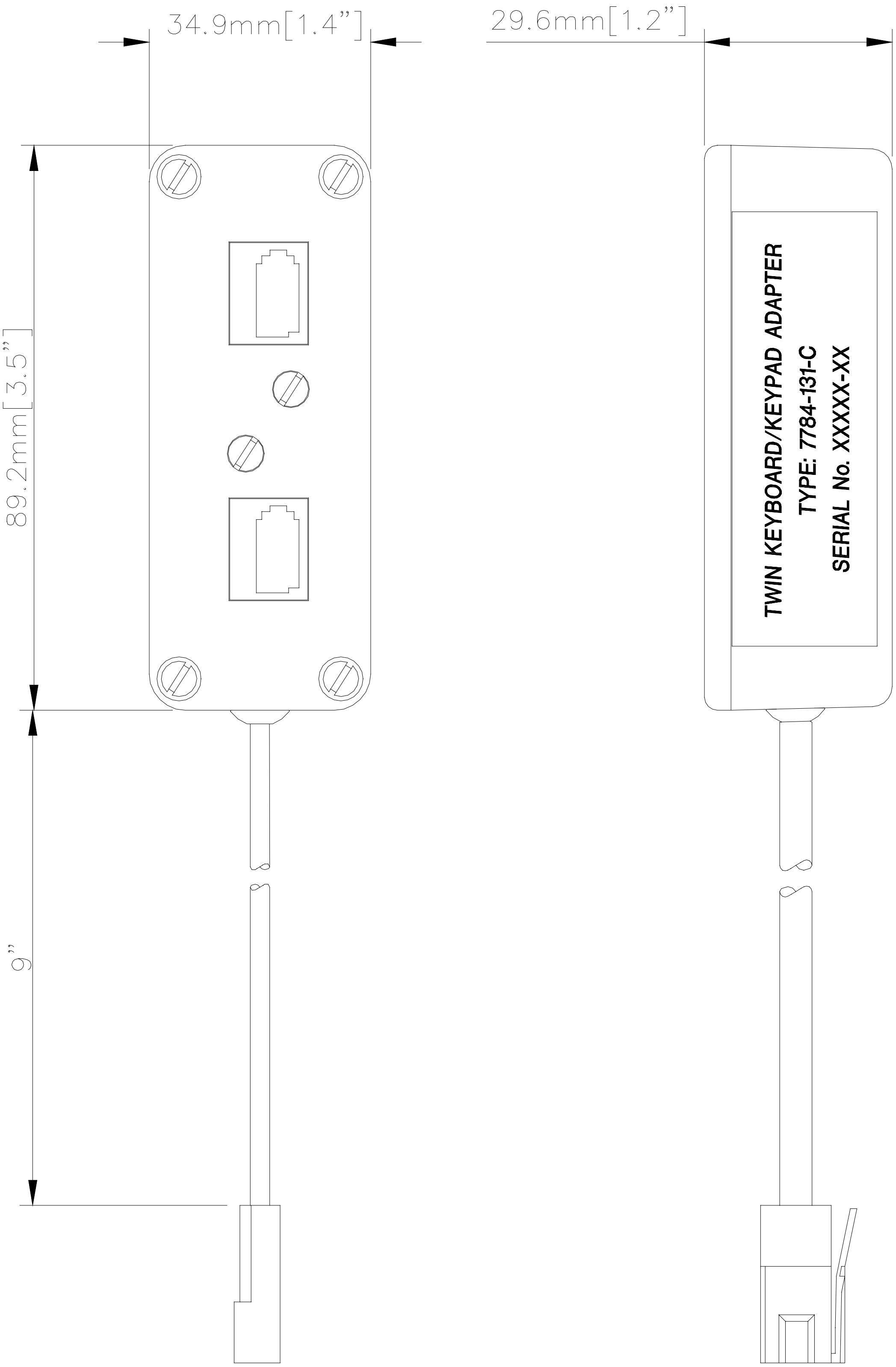


FIG 3.10 ADAPTER FLANGE

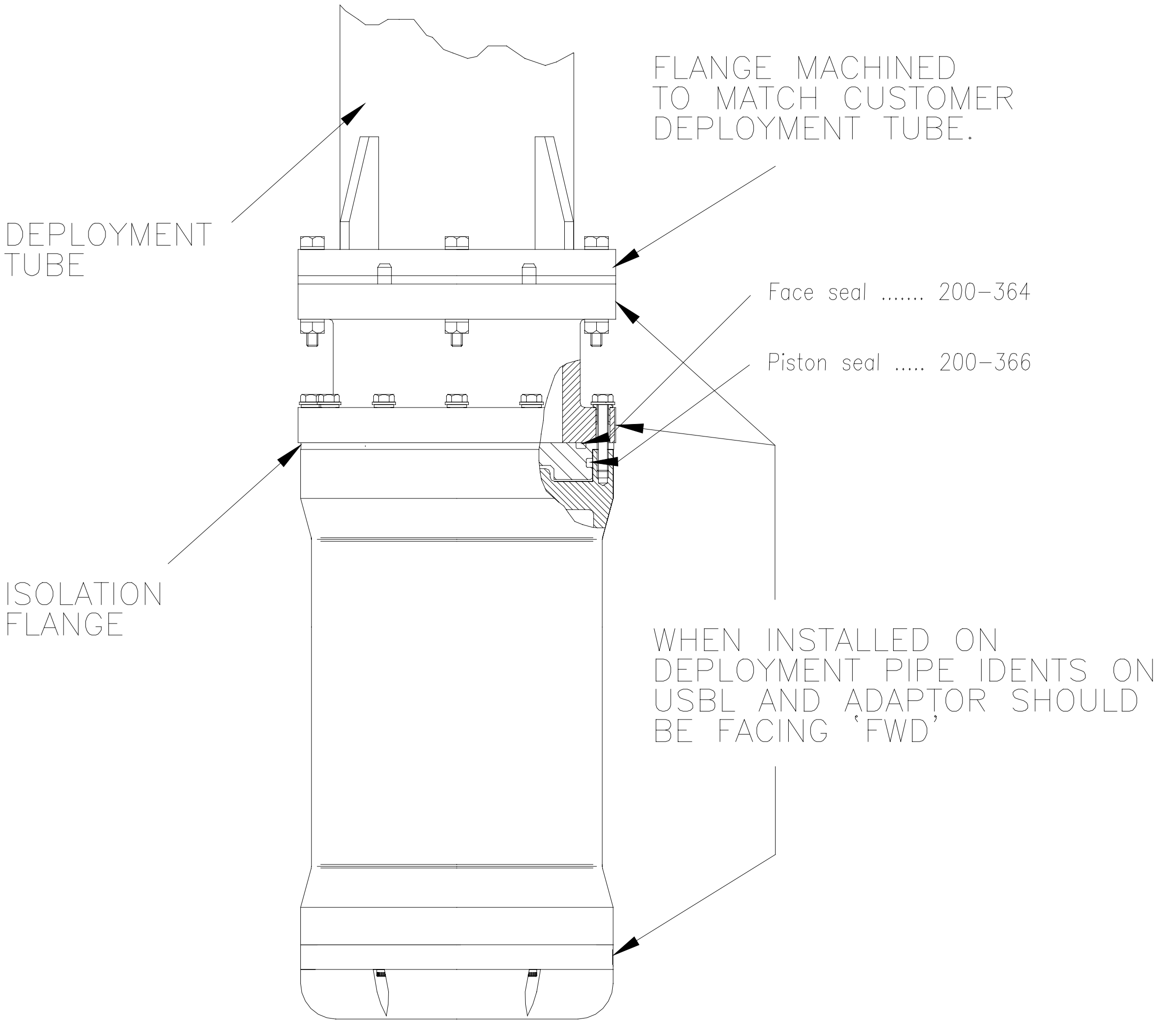


FIG 3.11 TRANSCEIVER FITTING

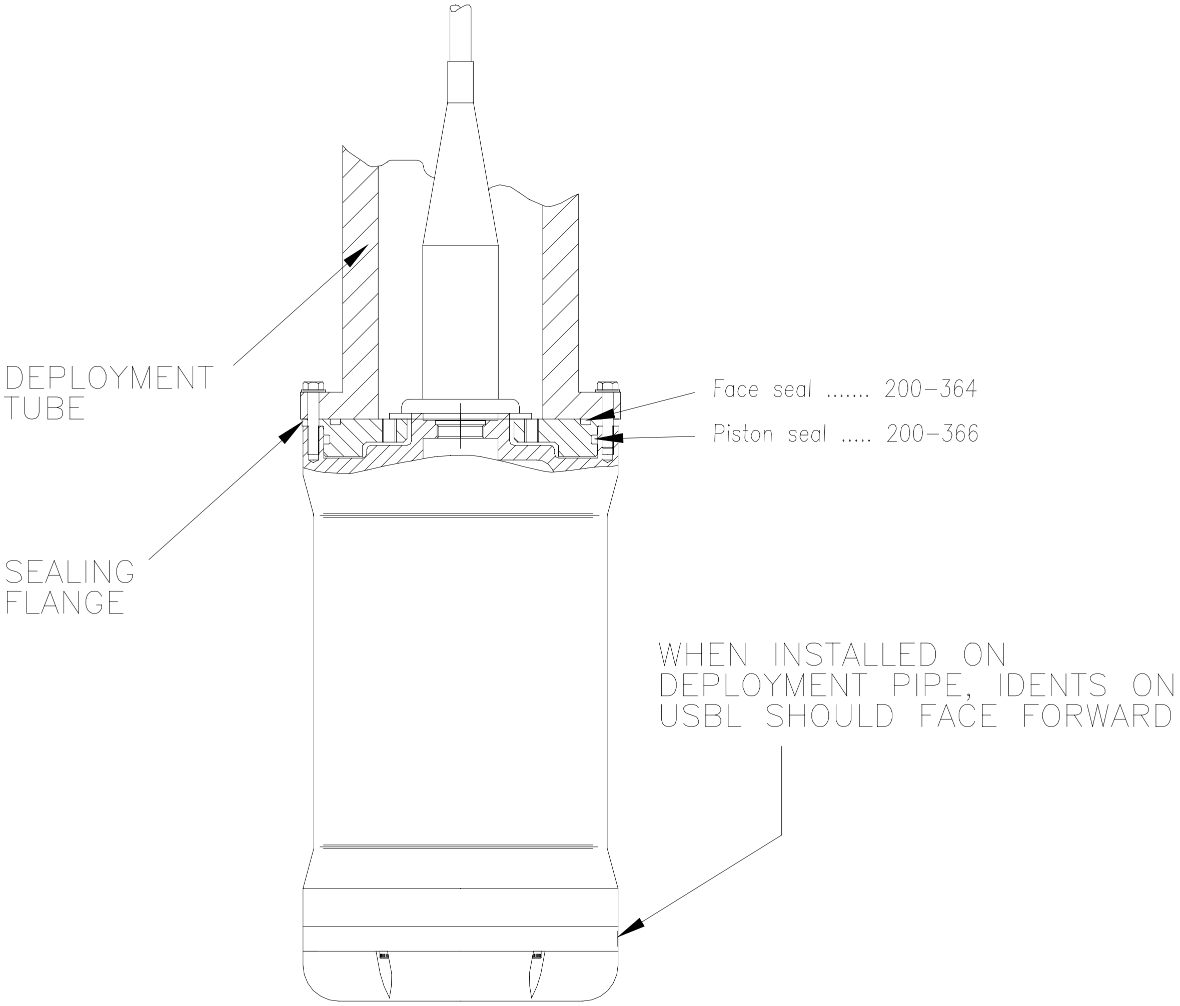
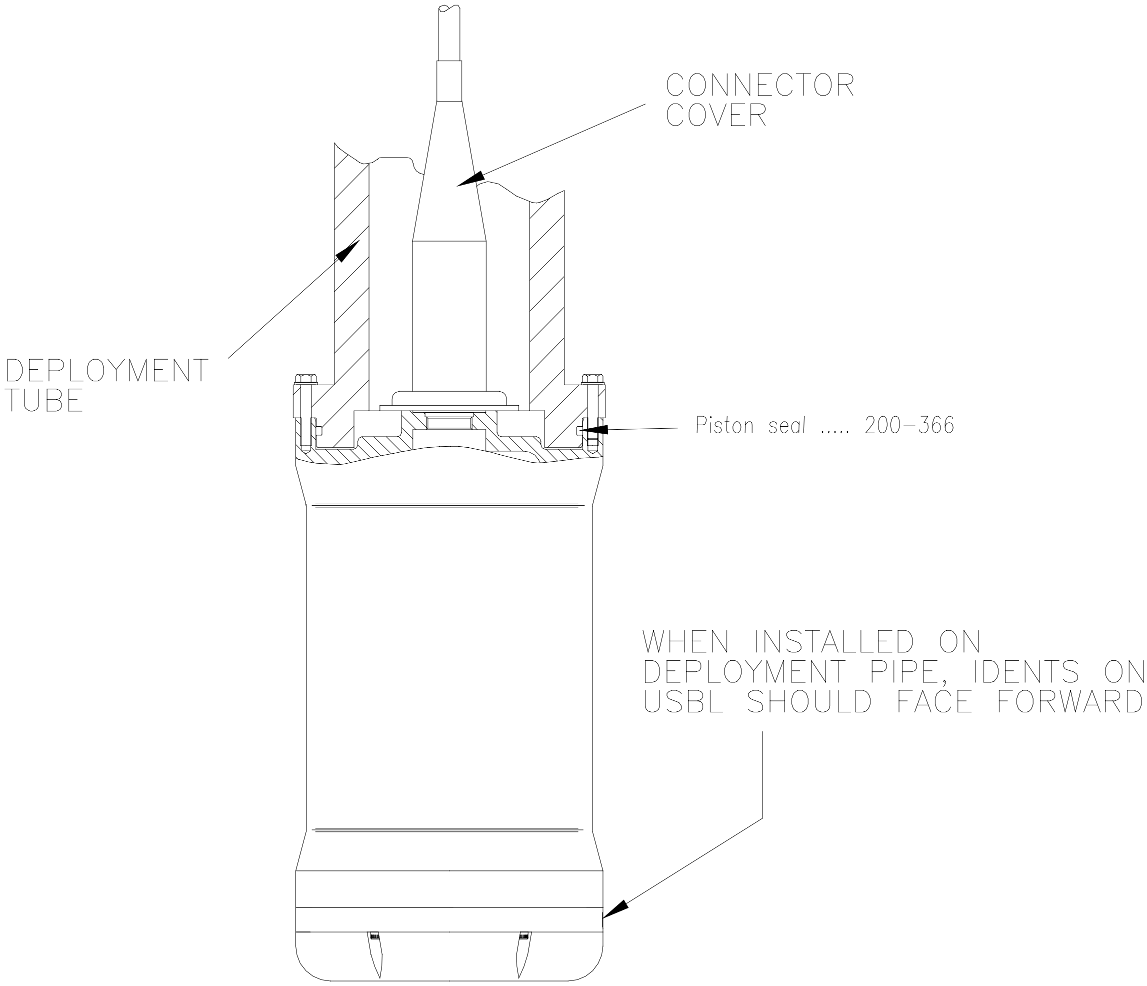


FIG 3.12 TRANSCEIVER FITTING



SECTION 4

4. INSTALLATION PARAMETERS SETUP

The procedures to be followed in using the system menu options to complete a typical installation task are described in this Section. Most of the differences in installation setup procedures which apply to the dual-redundant version of the LUSBL are covered in Appendix K.

In all of these procedures, the rules for working through the menu options and entering changes are as described in Section 2.1.

4.1 PRELIMINARY TASKS

4.1.1 Loading the Software

4.1.1.1 New System

In general, a new system shipped from Sonardyne will have the system software pre-installed from the Installation Set of floppy discs supplied with the system. It is recommended, however, that back-up copies are made of this Installation Set (except Disc 1) before proceeding further. The Installation Set of discs (except Disc 1) are in PC format and may be copied using any available PC disc copy procedure. The back-up set should then be used as the working copies for any future software re-load procedure, should this be necessary.

At this point, the system will have no Job files and one will have to be created before proceeding further with the installation task. To do this:

- Ensure that there is no disc in the floppy disc drive.
- Boot the system by switching on the unit (or operating the reset button on the Navigation Processor, if already powered up).

When the top level menu appears, use the "**Create New Job**" option from the "**Job File Management**" menu, as described in Section 2.5 to create a new job file. The content of this new job file will then be built up as the installation task proceeds.

4.1.1.2 Reloading Same Version Software to a Corrupted System

In this case, archived Installation files and Job files should be available on floppy discs from previous use of the system. Retrieve these from storage and proceed as follows:

- Insert Disc 1 from the Installation Set and switch on the unit (or operate the reset button).
- After approximately two minutes, the LUSBL screen will be displayed. Follow on-screen prompts, entering the numbers of <u>all</u> discs when prompted by "Select Discs to Install".
- When prompted, eject Disc 1 and insert Disc 2. At the prompt "Format hard disc" enter <1> (for YES).
- Continue software loading process following on-screen prompts as they occur.
- When prompted, enter date and installer's initials (example format:- 17JAN95.ARN).

- Enter the description of the file, type “SOFTWARE INSTALLED” and press <ENTER>. [In the case of a 17 inch Monitor installation, the <ENTER> key will be found on the Type 7941 Keyboard unit.] When prompted, enter date and installer’s initials (example format:- 17JAN95.ARN).

- Enter the description of the file, type “SOFTWARE INSTALLED” and press <ENTER>.

- When the screen prompt: “Installation complete. Re-boot” appears, eject the current disc in the floppy disc drive and reboot as described in paragraph 4.1.1.1.

- “Restore” Installation and Job files from the archive floppies using the appropriate options in the “**Job File Management**” menu - see Section 2.5.

> **NOTE**: From Software version 5.02 onwards, the archived Installation files are created in the same format as on the INST_files disc in the Installation Set so that the archive disc may be used to replace the INST_files disc in the working copy of the Installation set. This avoids the need to “restore” the archived copy of the Installation files when re-loading software.

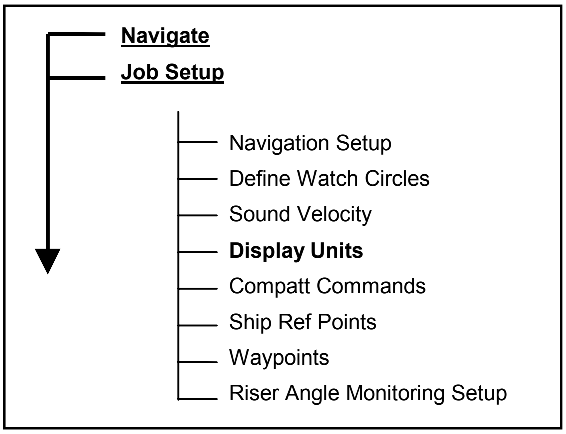
4.1.1.3 Loading New Version Software to a System

The procedure in this case is the same as described in paragraph 4.1.1.2 except that Job files from the old version system software will not be compatible with the new version system software and must be created anew.

4.1.2 Display Units

There is a choice of working in metres or feet - the default is metres. If it is appropriate to change to feet, this is best done before any other Setup activity.

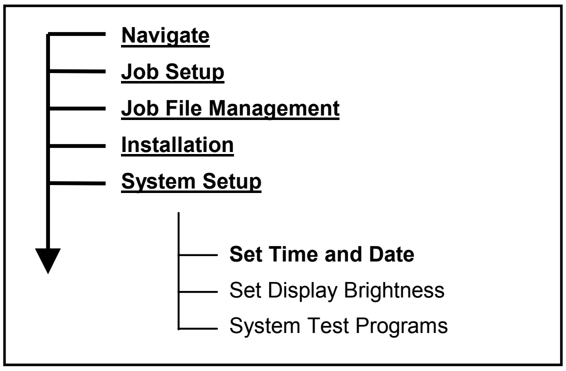
This menu option is found under “**Job Setup**” in the top level menu as shown to the right.



4.1.3 Set Time and Date

This menu option is found under “**System Setup**” in the top level menu as shown to the right.

The system has a calendar and a 24 hour clock with a resolution of 1 second. This menu option allows the operator to reset the calendar and the clock. In this way the system may be synchronised to a local time standard within about a second.



The standard rules for data entry apply. Any of the cursor keys may be used to step through the fields, but a consistent routine is to use the RIGHT cursor key to move through each of the time/date fields in turn. [In the case of a 17 inch Monitor installation, the cursor keys will be found on the Type 7941 Keyboard unit.] To modify an entry, move to the appropriate field, press <ENTER> and then use the UP/DOWN cursor keys to change the entry. Press <ENTER> again to confirm the final value.

The best technique is to set all fields so that the displayed time/date is about 30 seconds ahead of local time standard and then press <ENTER> as the local time standard displays the same time.

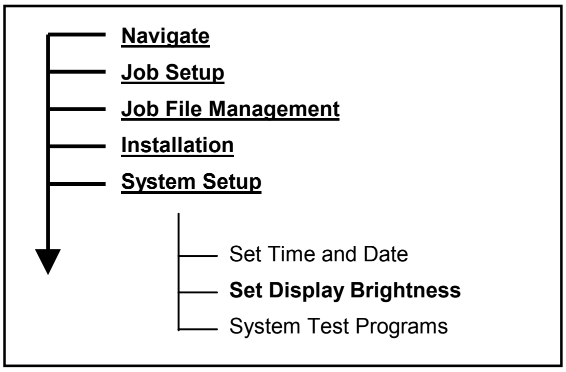
Alternatively, press <ESC> to do nothing if the time/date settings are correct.

4.1.4 Set Display Brightness

Use this option only if appropriate.

This menu option also is found under "**System Setup**" in the top level menu as shown to the right.

This menu option enables the monitor brightness to be varied to suit the ambient light level. Ten brightness levels are available.



4.2 INSTALLATION SETUP TASKS

The remaining tasks to be carried out in order to configure an installation are available under the "**Installation**" area of the menu - if not already set up by Sonardyne.

Entry to the "**Installation**" option on the top level menu is normally password-protected. However, on first entry as part of a new installation, no password will be set and should be set by selecting the "Set/Change Installation Password" option on the "**Installation**" menu (see diagram below), entering an appropriate password and confirming this by re-typing when prompted.

Having done this, all future entry to the "**Installation**" option on the top level menu will require entry of the password before access is enabled.

4.2.1 I/O Port Allocation and Setup

This menu option is located as shown to the right. A range of System Input/Output parameters may be set up using this facility.

On selecting this menu option, a window appears in which are listed all of the existing System I/O ports and the current settings applicable to them - see Fig 4.1 which follows.

Check and/or enter port interface details as described in the following.

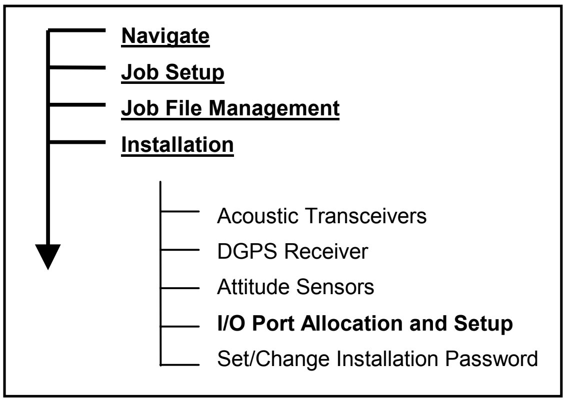


FIG 4.1 I/O PORT ALLOCATION AND SETUP SCREEN

	CURRENT LEVEL: TOP ->INSTALLATION ->PORT SETUP	11:50:35 10 MAR 95 FILE XXXXXXX.XXX MASTER AFT_TCVR

I/O PORT CARD	BITS/ NAME	USE	PROTOCOL	BAUD	STOP CHAR	FLOW BITS	PARITY	CTRL
CPU	SER1	DP TELEGRAM	HPR 418	9600	8	1	NONE	XON/OFF
CPU	SER2	NONE		38400	8	1	NONE	NONE
CPU	PRINTER	PRINTER	LINE PRINTER					
SYNC IO	VRU1	ALALOGUE VRU	SETTINGS					
SYNC IO	SYNC DIG	NONE						
SYNC IO	SERIAL	SERIAL GYRO	ROBERTSON					
SERIAL IO	SER1	ACOUSTIC TCVR	ASCII	38400	8	1	NONE	NONE
SERIAL IO	SER2	ACOUSTIC TCVR	ASCII	38400	8	1	NONE	NONE
SERIAL IO	SER3	NAV PROCESSOR	NONE	38400	8	1	NONE	NONE
SERIAL IO	SER4	NONE		9600	8	1	NONE	XON/OFF
SERIAL IO	SER5	PAN EMULATION	ASCII	9600	8	1	NONE	XON/OFF

As these details are being entered, it will be found useful if a log of all entries is kept for future reference. A blank form suitable for this purpose is included as a Table on the last page of this Section and may be copied and filled in as the task proceeds.

The following nine data entry options are available under this heading (the first two of which are standard to all systems and may not be edited):

- "**I/O CARD**". Identifies the circuit board in the Navigation Processor which carries the interface defined on this row. The entries in this column may not be edited.

- "**PORT NAME**". Names the interface on each card. The entries in this column may not be edited. CPU SER1 is reserved for DP Telegram use. CPU SER2 is reserved for Acoustic Transceiver use in a standard system (but not in a dual-redundant system).

  In a dual-redundant system, the SERIAL I/O ports 1 and 2 should be used for Transceiver communications and the Navigation Processor interlink should be placed on SERIAL I/O port 3 - as illustrated in Fig 4.1. Fig 4.1 also illustrates the settings normally used for the remaining data entry options for the Nav Processor.

- "**USE**". Defines how the interface is to be used in the System - i.e., what it is connected to. This entry may be changed by using the arrow keys to move to this location on the screen and pressing <ENTER>. Preferred uses for a dual-redundant system with a Serial Card fitted are illustrated in Fig 4.1.

  Depending on which row the cursor is in, a dialogue box will appear, as illustrated here to the right for any SER port. Select a use as required and press <ENTER>.

  Different dialogue boxes will appear for other rows as appropriate to the function of that row.

SET PORT USAGE
NONE
DGPS
ACOUSTIC TCVR
DP TELEGRAM
SURVEY OUTPUT
PAN EMULATION
PRINT TRACE
PRINT SCREEN
PRINTER
DEPTH INPUT
NAV PROCESSOR

If no Serial Card is fitted, preferred uses are:

- CPU SER1 — DP Telegram
- CPU SER2 — Acoustic Transceiver
- CPU PRINTER — Printer - must be attached and on-line if specified.
- SYNC IO VRU — Analogue VRU - if "**None**" is selected, the system will utilise the internal inclinometers in the Transceiver.
- SYNC IO SYNC DIG — Synchro VRU - set to "**None**" if Serial VRU or no VRU used.
- SYNC IO SERIAL — Serial Gyro - no other serial use allowed. Set to "**None**" if Synchro Gyro used.

❑ "**PROTOCOL**". Defines the format of the data which will flow into and out of this port. This entry may be changed by using the arrow keys to move to this location on the screen and pressing <ENTER>. A dialogue box will appear (again specific to the function of the channel in that row). Select a use as required and press <ENTER>. The protocols available for each of the port types is given in the Table which follows:-

PORT USE	**PROTOCOLS AVAILABLE**
DGPS	NMEA GGA
TCVR	ASCII or BINARY
DP OUTPUT	HPR 309; HPR 418; ATS ASCII
SURVEY OUTPUT	HPR 309; HPR 418; ATS ASCII; CSV (comma separated values)
SERIAL - GYRO	ROBERTSON; NMEA HDT
PAN EMULATION	ASCII
PRINT OPTION	ASCII; EPSON LQ; EPSON FX; HP THINKJET; HP LASERJET 3; HP DESKJET 320; BITMAP
DEPTH INPUT	ASCII
ANALOGUE VRU	SETTINGS (electrical interface)
SYNCHRO GYRO	GYRO (electrical interface)
NAV PROC	Not applicable - internal binary data stream

In the case where a SYNC IO channel has been selected for VRU use, pressing <ENTER> in the PROTOCOL column causes a new window to appear, as illustrated here to the right with typical values entered. Use the arrow keys as usual to access each column, type in the entry required and press <ENTER> when all entries have been completed. " INVERT ROLL" and "INVERT PITCH" should be set to "NO" if the Sonardyne co-ordinate frame convention (see Appendix C) is being used. The legend "SETTINGS" will remain in this column to indicate that settings have been entered.

VRU SETTINGS

VRU PORT	SCALING DEG/10V	LINEAR SCALING	INVERT ROLL	INVERT PITCH
1	20.0	NO	NO	NO

If no channel is allocated to VRU use, the system will default to using the inclinometers fitted in the Transceiver as a vertical reference.

- "**BAUD**" (⌘) Defines the baud rate at which the interface will operate. This entry may be changed as described above. As before, a dialogue box will appear offering a list of options appropriate to the function.

- "**BITS/CHAR**" (⌘) (⊕) Defines the number of bits comprising each character sent. This entry may be changed as described above. As before, a dialogue box will appear offering a list of options appropriate to the function.

- "**STOP BITS**" (⌘) (⊕) Defines the number of stop bits applicable to this interface. This entry may be changed as described above. As before, a dialogue box will appear offering a list of options appropriate to the function.

- "**PARITY**" (⌘) (⊕) Defines the parity convention to be applied to the interface. This entry may be changed as described above. As before, a dialogue box will appear offering a list of options appropriate to the function.

- "**FLOW CTRL**" (⌘) (⊕) Defines the flow control convention to be applied to the interface. Only XON/XOFF is available at this time. This entry may be changed as described above. As before, a dialogue box will appear offering a list of options appropriate to the function.

  ⌘ If any of HPR 309, HPR 418, ASCII or CSV protocols are selected, default values will be set here - but may be edited, if required.

  ⊕ If "**ACOUSTIC TCVR**" is selected as "**USE**", this parameter is auto-set and may not be edited.

4.2.2 System Tests

At this stage, it is good practice to test system performance before continuing with the Installation procedures which follow. A suitable set of test routines is included with the system software and procedures for using them are included in Appendix E.

4.2.3 Acoustic Transceivers

WARNING: **Do not fit a Transceiver until the Factory Trim and List values have been determined - see paragraph 4.2.4.1.**

The "**Acoustic Transceivers**" menu option is located as shown to the right.

On selecting this option, an integrated function page opens, as illustrated in Fig 4.1 - which follows. Check and/or enter the required Transceiver parameters as described in the following.

Installation
- **Acoustic Transceivers**
- DGPS Receiver
- Attitude Sensors
- I/O Port Allocation and Setup
- Set/Change Installation Password

Enter the Transceiver Name, the name of the object to which it is attached and the Transceiver Manufacturing Serial Number - as determined by the Transceiver's EPROM.

Deploy the Transceiver into its working position. The position of the Transceiver (the centre of the transducer face) should be measured in the SHIP grid and the data entered using this menu option. This data will usually be provided by the customer.

On this page also, enter the following parameters:

- "**Telemetry Baud Rate**" - set to Normal in most circumstances.

- "**Transmit Power**" - set to High unless other acoustic systems are operating in the area and there is a risk of interference. [One other level available]. (This is the transmit power for COMPATT commands)

- "**Receive Power**" - set to High unless operating in a noisy acoustic environment. (This is the COMPATT telemetry receive gain).

- "**Telemetry Wait Time**" - this is the time the system will wait for a reply after transmitting a command. The system takes account of Turn-Around-Time and other delays. The entry made here must take account of the slant range of the Transponder furthest away from the Transceivers.

- "**Max Range**" - this is the slant range of the Transponder furthest away from the Transceivers.

Repeat the above Transceiver deployment procedure for any other Transceivers (e.g., in the case of a dual-redundant system).

FIG 4.2 ACOUSTIC TRANSCEIVER SCREEN

	CURRENT LEVEL: TOP ->INSTALLATION -> ACOUSTIC TRANSCEIVERS	11:50:35 10 MAR 95 FILE XXXXXXX.XXX MASTER AFT_TCVR

TCVR NAME	OBJECT ATTACHED TO	SERIAL NUMBER	X OFFSET FROM DATUM	Y OFFSET FROM DATUM	DEPTH OFFSET FROM DATUM
AFT_TCVR	SHIP	01003	4.3	1.7	0.5

UNITS IN METRES

TELEMETRY BAUD RATE	TX POWER	RX GAIN	TELEMETRY WAIT TIME	MAX RANGE
NORMAL	HIGH	HIGH	3	1000

4.2.4 Attitude Sensors

This menu option is located as shown to the right - together with the sub-options available within it.

The procedure to be followed for each of these sub-options is given in the following.

It is important that the procedures given in paragraphs 4.2.4.1 through 4.2.4.4 are carried out in the order given.

Installation

- Acoustic Transceivers
- DGPS Receiver
- **Attitude Sensors**
  - TCVR Trim and List Factory
  - VRU/Ship Grid Corrections
  - VRU/Transceiver Grid Corrections
  - Corrections Page
- I/O Port Allocation and Setup
- Set/Change Installation Password

4.2.4.1 TCVR Trim and List Factory

Before installing the Transceiver on board ship, the Transceiver Trim and List offsets must be entered. In many cases, these values may be read from the label on the housing.

If, however, there is any doubt about this, the TCVR Trim and List Factory test procedure should be run.

Before running the test, set the "**TCVR FACT CORRECTIONS**" values to zero in the "**Corrections Page**" (see illustration to the right for the location of this option on the "**Installation**" menu).

Installation

- Acoustic Transceivers
- DGPS Receiver
- Attitude Sensors
  - **TCVR Trim and List Factory**
  - VRU/Ship Grid Corrections
  - VRU/Transceiver Grid Corrections
  - **Corrections Page**
- I/O Port Allocation and Setup
- Set/Change Installation Password

Next, place the Transceiver on a fixed, level surface and run the procedure by selecting the "**TCVR Trim and List Factory**" page from the "**Installation**" menu - see illustration to the right.

Turn the Transceiver through 180° when instructed to do so by the procedure and then continue until complete.

4.2.4.2 VRU/Ship Grid Corrections

This procedure is valid provided the ship is, on average, stationary during the procedure - that is:

- It is tied up alongside a quay and it is not subject to any net linear or rotational acceleration during the period.
- It is not being re-ballasted during the procedure (changing the average trim or list).
- The ship's average heading is not changing during the period.

Before starting this procedure, ensure that the "**VRU/SHIP GRID CORRECTIONS**" values are set to zero on the "**Corrections Page**" - as described for the Trim and List values in paragraph 4.2.4.1.

It is assumed that a reference surface (horizontal in the SHIP grid) is available. The Transceiver should be placed on this surface with its logical north aligned with the lubber line of the ship (ship logical north).

> **NOTE**: If there is any doubt about identifying a horizontal reference surface in the ship, assume the VRU is correct and omit this VRU/Ship Grid Corrections procedure entirely.

The procedure runs automatically as soon as the data page is entered. Simultaneous measurements are taken from the trim and list sensors in the Transceiver and from the VRU. Because the trim and list sensors are subject to acceleration-induced error, 256 measurements are taken, spread over a short period.

The procedure calculates the corrections that should be applied to the VRU measurements to obtain the true attitude (roll and pitch) of the ship. As the measurements are taken, the expected precision of the correction is displayed.

4.2.4.3 VRU/Transceiver Grid Corrections Procedure

This procedure is similar in principle to the above. Before running the procedure, ensure the Transceiver is installed in its working position with its logical north axis aligned with the lubber line of the ship.

Before starting this procedure, ensure that the “**TCVR/SHIP GRID CORRECTIONS**” values are set to zero on the “**Corrections Page**” - as described for the Trim and List values in paragraph 4.2.4.1. Ensure also that the correct “**TCVR TO SHIP GRID HEADING**” value is entered on the “**Corrections Page**” - use the procedure set out in Appendix D if necessary.

The procedure calculates the corrections that should be applied to the VRU data to determine the true roll and pitch of the Transceiver frame.

4.2.4.4 Corrections Data Page

Several items of data need to be entered on this page - as illustrated in Fig 4.3, which follows. All values are to be entered in degrees.

Firstly, enter the Transceiver Name and Manufacturing Serial No in the columns indicated. Then move across and enter the Transceiver Factory corrections - either from the data obtained from using the procedure given in paragraph 4.2.4.1 or as supplied by Sonardyne (enter a ‘List’ value as ‘Roll’ and ‘Trim’ as ‘Pitch’).

Move further across the page and enter the “Transceiver to Ship Grid Roll and Pitch” values obtained using the procedure given in paragraph 4.2.4.3.

Finally, on this row, enter the “Transceiver to Ship Grid Heading”. This latter parameter may be derived using the simple procedure set out in Appendix D.

Move down to the “VRU/Ship Grid Corrections” row and enter the Roll and Pitch values obtained using the procedure given in paragraph 4.2.4.2.

The final entry - “Gyro to Ship Grid Heading” - should be obtainable from ship installation data. If not, assume that the Gyro is correctly aligned in the ship grid and enter zero.

FIG 4.3 CORRECTIONS DATA PAGE

CURRENT LEVEL:
TOP ->INSTALLATION ->
ACOUSTIC SENSORS ->CORRECTIONS PAGE

11:50:35	10 MAR 95
FILE	XXXXXXX.XXX
MASTER	AFT_TCVR

TCVR NAME	CORRECTIONS SERIAL NO	TCVR FACT CORRECTIONS ROLL	TCVR FACT CORRECTIONS PITCH	TCVR/SHIP GRID SHIP GRID ROLL	TCVR/SHIP GRID SHIP GRID PITCH	TCVR TO HEADING
AFT_TCVR	01003	0.1	0.2	0.6	0.4	1.1

	ROLL	PITCH
VRU/SHIP GRID CORRECTIONS		

	HEADING
GYRO TO SHIP GRID CORRECTION	

ALL ANGLES IN DEGREES

Having entered all of these values, overall Gyro calibration may be checked using the following practical procedure - given that DGPS is available.

- With the USBL/LUSBL system in Navigation mode, deploy a Beacon immediately underneath the ship, noting ship position from DGPS.
- Move the ship away in a straight line about 200 metres.
- Note DGPS position again and compare with USBL/LUSBL position data. Any difference between these two sets of position data can be attributed to Transceiver/ Gyro alignment error and a corresponding adjustment made to the "Transceiver to Ship Grid Heading" correction.

If the procedures above are used, then the appropriate corrections are automatically entered into the installation database.

Once all installation setup procedures to this point have been carried out, the installation database should be archived using "**Archive Install Files to PC Disc**" option on the "**Job File Management**" menu.

4.2.5 VESSEL Shape

Normally, vessel shape data required to produce the graphic displayed on the screen in Navigation mode will have been entered by Sonardyne on the Installation discs provided with the system and should not need any further amendment.

However, if there is any need to vary this data it can be done using a DOS Editor, but users are recommended to consult Sonardyne before attempting it.

4.2.6 DGPS Receiver

Ignore this Section if no DGPS system is fitted.

This menu option is located as shown to the right.

On selecting the "**DGPS Receiver**" option, an integrated function page opens, as illustrated in Fig 4.4 - which follows.

Installation

- Acoustic Transceivers
- **DGPS Receiver**
- Attitude Sensors
- I/O Port Allocation and Setup
- Set/Change Installation Password

> **NOTE**: This procedure should only be attempted by a fully qualified DGPS operator.

FIG 4.4 DGPS RECEIVER SCREEN

	CURRENT LEVEL: TOP ->INSTALLATION -> GPS ANTENNA POSITION	11:50:35 10 MAR 95 FILE XXXXXXX.XXX MASTER AFT_TCVR

GPS ANTENNA OFFSETS	ANTENNA X OFFSET FROM DATUM POINT	ANTENNA Y OFFSET FROM DATUM POINT	ANTENNA Z OFFSET FROM DATUM POINT
	7.6	2.2	3.5
UNITS IN METRES			

SPHEROID RADIUS FLATTENING	SPHEROID OF ORIGIN	GRID LONG OF ORIGIN	FRID LAT EAST	FLASE NORTH	FASLE FACTOR	SCALE
6378137.00	0.003352813	-3.0000	0.0000	500000.00	0.00	0.9996

DGPS antenna offset co-ordinates in X, Y and Z axes will be provided by the customer. These values, converted if necessary to the current System Display units, should be entered in the appropriate columns of the page.

On completing these entries, use the down arrow key to move to the panel near the bottom of the screen and enter “Spheroid Radius”, etc. Press <ENTER> when complete.

4.2.7 System Calibration

Set up a job as described in Section 2.4. At any time in the execution of a job, it may be judged necessary to carry out a system calibration run to confirm that job settings are correct. For a first installation, it is recommended that this is done as routine. There are two main ways of doing this.

4.2.7.1 **Basic USBL**

The calibration procedure in this case requires a DGPS input and requires a DGPS input and involves using a Sonardyne proprietary software package (“CASIUS”). The ship is required to sail around a nominated beacon and CASIUS will compute any errors at the end of the voyage. Consult Sonardyne for more information on this procedure.

4.2.7.2 **LUSBL with DGPS**

A procedure for carrying out this system calibration is given in Appendix L.

4.2.8 Archiving

On completion of all setup procedures, archive the current job and the installation database using the procedures given in Section 2.5.

FIG 4.5 I/O PORT ALLOCATION AND SETUP LOG

I/O CARD	PORT NAME	USE	PROTOCOL	BAUD	BITS/ CHAR	STOP BITS	PARITY	FLOW CTRL
CPU	SER1							
CPU	SER2							
CPU	PRINTER							
SYNC I/O	VRU1							
SYNC I/O	SYNC DIG							
SYNC I/O	SERIAL							
SERIAL I/O	SER1							
SERIAL I/O	SER2							
SERIAL I/O	SER3							
SERIAL I/O	SER4							
SERIAL I/O	SER5							
SERIAL I/O	SER6							

SECTION 5

5. TECHNICAL SPECIFICATIONS – HARDWARE

5.1 TYPE 7784 NAVIGATION PROCESSOR

The dual-redundant version of the Navigation Processor is very similar to the standard version. The only externally visible difference is that the dual-redundant version has three Transceiver ports on the rear panel whereas the standard version has only one.

5.1.1 Mechanical

Size:	Height	7 in	178 mm
	Width	19 in	483 mm
	Depth	12.1 in	308 mm
	Weight:	< 33 lb	< 15 kg

Connectors:	Power Input	IEC 3 way
	Switched Power O/P	IEC 3 way
	Graphics	15 way Micro D
	DP Report	9 way D type socket

5.1.2 Electrical

Power:	90 - 132 VAC/ 180 - 264 VAC Auto-Sensing on later units
	47 - 63 Hz
Inrush current	< 25 A peak, cold start
Current:	5.50 A max @ 110 VAC
	2.75 A max @ 230 VAC

5.1.3 Processing Unit

Motorola 25/33 MHz 68040

5.1.4 Graphics

RGB 75 ohms sync-on-green or separate sync
680 x 480 Pixels, 16 colour.

5.1.5 Environmental

Temperature:	Operating	0 to 35 deg C
	Storage	-25 to 85 deg C

5.1.6 Mass Storage

Hard Disc:	40 Mbytes SCSI
Floppy Disc:	2 Mbytes SCSI

5.2 TYPE 7783 MONITOR/KEYPAD

5.2.1 Mechanical

Size:	Height	10.5 in	267 mm
	Width	19.0 in	483 mm
	Depth	13.0 in	356 mm
Weight:		33 lb	15 kg

5.2.2 Electrical

Power:	93 - 132 VAC and 187 - 264 VAC Auto-sensing.
Current:	2 A max @ 110 VAC
	1 A max @ 230 VAC

5.2.3 Graphics

Inputs:	RGB 75 ohms
Resolution:	640 x 480 pixels

5.2.4 Environmental

Temperature:	Operating	0 to 35 deg C
	Storage	-20 to 70 deg C

5.3 TYPE 7940 MONITOR UNIT

5.3.1 Mechanical

Size:	Height	14.0 in	356 mm
	Width	19.0 in	483 mm
	Depth	19.4 in	493 mm
Weight:		50 lb	22 kg

5.3.2 Electrical

Power:	110 - 240 VAC, 50 - 60 Hz, 90W
Current:	1.5 - 5.0 Amps - depending on supply voltage
Fused at:	2.5AT

5.3.3 Graphics

Inputs:	RGB 75 ohms
Resolution:	1280 x 1024 pixels

5.3.4 Environmental

Temperature:	Operating	0 to 55 deg C
	Storage	-20 to 70 deg C

5.4 TYPE 7941 KEYBOARD UNIT

5.4.1 Mechanical

Size:	Height	3.47 in	88 mm
	Width	19.00 in	483 mm
	Depth	18.68 in	474 mm
Weight:		16 lb	7 kg

5.4.2 Electrical

Voltage (from Navigation Processor):	5 V dc
Current (from Navigation Processor):	400 mA

5.4.3 Environmental

Temperature:	Operating	0 to 45 deg C
	Storage	-20 to 85 deg C

5.5 TYPE 7769 USBL ACOUSTIC TRANSCEIVER

5.5.1 Mechanical

Diameter (main body)	8.9 ins	225 mm
Diameter (over transducer)	8.9 ins	225 mm
Overall length	24 ins	600 mm
Weight in air	62 lbs	28 kgs
Weight in water	30 lbs	13.5 kgs

5.5.2 Electrical

Maximum power	36-72V DC - 25 W continuous	
Communication	RS 485 baud rate switchable	9600 - 38400
Processor	16/32 bit micro controller	
A/D Converter (ADC)	multi-channel 12 bit	

5.5.3 Acoustic

Transmitting:

Directivity Index	8 dB approx.
Power	25 watts acoustic
Source Level	193 dB ref 1 micropascal @ 1 m

Receiving:

Operating envelope	±80° (160 deg) min
Sensitivity	100 dB ref 1 micropascal
Directivity Index	10 dB
Repeatability	One standard deviation <0.5% of range for a signal/noise ratio (SNR) of 25 dB measured as a spectrum level by an omnidirectional hydrophone <0.2% if SNR >35 dB as measured by an omnidirectional hydrophone or SNR > 20 dB at phase meter
Accuracy	Better than 1% of range

5.5.4 Environmental

Temperature:	0 to 35°C in water

FIG 5.1 OUTLINE DRAWING TYPE 7784 NAVIGATION PROCESSOR

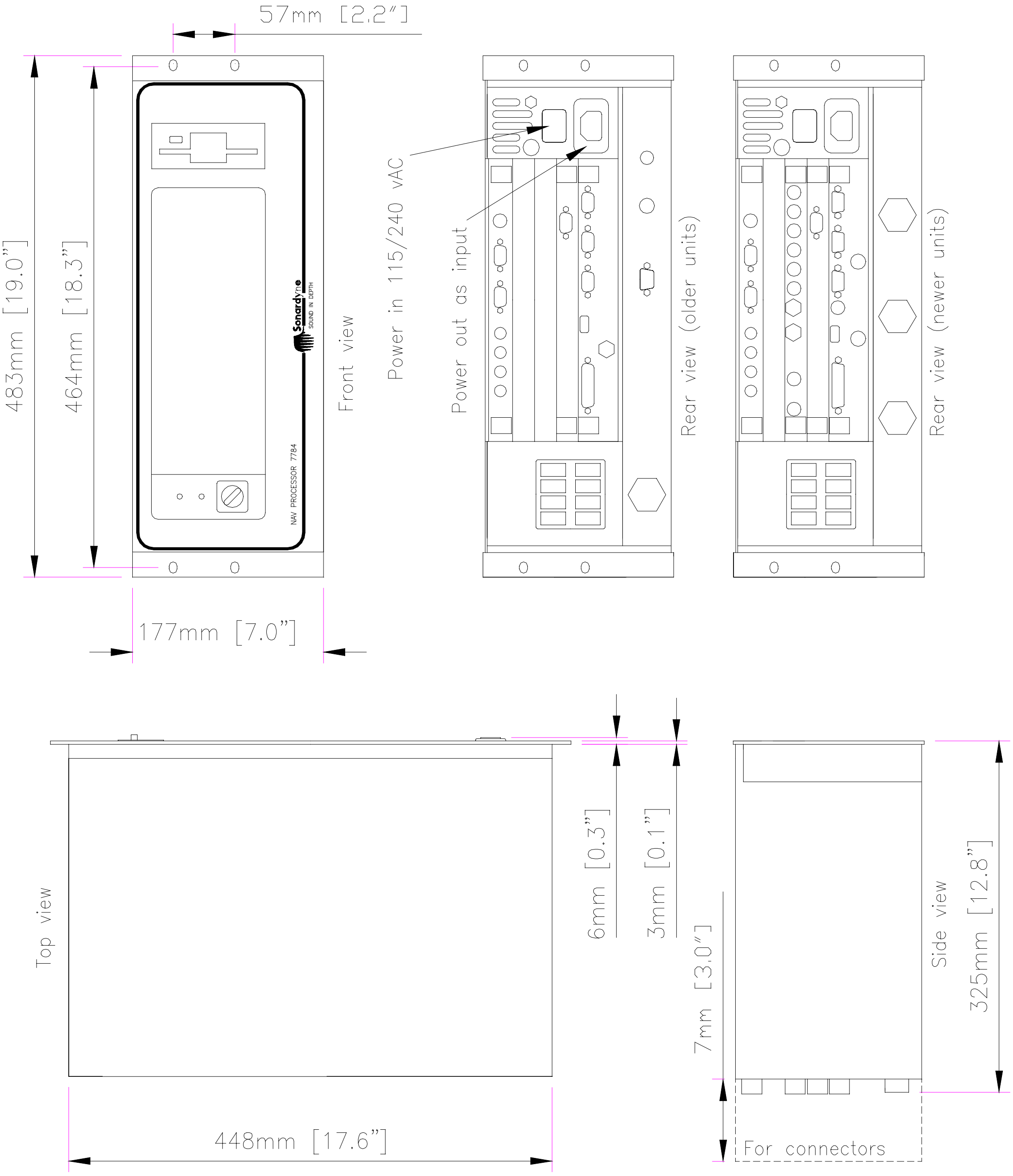


FIG 5.2 OUTLINE DRAWING TYPE 7783 MONITOR/KEYPAD

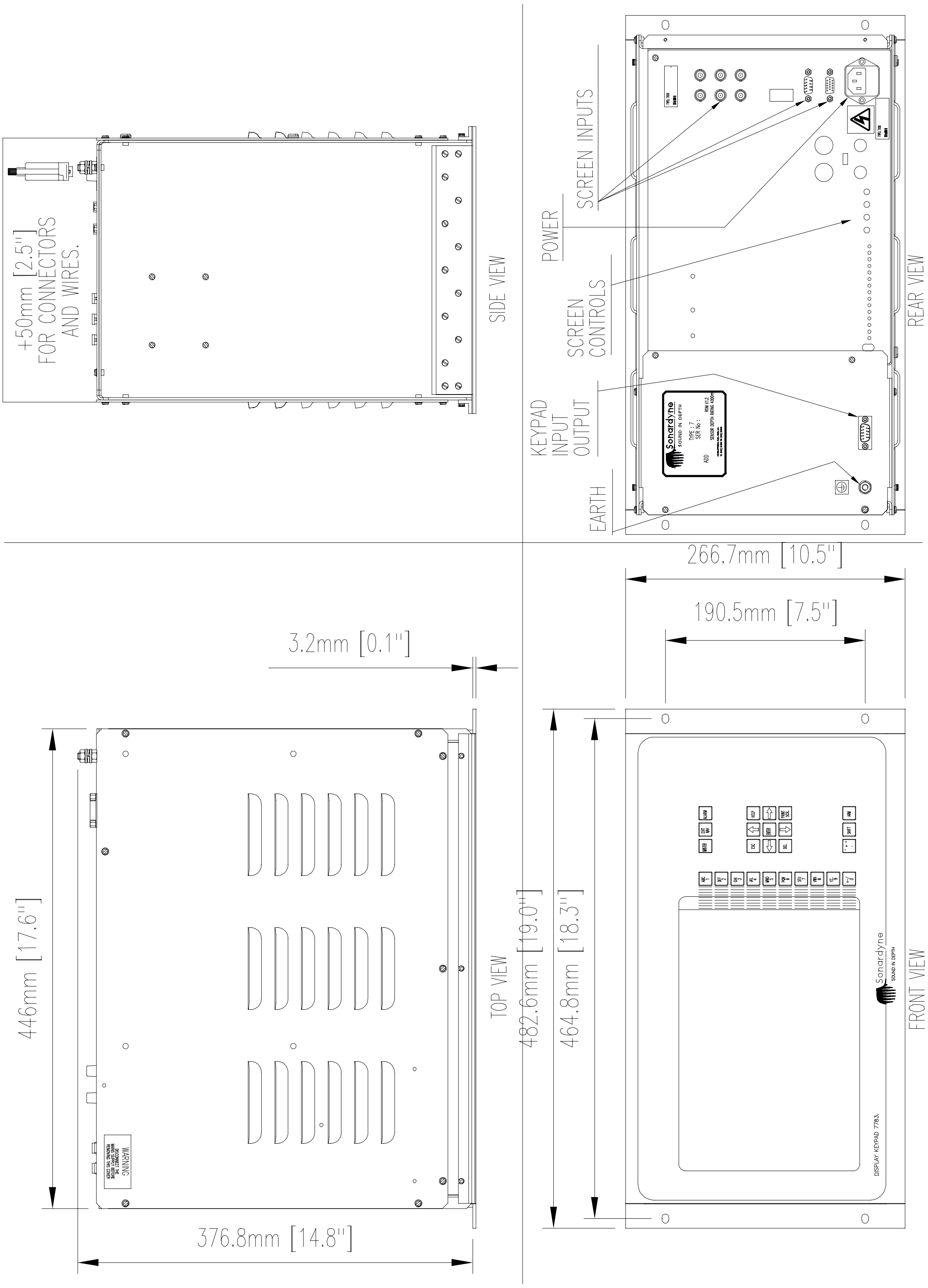


FIG 5.3 OUTLINE DRAWING TYPE 7940 MONITOR UNIT

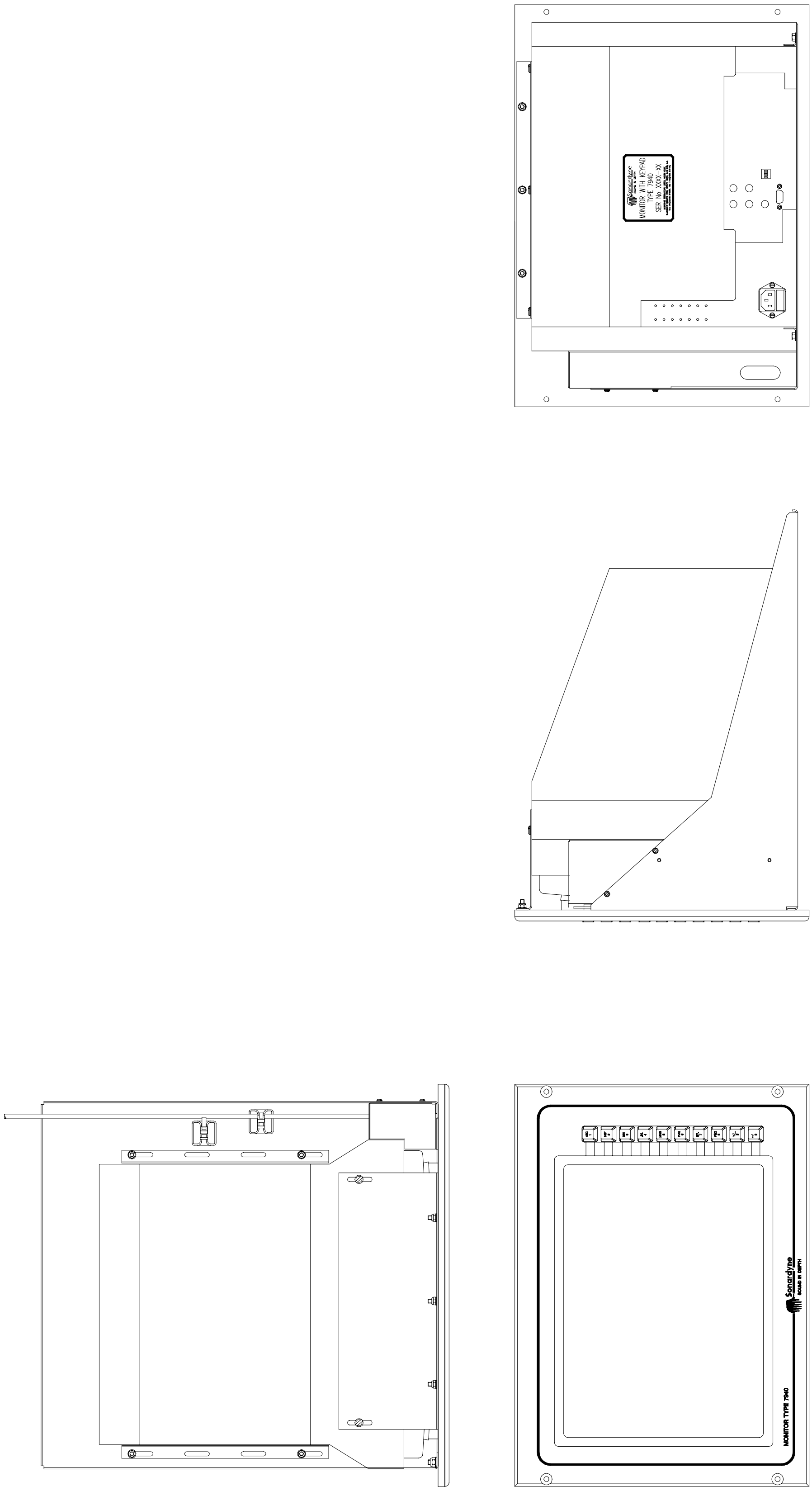


FIG 5.4 OUTLINE DRAWING TYPE 7941 KEYBOARD UNIT

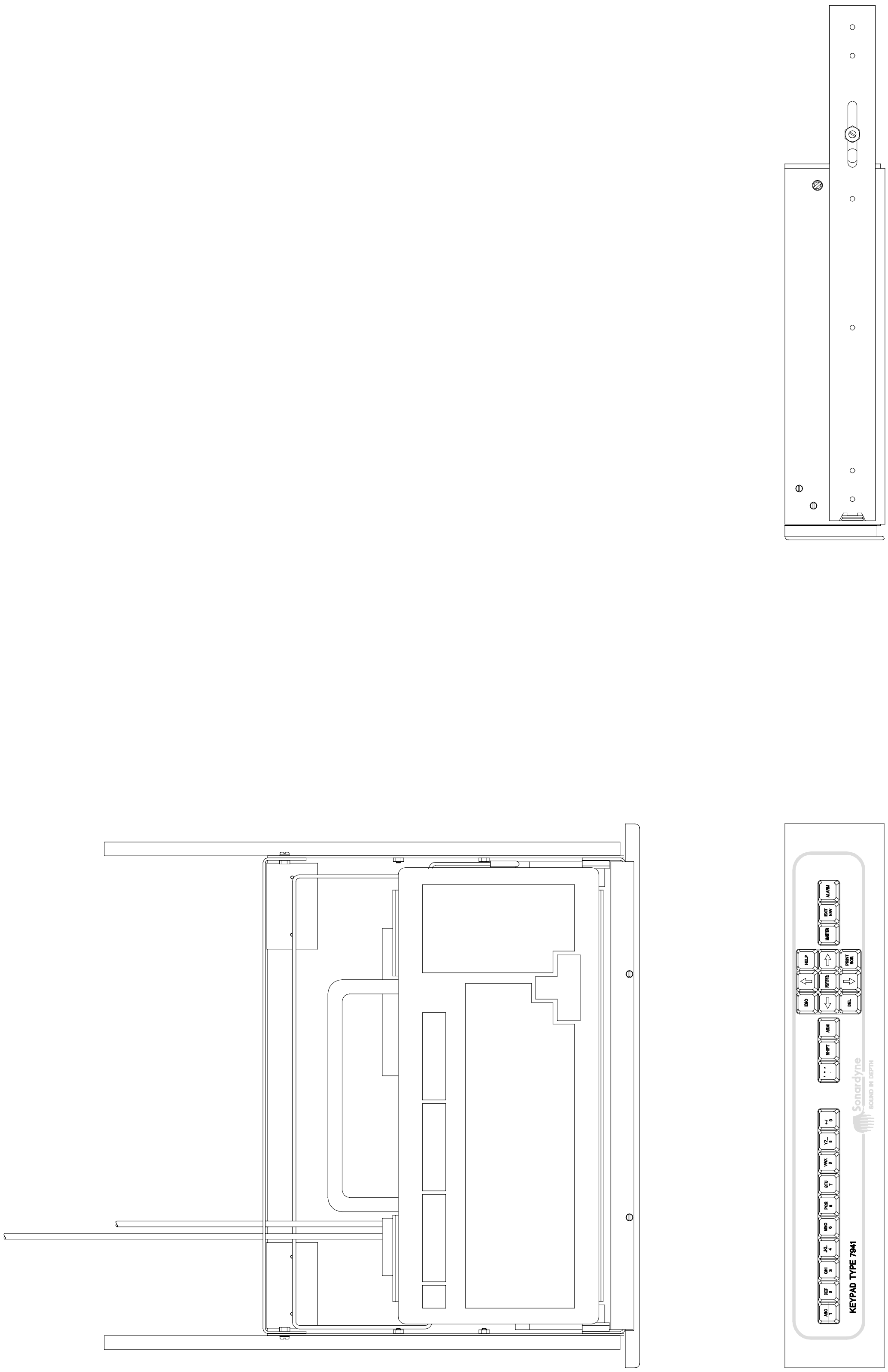
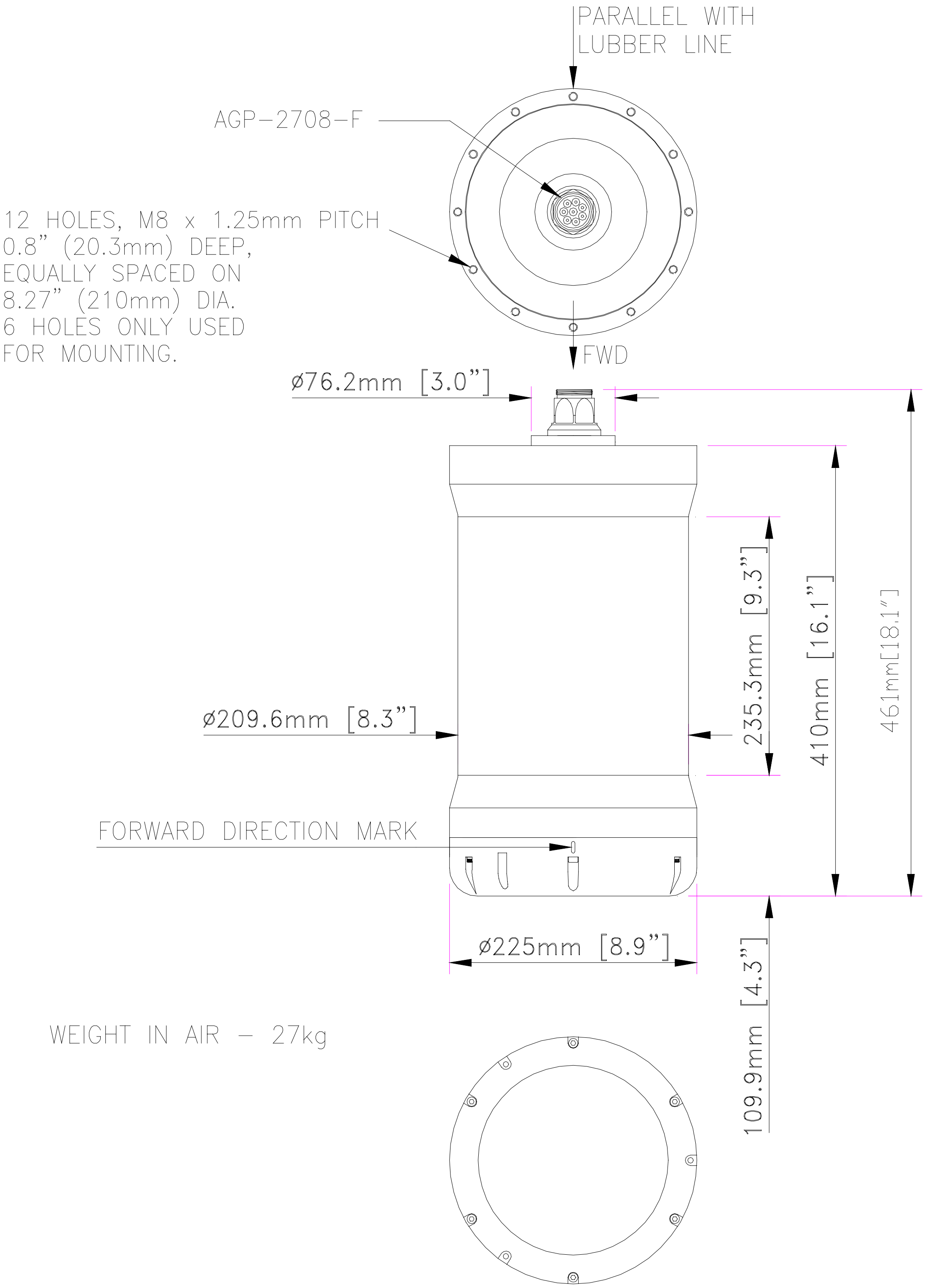


FIG 5.5 OUTLINE DRAWING TYPE 7769 USBL

Acoustic Transceiver



5.6 SYSTEM PERFORMANCE

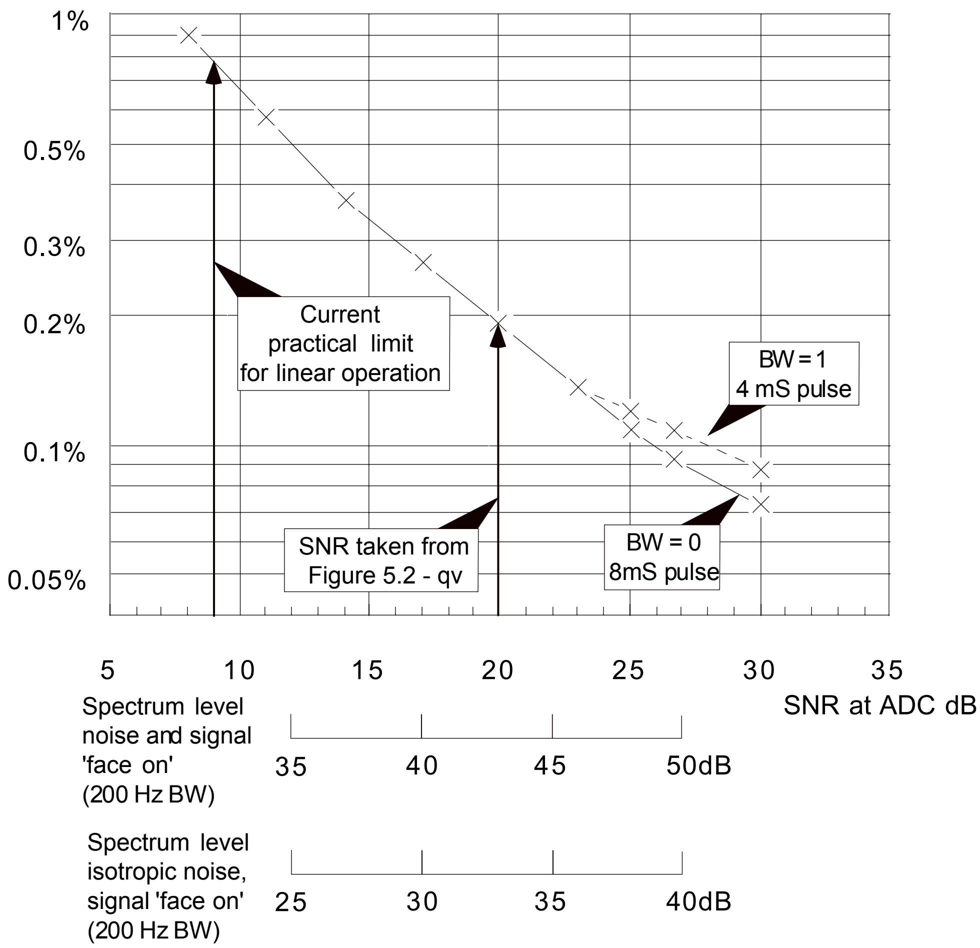
5.6.1 USBL Mode Repeatability (in Transceiver Grid) against Noise

Fig 5.6 illustrates the repeatability achievable purely by considering the performance of the USBL Transceiver in measuring the bearing of an incoming signal from a beacon. It is a simulated and ideal situation, and does not take into account error mechanisms in the VRU or Gyro-Compass.

In Fig 5.6, SNR means 'Signal to Noise Ratio', ADC means 'Analog to Digital Converter' and BW means 'Bandwidth'. As shown, the main plot is for BW = 0 (200 Hz, 8 mS pulse).

FIG 5.6 X-Y PLAN REPEATABILITY IN THE PRESENCE OF NOISE

(expressed as a % of slant range for the standard deviation of a population of fixes)



5.6.2 Maximum Range in the Presence of Typical Ship Noise

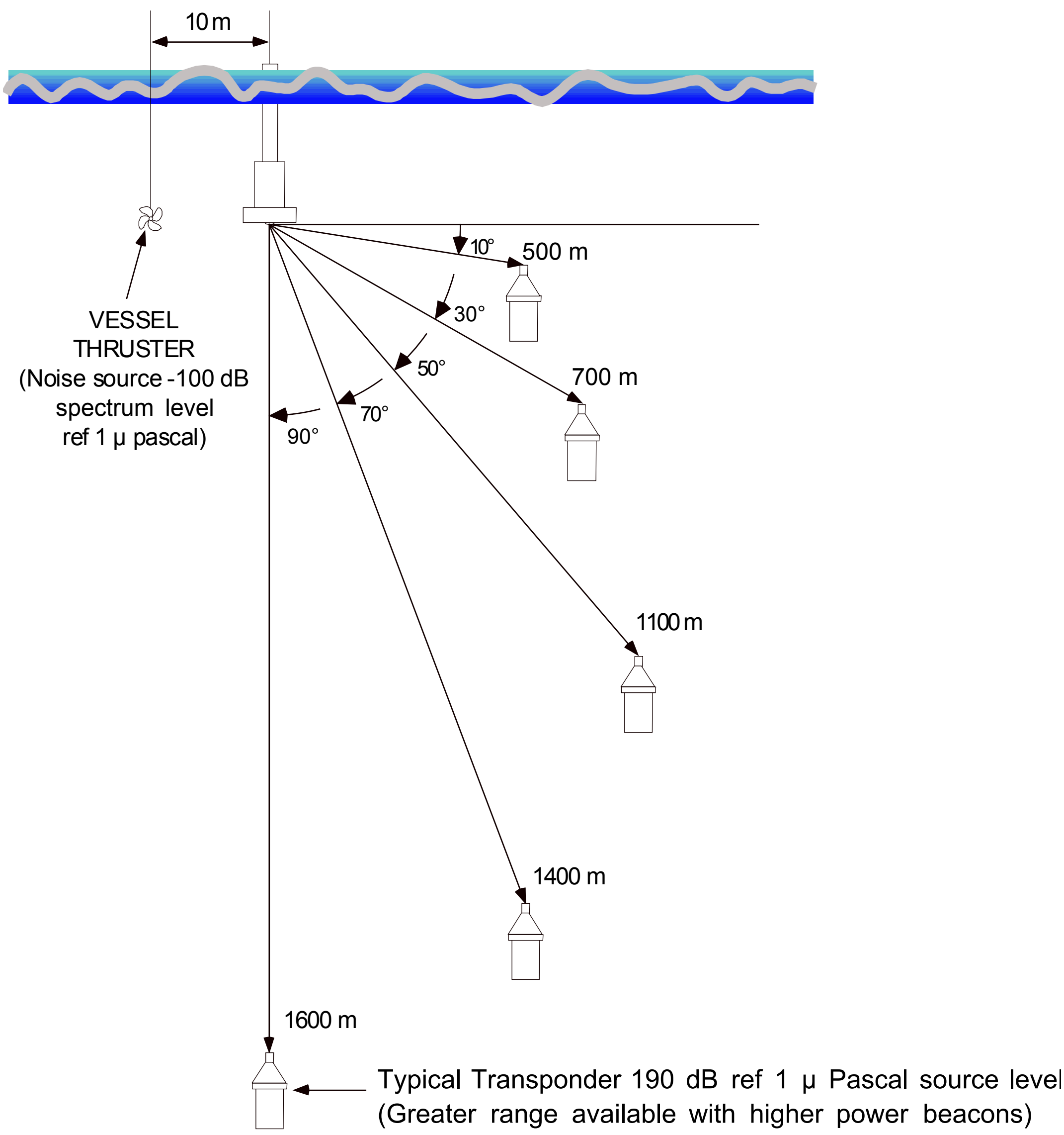
Fig 5.7 illustrates a typical vessel noise source (a vessel thruster) and a number of typical transponder beacons at a variety of angles of depression. At the ranges shown, and shorter ranges, the SNR at the ADC will typically be better than 20 dB. Using the figure of 20 dB in Fig 5.6 yields an X-Y plan repeatability, for 65% of fixes, of better than 0.2% of the slant range.

For low angles of depression, (nearly horizontal), Gyro-Compass errors and errors caused by high angular velocity in roll and pitch (typically greater than 6 degrees per second at peak) will be very significant. In deep water, a good quality VRU is essential.

FIG 5.7 RANGE OF OPERATION IN THE PRESENCE OF NOISE

for various angles of depression and for a typical noise source

(SNR - 20 dB at range/bearing discriminator)



5.6.3 Error Contribution from Attitude Sensors and Ship Motion

5.6.3.1 Impact of VRU Errors

Errors in the VRU ship's attitude outputs will lead to errors in the USBL's (or LUSBL's) computation of beacon position. In practice, VRU roll output errors lead to x co-ordinate errors in beacon position and VRU pitch output errors lead to y co-ordinate errors. The position error is similar in form for both roll and pitch cases and the roll case is examined in detail below as an example.

Fig 5.8 illustrates a ship with an angle of list, σ, and a beacon at range, R.

It can be shown that the seabed x co-ordinate error (ΔXB in Fig 5.8) is a function of the depth of the beacon on the seabed, D, and the angular error in roll, δσ.

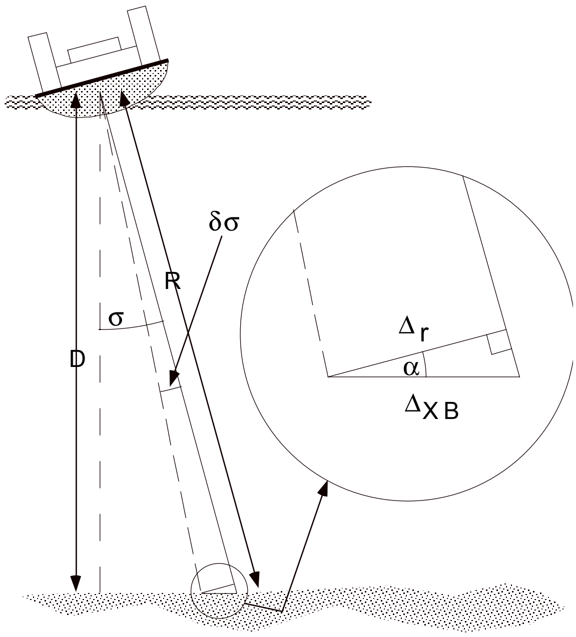
The full expression for the seabed x co-ordinate error is complex if the ship's angle of list, σ, is large. However, for small angles of list, a simplified expression may be used. From Fig 5.8:-

$$R = \frac{D}{\cos \sigma}$$

$$\text{Roll error } \Delta_r = R\,\delta\sigma = \frac{D\,\delta\sigma}{\cos \alpha}$$

where $\delta\sigma$ is in radians

FIG 5.8 ROLL ATTITUDE ERROR



$$\text{and, since angle } \alpha = \text{angle } \sigma,\ \Delta_r = \frac{D\,\delta\sigma}{\cos \sigma}$$

$$\text{Seabed x error, } \Delta_{XB} = \frac{\Delta_r}{\cos \alpha} = \frac{\Delta_r}{\cos \sigma}$$

$$= \frac{D\,\delta\sigma}{\cos^2 \sigma}$$

and, for small values of σ, this simplifies to:-

$$\Delta_{XB} = D\,\delta\sigma$$

A similar argument for the VRU pitch output leads to the following expression for the seabed y co-ordinate error, Δ_{YB}, attributable to a VRU pitch error, $\delta\theta$, as follows:-

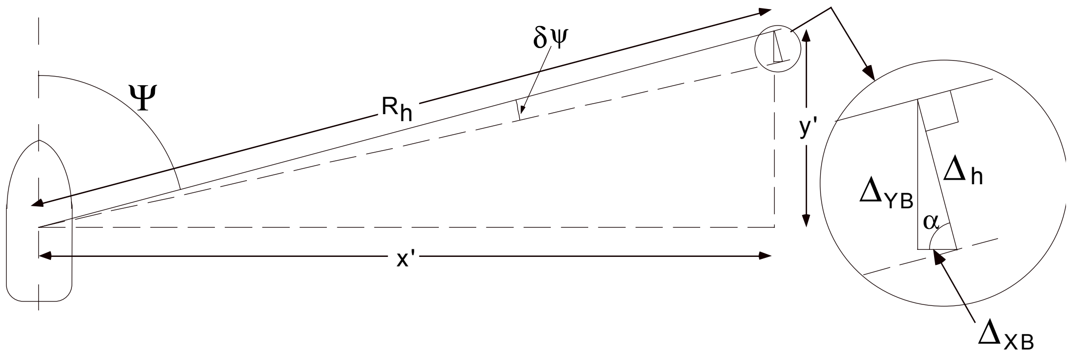
$\Delta_{YB} = D\ \delta\theta$

A graphical representation of these equations, given in Fig 5.10 which follows, simplifies the task of estimating position errors attributable to VRU roll and pitch errors.

5.6.3.2 Impact of Gyro Compass Errors

In the case of a gyro compass error, there is an impact on computation of beacon position in both x and y axes. In Fig 5.9 below, Ψ is the ship's heading angle, $\delta\psi$ is the error in that angle and x' and y' are the seabed x,y co-ordinates of the beacon position from the ship.

FIG 5.9 ROLL ATTITUDE ERROR



From Fig 5.9:-

$$\sin\Psi = \frac{x'}{R_h}$$

$$\text{and } \cos\Psi = \frac{y'}{R_h}$$

$$\text{also, } \Delta_h = R_h\,\delta\psi \text{ - where } \delta\psi \text{ is in radians}$$

$$\text{since } \alpha = \Psi,\ \Delta_{XB} = \Delta_h \cos\alpha = \Delta_h \cos\Psi$$

$$= R_h\,\delta\psi\,\frac{y'}{R_h}$$

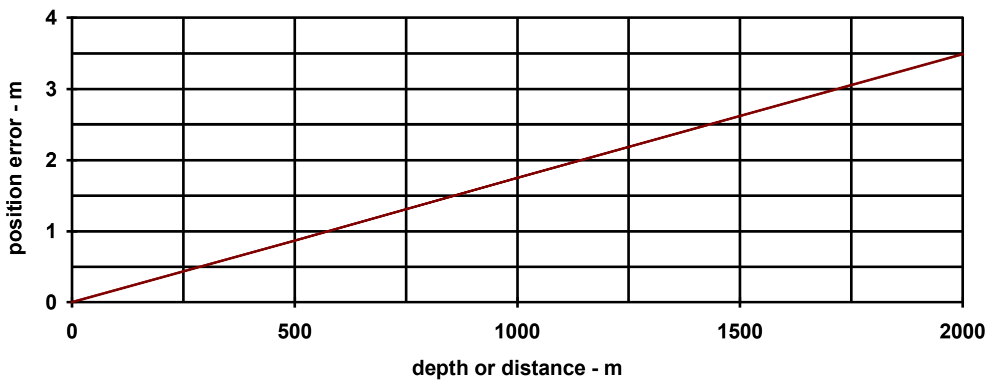
$$\therefore\ \Delta_{XB} = y'\,\delta\psi$$

A similar argument for the y co-ordinate leads to the following result for Δ_{YB}:

$$\Delta_{YB} = x'\,\delta\psi$$

Fig 5.10 illustrates the position error arising in the appropriate seabed co-ordinate (Δ_{XB} and/or Δ_{YB}) **<u>for each 0.1° error in attitude angle</u>** (roll, pitch or heading) over a range of depths (D) or distances (x' or y').

FIG 5.10 ONE TENTH DEGREE POSITION ERROR



SECTION 6

6. DESCRIPTION OF COMPONENTS

6.1 TYPE 7784 NAVIGATION PROCESSOR

Block diagrams for the main Navigation Processor components are given in Fig 6.1.

6.1.1 Overview

The Navigation Processor consists of:-

1. A "4U" high 19 inch rack mountable case that contains a power supply, cooling fans, hard and floppy disc drives and a section that can accommodate 5 double Eurocards.

   The double Eurocards are field replaceable through the removable front panel without disturbing the case or any wiring.

   A full 32 bit VME back plane connects the "P1" connectors and one row of the "P2" connectors. The remaining rows of "P2" are connected to sub-panels, via Spreader Cards, that are inserted from the rear. This feature makes the instrument easy to upgrade in the field as more Cards become available for the system or more capable processors become available etc.

   On older units (see Fig 5.1), the bottom "1U" of the instrument consists of a hinged tray retained by 2 quarter-turn DZUS fasteners. The tray accommodates a switched mode power supply supplying 48V for the Transceiver. It also accommodates two Cards: one carrying opto-isolated, serial RS 422 driver/receivers for communication with the Transceiver and the second one carrying Responder Driver circuits.

   On newer units (also shown in Fig 5.1), the bottom “1U” contain the 48V Supply and a power/communications distribution board. In these units, the driver/receivers are incorporated onto new versions of the Spreader Cards (CPU/Serial I/O).

2. One double Eurocard that contains a single board computer with the following features:-

   - 25/33 MHz Motorola MC 68040 32 bit Microprocessor with cache, MMU and FPU, and up to 32 Mbytes on-board DRAM and up to 4 Mbytes ROM/EPROM.
   - 20 MIPS, 3.5 MFLOPS.
   - Full 32 bit VME bus Interface- A32, D32/D64
   - On board SCSI Interface (used for disc I/O)
   - On board Ethernet Interface
   - Burst DMA.
   - 4 off RS232 D Serial Ports
   - Centronics compatible parallel port

3. One double Eurocard Graphics Card that features:-

   - TMS 34061 Graphics Processor.
   - 16 bit VME Interface
   - 512k x 4 bit VIDEO RAM, Resolution 640 x 480 pixels, colour look up table 16 colours from a palette of 16M

4. Type 7693-058 Navigation Interface Card that features:-

   - VME Interface:

Slave Data Options	A16:D8
Interrupter Options I	(1)(Stat)
Physical Configuration	NEXP

   - An 8 bit H6303 Microprocessor.
   - A single channel isolated Synchro to Digital Converter (SDC, 400 Hz or 60 Hz Scott transformers on Spreader Card)
   - Isolated analogue VRU Interface.
   - Up to 3 channels (provided isolation is not required between VRUs).
     Common 15 V DC supply.
     Common earth.
   - Receive Only 20 mA serial interface - RS232 / RS422 - for serial Gyro interface.
   - A 76.8 KBaud Manchester Encoded (LSBL Transceiver) RS422 isolated serial interface.
   - An RS 232 D console port.

5. An optional 6-channel Serial Interface Card.

6.1.2 Functional Description

110V or 240V AC power is taken into the unit through an input filter and a mains fuse to the switched output socket, to the bottom tray and the switch mode power. The switch mode power supply provides +24V, +12V, +5V, 0V, and -12V DC to the VME back plane or the ribbon back plane of the unit. These outputs are monitored for correct voltage by circuitry on the CPU Spreader Card. If all outputs are within limits then the power supply LED, visible through the front panel, is illuminated.

The single board computer or CPU Card takes power from the VME back plane. On power up it boots initially from on board EPROM and then if a floppy disc is present in the floppy disc drive from floppy disc or if not then from the hard disc drive.

Both the disc drives are operated over the SCSI bus. The SCSI bus runs from the CPU Card through the "P2" connector, onto the rear Spreader Card and then through a ribbon cable to the drives themselves.

To drive an external device operated over a SCSI bus, a tap on the SCSI bus ribbon cable runs to the panel underneath the front panel of the CPU Card. Similarly a +12V, +5V and 0V power bus runs to the internal drives and to the front sub-panel through 2 fuses.

The six channel serial interface Card is controlled over the VME bus from the CPU Card. Its Spreader Card has three fixed RS232 ports and three configurable RS232/RS422/RS425 ports which may be routed to the new panel or to the base tray for Transceiver comms via internal wiring. Additionally there are four Responder drives and one trigger monitor with hardware provided for a second trigger input (currently inactive).

The CPU Card has 6 I/O ports operating over buses passing through the "P2" connector and the Spreader Card. All serial ports operate to "RS232" standards across "P2" . Where necessary the inputs or outputs are transformed on the rear Spreader Card

- The "Keyboard" port operates TTL levels for data in, RS232 levels for data out, RTS and CTS, and supplies +5V for "QWERTY" keyboards that require it. When operating with the Monitor Keypad the RS 232 data out port is used to command the Keypad into various modes such as Alpha mode or numeric mode and to operate the beep functions.

- The "Serial" port operates RS 232 levels for Data out, Data in, RTS, CTS, DTR and DCD. (Synchronous modes are an option). In this system, this port is looped across to the bottom tray and is the Transceiver communications port.

- The "Console" port operates RS 232 levels for Data in, Data out, RTS and CTS. This port is for use by service engineers.

- The "Current loop" port operates RS232 levels for Data out and Data in, a 20 mA current loop for data out and a 20mA loop for Data in. For Data out the port is normally operated using the CS1 pin (12V supply) and the CLOT1 pin only and the loop is earthed on the Spreader Card via link 10. Normally the current loop Data in facility is used only for testing during installation and testing using the CLIN- and CLIN+ pins.

- The "Printer" port is an 8 bit parallel Centronics compatible port using standard IBM PC 25 pin "D" Connector pin-outs.

- The Ethernet option is not currently supported by the system software.

The CPU Card controls the GFX or Graphics Card over the VME interface and back plane by writing into video RAM through a graphics controller IC. The data is clocked out by the graphics controller IC into a colour look up table IC which drives the 75ohm RGB video outputs. "Sync" generated by the graphics controller IC is buffered and ORed into the G video producing "RGB with sync on Green". Alternatively, VGA is available by changing the jumper configuration of the Graphics and Graphics Spreader Cards - see Appendix J.

The CPU controls the Navigation Interface Card over the VME bus. The Navigation Interface Card contains an 8 bit H6303 Micro-controller that interfaces with a Synchro to Digital Converter (SDC) and a 12 bit ADC system as instructed by the main CPU on a command by command basis.

The power supply on the bottom tray transforms the AC mains voltage to 48V DC suitable for supply to the Transceiver. (In early units this PSU is NOT auto sensing and has to be configured to match the input mains voltage). These units are fitted with voltage labels by the mains inlet on the front of the “1U” drop-down tray - and inside the tray.

The Transceiver Communications Card on the bottom tray has an independent floating 5V DC supply. (On earlier units, this Card was not auto-sensing). This 5V supply is used to power the RS422 communications driver and receiver. The Card also uses +12V, -12V +5V and signal 0V from the main rack. Communications with the CPU Card is via the "Serial" port using RS 232 levels including RTS and CTS. The RX Data, TX data and RTS are buffered and pass through opto-isolators. RTS is used to switch the RS 422 transmitter/ receiver between the two modes of operation. On newer build units (see Fig 5.1), the functions of this Card are carried out on either the CPU Card or Serial I/O Spreader Card.

6.1.3 Dismantling for Maintenance

The unit should be switched off and disconnected from the mains before any removal or replacement of parts is carried out. The only exception is that the Double-Eurocards may be removed without disconnecting from the mains, provided that the unit has been switched off first.

During a fault finding operation, it may be necessary to run the system with the some of the exterior panels of the instrument removed. It is recommended that this type of operation is carried out ONLY by qualified personnel AND there should be a Residual Current Detector protecting the mains supply.

WARNING	**Many of the electronics components used within the system are liable to damage by static discharge. Work should be carried out at a workstation where the unit is earthed or can be placed on an earthed conductive mat. The Maintainer should be electrically connected to the earth of the equipment being worked upon.**

6.1.3.1 **Replacing Double Eurocards**

To gain access to the Double Eurocards the front panel has to be removed (see Fig 6.3, illustration 1).

The Cards are removed by unscrewing the 2 screws retaining the front panel (see Fig 6.3, illustration 2). These screws are captive therefore they should not be fully removed. Use the extractor handles to separate the connectors between the Card and back plane in combination with undoing the screws.

When inserting a Card it is important to press the Card and thus connectors fully home before securing the panel screws. This ensures the most reliable connection.

6.1.3.2 **Replacing the Spreader Cards**

(See Fig 6.3, illustration 3)

The rear Spreader Cards cannot be replaced without reasonable access to the rear of the unit. Similarly all the leads connected to the Spreader Panels should be removed. The Spreader Panels are removed by unscrewing the 2 or 4 screws retaining them.

The CPU Spreader Card is a special case as there are 2 ribbons connected to the under-side of the Card. Therefore, withdraw the Card about 5 cm, raise the rear edge of the Card a little and remove the two ribbons before withdrawing the whole assembly. [HINT: Removal/replacement of the CPU Spreader Card is much easier if the Graphics Spreader Card is removed first and replaced last].

Insertion is the reverse of the above process and is similar in principle to replacing the Double-Eurocards except that there are no Card guides. Push the panels and hence the connectors fully home before securing the panel with the screws.

6.1.3.3 **Gaining Access to the Rack Power Supply**

(See Fig 6.3, illustration 4)

Before access can be gained to the Power Supply, the top cover must be removed. 14 screws must be unfastened before the top cover can be removed. It is important that all screws are used on re-assembly to ensure reliable connection and cooling.

NOTE:	**The precautions described in Section 6.1.3 regarding safety and static electricity should be followed throughout.**

6.1.3.4 **Replacing the Rack Power Supply**

(See Fig 6.3, illustration 5.1 through 5.3)

The Back Panel, carrying the Transceiver and Responder Connectors, is removed by undoing the bolts “K” (see Fig 6.3, illustration 5.1). The Vent Panel, carrying the mains connectors and fuses, should be removed by undoing the screws “F” and “FH” as indicated in the same illustration.

Then the Bottom Tray should be hinged down as indicated in Fig 6.3, illustration 9.

Next remove the Switch Panel (as indicated in Fig 6.3, illustration 5.2) by removing the screws “B” and “BS”. Note that the screws “BS” are fitted with spacers. To get this Panel out more easily, remove the Plate “U” (see Fig 6.3, illustration 5.3) by undoing the screw “T” and then temporarily replacing it once the Switch Panel is out.

Finally, as indicated in Fig 6.3, illustration 5.3, remove the AC mains and DC connections to the power supply, remove the 4 screws securing the power supply to the LHS of the rack and remove the power supply.

Note that there is a spacer plate between the power supply and the LHS of the rack. This must be re-used on re-assembly.

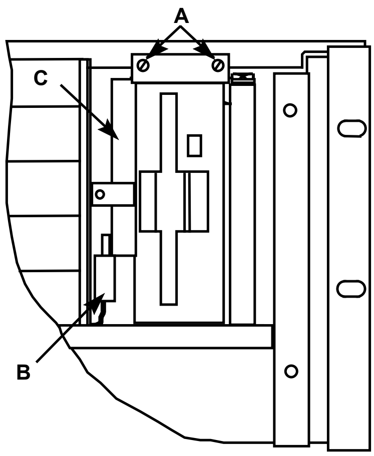
For re-assembly, the colour and position of each conductor is shown in Fig 6.2.1 for early design units and Fig 6.2.2 for later design units.

Re-assembly is the reverse procedure of dis-assembly, taking note of which Power Supply is being fitted and whether the Power Switch is of the rotary (older units) or toggle (newer units) type.

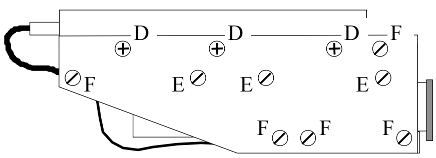
6.1.3.5 **Replacing a Disc Drive**

Remove the two screws “A” and slide the disc module forwards and to the left (see also Fig 6.3, illustration 6).

Remove the white Molex connector “B” and continue sliding the module forward to gain access to the ribbon cable “C”. Remove the ribbon cable using the two ejector levers and hold the two cables clear of the module. Remove the module, being careful not to damage the power cable or the ribbon cable.



To remove a hard disc (see also Fig 6.3, illustration 7):

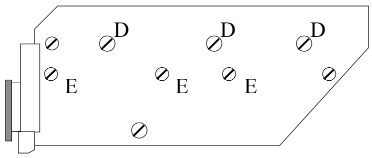


TOP VIEW

- Remove the six screws “D” (three shown in this top view and three in the bottom view given later) followed by the power and interface connectors.

- Slacken the screws “E” and “F” (in the top view only) and remove the drive.

To remove a floppy disc (see also Fig 6.3, illustration 8):



- Remove the six screws “E” (three shown in this bottom view and three in the top view given earlier) followed by the power and interface cables.
- Slacken screws “D” and “F” (in the top view only) and remove the drive.

Replace a module in the reverse order to the above.

6.1.3.6 Servicing Assemblies on the Bottom Tray

There are two basic forms of the Bottom Tray. In addition, the earliest Type I units used a mains-powered version of the Transceiver Communications card which was NOT auto voltage-sensing.

The two basic forms of the Bottom Tray are shown in Fig 6.3, illustrations 11.1 & 11.2. The early form of Type I Tray uses a Comms card with a large toroidal transformer, as shown in Fig 6.3 illustration 10.

The transceiver power supply is secured to the Tray using 4 screws (see Fig 6.3, illustration 10). These fasteners and the electrical connections must be removed before the card can be replaced. Assembly is the reverse procedure - the colour and pin-out of each conductor is shown in Fig 6.3, illustration 12.1 for Type I units or illustration 12.2 for Type II units.

In Type I Bottom Trays, the Transceiver Communications card (the larger of the two circuit cards in Fig 6.3 illustration 10) is secured using 4 screws. These fasteners and the electrical connections must be removed before the card can be replaced. Assembly is the reverse procedure - the colour and pin-out of each conductor is shown in Fig 6.3, illustration 11.1 for Type I units or illustration 11.2 for Type II units. If a Type I unit has the old Comms card, the newer style can be used to replace it as the connections are identical. The mains input to this card is to a connector which is used merely to restrain the existing mains wire (but is not otherwise used). If the Bottom Tray was built using the new style Comms card, the mains will not be connected to this card.

NOTE: Since the old Comms card is not mains voltage auto sensing, the links on its terminal connector have to be changed if the mains voltage is changed, as follows:

240V	120V
Pin 2 to Pin 3	Pin 1 to Pin 3 and Pin 2 to Pin 4

In Type I Bottom Trays the smaller Responder Card may be removed and replaced in a similar fashion.

In Type II Bottom Trays there is only one card. Undo the connector at the right hand edge of the card (or three connectors in dual-redundant systems) and the IDC ribbon cable. Remove the two screws holding the heat sink to the base of the Tray and then remove the five screws securing the main card. Assembly is the reverse procedure.

6.1.3.7 **Replacing the Bottom Tray as a Complete Unit**

(See Fig 6.3 illustration 11.1 for Type 1 units or 11.2 for Type II units)

The Bottom Tray should be released and hinged down as illustrated in Fig 6.3, illustration 9.

- Disconnect the 3 pin “mains” connector from the mating connector on the bottom plate of the rack. On a Type 1 Bottom Tray, disconnect the 25 way “D” connector from its mating connector on the bottom plate of the rack. On a Type II Bottom Tray, disconnect the IDC ribbon cable from the PCB.
- Remove the two bolts on the sides of the rack in the bottom rear corners.
- Unfasten the bolts through the 2 off hinge bearings. Note the enlarged detail on this in Fig 6.3, illustration 11.

Assembly is the reverse procedure to above.

6.2 TYPE 7783 MONITOR/KEYPAD

6.2.1 Overview

(See Fig 6.4)

The Type 7783 Monitor/Keypad consists of a 6U high 19 inch rack mountable case containing:-

- A 12 inch high resolution multi-sync colour monitor.
- A 4W fluorescent bulb Keypad back lighting system.
- A Keypad Card. This is a Microprocessor controlled "terminal" that receives data from the Navigation Processor, scans the membrane Keypad, transmits the key codes to the Navigation Processor and controls the audible alarm.
- A 12V auto sensing power supply for the Keypad Card and Invertor.
- A 12V input Invertor Card to drive the fluorescent backlight.
- A Membrane Keypad.

6.2.2 Functional Description

(See Fig 6.4)

The multi-sync monitor is powered by 110v AC or 240V AC as specified in Section **Error! Reference source not found.**. The internal power supply is auto sensing. It is only necessary to fit the correct type of fuse. It accepts RGB with sync-on-green video signals into the three BNC connectors marked RGB.

A spur from the mains supply in the Monitor feeds power to an auto-sensing power supply with a 12V DC output. This supplies power to an Invertor Card and the Keypad Card.

The Invertor Card supplies power and controls a 4W fluorescent bulb used in the Keypad back-lighting system.

The Keypad Card has an on-board Micro-Controller and a PSU system that generates all the necessary on-board DC power rails from the 12V supplied through P2. It has a serial interface operating through P1 that is used for communication with the Navigation Processor. This operates at TTL levels for data out of the Card and RS 232 levels for data in to the Card. The Keypad switch matrix is connected through P3. The system detects when a key switch contact closes, includes the necessary de-bounce circuitry and generates the appropriate ASCII keycode to be transmitted out of the serial port. The Keypad operates in two modes. In the normal mode numeric keycodes are generated when the 1 to 9 and 0 keys are pressed. In the Alpha mode alpha keycodes are generated when the same keys are pressed. The mode change is accomplished by sending commands over the serial interface. Similar commands are used to activate the audible alarms etc.

6.2.3 Dismantling for Maintenance

The unit should be switched off and disconnected from the mains before any removal or replacement of parts is carried out.

During a fault finding operation, it may be necessary to run the system with the some of the exterior panels of the instrument removed. It is recommended that this type of operation is carried out ONLY by qualified personnel AND there should be a Residual Current Detector protecting the mains supply.

Many of the electronics components used within the system are liable to damage by static discharge. Work should be carried out at a work station where the unit is earthed or can be placed on an earthed conductive mat. The Maintainer should be electrically connected to the earth of the equipment being worked upon.

6.2.3.1 **Removing the Lid**

(See Fig 6.6, illustration 1)

There are no active components that can be replaced without removing the lid. Before removing the lid remove the 8 slotted screws indicated.

6.2.3.2 **Removing the Power Supply**

(See Fig 6.6, illustration 2)

Undo the 4 off screws retaining the Card and Support Assembly. Remove all cable connections and set to one side. Lift Card/Support Assembly out of chassis. The PSU may now be removed from the Assembly.

Assembly is the reverse of the above procedure.

6.2.3.3 **Removing the Keypad Card**

(See Fig 6.6, illustration 3)

Undo the 3 off nuts retaining the Card and remove it from the Support Assembly.

Assembly is the reverse of the above procedure.

6.2.3.4 **Removing the Fluorescent Bulb**

(See Fig 6.6, illustration 4)

With the Card Support Assembly removed as above (see paragraph 6.2.3.2), undo the nuts and remove the Inverter Card and the bar retaining the reflector. Pull the bulb backwards and out of the 2 clips. Disconnect the leads on either end of the bulb and remove it.

Assembly is the reverse of the above procedure.

6.2.3.5 **Removing the Inverter Card**

(See Fig 6.6, illustration 5)

Remove the Inverter Card as described above.

Assembly is the reverse of the above procedure.

6.2.3.6 **Removing the Front Panel**

(See Fig 6.6, illustration 6)

Remove the lid, Card Support Assembly, Inverter Card and Lamp as described earlier. Loosen six screws above and below the Monitor (arrow B). Remove four nuts and washers (arrow A). Remove the Front Panel in the direction of arrow C.

Assembly is the reverse of the above procedure.

6.3 TYPE 7940 MONITOR UNIT (17 INCH)

6.3.1 Overview

The Type 7940 Monitor unit (see Fig 5.3) consists of an 8U high, 19 inch rack-mounting case, containing:

- A 17 inch high resolution colour monitor

- A Keypad. In the case of the Type 7940 Monitor unit, this keypad comprises only the menu keys. The remaining function keys and the cursor keys are located on the Type 7941 Keyboard unit - see Section 6.4.

- A Keypad Card. This is a simple circuit that scans the Keypad and converts the key codes to PC AT keyboard format.

6.3.2 Functional Description

(See Fig 5.3)

The Type 7940 Monitor unit is very similar, functionally, to the Type 7783 Monitor/Keypad unit. In particular, the power and video interfaces are the same. Apart from the size of the monitor itself (17 inch rather than 12 inch), the main differences are as follows:

The keypad comprises only the menu keys, fitted as a vertical strip down the right-hand side of the screen - as in the Type 7783.

Signals from the keypad are converted to PC AT format and are fed to an Interface Box mounted in the Type 7941 Keyboard unit - see Section 6.4 - rather than being fed directly to the Navigation Processor.

6.3.3 Dismantling for Maintenance

The Type 7940 Monitor unit is not designed for field repair. If any failure should occur, the unit should be replaced as a whole. To do this, switch off power to the system and disconnect from the mains supply. Disconnect the three video signal leads (marked RGB on the back of the unit) and the two keypad signal leads which lead down to the Type 7941 Keyboard unit. The four screws holding the unit to the rack may then be unscrewed and the unit removed.

6.4 TYPE 7941 KEYBOARD UNIT

6.4.1 Overview

(See Fig 5.4)

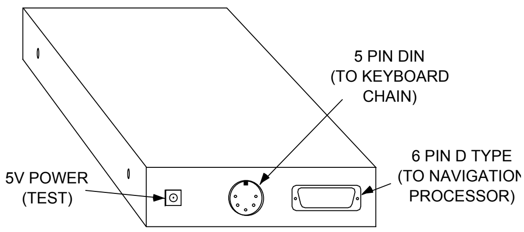
The Type 7941 Keyboard unit is a new unit for the LUSBL system and is aimed at making the task of entering long character strings much easier than is possible with the older Type 7783 Monitor/Keypad. The Type 7941 consists of a 2U high 19 inch rack-mounting drawer unit containing:-

- A Keypad mounted on the front of the drawer. In the case of the Type 7941 Keyboard unit, this keypad comprises a full set of cursor keys and function keys including a duplicate set of the alpha-numeric menu keys already included on the Type 7940 Monitor unit - see Section 6.3.

- A Keypad Card. This is a simple circuit that scans the Keypad and converts the key codes to PC AT keyboard format.

- A standard PC AT keyboard

- An Interface Box (Ref: 265-0738), illustrated here to the right, designed to convert PC standard keyboard signals into a serial stream of TTL format data as required by the Navigation Processor. It also contains the circuit which controls the audible alarm - used, for instance, in the Watch Circle function.



6.4.2 Functional Description

The Type 7941 Keyboard unit provides an operator with two useful options regarding data entry method. For simple, short data entry the set of alpha-numeric menu and function keys on the front keypad offers the same functionality as that provided by the older Type 7783 Monitor/Keypad.

Alternatively, the operator may open the drawer, tilt up the back of the PC standard keyboard until it is supported on a stand and make most data entries on this keyboard.

6.4.3 Dismantling for Maintenance

With two exceptions (see Section 7.10), the Type 7941 Keyboard unit is not designed for field repair. If any failure should occur, the unit should be replaced as a whole. To do this, switch off power to the system and disconnect from the mains supply. Disconnect the two cables which connect to the Type 7940 Monitor unit and withdraw them through the access hole in the back of the drawer. The 9 pin DIN connector on the Type 7941-005 cable to the Navigation Processor is too large to pass through the access hole. This cable must be disconnected at its other end so that the BT connector may be pulled through the access hole.

The six screws holding the unit to the drawer sliders may then be unscrewed and the unit removed.

6.5 TYPE 7769 USBL ACOUSTIC TRANSCEIVER

(See Fig 6.7)

6.5.1 Overview

The Transceiver is a complete microprocessor-controlled interrogator/receiver operating on command from the Navigation Processor. The main functions of the Transceiver are:

- Interpretation of commands from the Navigation Processor.
- Transmission of commands or transponder interrogation signals on any one of 29 frequencies between 19.2 and 31.6 kHz . The transmitted pulse can be variable in length between 1 and 8 mS in steps of 2, 4 and 8 mS. The output power can be adjusted in 2 steps of 10 dB each.
- Reception of transponder reply signals can be on any one of the 29 frequency channels between 19.2 and 31.6 kHz .
- Decoding of Acoustic Telemetry.
- Measurement of time and phase information in the received transponder reply.
- Transmission of measured (range and bearing) data to the Navigation Processor.

The electronics comprises:

- Floating voltage regulation circuits
- A microprocessor subsystem with RS422 comms.
- Six pre-amp channels.
- Six receiver channels including mixers, and other signal conditioning circuits controlled by the processor.
- Sampling and analogue-to-digital conversion circuits.
- Transmit circuit controlled by the processor.

The transducer face comprises an array of a number of ceramic receiver elements arranged evenly around a transmit element. They are recessed into a machined high grade plastic and encapsulated in polyurethane to form a strong smooth acoustic interface to the water.

The electronics chassis is attached to a metal base plate at the transducer face assembly. A cylindrical housing slides over it to mate with the face held together by six recessed bolts. To ensure maximum resistance to corrosion the housing is constructed in Aluminium Bronze.

An underwater connector is provided in the top of the housing for connection with the interface cable.

The microprocessor within the Transceiver runs a program stored in EPROM on the CPU Card. This firmware (a software program stored in EPROM) controls all the functions of the unit.

6.5.2 Functional Description

(See Fig 6.7.1)

Nominally 48V DC power is supplied to the unit using a single pair of conductors. Communications with the Navigation Processor is implemented using a half-duplex RS 422 link. This uses a second pair of conductors. The 4 conductors linking the Transceiver with the Navigation Processor connect to the PSU/TX Card. The RS 422 communication pair are routed via the motherboard back plane straight through to the CPU Card.

All the power supply rails used by the instrument are generated on the PSU/TX Card. The ±12V rails are produced by one DC/DC converter, +5v by a second DC/DC converter and - 5V is produced by linear regulation of the -12V supply.

The transmitter functions of the Card are controlled by the CPU Card over an I^2C serial interface. The 3 levels of the transmitter output power of are controlled using a programmable regulator supplied from the ±12V rails. The matching network between the transmitter drive circuit and the transmitting transducer elements is controlled by 2 tuning lines form the I^2C I/O expander. A "4xF" signal is supplied to the Card from the frequency synthesiser on the CPU Card together with a transmitter control (enable) signal. The signals are conditioned locally before being supplied to the transmitter drive circuit.

The PSU/TX Card is also fitted with the front end of an LBL receiver to be used with a future version of the CPU Card. The signal input is from the transmitting element, through the "TR" network and bandpass filter. The signal is amplified by IC10 before being passed to the CPU Card. There are 3 lines from the I^2C I/O expander controlling the sensitivity of the receiver.

The CPU Card uses a Philips SCC68070 micro-controller which as well as a CPU has a UART, and an I^2C bus. Peripheral components on the CPU bus include the RAM and ROM memory parts, the Analogue to Digital Converter (ADC) and multiplexer select lines, a 5 channel timer and an output latch used for high speed control of system functions. These control functions are: track and hold control, receiver quench, oscillator reset, RS422 direction control, calibrate control and the three control lines for the synthesiser's serial bus.

A frequency synthesiser controlled by the MPU generates signals for the transmitter, for the USBL receiver calibration injection signal and the reference signal for the RX multipliers.

A DAS system supplies reference signals to sensors (PRT, pressure transducer and inclinometer sensors). The conditioned signals are routed through a multiplexer controlled by the CPU into the ADC

The signal from the receiving elements are amplified by the pre-amplifiers. On the RX Card the signals are again amplified and multiplied by the reference signal. The output of the phase meters are sampled and multiplexed to the ADC on the CPU Card.

6.5.3 Dismantling for Maintenance

Before dismantling the unit should be washed in fresh water, dried and brought into a clean, dry area.

There are no parts that can be replaced whilst the unit is powered-up. Whilst dismantling is in progress the unit should be disconnected from the Navigation Processor.

During a fault finding operation, it may be necessary to run the system out of its case. It is recommended that this type of operation is carried out ONLY by qualified personnel.

Many of the electronics components used within the system are liable to damage by static discharge. Work should be carried out at a work station where the unit is earthed or can be placed on an earthed conductive mat. The Maintainer should be electrically connected to the earth of the equipment being worked upon.

6.5.3.1 **Removing the Electronics/Transducer Assembly from the Housing**

(See Fig 6.9, illustration 1)

Undo the 6 M5 socket cap screws (4mm A/F Allen driver) securing the end cap to the housing. Place three of the screws in to the jacking screw positions provided. Screw these in evenly until the end cap is raised enough to be removed. Make sure the assembly is not withdrawn so far and fast that the cable linking the electronics to the connector on the housing is damaged. Undo the connector where indicated in the Fig 6.9, illustration 1a.

Assembly is the reverse of the above procedure, except that the jacking procedure is not applicable.

6.5.3.2 **Replacing a PSU/TX Card**

(See Fig 6.9, illustration 2)

Undo the 2 pan head screws securing the Pre-amp box to the base plate. Carefully manoeuvre the pre-amp box to gain access to the 6 M3 nuts (5.5mm A/F Socket) securing the PSU/TX Card. Remove the nuts and pull the Card away at right angles to the chassis. Make sure the spacers are not lost, failure to use these on re-assembly will result in the replacement Card being mechanically stressed and render it unreliable.

Assembly is the reverse of the above procedure.

6.5.3.3 **Replacing a CPU/Timer Card**

(See Fig 6.9, illustration 3)

Undo the 6 M3 nuts (5.5mm A/F Socket) retaining the Card to the chassis. Disconnect the Power lead to the pre-amp and the Cable to the Inclinometer. Carefully withdraw the Card away from and at right angles to the chassis. When the connector between the Card and the "back plane" on the motherboard is disengaged, manoeuvre the Card out sideways and remove the CAL leads.

Make sure that all the spacers are in position before fitting the replacement Card. Failure to use these will stress the Card and render it unreliable.

Assembly is the reverse of the above procedure.

6.5.3.4 **Replacing an RX Card**

(See Fig 6.9, illustration 4)

Remove the socket-headed screws retaining the indicated inclinometer sensor bracket to the base plate. Disconnect the lead running between it and the CPU Card and remove the sensor and bracket.

NOTE:	**If you have a screwdriver which grips screws, then the inclinometer will not need to be removed as the screws are accessible through a cut-out in the mounting bracket.**

If you are replacing an RX Card then do the following:-

- For Channels A, B and C:-
    - Disconnect the Pre-amp Box power leads.
    - On the CPU side of the chassis undo the 8 pan head screws securing the screen to the chassis rails. Withdraw the cover away and at right angles to the chassis until the connectors disengage. Manoeuvre the cover and Card away from the chassis.
    - Undo the 8 pan head screws securing the Card to the chassis rails. Disconnect the coax connectors lead from the outputs of the Pre-amps and withdraw the Card away from and at right angles to the chassis.
- For Channels D, E and F:-
    - Disconnect the Pre-amp Box power leads and screws.
    - On the TX side of the chassis undo the 8 pan head screws securing the screen to the chassis rails. Withdraw the cover away and at right angles to the chassis until the connectors disengage. Manoeuvre the cover and Card away from the chassis.
    - Undo the 8 pan head screws securing the Card to the chassis rails. Disconnect the coax connectors lead from the outputs of the Pre-amps and withdraw the Card away from and at right angles to the chassis.

Assembly is the reverse of the above procedure.

NOTE:	**The basic Card is not position sensitive, but jumpers need to be configured differently for the D, E and F channels compared with those for the A, B and C channels - see Fig 6.7.2.**

6.5.3.5 **Replacing a Pre-amp Card**

(See Fig 6.9, illustration 5)

Undo the 4 screws securing the lid of the pre-amp box and remove the lid.

If only the top pre-amp is to be replaced then undo the 5 coaxial leads connected to this Card. Note the connections and label them if necessary. Try not to stress the cables and grip the connector bodies using an appropriate pair of pliers.

If the bottom pre-amp is to be replaced remove these connections as well.

Remove the lead with the 4 way Molex connector from the top pre-amp Card.

Undo the 4 M3 hexagonal nuts (5.5mm A/F Socket) securing the pre-amp Card to the box and remove the top pre-amp from the box. If necessary remove the spacers, undo the 4 way Molex connector on the second Card and remove the Card.

Assembly is the reverse of the above procedure. Take care to use all the appropriate spacers etc.

NOTE: On newer units, the separate Splitter Card is replaced by a second output on the Card for Channel A. The output lead labelled "F" is connected to "A" NOT "F".

The Pre-amp Cards are not position sensitive (Inner/Outer) provided both are of the same issue.

6.5.3.6 Replacing an Inclinometer Sensor

(See Fig 6.9, illustration 6)

Remove the hexagonal headed screws retaining the appropriate inclinometer sensor bracket to the base plate. Disconnect the lead running between it and the CPU Card and remove the sensor and bracket.

Undo the 2 pan head screws securing the sensor to the bracket and remove the sensor. The new sensor wires will have to be incorporated into the loom (see Fig 6.8.1 for wiring details of early design units or Fig 6.8.2 for later units).

Assembly is the reverse of the above procedure. Take care to use all the appropriate spacers etc.

NOTE: After the inclinometers have been replaced the Transceiver should be re-calibrated as an inclinometer sensor as indicated in paragraph 4.2.3.2.

FIG 6.1 BLOCK DIGARAMS

Fig 6.1.1 - Navigation Processor Block Diagram

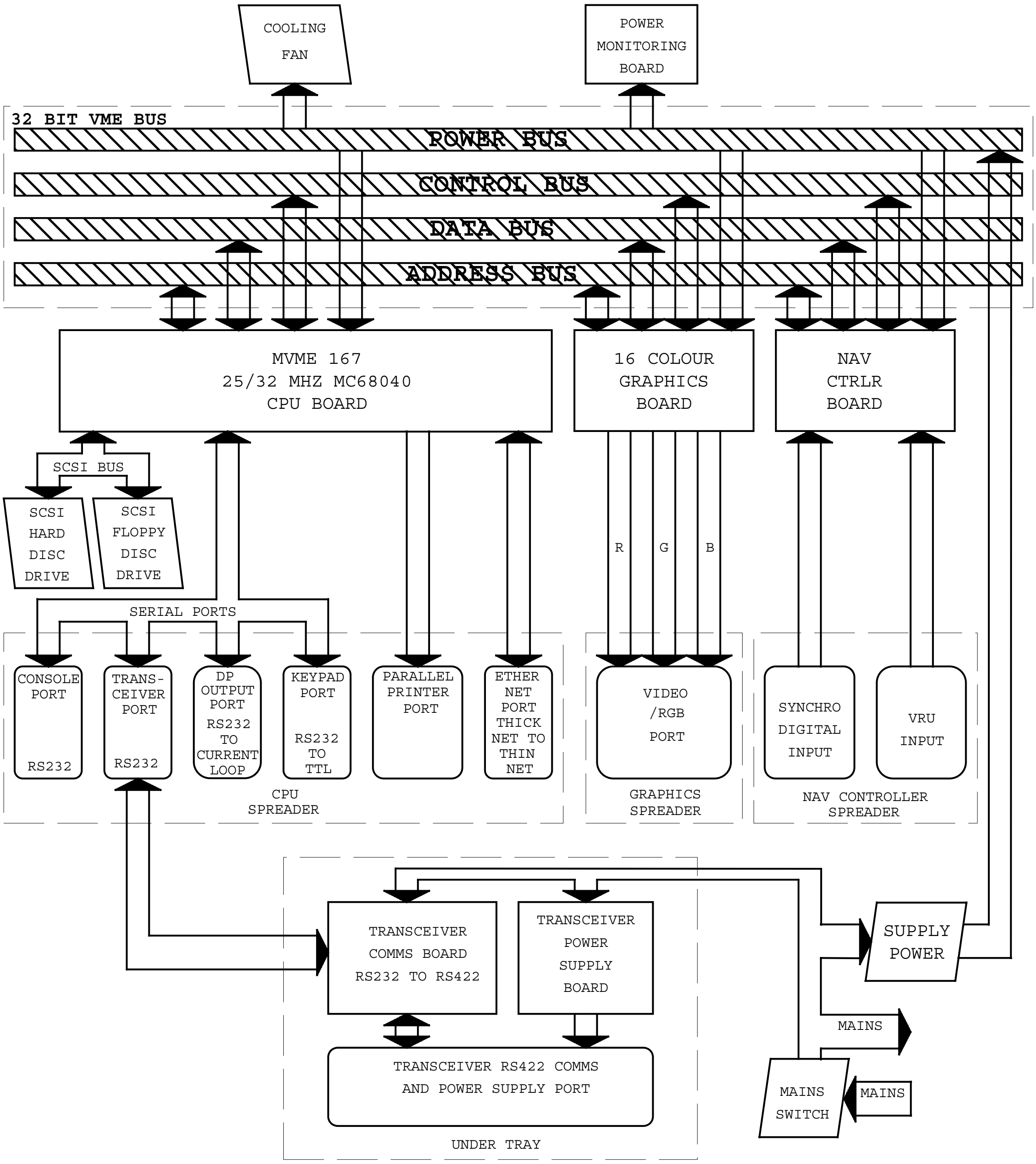


FIG 6.1 BLOCK DIGARAMS

Fig 6.1.2 - MVME 167 Block Diagram

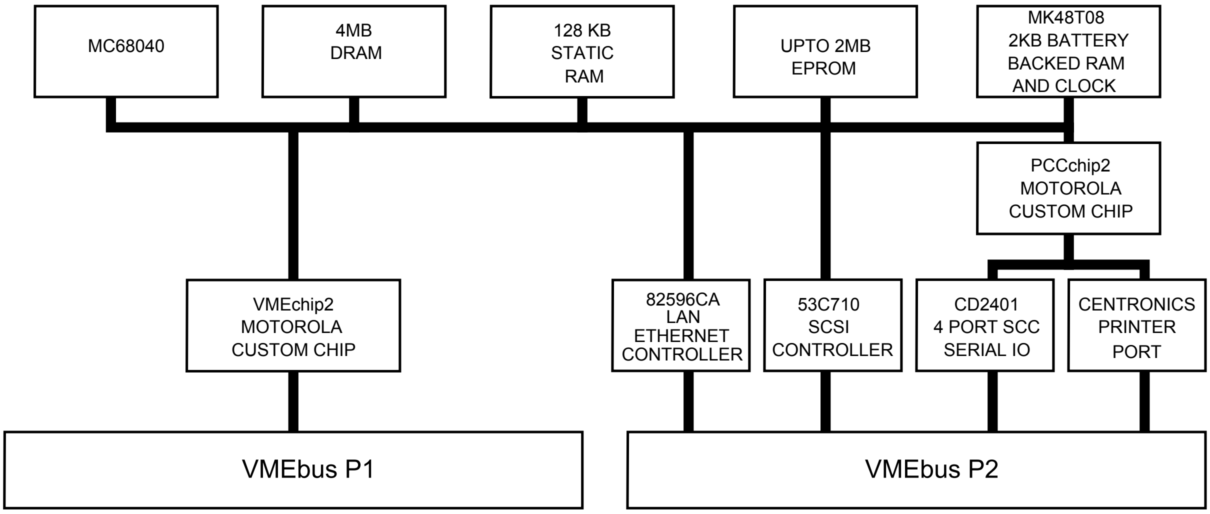


Fig 6.1.3 Graphics Board Block Diagram

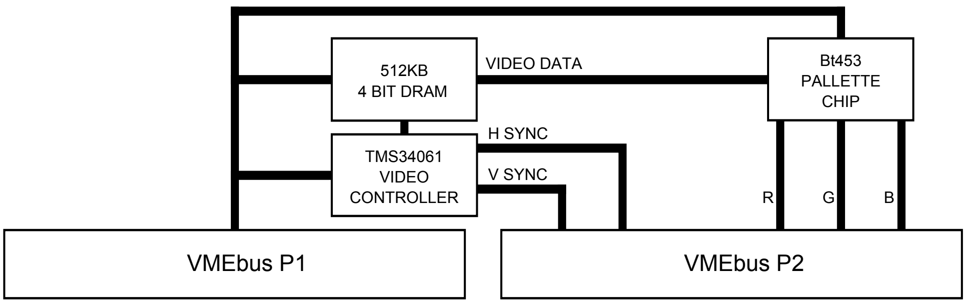


Fig 6.1.4 Navigation Interface Controller Block Diagram

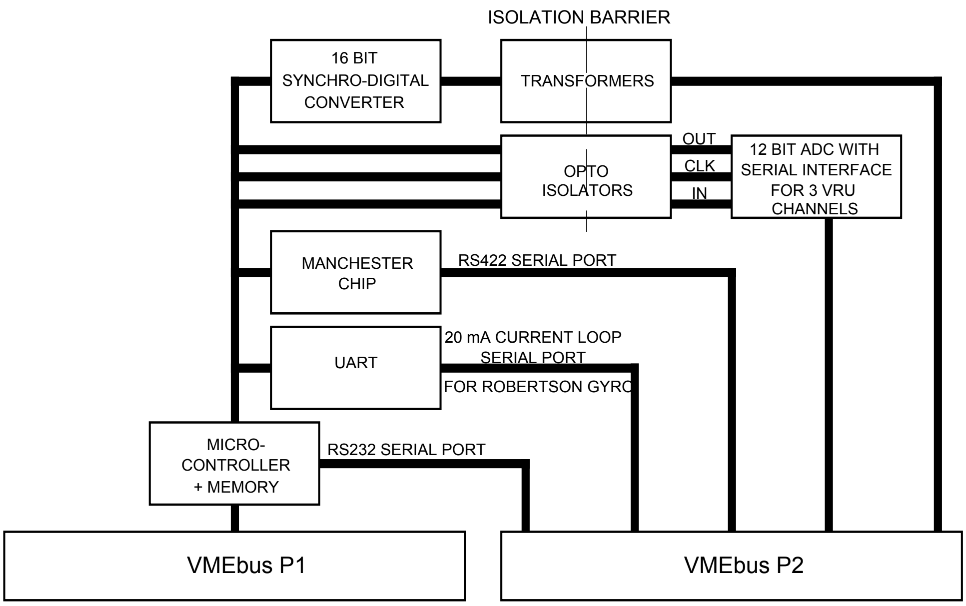


FIG 6.2 NAVIGATION PROCESSOR WIRING SCHEMATICS

FIG 6.2.1 - Type I Version

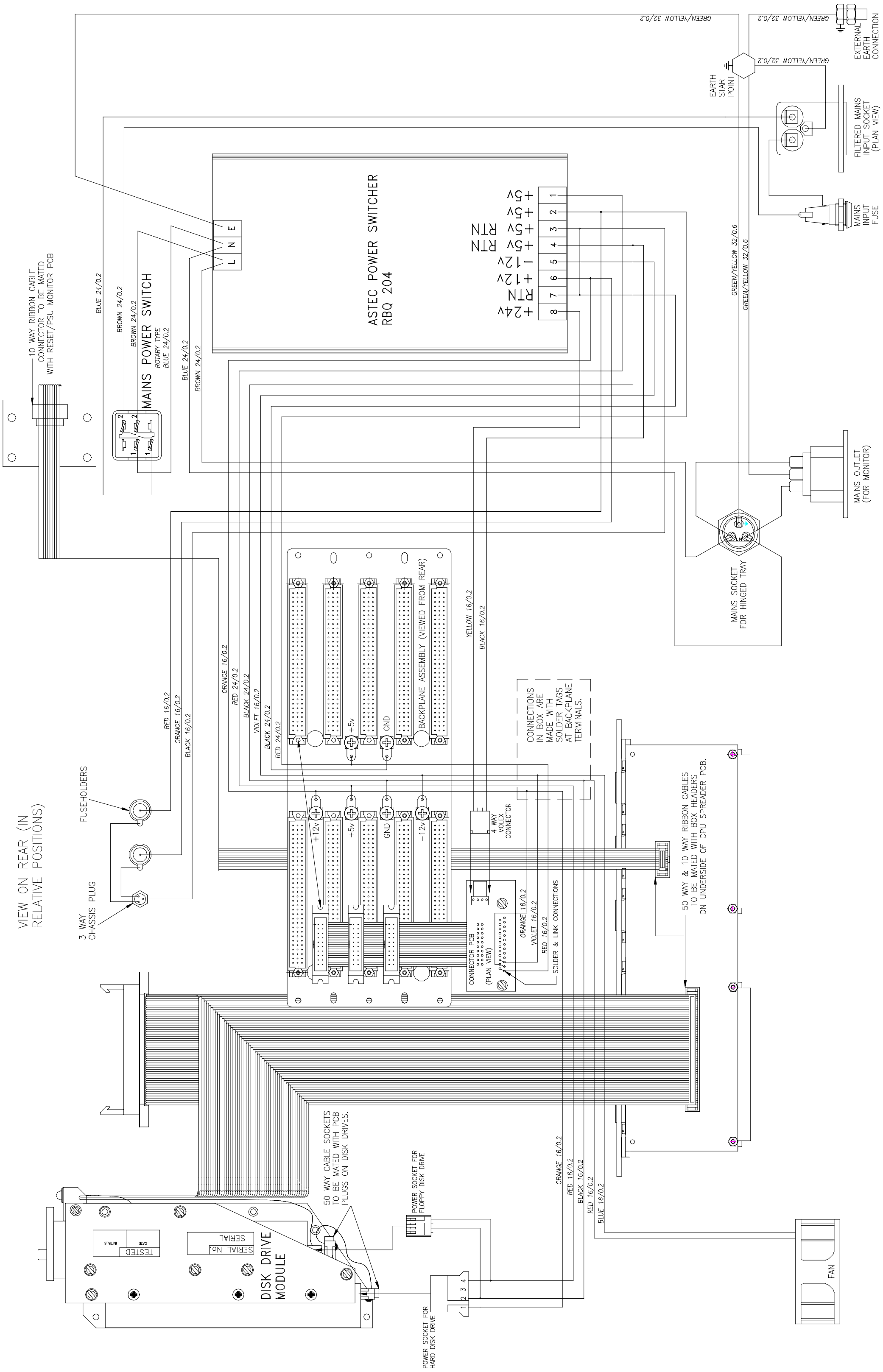


FIG 6.2 NAVIGATION PROCESSOR WIRING SCHEMATICS

Fig 6.2.2 - Type II Version

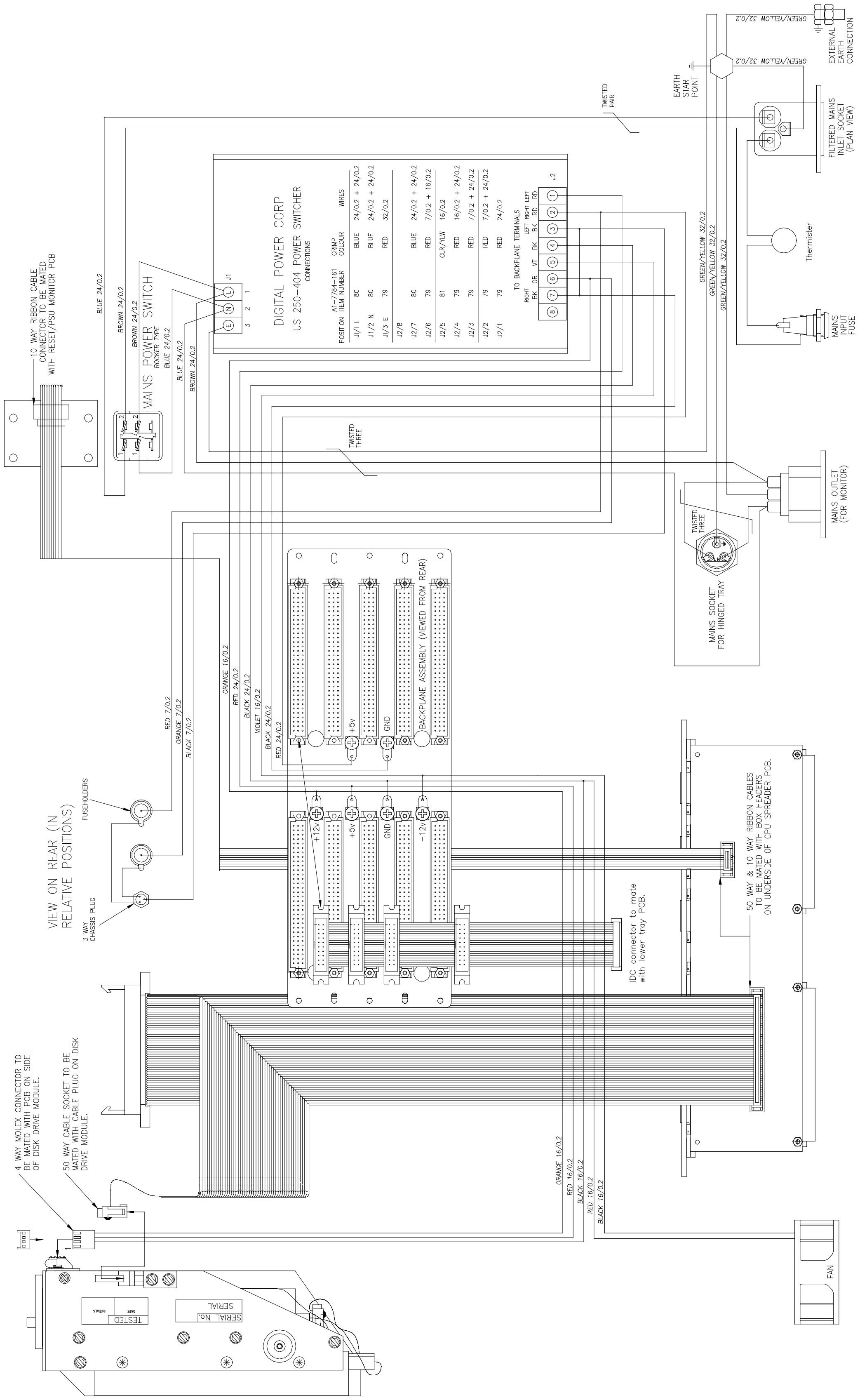
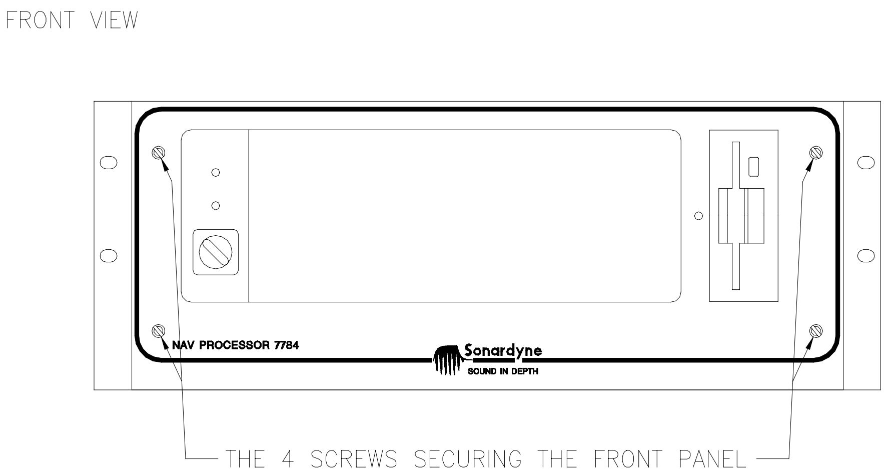


FIG 6.3 NAVIGATION PROCESSOR - DISMANTLING FOR REPAIR

1. REMOVING THE FRONT PANEL



2. REMOVING THE DOUBLE EUROCARD CIRCUIT BOARDS

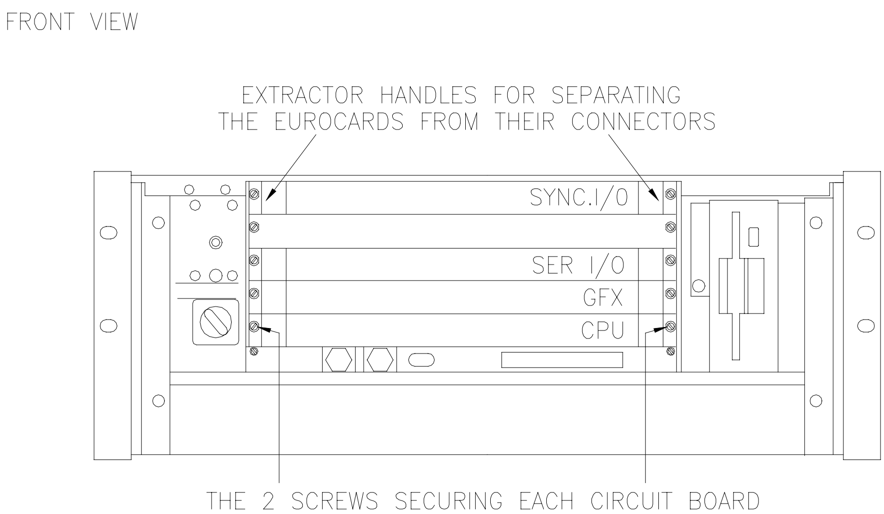
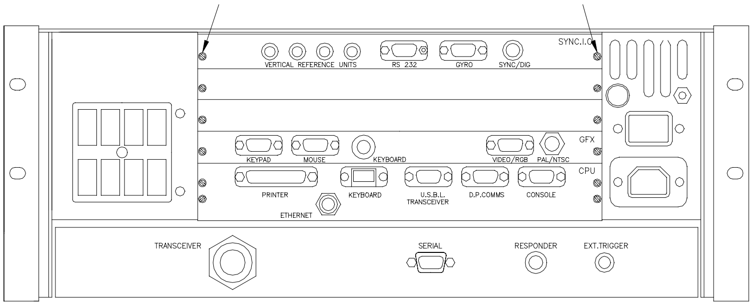


Fig 6.3 Cont …

3. REMOVING THE SPREADER CARDS

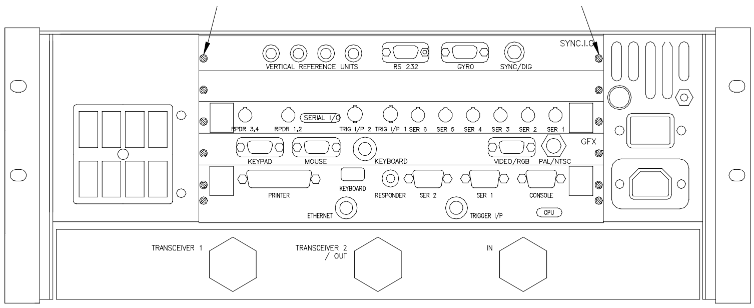
REAR VIEW - TYPE I UNITS

THE SCREWS SECURING A SPREADER CARD



REAR VIEW - TYPE II UNITS

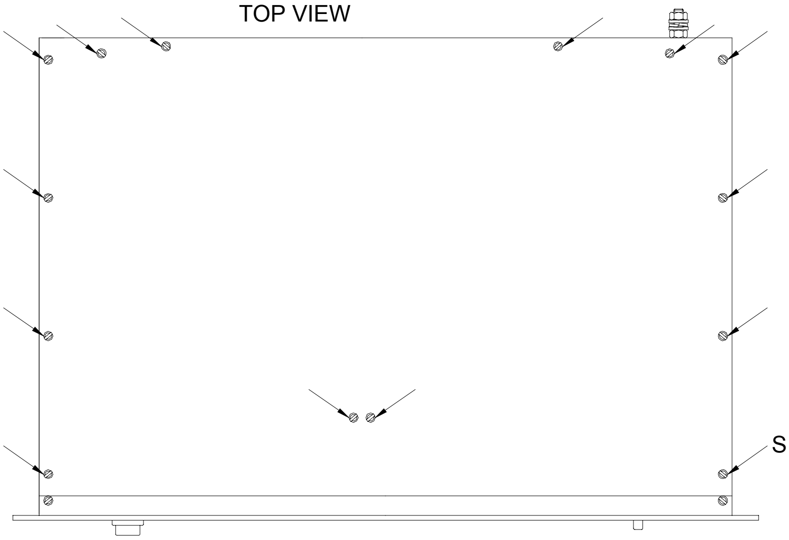
THE SCREWS SECURING A SPREADER CARD



NOTE: THE CPU SPREADER CARD IS SECURED USING 4 SCREWS. EACH OF THE REMAINING SPREADER CARDS IS SECURED USING 2 SCREWS.

4. REMOVING THE TOP COVER

TOP VIEW



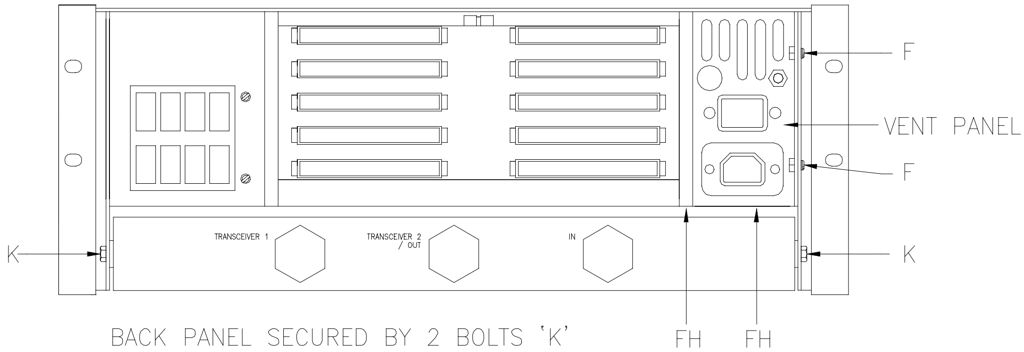
THE SCREWS ARROWED SECURE THE COVER.

NOTE: THE SCREWS ANNOTATED ‘S’ ARE SHORTER THAN THE REST AND MUST BE REPLACED IN THE POSITIONS SHOWN DURING RE-ASSEMBLY.

Fig 6.3 Cont …

5. REMOVING THE POWER SUPPLY

5.1 REAR VIEW WITH SPREADER CARDS REMOVED (TYPE I UNIT)



THE VENT PANEL IS SECURED BY 2 SCREWS 'F' AND 2 SCREWS AT FH ACCESSIBLE FROM THE UNDERSIDE (HIDDEN IN THIS VIEW) AFTER REMOVAL OF THE BACKPANEL.

5.2 REMOVING THE TOP COVER

THE SWITCH BRACKET IS SECURED BY 4 SCREWS AT 'B' & 'BS', THOSE AT B (HIDDEN FROM VIEW) ARE ACCESSIBLE FROM UNDERNEATH AFTER LOWERING THE HINGED TRAY. (SEE ILLUSTRATION 9 PAGE 8 OF THIS FIG.) THE SCREWS AT 'BS' ALSO RETAIN 2 SPACERS.

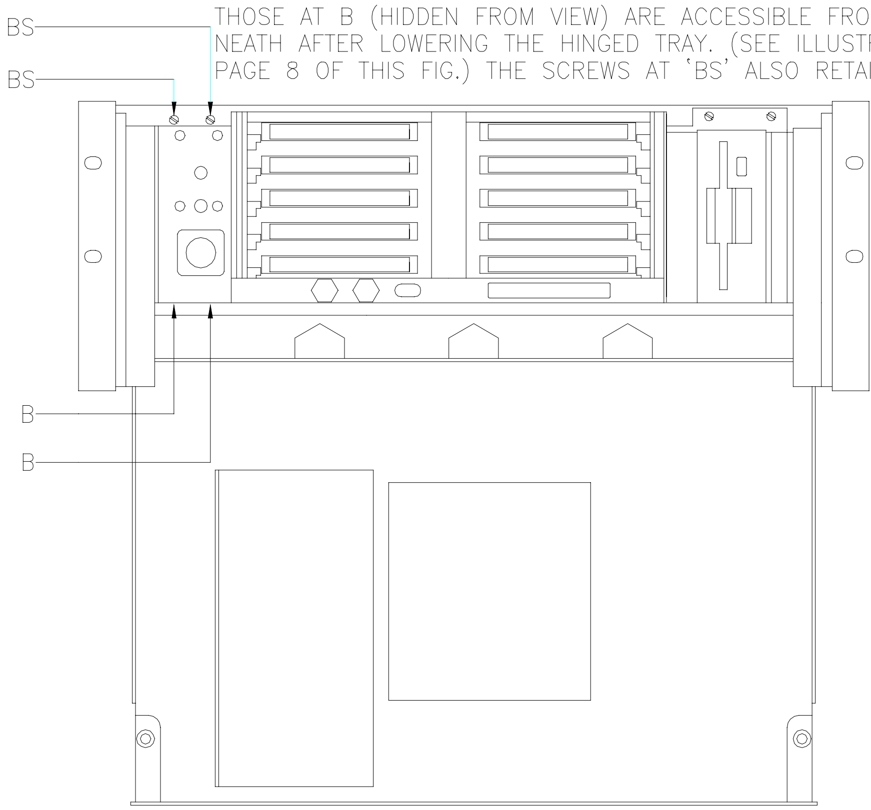


Fig 6.3 Cont …

5.3 PLAN VIEW (WITH SWITCH BRACKET AND VENT PANEL REMOVED)

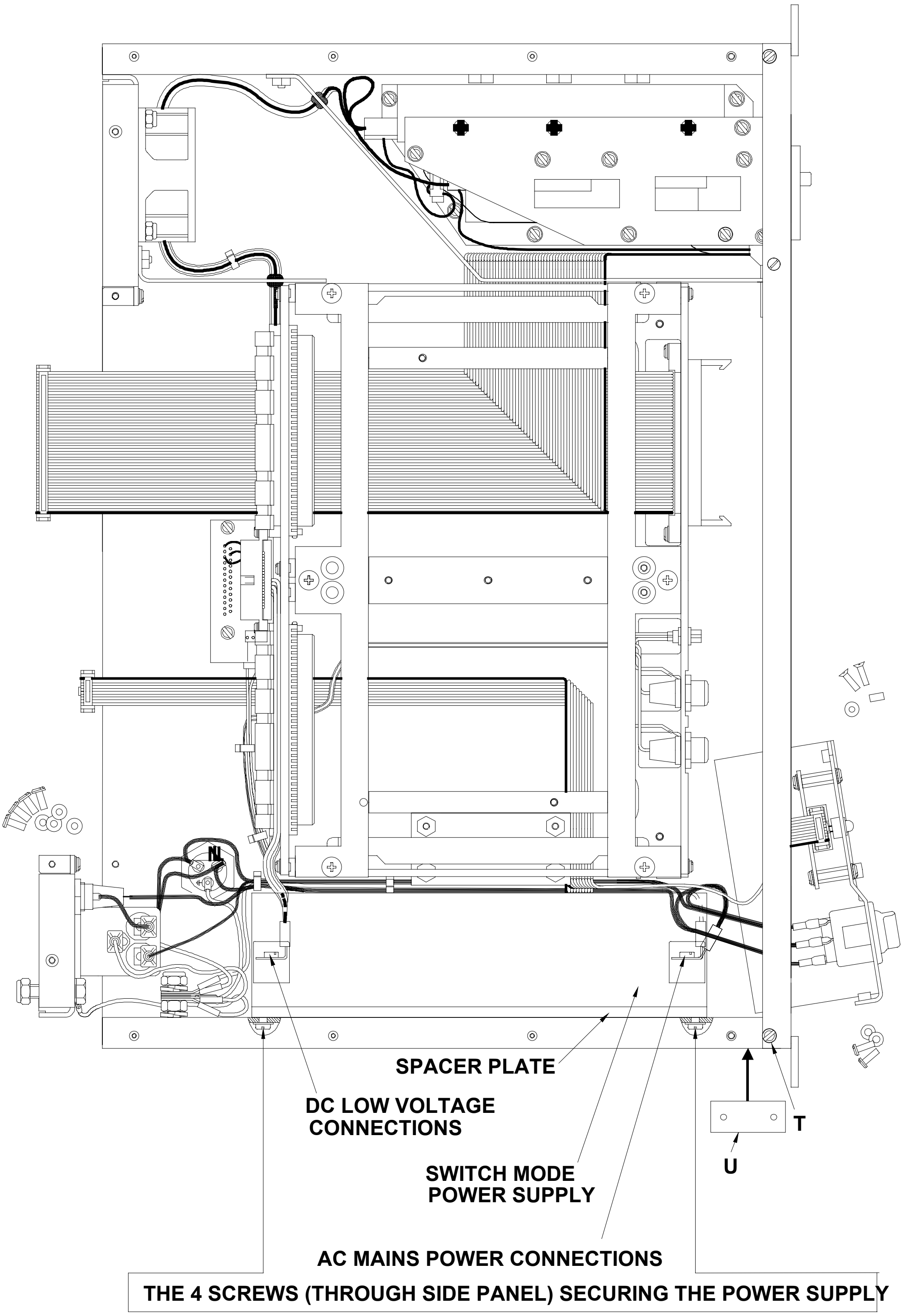
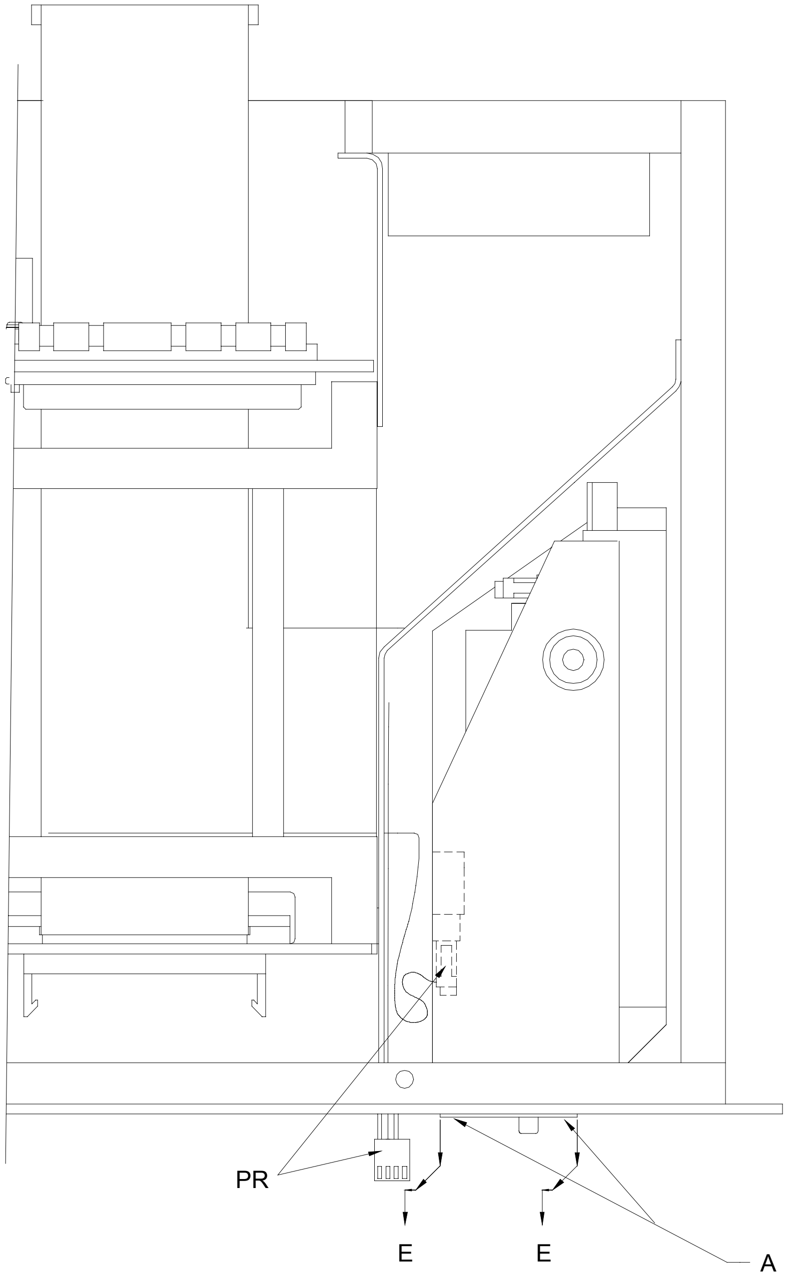


Fig 6.3 Cont …

6. REMOVING THE DISK DRIVE MODULE

PLAN VIEW OF RIGHT HAND SIDE

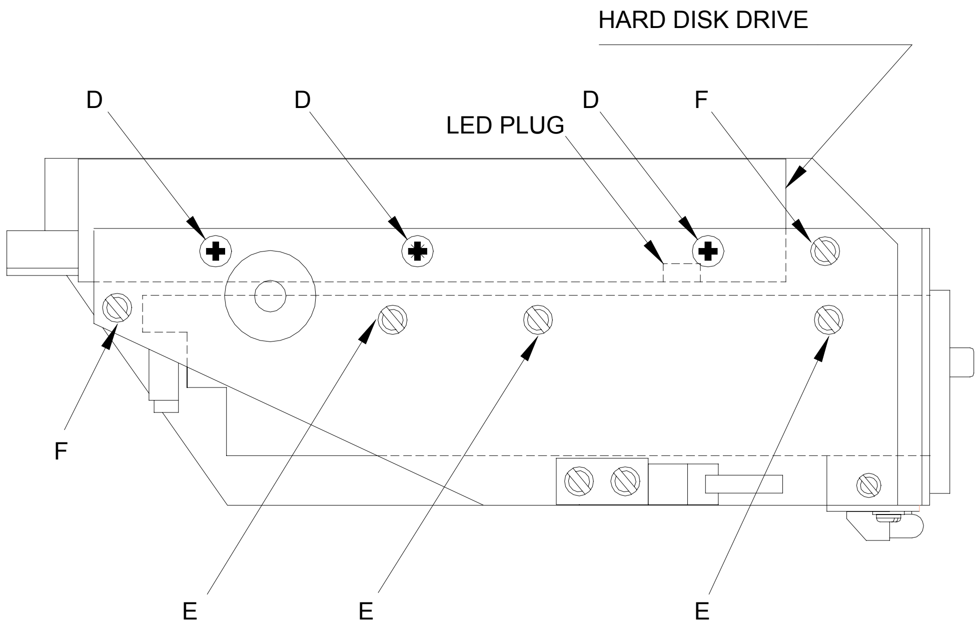


A - THE 2 SCREWS SECURING THE DISK DRIVE MODULE
E - THE EXIT PATH FOR REMOVING THE MODULE THROUGH THE FRONT APERTURE
PR - THE 2 CONNECTORS WHICH MATE WITH DISK DRIVE MODULE CONNECTORS

Fig 6.3 Cont …

7. REPLACING A HARD DISK DRIVE

DISK DRIVE MODULE - PLAN VIEW



DISK DRIVE MODULE - VIEW OF UNDERSIDE

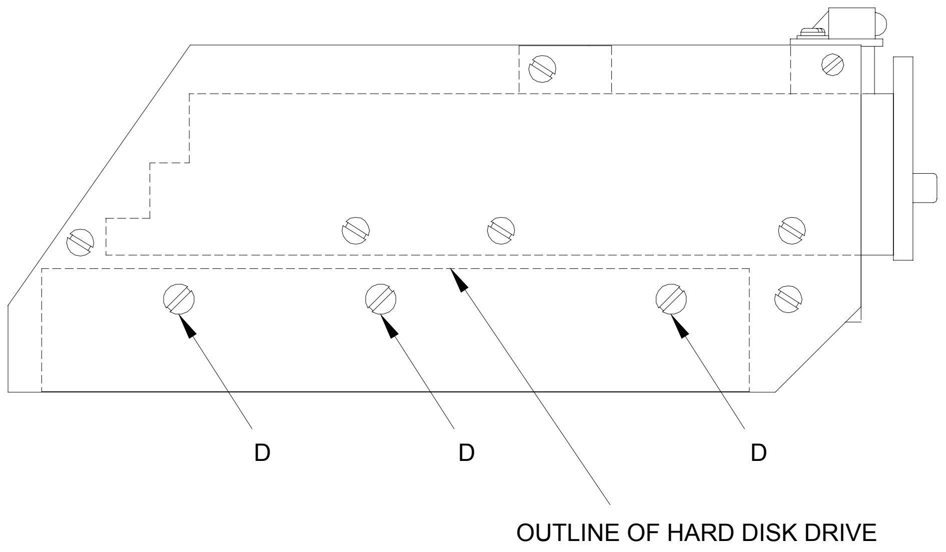
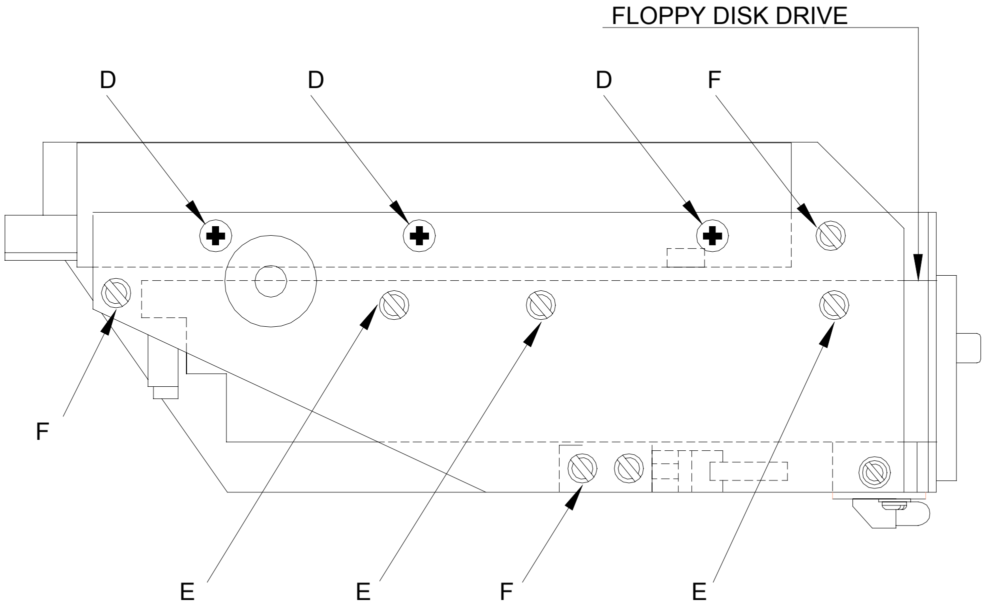


Fig 6.3 Cont …

8. REPLACING A FLOPPY DISK DRIVE

DISK DRIVE MODULE - PLAN VIEW



DISK DRIVE MODULE - VIEW OF UNDERSIDE

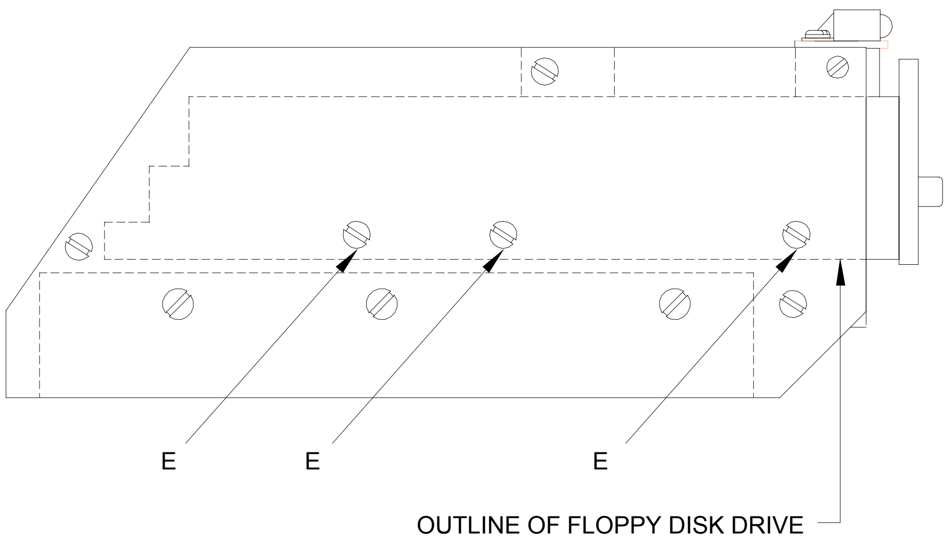
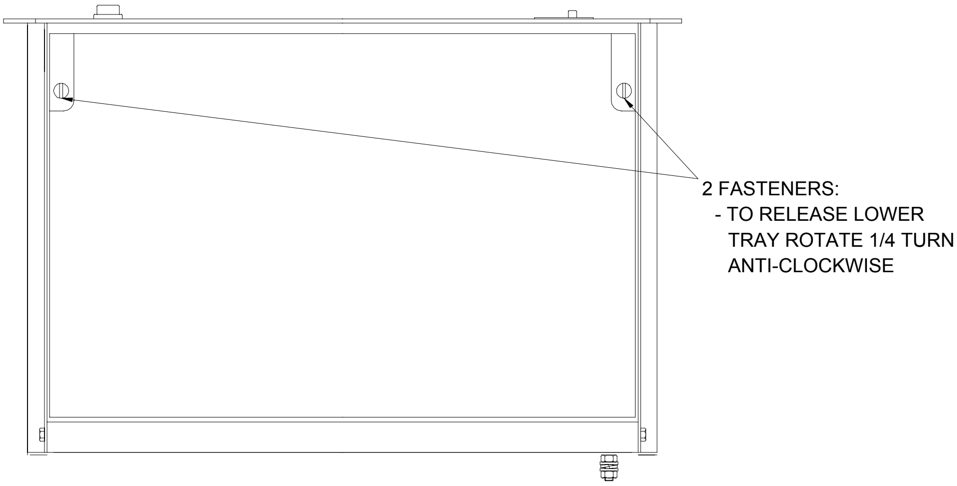
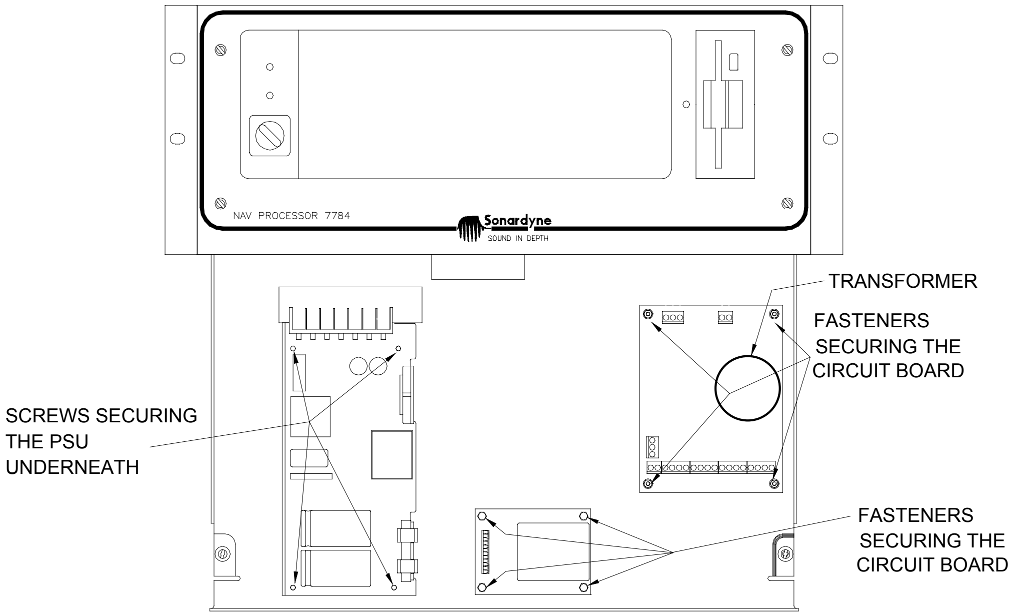


Fig 6.3 Cont …

9. RELEASING THE LOWER TRAY



10. SCREWS SECURING CIRCUIT BOARD AND PSU IN THE LOWER TRAY (EARLY TYPE I UNITS



VIEW OF LOWER TRAY ON TYPE II UNITS

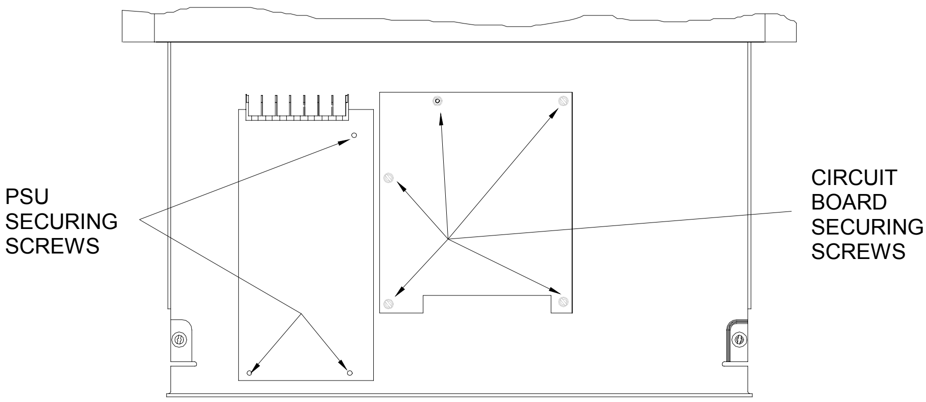


Fig 6.3 Cont …

11. REPLACING THE COMPLETE LOWER TRAYS

11.1. LATER TYPE I UNIT

FRONT VIEW WITH LOWER TRAY OPEN

EARLY TYPE I UNITS (WITH TOROIDAL TRANSFORMER – SEE FIG 6.3, ILLUSTRATION 10) ARE NOT MAINS VOLTAGE AUTO-SENSING. LATER TYPE I UNITS (AS BELOW) ARE.

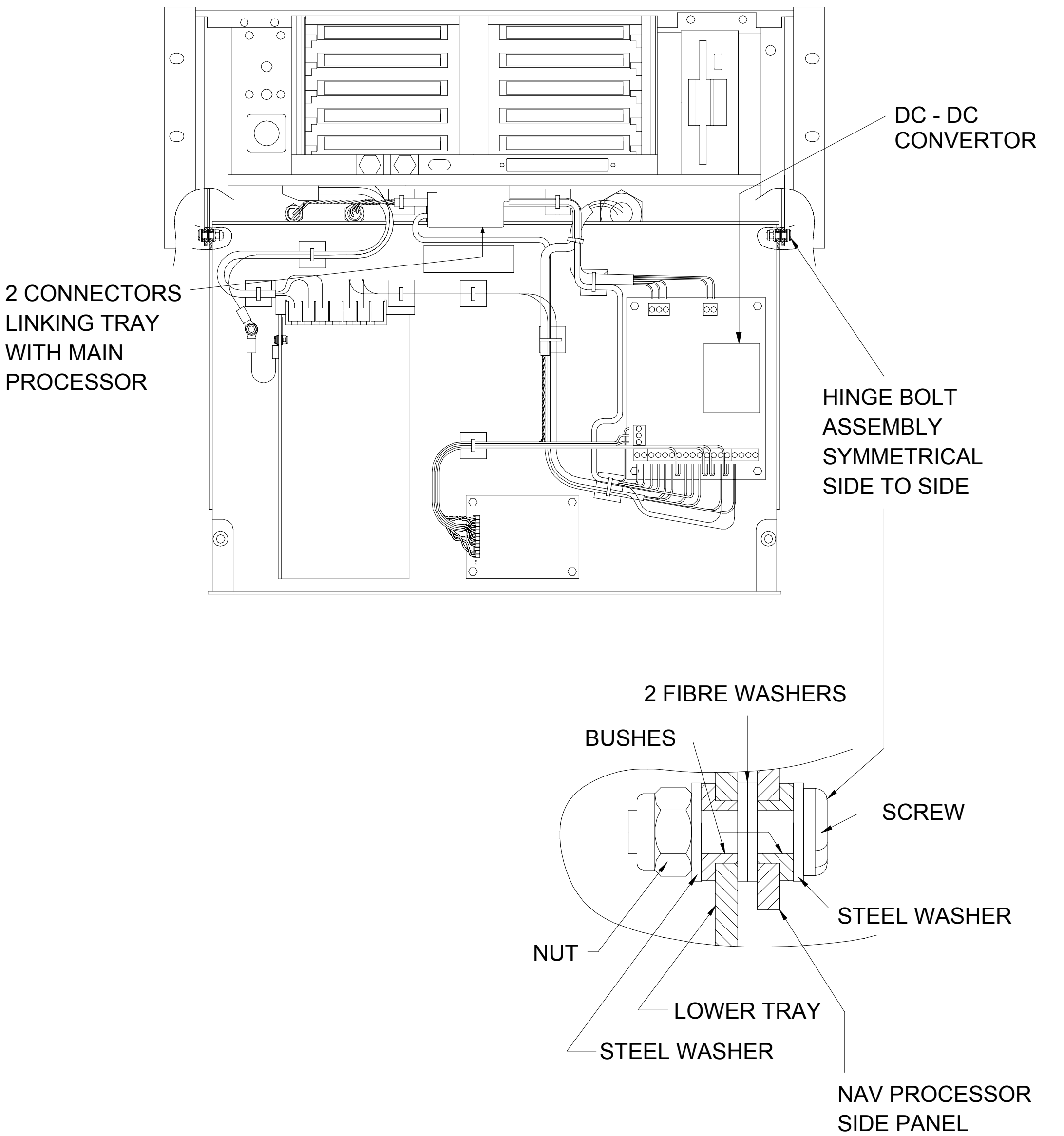


Fig 6.3 Cont …

11.2. TYPE II UNIT

FRONT VIEW WITH LOWER TRAY OPEN

(TYPE II UNITS ARE MAINS VOLTAGE AUTO-SENSING)

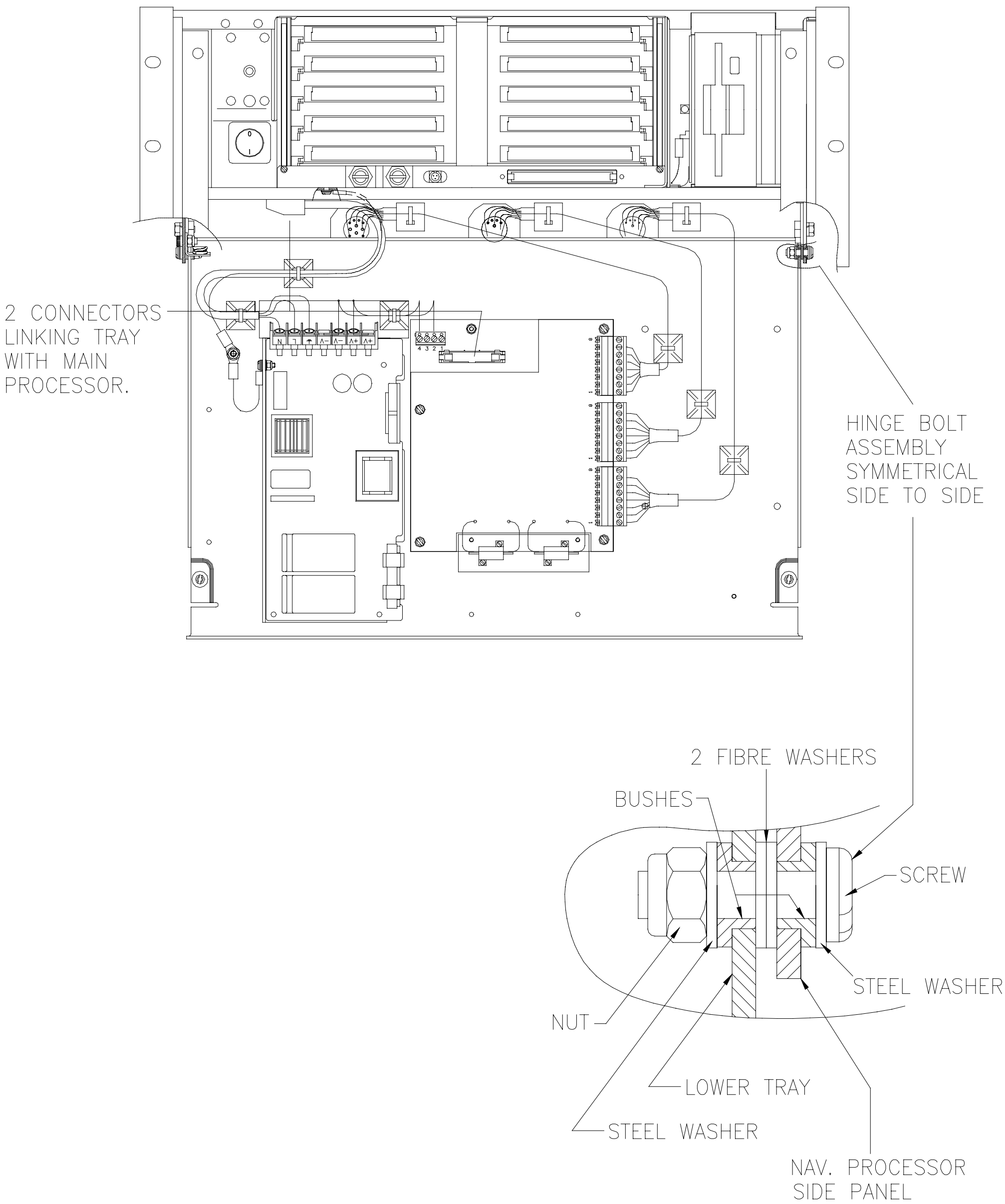


Fig 6.3 Cont …

12. WIRING DIAGRAMS FOR THE LOWER TRAYS

12.1. TYPE I UNIT

EARLY TYPE I UNITS (WITH TOROIDAL TRANSFORMER ON COMMS BOARD) WERE NOT MAINS VOLTAGE AUTO-SENSING.

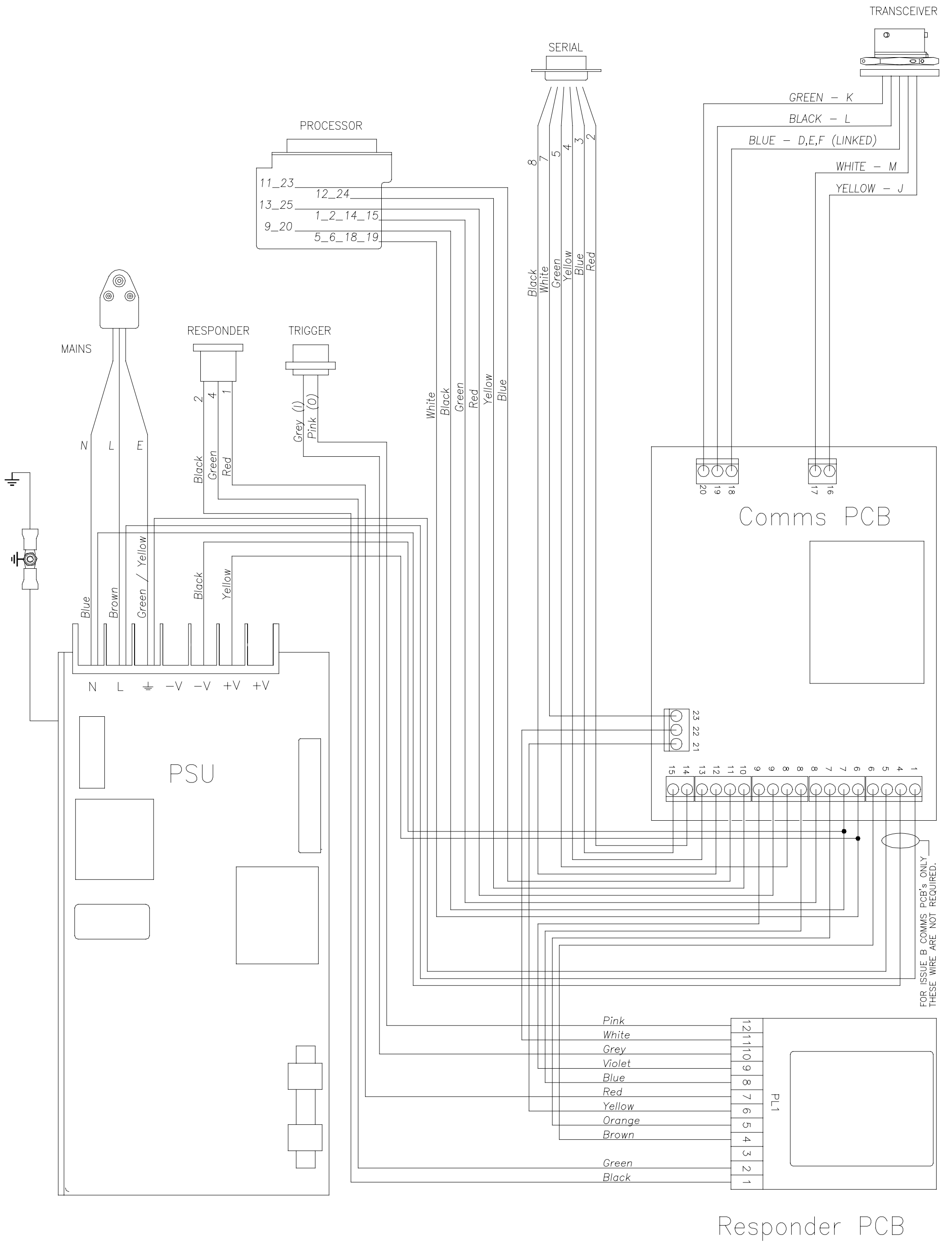


Fig 6.3 Cont …

12.2. TYPE II UNIT

(TYPE II UNITS ARE MAINS VOLTAGE AUTO-SENSING)

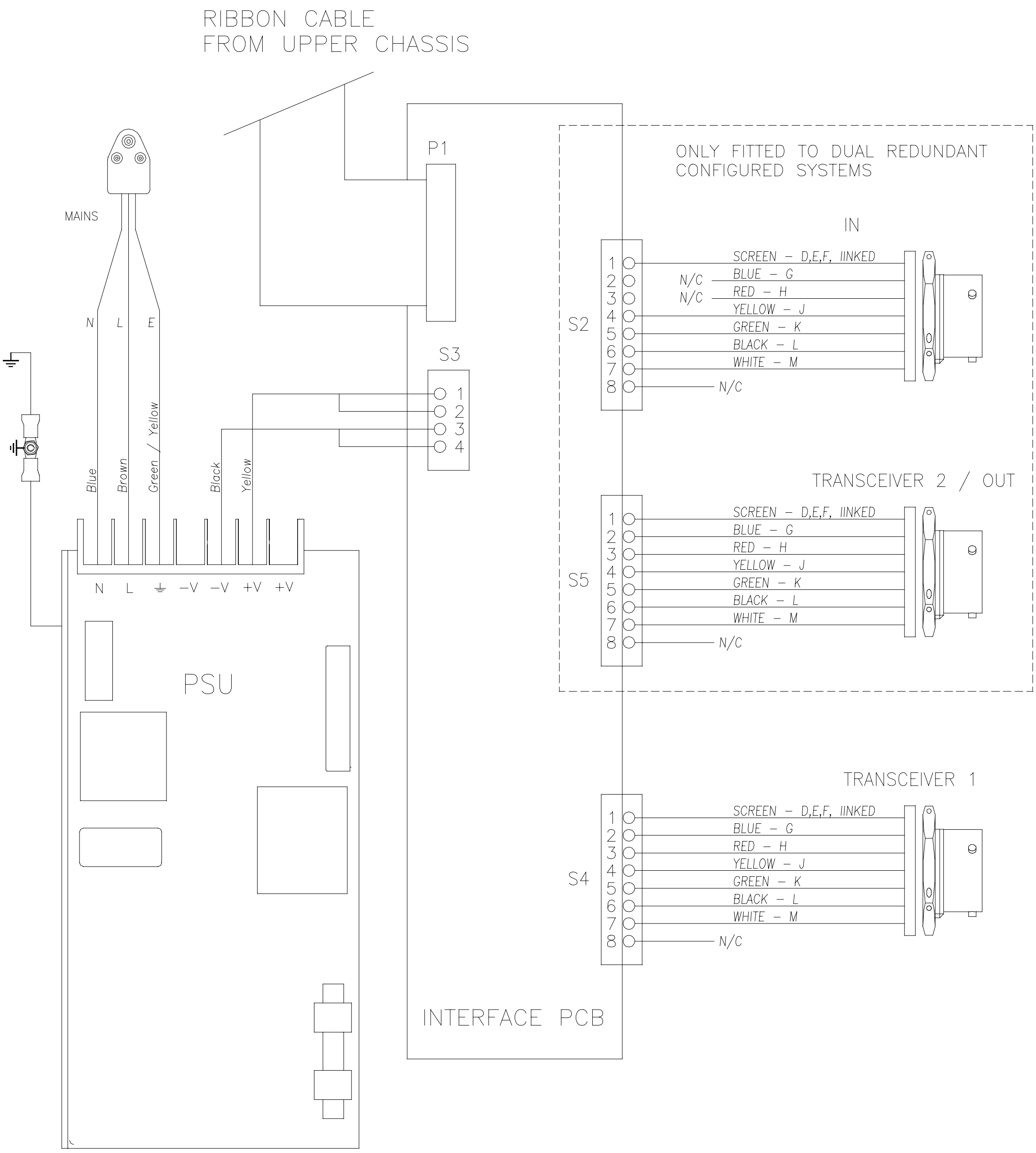


FIG 6.4 USBL MONITOR/KEYPAD - BLOCK DIAGRAM

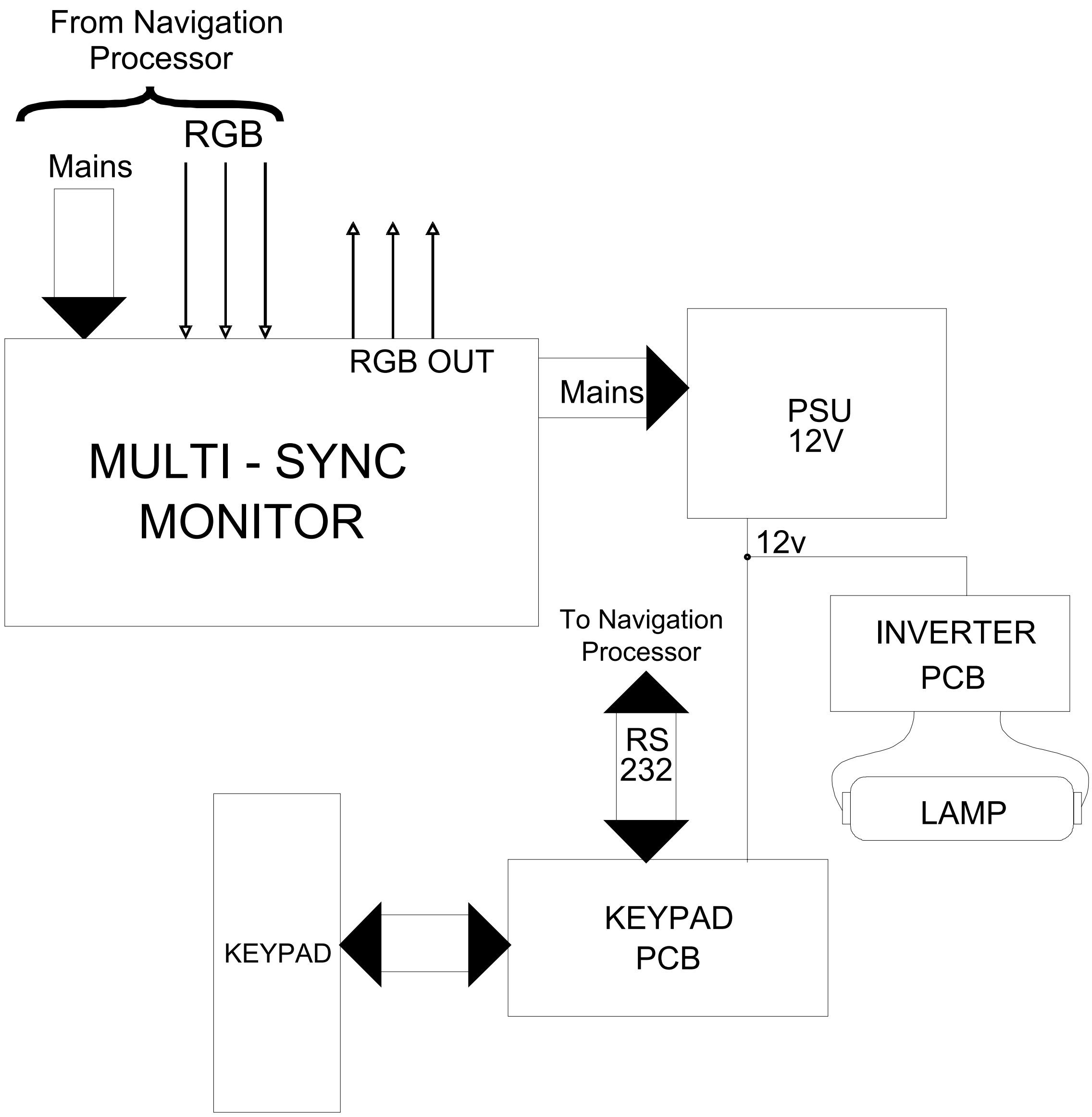


FIG 6.5 USBL MONITOR/KEYPAD - WIRING SCHEMATIC

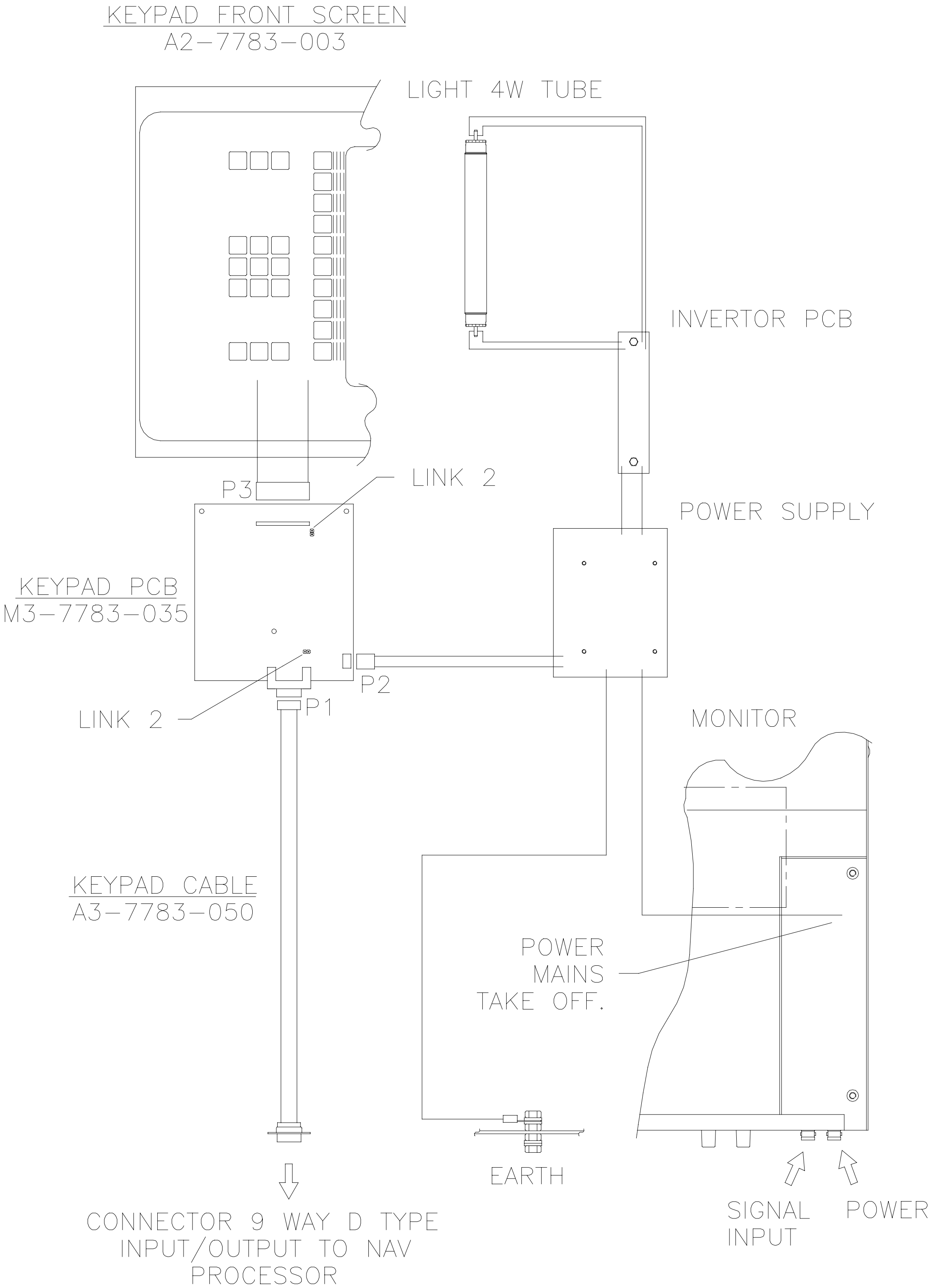
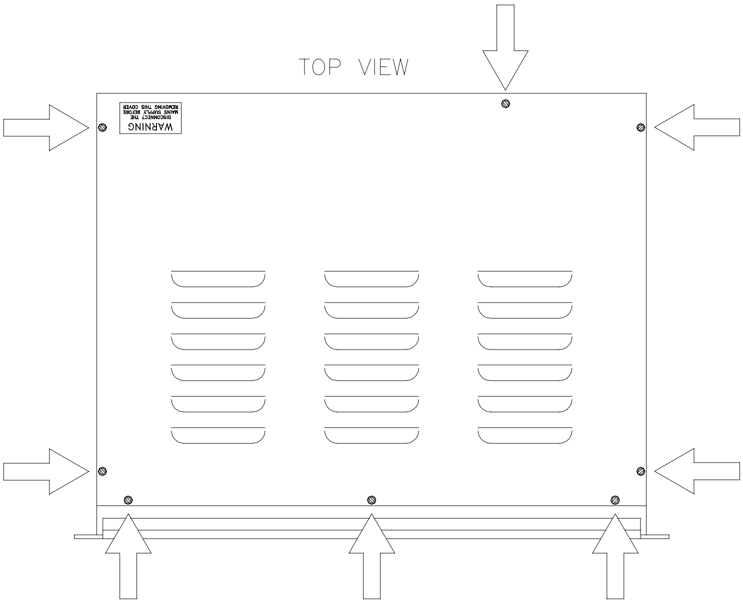


FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.1 - Type I Units

<u>MONITOR/KEYPAD</u>

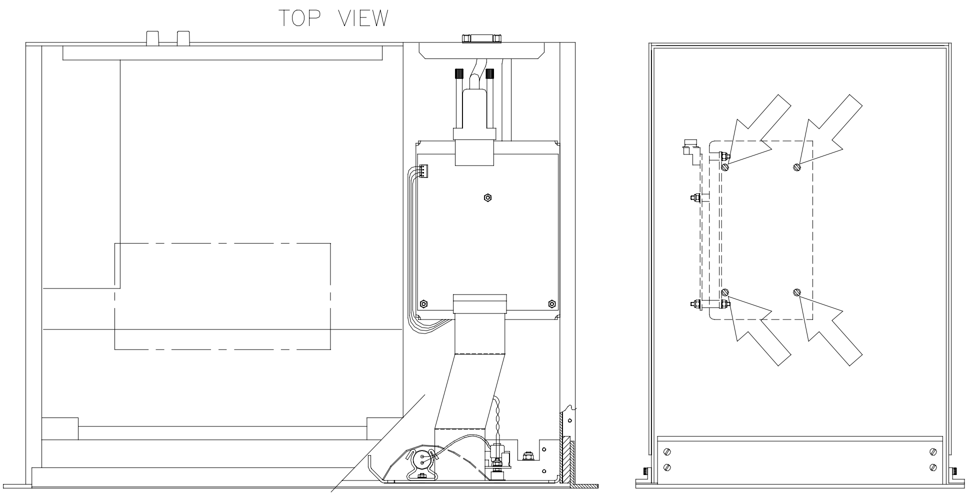
1. <u>REMOVING THE LID</u>



REMOVE THE 8 SLOTTED SCREWS INDICATED

2. <u>REMOVING THE 12V POWER SUPPLY</u>

FIRST REMOVE THE LID (SEE 1)



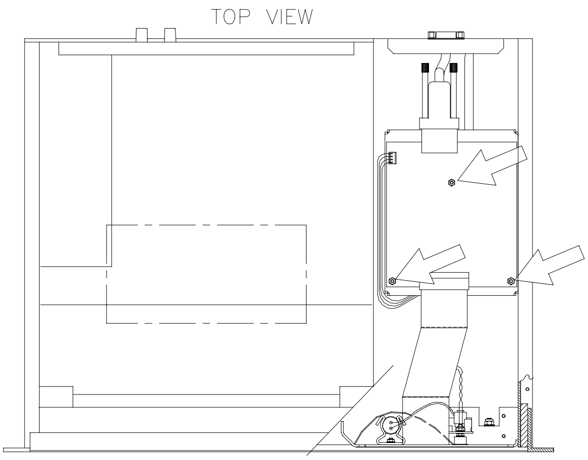
SECOND, REMOVE THE FOUR FIXING SCREWS, SUPPORT ASSEMBLY INSIDE
REMOVE ALL CABLES FROM ASSEMBLY AND REMOVE FROM CHASSIS
PSU CAN NOW BE REMOVED FROM ASSEMBLY
RE-ASSEMBLE IN REVERSE ORDER.

FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.1 cont … - Type I Units

3. REMOVING THE KEYPAD PCB

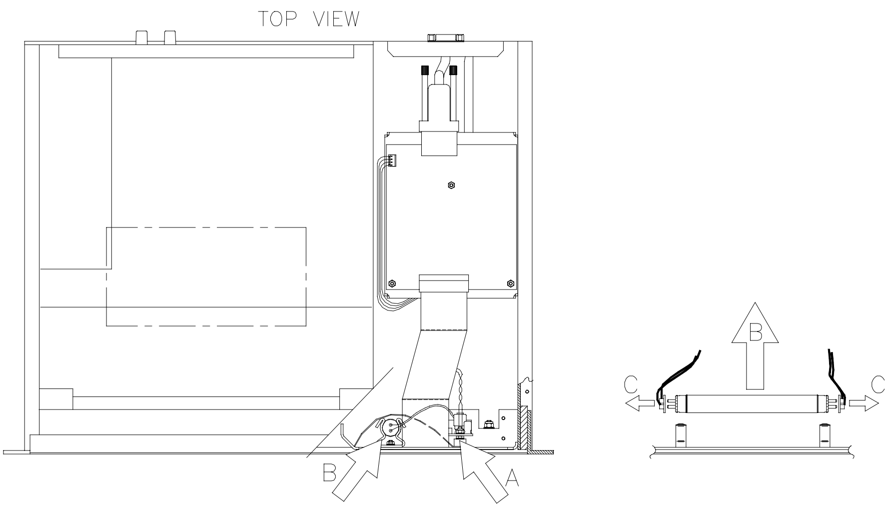
FIRST REMOVE THE LID (SEE 1)



SECOND, DISCONNECT THE RIBBON CABLE AND ‘D’ TYPE CONNECTOR FROM THE KEYPAD PCB
THEN UNDO THE 3 NUTS INDICATED HOLDING THE KEYPAD PCB.

4. REMOVING THE FLUORESCENT BULB

FIRST REMOVE THE LID (SEE 1)



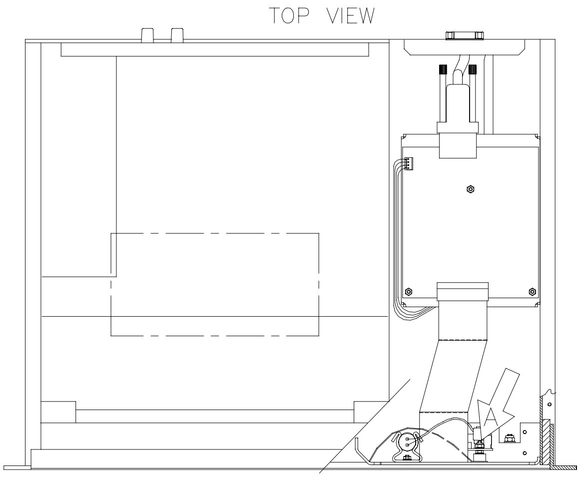
SECOND, DISCONNECT THE RIBBON CABLE FROM THE KEYPAD PCB
THEN UNDO THE 2 NUTS HOLDING THE PCB, BAR AND REFLECTOR AND REMOVE (ARROW A)
THEN JUST PULL THE BULB OUT OF ITS CLIPS, (ARROW B)
THEN DISCONNECT THE WIRES FROM EACH END BY SLIDING THEM OFF (ARROW C).

FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.1 cont … - Type I Units

5. REMOVING THE INVERTER PCB

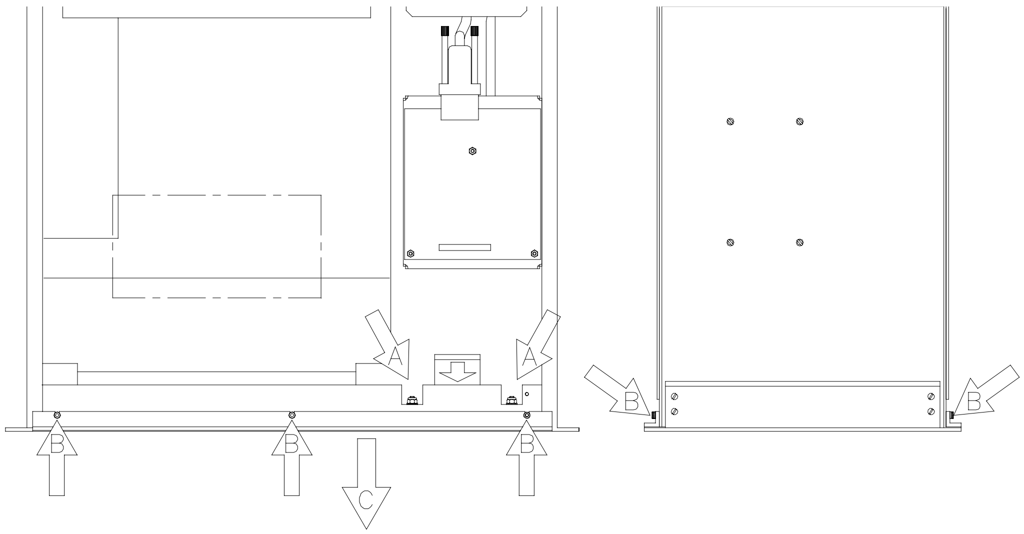
FIRST REMOVE THE LID AND PCB CARRIER (SEE 1 AND 2)



SECOND, DISCONNECT THE POWER CABLE FROM THE LOOM, REMOVE THE LAMP (SEE 4)
DISCONNECT PCB FROM LAMP, REMOVE INVERTER.
RE-ASSEMBLE IN REVERSE ORDER.

6. REMOVING THE FRONT PANEL

FIRST REMOVE THE LID THEN TAKE OUT THE LAMP AND INVERTER (SEE 1, 4 AND 5)



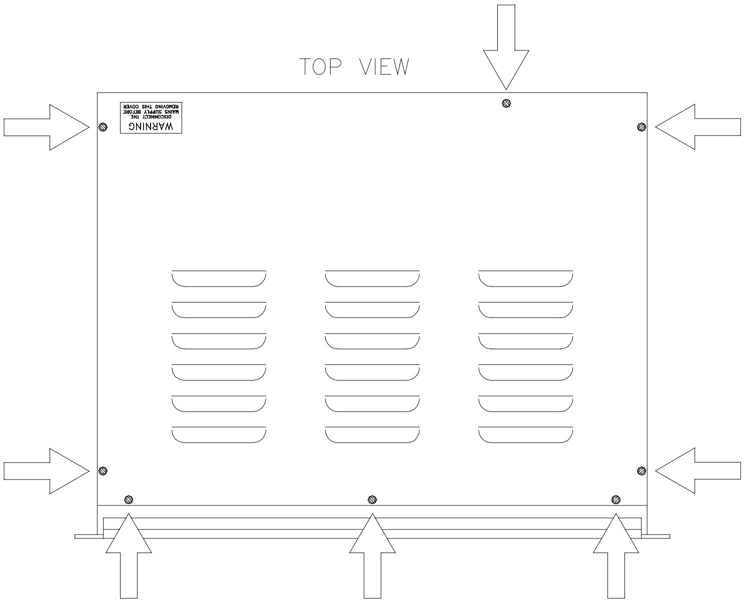
SECOND, UNDO THE 4 NUTS (2 UP, 2 DOWN – ARROW A)
THEN LOOSEN THE 6 CAP SCREWS (3 UP, 3 DOWN – ARROW B)
THEN PULL OFF THE FRONT PANEL (ARROW C)

FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.2 - Type II Units

MONITOR/KEYPAD

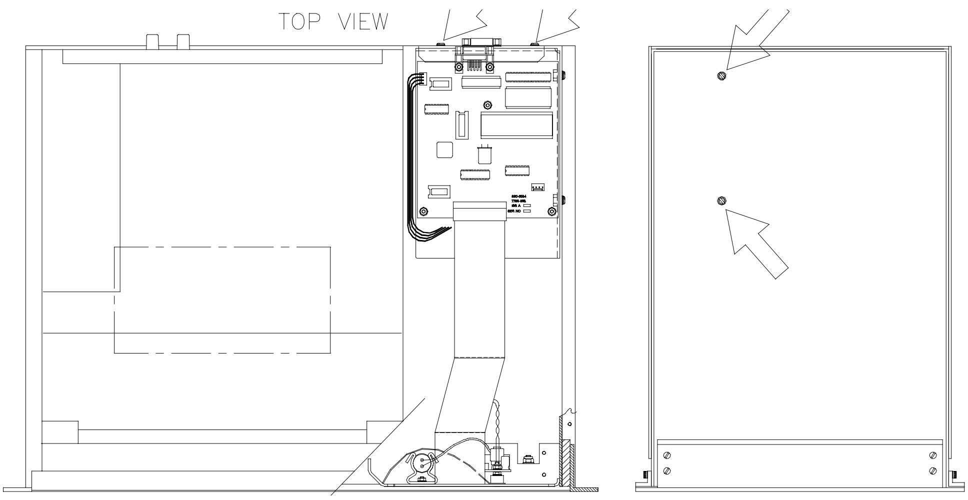
1. REMOVING THE LID



REMOVE THE 8 SLOTTED SCREWS INDICATED

2. REMOVING THE 12V POWER SUPPLY

FIRST REMOVE THE LID (SEE 1)



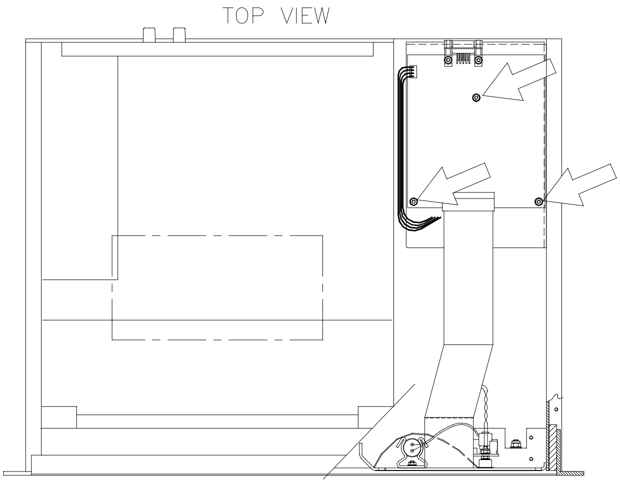
SECOND, REMOVE THE FOUR FIXING SCREWS, SUPPORT ASSEMBLY INSIDE
REMOVE ALL CABLES FROM ASSEMBLY AND REMOVE FROM CHASSIS
PSU CAN NOW BE REMOVED FROM ASSEMBLY.
RE-ASSEMBLE IN REVERSE ORDER.

FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.2 cont … - Type II Units

3. REMOVING THE KEYPAD PCB

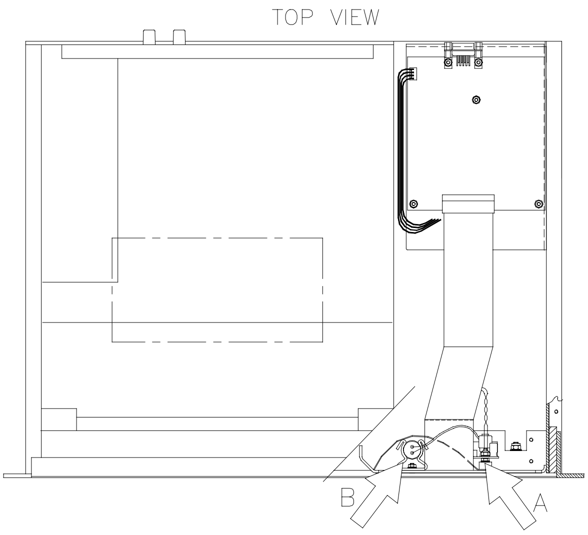
FIRST REMOVE THE LID (SEE 1)

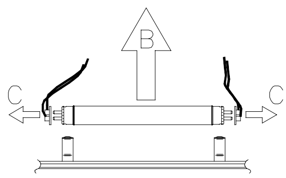


SECOND, DISCONNECT THE RIBBON CABLE AND 'D' TYPE CONNECTOR FROM THE KEYPAD PCB
THEN UNDO THE 3 NUTS INDICATED HOLDING THE KEYPAD PCB.

4. REMOVING THE FLUORESCENT BULB

FIRST REMOVE THE LID (SEE 1)





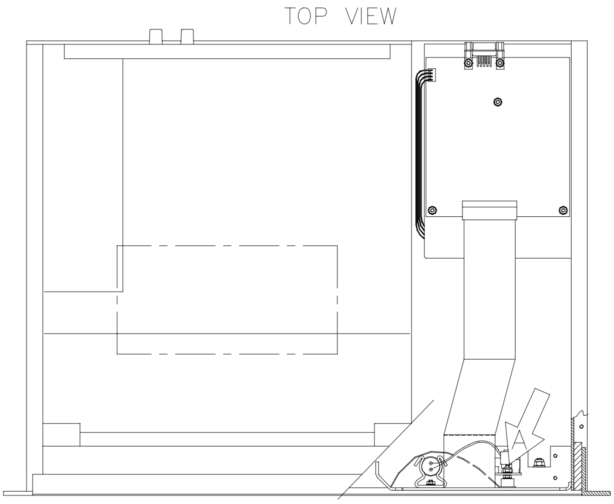
SECOND, DISCONNECT THE RIBBON CABLE FROM THE KEYPAD PCB
THEN UNDO THE 2 NUTS HOLDING THE PCB, BAR AND REFLECTOR AND REMOVE (ARROW A)
THEN JUST PULL THE BULB OUT OF ITS CLIPS, (ARROW B)
THEN DISCONNECT THE WIRES FROM EACH END BY SLIDING THEM OFF (ARROW C).

FIG 6.6 MONITOR/KEYPAD - DISMANTLING FOR REPAIR

Fig 6.6.2 cont … - Type II Units

5. REMOVING THE INVERTER PCB

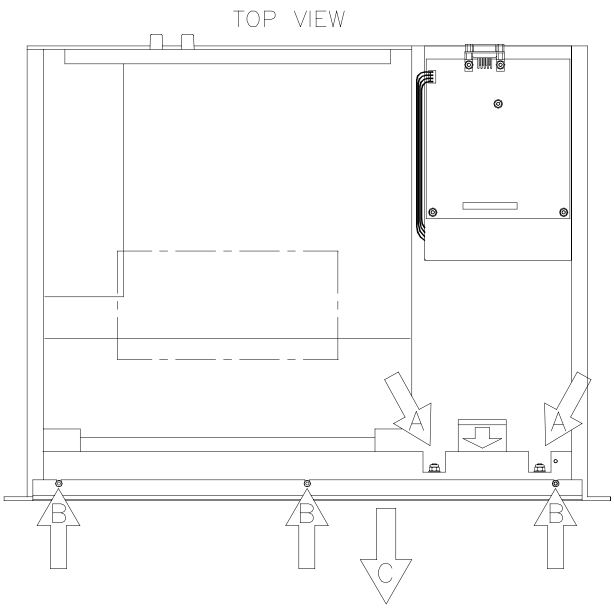
FIRST REMOVE THE LID AND PCB CARRIER (SEE 1 AND 2)

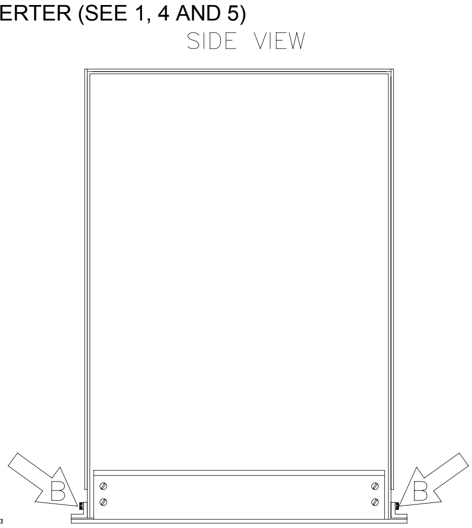


SECOND, DISCONNECT THE POWER CABLE FROM THE LOOM, REMOVE THE LAMP (SEE 4)
DISCONNECT PCB FROM LAMP, REMOVE INVERTER.
RE-ASSEMBLE IN REVERSE ORDER

6. REMOVING THE FRONT PANEL

FIRST REMOVE THE LID THEN TAKE OUT THE LAMP AND INVERTER (SEE 1, 4 AND 5)





SECOND, UNDO THE 4 NUTS (2 UP, 2 DOWN – ARROW A)
THEN LOOSEN THE 6 CAP SCREWS (3 UP, 3 DOWN – ARROW B)
THEN PULL OFF THE FRONT PANEL (ARROW C).

FIG 6.7 7769 USBL BLOCK DIAGRAMS AND JUMPER SETTINGS

Fig 6.7.1 - 7769 USBL Acoustic Transceiver – Block Diagram

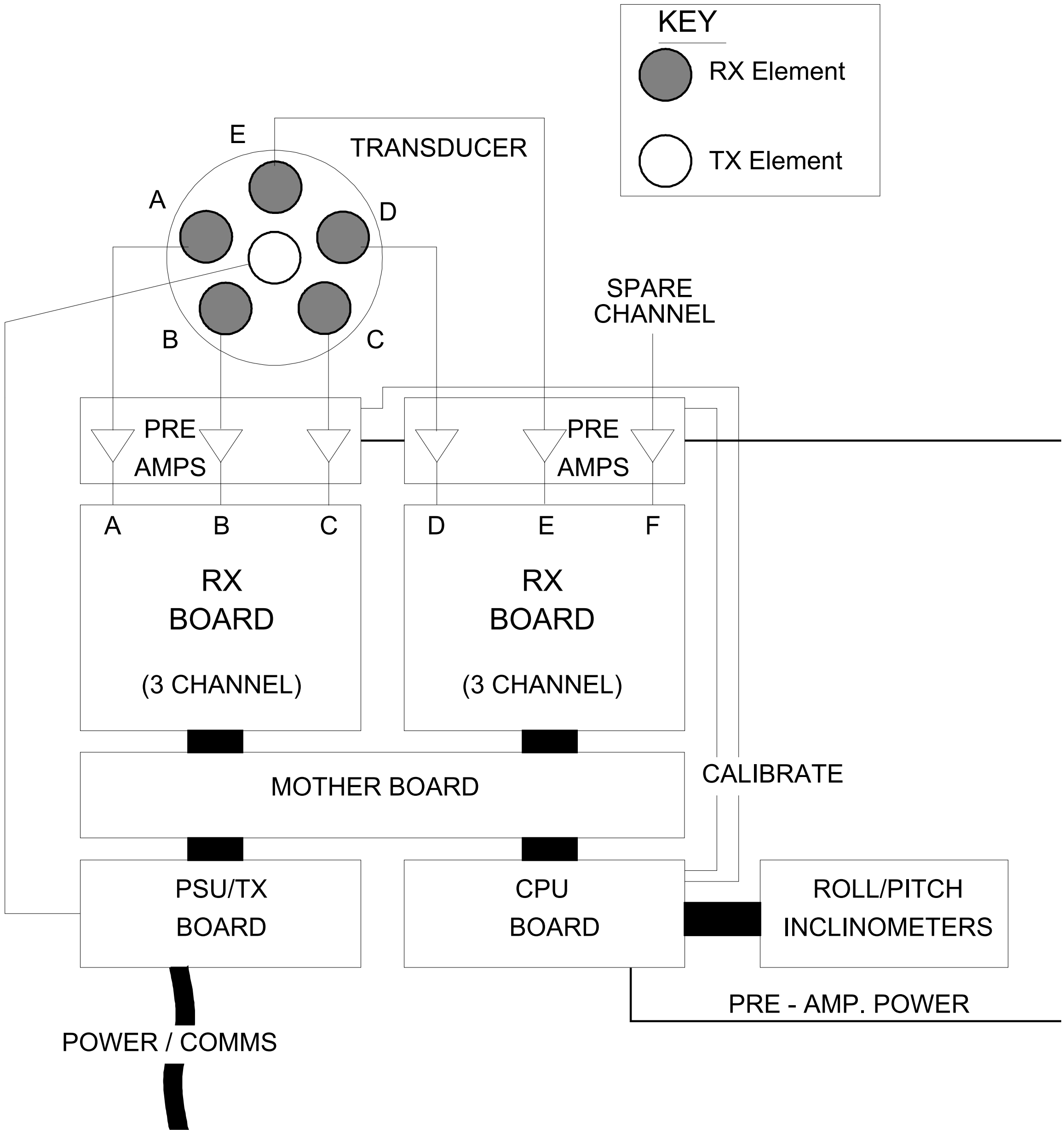


FIG 6.7 7769 USBL BLOCK DIAGRAMS AND JUMPER SETTINGS

Fig 6.7.2 - 7769 USBL Receiver Card – Jumper Settings

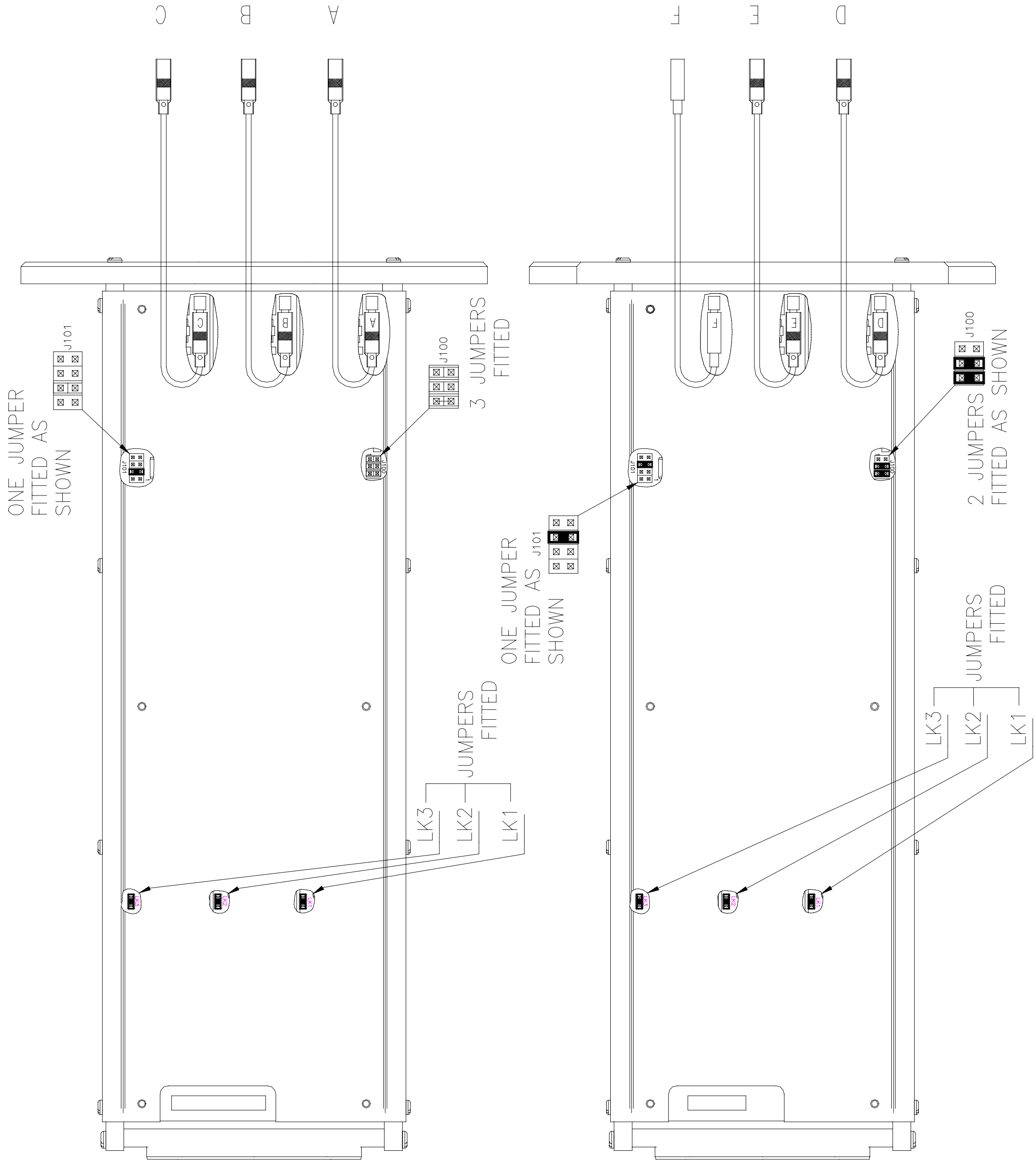


Fig 6.7.3 - 7769 USBL Receiver Card – Block Diagram

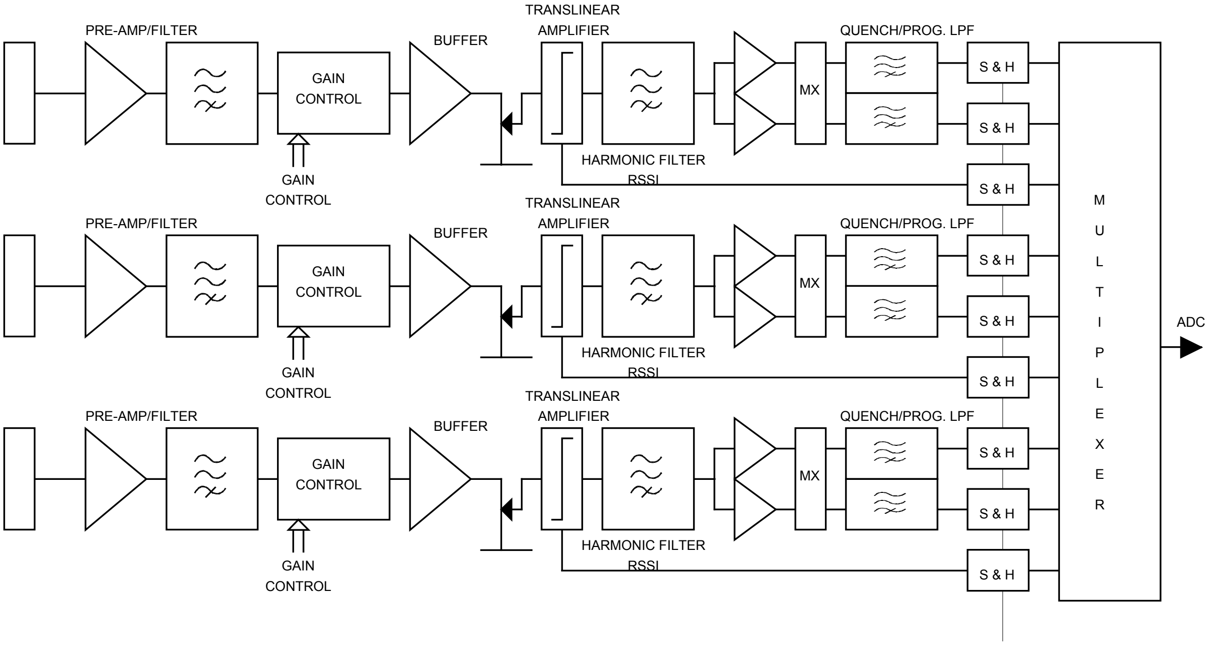


Fig 6.7.4 - 7769 USBL CPU Card – Block Diagram

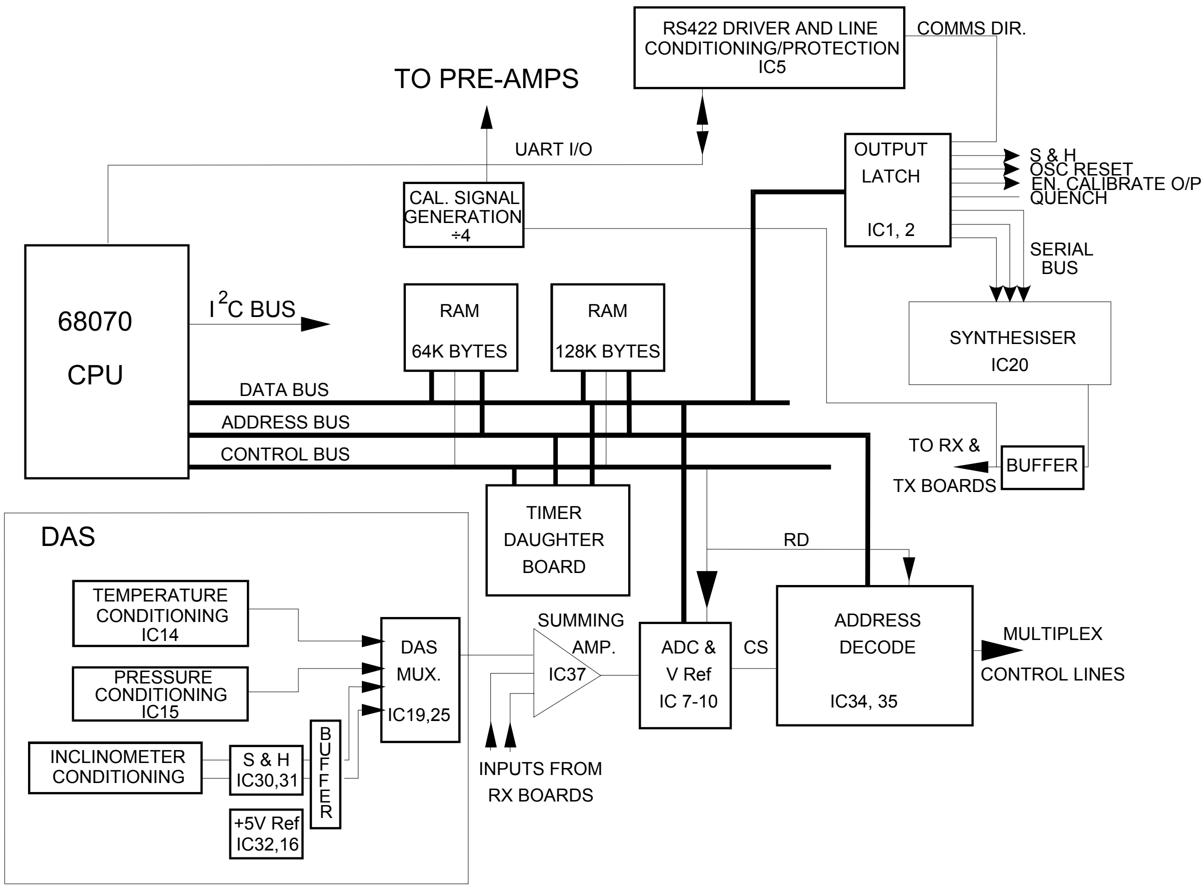


Fig 6.7.5 - 7769 USBL PSU TX Card – Block Diagram

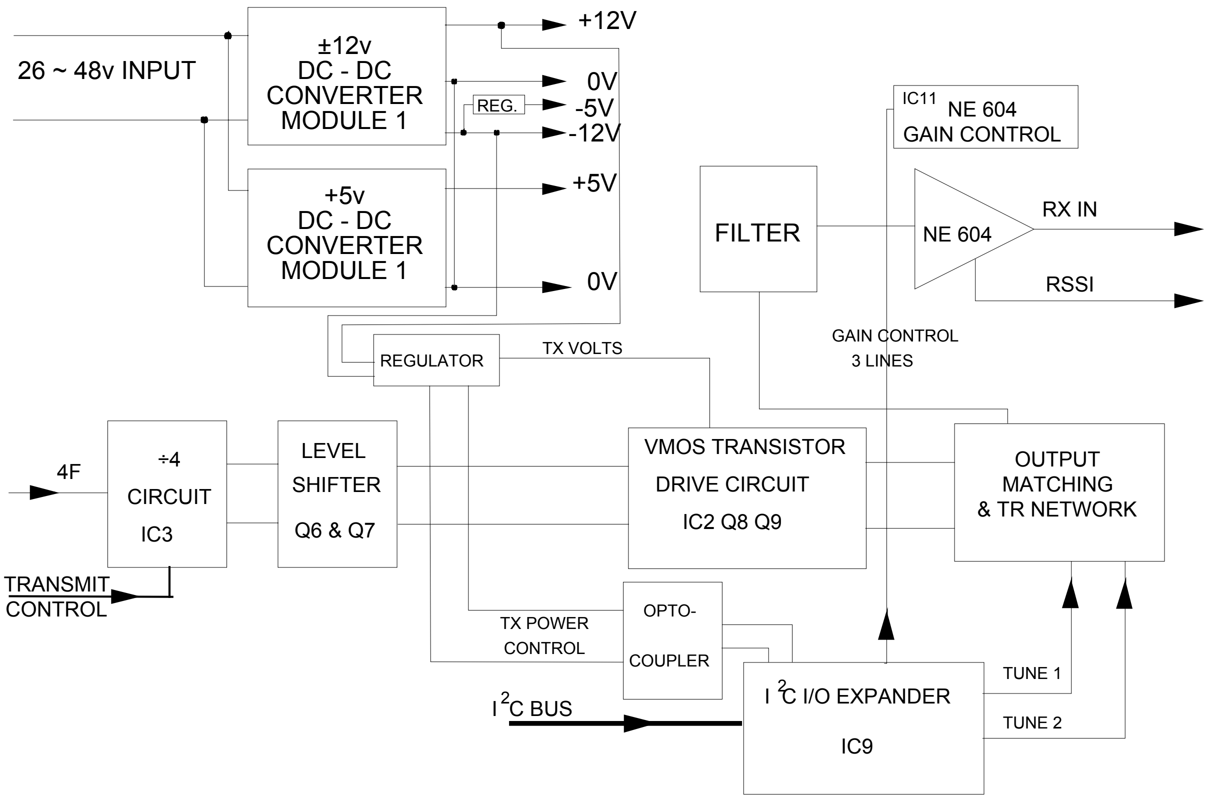


FIG 6.8 7769 USBL ACOUSTIC TRANSCEIVER - WIRING DIAGRAMS

Fig 6.8.1 - (Type I Units)

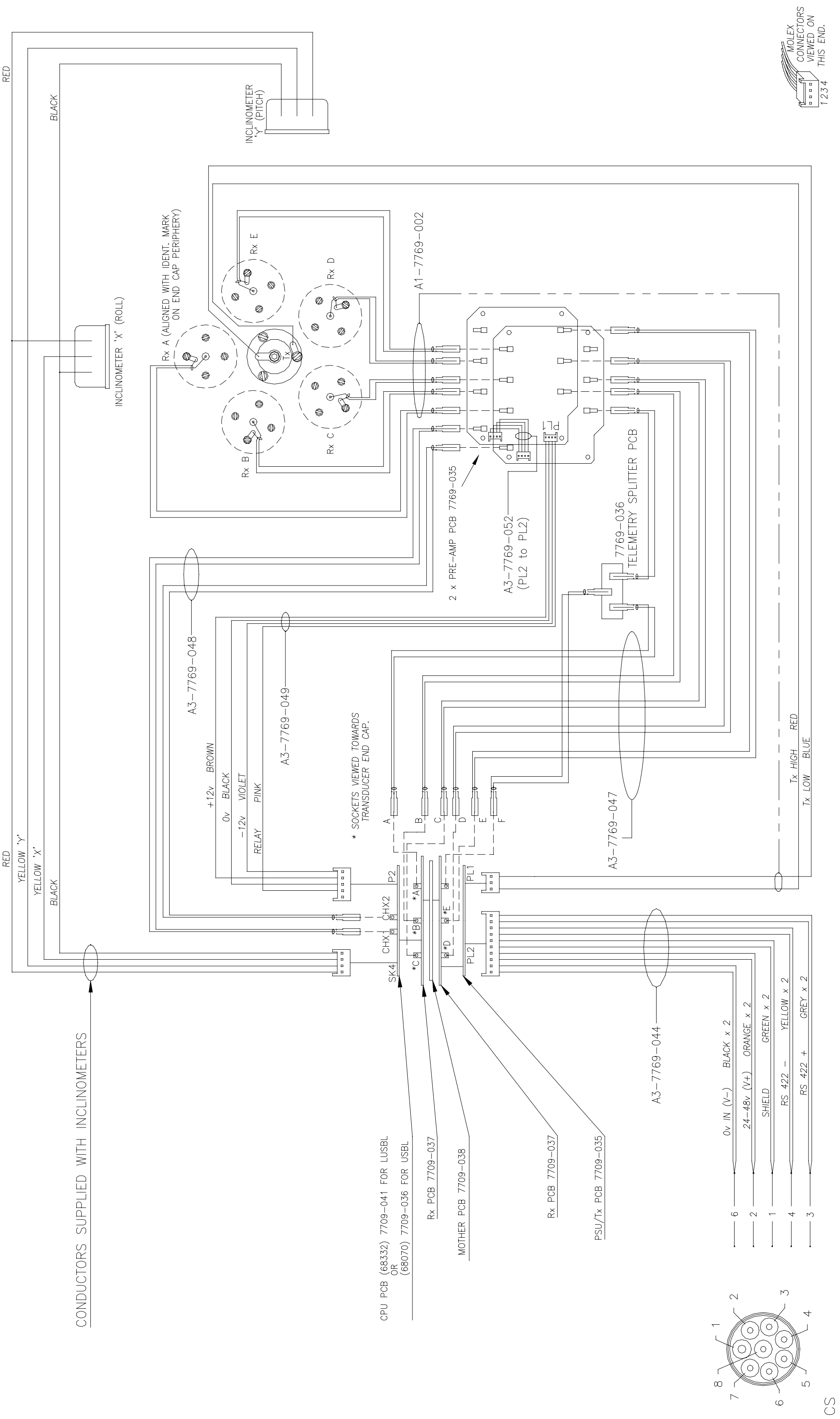


FIG 6.8 7769 USBL ACOUSTIC TRANSCEIVER - WIRING DIAGRAMS

Fig 6.8.2 - (Type II Units)

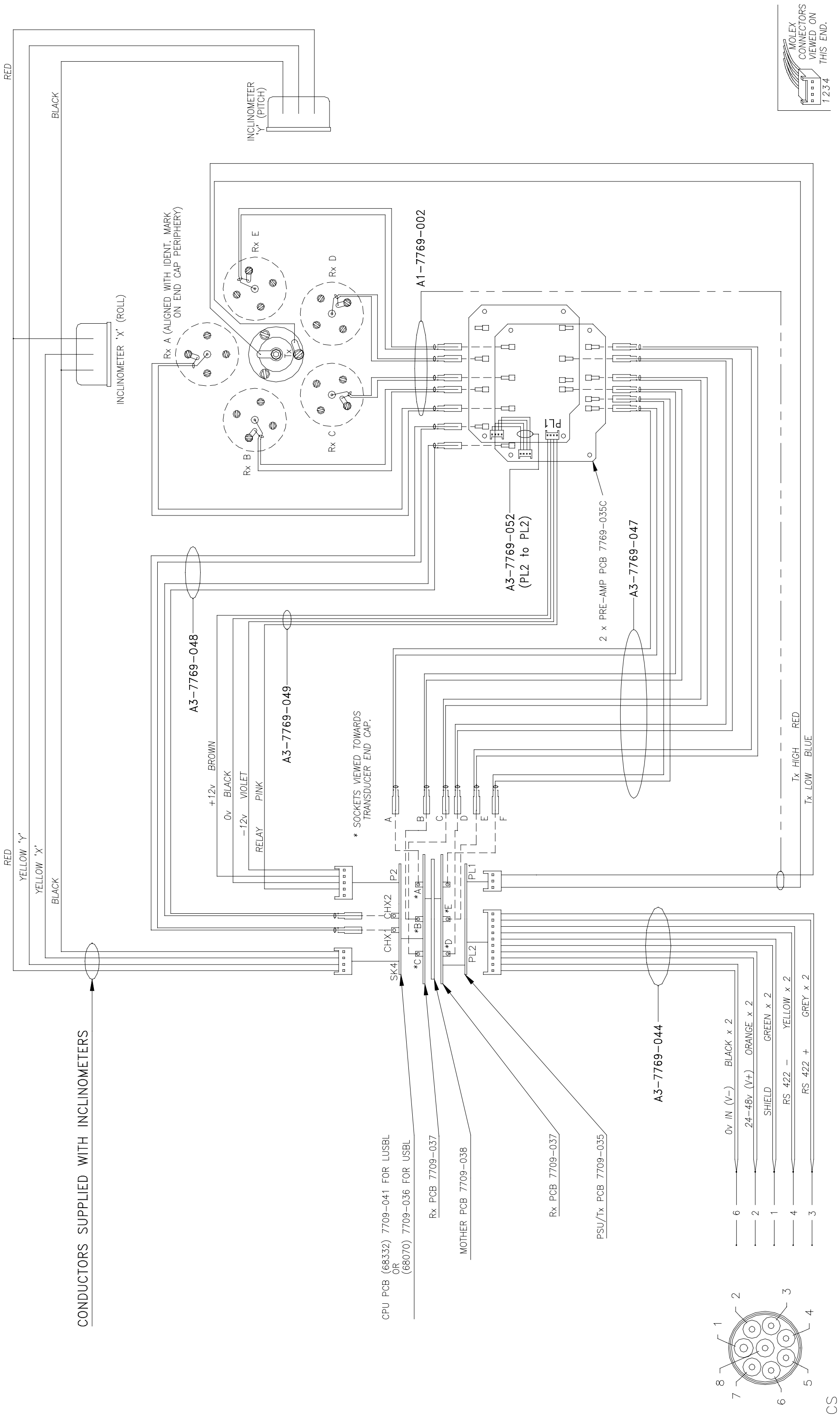


FIG 6.9 7769 USBL ACOUSTIC TRANSCEIVER - DISMANTLING FOR REPAIR

1a. <u>REMOVING ELECTRONIC/TRANSDUCER FROM HOUSING</u>

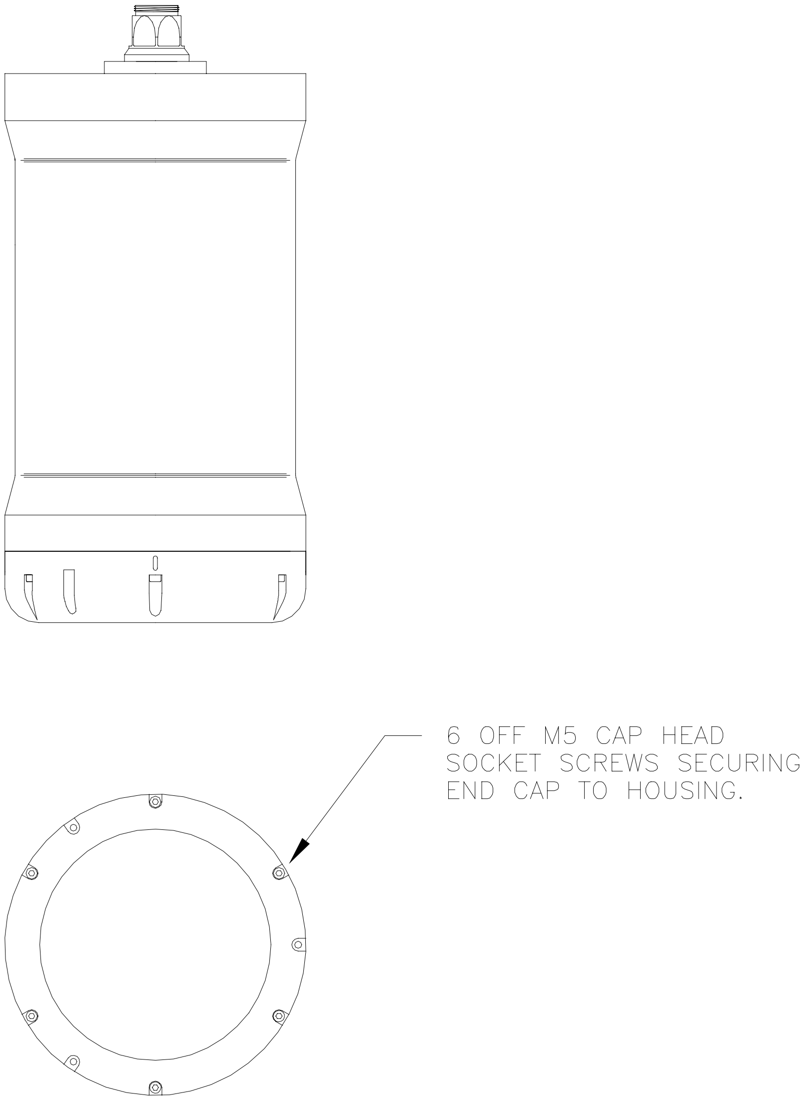


Fig 6.9 cont …

1b. **REMOVING ELECTRONIC/TRANSDUCER FROM HOUSING**

DISCONNECTING CABLE

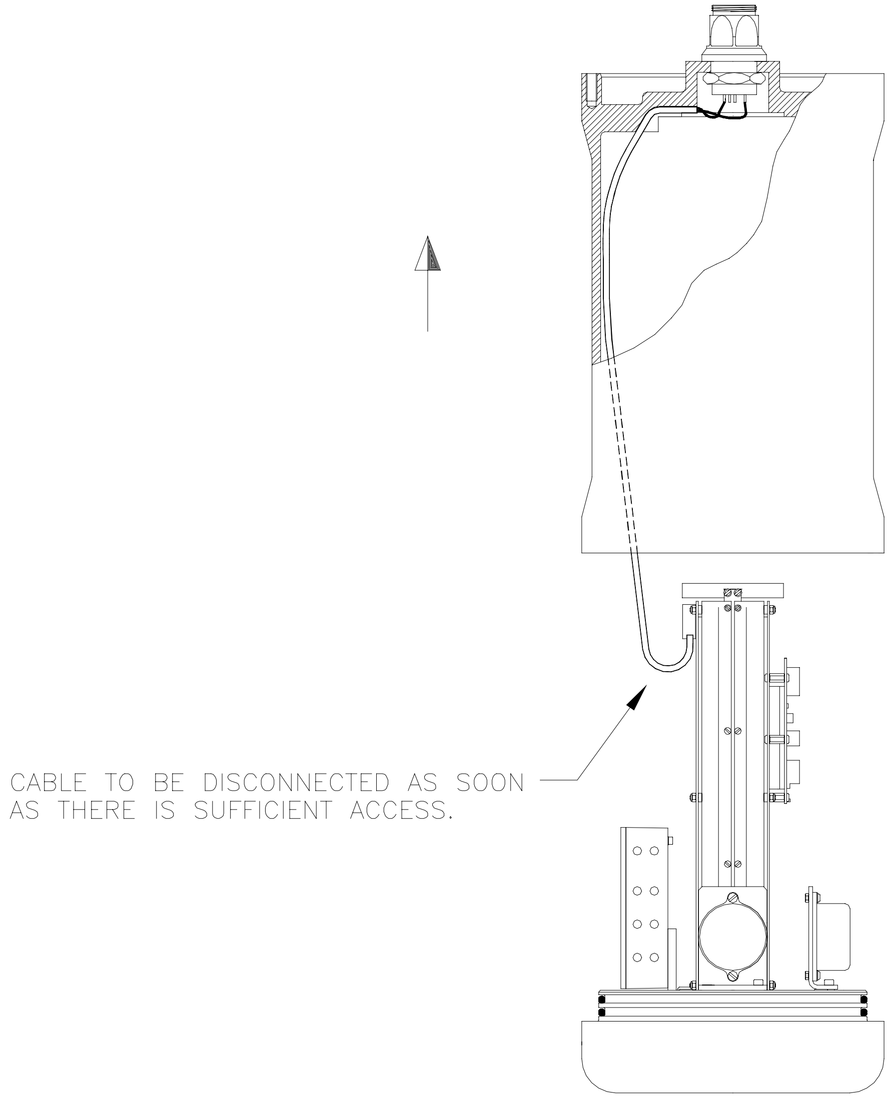
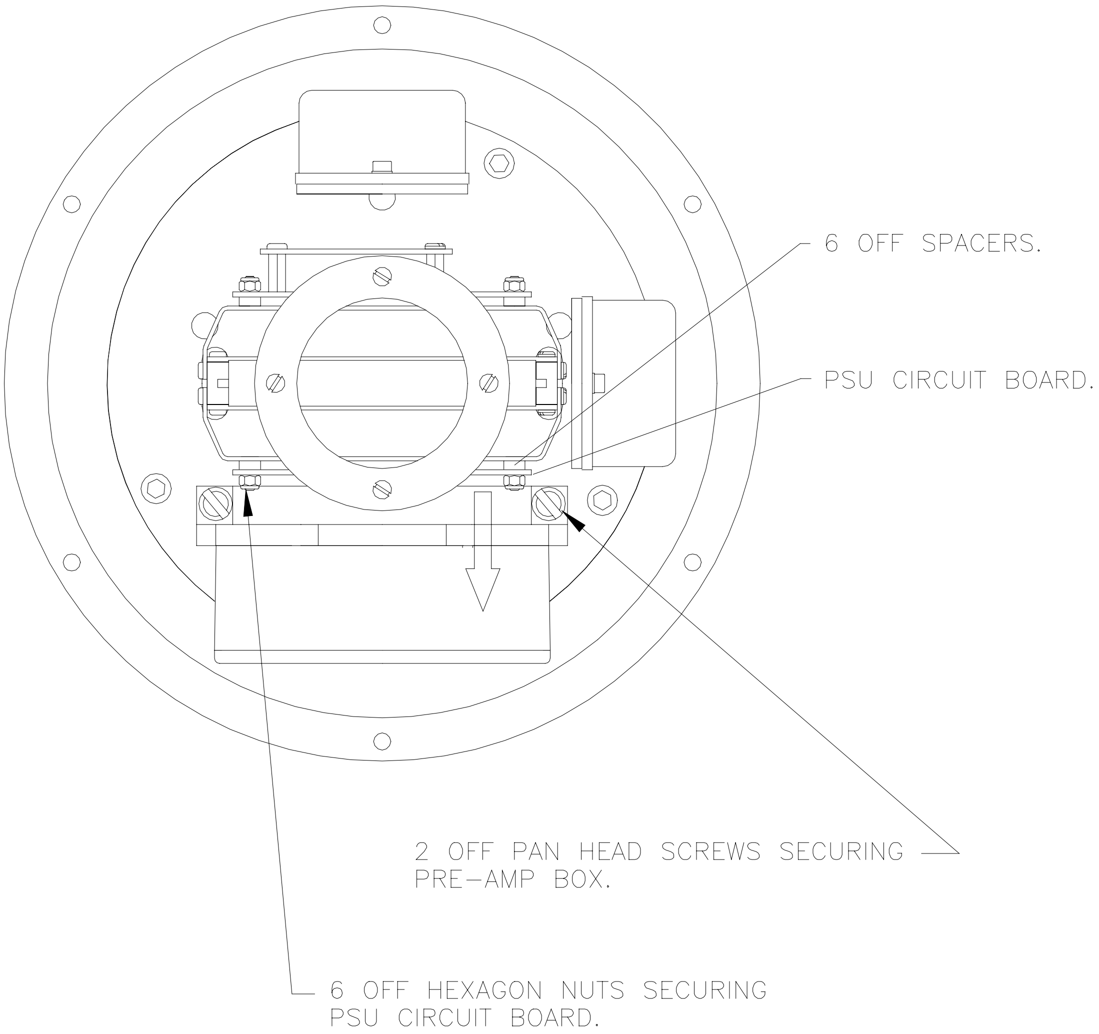


Fig 6.9 cont …

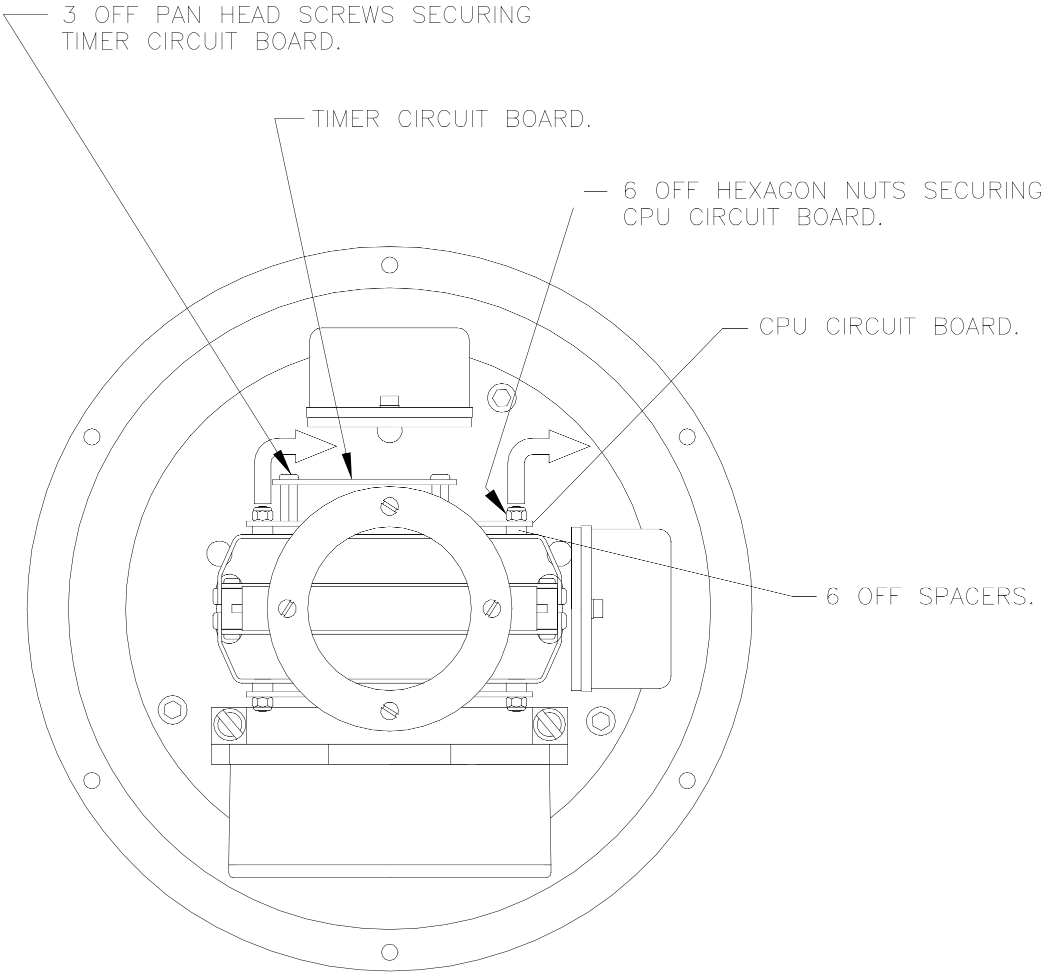
2. REMOVING ELECTRONIC/TRANSDUCER FROM HOUSING



VIEW ON END OF CHASSIS

Fig 6.9 cont …

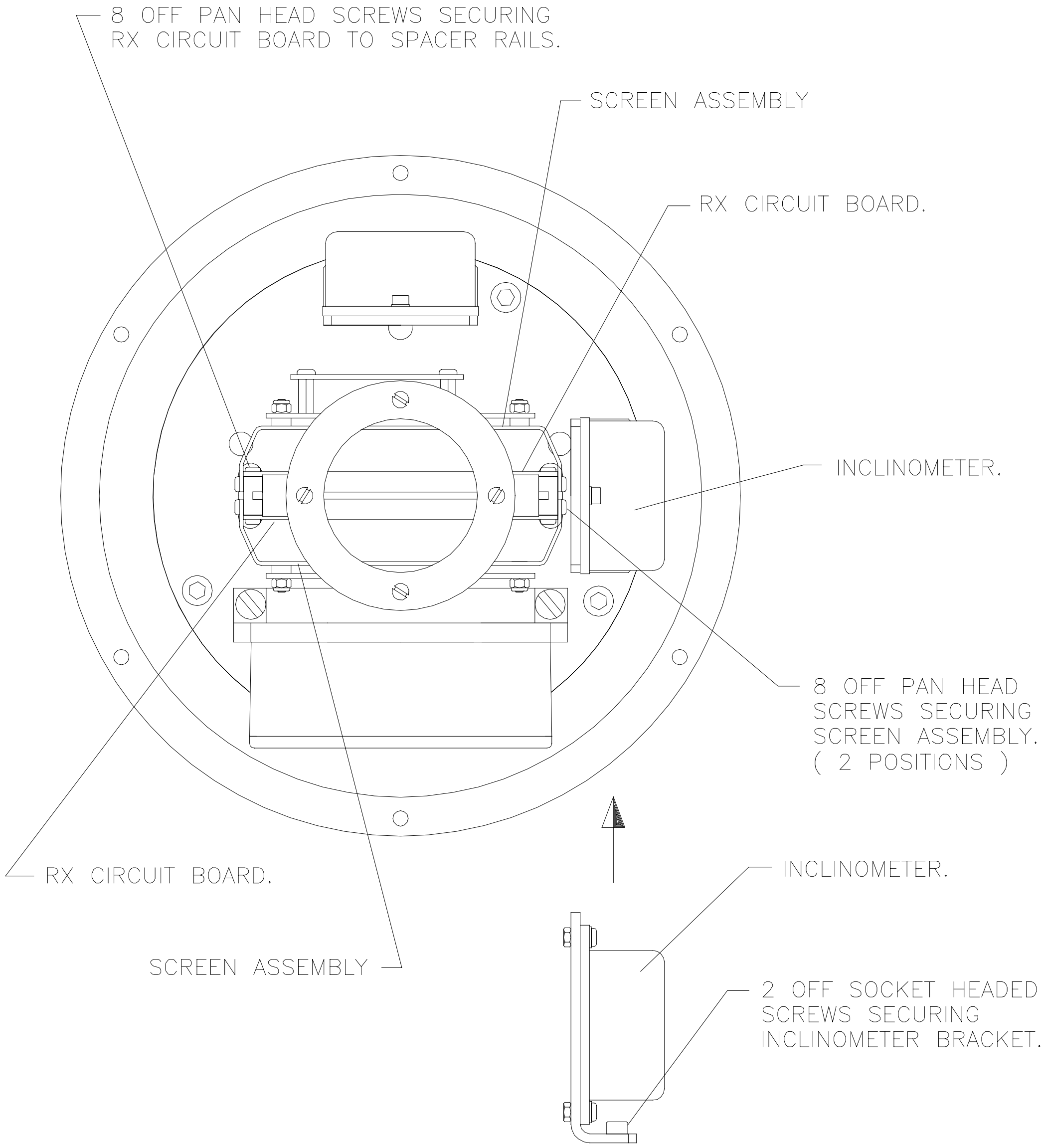
3. REPLACING A CPU/TIMER CIRCUIT BOARD



VIEW ON END OF CHASSIS

Fig 6.9 cont …

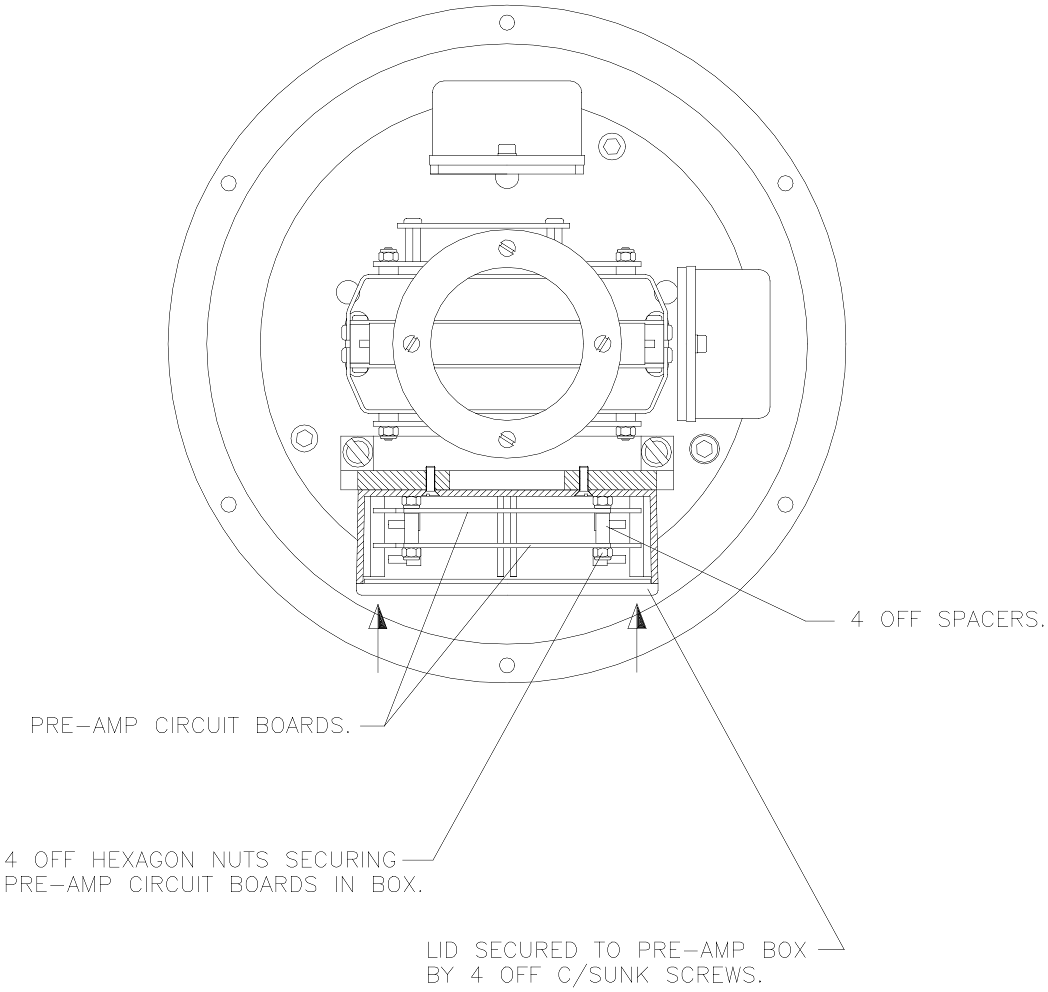
4. REPLACING AN RX CIRCUIT BOARD



VIEW ON END OF CHASSIS

Fig 6.9 cont …

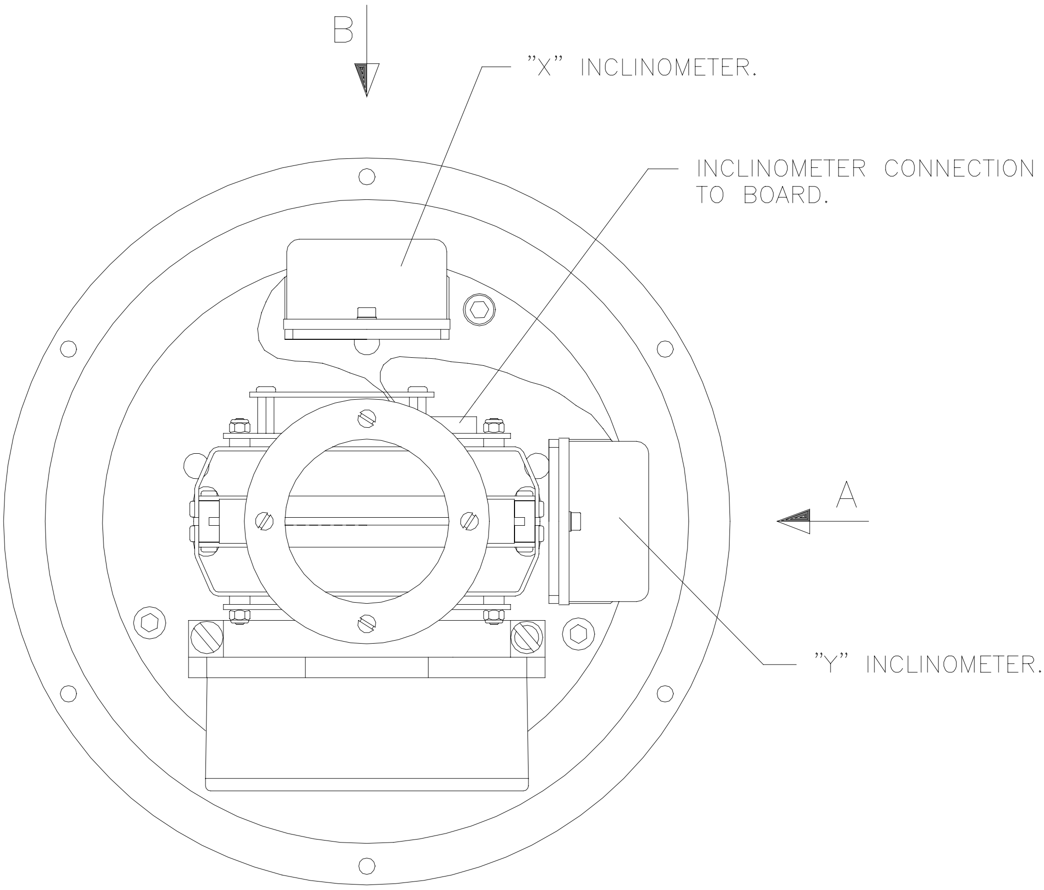
5. REPLACING A PRE-AMP CIRCUIT BOARD



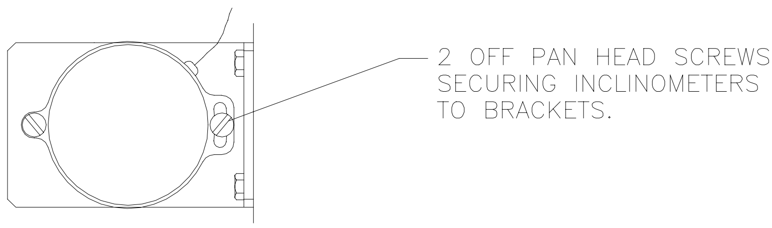
VIEW ON END OF CHASSIS

Fig 6.9 cont …

6. REPLACING A PITCH/ROLL INCLINOMETER



VIEW ON END OF CHASSIS



VIEW ON ARROW "A"
(VIEW ON ARROW "B" SIMILAR.)

SECTION 7

7. MAINTENANCE

7.1 GENERAL

This Section defines maintenance strategy, identifies the routine maintenance tasks to be carried out on a periodic basis and also includes a comprehensive set of fault-finding procedures which can be used under failure conditions.

The procedures included in this Section apply equally to the standard and dual-redundant versions of the system. Any differences which may arise with the dual-redundant version are covered in Appendix K.

7.2 MAINTENANCE STRATEGY

In an ideal situation, the Sonardyne maintenance strategy is to isolate a fault to a particular system component assembly, in this case the Navigation Processor, Monitor/Keypad etc and then replace that system component. However, it may be uneconomic or impractical to stock spares to this level and a common practical strategy is to isolate a fault to a particular PCB, or sub-assembly and to replace that.

It is not considered practical to fault find at PCB level with the aim of replacing components on PCBs in the field.

7.3 ROUTINE MAINTENANCE

7.3.1 The Type 7784 Navigation Processor

DAILY

On a daily basis the fan should be checked for operation. The easiest way to do this is to listen for fan operation.

WEEKLY

The cooling fan blows air into the unit through a fibre filter. This should be inspected and cleaned if necessary (by blowing the dust out of it) on a weekly basis.

The filter is accessed from the rear panel of the unit. Rotate the locking fastener in the centre of the fan cover by a $^1/_4$ turn and withdraw the cover. The filter is located within the cover and may be removed easily for cleaning.

Re-assemble by rotating the fastener back to its original orientation and pressing home.

3 MONTHLY

On a three-monthly basis the PCBs should be inspected for a build up of fluff and dirt that may adversely affect the cooling of the boards. The fluff and dirt may be removed using a dry airline or a suitable brush.

NOTE: The boards use CMOS parts and precautions should be taken to prevent damage by static discharge.

7.3.2 The Type 7783 Monitor/Keypad, Type 7940 Monitor and Type 7941 Keyboard

The Monitor screen and keypad(s) should be kept clean. Cleaning may be best achieved using a clean lint free cloth and a household glass cleaner spray.

7.3.3 The USBL Transceiver

Routine maintenance is not normally possible. In port, it should be inspected for fouling, connector condition, corrosion and tightness. If in dry dock, the pole should be lowered carefully and the housing and pole should be cleaned.

7.4 FAULT FINDING - GENERAL

Sections 7.5 onwards describe a series of tests for diagnosing faults in the Navigation Processor and/or the Type 7783 Monitor/Keypad. Separate guidance is given for the Type 7940 Monitor unit and the Type 7941 Keyboard unit.

Throughout the tests defined in these Sections references are made to the various boards in the Navigation Processor. In practice each board is a two card set - the VME board that plugs in through the front of the Navigation Processor and its associated 'spreader' card that plugs in through the rear. When a fault suggests the replacement of a VME board, its associated spreader card should be replaced first and the test re-run. Only then should the VME board itself be replaced.

WARNING	**Some of the following test procedures involve exposed mains power connections and testing for the presence of mains voltages. These tests should be carried out only by suitably qualified personnel.**

7.5 DEAD SYSTEM

A dead system is defined as one where nothing happens when the Navigation Processor is switched on, i.e. the mains neon does not light and the cooling fan and hard disc drive do not power up.

There are several faults that can cause a dead system. These are:-

- Mains Supply missing/incorrect.
- Mains Plug/Fuse/Cable faulty.
- Navigation Processor Mains Fuse faulty.
- Navigation Processor Mains Socket faulty.
- Navigation Processor Mains Switch faulty.
- Navigation Processor Mains Cabling faulty.

A quick way to check for one of the above faults being present is to check if the monitor has powered up - provided that it is powered from the Navigation Processor. This is indicated by a short beep. If the monitor has powered up then none of the above faults are present. This implies that the fault is in the cabling between the mains switch and the power supply in the Navigation Processor.

7.5.1 Check Mains Supply

- Check that power is available at the mains outlet and that it conforms to the specification given in Section **Error! Reference source not found.**.

7.5.2 Check Mains Plug/Fuse/Cable

- Check that all connections in the mains plug are correctly made.

- If the mains plug is fitted with a fuse then check that it has not blown. For a 110V supply it should be rated at 10 Amps. For a 240V supply it should be rated at 5 Amps.

- Check that the mains cable as a whole is in good order with continuity from one end to the other.

7.5.3 Check Navigation Processor Mains Fuse

- Check the mains fuse on the rear of the Navigation Processor. The fuse is a slow blow type rated at 6 Amps for a 110V supply and 3 Amps for a 240V supply.

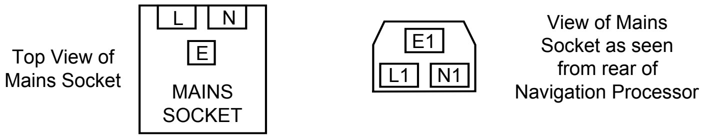
7.5.4 Checking the Navigation Processor Mains Socket

- Make sure that the Navigation Processor is switched off and disconnected from the mains supply.

- Remove the top of the Navigation Processor.

- Using a suitable meter, check for continuity between the E1 pin and the E terminal, the L1 pin and the L terminal and the N1 pin and the N terminal of the socket. If any of these is faulty then the mains socket must be replaced.

FIG 7.1 NAVIGATION PROCESSOR MAINS SOCKET



7.5.5 Checking the Navigation Processor Mains Switch

- Ensure that the Navigation Processor is disconnected from the mains supply.

- Remove the top of the Navigation Processor.

- Unscrew the mains switch assembly as described in Fig 6.3, illustrations 5.2 and 5.3 but do NOT remove any connections.

- Ease the assembly to one side in order to gain access to the mains input terminals of the power supply. Ensure that these terminals cannot short out.

- With the Navigation Processor disconnected from the mains turn the mains switch to the ON position and then using a suitable meter, check for continuity between the two live terminals and then the two neutral terminals of the mains switch. Turn the Switch to the OFF position. If there was a lack of continuity on either the live side or the neutral side of the switch then the switch will have to be replaced.

NOTE: The live input/output terminals of the mains switch are both numbered 2 on the switch body. Similarly, the neutral terminals on each mains switch are both numbered 1. Correct orientations for both rotary and rocker types of switch are as shown in the drawings below

FIG 7.2 MAINS SWITCH AND POWER SUPPLY MAINS WIRING

Fig 7.2.1 - Rotary Mains Switch

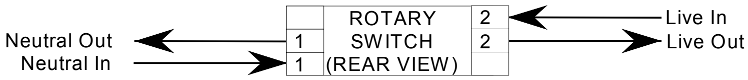


Fig 7.2.2 - Rocker Type Mains Switch

7.5.6 Checking the Navigation Processor Mains Wiring

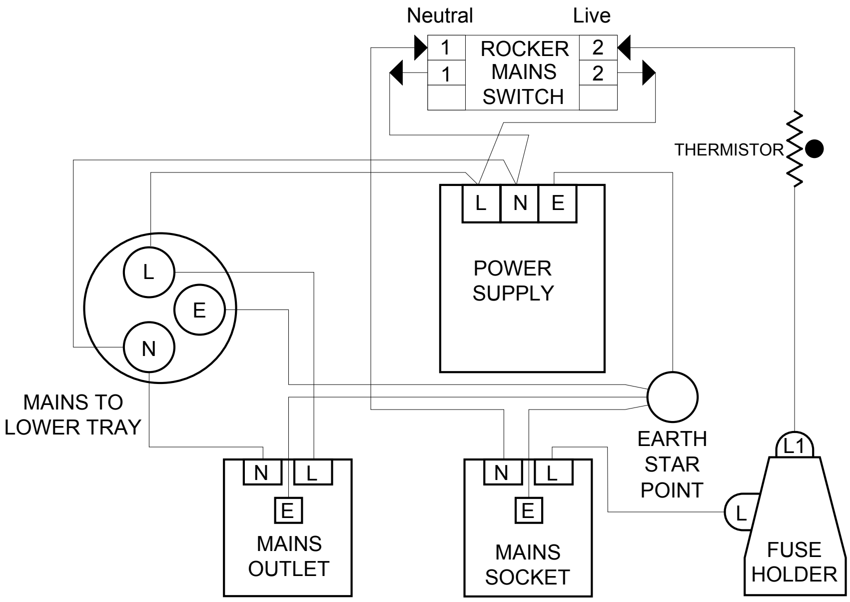
- Ensure the Navigation Processor is disconnected from the mains supply.
- Remove the top of the Navigation Processor.
- Unscrew the mains switch assembly as described in Figure 6.3, illustrations 5.2 and 5.3 but do NOT remove any connections.
- Ease the assembly to one side in order to gain access to the mains input terminals of the power supply. Ensure that these terminals cannot short out.
- Using a suitable meter check the continuity between the following points :-

L terminal mains socket	L terminal fuse holder (thermistor in line).
L terminal fuse holder	L1 terminal of the fuse holder.
L1 terminal fuse holder	live input terminal mains switch.
live output terminal mains switch	L terminal power supply.
L terminal power supply	L terminal bottom tray
L terminal bottom tray	L terminal mains outlet.
N terminal mains socket	neutral input terminal mains switch.
neutral output terminal mains switch	N terminal power supply.
N terminal power supply	N terminal bottom tray
N terminal bottom tray	N terminal mains outlet.
E terminal mains socket	earth star point
E terminal power supply	earth star point
E terminal mains outlet	earth star point.
E terminal bottom tray	earth star point.

NOTE: The live input/output terminals of the mains switch are both numbered 2 on the switch body. Correct orientation for the rocker type of mains switch is as shown in Fig 7.3. Similarly the neutral terminals on the mains switch are both numbered 1. Navigation Processor mains wiring for the earlier design units using a rotary type mains switch are as shown in Fig 7.3 except for the different layout of the mains switch itself (see Fig 7.2.1) and the absence of the thermistor.

If any of the leads are faulty then these should be repaired or replaced using suitable cable and connectors. After the fault has been corrected re-fit the mains switch assembly and re-fit the top.

FIG 7.3 NAVIGATION PROCESSOR MAINS WIRING



7.6 NAVIGATION PROCESSOR DOES NOT BOOT

There are several reasons why the Navigation Processor may refuse to boot. These are:-

- The CPU board is faulty.
- Data on the hard disc drive has become corrupted.
- The hard disc drive or its cabling is faulty.
- The power supply is faulty.
- The Graphics board is faulty.

It is possible for the Navigation Processor to appear to fail to boot when the problem is actually loss of video - i.e. a blank display.

Before attempting any of the other tests in this section always run the test in the following section first as this will help in localising the fault area.

7.6.1 Check CPU Board

- If the Navigation Processor is switched on then switch it off as this test has to be run from power on. Ensure that the floppy disc drive is empty.

- Switch on the Navigation Processor and observe the LEDs on the front panel of the CPU board. Also observe the floppy disc drive and hard disc drive access LEDs.

- When power is applied to the CPU board (the board in slot 1 of the VME back plane) all of the LEDs should light. After approximately 1 second all but the RUN, SCON and +12V LEDs should go out. The VME LED should then go on and off twice. At the same time the floppy disc drive and the hard disc drive access LEDs should also flicker. After this the VME, RUN and hard disc LEDs should flicker rapidly for about 2 seconds. Next, the VME and hard disc LEDs should go out leaving just the SCON and +12V LEDs glowing brightly and the RUN LED flickering dimly.

- If the CPU and disc drive LEDs follow the above sequence then the Navigation Processor has booted up correctly and the fault is in the monitor or the video cables. See Section 7.7 for how to check the video display.

- If the FAIL LED stays on then the CPU board has failed one of its power up tests. Try switching off, wait at least 60 seconds and then switch on again. If the FAIL LED persists then switch off, remove the front panel from the Navigation Processor, remove all the VME boards and then refit them. Replace the front panel and switch on again. If the FAIL LED still persists then replace the CPU board.

- If the floppy disc drive LED lit, but the hard disc drive LED did not, then there is a fault in the hard disc drive or its cabling.

- If the neither the floppy disc drive LED nor the hard disc drive LED lit then there is a fault in the cabling to the disc drives or the SCSI interface (the logic that handles the disc drives) on the CPU board is faulty.

- First, replace the CPU board and repeat the test. If the Navigation Processor now boots up correctly then the CPU board was faulty. Return the faulty CPU board to Sonardyne for repair.

- If the fault persists then the floppy disc drive and hard disc drive cabling must be checked.

If these tests have failed to isolate the fault area then the hard disc is corrupted or the CPU board is faulty. Try replacing the CPU board before checking the hard disc drive.

7.6.2 Checking the Hard Disc for Corruption

- From the top level menu, select “**System Setup**” and then “**System Test Programs**”.

- Select the “**Hard Disc Check**” option.

Firstly the SCSI inquiry command is sent to the hard disc drive to check that the drive is responding to commands. If the inquiry command succeeds then the display will show 'Located hard disc drive'. If the inquiry command failed then the display will show 'Cannot locate hard disc drive. Check drive cabling'.

If the inquiry command succeeded then an integrity test is performed on the files on the hard disc drive.

If the integrity check cannot be performed due to errors on the hard disc then a suitable error message will be displayed. Return to the menu and select the Install USBL option.

If the files are intact then the display will typically look like this :-

Volume - 'SONARDYNE Vn.nn' on device /h0

$01419c total sectors on media, 512 bytes per sector

Sector $000001 is start of bitmap

$2834 bytes in allocation map, 1 sector(s) per cluster

Sector $000016 is start of root dir

Building allocation map...

$0016 sectors used for id sector and allocation map

Checking allocation map...

'SONARDYNE Vn.nn' file structure is intact

71 directories, 1003 files

15200768 of 42153984 bytes (14.49 of 40.20 meg) used on media

Integrity check completed. Press ENTER to continue.

The important part is the line - 'SONARDYNE Vn.nn' file structure is intact. Any errors found will be listed before this line. If errors are found then the software will have to be re-installed - re-boot and then select the Install USBL option from the menu. If the damage to the hard disc is not extensive it may be possible to archive jobs to floppy disc before the software is re-installed. Press ENTER to return to the menu and then select the Archive option from the menu to do this.

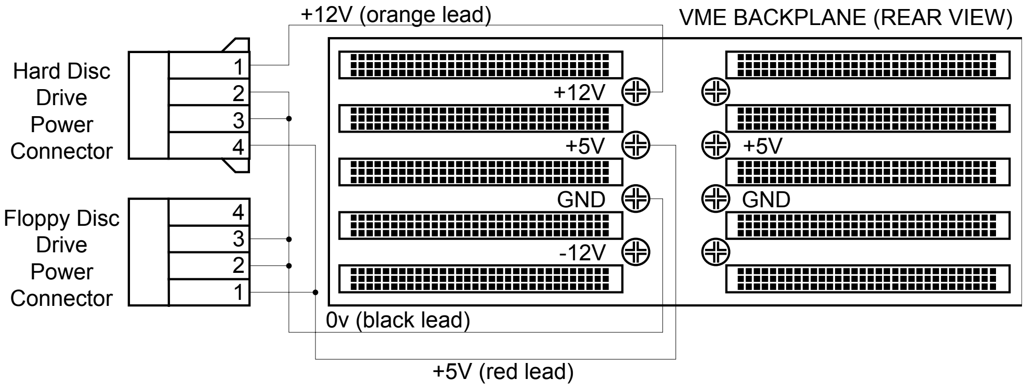
If the hard disc is error free then press <ESC> to return to the menu.

7.6.3 Check Hard disc drive and Floppy Disc Drive Cabling

- Switch off the Navigation Processor, remove the CPU spreader card and check that the 50 way ribbon cable connector on the under side is correctly mated.
- Remove the lid of the Navigation Processor and all the remaining spreader cards.
- Unplug the power connectors from the floppy disc and hard disc drives.
- Check that the 50 way ribbon cable is correctly mated to both the floppy disc drive and the hard disc drive.
- Using a suitable meter check for continuity between the following points :-

pin 1 hard disc power connector	+12V terminal VME back plane.
pin 2 hard disc power connector	GND terminal VME back plane.
pin 4 hard disc power connector	+5V terminal VME back plane.
pin 2 floppy disc power connector	GND terminal VME back plane.
pin 1 floppy disc power connector	+5V terminal VME back plane.

FIG 7.4 WIRING DIAGRAM OF DISC DRIVE POWER CONNECTIONS



- Repair/replace any faulty leads.
- Switch on the Navigation Processor and using a suitable volt meter check the power supply to the disc drives.
- Check for 5V ± 5% across pins 1 and 2 of the floppy drive power connector.
- Check for 5V ± 5% across pins 3 and 4 of the hard disc drive power connector.
- Check for 12V ± 10% across pins 1 and 2 of the hard disc drive power connector.
- If any of the power levels are out of specification then check the power supply.
- Re-fit the disc drive power connectors.
- Re-fit the spreader cards and the lid. See Section 6.1.3.2.

7.6.4 Checking the Navigation Processor Power Supply

- Switch OFF the Navigation Processor, remove the front panel and all the VME boards from the front and their associated spreader cards from the rear. See Sections 6.3.1 and 6.1.3.2.
- Fit the Power Test Board - Part No. 7384-060 - into the rear of slot 5 (the top slot) of the VME back plane.

NOTE: Keep the duration of this test as short as possible in order to prevent damage to the load resistors - which get extremely hot.

- Switch on the Navigation Processor.
- Using a suitable volt meter check for the following voltages:

Test Point 0 - Test Point 1	+5V ± 5%
Test Point 0 - Test Point 2	+5V ± 5%
Test Point 0 - Test Point 3	+5V ± 5%
Test Point 0 - Test Point 4	+5V ± 5%
Test Point 0 - Test Point 5	+12V ± 10%
Test Point 0 - Test Point 6	-12V ± 10%
Test Point 0 - Test Point 7	+24V ± 10%

If any of these voltages are outside the permissible limits then replace the power supply and repeat this test.

If any of these voltages are 0V (i.e. open circuit) then it will be necessary to check out the Navigation Processor's wiring loom to the VME back plane.

7.6.5 Check Navigation Processor Wiring Loom

The back of the VME back plane and the power outputs from the power supply can be reached through the area normally occupied by the spreader cards.

- Check that the leads between the VME back plane and the power supply are firmly made and undamaged. Repair or replace any faulty leads.

- Using a suitable meter check for continuity of the VME back plane wiring loom. When the spreader cards are removed from the back of the Navigation Processor access is available to both the VME back plane and the power supply through the rear of the Navigation Processor.

- Check left side of back plane.

  1. Check the continuity between +12V on the back plane and the connection 6 of the power supply.

  2. Check for continuity between +5V on the back plane and connection 1 of the power supply.

  3. Check for continuity between GND on the back plane and connection 4 of the power supply.

  4. Check for continuity between -12V on the back plane and the connection 5 of the power supply.

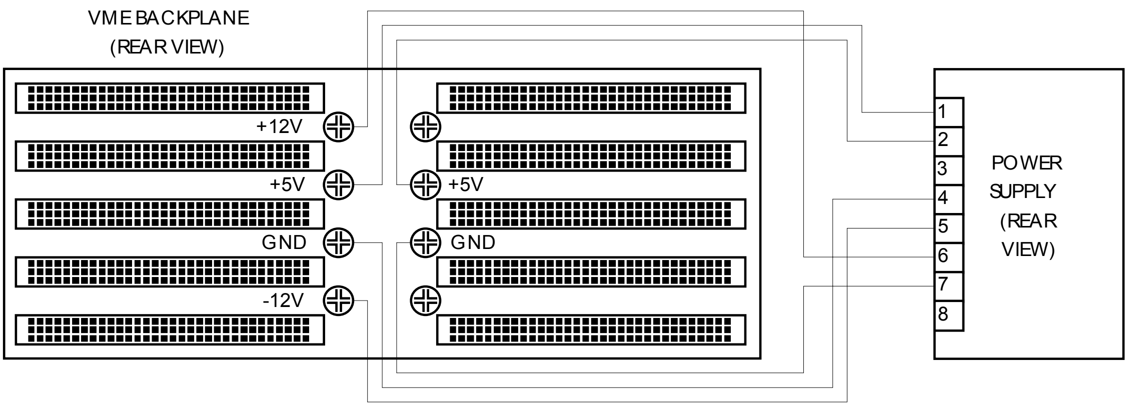
- Check right side of the back plane.

  1. Check for continuity between +5V on the back plane and connection 2 of the power supply.

  2. Check for continuity between GND on the back plane and connection 7 of the power supply.

- Repair or replace any faulty leads using suitable cable and connectors and repeat the test.

FIG 7.5 VIEW ON REAR OF VME BACK PLANE AND POWER SUPPLY



7.6.6 Checking the Graphics Board

If the graphics board has a fault that prevents the Navigation Processor from booting up this is indicated by the LEDs on the CPU board. The sequence of 'all CPU LEDs on', 'all but RUN, SCON and +12V off', 'hard disc LED on' will continuously repeat. Try removing and refitting the Graphics board and re-booting. If this fails to fix the problem then the Graphics board will have to be replaced.

7.7 LOSS OF VIDEO

Loss of video can be caused by:-

- Monitor Fuse/Cable faulty.
- No mains output from the Navigation Processor.
- No video output from Navigation Processor.
- Faulty video lead.

7.7.1 Check Monitor Mains Fuse/Cable

- Check the Monitor mains fuse and if blown replace it. For a 110V supply it should be rated at 6 Amps. For a 240V supply it should be rated at 3 Amps. For the Type 7940 Monitor Unit the fuse rating is 2.5 AT.
- Check that the mains cable as a whole is in good order with continuity from one end to the other.

7.7.2 Check Mains Output from Navigation Processor

WARNING: When doing this test, exercise extreme care not to touch any exposed live terminals.

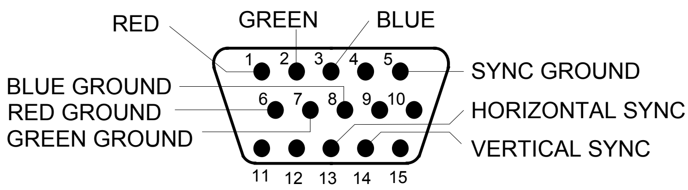
Using a suitable volt meter check for mains voltage across the Live and Neutral pins of the Navigation Processor mains outlet socket.

7.7.3 Checking Video Output from Navigation Processor

- Ensure the keypad and mains leads are connected and the video lead is disconnected.
- Switch on or press Reset to reboot the Navigation Processor and then wait until the CPU and Disc Drive LEDs stop flashing. This takes several seconds.
- Using an oscilloscope check for the following signals on the video output connector on the rear of the Navigation Processor:-

Cable with Mini 15 way D type connectors at each end.	Cable with Mini 15 way D type at one end and 3 BNC connectors at the other.
Red on pin 1 Green on pin 2 Blue on pin 3 Horizontal Sync on pin 13 Vertical Sync on pin 14	Red on pin 1 Green + composite sync on pin 2 Blue on pin 3

FIG 7.6 VIEW ON REAR OF VME BACK PLANE AND POWER SUPPLY



If any of the signals are missing or incorrect then replace the graphics card and repeat the test.

7.7.4 Check Video Lead

There are two types of video lead that can be used with the Navigation Processor and the Type 7783 Monitor/Keyboard. One is a standard VGA type cable with mini 15 pin D type connectors at each end, and the other has a mini 15 pin D type at the Navigation processor end and three BNC connectors at the Monitor end. The Type 1 cable is a standard VGA type that is compatible with PCs. The Type 2 cable has a composite sync signal that is output with the green signal. If the latter cable is used, an additional Monitor can be connected to the alternative set of BNC connectors on the rear of the Monitor to drive a second display.

The Type 7940 Monitor unit uses the Type 2 cable.

7.7.4.1 **Testing the Type 2 Cable (RGB) - Type 7783 and Type 7940 Monitors**

Since substitution is not possible with this cable it will be necessary to use a suitable meter to check the cable for continuity. Repair or replace the cable if any faults are found. Before installing a replacement graphics card, when using this cable, check that link 3 on the graphics card IS made (see Appendix J for more details on links).

FIG 7.7 VIDEO CABLE USING A 15 WAY MINI D TYPE AND 3 BNC TYPE CONNECTORS

Pin 1 = Red
Pin 2 = Green + Composite Sync
Pin 3 = Blue
Pin 5 = Ground
Pin 6 = Red Return
Pin 7 = Green Return
Pin 8 = Blue Return

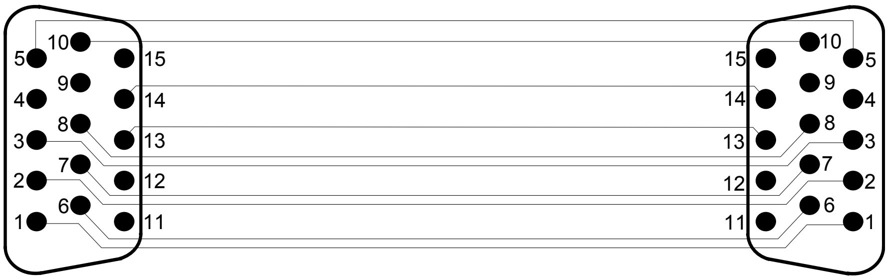
7.7.4.2 **Testing the Type 1 Cable (VGA) - Type 7783 Monitor/Keyboard only**

If a suitable PC VGA video cable is available (i.e. one with mini 15 way D type connectors at each end) and is known to work then this can be substituted for the video cable. Connect one end of the PC cable to the Navigation Processor and the other to the Monitor. If the Monitor now works correctly then the original cable is faulty and must be repaired or replaced. If the Monitor still fails to work then the fault is in the graphics card which will have to be replaced. Before installing a replacement graphics card, when using this cable, check that link 3 on the graphics card is NOT made (see Appendix J for more details on links).

FIG 7.8 VIDEO CABLE USING 2 OFF 15 WAY MINI D TYPE CONNECTORS

(VGA COMPATIBLE)

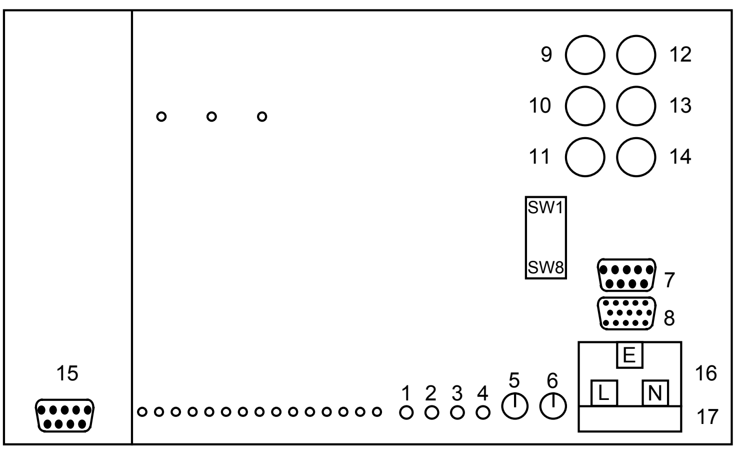
Pin 1 = Red
Pin 2 = Green
Pin 3 = Blue
Pin 5 = Ground
Pin 6 = Red Return
Pin 7 = Green Return
Pin 8 = Blue Return
Pin 10 = Sync Return
Pin 13 = Horizontal Sync
Pin 14 = Vertical Sync



7.8 SETTING UP THE VIDEO DISPLAY

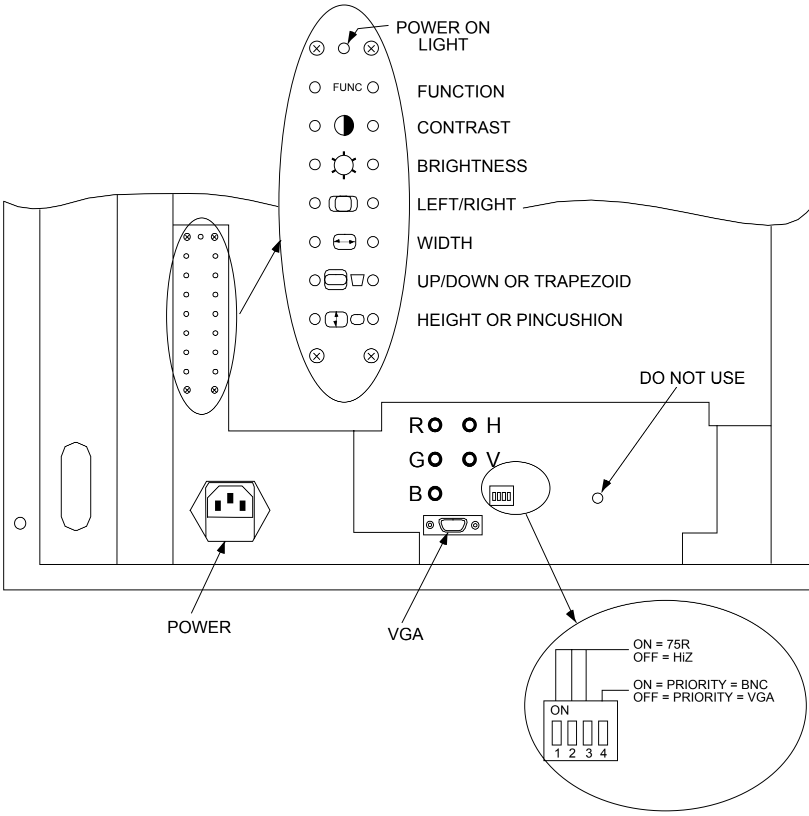
- Switch on the Navigation Processor or return to the top level menu.
- Select the Setup option.
- Select the Installation option.
- Select the Monitor Brightness option.
- Select option 5 - maximum brightness.
- Select the Maintenance option.
- Select the Graphics Test option.
- Adjust the contrast to give minimum flare and maximum black level - see Fig 7.9 for the Type 7783 Monitor/Keypad and Fig 7.10 for the Type 7940 Monitor.
- Adjust the brightness to give the optimum display.
- Adjust the Picture Height and Vertical centring to align the option labels on the display with the keypad.
- Adjust the Horizontal Centring to align the option labels on the display with the keypad.
- Adjust the Picture Width until the displayed circle looks circular.

FIG 7.9 REAR VIEW OF TYPE 7783 MONITOR



1 = Adjust Picture Height
2 = Adjust Picture Width
3 = Adjust Vertical Centering
4 = Adjust Horizontal Centering
5 = Brightness Control
6 = Contrast Control
7 = TTL Video Input (not used)
8 = VGA Video Input
9 = Red Input
10 = Green Input
11 = Blue Input
12 = Red Output
13 = Green Output
14 = Blue Output
15 = Keypad I/O Socket
16 = Mains Socket
17 = Mains Fuse

FIG 7.10 REAR VIEW OF TYPE 7940 MONITOR



7.9 KEYPAD NOT WORKING (TYPE 7783 MONITOR/KEYPAD)

The following guidance applies only to the Type 7783 Monitor/Keypad. Please refer to Section 7.10 for the keypads fitted to the Type 7940 Monitor unit and the Type 7941 Keyboard unit.

Fig 7.11, which follows, illustrates the main components involved in the following fault-finding steps.

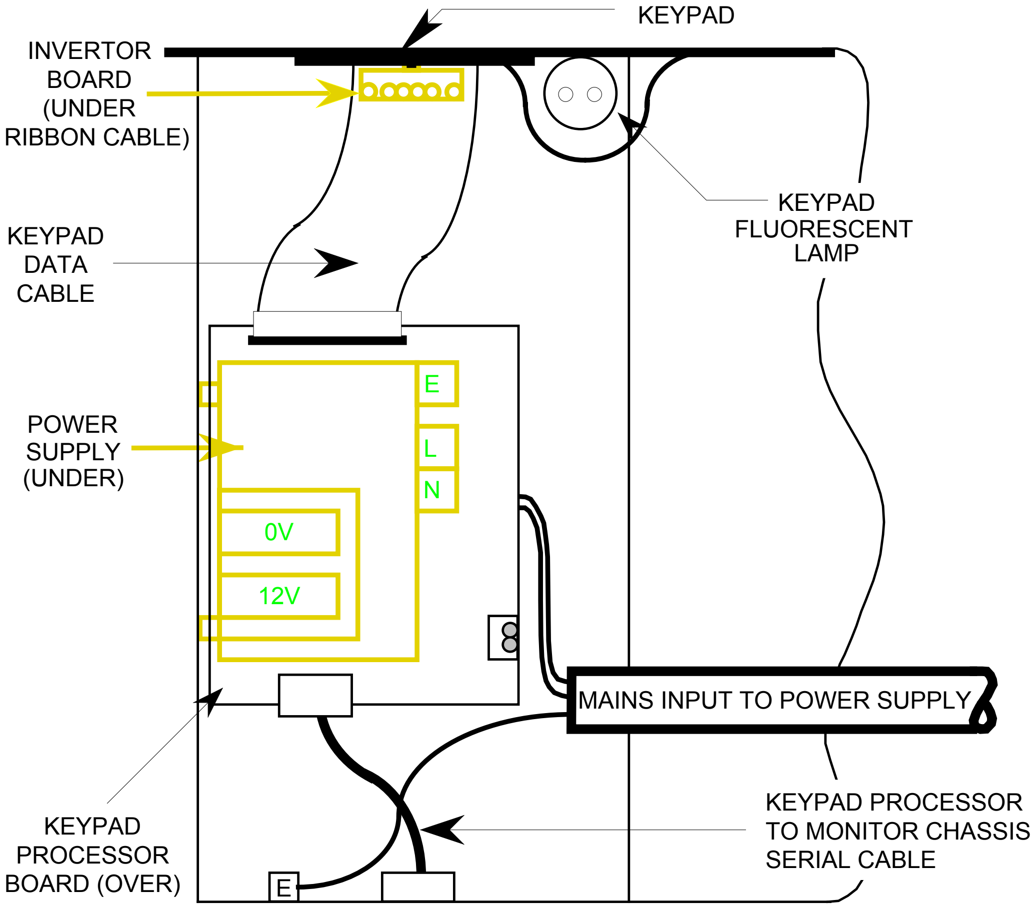
If the keypad fails (indicated by key presses being ignored by the application software or giving an incorrect response) then one of the following faults applies:-

- The keypad cable between the Monitor and the Navigation Processor is faulty.
- The internal serial cable between the Monitor Chassis and the keypad processor board is faulty.
- The keypad to keypad processor board data cable is faulty.
- The keypad power supply is faulty.
- The keypad processor board is faulty.
- The keypad itself.

Before running any tests power up the Monitor and listen for a beep. If the beep is heard then the mains lead and keypad power supply are not the fault and the keypad processor board is unlikely to be the fault.

FIG 7.11 VIEW OF KEYPAD COMPONENTS LOOKING DOWN ON MONITOR

WITH TOP REMOVED

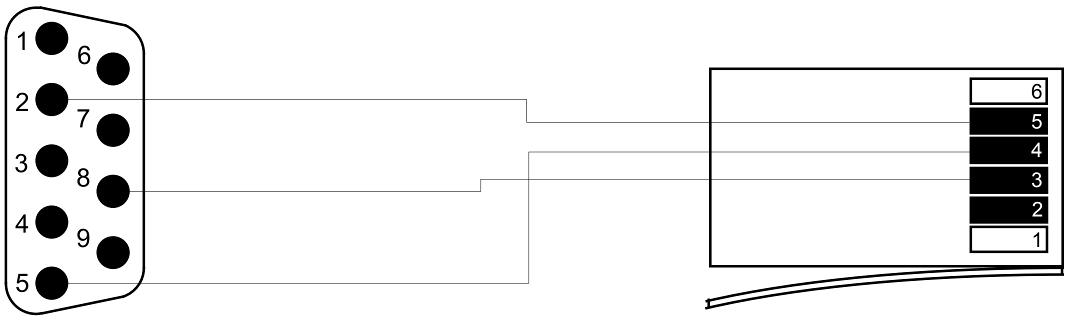


7.9.1 Check Keypad Monitor Cable

Using a suitable meter check the cable between Monitor and Navigation Processor for continuity. Repair or replace if faulty.

FIG 7.12 MONITOR TO NAVIGATION PROCESSOR KEYPAD SERIAL CABLE

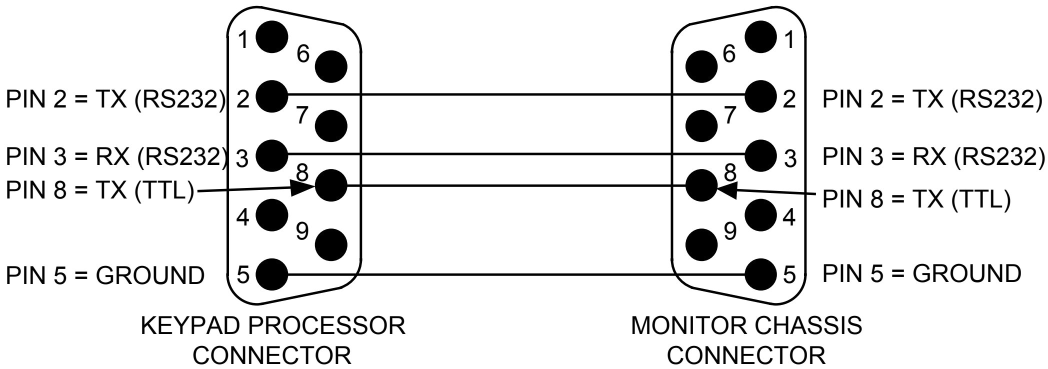
TYPE 7784-042



7.9.2 Check Internal Keypad Data Cable

Remove the lid from the Monitor and then remove the serial cable between chassis connector and Keypad Processor Board. Using a suitable meter check cable for continuity. Note that the data signals are on pin 3 and pin 8 at the processor end of the cable. The RX signal is RS232 and the TX signal is TTL.

FIG 7.13 KEYPAD PROCESSOR TO MONITOR CHASSIS SERIAL CABLE



7.9.3 Check Keypad to Processor Board Data Cable

This cable cannot be repaired. The only check available is to make sure that the cable is correctly fitted to the keypad processor board.

7.9.4 Check Keypad Processor Power Supply

This power supply provides power for the Keypad Processor and the Keypad Backlight. See Fig 7.11.

- Switch on the system. If the keypad power-up beep is heard and/or the Keypad Backlight illuminates then the power supply is functioning.
- With the system switched off remove the lid from the Monitor. Check that the mains input to the power supply is correctly fitted.
- Check that the 12V power cable between the power supply and the keypad processor is correctly fitted.
- Disconnect the lead and check for continuity. Repair or replace if faulty.

If these steps do not solve the problem then the Monitor must be changed.

7.9.5 Keypad Backlight Failure

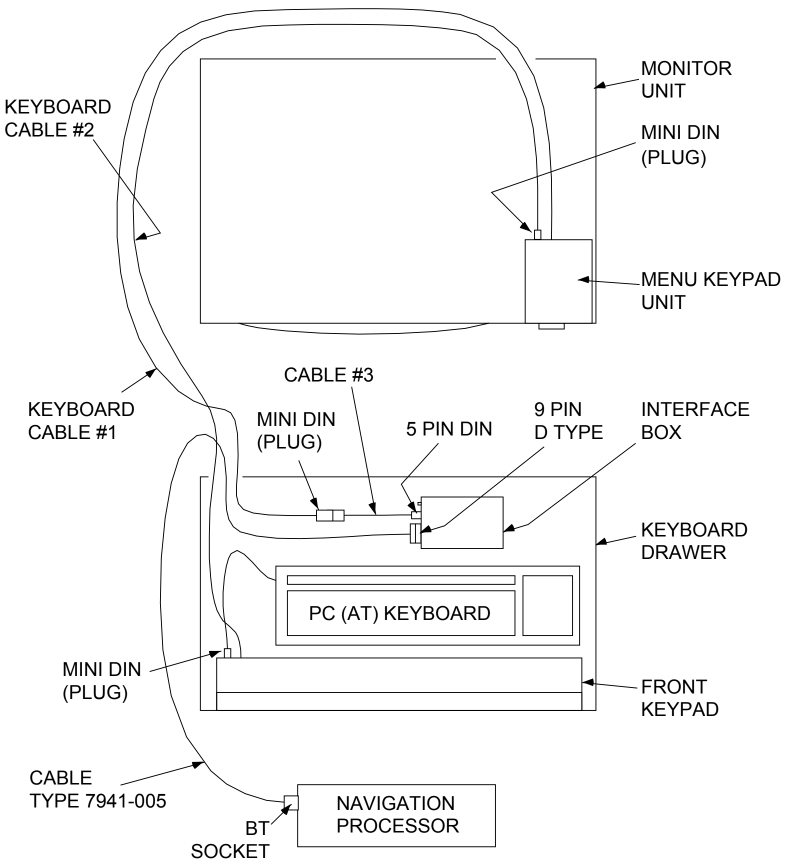
If the Backlight fails remove the top of the Monitor and check that the power lead from the power supply to the keypad lamp driver board is OK. If no fault is found then the Monitor must be changed.

7.10 KEYPAD FAILURE ON THE TYPE 7940 MONITOR UNIT OR TYPE 7941 KEYBOARD UNIT

Between them, these two units embody three keyboard-type assemblies - the keypad in the Monitor unit, the keypad mounted on the front face of the Keyboard unit and the PC AT keyboard mounted inside the drawer of the same unit. All three produce PC standard keyboard output data and all three utilise the same connector on the ends of their output leads.

These three “keyboards” are “daisy-chained” together and then connected into the input side of the Interface Box (see description in Section 6.4.1) - the first in the chain being the PC AT keyboard and the last (connected to the Interface Box) being the Monitor unit keypad - see Fig 7.14. The output of the Interface Box is fed to the Type 7784 Navigation Processor. The cables involved in this daisy chain carry 5V dc power from the Navigation Processor to the three “keyboards” as well as returning key press signals from them.

FIG 7.14 TYPE 7941 KEYBOARD UNIT - DAISY CHAIN CONNECTIONS



NOTE: SCHEMATIC ONLY

A range of tests may be carried out to isolate any fault to a particular sub-assembly, as follows:

7.10.1 No Keyboard Is Working

If none of the "keyboards" produces any response on the monitor screen, it is likely that (a) the +5V power supply from the Navigation Processor has failed or is not getting through or (b) there is an open circuit in the data lines in the "daisy chain" cables connecting the Navigation Processor through to the Monitor Unit or (c) the interface circuits in the Interface Box have failed.

5V supply loss may be confirmed if there is no "beep" on power on to the keyboard chain and if the "NUM LOCK", etc, lights on the PC AT keyboard do not respond to the corresponding keys being toggled on and off.

In any event, switch off system power.

Disconnect all cables (the Type 7941-005 cable and keyboard cables #1 through #3) and check continuity for the Type 7941-005 cable - Fig 7.15 - and keyboard cable #3 - Fig 7.16.

If any of the continuity tests fail, replace the cable concerned.

If loss of 5V supply is suspected and the +5V and GND lines check out OK, then there is some fault with the +5V supply in the Navigation Processor. In this case, refer to Section 7.6.4 for further guidance.

If no keyboard is working and the 5V supply seems to be OK, it is most likely that the Interface Box has failed and should be replaced.

FIG 7.15 PIN CONNECTIONS - TYPE 7941-005 CABLE

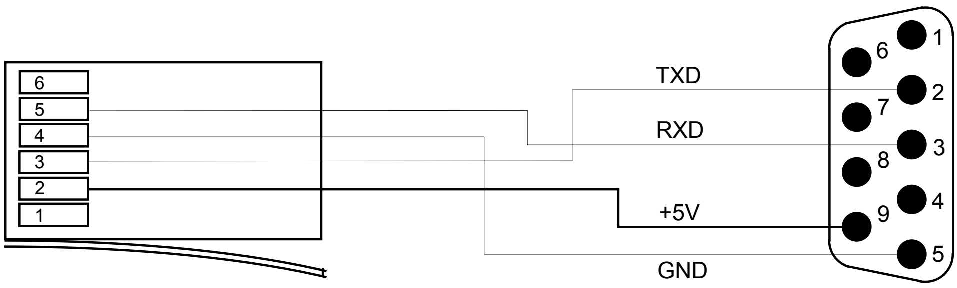
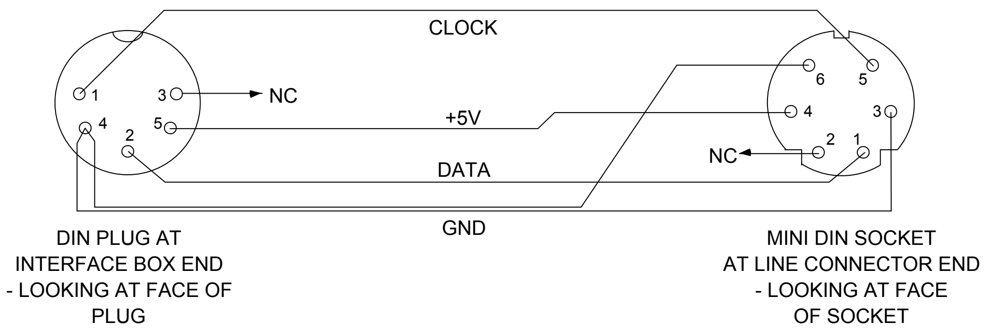


FIG 7.16 PIN CONNECTIONS - CABLE #3



7.10.2 One Keyboard Not Working

In this case, it will often be obvious if either of the keypads or the PC AT keyboard is not working in that monitor screen responses will not be seen for one of the three but will be seen for the other two. This is certainly true for functions which are common to all three items.

Diagnosis may be confirmed readily by taking advantage of the fact that all “daisy chain” interlinking is achieved using mini DIN connectors:-

- If the Monitor unit’s keypad is suspect, break the chain by disconnecting keyboard cable #2 - at the Monitor unit end. If the Monitor unit keypad still does not work, the Monitor unit should be replaced.
- For either of the other two cases, disconnect the mini DIN line connection between cables #1 and #3.
- Disconnect the outboard end (plug) of the suspect item’s output cable and plug it into the mini DIN socket at the end of cable #3. If the suspect item still does not work, it should be replaced.

If the failure is confirmed in the PC AT keyboard, this may be replaced by any standard PC AT keyboard. However, be aware that, in this case, it will be necessary to note the locations of the special function keys (ARM, ALARM, etc) on the Sonardyne-supplied keyboard and use the corresponding ones on the standard keyboard. If the keypad on the Keyboard unit has failed, the Keyboard unit as a whole must be replaced. If the failure is in the Monitor unit keypad, the Monitor unit as a whole must be replaced.

7.11 TRANSCEIVER COMMS FAILURE

If it is suspected that the Transceiver comms have failed, then the first check is to reboot the system. When the opening menu is displayed the system polls for connected devices, one of which is the Transceiver. If the comms are not working, the message ‘HEAD NOT FOUND’ will be displayed. There are several possible reasons for the Transceiver comms to fail.

For Navigation processors with Type I Bottom Trays these are:-

- Faulty serial cable between CPU spreader and Bottom Tray.
- Faulty cable between Bottom Tray and Transceiver.
- Faulty Transceiver power supply in Bottom Tray.
- Faulty RS422 comms board or blown fuse in Bottom Tray.
- Faulty wiring in Bottom Tray.
- Faulty Transceiver.
- Faulty CPU board.
- Faulty CPU spreader board.

For Navigation processors with Type II Bottom Trays these are:-

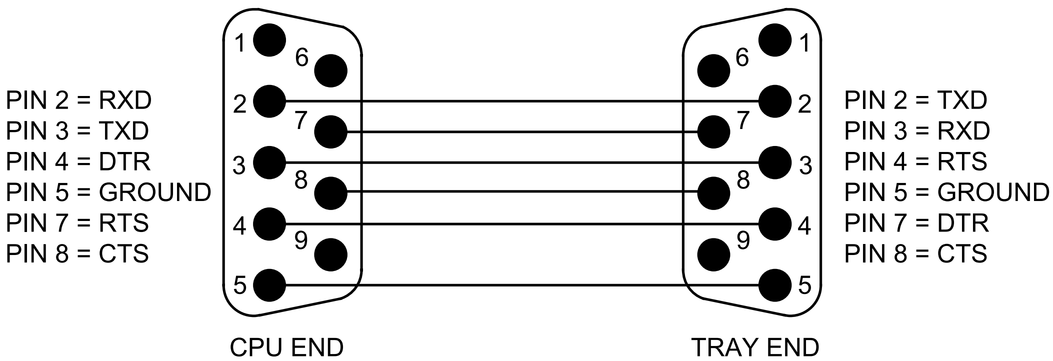
- Faulty cable between Bottom Tray and Transceiver.
- Faulty Transceiver power supply in Bottom Tray.
- Faulty Bottom Tray PCB.
- Faulty internal ribbon cable to Bottom Tray.
- Faulty wiring in Bottom Tray.
- Faulty Transceiver.
- Faulty CPU board.
- Faulty CPU spreader board.

For a dual-redundant system, or one using the Serial Card instead of the CPU to drive a Transceiver, substitute Serial IO Card and Spreader for the CPU Card and Spreader.

7.11.1 Check CPU to Bottom Tray Serial Cable

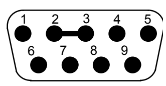
Remove the cable from the Navigation Processor and using a suitable meter check for continuity. Repair or replace if faulty.

FIG 7.17 CPU TO BOTTOM TRAY SERIAL CABLE



7.11.2 Check CPU Serial Output

- Switch off the Navigation Processor.
- For a Type I Bottom Tray, unplug the CPU to Bottom Tray cable. For a Type II Bottom Tray with one Transceiver driven from the CPU Card, remove the CPU Spreader (see 6.1.3.2), make link 8 and ensure that link 9 is not made. (See Appendix J Fig J.3 for diagram of board). Replace the CPU Spreader.


View on Spreader Card

- Link pins 2 & 3 of the Navigation Processor output port labelled SERIAL (newer Navigation Processors label this port SER 2). This is best achieved by linking pins 2 & 3 on a spare 9 pin socket rather than pushing wires into the socket as such an action may damage the socket.

- From the top level menu, select "**System Setup**" and then "**System Test Programs**". Select "**Serial Ports Test Utility**" from the test menu (see Appendix E.7 for more detail on the procedure for this test).

- The Navigation Processor will output a series of test bytes to the serial port and read them back in again. The bytes read back are compared with the bytes sent in order to check the functioning of the port. The operator is informed as to the success or failure of the test. If the test fails then the CPU board will have to be replaced. The test is repeated at several baud rates.

- Whilst the test is running use an oscilloscope to check the RTS output on pin 7. If the RTS signal is absent then the CPU board will have to be replaced.

- Remove the test plug and re-connect the serial cable.

7.11.3 Check Mains Cabling and Power Supply in Bottom Tray

(Refer to Fig 6.3 illustration 12.1 & 12.2 for type I & II lower trays)

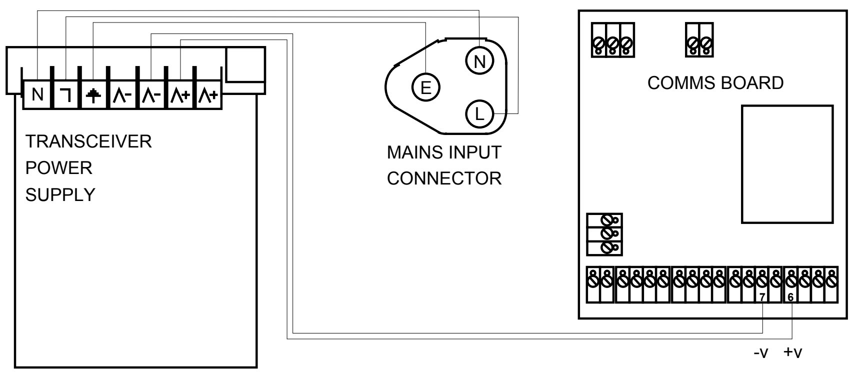
- Switch off the Navigation Processor.

- Lower the Bottom Tray as described in Section 6.1.3.6.

- Unplug the mains input connector from the socket in the main assembly.

- Using a suitable meter check the mains wiring in the Bottom Tray for continuity - see Fig 7.18. Repair or replace any faulty cables.

FIG 7.18 MAINS AND 24V WIRING FOR BOTTOM TRAY



- Reconnect the mains input plug.

- For Type I Bottom Trays, check for continuity between the -V pin on the power supply and pin 7 on the comms board and between the +V pin on the power supply and pin 6 on the comms board - see Fig 7.18. For type II Bottom Trays, check for continuity between the -V pin on the power supply and S3 pin 4 on the Bottom Tray PCB and then between the +V pin on the power supply and S3 pin 1 on the Bottom Tray PCB.

- Check that nothing can short out and then switch on the Navigation Processor.

- Using a suitable meter check for 48 Volts ± 10% across the -V and +V pins on the power supply - see Fig 7.18. If the output of the power supply is out of specification then it will have to be changed.

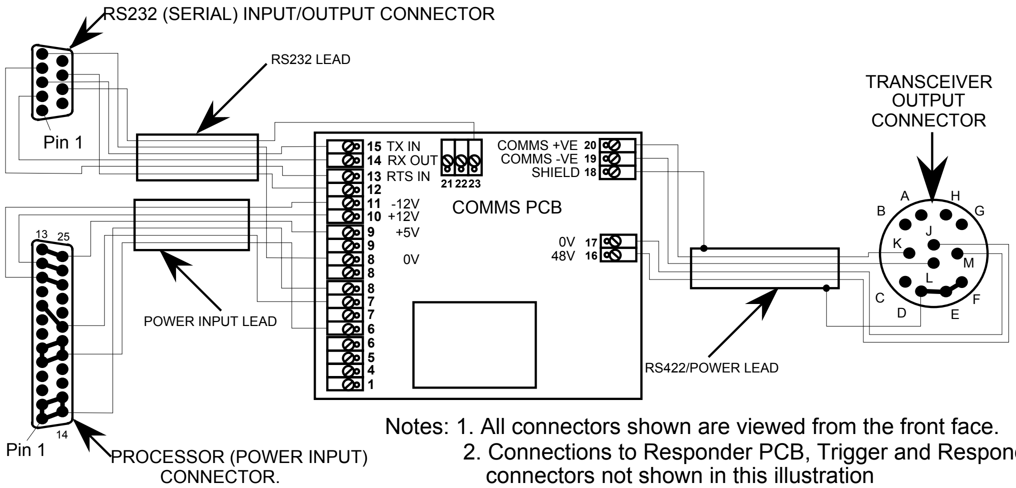
- Switch off and re-assemble.

7.11.4 Check RS422 Comms Board (on Type I Units).

- ❑ Switch off the Navigation Processor.

- ❑ Lower the Bottom Tray as described in Section 6.1.3.6.

FIG 7.19 WIRING DIAGRAM FOR BOTTOM TRAY



Notes: 1. All connectors shown are viewed from the front face.
2. Connections to Responder PCB, Trigger and Responder connectors not shown in this illustration

- ❑ Check the RS232 Serial, Power Input and RS422/Power leads for continuity. Make good any poor connections and repair or replace any faulty wires.

- ❑ Taking care not to short any connections, switch on the Navigation Processor.

- ❑ Check for +5V ± 5% on pin 9 wrt pin 8 (0V), for +12V ±10% on pin 10 wrt pin 8 and for -12V ±10% on pin 11 wrt pin 8. If any of these voltages are out of specification then first re-check the power input lead and if this is not at fault then check the main system power supply as this provides the power to the comms board. See Section 7.6.4.

- ❑ Using a suitable meter check for 48V ±10% on pin 16 wrt pin 17 (0V). If this voltage is outside this range or is not present then the Comms Board is faulty and must be replaced.

- ❑ Using an oscilloscope, check for data on pin 15 for RS232 output from the Navigation Processor. The data will come through in bursts each time the Navigation Processor sends a command to the Transceiver. At the same time check the RTS signal on pin 13. The RTS signal should be active whilst data is being transmitted. If there are any problems then either the data cable between the 9 pin D type connector on the rear of the Bottom Tray chassis and the comms board is faulty or the CPU board is faulty.

- ❑ Using an oscilloscope check for replies from the Transceiver on pin 14. If the Transceiver is replying to commands then either the data cable between the 9 pin D type connector on the rear of the Bottom Tray chassis and the comms board is faulty or the CPU board is faulty.

- Using an oscilloscope check for RS422 data on pins 19 and 20. When commands are being transmitted to the Transceiver this data should coincide with the RTS going active. When the Transceiver is replying the RTS should be inactive. If RS232 data is coming in to the Comms Board but no RS422 data is being sent to the Transceiver then the Comms Board is faulty and must be replaced. If RS422 data is being sent to the Transceiver but replies are not coming back then either the cable between the Navigation Processor and the Transceiver is faulty or there is a fault in the Transceiver itself. If RS422 data is being received from the head but there is no corresponding RS232 output to the Navigation Processor by the Comms Board then the Comms Board is faulty and must be replaced.

7.11.5 Check Bottom Tray Board (on Type II Units).

Check that there is approximately 48V on S4 pin 4 wrt S4 pin 7 (46V on a dual-redundant system). On a dual-redundant system, check that there is approx 46V on S5 pin 4 wrt S5 pin 7.

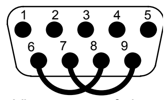
Check that the wiring is correct and the ribbon cable is correctly fitted to P1.

7.12 LOSS OF DP OUTPUT

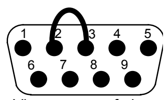
Loss of DP output could be caused by "operator" error. Therefore before embarking on fault finding, check that an active target has been selected on the DP Output page of the Monitor. If there is still no output:

- Switch off the Navigation Processor.

- Unplug the DP Comms lead from the Navigation Processor. Link pins 6 to 8 and 7 to 9 (or 2 to 3 if RS232) of the Navigation Processor output port labelled Current Loop Output. This is best achieved by linking the pins on a spare 9 pin plug rather than pushing wires into the socket as such an action may damage the socket.



View on rear of plug (non RS232)



View on rear of plug (RS232)

- Load disc 1 of the Installation & Maintenance discs into the floppy drive. Switch on the Navigation Processor. When the menu appears, (after about 30 seconds) select the Test DP Comms Port option from the Maintenance menu.

- The Navigation Processor will output a series of test bytes to the serial port and read them back in again. The bytes read back are compared with the bytes sent in order to check the functioning of the port. The operator is informed as to the success or failure of the test. If the test fails then the CPU board or Spreader card will have to be replaced. The test is repeated at several baud rates.

- Remove the test plug and re-connect the DP comms cable.

7.13 TRANSCEIVER FAILURE

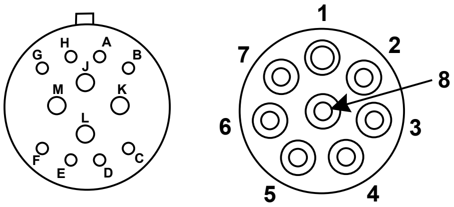
7.13.1 Communication Failure

The Transceiver is an intelligent instrument controlled by a Micro-Controller and without communications between the Navigation Processor and the Transceiver fault finding is virtually impossible and the instrument certainly cannot function.

Before considering this Section of the fault finding procedure, the tests outlined in Section 7.11 (Transceiver Communications) should be completed to eliminate faults at the Navigation Processor end.

The connection for power and communications pairs between the Navigation Processor Transceiver connector and the connector for the Power and communication pairs to the Transceiver PSU /TX board is made up of two cables joined at a termination panel.

FIG 7.20 PIN CONNECTIONS FOR TRANSCEIVER CABLE



Transceiver Port			Transceiver	
Pin No.	Colour	Signal	Colour	Pin No.
E	Screen	Ground	Green	1
		Ground	Yellow	
J	Red	+ V	Red	2
K	White	+ Signal	White	3
L	Blue	- Signal	Blue	4
M	Black	- V	Black	6

A full continuity check of the cables can be avoided by doing the following which should be sufficient to ensure operation. On the connector which plugs into the Transceiver, link skts 3 to 4 and 2 to 6. Using a meter check at the connector to the Navigation Processor Transceiver port that there is continuity between J and M and between K and L. Remove these links and replace them with a link between pins 1 and 4. Check at the connector to the Navigation Processor Transceiver port that there is continuity between L and E. The loop resistance should not exceed 15 ohms. Remake the cabling as necessary.

REMOVE THE LINKS.

Now test each used core (as listed in the following) for insulation resistance using an insulation tester set to at least 100V. The Transceiver connector MUST NOT be connected. Test for leakage, and remake the cabling as necessary.

J to K	J to L	J to M	J to E
K to L	K to M	K to E	
L to M	L to E		
M to E			

If the above failed to clear the fault, it will be necessary to dismantle the Transceiver. The electronics/transducer module should be removed from the housing. (See Section 6.5.3)

7.13.2 Servicing by Replacing Electronics/Transducer Module

Servicing the unit by replacing the entire Electronics/Transducer module with a known working spare is the simplest way of servicing the unit. If the tests above have failed to clear the fault then replace the entire module.

The faulty module should be returned to Sonardyne for repair.

7.13.3 Servicing by PCB Replacement.

Before any PCBs are replaced the tests at the top of the section should be carried out.

If faults in the Navigation Processor and the cabling have been cleared then failure of communications must be due to:-

- Failure of 5V power to the CPU PCB
- Loss of continuity of RS 422 lines
- Fault on the CPU PCB

Remove the Electronics/Transducer module and connect to the Transceiver connector of the Navigation Processor using a test cable (7009-304).

Switch the Navigation Processor ON and check the following voltages on the PSU/TX board.

- Measure the voltage between D1 Anode (0V) and TP1 (24V to 48V)
- Measure the voltage between TP 0 (0V) and TP2 (12V ± 0.5V)
- Measure the voltage between TP 0 (0V) and TP3 (-12V ±0.5V)
- Measure the voltage between TP 0 (0V) and TP4 (+5V ± 0.3V)
- Measure the voltage between TP 0 (0V) and SK1 pin 6 (-5V ± 0.3V)

If any of the above voltages are unsatisfactory replace the PSU/TX PCB and on re-powering the system check for the Transceiver found message on the display.

On the CPU PCB measure the voltage between TP0 and pin 18 of P1 (5V ± 0.3V)

If this is not present check for switch off and check for continuity between TP4 on the PSU/TX card and pin 18 of P1 on the CPU PCB and between TP0 on the PSU/TX PCB and the CPU PCB. Re-check FS2.

Check continuity between pin 7 of PL2 on the PSU/TX PCB and pin 15 of P1 on the CPU PCB. (RS 422 - line)

Check continuity between pin 9 of PL2 on the PSU/TX PCB and pin 14 of P1 on the CPU PCB. (RS 422 + line).

If continuity is OK and the above voltages are OK then replace the CPU PCB.

7.13.4 Failure to Track Transponders

Failure to track any transponders in known and familiar circumstances or a sudden loss of ability to track any transponders when all was well before does indicate a hardware problem.

Failure to track just one transponder when others are being tracked successfully does not indicate a major failure of the system but could still indicate a hardware problem. Examples of partial hardware problems could be:-

- Failure of TX on a particular tuning band
- Failure of TX on a particular power output.
- Failure of RX for a particular gain or BW setting.

7.13.4.1 **Servicing by PCB Replacement**

NOTE: Servicing the unit by replacing the entire Electronics/Transducer module with a known working spare is the simplest way of servicing the unit. If the tests above have failed to clear the fault then if possible replace the entire module and return the faulty module to Sonardyne for repair.

Before the tests in this Section are carried out all the tests outlined in earlier Sections of 7.14 should have been carried out and communications must be operational.

The transducer assembly should as far as possible be eliminated as a cause of failure first:-

- Disconnect the transmitting element from the PSU/TX PCB by disconnecting the 3 pin Molex connector (PL 1 at the transducer end of the board).
- Disconnect the receiving elements by disconnecting the RX inputs A through E from the pre-amp box.
- Measure the capacitance of each element @ 1 kHz using an LCR meter
- The TX element should read:- 930 pf ± 235 pf
- The RX elements should read 450 pf ± 113 pf
- Next check the insulation resistance of the TX element @ 1000V and the RX elements @ 50V. It is particularly important to be sure of the TX elements as this is constantly stressed electrically.

7.13.5 Receiver/Transmitter Functional Tests

The following is a logical sequence of tests to check the functions of the receivers and the transmitters. In the process the vital functions of the CPU board will be tested.

All of the tests are to be found by selecting "**System Setup**" from the top level menu and then selecting the "**System Test Programs**" option. Appendix E should be referred to for further information on these System Test Programs.

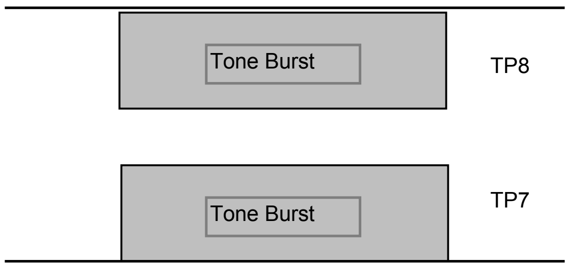
If the Transducer test described in Section 7.14.1 above has been carried out and the unit found to be OK, re-connect all leads.

Switch off the Navigation Processor.

7.13.5.1 **TX Tests - Synthesiser and TX Gate Output**

Connect the Transceiver Test lead (7009-304) between the 10 way Molex (PL2) connector on the PSU / TX board and the Transceiver output connector.

- From the "**System Test Programs**" menu, select "**Transceiver Test Utilities**". This option tests the transmitter at various Frequencies and Power Levels.
- Use the "**Setup Transmit Parameters**" option to set up the Transmitter to LOW MEDIUM or LOW power, the pulse width to 4 ms and the frequency to CH1.
- Use the "**Setup Receive Pulse Parameters**" option to set up the Receiver to LINEAR / 0dB / 14dB / 12dB / 7kHz / 125ms / ±200Hz / 1s / 1500m/s / TRANSPONDER / CRF.
- Using an Oscilloscope (5V & 2ms per division) monitor the signals on TP 7 & 8 (connect the ground of the scope probe to TP 0). A Storage or Digital Storage Scope would be a great advantage here as the repetition rate will be very slow.
- Select the "**Range Test**" option.
- With no replies and zero range, all QB should be white. On TP 7 & 8, check for a logic signal of ~ 4 ms duration swinging between -12V and 0V, as illustrated in the diagram which follows.



- Expanding the time base should reveal a square wave inside the grey areas shown above. The period of the Square Wave should be ~ 50µs.

If this is all OK, the Synthesiser and the TX gate signal are OK.

7.13.5.2 **TX Tests - TX Output**

Power down the Unit while the following connections are carried out.

To monitor the Transducer Output connector PL1 (this is hidden behind the Pre-Amplifier box at the base of the board), connect the scope probe across pins 1 and 3 of PL1 (do not remove the connector as the TX circuit needs a load to operate correctly).

N.B. **The transmitter can produce > 6000V p/p across the transducer when operated in High Power. If you wish to check this voltage, make sure you are using a high voltage (x100 - 4kV or greater) probe and be careful not to touch the PSU / TX board during High Power tests.**

The unit should not be operated for too long at high power in air as the matching of the Transducer will be incorrect out of the water.

Switch on the unit.

- ❑ Using the Transmit Setup facility again, select the CIF frequency (24.752kHz) and set the Transmit power to LOW.
  - Select the Range Test option and check for a 4ms long tone burst with an amplitude of > 200V peak to peak.
  - Repeat with the Transmit frequency set to CH14.
- ❑ Using the Transmit Setup facility again to change the Transmit power to HIGH MEDIUM and the frequency to CH1.
  - Select the Range Test option and check that the output voltage is > 800V peak to peak.
  - Repeat with the Transmit frequency set to CIF and then CH14.
- ❑ Using the Transmit Setup facility again to change the Transmit power to HIGH and the frequency to CH1.
  - Select the Range Test option and check that the output voltage is > 2000V peak to peak.
  - Repeat with the Transmit frequency set to CIF and then CH14.

Power the unit down, remove the probe and ensure the TX connector is correctly mated.

7.13.5.3 **TX Tests - Audible Response**

If an Oscilloscope is not available, the Transmitter can be checked (to a very limited extent) audibly.

Switch on the unit and return to the Transmitter test as described above.

- ❑ Select LOW power and listen for a click at the face of the Transducer - this will fall in volume as the voltage of the storage capacitor falls to the correct value. Once this value is attained you may have to place your ear fairly close to the Transducer face to hear the click. If no click can be heard at the transducer face then the transmitter is faulty.
- ❑ Select HIGH MEDIUM power and listen for a much large volume click at the Transducer Face.
- ❑ Select HIGH power and listen for a very much larger volume click at the Transducer Face. This should be audible from a reasonable distance (say 1 to 2m) from the face. If not then the Transmitter is faulty.

Power the unit down.

7.13.5.4 **Receiver Tests**

This test requires the Signal Injector Test Jig, 7009-389, a 7343 ANT Test Unit and a BNC/BNC test lead. The ANT should be programmed to act as a Transponder, as described in Appendix M. Connect the ANT OUT terminal to the Test Jig and stand the Transceiver on the Test Jig ensuring that the Transceiver's transducers are correctly orientated.

Switch on all units. From the "**System Test Programs**" menu select the "**Transceiver Test Utilities**" and set the Transceiver to transmit on CH5 and receive on CRF. Return to the "**System Test Programs**" menu and select "**Transceiver Calibration Test**".

This test starts by requesting which Transceiver is to be tested. Respond to the prompt and press <ENTER>. The procedure is then run automatically over the full range of channels and the full range of transducer elements, producing the following display:-

TRANSCEIVER CALIBRATION TEST

	Element A	Element B	Element C	Element D	Element E	Element F
0	17.8	20.3	21.0	18.2	18.7	20.4
1	18.8	19.5	19.7	21.6	20.9	19.0
↓	etc					
↓						
↓						
14						
HPR1						
↓						
↓						
↓						
HPR9						
□						
○						
Δ						
X						
Y						

For each channel, the set of phase angles measured on all transducers is displayed on the screen and should lie within about 10° of each other (ie, the largest angle minus the smallest angle should be less than 10°). If any phase angle is significantly different from its peers in the same channel, a transducer channel error may be indicated. Sonardyne should be contacted for advice if this should happen.

If one channel is suspect then the problem could be a faulty ceramic, pre-amplifier channel or receiver channel or connections between boards. Check all cables for this channel for possible breaks or damage. Channel F of the pre-amp is unused and can be used by removing the input and output connection from the suspect channel and connecting to channel F.

If two or more channels are suspect then it is unlikely that the problem is the transducer or the cables. As the Pre-amps and the receiver cards each have 3 channels per board it is possible to narrow down the problem. The Receiver Boards have channels A, B & C on one board and D, E & F on the other while the Pre-Amps have A, C & E on one board and B, D & F on the other. Thus if channels B, D & F give suspect readings the problem is likely to be the Pre-Amp board with B, D & F connected.

Power down the unit.

7.14 GYRO FAILURE

The Gyro signals are decoded by the Navigation Interface Card. The fault could be any of the following:-

- The Gyro is failing to transmit the correct signals
- Connections between the Gyro output and the Navigation Interface card
- The spreader card for the Navigation Interface Card
- The Navigation Interface Card

7.14.1 To Eliminate Gyro Failure (Synchro Output)

Either replace with a known working Gyro, or Measure the gyro signals using an AC voltmeter. The voltages should be as follows:

Ref Low to High	V1 Volts AC
S1 to S3	V2 Sin(A) Volts AC
S3 to S2	V2 Sin(A + 120°) Volts AC
S23 to S1	V2 Sin(A - 120°) Volts AC

Where V1 is the reference voltage of the system (usually 110V 60Hz or 28V 400 Hz) V2 is nominally the same as V1, and A is the angle which the Gyro is measuring.

7.14.2 To Eliminate Gyro Connection Failure (Synchro Output)

Either check for the above voltages where the Gyro signals reach the Spreader card, or check for continuity between the Gyro and the Spreader Card.

Gyro	Spreader
Hi	PL5 2
Lo	PL5 3
S1	PL5 1
S2	PL5 5
S3	PL5 4

7.14.3 To Eliminate Navigation Interface Card and Spreader

These cards may be eliminated by replacing them with known working examples and re-testing the system. The Gyro output can be read on the Navigation Page on the Monitor.

7.14.4 To Eliminate Gyro Failure (Serial Output)

Check initially that the Gyro setting in the “**I/O Port Allocation & Setup**” page is still set to the correct format.

If the Gyro has a local display, check that this is functioning correctly.

If the serial output is RS232 and a terminal or a PC running a terminal emulator (e.g., WINDOWS TERMINAL or PROCOMM PLUS) is available, then set up the “terminal” for the correct baud rate, data bits, etc. Connect the Gyro output to the terminal to check that the data is being sent correctly.

If a “terminal” is not available or the serial output is RS422, then the output signal may be checked using a ‘scope. Check the serial signal at the output of the Gyro (consult manufacturer’s handbook for details). Look for ±12V signals for RS232 or 0 → 5V signals for RS422.

Check the serial signal at the Navigation Interface spreader cable connector:

- pin 2 is the RS232 i/p
- pin 8 is the RS422 +ve signal
- pin 4 is the RS422 -ve signal

Current loop signals are on pin 6 (CLIN -) and pin 9 (CLIN +).

If the signals are OK at this connector then the problem must be the spreader or the Navigation Controller. In this event, replace with known good units.

7.15 VRU FAILURE

VRU signals are decoded by the Navigation Interface Card. The fault could be

- The VRU is failing to transmit the correct signals,
- Connections between the VRU output and the Navigation Interface card,
- The spreader card for the Navigation Interface Card,
- The Navigation Interface Card.

7.15.1 To Eliminate VRU Failure

Either replace with a known working VRU, or Measure the VRU signals using a DC voltmeter. If using a "sine" scaled unit, then the voltages should be:

Common - Pitch	10 Sin(A) / Sin(B) Volts DC
Common - Roll	10 Sin(A) / Sin(B) Volts DC

Where A is the angle which the VRU is measuring in X or Y (Pitch or Roll) and B is the Full Scale angle.

If the VRU is a "linear" unit, then the voltages should be:

Common - Pitch	(10 x A) / B Volts DC
Common - Roll	(10 x A) / B Volts DC

Where A and B are as before.

7.15.2 To Eliminate VRU Connection Failure

Either check for the above voltages where the VRU signals reach the Spreader card, or check for continuity between the VRU and the Spreader Card.

VRU	Spreader
Common	PL1-4 1
Roll	PL1-4 3
Pitch	PL1-4 2

7.15.3 To Eliminate Navigation Interface Card and Spreader

These cards may be eliminated by replacing them with known working examples and re-testing the system. The VRU output can be read on the Navigation Page on the Monitor.

7.15.4 VRU Interface Test

Correct functioning of the VRU interface into Navigation Processor may be verified by carrying out the test described in Appendix E.8.4. This test uses Power Supply Unit sources to simulate the signal voltages generated by the VRU in operation and checks the Navigation Processor responses to them.

7.16 SERIAL INTERFACE FAILURE

The serial interface card is fitted in dual redundant systems and optionally in other systems. Its functions are:-

- To drive one or two acoustic Transceivers via the internal wiring to the Bottom Tray. (Type II Bottom Trays only).
- To provide serial communications to or from other peripherals or equipment such as DGPS Receivers or Surveyors' Outputs.
- To provide responder trigger and input trigger signals. (The system software assumes that if an acoustic Transceiver is to be used from the Serial Card rather than the CPU then the responder trigger is also to be driven from the Serial Card and trigger inputs are connected to it.)

Failures involving the Transceiver are dealt with in Section 7.11. If the comms failure appears to indicate that the Serial IO Card or Spreader are faulty then go to the "**Installation**" -> "**I/O Port Allocation and Setup**" page and set "**Ser 1**" and "**Ser 2**" on the "**Serial IO**" rows to "**None**" under "**USE**", if they were set to "**Acoustic TCVR**". Power down the unit and remove the Serial IO Spreader (see paragraph 6.1.3.2).

Change the following links on the Spreader:

- For a Transceiver on channel 1
  - Remove link 3 and remove link 23 1-2 and 2-3.
- For a Transceiver on channel 2 (only for dual-redundant bottom tray).
  - Remove link 11 and remove link 23 4-5 and 6-7.
- Replace the Spreader and power up the unit.
- Follow the loop-back test described in Appendix E.7.

If the TX light for the channel on the front panel of the Serial Card does not flash during the test try replacing the Serial Card first, followed by the Spreader. In all other circumstances if the test fails try replacing the Spreader before the Serial Card.

Return the links on the Spreader to their original state.

For apparent failures of channel 1 or 2, if not used for Transceivers or other serial channels, use a loop-back lemo connector with pin 1 shorted to pin 3 and pin 2 shorted to pin 4. (For a standard 7784-159 serial cable this means red to blue and black to green with yellow not connected). This can be used for both RS 232 and RS485/422 serial I/O. There is no need to alter any links. Repeat the test as above.

The Responder trigger & Trigger inputs are TBA.

APPENDIX A

A. GLOSSARY OF TERMS

This appendix contains two glossaries:

- User Operator Terms
- Signal Processing and Communication Terms

A.1 USER OPERATOR TERMS

A.1.1 Acoustic (Beacon)

An instrument that emits acoustic signals. It is used to mark a point on the seabed or is fixed to a Mobile so that it can be tracked or positioned in space.

The major types of beacon are described below but some beacons can be configured as several or any of the types.

- **Acoustic (Transponder) Beacon**

  A particular type of beacon that emits an acoustic signal when it detects an interrogating acoustic signal.

- **Acoustic (Responder) Beacon**

  A particular type of beacon that emits an acoustic signal in response to an electrical signal carried to it by cable.

- **Acoustic (Pinger) Beacon**

  A particular type of beacon that emits signals regularly without an interrogating signal. A SYNCHRONOUS pinger is one that can be synchronised to an external master signal. A PRECISION pinger is one with an accurate internal time standard.

- **Acoustic Transducer**

  A device that converts electrical signals into acoustic signals and vice-versa. A HYDROPHONE is a device used to convert acoustic signals into electrical signals only.

  Note: Often the term is applied to a complete instrument that contains pre-amplifiers, matching networks etc.

- **Acoustic Transceiver**

  An instrument that can generate electrical signals suitable for conversion to acoustic signals by a transducer. It can detect received signals and extract information from them.

  For example some transceivers can measure the time it takes a signal to travel from a transducer to a transponder and return. Some can encode and send data in a message and extract digital data from a message (Acoustic Telemetry).

- **Acoustic (Intelligent Transponder Beacon)**

  A particular type of transponder beacon that is managed by a micro-controller. It is commonly referred to as a COMPATT (qv). It can decode acoustic telemetered commands from a transceiver and can send telemetered data to the transceiver. It can measure the distance between itself and other transponder beacons and then telemeter the data to a transceiver.

  Usually the instrument is capable of measuring its depth and the temperature of the water and may be commanded to telemeter its own internal state back to the surface. It may be used to measure a variety of underwater parameters and telemeter these back to the surface. It is used, for example, as an intelligent angle-measuring device in a Riser Angle Monitoring System (qv). Very often is fitted with a release mechanism enabling it to be returned, on command, back to the surface at the end of a mission (or if battery power is low).

  The intelligent beacon can be developed to the state where it becomes a remotely operated transceiver.

A.1.2 Acoustic Signal

A message carried by sound pressure waves through the water. In the Sonardyne case, the message has finite length in time.

A.1.3 COMPATT

COMPuting And Telemetry Transponder (see Acoustic Intelligent Transponder Beacon). A range of COMPATTs is available from Sonardyne to perform a variety of tasks.

A.1.4 Co-ordinate Frame

A system that is used to define the position of body in space. The system used is a right-handed Rectangular Cartesian co-ordinate system in three dimensions where the three axes used are orthogonal.

[Sometimes "polar" co-ordinates may be used. The z co-ordinate is the same as above but the position reflected in the x-y plane is expressed as a radius from the z axis and a bearing in degrees measured clockwise from the y axis].

A frame with its z axis vertical and stationary with respect to the seabed is known as a SEABED FRAME or an INERTIAL FRAME. (Normally for convenience the x,y plane where z = 0 is at or just below the lowest point on the seabed in the area. Positions above this plane have a positive z co-ordinate or height. Depth is considered as negative height and is measured from the sea-surface or from a height close to it).

A vessel frame is a frame that is fixed to a vessel.

An RPH (Roll, Pitch and Heading) compensated vessel frame is a frame sharing the same origin as the vessel frame but with the z axis vertical and the y axis parallel with a meridian passing through the origin (points true north).

A.1.5 Database

A Database is a body of data stored in a computer memory or on magnetic disc media such as an embedded hard disc or on portable floppy disc.

A.1.6 DP (Dynamic Positioning)

A system that automatically maintains a vessel with a constant heading and in a fixed position in an inertial frame or with respect to a mobile. It avoids the need to anchor a vessel and provides more flexibility in operation.

Normally such a system uses a number of position inputs such as GPS (qv) receivers, taut wire sensors, LBL, SBL or USBL acoustic positioning sensors, wind speed indicators etc. The system controls thrusters on the vessel to maintain position and attitude in yaw.

A.1.7 DP Reference

The acoustic positioning system reports the position of a reference point on the seabed OR a mobile in the ships frame OR a stabilised ships frame REGARDLESS of what else the system is doing.

This is to maintain compatibility with earlier systems and to provide a standard interface regardless of the type of system used (LBL, SBL, USBL, LSBL, LUSBL etc) and the manner in which it is being used (e.g. LSBL in SBL or LBL mode).

A.1.8 DP Report

The report an acoustic positioning system sends to a DP system over a serial interface.

A.1.9 Geodetic Co-ordinates

The earth is modelled by a reference spheroid (of which there is a large selection). The position of any point on or near the earth surface is defined by an angle of latitude and an angle of longitude.

For a point on the spheroid P:-

Latitude is defined as the angle between the normal at P and the plane of the spheroidal equator.

Longitude is defined as the angle between the meridian plane through P and the arbitrarily defined zero meridian plane or the "Greenwich" plane. (See Geodesy, fourth edition, Bomford, Oxford, sections 2.03 and 4.10(d) for more precise definitions.)

Note: This co-ordinate system is not the same as the astronomical co-ordinate system.

A.1.10 GPS (Global Positioning System) Attitude Sensor

A system based on the GPS system and a receiver using three or more antennae with known baselines. It is able to computed the instantaneous attitude of a vessel about the roll, pitch and yaw axes.

A.1.11 GPS (Global Positioning System)

A multi-user, 24 hour, world-wide radio navigation system using the NAVSTAR constellation of satellites. GPS receivers are capable of tracking and decoding the data from the satellites and computing the position and velocity of a vehicle in space. The system uses the WGS 84 Geodetic Co-ordinate system.

A.1.12 Gyro Compass

A North-seeking Gyroscope uses the properties of a gyroscope when its spin axis is maintained horizontal. The gyroscope senses the spin axis of the earth and will align itself with true north.

A.1.13 Inclinometer

An analogue device, usually fitted into a COMPATT (qv), which measures the angle of the transponder in which it is mounted with respect to the local vertical.

A.1.14 Mobile

A body that is free to move relative to the seabed through the space between the sea surface and the seabed.

A.1.15 Monitor/Keypad

An instrument that contains a 12 inch colour graphics display monitor and has a keypad in close proximity suitable for operator input to the system.

Note that, in a later version of this unit, incorporating a 17 inch high resolution monitor, the Monitor and Keypad are split into two separate units - Type 7940 Monitor unit and the Type 7941 Keyboard unit. Both are designed for 19 inch rack mounting.

A.1.16 Navigation Processor

An instrument that:-

- Acts as the system controller.
- Accepts operator input from the keypad.
- Generates the display signals for the Monitor.
- Processes the data from the transceiver into a form suitable for display to the operator and output to a DP system.
- Interfaces to various "attitude" sensors and other navigation systems.

A.1.17 Riser Angle Monitoring System (RAMS)

Used for measuring the differential angle between a BOP (Blow-Out Preventer) on the seabed and the RRiser, connecting the BOP to the rig. Comprises a COMPATT type transponder (qv) which is rigidly mounted to the BOP and an external inclinometer unit mounted on the Riser and connected by cable to the COMPATT. On command, the system measures the angle of the BOP with respect to the local vertical and reports this back to the surface and can then repeat this process for the Riser using the external inclinometer.

A.1.18 ROV (Remotely Operated Vehicle)

A vehicle controlled and powered over a cable connection so that it can travel in the space between the sea surface and the seabed.

A.1.19 Seabed

The surface of the earth covered by water or sea. The seabed is considered stationary.

A.1.20 Sonardyne Systems

- **LBL (Long-Base-Line) System**

  A system where there are two or more (typically four) transponders on the seabed. The positions of the transponders are established by a calibration process in a seabed frame. The distances from a transducer to each transponder are measured using a transceiver. The position of the transducer can be computed in the seabed frame.

  It takes its name from the "baselines" joining each transponder. It is sometimes referred to as a range-range system.

- **SBL (Short-Base-Line) System**

  A system where three or more transducers are fixed to a vessel and connected to a single transceiver. The position of each transducer is measured and co-ordinated in the vessel frame. By measuring the time of arrival of the signal from a beacon at each transducer the position of the beacon in the vessel frame can be computed.

- **LSBL System**

  A hybrid of an LBL and an SBL system.

- **USBL (Ultra-Short-Base-Line) System**

  A system similar in principle to an SBL system except the system uses three or more elements in a single transducer array. The measurements it makes are the differences in "time-phase" of the signals from each element.

  The co-ordinate frame is fixed to the transducer array which must be oriented in the vessel frame to be equivalent to the SBL system.

- **LUSBL System**

  A hybrid of an LBL and a USBL system. It utilises USBL equipment in an LBL configuration.

- **Dual-redundant LUSBL System**

  Two complete sets of LUSBL equipment working in tandem on a master/slave basis. The two sub-systems are cross-linked in such a way that, in the event of a failure of any major element, system operation will continue without the need for operator intervention. From the operator’s point of view, operation of the dual-redundant version is essentially identical to that of the standard version.

A.1.21 Sound Velocity

For seawater, for constant temperature, salinity and pressure the speed at which sound travels in seawater is constant.

A.1.22 Sound Velocity Profile

At different depths the temperature, salinity and pressure vary; therefore the local sound velocity varies.

In practice the depth cannot be measured directly. Therefore pressure measurements are made, and depth computed, using a knowledge of density. Derivation of density requires a knowledge of temperature and salinity. Salinity cannot be measured directly but conductivity can be measured. Therefore a popular method of measuring the sound velocity profile is from a profile of pressure, temperature and conductivity and the use of empirically derived formulae to compute depth and sound velocity.

Sound velocity can be measured directly using a dedicated and calibrated instrument called a sound velocimeter. (One still needs a set of depth measurements.)

A.1.23 Submersible

A vehicle that operates below the sea surface, carries men in a one atmosphere environment. One man pilots the craft. It carries a supply of air for the men and a supply power for propulsion etc. It is capable of autonomous operation form a vessel for a limited time.

A.1.24 True North

The direction of the shortest line that can be drawn, across the surface of the earth, from the observer and the north pole. (The north pole is where the north end of the spin axis of the earth meets the surface.)

A.1.25 UTM (Universal Transverse Mercator)

A Projection system that is used to transform Geodetic co-ordinates into an orthogonal two dimensional system suitable for representation on a plane such as a chart. Normally the co-ordinates are called easting and northing which are equivalent to x and y respectively.

The UTM system is a world wide system. Each projection covers 6 degrees of longitude with the central meridian at 3, 9 degrees etc east of Greenwich and from 84 degrees north to 80 degrees south. The scale factor on a central meridian is 0.9996 (with some exceptions).

The projection is orthomorphic which means that at a point the scale in all directions is the same and there is no LOCAL distortion. However it should be noted that the scale factor changes with distance from the central meridian. For points away from the central meridian grid north and true north diverge. The difference is called the CONVERGENCE which is positive when grid north is east of true north.

Usually, the point where the central meridian meets the spheroid equator is given a false easting of 500,000 m.

Many countries' mapping systems are based on the same system but use a particular reference spheroid, non standard central meridians, scale factors and different false eastings and northings.

The polar regions are covered by two Zenithal orthomorphic projections.

A.1.26 VRG (Vertical Reference Gyroscope)

A gyroscopically stabilised VRU.

A.1.27 VRU (Vertical Reference Unit)

An instrument that measures the instantaneous roll and pitch of a vessel.

A.1.28 Vessel

A body floating in the sea with at least part of it penetrating the surface. It is free to move and rotate relative to the seabed.

A.2 SIGNAL PROCESSING AND COMMUNICATIONS TERMS

A.2.1 Bore-sight

The axis about which the transducer maximum power gain is being directed.

A.2.2 Capture Area

The effective aperture size of the array. It is directly related to the array gain.

A.2.3 Carrier to Noise Density

This is the ratio of the signal power(C) to noise power (No) in unit bandwidth (C/No); generally quoted in dBHz.

A.2.4 Directivity Index

This is the ratio of the radiation intensity in the direction of interest compared with an isotropic radiator.

A.2.5 False Alarm

An invalid signal has satisfied all of the detection criteria and the detection process incorrectly declares the presence of a valid signal

A.2.6 False Alarm Probability

The resultant probability of ALL the false alert probabilities.

A.2.7 False Alarm Rate

Predicts the number of false alarms that will occur in a specified time.

A.2.8 False Alarm Number

Predicts the average number of possible decisions between false alarms.

A.2.9 False Alert

An invalid signal has satisfied ONE detection criterion and the detection process incorrectly declares the presence of a valid signal.

A.2.10 False Alert Rate

Predicts the number of false alerts that will occur in a specified time.

A.2.11 Front to Back Ratio for a Transducer

It refers to the ratio of power transmitted in the forward hemisphere of the polar diagram to that transmitted in the reverse hemisphere of the polar diagram.

A.2.12 Kalman Filter

An adaptive filter that provides optimum filtering of a signal that has been subjected to a non stationary environment (ie, when the data is significantly changing during the filter convergence time).

A.2.13 Middleton Noise

This noise is impulsive in nature and is described by a Middleton probability density function. There are three classes of noise description - A, B and C:-

- **Class A**

  Typically narrower spectrally than the receiver bandwidth in question and, as such, generates ignorable transients in the receiver's front end (initial linear stages) when source emission terminates.

- **Class B**

  The bandwidth of the incoming noise is larger than that of the receiver's front end stages, so that transient effects both in the build up and decay occur; the latter predominates. To varying degrees, the receiver is "shock excited", particularly for inputs of very short duration; the receiver is said to "ring".

- **Class C**

  The sum of Class A and Class B interference.

A.2.14 Rayleigh Fading Channel

The fading characteristics of the propagating channel are in accordance with a Rayleigh Probability Density function. Such a channel does not support constant signal. The phase of the signal is uniformly distributed between 0 and 2_ radians.

A.2.15 Rayleigh Probability Density Function

A Rayleigh Probability Density function is the instantaneous vectorial addition of two independent zero mean time variant Gaussian processes. The phase of the resultant vector is uniformly distributed between 0 and 2_ radians.

A.2.16 Rician Fading Channel

The fading characteristics of the propagating channel are in accordance with a Rician Probability Density function. Such a channel does support a constant signal level. Associated with this signal is a non-coherent Gaussian signal of lower strength.

A.2.17 Rician Probability Density Function

A Rician Probability Density function is the instantaneous vectorial addition of two independent zero mean time variant Gaussian processes where one of the designated signal vectors is not only consistently larger than the other but remains so during the observation time.

A.2.18 Translinear Mode

The system operates in linear mode for signals within specified dynamic range. Once the input signal level is larger than the upper limit set by the input dynamic range, hard limiting occurs.

APPENDIX B

B. ACOUSTIC NAVIGATION SYSTEM PRINCIPLES

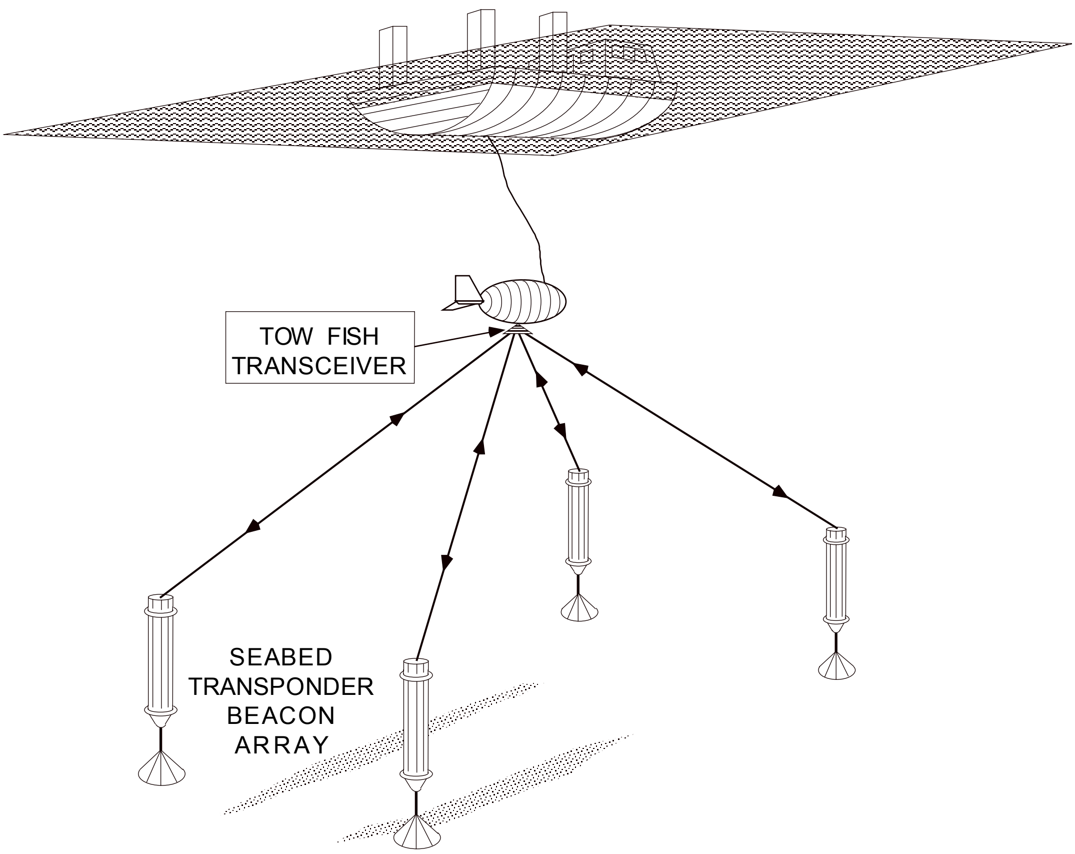
B.1 LBL PRINCIPLES

A "Long-Base-Line" system has two parts or segments.

The first segment comprises a number of acoustic transponder beacons moored in fixed locations on the seabed - see Fig B.1. The positions of the beacons are described in a co-ordinate frame fixed to the seabed. The distances between them form the “baselines” used by the system.

The second segment comprises an acoustic transducer on a transceiver which is normally temporarily installed on the vessel - or on a Tow Fish in the example shown in Fig B.1. The distance from a transducer to a transponder beacon can be measured by causing the transducer to transmit a short acoustic signal which the transponder detects and causes it to transmit an acoustic signal in response. The time from the transmission of the first signal to the reception of the second is measured. As sound travels through the water at a fixed speed, the distance between the transducer and the beacon can be estimated. The process is repeated for the remaining beacons and the position of the vessel relative to the array of beacons is then calculated or estimated.

FIG B.1 A CLASSICAL LBL SYSTEM



In principle, navigation can be achieved using just two seabed transponder beacons but in this case there is a possible ambiguity as to which side of the baseline (a line drawn between the beacons) the vessel may be. In addition, the depth or height of the transducer has to be assumed. Three transponder beacons is the minimum required for unambiguous navigation in three dimensions; four is the minimum number required for some degree of redundancy - which is useful for checks on the quality of navigation.

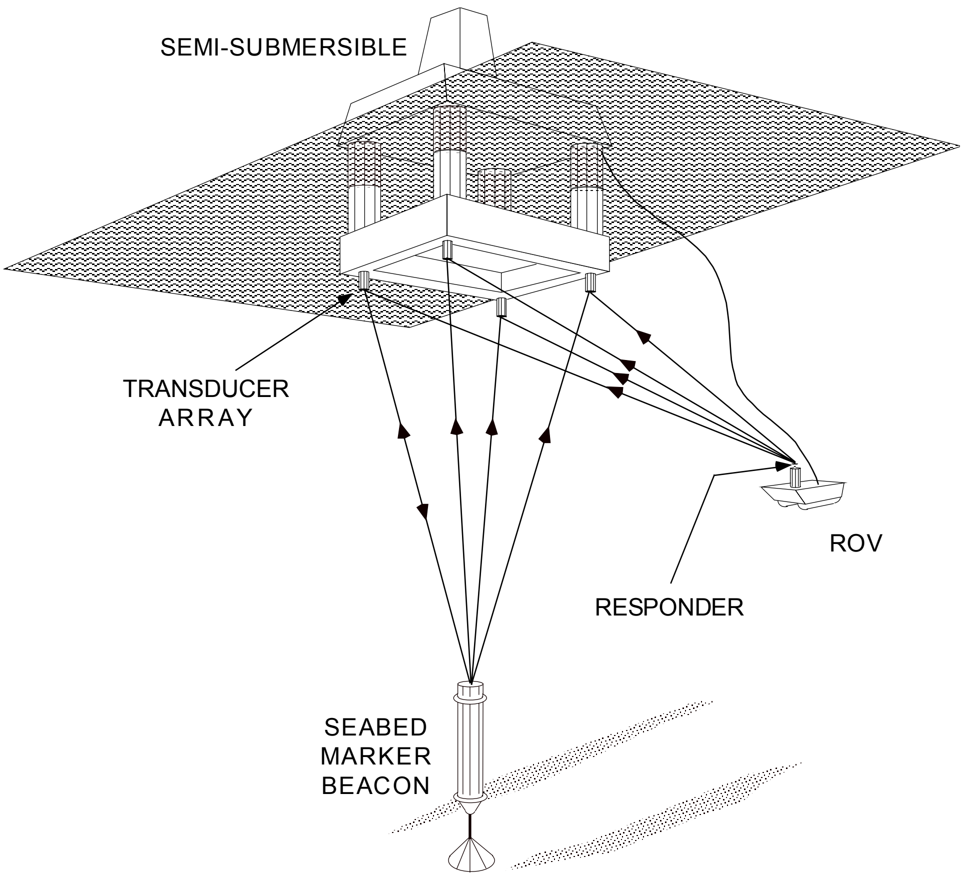
The term "Long-Base-Line" is used because in general the baseline distances are much greater for LBL than for SBL (Short Base-Line) and certainly for USBL (Ultra Short Base-Line)! Because the baselines are much larger, an LBL system is very accurate compared with the SBL and USBL versions and also has the advantage of positioning the vessel (or any other object) directly in a "fixed" or an inertial frame. This removes most of the problems associated with vessel motion.

The array of seabed beacons needs to be calibrated and there are several techniques available for achieving this. The most appropriate technique depends on the requirements of the task or job in hand and the available hardware. With the continuing integration of LBL, SBL and USBL systems, intelligent transponder beacons (that measure baselines directly) and satellite navigation systems, the calibration of seabed arrays is becoming a quick and simple operation. The operator will be free to choose the techniques appropriate to the requirements and the task.

B.2 SBL PRINCIPLES

A "Short-Base-Line" system is normally fitted to a vessel such as a barge, semi-submersible or a large drilling vessel - see Fig B.2. A number of (at least three but typically four) acoustic transducers are fitted in a triangle or a square on the lower part of the vessel. The distances between the transducers (the "baselines") are made as large as is practical, typically they are at least 10 metres long. The position of each transducer within a co-ordinate frame fixed to the vessel is determined by conventional survey techniques or from the "as built" survey of the vessel.

FIG B.2 A CLASSICAL SBL SYSTEM



The term "Short" is used as a comparison with "Long-Base-Line" techniques where, in general, the "baselines" are much bigger.

If the distances from the transducers to an acoustic beacon are measured as described for LBL, then the position of the beacon, within the vessel co-ordinate frame, can be computed. Moreover, if redundant measurements are made, a best estimate can be determined which is, statistically, more likely to be more accurate than the basic position calculation.

It is impractical to transmit a signal from each SBL transducer in turn. Therefore systems that use transponder beacons transmit from one transducer but receive simultaneously on all transducers. The result is one distance (or range) measurement and a number of range (or time) differences.

With an SBL system, the co-ordinate frame is fixed to the vessel - which is subject to roll (change in list), pitch (change in trim) and yaw (change in heading) motion. This "disadvantage" can be overcome by using additional equipment such as a VRU (Vertical Reference Unit - see glossary) to measure roll and pitch and a Gyro-compass to measure heading. The co-ordinates of the beacon can then be transformed mathematically to remove the effect of these rotational motions.

If the requirement is to estimate the position of the vessel in some "fixed" or "inertial" frame such as one fixed to the seabed, then at least one beacon should be placed in a fixed position on the seabed and used as a reference point. It is this principle that is used for "DP" vessels. Fig B.2 illustrates a system having a transponder beacon fixed to the seabed and a responder beacon located on an ROV (Remotely Operated Vehicle). In such a case, the system can calculate the position of both the vessel and the ROV in a seabed-fixed frame.

B.3 USBL PRINCIPLES

USBL (Ultra-Short-Base-Line) techniques are very similar to SBL techniques except that the transducers are all built into a single transceiver assembly - or the array of transducers is replaced by an array of transducer elements in a single transceiver assembly - see Fig B.3, which follows.

The distances or ranges are measured as they are in an SBL system but the time differences are now much less. Systems using sinusoidal signals measure the "time-phase" of the signal in each element with respect to a reference in the receiver. The "time-phase differences" between transducer elements are computed by subtraction and then the system is equivalent to an SBL system.

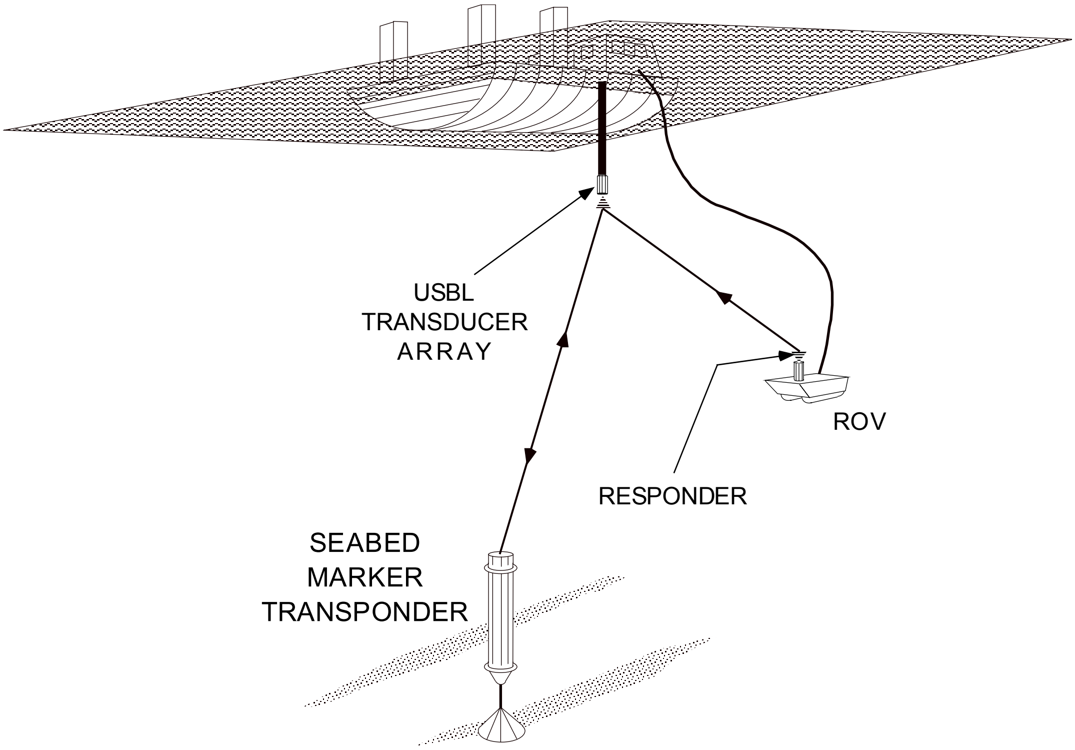
[Systems using "wide band" signals effectively do the same thing by mathematically dividing the signal into a number of "narrow band", or sinusoidal, signals and then calculating a larger number of time-differences].

Similar rules apply in that systems using three elements (or groups of elements) have the same restrictions as SBL systems with three transducers. USBL systems using four elements have the same restrictions as SBL systems using four transducers and so on.

An additional restriction is that if an unambiguous position within a hemisphere is required and there are only three elements or element groups in use, then the element spacing must be less than one-half wavelength of the signal. Alternatively, a prior set of measurements must have been made with an element spacing of less than one-half wavelength.

Another practical difference is that the transducer elements are in a Transceiver assembly that is placed somewhere in the vessel frame. The attitude of the assembly in the vessel frame must be measured during installation. It should be remembered that, intrinsically, a USBL system positions a beacon in a frame fixed to the Transceiver assembly, not directly in a vessel-fixed frame as in the SBL case.

FIG B.3 A CLASSICAL USBL SYSTEM



B.4 LUSBL PRINCIPLES

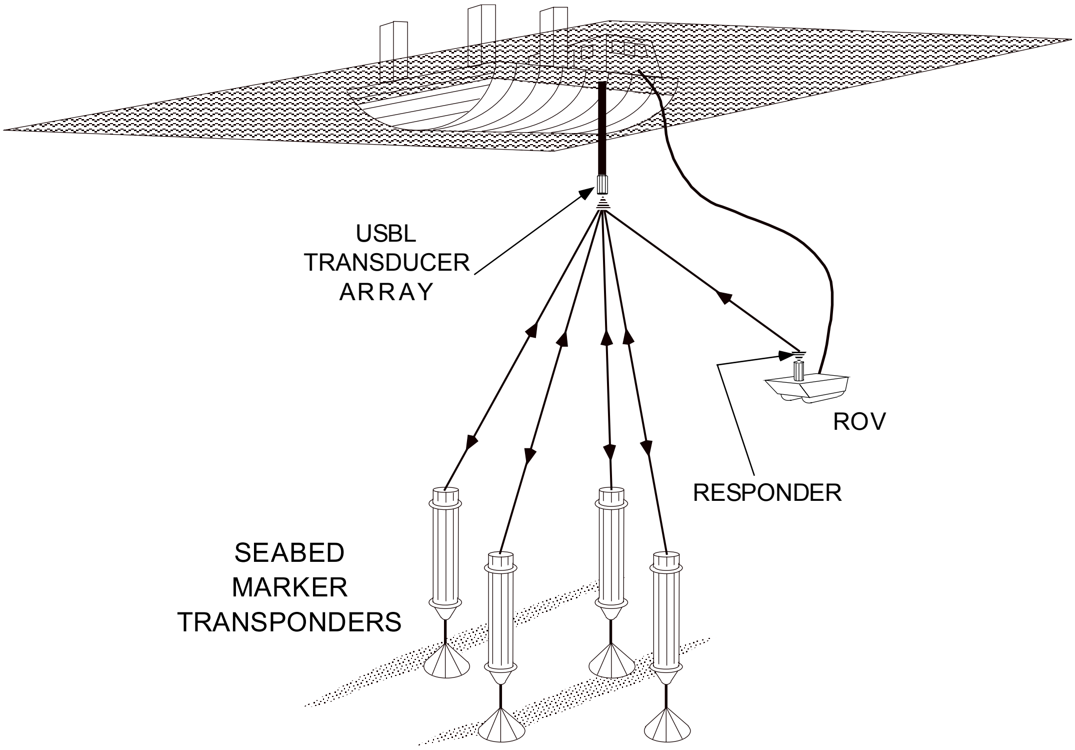
The LUSBL system is a special case of a USBL system. It utilises USBL hardware in a configuration similar to the one described for the LBL system - see Fig B.4 which follows.

Range and bearing in an LUSBL system are still measured as described for a basic USBL system. However, because a larger number of beacons is deployed on the seabed, a considerable improvement in accuracy may be achieved.

In a basic LUSBL system as illustrated in Fig B.4, the seabed array must be calibrated separately and the resultant baseline data entered manually into the LUSBL Navigation Processor. If, however, a Radio Navigation input is available to the LUSBL system, it is feasible to locate each seabed beacon directly in an earth-referenced frame to an accuracy determined by the accuracy of the Radio Navigation system. Thus, in this case, there would be no need for separate calibration of the seabed beacon array.

Similarly, if beacons of the COMPATT type (see Glossary) are used on the seabed, the potential exists for the seabed array, under command from the LUSBL system, to be self-calibrating. Using COMPATT beacons has the advantage also of affording the system considerably more flexibility in that they can be commanded to respond on any of a variety of frequencies and with any desired delay time. Thus, from the operator's point of view, the COMPATT version of the system becomes simpler and faster to set up and use.

FIG B.4 A CLASSICAL USBL SYSTEM



Two complete sets of LUSBL equipment (Navigation Processor, Monitor/Keypad and Transceiver) may operated in tandem to form a dual-redundant version of the System. The two sub-systems are cross-linked in such a way that, in the event of a failure of any major element, system operation will continue without the need for operator intervention. From the operator's point of view, operation of the dual-redundant version is essentially identical to that of the standard version.

In operation, one sub-system or the other operates as the "master" and performs all normal system functions. The second sub-system monitors the function of the "master" and will commandeer system operation if it detects that the erstwhile "master" is not functioning.

More information on the dual-redundant version is given in Appendix K.

APPENDIX C

C. CO-ORDINATE FRAME CONVENTIONS

C.1 INTRODUCTION

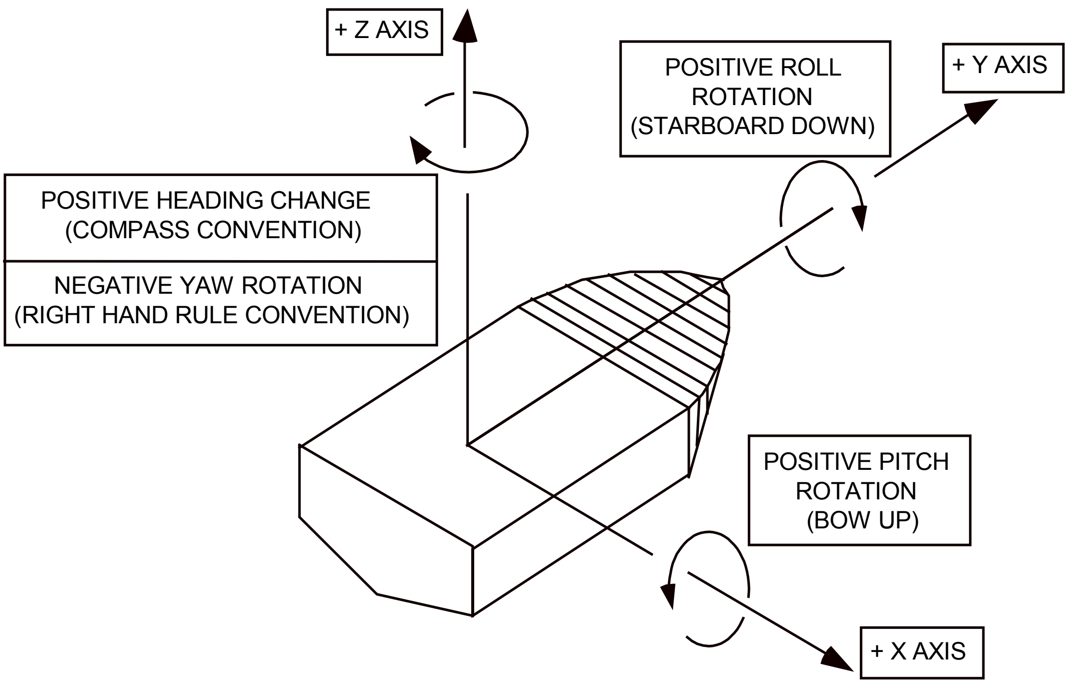
As shown in Fig C.1, the system operates in three dimensions and the co-ordinate frames use three mutually orthogonal "right handed" axes. The axes are labelled x, y, z respectively for easting, northing and depth.

In a right-handed system the following rotations are positive:-

- Positive Yaw rotation - "x" axis rotates towards the current "y" axis direction.
- Positive Pitch rotation - "y" axis rotates towards the current "z" axis direction.
- Positive Roll rotation - "z" axis rotates towards the current "x" axis direction.

  i.e. x ---> y --> z --> x are POSITIVE rotations.

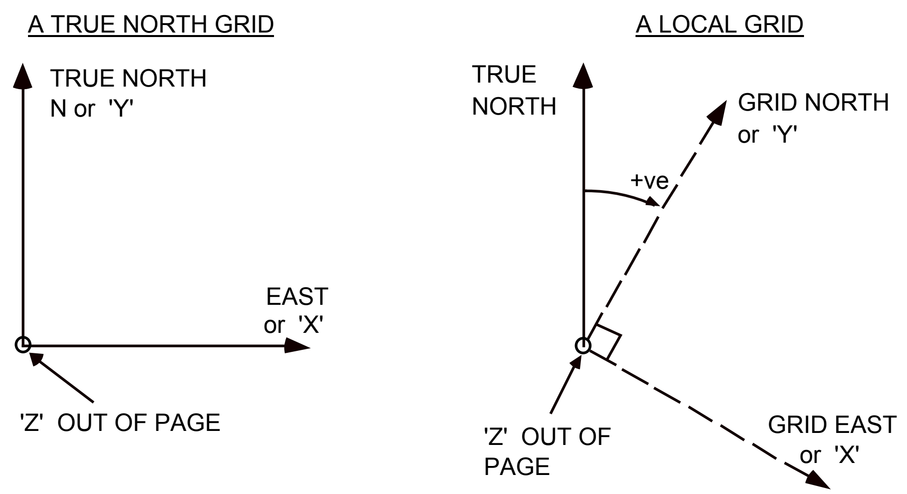
FIG C.1 CO-ORDINATE FRAME CONVENTIONS



As shown in Figure C2 which follows;-

- The "x" direction is reserved for the "true" east direction, any grid east direction or the "logical" east direction of an object such as the "starboard" direction of a vessel.
- The "y" direction is reserved for the "true" north direction, or any grid north direction or the "logical" north direction of an object based frame, such as the lubber line (fore/aft axis) of a vessel. In the construction industry, the "logical" north is referred to as "plant north".
- The z axis is reserved for the true vertical direction or, in the case of an object, the "logical" vertical direction. Depth is in the negative direction of the "z" axis.

FIG C.2 CO-ORDINATE GRIDS



C.2 SOME EXCEPTIONS

The convention for the heading of a vessel conflicts with the convention for right-handed systems (which are also used for mathematical trigonometric functions). Vessel heading rotation is in the wrong sense, is 0 to 360 degrees instead of plus and minus 180 degrees and the zero is in the "y" direction instead of the "x" direction. [Everything works mathematically if one forgets the zero direction problem (imagine that the x axis is displaced) and make the heading negative.]

C.3 SOME EXAMPLES

Positive Pitch of a ship is when the bow end of the vessel rises with respect to the aft end.

Positive Roll of a ship is when the starboard side of the vessel drops with respect to the port side.

Positive displacements and velocities are in the "y" or north direction, "x" or east direction or in the "z" or vertically up direction.

C.4 LOCAL GRID

Charts provide a two dimensional representation of the earth's three-dimensional surface. One consequence is that in most places the local representation or local grid does not align perfectly with True North. The angle between these is the local convergence. See UTM in the Glossary, Appendix A.

APPENDIX D

D. USBL TRANSCEIVER HEADING ALIGNMENT

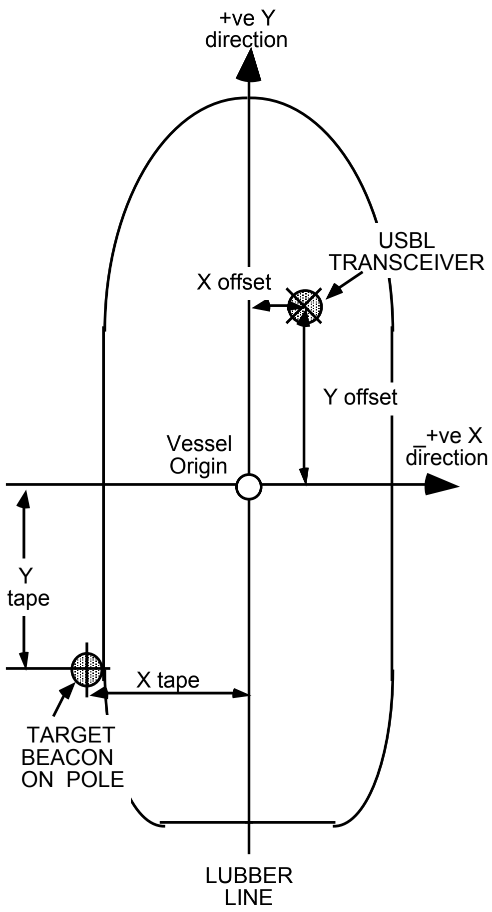
D.1 GENERAL CASE

The procedure given below enables the Transceiver to Ship Grid correction to be derived with the Transceiver installed in its normal operating position.

Suspend a Transponder over the side of the ship on a pole, taking care to ensure that the pole is clamped parallel to the Ship's Z axis as accurately as possible. The actual bearing of the Transponder from the Transceiver may then be determined from the relationship:-

$$\text{Actual Bearing } \alpha = \tan^{-1}\left(\frac{x_{tape}}{y_{tape}}\right)$$

where x_{tape} and y_{tape} are tape measurements, as shown on the diagram.



Before using this information, work through the menu structure to the Set-Up / Installation / Transceiver Positions page and ensure that there are no Transceiver Offsets entered on the page.

Then go to Navigation/Chart Co-ord Frame / Ship Frame/Bows Up page and calculate the USBL Transceiver version of the bearing as follows:-

$$\text{USBL Bearing } \beta = \tan^{-1}\left(\frac{x_{display}}{y_{display}}\right)$$

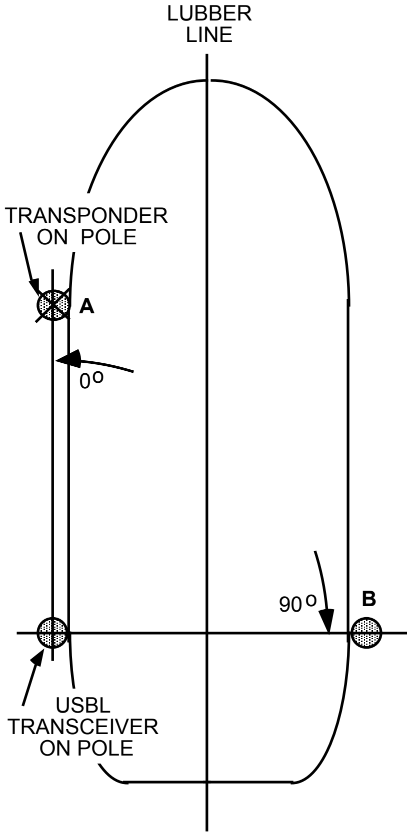
where $x_{display}$ and $y_{display}$ are taken from the data box on the "Bows Up" page. The correction to be applied can now be calculated as:-

Correction Angle = $\alpha - \beta$

Enter this value as the "Transceiver to Ship Grid Heading" on the Set-Up/Installation/Roll-Pitch and Heading Sensors/Corrections page. Go back to the data box on the "Bows Up" page and recalculate the USBL Bearing, β. It should now be very close to the Actual Bearing, α, as determined from the tape measurements. If it is not, repeat the correction procedure.

D.2 SPECIAL CASE - PREFERRED

Correction of Transceiver alignment errors may be achieved more conveniently by positioning the Transponder, on its pole, either directly forward of the Transceiver (at A on the diagram) or, if this is difficult for some reason, directly athwartships (at B on the diagram). Note that, for this procedure to work, position A must lie on a line from the Transceiver parallel to the lubber line (or position B must lie on a similar line at right angles to the lubber line). As before, the Transponder pole must be clamped parallel to the ship's Z axis as accurately as possible.



Greater accuracy will be achieved by positioning the Transponder pole as far as possible away from the Transceiver. For this reason, position A is preferred to position B.

For position A, the actual bearing will be 0° and the $x_{display}$ value on the "Bows Up" page should also be zero if the Transceiver is correctly set up. If $x_{display}$ is not zero, calculate the correction angle again as described in Appendix D.1 and enter this value on the Corrections page. Repeat the process as necessary to achieve an acceptably small error.

If position B is used, the procedure will be the same, but the actual bearing will be 90° and $y_{display}$ on the "Bows Up" page should be zero once the Transceiver is correctly set up.

APPENDIX E

E. SYSTEM TESTS

From the top level menu, select “System Setup” followed by “System Test Programs”. Seven System Tests are available under this heading.

E.1 TRANSCEIVER CALIBRATION TEST

Start by selecting “**Transceiver Calibration Test**” from the “**System Test Programs**” menu.

When the system is installed, the receivers should be given a functional test to make sure that the calibration values for the transducer elements have not changed in transit. The Transceiver system can inject a test signal into all transducer elements and measure the electrical phase angle in each case with respect to the reference.

This test starts by requesting which Transceiver is to be tested. Respond to the prompt and press <ENTER>. The procedure is then run automatically over the full range of channels. For each channel, the set of phase angles measured on all transducers is displayed on the screen and should lie within about 5° of each other (ie, the largest angle minus the smallest angle should be less than 5°). If any phase angle is significantly different from its peers in the same channel, a transducer channel error may be indicated. Sonardyne should be contacted for advice if this should happen.

If testing a dual-redundant version of the LUSBL, repeat the test for the other Transceiver.

Having completed this test, return to the “**System Test Programs**” menu.

E.2 DP TELEGRAM TEST

Select “**DP Telegram Test**”.

At installation, the data link between the Navigation Processor and a DP system should be tested. It is also tested as part of a Factory Acceptance Test - FAT.

This test outputs a DP Telegram, using the parameters set using the I/O Port Setup procedures - see Section 4.2.1. It checks that not only is the hardware of the receiving system receiving and decoding the message correctly, but also the software procedures are interpreting it correctly.

The DP system is interfaced through a 50 ma current loop (or serial RS 232) interface using the "Current loop" connector on the rear panel of the CPU card. A Type 7784-132 lead is used (see Figure 3.2). [For connection details see Figure 3.1]

Having completed this test, return to the “**System Test Programs**” menu.

E.3 KEYPAD TEST

Select “**Keypad Test**”.

Follow the instructions given on the monitor screen to test the function of all keys (and some of the more important key combinations). Having completed this test, return to the “**System Test Programs**” menu.

E.4 TRANSCEIVER TEST UTILITIES

Select "**Transceiver Test Utilities**".

There are five utilities available on this page. Pressing <ESC> terminates any utility. This test also starts by requesting which Transceiver is to be tested. Respond to the prompt and press <ENTER>. Then proceed through the test procedures in the following order.

1. **Setup Transmit Parameters.** This routine enables transmit parameters to be edited as necessary in preparation for Test No 3. Common settings are:

❑ **TX POWER**

- Use LOW Power for shallow water or in-air testing
- LOW MEDIIUM Power is not very different in output power from LOW Power and is therefore generally not used
- Use HIGH MEDIUM Power in shallow water if the target is suspected to be deaf or in air
- Use HIGH Power for deep water. NOT FOR USE IN AIR.

TX PULSE WIDTH

- If dealing with COMPATTs, set to 4ms.
- If dealing with SIMRAD Beacons or SONARDYNE Beacons operating on SIMRAD channels, select 8ms.

TX FREQUENCY

- For SIMRAD Beacons or SONARDYNE Beacons operating on SIMRAD channels, select the required channel from G21 to G29 (for SIMRAD channels 1 to 9) or G31 to G35 (for the SIMRAD symbol channels).
- For SONARDYNE channels, select the desired channel in the ranges G0 to G14 and G16 (CIF).

2. **Setup Receive Pulse Parameters.** This routine enables receive parameters to be edited as necessary also in preparation for Test No 3. Common settings are:

RECEIVER MODE	Normally Linear
SENSITIVITY	In shallow water, or in a reverberant environment, start at 30dB attenuation. Otherwise set at 0dB attenuation.
DETECTION THRESHOLD	Start with 14dB
VALIDATION THRESHOLD	Start with 12dB
SAMPLE RATE	Start at 7kHz but adjust to (say) 6kHz if the channel to be received is close to a multiple of 7kHz.
TURN AROUND TIME	Use default time.
BANDWIDTH	Start with ±200Hz
REPLY PERIOD	Start with 1 second but increase in deep water.
SOUND VELOCITY	Use a sound velocity meter or make an educated guess based on knowledge of the area you are working in.
BEACON TYPE	Select appropriate option.
RX FREQUENCY	Select required channel. For Sonardyne COMPATTs and DMTs, the RX channel name/number is <u>different</u> from the TX channel name/number. For SIMRAD and Sonardyne Simrad-compatible Transponders and USBL/LUSBL Transponders, the RX channel name/number matches the TX channel although different frequencies are used. SIMRAD channel 4 is not available.

3. **Range Test.** This routine interrogates a beacon and displays the received pulse graphically. This test uses the transmit and receive parameters set up in options 1 and 2 but makes those two pages accessible for editing, if required.

4. **Noise Test.** This routine is very useful for trouble-shooting acoustic noise problems at sea. It causes the system to go through a transmit/receive sequence on each channel and displays the results as total noise and in-band noise for each channel. A bar graph is displayed - wait until at least three runs have taken place to stabilise the data.

   In a reasonably quiet environment all the bar lengths will be within a 6dB spread and will be in the region of 55dB to 70dB. If a particular bar shows a high level, avoid using transponders on that channel. Bars shown in red are Sonardyne channels that the LUSBL Transceiver is capable of receiving. Blue bars are SIMRAD channels.

   This test makes no reference to the transmit/receive parameters set in options 1 and 2.

5. **Transceiver Commands Interface.** This routine enables command mnemonics to be sent manually to the Transceiver. This process requires specialist knowledge and should not be attempted except with Sonardyne help.

   If testing a dual-redundant version of the LUSBL, select option 6 (Escape) and repeat the whole test sequence for the other Transceiver.

   Having completed these procedures, return to the “**System Test Programs**” menu.

E.5 GRAPHICS DISPLAY TEST

Select “**Graphics Display Test**”.

This page checks all colours displayed and enables screen aspect ratio and alignment to be adjusted.

Having completed this test, return to the “**System Test Programs**” menu.

E.6 HARD DISC TEST

Select “**Hard Disc Test**”.

This test carries out an integrity check of the HD filing system. If this test fails contact Sonardyne for advice.

Having completed this test, return to the “**System Test Programs**” menu.

E.7 SERIAL PORTS TEST UTILITY

Select “**Serial Ports Test Utility**”.

This test involves using loop-back connectors which can be used on any of the 6 serial ports available on the Serial Card and the two serial ports on the CPU Card. With the connector in place, the test routine checks the serial interface over a range of baud rates (2400, 4800, 9600, 19200 and 38400 baud). However, the setup for this test requires detailed knowledge of the configuration of the particular system being tested and there is a risk of damage if the correct preparations are not made. Sonardyne should be consulted before attempting this test.

E.8 INTERFACE TESTS

These tests may be used to check out the Gyro and VRU interfaces given that the necessary test equipment and test software is available. Gyro and VRU outputs are monitored by reference to the values given on the polling page which is displayed on system start-up.

E.8.1 Equipment Required

- Synchro Gyro Lead, Type 7784-049
- VRU Lead, Type 7784-047
- Power Supplies for VRU Interface Test (Appendix E.8.4) - see also Fig E.2 in this Appendix.
- Digital Multimeter

E.8.2 Preliminary Tasks

The Gyro and VRU interfaces are user configurable and, if not already done, must be set to the correct settings before these tests commence. Carry out the following to configure the Interfaces:-

E.8.2.1 **Power-Up**

Ensure that the Gyro and VRU are connected to the appropriate connectors on the Navigation Processor - see Section 3.

Power up all units.

E.8.2.2 **Setup**

If the Gyro and VRU port port settings in the Navigation Processor are not known to be correct, carry out the setup procedure given in Section 4.2.1.

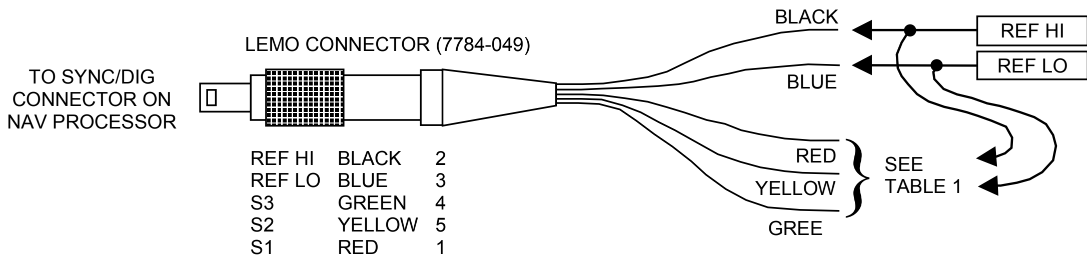
E.8.3 GYRO-COMPASS INTERFACE TEST

These tests require the 7784-049 Synchro Gyro Lead. It will be necessary also to make connections to the Synchro Reference signal (REF HI and REF LO) from the Gyro - as shown in Figure E1 which follows.

CAUTION:	On 400Hz 115V and 60Hz 115V Synchros, the Reference is at **115V AC**. Therefore extreme care must be exercised whilst performing these tests.

The REF HI and REF LO outputs from the Gyro must be connected in various combinations (see Table 1 below) to the three Synchro inputs (S1, S2 and S3) on the SYNC/DIG interface connector on the Navigation Processor. During these tests, REF HI and REF LO must still be connected to their normal inputs on the SYNC/DIG connector as well as to the Synchro inputs shown in Table 1.

FIG E.1 CONNECTIONS FOR GYRO INTERFACE TESTS



For each of the tests listed in Table 1, connect the relevant Synchro phases to the 7784-049 tails and plug the LEMO connector into the Nav Interface SYNC/DIG input. Turn on the Navigation Processor and look at the angle displayed after “GYRO” on the polling page. The angle should be as shown in Table 1 in Table 1 ± 0.1 degrees.

Turn off the Navigation Processor and change the wiring. Repeat until all 6 angles have been checked.

REF HI:- to black wire throughout throughout.

REF LO:- to blue wire throughout throughout.

TABLE 1

Red (S1)	Yellow (S2)	Green (S3)	Angle expected
REF LO	REF HI	REF LO	0 or 360
REF LO	REF HI	REF HI	60
REF LO	REF LO	REF HI	120
REF HI	REF LO	REF HI	180
REF HI	REF LO	REF LO	240
REF HI	REF HI	REF LO	300

E.8.4 <u>VERTICAL REFERENCE UNIT INTERFACE TEST</u>

Connect the power supplies to the VRU lead Type 7784-047 as shown in Figure E2.

Connect a DVM across each power supply output to provide an accurate measurement of the voltage.

If not already running from the previous section, select the Navigation front page.

Set Power Supply 1 (ROLL) to +3.000V ±25 mV and Power Supply 2 (PITCH) to -5.000V ±25 mV. (Reverse the leads at the Power Supply to provide a negative voltage).

Note:	This procedure assumes the vessel is fitted with a Datawell VRU, with a full-scale output of 10 volts at ±15 degrees.

i. The voltage output for pitch or roll is given by V = 10 x $\underline{\text{Sin } \varnothing}$ Sin 15°

3 volts is therefore equivalent to 4.45 degrees (ROLL)

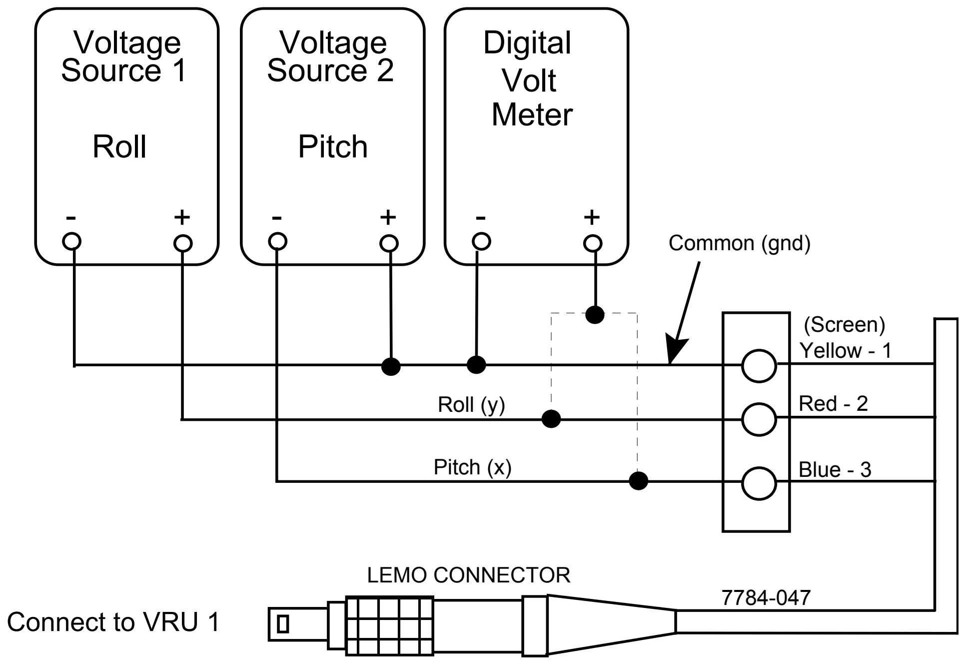
and 5 volts is therefore equivalent to 7.44 degrees (PITCH)

ii. Check the VRU reading on the polling page for compliance with these values ±0.1 degrees.

iii. The Datawell VRU and Sonardyne sign conventions differ as follows:

	Datawell	Sonardyne
Positive Pitch:	Bow down	Bow up
Positive Roll:	Port up, roll to starboard	Port up, roll to starboard

FIG E.2 CONNECTIONS FOR VRU INTERFACE TEST



APPENDIX F

F. DP TELEGRAM FORMATS

This appendix describes the format and contents of HPR 309, HPR 418 and ATS ASCII telegrams sent by the USBL/LUSBL system to the DP system.

F.1 HPR 309 TELEGRAM

F.1.1 Format of HPR 309 Telegram

Field name	Size(bytes)	Byte offset	Default for DP_test
Head	**1**	**0**	**1**
Roll	**2**	**1**	**As required**
Pitch	**2**	**3**	**As required**
Heading	**2**	**5**	**As required**
Transponder index	**1**	**7**	**As required**
X position	**3**	**8**	**As required**
Y position	**3**	**11**	**As required**
Depth	**3**	**14**	**As required**
Position status	**1**	**17**	**0**
Not used (Time-out)	**1**	**18**	**0**
Transponders in sequence	**3**	**19**	**[automatic]**
Not used (Tracking TD angle)	**2**	**22**	**N/A**
Not used (Test)	**1**	**24**	**N/A**
Not used (Transponder type)	**1**	**25**	**0**
Transponder specification	**1**	**26**	**0**
Not used (Transducers)	**1**	**27**	**0**
Not used (Transducer status)	**1**	**28**	**0**
Kalman filter window	**1**	**29**	**0**
Checksum	**1**	**30**	**[automatic]**
End of telegram	**1**	**31**	**[automatic]**

Bits 0-5 contain data. Bit 6 is only ever set on the last byte of the telegram. If there is a bit 7, it is zero.

F.1.2 Definition of Field Names - HPR 309 Telegram

- **Head**

The telegram header - Various flags.

The flag indicates: acoustics running, data is unfiltered, and is in Cartesian, lubberline north facing co-ordinates.

Currently set to 1.

- **Roll**

The roll of the ship.

- Positive direction is port side up.
- Scaled integer, 12bit, 2's complement.
- Resolution = 360.0 / 4096 degrees. (= 0.0878906 degrees)
- Min = 800000h = -2048 -> -180.0 degrees.
- 0 -> 0.0 degrees.
- Max = 7fffffh = 2047 -> (180 - resolution) degrees.

The first byte of this field in the telegram contains the 6 most significant bits, and the next byte contains the 6 least significant bits.

- **Pitch**

The pitch of the ship.

- Positive direction is bows up.
- Scaled integer, 12bit, 2's complement.
- Resolution = 360.0 / 4096.0 degrees.
- Min = 800000h = -2048 -> -180.0 degrees.
- 0 -> 0.0 degrees.
- Max = 7fffffh = 2047 -> (180 - resolution) degrees.

The first byte of this field in the telegram contains the 6 most significant bits, and the next byte contains the 6 least significant bits.

- **Heading**

  The heading of the ship.

  - Positive direction is clockwise.
  - Zero is north
  - Scaled integer, 12bit, 2's complement.
  - Resolution = 360.0 / 4096.0 degrees.
  - Min = 800000h = -2048 -> -180.0 degrees.
  - 0 -> 0.0 degrees.
  - Max = 7ffffh = 2047 -> (180 - resolution) degrees.

  The first byte of this field in the telegram contains the 6 most significant bits, and the next byte contains the 6 least significant bits.

- **Transponder Index**

  Zero means that the position is invalid.

  Otherwise, this field contains the index of the transponder.

  - 1 to 9 = HPR Channels 1 to 9
  - 10 to 14 = HPR Channels □, O, Δ, X, Y.
  - 15 to 63 = Undefined.

- **X Position**

  The X position of the transponder with respect to the ship's datum.

  - The positive direction is starboard.
  - Valid when "transponder index" is not zero and when "Status" is not zero.
  - Scaled integer, 16bit (sign-extended to 18 bits), 2's complement.
  - Resolution = 8192.0 / 65536 metres. (= 0.125m)
  - Min = 8000h -> --4096.0 metres.
  - 0 -> 0.0 degrees.
  - Max = 7fffh -> (4096.0 - Resolution) metres.

  The first byte of this field in the telegram contains the 6 most significant bits, the next byte contains bits 6 to 11 and the next byte contains the 6 least significant bits.

- **Y Position**

  The Y position of the transponder with respect to the ship's datum.

  - The positive direction is forwards.
  - Valid when "transponder index" is not zero and when "Status" is not zero.
  - Scaled integer, 16bit (sign-extended to 18 bits), 2's complement.
  - Resolution = 8192.0 / 65536 metres. (= 0.125m)
  - Min = 8000h -> --4096.0 metres.
  - 0 -> 0.0 degrees.
  - Max = 7fffh -> (4096.0 - Resolution) metres.

  The first byte of this field in the telegram contains the 6 most significant bits, the next byte contains bits 6 to 11 and the next byte contains the 6 least significant bits.

- **Z Position**

  The Z position of the transponder with respect to the ship's datum.

  - The positive direction is down.
  - (This is not depth. Depth is with respect to the surface of the water).
  - Valid when "transponder index" is not zero and when "Status" is not zero.
  - Scaled integer, 16bit (sign-extended to 18 bits), 2's complement.
  - Resolution = 8192.0 / 65536 metres. (= 0.125m)
  - Min = 8000h -> --4096.0 metres.
  - 0 -> 0.0 degrees.
  - Max = 7fffh -> (4096.0 - Resolution) metres.

  The first byte of this field in the telegram contains the 6 most significant bits, the next byte contains bits 6 to 11 and the next byte contains the 6 least significant bits.

- **Status**

  Flags.

  Bit 0 is set when the position data is invalid.

  Bits 1 to 5 are not used and are all cleared.

  Watchdog telegrams do not contain valid position data, so bit 0 is set. The roll pitch and heading data is valid in a watchdog telegram.

- **Not Used (Time-out)**

  Zero.

- **Transponders in Sequence**

  Flags to indicate which transponders are being used.

  HPR channel:

	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1st byte	**undefined**	**undefined**	**undefined**	**undefined**	**Y**	**X**
2nd byte	**Δ**	**O**	**□**	**9**	**8**	**7**
3rd byte	**6**	**5**	**4**	**3**	**2**	**1**

  Bits are set for the transponders that are used.

  All other bits are cleared (including those whose meaning is undefined).

- **Not Used (Tracking TD Angle)**

  Zero.

- **Not Used (Test)**

  Zero.

- **Not Used (Transponder Type)**

  Zero.

- **Transponder Specification**

  Flags.

  Bit 0: Set for a mobile transponder, Cleared for a reference transponder.

  Bits 1 to 5: Unused, all cleared.

- **Not Used (Transducers)**

  Zero.

- **Not Used (Transducer Status)**

  Zero.

- **Kalman filter window**

  This is the horizontal position quality, rounded to the nearest metre.

- **Checksum**

  The result of performing an exclusive-or on all bytes in the telegram up to but not including this byte.

- **End of Telegram**

  This byte marks the end of a telegram.

  It is always 40h. It is the only byte of the telegram with bit 6 set.

F.2 HPR 418 TELEGRAM

There are two HPR 418 messages types supported by the LUSBL. Message 1 (Section F.2.1) gives information relating to the beacons used in the system. Message 2 (Section F.2.2) gives the LBL position of the ship.

F.2.1 HPR 418 Message 1 - Transponder Position Data

F.2.1.1 HPR 418 Message 1 - Format

Field name	Size(bytes)	Byte offset	Default for DP_test
Start Character	**1**	**0**	**0x55**
Block Length	**2**	**1**	**0x3A (if no Inst_data)**
Message Type	**1**	**3**	**1**
Destination	**1**	**4**	**0x30**
Tp_index	**2**	**5**	**1**
Operation_mode	**1**	**7**	**0 (Std Navigation)**
Sync_mode	**1**	**8**	**0 (No sync)**
Tp_type	**1**	**9**	**0 (Std Transponder)**
Tp_operation	**1**	**10**	**0 (Fixed)**
Pos_data_form	**1**	**11**	**0 (Ship head relative)**
Reply_status	**1**	**12**	**0 (OK)**
Filt_x_pos	**4**	**13**	**0.0 (linked to raw)**
Filt_y_pos	**4**	**17**	**0.0 (linked to raw)**
Filt_z_pos	**4**	**21**	**0.0 (linked to raw)**
x_pos	**4**	**25**	**0.0**
y_pos	**4**	**29**	**0.0**
z_pos	**4**	**33**	**0.0**
Slant_range	**4**	**37**	**0.0**
P_course	**4**	**41**	**0.0**
P_roll	**4**	**45**	**0.0**
P_pitch	**4**	**49**	**0.0**
Td_beam	**1**	**53**	**0 (Wide)**
Td_type	**1**	**54**	**0 (Wide Only)**
Td_num	**2**	**55**	**1 (tdcr 1 on tcvr 1)**
Diagnostic	**2**	**57**	**0 (No errors)**
Stand_dev	**4**	**59**	**0**
Instr_data *	**4*n**	**63**	**0.0 (when required)**
Sumcheck	**2**	**63+4*n**	**Automatic**
Stop character	**1**	**65+4*n**	**0xAA**

Instrument Data is dependent upon the type of transponder and takes n fields. n would be zero for a transponder without instrumentation.

F.2.1.2 HPR 418 Message 1 - Definition of Field Names

- **Start Character**

  This is a single byte start character 55 hex.

- **Block Length**

  A 2 byte block length number from 0 to 65536 defining the number of bytes after Destination field and before Sumcheck. (Message length minus 8). In this case it is set to 3A hex plus the number of bytes of Instrument Data. There will usually be 0 bytes of Instrument Data. The number of bytes is dependent upon the type of transponder.

- **Message Type**

  A single byte defining a number from 0 to 255 which is the type of the message transmitted.

  In this case it is 1.

- **Destination**

  A single byte number from 0 to 255 defining the device to which the message is transmitted.

  This is not used by Sonardyne, but is set to 30 hex.

- **Tp_index**

  A single byte defining the transponder channel.

  In USBL/LUSBL it is a number between 0 and 16. The Simrad 418 uses number 0 to 298 from the HPR 418 frequency plan.

  Currently set to 1.

- **Operation_mode**

  A single byte containing the operation mode of the transceiver.

  - 00 = standard navigation mode
  - 01 = simulated position test mode. (Training)
  - 10 = telemetry mode (not used by Sonardyne).

- **Sync_mode**

  A single byte containing the synchronisation mode of the transceiver.

  - 0 = no synchronisation
  - 1 = sequence sync. (Not used by Sonardyne)
  - 2 = interrogation sync (Not used by Sonardyne)

- **Tp_type**

  A single byte defining the transponder type:

  - 000 = transponder
  - 001 = depth transponder
  - 002 = inclinometer transponder
  - 003 = diff inc transponder
  - 004 = compass transponder
  - 005 = acoustic control transponder
  - 006 = beacon
  - 007 = depth beacon
  - 010 = responder drive 1
  - 011 = responder drive 2
  - 012 = responder drive 3
  - 013 = responder drive 4

- **Tp_operation**

  A single byte defining the operation mode of the transponder:

  - 000 = fixed standard transponder
  - 001 = mobile standard transponder
  - 002 = fixed depth on transponder
  - 003 = fixed up and fixed depth
  - 004 = mobile tp and fixed depth

- **Pos_data_form**

  A single byte defining the position co-ordinate format:

  - Bit 0 = 0 vessel oriented, cartesian
  - Bit 0 = 1 north oriented, cartesian
  - Bit 3 = 1 ping count data valid

- **Reply_status**

  A single byte defining the transponder reply status:

  - 000 = reply OK
  - 001 = timeout 1 pulse
  - 002 = timeout 2 pulse
  - 003 = timeout 3 pulse
  - Bit 3 set = reply rejected by filter
  - Bit 4 set = VRU or gyro error. The position is calculated with zero course and/or zero roll and pitch. The VRU and/or gyro error is reported in the DIAGNOSTIC parameter

- **Filt_X_pos**

  A value in REAL format.

  The filtered x - position co-ordinates of the transponder. Transponder's horizontal athwart ship distance from reference point in metres.

- **Filt_Y_pos**

  A value in REAL format.

  The filtered y - position co-ordinates of the transponder. Transponder's horizontal fore and aft ship distance from reference point in metres.

- **Filt_Z_pos (Depth)**

  A value in REAL format.

  The filtered z - position co-ordinates of the transponder. Transponder's vertical distance from reference point in metres.

- **X_pos**

  A value in REAL format.

  The raw x - position co-ordinates of the transponder. Transponder's horizontal athwart ship distance from reference point in metres.

- **Y_pos**

  A value in REAL format.

  The raw y - position co-ordinates of the transponder. Transponder's horizontal fore and aft ship distance from reference point in metres.

- **Z_pos (DEPTH)**

  A value in REAL format.

  The raw z - position co-ordinates of the transponder. Transponder's vertical distance from reference point in metres.

- **Slant_range**

  A value in REAL format.

  The direct raw slant range from the vessel's transducer to the transponder in metres.

- **P_course**

  A value in REAL format.

  The vessels course at the time of transponder position measurement; 0 to 360 degrees.

- **P_roll**

  A value in REAL format.

  The vessels roll at the time of transponder position measurement +/-180 degrees.

- **P_pitch**

  A value in REAL format.

  The vessels pitch at the time of transponder position measurement +/-180 degrees.

- **Td_beam**

  A single byte defining the transducer beam.

  - 0 = wide,
  - 1 = narrow.

  Sonardyne uses value 0 (wide).

- **Td_type**

  Defines the transducer type.

  Sonardyne uses value 0 (wide beam).

- **Td_num**

  A 16 bit word defining the transducer number.

  Sonardyne uses value 1 (meaning transducer 1 on transceiver 1)

- **Diagnostic**

  Sonardyne do not use this field and always return 0 (no errors).

- **Stand_dev**

  A value in REAL format.

  This is the horizontal position quality in metres.

- **Instr_data (*)**

  Values in REAL format.

  This is only used if the message contains data from an Inclinometer transponder, (Tp_type = 2 or 3). The first two reals contain the Inclination of the transponder. The first contains X inclination and the second contains the Y inclination in the form +/- 180 degrees.

- **Sumcheck**

  Sumcheck of the contents of the entire telegram except for the sumcheck itself and the stop character. The sumcheck is a 16 bit integer calculated by normal byte + byte addition.

- **Stop Character**

  This is a single byte stop character AA hex.

F.2.2 HPR 418 Message 2 - LBL Position Data

F.2.2.1 HPR 418 Message 2 - Format

Field name	Size(bytes)	Byte offset	Default for DP_test
Start Character	**1**	**0**	**0x55**
Block Length	**2**	**1**	**0x2E**
Message Type	**1**	**3**	**2**
Destination	**1**	**4**	**0x30**
Tp_array	**1**	**5**	**0**
Td_num	**1**	**6**	**1 (tdcr 1 on tcvr 1)**
Pos_East	**4**	**7**	**0.0**
Pos_North	**4**	**11**	**0.0**
Depth	**4**	**15**	**0.0**
Horr_err_ellipse_direction	**4**	**19**	**0.0**
Horr_err_ellipse_major	**4**	**23**	**0.0**
Horr_err_ellipse_minor	**4**	**27**	**0.0**
Z_Standard_deviation	**4**	**31**	**0.0**
Pos_type	**1**	**35**	**0 (Vessel position)**
Pos_status	**1**	**36**	**0 (OK)**
P_course	**4**	**37**	**0.0**
P_roll	**4**	**41**	**0.0**
P_pitch	**4**	**45**	**0.0**
Diagnostic	**2**	**49**	**0 (No Errors)**
Sumcheck	**2**	**51**	**Automatic**
Stop character	**1**	**53**	**0xAA**

LBL position contains vessels position relative to the origin at the LBL transponder array. This is the position of the first reference beacon in the list on the beacon set up page. The position is transmitted after each position calculation. If the transponder array is north oriented, the co-ordinates are relative true North, else they are relative local north.

F.2.2.2 **HPR 418 Message 2 - Definition of Field Names**

- **Start Character**

  This is a single byte start character 55 hex.

- **Block Length**

  A 2 byte block length number from 0 to 65536 defining the number of bytes after Destination field and before Sumcheck. (Message length minus 8). In this case it is set to 36 hex.

- **Message Type**

  A single byte number from 0 to 255 defining the type of the message transmitted.

  In this case it is 2.

- **Destination**

  A single byte number from 0 to 255 defining the device to which the message is transmitted.

  This is not used by Sonardyne, but is set to 30 hex.

- **Tp_array**

  A single byte defining the number of the tp array that are in use, 0,1, 2 and 3. Sonardyne sets this to 0.

- **Td_num**

  A 16 bit word defining the transducer number.

  Sonardyne uses value 1 (meaning transducer 1 on transceiver 1)

  0 has a special meaning. Then the position is calculated based on measurements on more than one transducer.

- **Pos_east**

  A value in REAL format.

  East co-ordinates in metres. Positive value is East. Negative value is West.

- **Pos_north**

  A value in REAL format.

  East co-ordinates in metres. Positive value is North. Negative value is South.

- **Depth**

  A value in REAL format.

  The depth co-ordinate. Positive value is downwards.

  For the vessel, the depth is the vertical distance from the sea level to the vessel reference point. For ROVs and relay transponders, the depth is the depth below the sea surface of the transducer on the unit.

- **Hor_err_ellipse_direction**

  A value in REAL format.

  Each LBL position measurement has a likelihood ellipse associated with it. It is based on 1 δ in each of the axis. The direction is the angle in degrees between the north axis and the major axis of the ellipse.

- **Horr_err_ellipse_major**

  A value in REAL format.

  The major axis of the likelihood ellipse in metres.

- **Horr_err_ellipse_minor**

  A value in REAL format.

  The minor axis of the likelihood ellipse in metres.

- **Z_standard_deviation**

  A value in REAL format.

  The standard deviation (δ) of the depth in metres.

- **Pos_type**

  A single byte with value:

  - 0 = Position of the vessel
  - 1 = Position of ROV1

    : :

  - 16 = Position of ROV16
  - 17 = Position of RELAY1
  - 18 = Position of RELAY2
  - 19 = Position of RELAY3
  - 20 = Position of RELAY4

- **Pos_status**

  A single byte with value:

  This variable tells the status of the position calculation. Any status with an asterix in the table below is so serious that no position is contained in the telegram.

  - 0 = OK position
  - 1 = The measured ranges match badly the calculated position the range residuals are big
  - 16 = Too few ranges are measured
  - 17 = The position calculation does not converge

- **P_course**

  A value in REAL format.

  An average of the vessels course at the time of transponder position measurement; 0 to 360 degrees.

- **P_roll**

  A value in REAL format.

  An average of the vessels roll at the time of transponder position measurement +/-180 degrees.

- **P_pitch**

  A value in REAL format.

  An average of the vessels pitch at the time of transponder position measurement +/-180 degrees.

- **Diagnostic**

  Sonardyne do not use this field and always return 0 (no errors).

F.3 ATS ASCII TELEGRAM

The ATS ASCII telegram is used by Nautronix ATS-S02, ATS-S04 and ATS-S08 systems.

Each line of the data contains position data for one object, is terminated by line feed <LF> and carriage return <CR> characters (ASCII 10 and 13).

The format is:

dd mmm yy hh:mm:ss B:d X:ddd.d Y:ddd.d D:ddd.d P:d.d R:d.d H:ddd.d<LF><CR>

Where:

- dd mmm yy hh:mm:ss Date and time of receipt of the acoustic reply
- B: Beacon Index 0 = ship, 1-10=beacons 1 to 10
- X: X co-ordinate in metres.
- Y: Y co-ordinate in metres.
- D: Depth in metres.
- P: Ship's pitch in degrees. Positive pitch is Bow up. +/-9.9
- R: Ship's roll in degrees. Positive roll is Port up. +/-9.9
- H: Ship's heading relative to North in degrees. 0-360

The co-ordinate frame for beacon position data is relative to the ship datum point.

- Positive Y is forward
- Positive X is starboard
- Positive Depth is down.

The co-ordintate frame for ship position is the seabed LBL array co-ordinate frame with positive Y North and positive X East. In this case Depth is nominally the position of the ship's datum relative to sea level; however it is highly dependent upon water depth and calibrated beacon depths and is therefore not to be relied upon.

Example telegrams look like:

- 19 Sep 95 11:32:53 B:4 X:-107.3 Y:102.2 D:99.8 P:0.2 R:-0.3 H:25.4<LF><CR>
- 19 Sep 95 11:32:54 B:0 X:416739.9 Y:5579729.2 D:1.2 P:0.2 R:-0.3 H:25.4<LF><CR>

APPENDIX G

G. **LUSBL SURVEYOR'S OUTPUT**

This appendix describes the format and content of the LUSBL Surveyor’s output message and gives examples of typical messages.

G.1 MESSAGE FORMATS

There are two types of data message:

- Transponder messages (Type 1).
- Ship messages (Type 2).

G.1.1 Transponder Messages (Type 1)

The following fields are available:

- **tick**

  The time when the message was sent.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **fix**

  The fix number. A number to identify which interrogation produced the data.

  A fix can produce a number of transponder ranges and hence a number of transponder messages.

  - Integer.
  - Range 0-4294967295

  See also: Ship message / fix

- **flag**

  Zero indicates a bad fix.

  Non zero indicates a good fix.

  - Integer.

  See also: Ship message / flag.

- **index**

  The transponder index. There can be a number of transponders. They are distinguished by the index.

  - Integer.
  - Range: 0-9

- **time**

  The time of the interrogation.

  - Floating Point.
  - Units: 1/100 second.
  - Range 0.0-4294967296.0 (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

  See also: Ship message / time.

- **raw_x**

  The unfiltered X position of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)
  - Sign convention: Port = +ve.

  See also: filt_e.

- **raw_y**

  The unfiltered Y position of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)
  - Sign convention: Ahead = +ve.

  See also: filt_n.

- **raw_d**

  The unfiltered depth of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_d.

- **pitch**

  The pitch angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Bows up = +ve.

  See also: Ship message / pitch.

- **roll**

  The roll angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Starboard down = +ve.

  See also: Ship message / roll.

- **bearing**

  The ship's bearing at the time of the fix.

  - Floating Point.
  - Units: Degrees

  See also: Ship message / bearing.

- **quality**

  The predicted horizontal standard deviation of the range in user-units. It is computed from the current fix.

  Smaller numbers are better.

  - Positive Floating Point.

- **filt_e**

  The filtered easting of the transponder relative to the ship's datum

  Only different from raw_x if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_x.

- **filt_n**

  The filtered northing of the transponder relative to the ship's datum

  Only different from raw_y if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_y.

- **filt_d**

  The filtered depth of the transponder relative to the ship's datum

  Only different from raw_d if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_d.

- **slant_range**

  The range from the transceiver to the transponder

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

G.1.2 Ship Messages (Type 2)

The following fields are available:

- **tick**

  The time when the measurement (fix) was made.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **fix**

  The fix number. A number to identify which interrogation produced the data.

  A fix can produce a number of transponder ranges and hence a number of transponder messages.

  - Integer.
  - Range 0-4294967295

  See also: Transponder message / fix.

- **flag**

  Zero indicates a bad fix.

  Non zero indicates a good fix.

  - Integer.

  See also: Transponder message / flag.

- **time**

  The time of the interrogation.

  - Floating Point.
  - Units: 1/100 second.
  - Range 0.0-4294967296.0 (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

  See also: Transponder message / time.

- **raw_e**

  The unfiltered easting of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_e.

- **raw_n**

  The unfiltered northing of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_n.

- **raw_d**

  The unfiltered depth of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_d.

- **pitch**

  The pitch angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Bows up = +ve.

  See also: Transponder message / pitch.

- **roll**

  The roll angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Starboard down = +ve.

  See also: Transponder message / roll.

- **bearing**

  The ship's bearing at the time of the fix.

  - Floating Point.
  - Units: Degrees

  See also: Transponder message / bearing.

- **h_ell_drn**

  Horizontal error ellipse direction.

  - Floating Point.
  - Units: Degrees
  - Sign convention: +ve X-axis is 0. +ve is anticlockwise.

  See Figure G1, "Error ellipse"

- **h_ell_maj**

  Horizontal error ellipse - major radius.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See Figure G1, "Error ellipse"

- **h_ell_min**

  Horizontal error ellipse - minor radius.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See Figure G1, “Error ellipse”

- **z_err**

  The predicted standard deviation of the depth observation.

  - Smaller numbers are better.
  - Positive Floating Point.

  See also: Transponder message / quality

- **filt_e**

  The filtered easting of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_e.

- **filt_n**

  The filtered northing of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_n.

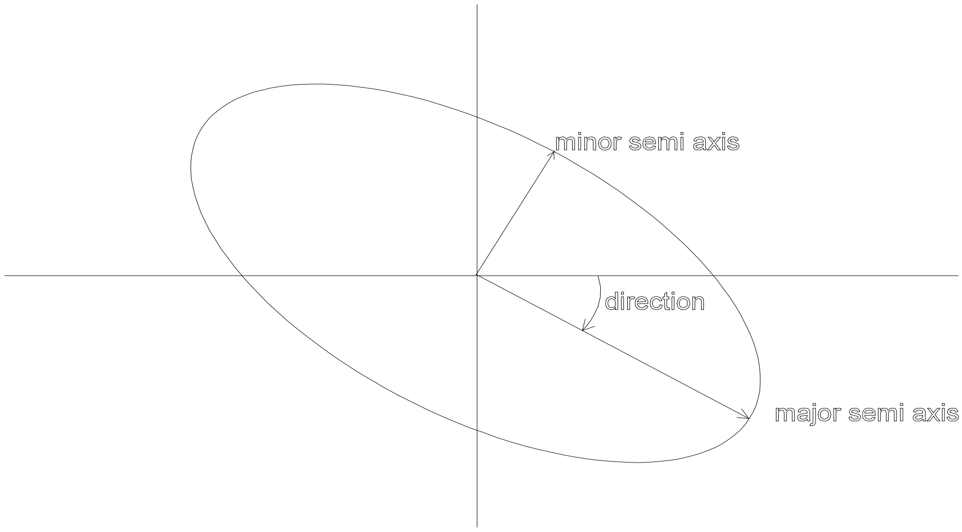
- **filt_d**

  The filtered depth of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_d.

FIG G.1 ERROR ELIPSE



G.2 SELECTING FIELDS FOR OUTPUT

On start-up, the previous field selections are read from disc, and the field names are sent to the surveyor.

The field selection can be changed by sending commands over the serial port.

- Characters are not echoed.
- The command and field names are case-sensitive.
- The command and field names cannot be abbreviated.
- The maximum length of a command is 250 characters.
- The field names can be in any order, and repeated.
- If no fields are given, there will be no output for that type of message.
- Spaces are allowed before and after commas.
- The backspace character deletes the previous character in a command.
- Control-X deletes all characters in the current command.

❑ **Valid field names for Transponder (type 1) messages:**

tick fix flag index raw_x raw_y raw_d pitch roll bearing quality filt_e filt_n filt_d slant_range

❑ **Valid field names for Ship (type 2) messages:**

tick fix flag raw_e raw_n raw_d pitch roll bearing h_ell_drn h_ell_maj h_ell_min z_err filt_e filt_n filt_d

G.3 TYPICAL MESSAGES

Messages of type 1 (Transponder) start with '1,'

and are followed by the values of the selected fields separated by commas.

Similarly, messages of type 2 (Ship) start with '2,'

and are followed by the values of the selected fields separated by commas.

Data messages are sent as new data becomes available.

E.g. The system is started

- **The surveyor is sent the currently selected field names**

  Surveyor sends: select,1,fix,index,raw_x,raw_y <cr>
  System sends: * selected,1,fix,index,raw_x,raw_y <cr>
  Surveyor sends: select,2,fix,raw_e,raw_n <cr>
  System sends: * selected,2,fix,raw_e,raw_n <cr>

- **The system does a fix**

  System sends: 1,0,2,-99.54,-100.36 <cr>
  System sends: 1,0,3,-100.90,100.80 <cr>
  System sends: 1,0,0,100.13,99.97 <cr>
  System sends: 1,0,1,100.40,-99.74 <cr>
  System sends: 2,1,-0.18,-0.08 <cr>

- **The surveyor wants to change the field selection**

  Surveyor sends: select,1,index,filt_e,filt_n,filt_d <cr>
  System sends: * selected,1,index,filt_e,filt_n,filt_d <cr>

- **The system does a fix**

  System sends: 1,2,-99.54,-100.36 <cr>
  System sends: 1,3,-100.90,100.80 <cr>
  System sends: 1,0,100.13,99.97 <cr>
  System sends: 1,1,100.40,-99.74 <cr>
  System sends: 2,2,-0.18,-0.08 <cr>

- **The surveyor wants to turn off ship messages**

  Surveyor sends: select,2 <cr>
  System sends: * selected,2 <cr>

- **The system does a fix**

  System sends: 1,2,-99.54,-100.36 <cr>
  System sends: 1,3,-100.90,100.80 <cr>
  System sends: 1,0,100.13,99.97 <cr>
  System sends: 1,1,100.40,-99.74 <cr>

G.4 USE OF TERMINAL EMULATOR TO EXTRACT SURVEY OUTPUT

G.4.1 Introduction

This section suggests how terminal emulators can be used to view, control and log data. It defines the necessary requirements to be able to do this (Section G.4.2 below), and how to set two common terminal emulators to control, view and log the data from the Surveyor's output.

There are several "types" of data that can be sent from the Surveyor's output. For each type there are several fields. It is possible to control which types of data are output, and also within those types which fields should be present.

The terminal emulator packages will display the data being output on the Surveyor's output, but also can be used to log the selected data. In addition, it is possible to set up Keys within the terminal emulator package which send commands to control the Surveyor's output. It is also possible to turn the logging of the data on and off within the terminal emulator package.

This section gives examples for PC Plus and Windows Terminal for setting the Keys and controlling the logging of data from the Surveyor's output.

In Section G.5, which follows, is an example of how the Surveyor's output can be used with PC-Plus to log data for the CASIUS calibration software.

G.4.2 Pre-Requisites

- ❑ USBL is configured so that the Surveyor's output is on a serial port that is connected to the PC
- ❑ The terminal emulator (on the PC) is already configured with the correct serial port, baud rate, etc.
- ❑ One or more beacons is selected for Surveyor's output in the USBL software.
- ❑ Navigation is running on the Navigation Processor.
- ❑ No fields are already selected for output

G.4.3 PC-Plus 1.1b

G.4.3.1 Set up the Macro Keys

- Press *Alt-M* to get the "Keyboard Macros" dialogue box.
- Press the Down arrow key to select the line that starts with "Alt-1"
- Press R to change the entry.
- Delete any existing text using the *delete* key.
- Type the new text: **select,1,all^m**
- Press enter.
- Press the Down arrow key to select the line that starts with "Alt-2" and repeat the process, typing in the text from the table, e.g.

Key	Text to be entered	Effect of key
Alt-0		
Alt-1	select,1,all^m	Select all fields of message type 1 (tpdr msg)
Alt-2	select,1^m	Turn off all fields of message type 1 (tpdr msg)
Alt-3	select,2,all^m	Select all fields of message type 2 (ship msg)
Alt-4	select,2^m	Turn off all fields of message type 2 (ship msg)
Alt-5	select,12,all^m	Select all fields of message type 12 (range msg)
Alt-6	select,12^m	Turn off all fields of message type 12 (range msg)
Alt-7	select,1,all^m select,11,all^m	Select all fields of message types 1 & 11 (Casius msg)
Alt-8	select,1^mselect,11^m	Turn off all fields of message types 1 & 11 (Casius msg)

Note that '**^m**' means type '^' followed by 'm'. Do NOT type Ctrl-M, though subsequent pressing of the Alt n key will cause Ctrl-M to be sent where **'^m'** has been typed during this set-up procedure.

G.4.3.2 Start Logging Data from Surveyor's Output

- While holding down the Alt key, press F1.
- At the prompt: Enter log filename, or CR for default:, type in a filename for the received data, then press Enter, e.g. **c:\usblsurv.txt**.
- The Words LOG OPEN will now appear in the status bar at the foot of the screen.

G.4.3.3 Activate the Data Messages from Surveyor's Output

- Hold down the *Alt* key and press the appropriate number key (1, 3, 5 or 7 in the examples above). Now release the *Alt* key.
- **WAIT UNTIL YOU'VE GOT ENOUGH DATA.**

G.4.3.4 Deactivate the Data Messages (optional)

A field selection remains in effect until a new selection is made. This includes the case where The Navigation Processor is powered down.

- Hold down the *Alt* key and press the appropriate number key (2, 4, 6 or 8 in the examples above). Now release the *Alt* key.

G.4.3.5 Stop Logging Data from Surveyor's Output

- While holding down the *Alt* key, press *F1*.
- The Words *LOG CLOSED* will now appear in the status bar at the foot of the screen.

G.4.4 Windows Terminal 3.N

G.4.4.1 Set up the Macro Keys

- From the menu bar, select ***Settings***, then ***Function Keys...***
- This brings up the *Function Keys* dialogue box.
- Enter the following settings:

Key	Key Name	Text to be entered	Effect of key
F1	tpdr msg ON	select,1,all^m	Select all fields of message type 1 (tpdr msg)
F2	tpdr msg OFF	select,1^m	Turn off all fields of message type 1 (tpdr msg)
F3	ship msg ON	select,2,all^m	Select all fields of message type 2 (ship msg)
F4	ship msg OFF	select,2^m	Turn off all fields of message type 2 (ship msg)
F5	range msg ON	select,12,all^m	Select all fields of message type 12 (range msg)
F6	range msg OFF	select,12^m	Turn off all fields of message type 12 (range msg)
F7	Casius ON	select,1,all^m select,11,all^m	Select all fields of message types 1 & 11
F8	Casius OFF	select,1^mselect,11^m	Turn off all fields of message types 1 & 11

Note that '**^m**' means type '^' followed by 'm'. Do NOT type Ctrl-M, though subsequent pressing of the Alt n key will cause Ctrl-M to be sent where **'^m'** has been typed during this set-up procedure.

- If ***Keys Visible*** (lower right hand corner of the dialogue box) is not already marked with an X, then click it.
- Click the OK button.

The macro buttons should now be visible at the foot of the Terminal window.

G.4.4.2 Start Logging Data from Surveyor's Output

- From the menu bar, select ***Transfers***, then ***Receive Text File...***
- Decide on a file name, and type it into the dialogue box.
- Click the OK button.

A status/control bar for the text transfer will appear at the lower edge of the *Terminal* window. The ***Stop*** button will be used later, to stop the ASCII capture.

G.4.4.3 Activate the Data Messages from Surveyor's Output

- If your mouse is not connected, you can press a macro button by holding down the *ctrl* and *alt* keys while pressing the appropriate function key.
- Click the macro buttons: **tpdr msg ON**, **ship msg ON**, and **range msg ON etc.** (Without a mouse: Ctrl-Alt F1 Ctrl-Alt F3 and Ctrl-Alt F5 etc.)
- **WAIT UNTIL YOU'VE GOT ENOUGH DATA.**

G.4.4.4 Deactivate the Data Messages (optional)

- Click the macro buttons: tpdr msg OFF, ship msg OFF, and range msg OFF.
- The data should stop.

G.4.4.5 Stop Logging Data from Surveyor's Output

- Click the ***Stop*** button mentioned in the section "Start logging data from Surveyor's output".

G.4.4.6 **Other Information**

For further information see the chapter about *Terminal* in the *Microsoft Windows User Guide* that comes with Windows 3.n.

G.5 LOGGING DATA FOR CASIUS

To use the Surveyor’s output to log data for the Casius calibration package, start logging, select only the message types 1 and 11 (Beacon and DGPS). While the manoeuvring is being done, the logging can be left running continuously, but the data stream turned on and off using the macro keys already defined. As an example using PC Plus (see Section G.4.3 in this Appendix) the following procedure would be adopted.

- Enter PC Plus and set up serial port.
- Set up the macro keys as defined in Section G.4.3.1
- Turn off all data types using macro keys set.
- Turn on the logging within PC Plus as described in Section G.4.3.2
- When the vessel is in the appropriate place to collect data, turn on data streams for Casius using 'Alt 7' check that the data stream is as expected.
- During data collection, turn off and on the data stream using 'Alt 8' and 'Alt 7' as appropriate.

When the manoeuvring is complete, turn off the logging as described in Section G.4.3.5.

APPENDIX H

H. LOGGING OUTPUT

This appendix describes the various types of message likely to be encountered in the logging csv file Note that Logging output messages may contain additional fields not listed in this Appendix. These are for Sonardyne specialist use and are not relevant to any customer operation. Customer messages available are:

- Transponder (Type 1).
- Ship (Type 2).
- Attitude (Type 5).
- Riser Angle Monitoring (Type 9).
- Analogue Measurement (Type 10).
- DGPS (Type 11).

H.1 TRANSPONDER MESSAGES

The following fields are available:

- **tick**

  The time when the message was sent.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **fix**

  The fix number. A number to identify which interrogation produced the data.

  A fix can produce a number of transponder ranges and hence a number of transponder messages.

  - Integer.
  - Range 0-4294967295

  See also: Ship message / fix

- **flag**

  Zero indicates a bad fix.

  Non zero indicates a good fix.

  - Integer.

  See also: Ship message / flag.

- **index**

  The transponder index. There can be a number of transponders. They are distinguished by the index.

  - Integer.
  - Range: 0-9

- **time**

  The time of the interrogation.

  - Floating Point.
  - Units: 1/100 second.
  - Range 0.0-4294967296.0 (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

  See also: Ship message / time.

- **raw_x**

  The unfiltered X position of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)
  - Sign convention: Port = +ve.

  See also: filt_e.

- **raw_y**

  The unfiltered Y position of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)
  - Sign convention: Ahead = +ve.

  See also: filt_n.

- **raw_d**

  The unfiltered depth of the transponder relative to the ship's datum

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_d.

- **pitch**

  The pitch angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Bows up = +ve.

  See also: Ship message / pitch.

- **roll**

  The roll angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees
  - Sign convention: Starboard down = +ve.

  See also: Ship message / roll.

- **bearing**

  The ship's bearing at the time of the fix.

  - Floating Point.
  - Units: Degrees

  See also: Ship message / bearing.

- **quality**

  The predicted horizontal standard deviation of the range in user-units. It is computed from the current fix.

  Smaller numbers are better.

  - Positive Floating Point.

- **filt_e**

  The filtered easting of the transponder relative to the ship's datum.

  Only different from raw_x if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_x.

- **filt_n**

  The filtered northing of the transponder relative to the ship's datum.

  Only different from raw_y if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_y.

- **filt_d**

  The filtered depth of the transponder relative to the ship's datum.

  Only different from raw_d if a gyro is connected and filtering is enabled.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet).

  See also: raw_d.

- **slant_range**

  The range from the transceiver to the transponder.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

H.2 SHIP MESSAGES

The following fields are available:

- **tick**

  The time when the measurement (fix) was made.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks).
  - 0 = when the Navigation Processor was last switched on.

- **fix**

  The fix number. A number to identify which interrogation produced the data. A fix can produce a number of transponder ranges and hence a number of transponder messages.

  - Integer.
  - Range 0-4294967295

  See also: Transponder message / fix.

- **flag**

  Zero indicates a bad fix.

  Non zero indicates a good fix.

  - Integer.

  See also: Transponder message / flag.

- **time**

  The time of the interrogation.

  - Floating Point.
  - Units: 1/100 second.
  - Range 0.0-4294967296.0 (Roll-over after 71 weeks).
  - 0 = when the Navigation Processor was last switched on.

  See also: Transponder message / time.

- **raw_e**

  The unfiltered easting of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_e.

- **raw_n**

  The unfiltered northing of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

See also: filt_n.

- **raw_d**

  The unfiltered depth of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: filt_d.

- **pitch**

  The pitch angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Bows up = +ve.

  See also: Transponder message / pitch.

- **roll**

  The roll angle of the ship at the time of the fix.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Starboard down = +ve.

  See also: Transponder message / roll.

- **bearing**

  The ship's bearing at the time of the fix.

  - Floating Point.
  - Units: Degrees.

  See also: Transponder message / bearing.

- **h_ell_drn**

  Horizontal error ellipse direction.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: +ve X-axis is 0. +ve is anticlockwise.

  See Figure H1, "Error ellipse".

- **h_ell_maj**

  Horizontal error ellipse - major radius.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See Figure H1, "Error ellipse".

- **h_ell_min**

  Horizontal error ellipse - minor radius.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See Figure H1, "Error ellipse".

- **z_err**

  The predicted standard deviation of the depth observation.

  Smaller numbers are better.

  - Positive Floating Point.

  See also: Transponder message / quality.

- **filt_e**

  The filtered easting of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_e.

- **filt_n**

  The filtered northing of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_n.

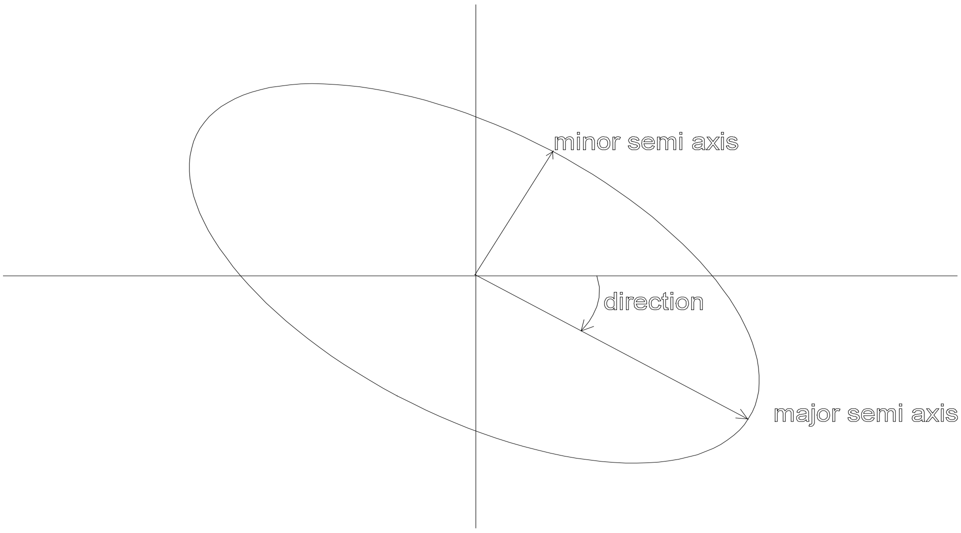
- **filt_d**

  The filtered depth of the ship.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

  See also: raw_d.

FIG H.1 ERROR ELLIPSE



H.3 ATTITUDE MESSAGES

TBA

H.4 RISER ANGLE MONITORING MESSAGES

The following fields are available:

- **tick**

  The time when the message was sent.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **index**

  The transponder index. There can be a number of transponders. They are distinguished by the index.

  - Integer.
  - Range: 0-9.

- **Riser_x**

  The pitch angle of the riser either reported from the Riser Angle Transponder or calculated from Differential and BOP pitch.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Bows up = +ve.

  See also: Ship message / pitch.

- **Riser_y**

  The roll angle of the riser either reported from the Riser Angle Transponder or calculated from Differential and BOP roll.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Starboard down = +ve.

  See also: Ship message / roll.

- **BOP_x**

  The pitch angle of the BOP reported from the Riser AngleTransponder.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Bows up = +ve.

  See also: Ship message / pitch.

- **BOP_y**

  The roll angle of the BOP reported from the Riser AngleTransponder.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Starboard down = +ve.

  See also: Ship message / roll.

- **Differential_x**

  The differential pitch angle of the BOP & riser either reported from the Riser Angle Transponder or calculated from Riser and BOP pitch.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Bows up = +ve.

  See also: Ship message / pitch.

- **Differential_y**

  The differential roll angle of the BOP & riser either reported from the Riser Angle Transponder or calculated from Riser and BOP roll.

  - Floating Point.
  - Units: Degrees.
  - Sign convention: Starboard down = +ve.

  See also: Ship message / roll.

- **tilt**

  The included angle between the axis of the BOP stack and the riser.

  - Floating Point.
  - Units: Degrees.

  Sign convention: zero represents Riser in line with BOP axis. All realistic angles will be positive.

- **bearing**

  The true bearing of the course to be made good to minimise the tilt angle.

  - Floating Point.
  - Units: Degrees.

  See also: Ship message / bearing.

H.5 ANALOGUE MEASUREMENT MESSAGES

The following fields are available:

- **tick**

  The time when the message was sent.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **index**

  The index of the transponder returning the analogue data. There can be a number of transponders. They are distinguished by the index.

  - Integer.
  - Range: 0-9

- **internal**

  This is a Boolean defining whether data from the internal or external sensor is being reported.

  - Integer.
  - Binary Value 0 represents External.
  - Binary Value 1 represents Internal.

- **volts1**

  A floating point representation of the first analogue voltage measured. With a Riser Angle Transponder this represents Roll at 0.0768 Volts per degree.

  - Floating Point.
  - Units: Volts.

- **volts2**

  A floating point representation of the second analogue voltage measured. With a Riser Angle Transponder this represents Pitch at 0.0768 Volts per degree.

  - Floating Point.
  - Units: Volts.

H.6 DGPS MESSAGES

The following fields are available:

- **tick**

  The time when the message was sent.

  - Integer.
  - Units: 1/100 second.
  - Range 0-4294967295. (Roll-over after 71 weeks)
  - 0 = when the Navigation Processor was last switched on.

- **qual**

  A figure representing the quality of the data.

  - Integer.
  - 0 for fix not available, 1 for GPS 2-9 for DGPS (Sercel use 1-3 for GPS).

- **numsats**

  The number of satellites currently in use.

  - Integer.

- **hdop**

  The horizontal dilution of precision.

  - Integer.
  - Units:1 is good increasing numbers represent poorer precision.

- **dgps_east**

  The UTM easting reported by the DGPS.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

- **dgps_north**

  The UTM northing reported by the DGPS.

  - Floating Point.
  - Units: The current LUSBL units. (Metres or feet)

APPENDIX I

I. PAN EMULATION MODE COMMANDS

Transceiver Set Up Commands		
Command	**Operation**	**Ref Section in PAN Manual**
TA	Turn-Around Time Subtracted by PAN	5.10
AD	Select Compatt or DMT Address	6.1
BF	PAN Telemetry Data Rate (Fast)	6.2
BN	PAN Telemetry Data Rate (Normal)	6.2
BS	PAN Telemetry Data Rate (Slow)	6.2
FV	Firmware Version	6.4
PG	PAN Gain Level	6.9
PL	PAN Tx Power Level	6.8
RS	PAN Reset	6.6
TW	Telemetry Wait	6.5

Compatt Commands		
Command	**Operation**	**Ref Section in PAN Manual**
DC	Disable CIF Interrogation Replies	7.5
DI	Disable IIF Interrogation Replies	7.5
DS	Disable ALL Interrogation Replies	7.4
DU	Disable USBL Interrogation Replies	7.5
EC	Enable CIF Interrogation Replies	7.3
EF, EN, ES	Enable ALL Interrogation Replies	7.2
EI	Enable IIF Interrogation Replies	7.3
EU	Enable USBL Interrogation Replies	7.3
RL	Release	7.6
AN	Analogue Voltage Measurement	8.7
BC	Battery Check	8.5
CD	Depth Measurement	8.3
CI	Sequential Interrogation	8.1
CQ	Quartz Depth Sensor Pressure Measurement	8.3
TQ	Quartz Depth Sensor Temperature Measurement	Addendum to 8
CT	Temperature Measurement	8.4
CY	Cycle Command	8.8
EL	Elapsed Time	8.6

FS	Fast Simultaneous Interrogation	8.2
SI	Simultaneous Interrogation	8.2
TC	Terminate Cycle Stack	8.8
BX	Battery Check Reset	9.4
CF	Change Reply Frequency (to CIF Interrogation)	9.7
CG	Change Receiver Gain (option)	9.9
CP	Change Transmission Power	9.6
CW	Change Wait Times	9.10
FE	Set Channel Frequency Reply to IIF Interrogation	9.12
FM	Set Fast Simultaneous Mode Reply to IIF Interrogation	9.12
JD	Jitter Suppression Disable	9.11
JE	Jitter Suppression Enable	9.11
NM	Set Normal (CRF) Reply to IIF Interrogation	9.12
OV	Override Low Battery Auto-Disable	9.5
PS	Power Status Request	9.2
RD	Reset Default Parameters	9.3
RM	Set Relay Mode Reply to IIF Interrogation	9.12
TS	Transponder Status Request	9.1
TT	Change Turn-Around Time	9.8

Riser Angle Compatt Commands		
Command	**Operation**	**Ref Section in LUSBL Manual**
RIA	Set Interrogation to Return Internal sensor Angles	As Below
RRA	Set Interrogation to Return Remote sensor Angles	As Below
RDA	Set Interrogation to Return the Difference Angles between the Internal sensors and the Remote sensors	As Below

These three commands are not implemented in the PAN as they are specific to Riser Angle Monitoring which is carried out using the LUSBL system, and are therefore not described in the PAN operating manual. The Structure of the Commands are however similar to the Sequential Interrogation Reply Modes commands syntax shown in Section 9.12.1 of the PAN operating manual. There is however a difference in the Status message B reply syntax (PAN Section 9.1.1 second page of flow chart), in that after the interrogation mode Enabled / Disabled fields an additional field for the Riser Angle Mode set exists before the Errors field. The additional field can be I for Internal, or X for eXternal or R for Relative. R for Relative is used instead of D for Differential so as not to be confused with D for Disabled. Similarly X for eXternal is used so as not to be confused with E for Enabled.

Example for Differential angles in USBL format.

"**RDA103t** C : 103 PENDING ... C : 103 CRF T2.5/5.5/0.50 DDER E : 0"

APPENDIX J

J. IO CONFIGURATION LINKS

This Appendix defines the functions of the links on the Serial IO Card (7784-146), the Serial IO Spreader (7784-142) and the new CPU Spreader (7784-141). Standard configurations of links are also given. In most circumstances it will not be necessary to adjust these links since Sonardyne supply these cards pre-configured to suit the particular application. However, in the event that the job changes for any reason, it may be necessary to change these links to suit. It is recommended that links are not changed unless Sonardyne has been consulted beforehand.

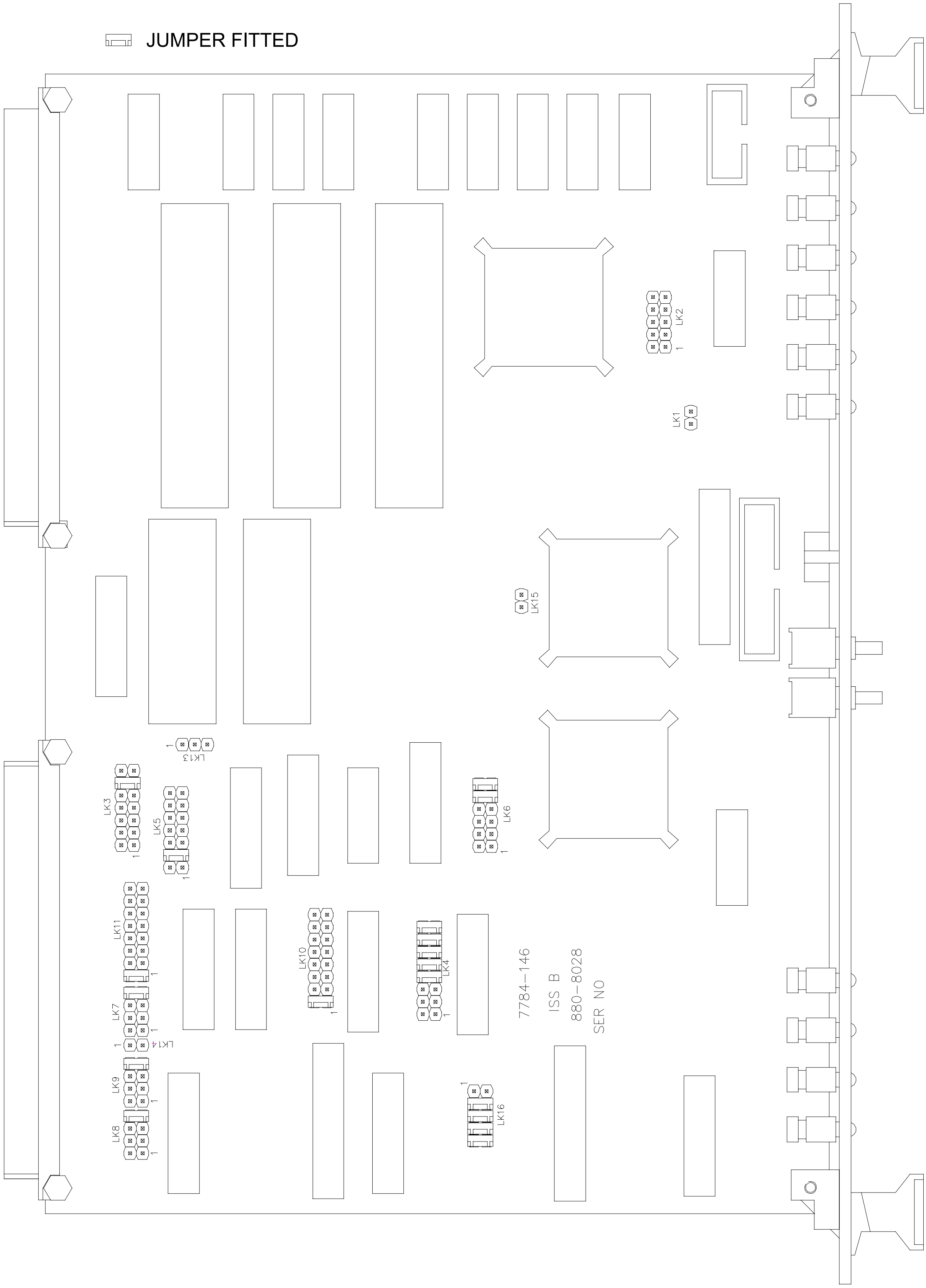
J.1 FUNCTIONS OF LINKS ON SERIAL IO CARD 7784-146

The list which follows defines the function of all of the links on this card. Default settings for a standard application are ticked (√). Figure J1 shows the locations of the links on the card with the default links in place.

Lk 1		When set puts the MC68332 in test mode on power up. (DO NOT FIT)
Lk 2		This is a header for connecting a hardware debugger.
Lk 3		1-2 enable VME IRQ7 out.
		3-4 enable VME IRQ6 out.
		5-6 enable VME IRQ5 out.
		7-8 enable VME IRQ4 out.
		9-10 enable VME IRQ3 out.
	√	11-12 enable VME IRQ2 out.
		13-14 enable VME IRQ1 out.
Lk 4		1-2 enable comparison of VME addr mod 0 with value set by Lk 6 1-2.
		3-4 enable comparison of VME addr mod 1 with value set by Lk 6 3-4.
		5-6 enable comparison of VME addr mod 2 with value set by Lk 6 5-6.
	√	7-8 enable comparison of VME addr mod 3 with logic 1.
	√	9-10 enable comparison of VME addr mod 4 with value set by Lk 6 7-8.
	√	11-12 enable comparison of VME addr mod 5 with logic 1.
	√	13-14 enable comparison of VME addr 23(msb) with value set by Lk 6 9-10.
	√	15-16 enable comparison of VME addr 22 with value set by Lk 6 11-12.
Lk 5		1-2 enable VME IRQ7 in.
	√	3-4 enable VME IRQ6 in.
		5-6 enable VME IRQ5 in.
		7-8 enable VME IRQ4 in.
		9-10 enable VME IRQ3 in.
		11-12 enable VME IRQ2 in.
		13-14 enable VME IRQ1 in.
Lk 6		1-2 compare VME address modifier 0 with 0. Do not fit if Lk 4 1-2 not fitted.
		3-4 compare VME address modifier 1 with 0. Do not fit if Lk 4 3-4 not fitted.
		5-6 compare VME address modifier 2 with 0. Do not fit if Lk 4 5-6 not fitted.
		7-8 compare VME address modifier 4 with 0. Do not fit if Lk 4 7-8 not fitted.
	√	9-10 compare VME address 23 with 0. Do not fit if Lk 4 9-10 not fitted.
	√	11-12 compare VME address 22 with 0. Do not fit if Lk 4 11-12 not fitted.

Lk 7		1-2 VME Bus Request is level 3.
		3-4 VME Bus Request is level 2.
		5-6 VME Bus Request is level 1.
	√	7-8 VME Bus Request is level 0.
		(Only one of the above should be made).
Lk 8		1-2 VME Bus Grant In is level 3.
		3-4 VME Bus Grant In is level 2.
		5-6 VME Bus Grant In is level 1.
	√	7-8 VME Bus Grant In is level 0.
		(Only one of the above should be made).
Lk 9		1-2 VME Bus Grant Out is level 3.
		3-4 VME Bus Grant Out is level 2.
		5-6 VME Bus Grant Out is level 1.
	√	7-8 VME Bus Grant Out is level 0.
		(Only one of the above should be made).
		N.B. Links Lk 7, Lk 8 and Lk 9 should be set to the same value.
Lk 10	√	1-2 compare VME address 21 with 0. Do not fit if Lk 11 1-2 not fitted.
		3-4 compare VME address 20 with 0. Do not fit if Lk 11 3-4 not fitted.
		5-6 compare VME address 19 with 0. Do not fit if Lk 11 5-6 not fitted.
		7-8 compare VME address 18 with 0. Do not fit if Lk 11 7-8 not fitted.
		9-10 compare VME address 17 with 0. Do not fit if Lk 11 9-10 not fitted.
		11-12 compare VME address 16 with 0. Do not fit if Lk 11 11-12 not fitted.
		13-14 compare VME address 15 with 0. Do not fit if Lk 11 13-14 not fitted.
		15-16 compare VME address 14 with 0. Do not fit if Lk 11 15-16 not fitted.
Lk 11	√	1-2 enable comparison of VME address 21 with value set by Lk 10 1-2.
		3-4 enable comparison of VME address 20 with value set by Lk 10 3-4.
		5-6 enable comparison of VME address 19 with value set by Lk 10 5-6.
		7-8 enable comparison of VME address 18 with value set by Lk 10 7-8.
		9-10 enable comparison of VME address 17 with value set by Lk 10 9-10.
		11-12 enable comparison of VME address 16 with value set by Lk 10 11-12.
		13-14 enable comparison of VME address 15 with value set by Lk 10 13-14.
		15-16 enable comparison of VME address 14 with value set by Lk 10 15-16.
Lk 12		Not Present.
Lk 13		1-2 Eproms are 27C010s.
		2-3 Eproms are 27C020s.
Lk 14		Not Present.
Lk 15		Enables FPGA permanent programming. DO NOT MAKE THIS LINK.
Lk 16		1-2 bit 7 of VME interrupt status byte is 0.
	√	3-4 bit 6 of VME interrupt status byte is 0.
	√	5-6 bit 5 of VME interrupt status byte is 0.
	√	7-8 bit 4 of VME interrupt status byte is 0.
	√	9-10 bit 3 of VME interrupt status byte is 0.

FIG J.1 DEFAULT LINK SETTINGS - SERIAL IO CARD 7784-146



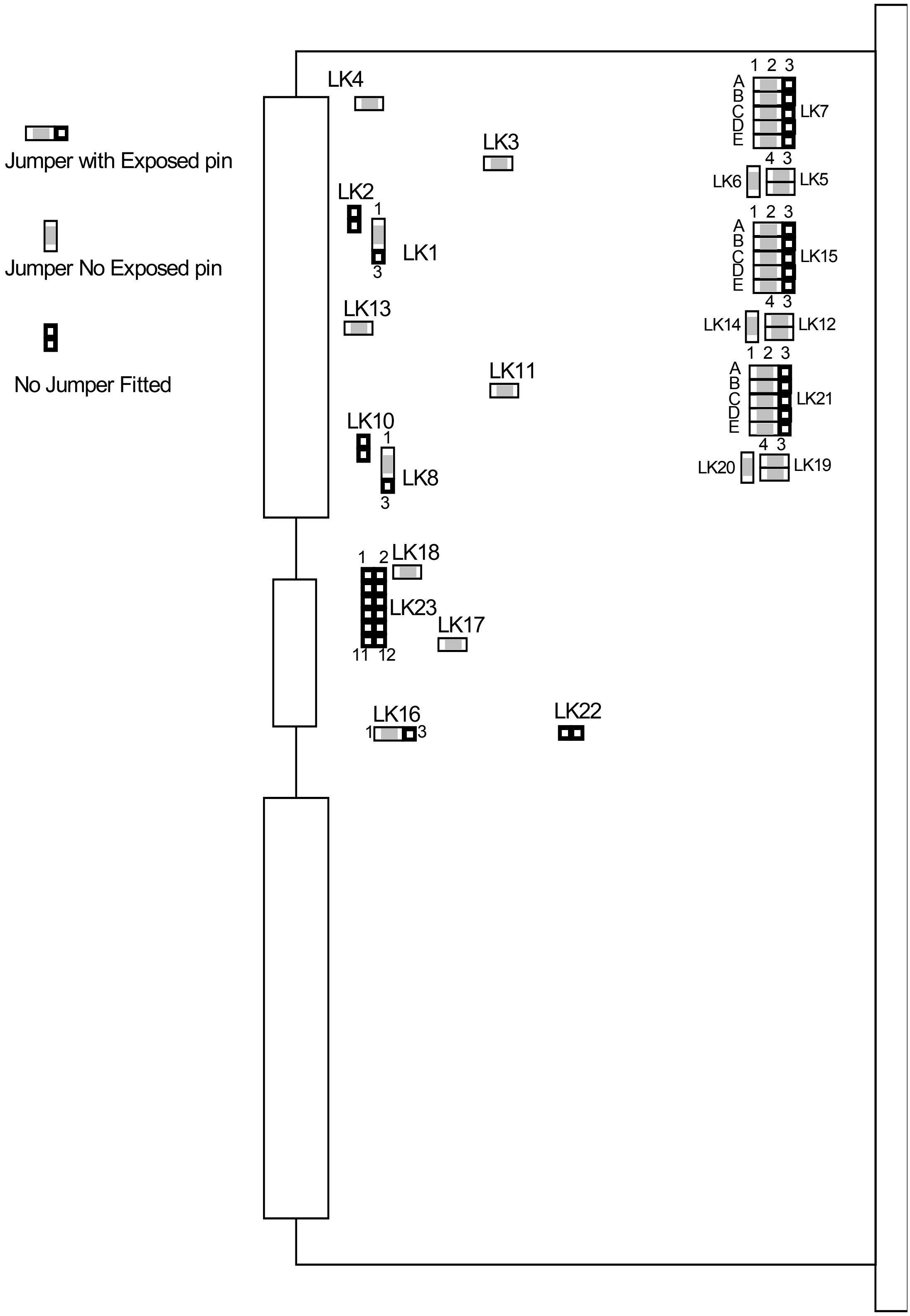
J.2 SUMMARY OF LINKS ON SERIAL IO SPREADER 7784-142

The list which follows defines the function of all of the links on this card. Default settings for a standard application are ticked (√). Figure J2 shows the locations of the links on the card with the default links in place.

Lk 1		1-2 RS232 selected for Channel 1 RX 2-3 RS485 selected for Channel 1 RX
Lk 2		When made, Sk 1 0V connected to mains earth.
Lk 3	√	When made, RTS controls TX (half duplex).
Lk 4	√	When made, centre tap of RS485 terminator is capacitively coupled to 0V (Lk 6 must also be made). (Channel 1).
Lk 5	√ √	1-2 3-4 When made, connects the RX+ to the TX+ line and the RX- to the TX- line for half duplex RS485 comms. (Channel 1).
Lk 6	√	When made, terminates the RS485 input with 100R (Channel 1).
Lk 7	 √	Rows A to E: 1-2 position Sk1 is RS232. 2-3 position Sk1 is RS485. When not fitted, Sk1 is isolated.
Lk 8	√	1-2 RS232 selected for Channel 2 RX 2-3 RS485 selected for Channel 2 RX
Lk 9		Not present.
Lk 10		When made, Sk 4 0V connected to mains earth.
Lk 11	√	When made, RTS controls TX (half duplex). (Channel 2).
Lk 12	√ √	1-2 3-4 When made, connects the RX+ to the TX+ line and the RX- to the TX - line for half duplex RS485 comms. (Channel 2).
Lk 13	√	When made, centre tap of RS485 terminator is capacitively coupled to (Lk 14 must also be made). (Channel 2).
Lk 14	√	When made, terminates the RS485 input with 100R. (Channel 2).
Lk 15	 √	Rows A to E: 1-2 Sk4 is RS232. 2-3 Sk4 is RS485. When not fitted, Sk4 is isolated.
Lk 16	√	1-2 RS232 selected for channel 3 RX 2-3 RS485 selected for channel 3 RX
Lk 17	√	When made, RTS controls TX (half duplex) (Channel 3).
Lk 18	√	When made, centre tap of RS485 terminator is capacitively coupled to 0V. (Lk 20 must also be made). (Channel 3).

Lk 19	√	1-2 3-4	When made, connects the RX+ to the TX+ line and the RX- to the TX - line for half duplex RS485 comms. (Channel 3).
Lk 20	√	When made, terminates the RS485 input with 100R. (Channel 3).	
Lk 21	 √	Rows A to E: 1-2 Sk6 is RS232. 2-3 Sk6 is RS485. When not fitted, Sk1 is isolated.	
Lk 22		When made, Sk 6 0V connected to mains earth.	
Lk 23		1-2 3-4 5-6 7-8 9-10 11-12	When made, connects Ch1+, Ch1-, Ch2+, Ch2-, Ch3+, Ch3- respectively to S3, the internal ribbon. (Must also put in half duplex RS485 to work.)

FIG J.2 DEFAULT LINK SETTINGS - SERIAL IO SPREADER 7784-142



The default settings set the board up as 6 RS232 serial channels, with the internal ribbon isolated from the board. The RS485 terminators and centre taps are in place, and half duplex is selected, but as the RS485 chips are disconnected from both the external Lemo connector and the internal ribbon cables, this makes no difference.

a. To set the board up to drive a USBL Transceiver on channel 1, it is necessary to make:

Lk 1 2-3.

Lk 2 not fitted.

Lk 3 fitted.

Lk 4 not fitted.

Lk 5 1-2 & 3-4.

Lk 6 fitted.

Lk 7 A-E 2-3.

Lk 23 1-2 & 3-4.

b. To set the board up to drive a USBL transceiver on channel 2, it is necessary to make:

Lk 8 2-3.

Lk 10 not fitted.

Lk 11 fitted.

Lk 12 1-2 & 3-4.

Lk 13 not fitted.

Lk 14 fitted.

Lk 15 A-E 2-3.

Lk 23 5-6 & 7-8.

c. To set the board up to talk to a second Navigation Processor externally on channel 3, it is necessary to make:

Lk 16 2-3.

Lk 17 not fitted.

Lk 18 not fitted.

Lk 19 not fitted.

Lk 20 fitted.

Lk 21 A-E 2-3.

Lk 22 not fitted.

Lk 23 9-10 not fitted & 11-12 not fitted.

It is recommended that all these links - (a), (b) and (c) above - are made for a dual-redundant system.

J.3 SUMMARY OF LINKS ON CPU SPREADER 7784-054 (TYPE I UNITS)

The list which follows defines the function of all of the links on this card. Default settings for a standard application are ticked (√).

Lk 1	√	The board provides the termination power to the SCSI bus.
Lk 2	√	AUTOFD active (low) on printer bus.
Lk 3	√	SELINP active (low) on printer bus.
LK 4		1-2 Heartbeat not enabled on Ethernet.
	√	2-3 Heartbeat enabled on Ethernet.
LK 5	√	TRXC 4 serial clock connected to DSR pin on PL4 (USBL TRANSCEIVER)
LK 6	√	RTXC 4 serial clock connected to RI pin on PL4 (USBL TRANSCEIVER).
LK 7		Not present
LK 8		Not present
LK 9	√	RXD on port 2 (DP comms) driven by current loop input
LK 10	√	CL out- connected to Navigation Processor 0V.
LK 11	√	CS2 connected to CL in+.

J.4 SUMMARY OF LINKS ON CPU SPREADER 7784-141 (TYPE II UNITS)

The list which follows defines the function of all of the links on this card. Default settings for a standard application are ticked (√). Figure J3 shows the locations of the links on the card with the default links in place.

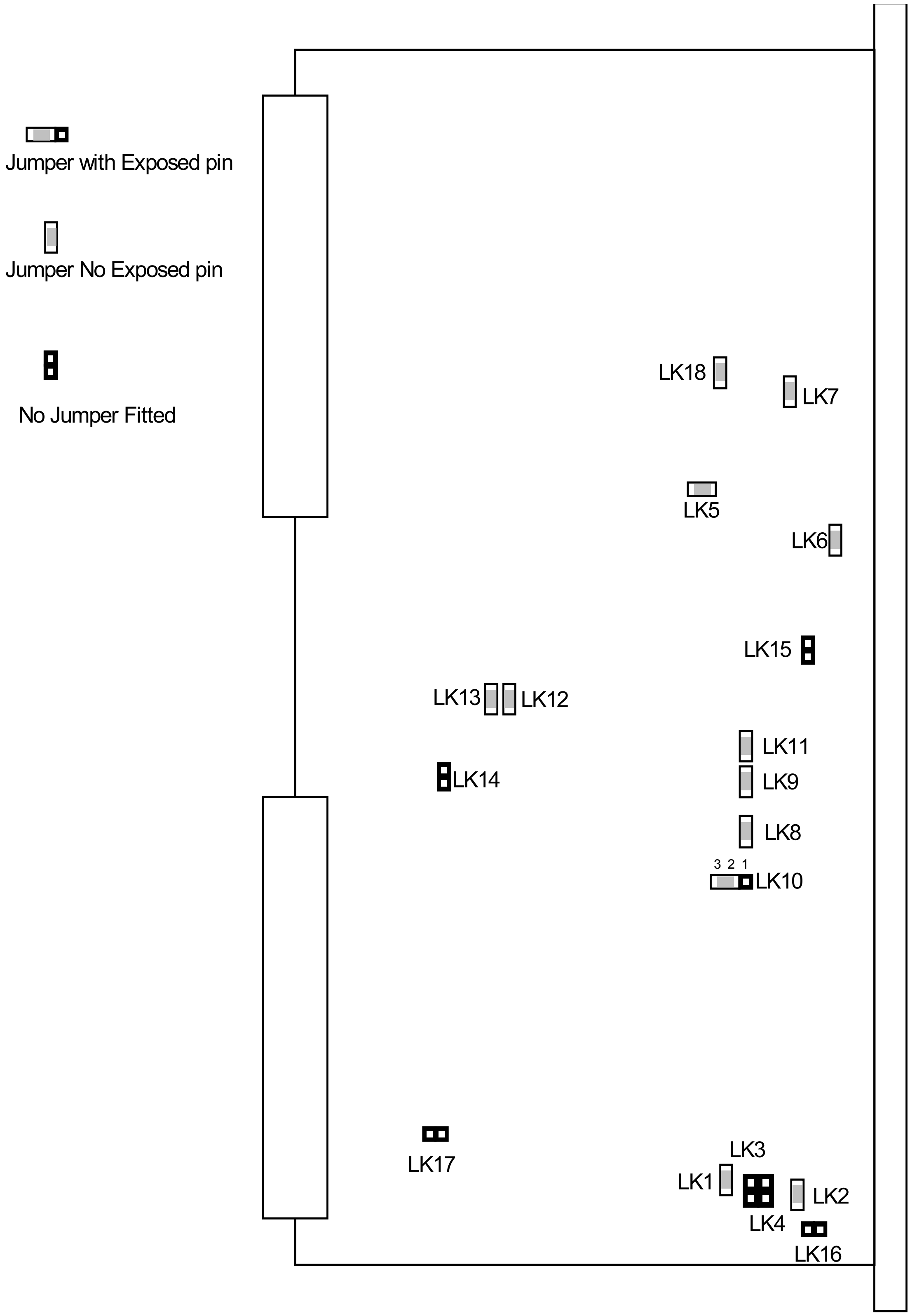
Lk 1	√	The board provides the termination power to the SCSI bus.
Lk 2	√	Heartbeat enabled on Ethernet.
Lk 3		AUTOFD active (low) on printer bus.
Lk 4		SELINP active (low) on printer bus.
Lk 5	√	RXD on port 2 driven by current loop input.
Lk 6	√	CL out- connected to NAVIGATION PROCESSOR 0V.
Lk 7	√	CS2 connected to CL in+.
Lk 8	√	RXD 4 on CPU card connected to PL4 pin 2.
Lk 9	√	Ribbon cable RX connected to RXD 4 on CPU card.
Lk 10		1-2 CTS4 input to CPU card driven from PL4.
	√	2-3 CTS4 driven from ribbon cable.
Lk 11	√	DTR output from CPU card drives direction of ribbon cable comms (half duplex). (If not made then configured as input).
Lk 12	√	Centre tap of RS485 terminator capacitively coupled to OV.
Lk 13	√	100 ohm RS485 terminator connected.
Lk 14		Floating RS485 0V connected to NAVIGATION PROCESSOR 0V.
Lk 15		Floating RS485 0V connected to mains earth.
Lk 16		RTXC 4 serial clock connected to RI pin on PL4.
Lk 17		TRXC 4 serial clock connected to DSR pin on PL4.
Lk 18	√	Responder trigger out enabled (if not fitted low).

To use a 7784-141 spreader to replace a 7784-054 spreader in a system with a Type I base tray, make the following:- link 8, link 10 1-2 and Link 11. Do not make link 9. Make links 5, 6 & 7 reflect the state of links 9,10 & 11 respectively on the 7784-054 board being replaced.

For a non dual-redundant system with a Type II base tray and the Transceiver driven from the Serial Card, links 8-13 should be fitted and links 14 & 15 not fitted.

For a dual-redundant system,, or one where a Transceiver is driven from the Serial Card, link 8 must be fitted and links 11, 12 , 13, 14 & 15 must not be fitted.

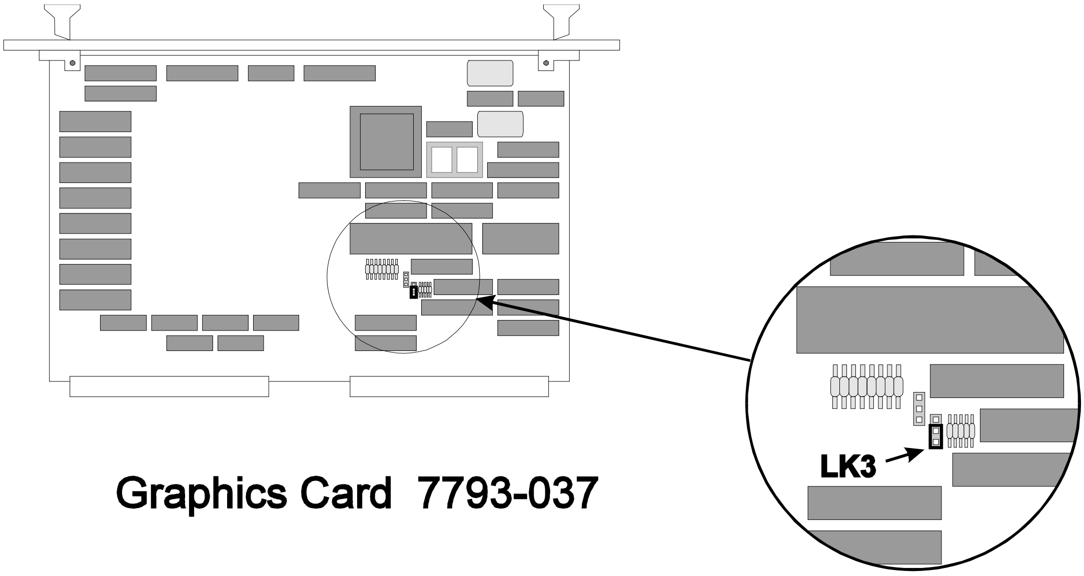
FIG J.3 DEFAULT LINK SETTINGS - CPU SPREADER 7784-141



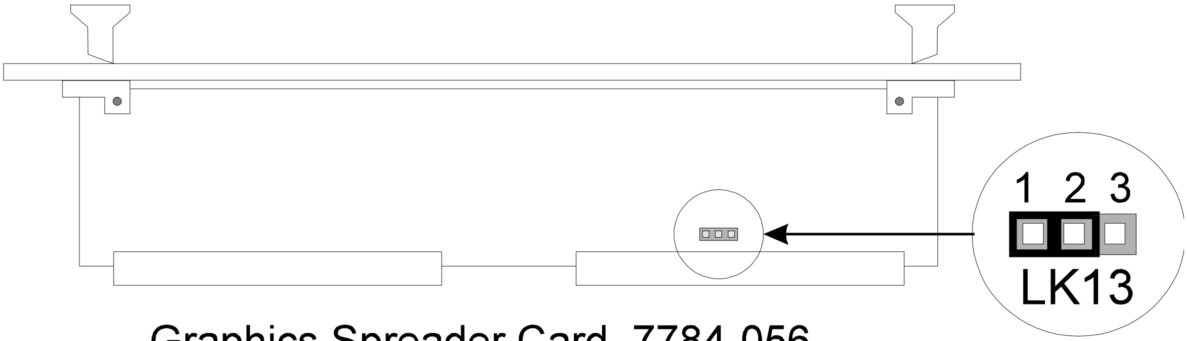
J.5 CONVERTING GRAPHICS CARD TO VGA FROM SYNC ON GREEN

To change from RGB sync on green to VGA video output:- Remove the jumper from Link 3 of the Graphics Card (7793 - 037) and use this jumper to link pins 1 and 2 of Link 13 on the Graphics Spreader Card 7784 - 056.

FIG J.4 LINK SETTINGS - GRAPHICS CARD AND SPREADER



Graphics Card 7793-037

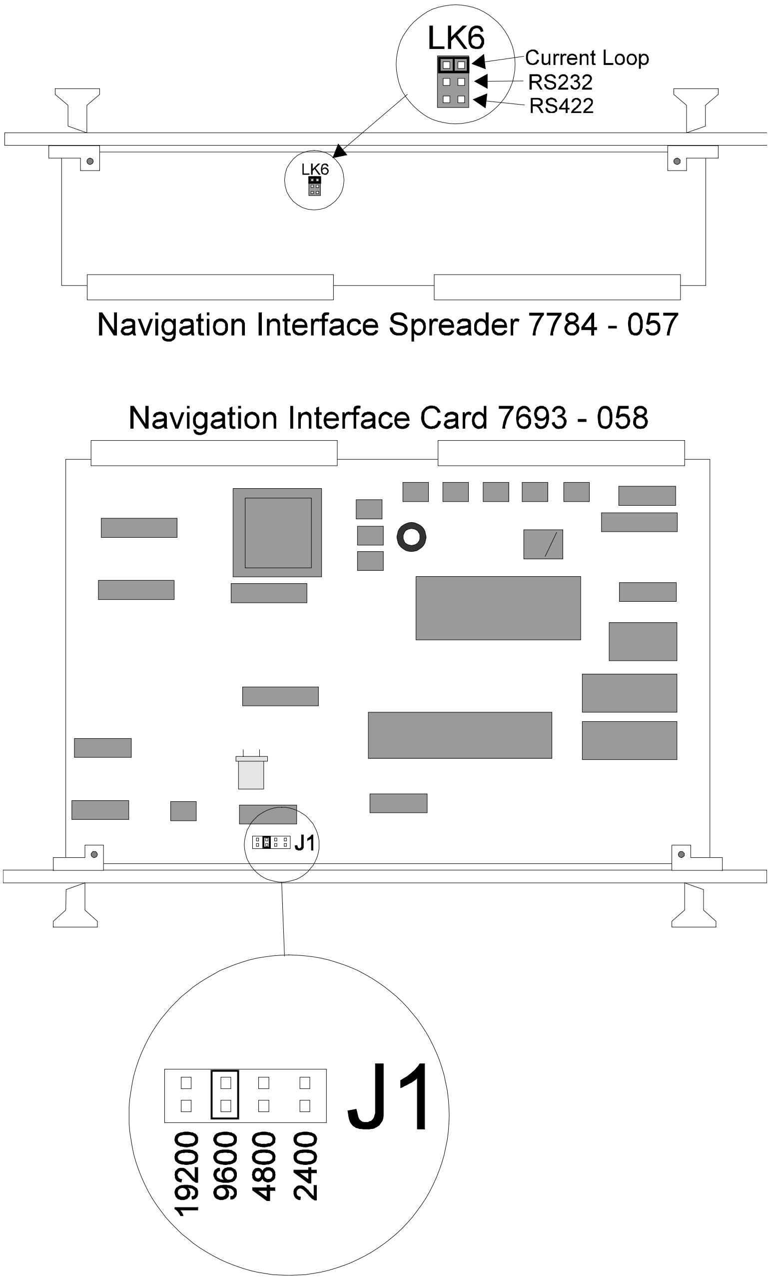


Graphics Spreader Card 7784-056

J.6 CHANGING FORMAT AND BAUD RATE FOR SERIAL GYROS

To change from current loop to RS232 or RS485 change link 6 on the navigation interface spreader. To change the baud rate change JI on the Navigation Interface card.
13 on the Graphics Spreader Card 7784 - 056.

FIG J.5 LINK SETTINGS - NAVIGATION INTERFACE AND SPREADER



APPENDIX K

K. DUAL-REDUNDANT LUSBL SYSTEM

K.1 INTRODUCTION

This Appendix covers the differences which apply to the Installation, Operation and Maintenance of the dual-redundant version of the LUSBL.

K.2 DESCRIPTION

In the dual-redundant version of the system, two complete sets of LUSBL equipment (Navigation Processor, Monitor/Keypad and Transceiver) are operated in tandem. The two sub-systems are cross-linked in such a way that, in the event of a failure of any major element, system operation will continue without the need for operator intervention. From the operator’s point of view, operation of the dual-redundant version is essentially identical to that of the standard version. A block schematic diagram of a typical system is given in Fig K.1.

In operation, one sub-system or the other operates as the “master” and performs all normal system functions. The second sub-system monitors the function of the “master” and will commandeer system operation as a new “master” if it detects that the erstwhile “master” is not functioning.

K.2.1 Hardware Implications

The only hardware differences between a dual-redundant version and a standard version (other than there being two of each item) are in the connections to the Navigation Processor.

In the dual-redundant version, two Transceiver output ports are available - one connected directly to the local Transceiver and the other connected via the remote Navigation Processor to the remote Transceiver (see Figure K1). In addition, on each Navigation Processor, a serial port is allocated to act as a communications interlink between the two sub-systems. This comms link is used for data communications between the two sub-systems - in particular, the “tick” messages (see below) and database transfers.

K.2.2 Functional Implications

Inter-system monitoring is carried out by means of a continual stream of messages (known as ticks) passing between the two sub-systems. The content of a tick can be varied so that it can convey information to the other sub-system. The tick messages are used to achieve a number of functions, as follows:

- On start-up, a sub-system (the local sub-system) waits for a period corresponding to eight ticks during which time it “listens” for ticks from the other (remote) sub-system. If no ticks have been received over this period, the local sub-system assumes the role of “master” and will operate the LUSBL system on its own.
  - If, subsequently, the remote sub-system is powered-up, it will always become the “slave” sub-system.
  - If, on start-up, a sub-system receives ticks from another sub-system within the eight tick period, then the sub-system having the lower ID automatically becomes master.

- During the start-up phase, the “master” transfers its version of the job database to the “slave” and thereafter maintains control of both the database and the Transceiver link for as long as it remains “master”. All normal system operation is executed by the “master”. If the operator subsequently makes changes to the database, the “master” will automatically transfer the new database to the “slave”.

- At any time, the operator may force a master/slave changeover by pressing the ARM and MASTER keys on the Type 7783 Monitor/Keypad simultaneously. If this happens, the “slave” will wait for the next tick from the current “master” and then send its own response tick indicating that it is waiting to become master. This will then indicate to the current “master” that it must complete any outstanding database transfers immediately, prevent the operator making any further changes, and then confirm that it has become “slave”.

Note that, in the case of the Type 7940 Monitor unit, the ARM and MASTER keys are found not on the Monitor unit itself but on the Type 7941 Keyboard unit mounted underneath.

- Similarly, if, after a few seconds, the current “slave” detects that it is no longer receiving ticks from the current “master” or that there is no activity on the Transceiver link, it will assume that the “master” is no longer in control, and will generate a Level 1 alarm and will automatically become the new “master” itself.

The Level 1 alarm triggers a continuous audible alarm and displays a warning message in the main display area. The audible alarm may be switched off by pressing the “ARM” and “ALARM” keys together but the warning message will remain until the fault is cleared. However, in the case of a dual-redundant system, operation may be continued with normal performance until it is convenient to halt the system and clear the fault.

K.3 OPERATION

From the operator’s viewpoint, operating a dual-redundant LUSBL is very similar to operating a standard one.

System start-up is essentially normal - except that two sub-systems have to be powered-up instead of one. As described earlier, the two sub-systems will sort out automatically which of them is to become “master” and, thereafter, operation will proceed in much the same way as a standard system.

The operator will be aware at all times, by observing the status display box on the Monitor screen, whether or not his local sub-system is currently “master” or “slave” and, if system operation is normal, there will be no need to change the master/slave situation.

If, however, there is a need to make some change to the job database, the operator will have to switch his local sub-system over to “master” status (using the ARM and MASTER keys as described earlier), if it is not already in that state. He will then be able to make whatever changes are needed (using the procedures described in Section 2 in the main document) and, externally at least, the system will respond to these changes exactly as though it were a standard system. Internally, the changes to the database made on the “master” will be communicated automatically to the “slave”.

- If a sub-system failure occurs, the system will continue operating normally without operator intervention, although the operator is made aware that a failure has occurred by means of an audible alarm and a warning message on his screen - see Appendix K.5. If such a message does appear, the operator should note the contents of the message and whether his local station is currently “master” or “slave”. He should then move to the remote station and note the same information on that sub-system - if applicable. The audible alarm may be switched off by pressing the “ARM” and “ALARM” keys together but the warning message will remain until the fault is cleared.

K.4 INSTALLATION

For the most part, installation procedures and connections required for a dual-redundant version of the LUSBL are as described in Section 3 of the main document for a standard system - except, of course, there are two sets of equipment to be installed. The only new features are:

- Connection of the second Transceiver port on each Navigation Processor to the other Navigation Processor.
- Connection of a comms serial port (usually Ser 3) on one Navigation Processor to the corresponding port on the other.

Similarly, installation setup procedure is very similar to that described in Section 4 of the main document for a standard system - with a few differences, as follows:

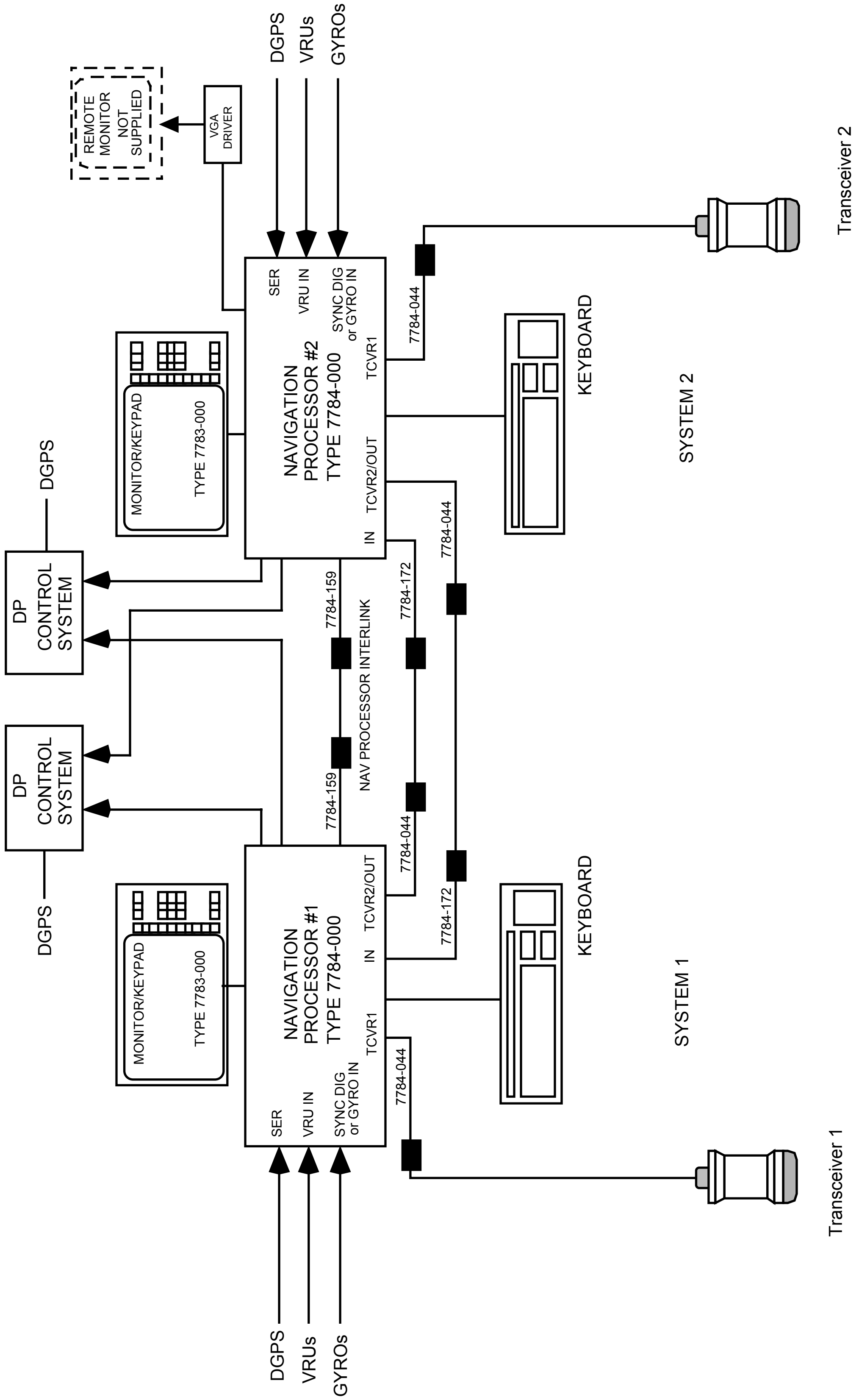
- From the “master” sub-system, access the “**Acoustic Transceivers**” page as described in Section 4.2.3 and enter, for each Transceiver, details of “**Object Attached to**” and “**Serial Number**”. Enter also the positions of both Transceivers in the SHIP grid.
- From the “master” sub-system again, access the “**I/O Port Allocation & Setup**” page as described in Section 4.2.1. Enter, for each Transceiver, the serial port settings required. As illustrated in Figure 4.1, serial ports Ser 1 and Ser 2 are usually used for this purpose. Ensure that the port settings for the two Transceivers are identical.
- On the same page, select the serial port allocated to the Navigation Processor interlink (usually Ser 3) and enter the port settings required. Usually, these will be as illustrated in Figure 4.1.
- Having made these entries, save the installation database using the “**Archive Install files to PC Disc**” option under “**Job File Management**” - see Section 2.5 in the main document. Re-boot the “master” system using the reset button on the Navigation Processor.
- The same installation database may now be installed on the remote system by moving to the remote system, making it the master and copying the installation database onto it from the floppy disc using the “**Restore Install files from Disc**” option under “**Job File Management**”. Be aware, though, that not all installation details are necessarily the same (VRU and Gyro details, for instance, will probably be different) on this sub-system.
- Having ensured that all installation details are correct on this sub-system, save this installation database as described above and re-boot this system also.

K.5 MAINTENANCE

Maintenance strategy and routine maintenance tasks are as described in Section 7 of the main document.

If a failure occurs, the error message(s) noted by the operator at the time of the failure should be analysed to give an indication of the type of fault and its location. From this starting point, when a suitable opportunity for failure investigation occurs, the maintainer should follow the same procedures described in Section 7 of the main document.

FIG K.1 BLOCK SCHEMATIC DIAGRAM - DUAL-REDUNDANT SYSTEM



APPENDIX L

L. SYSTEM CALIBRATION

L.1 INTRODUCTION

This Appendix describes a procedure which may be used to check Gyro and VRU offset errors with a fully installed and operational LUSBL system.

L.2 INITIAL REQUIREMENTS

This procedure assumes that all installation setup procedures through to and including Section 4.2.7 have been carried out, that a Reference array of four COMPATT Beacons has been set up on the seabed and that at least one of these COMPATTs has a depth sensor. It is also assumed that an extra Beacon is available to be used as "Mobile" Beacon and that this Beacon also has a depth sensor.

L.3 GYRO CALIBRATION PROCEDURE

L.3.1 Array Setup

- Select "**Navigation Setup**" from the "**Job Setup**" menu. Use the Status option to change the status of the four Reference Beacons from "Offline" to "Not Set" - if not in this state already.

- Check that the current depths of the four Reference Beacons are correct as displayed.

  If there is any doubt about array depth, and assuming that at least one of the Reference Beacons has a depth sensor, open the Beacon summary page for the appropriate Beacon(s) and use the "Depth" button to obtain the Beacon depth. The system will respond by transmitting acoustic commands, receiving telemetry via the Transceiver and will modify the LUSBL database to suit.

- Escape back to the top level menu and enter the correct password (obtainable from Sonardyne on request) to display the USBL-determined 'back plot' positions for the four Reference Beacons during navigation.

L.3.2 Compatt Setup

Select "Navigation" from the top level menu. Prior to starting navigation, the four Reference Beacons should be set up under program control, with the command prompts displayed in the top centre menu box for each Beacon in turn:

- Enabling <addr> with Normal Telemetry
- Reset defaults on <addr>
- Change to High Power on <addr>
- Set TAT on <addr> to 4 (250.0)
- Disabling CIF for <addr> (Note: Mk3 Beacons only)
- Enabling IIF for <addr>
- Enabling new frequency for <addr>
- Changing frequency of <addr> to <IRF>

NB <addr> refers to the address of the Beacon concerned.

If COMPATT command difficulty is experienced, the following prompts will be displayed following three unsuccessful command attempts:

- Retry Card
- Abort Card
- Take Beacon Off Line

Following correct setup of each Reference Beacon, the program will set the COMPATT status to “Ready” on the Nav SETUP page and display “Initialising Ref Beacon Filter” in the top centre box.

Following correct setup of all the Reference Beacons, the program will display “Initialising Ship Filter” in the top centre box and commence navigation.

Select “**Nav Setup**” and move to the Reference Beacons panel. Display the Beacon summary page of each Reference Beacon in turn. Change the Beacon Transponder Power from HIGH to LOW and Transponder Gain from HIGH to LOW. The correct commands will be interleaved with navigation under program control, with the relevant command prompt displayed in the top centre menu box.

L.3.3 Navigation:

Escape from “**Nav Setup**” to “**Navigation**”:

- Select “**Chart Co-ord FRAME**” followed by “**SEABED Frame**” and “**Gyro North Up**”.
- Escape to “**Navigation**” and select “**Chart CENTRE**” followed by “**SHIP Centred Chart Display**”.
- Escape to “**Navigation**” and select “**Chart SCALE**”. Select an appropriate display scale to view both the vessel and the four Reference Beacons.
- Confirm that the four Reference Beacons are displayed in the expected position in a North-up, Seabed Reference frame, with the vessel plotted near the centre of the screen with the correct heading.

Set up the Data Boxes as follows:

- Escape to “**Navigation**” and select “**Data BOXES**”. Select “**Box 1 Position Data**” followed by “**Ship Position Data**”. Confirm that the vessel Eastings, Northings, depth, computed position error and the current filter setting are displayed in the first Box; the mean depth should be zero metres with a spread under +/- 0.5 metres.
- Return to “**Data BOXES**” and select the following:
    - “Box 1 Position Data”, “Seabed Target Data”, “First Beacon”.
    - **“Box 2 Position Data”, “Seabed Target Data”, “Second Beacon”.**
    - **“Box 3 Position Data”, “Seabed Target Data”, “Third Beacon”.**
    - **“Box 4 Position Data”, “Seabed Target Data”, “Fourth Beacon”.**
- Confirm that the positions, computed position errors and current filter setting of each Reference Beacon are displayed in the four Boxes.

Note:	As the password has been entered, the 'back plotted' USBL-derived positions for each reference beacon will be displayed both on the screen and in the data boxes. Hence, the positions will vary slightly with each update. Had the password not been entered, the fixed reference beacon positions and co-ordinates would be displayed underlined.

L.3.4 Reference Beacon 'Back Plots'

A consistent angular offset will arise between externally calibrated seabed Reference Beacon positions and the LUSBL 'back plotted' positions if there is still a misalignment offset between the USBL Transceiver and/or the vessel heading determined from the Gyro, and the orientation of the seabed array. This angular error is best determined by attaching more importance to the Reference Beacon(s) deployed furthest from the vessel. However the 'sense' of any angular offset should be determined using all the Reference Beacons in the array.

Collect range and offset data for all Reference Beacons (assuming there are four) as described below and enter all values into a table similar to the sample one shown below.

- From the "Navigation" menu, select "**Chart CENTRE**" followed by "**REFERENCE Beacon Centred Chart Display**" and "**First Beacon**", choosing an appropriate display scale to view both the fixed position of the Reference Beacon and the LUSBL 'back plot'. Estimate the mean offset between the fixed position and the backplot along a bearing at right angles to a line between the vessel and Reference Beacon.

- Then select "**Data BOXES**" followed by "**FROM/TO Data Box**", "**RANGE AND BEARING**", "**Relative Position From**", "**Ship Ref Point Data**", "*NAME OF TRANSCEIVER*". Escape back to "**RANGE AND BEARING**" and then select "**Relative Position Data To**" followed by "**Seabed Target Data**" and "**First Beacon**" (etc) and record the mean range.

#	Ref. Bcn Addr	Range to Ship	Mean Offset	Angle Offset	Sense CW/ACW
1					
2					
3					
4					

Calculate the angular correction for this Transceiver. Return to the top level menu and select "**Job SETUP**" followed by "**Attitude SENSOR CORRECT**". Enter the calculated value as the Transceiver Heading Correction for the Transceiver. Escape back to "**Navigation**", selecting the most distant Reference Beacon as the Chart Centre and confirm that the correction has been applied in the correct sense.

In the case of a dual-redundant LUSBL, this whole procedure should now be repeated for the other sub-system and the other Transceiver.

L.4 VRU CALIBRATION PROCEDURE

Move the ship to a position approximately above the centre of the Reference array and maintain this position throughout, with the LUSBL in "Navigate" mode and using DP if available.

Deploy a spare Beacon over the side so that it arrives at a position on the seabed immediately underneath the ship.

From the top level menu, select "**Nav Setup**" and enter this Beacon onto the Beacon Navigation panel as a "Mobile" Beacon. Select the Beacon Summary page for this Beacon and measure its depth, as described earlier.

Then select "**Data BOXES**" followed by "**FROM/TO Data Box**", "**CARTESIAN Coords**", "**Relative Position From**", "**Ship Ref Point Data**", "*NAME OF TRANSCEIVER*". Escape back to "**CARTESIAN Coords**" and then select "**Relative Position Data To**" followed by "**Seabed Target Data**" and "*NAME OF 'MOBILE' BEACON*".

If the VRU offsets are correctly set, the X and Y co-ordinates in the "**FROM/TO Data Box**" should both be zero. If they are not, an error in the X co-ordinate implies that there is a Pitch offset error and an error in the Y co-ordinate implies that there is a Roll offset error.

Note any X and/or Y co-ordinate values, together with the Beacon depth, and calculate the offset corrections to be applied, taking the sign of the offset errors into account.

Return to the top level menu and select "**Job SETUP**" followed by "**Attitude SENSOR CORRECT**". Enter the calculated value(s) in the "**TCVR/Ship Grid Corrections**" column for the Transceiver concerned.

APPENDIX M

M. ANT PROGRAMMING

M.1 INTRODUCTION

The programme given in this Appendix enables the ANT to act as a Transponder.

M.2 ANT TRANSPONDER PROGRAMME

KEY	LABEL	COMMENTS
ON	POWER UP	
3	MULTI	
3	OLD PAN	PAN MODE
2	INTERROGATE	
2	SET	
4	SWAP	ANT BECOMES TRANSPONDER
2	TX REPLY	
6	MF	
3	CRF	
3	RX INT'G'N	
6	MF	
2	CHAN	
5	<ENTER>	TRANSPONDER INT'G'N CHANNEL
4	TRT	TURN AROUND TIME
250	<ENTER>	
1	EXIT	
3	STORE	
1	<ENTER>	SAVE IN STORE 1

APPENDIX N

N. ACOUSTIC FREQUENCY CHANNELS

Frequency clashes with a USBL or LUSBL system can be avoided by prudent choice of interrogate and reply channels for the COMPATTs being interrogated by the system. This is particularly true in the case of an LUSBL system (which tends to utilise more COMPATTs) and where other acoustic systems are in use in the same area of sea.

The general rule is “choose frequencies which are well separated from those being used by other Beacons in the vicinity”. For an LUSBL with (say) four COMPATTs, it is safest to pick four separate IIFs and a different four separate IRFs. However, in many cases, it is possible to economise on frequencies and still achieve sufficient discrimination by setting one CIF and four different IRFs together with four different turn-around times.

The diagrams which follow summarise the range of Sonardyne and SIMRAD frequencies associated with HPR 309 telegram transmissions (Fig N.1) and HPR 418 telegram transmissions (Fig N.2). Assuming other frequencies being used in the area are known, it is possible, using these diagrams, to select frequencies for the current job which are well separated from each other and all other known frequencies.

FIG N.1 SONARDYNE AND SIMRAD CHANNEL FREQUENCIES - HPR 309

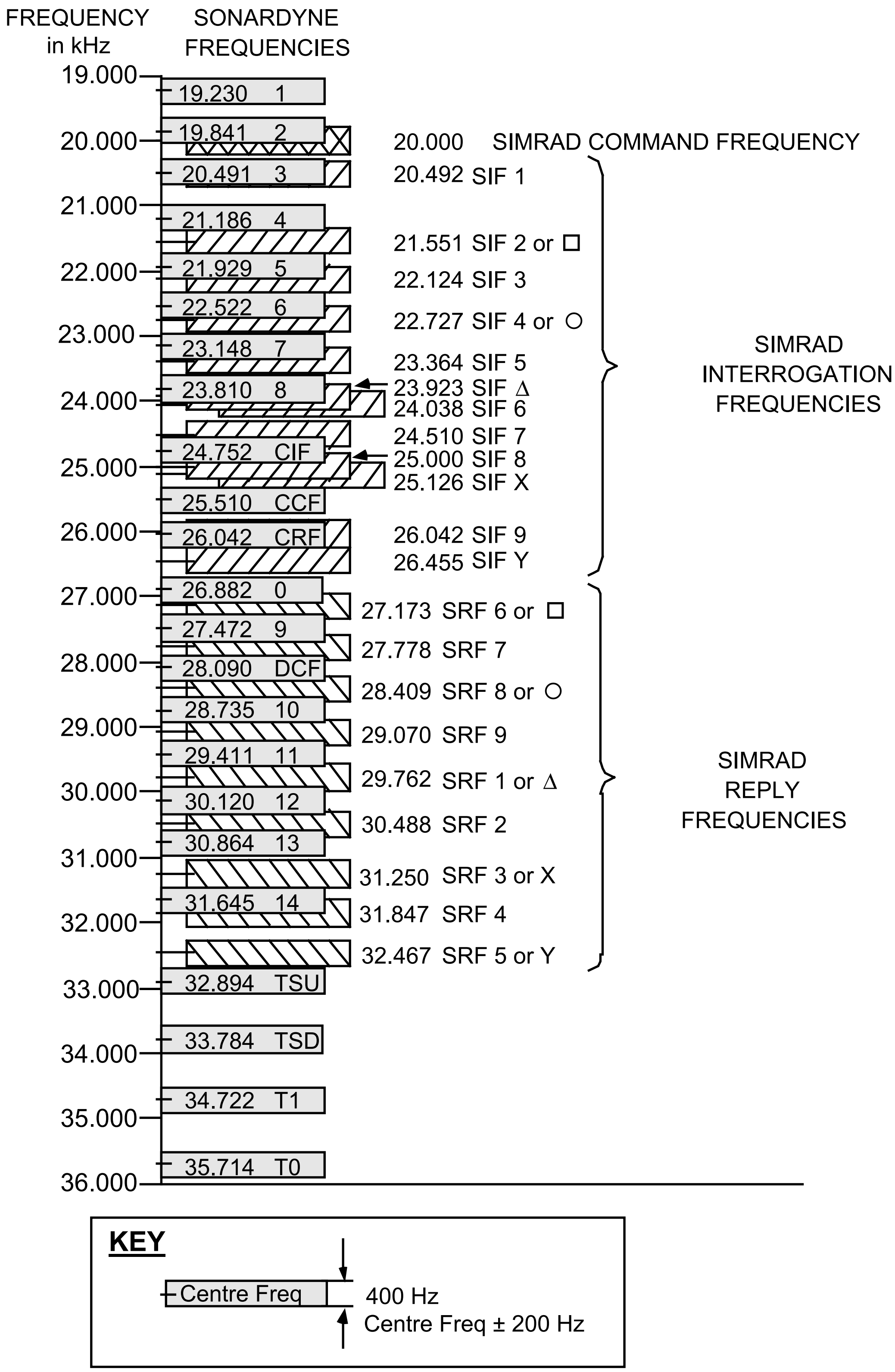


FIG N.2 SONARDYNE AND SIMRAD CHANNEL FREQUENCIES - HPR 418