



440 Pipe and Cable Survey System

System Manual Covers DeepView Software Version 3.1.3 and Firmware Version 1.14

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CAUTIONARY NOTICES

This System Manual contains full installation and operating instructions and is an important part of the 440 System. This Manual should remain easily available for use by those who will install, operate and maintain the System.

WARNINGS and CAUTIONS



Where appropriate, this Manual includes important safety information. Safety information appears as **WARNING** and **CAUTION** instructions.

You must obey these instructions:

- ❑ **WARNING** instructions alert you to a potential risk of death or injury to users of the 440 System.
- ❑ **CAUTION** instructions alert you to the potential risk of damage to the 440 System.

For your convenience, the Table of Contents section includes copies of all the **WARNING** and **CAUTION** instructions contained in this Manual.





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GLOSSARY

Item	Definition as used throughout this Manual
ROV	Remotely operated vehicle. Any form of sub-sea or surface vehicle supporting the 440 System during survey operations.
SDC	Surface display computer. The configuration, control and display computer supplied by TSS to operate the 440 System.
SEP	Sub-sea electronics pod. The depth rated unit that performs the measurement operation on the target.
PSU	Sub-sea power supply pod. The depth rated unit that accepts an electrical supply from the ROV and produces the conditioned and stabilised DC supplies used by the SEP.
VRT	Vertical range to target. The distance measured by the 440 System along a line perpendicular to the coil surface, between the coil array and the closest point of the conductive target.
LAT	Lateral offset. The horizontal distance measured by the 440 System between the top of the target and the centre line of the coil array. Positive measurements indicate a target to starboard of the centre line.
ALT	Coil altitude above the seabed. This could be measured by a sub-sea altimeter connected either directly to the SEP or through the umbilical to the SDC. Where there is no altimeter fitted to the System, ALT could contain a fixed coil height that you specify during the configuration procedure.
COV	Target depth of cover. The SDC calculates this distance by using $COV = VRT - ALT$.
CV	Composite Video. This can be utilised in either NTSC or PAL formats.

AMENDMENTS

Old Issue No.	New Issue No.	Date	Details
-	0.5	Dec. 2002	Proof level 1
	0.7	Jan. 16 2003	Proof Level 2
0.7	0.8	Jan. 30 2003	Proof Level 3
0.8	0.9	Feb. 6 2003	Proof Level 4
0.9	1.0	Feb. 19 2003	First Issue
1.0	1.1	Nov. 2003	<p>Attention drawn to more stringent requirements for coil mounting and background compensation over 340 system.</p> <p>Clarification of centre coil mounting above port and starboard coils added.</p> <p>References to use of GPS to derive system time removed</p> <p>References to 3 coil algorithm removed</p> <p>Seawater compensation details added</p> <p>Factory defaults note added</p> <p>Video overlay modes clarified</p> <p>Note re signals data packet identifier added</p> <p>Note re spaces in altimeter strings added</p>



1 INTRODUCTION

The TSS 440 Pipe and Cable Survey System is a complete package of equipment that you may install on board a remotely operated sub-sea vehicle (ROV). The 440 System represents a considerable advance over its predecessor, the 340, in that signal processing routines are used which can discriminate between seawater and metallic targets which helps to enhance the accuracy of the information gathered during a survey. The System provides a convenient and uncomplicated method for performing accurate submarine surveys on a conductive target such as a cable or pipe.

The burial state of the target has no effect on System operation. However, you should note the following:

- The special characteristics of 316 stainless steel do not allow the 440 System to detect this material reliably.
- Do not use the 440 System to survey targets buried beneath iron ore, which will mask signals from the target.

The 440 System includes a display and control computer that you should install where you may see its screen easily while you operate the ROV. The display includes information to help you guide the ROV along the course of the target. With the introduction of the 440 Pipe and Cable Survey System, TSS have also introduced their new DeepView for Windows software, which makes configuration and operation of the system easier under a familiar working environment. This runs on the Surface Display Computer (SDC) and makes all acquired survey data available to view or report to an external data logging equipment.

The 440 System operates in real time and provides accurate measurements at a rate that allows deployment on board faster ROVs. The measurement technology used by the System also allows it to operate out of water with no degradation in performance, range or accuracy. You may therefore use the 440 System for land-based or amphibious survey applications.

This System Manual contains full installation and operating instructions and is an important part of the 440 System. You should ensure the Manual remains easily available for use by those who will install, operate and maintain the System.

When supplied new, the sub-sea components are all fully sealed and depth rated to the specifications listed in Section 9. To maintain the specified depth rating throughout the lifetime of the System, follow the maintenance and care instructions included in Section 10.

Provided you follow the installation, operating and maintenance instructions included throughout this Manual, the 440 System will maintain its specified measurement accuracy with no need for further factory re-calibration.

1.1 MIGRATION FROM THE 340 CABLE AND PIPE SURVEY SYSTEM - SUMMARY OF BENEFITS

The TSS 440 system represents a considerable improvement over the previous 340 system. It operates to a greater target range than the previous system, yet is simpler to set up and operate.

The previous generation of products used a geometric algorithm to reject seawater which was based on the assumption that the undesired seawater signal is the same across the three coils. The new 440 product has an advanced compensation method which exploits the different types of signals generated by target and seawater. This allows the range to be determined from two



search coils, giving up to a 50% improvement in range. Although the conductivity of seawater varies widely, the system can accommodate all situations.

Extensive testing under a variety of water conditions shows that the characteristics for the local water conditions need only be determined once per survey: the user merely inputs the approximate water temperature. An automatic method to tune the system after deployment is provided, but need only be used in exceptional circumstances.

Significant differences between 340 and 440.

- ❑ Increased range due to improved detection algorithm.
- ❑ Increased sensitivity from new search coils.
- ❑ Easier setup and survey from new Windows SDC and software.
- ❑ Raw signal data available at SDC.
- ❑ New improved video overlay facility.
- ❑ New altimeter.

Familiar advantages

- ❑ Proven, reliable PSU and electronic subsea pods.
- ❑ Standard SDC logging output format.
- ❑ TSS support.
- ❑ Connector pinouts, voltages and protocols identical.

WARNINGS and CAUTIONS



Where appropriate, this Manual includes important safety information. Safety information appears as **WARNING** and **CAUTION** instructions.

You must obey these instructions:

- ❑ **WARNING** instructions alert you to a potential risk of death or injury to users of the 440 System.
- ❑ **CAUTION** instructions alert you to the potential risk of damage to the 440 System.

For your convenience, the Table of Contents section includes copies of all the **WARNING** and **CAUTION** instructions contained in this Manual.



Installation and operation of the 440 System are not complex tasks. However, you should spend time to familiarise yourself with the contents of this Manual before you start to install or use the System. Time you spend in identifying the task sequence now will help you to have your System operational in the minimum of time.

Throughout this Manual all measurements conform to the SI standard of units unless stated otherwise.

For your convenience, this Manual includes several sections, each of which describes specific features of the 440 System:

You should read sections 1 to 4 before you attempt to install the 440 System:

-
- | | |
|------------------|---|
| Section 1 | contains introductory notes to describe the TSS 440 System. |
| Section 2 | describes the 440 Pipe and Cable Survey System and its sub-assemblies. |
| Section 3 | explains how to install the surface and the sub-sea components correctly. |
| Section 4 | explains how to complete the electrical interconnection between the surface and the sub-sea components. This section also explains how you should select and establish a suitable communication method between the surface and sub-sea installations. |

You should read sections 5 to 9 before you use the 440 System to perform a survey:

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- | | |
|------------------|---|
| Section 5 | explains how to configure the 440 System for a particular installation by using the DeepView software. |
| Section 6 | describes how to operate the 440 System using the DeepView for Windows software. The software allows you easy access to all the facilities that you may require during a target survey. |
| Section 7 | explains how to use the 440 System before, during and after a survey operation. |
| Section 8 | explains some of the factors that may affect the performance of the 440 System during a survey. |
| Section 9 | provides a full set of hardware specifications for the standard 440 System. This section also shows the operational capabilities of the 440 System under ideal survey conditions. |

You should read sections 10 and 11 if the 440 System fails to operate normally due to a suspected fault condition:

Section 10 provides a brief circuit description of the sub-sea components, and includes flow charts to help you identify and eliminate faults by board replacement.

Section 11 contains the technical drawings for the System.

Follow the advice and instructions in Section 10 if you suspect a failure of the 440 System. If you cannot correct the problem, contact TSS for technical assistance. The title page of this Manual includes the contact details including a 24-hour emergency customer support service managed by trained and experienced engineers. Please make certain you have read Section 10 of this Manual and that you have a full description of the suspected fault condition *before* you contact TSS for technical assistance.

For reference, this Manual also contains Appendices that provide additional information about the 440 System:

Appendix A describes the operating theory of the 440 System and also gives details of the seawater compensation procedure.

Appendix B describes the options available for use with the System:

- The Analogue Output feature that you may use to provide control signals for an automatic steering feature on a tracked ROV.
- Use of the TSS 440 System when combined with the sub-sea components of a TSS 350 Cable Survey System and controlled by a single SDC. This is called the TSS Dualtrack.
- A specialised TSS training program available for those who may be involved in any survey that uses the 440 System.

Appendix C gives operating and service information for the TSS ALT-250.

Appendix D includes a sample Configuration Log sheet, and drawings to show the Run Display screen of the 440 System.

1.2 SYSTEM DESCRIPTION



WARNING

The protection provided by the 440 System might be impaired if you use the equipment in a manner not specified by TSS. For safety reasons, always follow the instructions and advice included throughout this Manual. If necessary, contact TSS for technical advice.

TSS has designed the 440 Pipe and Cable Survey System primarily for use in surveying operations on submarine pipes and cables. In this application the System measures, displays and records the position of the target relative to the ROV, and its depth of cover beneath the seabed.

The technology used by the System gives it the flexibility to detect any conductive target, whether the material is exposed or buried. For this reason, many other fields of operation could benefit from its capabilities.



TSS has optimised the standard 440 System and its software to provide the best performance for use in pipe and cable survey operations. This Manual describes the standard 440 System.

You should consult TSS if you need to use the System within an alternative application where a non-standard configuration might be necessary

The TSS 440 System consists of a surface control and display computer and the depth rated components of the sub-sea installation:

Surface Display Computer (SDC)

You should use the SDC to configure and control the 440 System. It communicates with the sub-sea installation using bi-directional signals transmitted through the ROV umbilical.

By interpreting the signals from the sub-sea installation, the SDC generates a clear graphical display that helps you to guide the ROV along the course of the target.

Simultaneously, the SDC uses one of its five serial data ports to transmit the real time survey information to an external data logging system.

Sub-sea installation

The sub-sea installation includes the following components:

- A sub-sea electronics pod (SEP)
- A sub-sea power supply unit (PSU)
- Three search-coils
- A sub-sea altimeter
- Coil mounting components
- Cables you will need to interconnect the sub-sea components of the 440 System.

All sub-sea components of a new installation have a depth rating to the specifications listed in Section 9. The main labels of the SEP and PSU also confirm the depth rating for these components. Provided you exercise all proper maintenance procedures explained in Section 9, the sub-sea components will retain their specified depth rating throughout their working life.

Refer to sub-section 2.4 for descriptions of the main sub-sea components of the 440 System.

During survey operations, the sub-sea installation measures target co-ordinates. These are:

- The vertical range to the target (VRT)
- The lateral offset of the target relative to the centre of the coil array (LAT).
- The altitude (ALT) of the coil array above the seabed and the depth of target cover (COV). To make these measurements, the 440 System must receive altitude information from an altimeter. Alternatively, where the design of the ROV allows for a constant coil height, you may configure the System with this information instead.

The SEP collects the information and performs the signal processing functions necessary for the SDC and DeepView for Windows to generate accurate survey data using a powerful algorithm developed especially for this application.

The 440 System operates continuously in real time and provides accurate measurements at a rate that allows deployment on board faster ROVs. The System displays the information that it acquires in a clear graphical format on the SDC. The SDC also makes the same information available for serial transmission to an external logging system.

When supplied new, the SEP and the PSU, the coils, cables and other sub-sea components are all fully sealed and depth rated. To maintain their approved depth rating throughout the lifetime of the System, follow the installation, operating, care and maintenance instructions included throughout this Manual. Provided you follow the instructions included throughout this Manual, the 440 System will maintain its specified measurement accuracy with no need for further factory re-calibration.

1.3 PRINCIPLE OF OPERATION

The TSS 440 Pipe and Cable Survey System relies on the principle of 'Pulse Induction' to detect the presence of a target and to measure the range of that target from each of three search coils. Using an adaptive algorithm the System can locate, using either two or three search coils, the position of the target.

Refer to Appendix A for a full description of the operating theory.

The pulse induction method of target detection provides four major advantages over other systems when used in pipe and cable survey applications:

1. It detects any type of conductive material – including non-ferrous metals such as brass, bronze, aluminium, and light alloys. *Note that the special characteristics of 316 stainless steel do not allow the 440 System to detect it reliably.*
2. Terrestrial magnetism has no effect upon the System operation or its measurement accuracy.

3. The System can measure and electronically compensate for the local conductive effects of the ROV, regardless of the ROV heading.
4. Simplified operating procedures built into the System give it a high degree of measurement stability.

1.4 WARRANTY

TSS warrants the 440 Pipe and Cable Survey System to be free of defects in materials or workmanship for one year beginning on the date when the equipment was shipped from the TSS factory or from an authorised distributor of equipment manufactured by TSS.



To ship the units between installation sites or to return them to TSS or an authorised distributor for repair, package them with care. TSS recommends that you should retain the original packing cases for this purpose.

The use of improper packing for shipping any part of this equipment will void the warranty.

For information concerning the proper return location and procedure, contact TSS or an authorised distributor. The title page of this Manual lists the contact details for TSS.

The responsibility of TSS in respect of this warranty is limited solely to product replacement or product repair at an authorised location only. Determination of replacement or repair will be made by TSS personnel or by personnel expressly authorised by TSS for this purpose.

This warranty will not extend to damage or failure resulting from misuse, neglect, accident, alteration, abuse, improper installation, non-approved cables or accessories, or operation in an environment other than that intended.



In no event will TSS be liable for any indirect, incidental, special or consequential damages whether through tort, contract or otherwise. This warranty is expressly in lieu of all other warranties, expressed or implied, including without limitation the implied warranties of merchantability or fitness for a particular purpose. The foregoing states the entire liability of TSS with respect to the products described herein.

Contact TSS for information if further cover is required beyond the warranty period.



2 SYSTEM OVERVIEW

You should read this section of the Manual before you unpack or install the 440 System.

This section tells you about the important checks and inspections that you should make when you first receive the TSS 440 System. It also includes a brief description of the main items supplied as standard with the System.

If you must ever replace any of the System sub-assemblies, please make certain you include a full description of the part you require with your order. If possible, also include the part number of the component you require and the serial number of the relevant sub-assembly.

2.1 Scope of Delivery **Page 2**

Describes the items supplied with the standard TSS 440 Pipe and Cable Survey System.

2.2 Unpacking and Inspection **Page 3**

Explains the inspections and checks that you should make on the TSS 440 System as you unpack it.

2.3 Surface Components **Page 4**

Describes in detail the surface components of the standard TSS 440 System.

2.4 Sub-sea Components **Page 8**

Describes in detail the sub-sea components of the standard TSS 440 System.

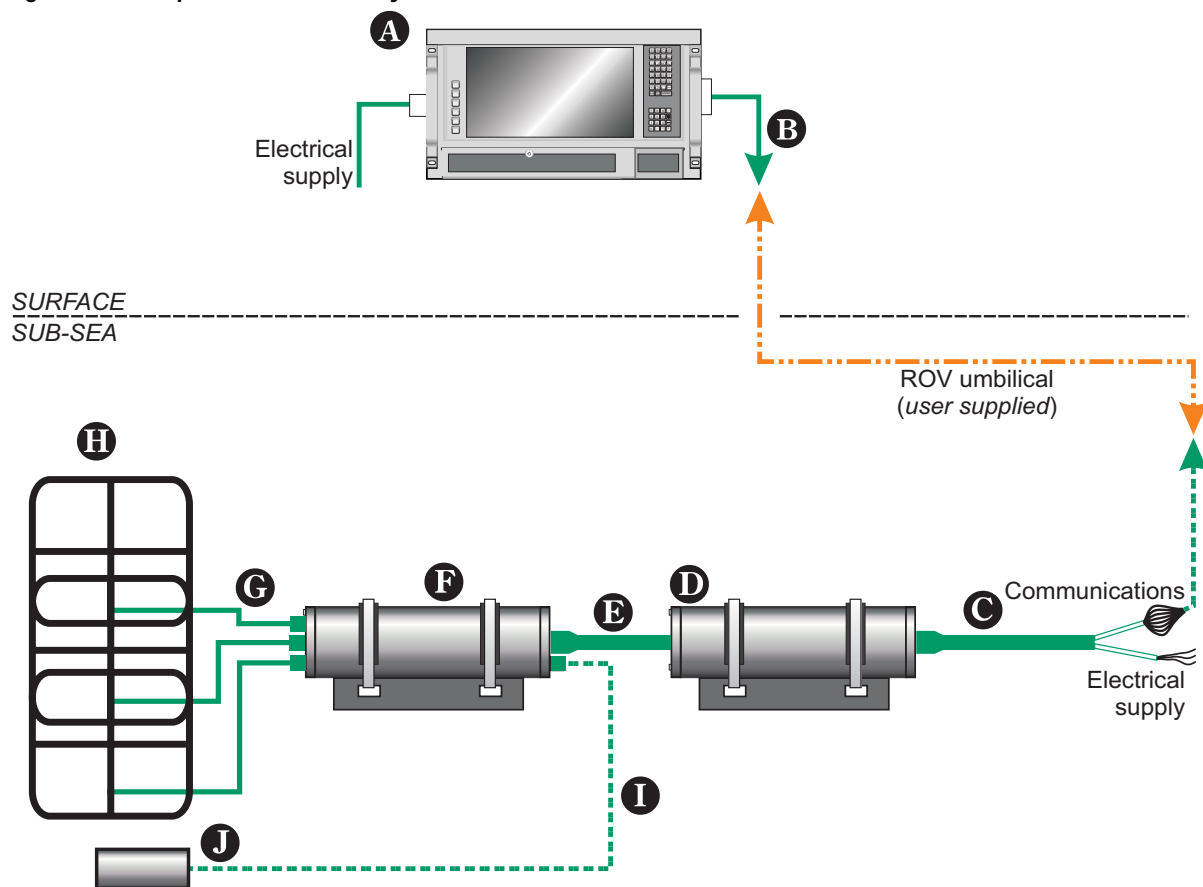
2.1 SCOPE OF DELIVERY

The 440 System includes various sub-assemblies that you must interconnect properly before the System will work.

Figure 2–1 shows a typical stand-alone configuration for the 440 System that has the SDC installed on a surface vessel and the sub-sea components mounted on the ROV. Table 2–1 identifies the individual components of the installation.

Optionally, you may use the 440 System as part of a Dualtrack installation. In this mode, a single SDC controls the operation of the 440 Pipe and Cable Survey System when its sub-sea components are connected to a TSS 350 Cable Survey System. Refer to Appendix B for instructions to connect and configure the 440 System within a Dualtrack installation.

Figure 2-1: Components of the 440 System



Sub-sections 2.3 and 2.4 below provide detailed descriptions of the surface and the sub-sea components of the 440 System.

Table 2-1: Components of the 440 Pipe and Cable Survey System

Item	Description
A	Surface display computer (SDC) with: <ul style="list-style-type: none"> <input type="checkbox"/> Proprietary TSS control, display and logging software pre-installed on the internal hard disk <input type="checkbox"/> Auto-range power supply that accepts AC supply voltages in the range 85 to 265V (47 to 63Hz) at 250VA maximum <input type="checkbox"/> Integral alphanumeric and function keypads <input type="checkbox"/> Integral flat panel colour display <input type="checkbox"/> Single 3.5-inch floppy disk drive (behind the fold-down front panel) <input type="checkbox"/> Current-loop interface card <input type="checkbox"/> CD-ROM (behind the fold-down front panel)
B	Data cable for connection between the SDC and the ROV umbilical
C	Power and data cable (or 'ROV Tail') that connects the PSU to the ROV umbilical and power distribution system
D	Depth rated sub-sea power supply unit (PSU)
E	Power and data cable that connects the PSU to the SEP
F	Depth rated sub-sea electronics pod (SEP)
G	Three coil connection cables
H	Three TSS search coils arranged as shown with connections to Channels 1 to 3 on the SEP.
I	Power and data cable that connects the altimeter to the SEP
J	Sub-sea altimeter

TSS can supply the SDC fitted with an Analogue Output board. This optional facility supplies an analogue output voltage that varies with the relative lateral offset distance between the target and the centre of the coil array. If you interface the Analogue Output option to a suitable steering system, the 440 System could steer a tracked ROV automatically along the path of the buried target. The SDC software allows you to configure the polarity, scale and offset values for the analogue output so that it matches the needs of the automatic steering facility on your ROV.

Refer to Appendix B for a description of the Analogue Output option.

2.2 UNPACKING AND INSPECTION

TSS performs a series of careful examinations and tests on the electrical function and mechanical integrity of the 440 System during manufacture and before dispatch. Special shock protecting cases safeguard the System during transit so that it should arrive without damage or defect.



Retain the original transit cases so that you may use them if you must transport the 440 System for any reason. You will invalidate the warranty if you use improper packing during transportation.

As soon as possible after you have received the 440 System, check all items against the shipping documents. Perform a careful visual examination of all sub-assemblies and inspect them for any damage that might have occurred during transportation.

Notify TSS immediately if there are parts or sub-assemblies missing from your shipment. If you see any damage to the System, file a claim with the insurers and inform TSS. The title page of this Manual lists the contact details for TSS. TSS also operates a 24-hour emergency telephone support line managed by trained and experienced engineers.

To avoid loss or damage to any components of the System, store all sub-assemblies safely in their transit cases until you need to install them. Obey the environmental limits for storage listed in Section 9 for all sub-assemblies.

2.3 SURFACE COMPONENTS

The SDC receives and processes information from the sub-sea installation. Its display provides clear information to help you guide the ROV along the course of the target.

Simultaneously, the SDC makes the same survey information available at one of its serial ports for recording by an external data logger.

Figure 2-2: Surface Display Computer



The main functions of the SDC are:

- ❑ **To communicate with the sub-sea installation.**
You may adjust links inside the SDC and inside the SEP to select among three available communication methods. Refer to sub-section 4.2.2.1 for instructions to make these changes.
- ❑ **To configure and control the 440 System.**
The SDC uses the Windows 2000 operating environment. Within that DeepView for Windows software is used to configure the System after installation, and to operate the System during a survey. Refer to Sections 5 and 6 for full instructions to use this software.
- ❑ **To display the survey measurements graphically.**
The display on the SDC shows information that helps you to guide the ROV along the course of the target. Refer to Section 6 for a description of the display features.

There are two options that are available to display information on an external video monitor. The first is to repeat the SDC display at a remote location using SVGA signals provided on a 15-way high density D-type connector. The second is the video overlay which is transmitted as composite video or S-Video in either PAL or NTSC. Refer to sub-section 4.2.4 for instructions to use this feature.

□ **To send the acquired data to an external data logger.**

The SDC allows you to log survey data externally (for use by post-processing engineers) and internally (to provide a simple record of the survey that you may replay through the SDC).

You may also use the SDC and DeepView for Windows software to control a Dualtrack installation. Refer to Appendix B for details.

The SDC is a ruggedised IBM-compatible computer mounted in a purpose-designed shock protecting transit case. The design of the transit case allows you to operate the SDC by removing the front and the rear access panels. Alternatively, you may remove the SDC from the transit case and mount it in a 19-inch instrument rack if this arrangement is more appropriate.

Refer to sub-section 3.1 for full instructions to install the SDC.



Pay particular attention to the warning and caution notices that are included within the SDC installation instructions.

The SDC has an integral alphanumeric and function key pad and a trackpad. You may use these tactile membrane key pads to enter commands and System configuration parameters. For convenience, you may also connect an external keyboard and a pointing device such as a mouse or trackball to the SDC. The System does not include external pointing device or keyboard.

The SDC uses a 15 inch flat panel colour display.

Figure 2-3: SDC control features



Figure 2-3 shows the SDC front panel with its alphanumeric and function key pads, trackpad and flat panel screen. The fold-down panel on the SDC covers the power switch, the 3½-inch floppy disk drive, the CD-ROM drive, the 'Power', 'Hard drive' and 'Current loop' indicator



lights, a USB port, and a PS2 connection port for an external keyboard. To open this panel, operate the lock and swing the panel down on its hinge.

When TSS dispatches the 440 System, the SDC will have the current version of the DeepView graphical display software pre-loaded onto its hard disk. Refer to Sections 5 and 6 for instructions to use this operating software.



CAUTION

You may adversely and seriously affect the operating functions of the 440 System if you load unauthorised software onto the SDC hard disk, or if you attempt to use such software with the SDC. You will invalidate the warranty if you attempt to install or use unauthorised software with the SDC.

Do not load any unauthorised software onto the SDC. If you are in any doubt about the SDC software, contact TSS for advice.



CAUTION

You might destroy logged data and program files on the SDC if you allow computer viruses to infect the unit.

Computer viruses can pass from one computer to another when you transfer files, either directly through a cable or by disk. To protect the SDC against this type of damage, always take the following precautions:

- ❑ Never try to use unauthorised software with the SDC.
- ❑ Never power-on or reset the SDC with a diskette loaded into its floppy disk drive or CD loaded into its CD-ROM drive.
- ❑ Use an external PC running up-to-date anti-virus software to check diskettes or CDs before you use them with the SDC. Use only virus-free diskette or CDs with the SDC. You may install appropriate and approved virus protection software on the SDC if you prefer. To maintain full effectiveness you must keep this type of protection up to date.
- ❑ Do not use any diskette or CDs with the SDC if you are unsure whether it is free from viruses.
- ❑ **DO NOT** power-on the SDC if you suspect a virus has infected it.

TSS takes every possible precaution to prevent virus infection before shipment. If you suspect your SDC has become virus infected, contact TSS for advice and then arrange to return the SDC to TSS for repair.

The SDC accepts an AC electrical supply in the range 85 to 265V (47 to 63Hz) through a 3-pin IEC power inlet port. The SDC will configure itself automatically to the appropriate electrical supply when you power-on the unit.

2.4 SUB-SEA COMPONENTS

The sub-sea installation comprises the following component parts:

- ❑ A Sub-sea Electronics Pod (SEP).
- ❑ A Sub-sea Power Supply Unit (PSU).
- ❑ A coil array with three TSS search-coils. Refer to sub-section 3.2.2.3 for instructions to install the coils.
- ❑ Frame components to mount the coils onto the ROV.
- ❑ A sub-sea altimeter.
- ❑ Cables to interconnect the sub-sea components of the 440 System and to connect them to the electrical distribution system of the ROV.

2.4.1 Power Supply Unit

The PSU accepts a single phase AC electrical supply nominally at 110V AC at 45 to 65Hz. A switched-mode circuit inside the PSU generates the conditioned DC supplies required by the SEP, with all DC supplies passing through a π -filter network to prevent noise and interference from reaching the SEP.

Refer to the specifications sub section 9.1.3 for full details of the PSU power requirement. There is a cartridge fuse inside the PSU to protect the System from overload conditions.

The PSU has a port for connection to the ROV electrical distribution system and umbilical. This connection uses a Power and Communications cable supplied with the System that has a multiway connector that mates to the PSU and open tails for connection to the ROV.

Connection between the SEP and the PSU is through a single cable that has a multiway connector at each end.

2.4.2 Sub-sea Electronics Pod

The SEP performs several functions:

- ❑ Timing and amplitude control for the pulsed-current drive to the search-coils.
- ❑ High-speed data acquisition and digital signal processing.
- ❑ Interpretation of data from an appropriate sub-sea altimeter connected to the SEP 'Altimeter' port.
- ❑ Communication with the SDC through the ROV umbilical using whichever communication method you have established for the System.

Non-volatile memory within the SEP stores certain installation-specific parameters that the SEP needs. You may examine and change these configuration parameters remotely from the SDC – refer to Section 5 and 6 for instructions to configure the System.

EPROM memory devices within the SEP store the software that controls all the SEP functions.

The SEP is a sealed unit with six ports:

On one end-cap:

- ❑ **POWER/COMMS**
This port accepts the 12-way connector from the PSU, carrying stabilised and conditioned DC supplies and the bi-directional communication signals.
- ❑ **ALTIMETER.**
You may connect the TSS or a Datasonics sub-sea altimeter directly to this port. The port provides DC power to operate these types of altimeter and a signal path for their RS232 communications.

On the other end-cap:

There are four electrically identical connection ports for the four active channels. Note that the 440 System uses only channels 1 to 3 during normal operations, although you may use channel 4 as a substitute if one of the other channels fails. You must connect each coil to its correct port on the SEP. Refer to sub-section 4.1.5 for instructions to connect the coils.



CAUTION

You will damage the SEP if you leave any port exposed to seawater during deployment on the ROV, even if you are not using the 440 System.

You must fit the supplied blanking plugs to any port on the SEP that you will not be using during ROV deployment.

Refer to sub-section 3.2.1 for instructions to install the SEP and the PSU.

2.4.3 Search-coils

TSS supplies three search-coils as part of a standard installation. A drawing showing dimensions is available in Section 11 and details of specification can be found in Section 9.

See sub-section 3.2.2 for full instructions to assemble the coils and mount them onto an ROV.

2.4.4 Altimeter

The main function of the 440 System is to locate and survey a target lying on or buried beneath the seabed.

If the 440 System measures the altitude of its coil array above the seabed, then it can also deliver a good estimation of the depth of target cover. A sub-sea altimeter can supply such altitude measurements to the 440 System.



You should remember that an altimeter measures to a point on the seabed directly beneath its transducer face. This single-point measurement may not be the same as the local mean seabed level.

This means that an uneven seabed topography might degrade the quality and accuracy of depth of cover measurements derived using a single altimeter.

For surveys where you must measure an accurate and certifiable target burial depth, you should use an independent seabed profiling system. Log the measurements from such a system separately and then use the post-processing operation to merge them with data acquired by the 440 System.

On some types of tracked ROV, you may arrange to keep the coil array of the 440 System at a fixed height above the seabed. In these circumstances you could avoid the need for an altimeter by configuring the DeepView for Windows to use a fixed coil height.

The standard 440 System includes a sub-sea altimeter. You will need to install this on the ROV frame close to the centre of the coil array. Refer to sub-section 3.2.3 for instructions to install the altimeter on the ROV, and to sub-section 4.1.6 for instructions to connect it directly to the SEP.

Refer to Section 5 for instructions to configure the altimeter after installation.

2.4.5 Remotely Operated Vehicles

The type and size of ROV you use for a survey will depend on the specific application and on the capabilities of the survey vessel.

You may deploy the 440 System on a wide range of ROVs including:

- Free-flying ROVs of differing sizes and types.
- Tracked ROVs or crawlers.
- Trenching ploughs.
- Towed sleds.

See Section 3 for detailed instructions and recommendations concerning the physical installation of the sub-sea components of the 440 System.

3 PHYSICAL INSTALLATION

This section of the Manual explains how to install the surface and the sub-sea components of the TSS 440 System.

During the installation procedure you should make a written record of certain parameters and retain them with the survey log for reference during the post-processing operation. The Deep-View for Windows software on the SDC allows you to examine the System parameters and to create a printed copy that you may retain with the survey records.

There are many different types and size of survey vessel and ROV and it would be impossible for this Manual to cover all installation possibilities. The instructions in this section therefore represent a set of general guidelines and recommendations that experience has proved effective.



IMPORTANT

Note however that you cannot regard certain aspects of the 440 installation procedure as optional: The instructions relating to coil location, orientation and mounting configuration are of critical importance to the successful operation of the 440 System. You must follow these instructions.

3.1 SDC Installation

Page 2

You may use the SDC while it remains mounted in the shock-protecting transit case, or you may install the SDC in a 19-inch instrument rack. You should install the SDC where you may see and operate it easily.

3.2 Sub-sea Installation

Page 3

The success of any survey performed by the 440 System relies heavily on the care you exercise when you install its sub-sea components.

3.3 Installation Check-list

Page 12

This post-installation checklist helps you to avoid some common errors and omissions when you install the 440 System.

3.1 SDC INSTALLATION



WARNING

You must take precautions to secure the SDC when you store and operate this unit in its transit case.

Protect personnel from the hazard of falling equipment and protect the unit from damage when the survey vessel moves due to the action of waves.

Install cables away from walkways and secure them so they do not present a hazard to personnel.



CAUTION

To avoid potential damage to the SDC, make certain it has sufficient ventilation to dissipate the heat that it generates during normal operation.

If you mount the SDC in a 19-inch instrument rack you must allow a minimum 30mm clearance between the top of the SDC and any other equipment mounted directly above it in the rack. Also, allow a minimum 100mm space between the SDC rear panel and the rear of the instrument rack to allow for connectors and cable routing.

The SDC is a ruggedised IBM-compatible computer supplied by TSS in a shock-protecting transit case. You may operate the SDC in this transit case, or you may install it into a 19-inch shock-protecting instrument rack. TSS does not supply the fixings that you will need to install the SDC in a 19-inch instrument rack.



If you intend to change the communication method used by the 440 System, make the necessary changes to the SDC *before* you install it into the instrument rack. Refer to sub-section 4.2.2.1 for instructions to change the SDC communication method.

The SDC transit case has removable front and rear access panels. If you operate the SDC in its transit case, you **must** remove both these panels to allow effective ventilation and heat dissipation.



CAUTION

You might damage the SDC if you allow it to overheat. To operate the SDC inside its transit case, release and remove the front and the rear access panels of the transit case to allow effective ventilation and heat dissipation.

Although the SDC uses solid state electronics, the hard-disk drive and parts of the display panel are susceptible to damage through shock or excessive vibration. You must therefore exercise some care when you select a suitable location for this unit:

- Install the SDC where you have easy access to the controls. Choose a position for the SDC that allows you to see the screen easily while you operate the ROV.
- If you do not mount the SDC in an instrument rack, use the original SDC transit case to provide shock protection for the unit. Secure the transit case so that it cannot slide or fall with movements of the vessel.

- Make certain there is sufficient ventilation space above the unit to remove the heat that it generates during normal operation. If necessary, use an electric fan to provide additional ventilation.
- Do not subject the SDC to extremes of temperature or humidity, or to severe vibration or electrical noise. Never allow the SDC to become wet.



Obey the environmental limits listed in sub-section 9.1.1 when you store and operate the SDC.

3.2 SUB-SEA INSTALLATION

The care that you take when you install the sub-sea components of the 440 System will have a significant influence on the accuracy of survey data. Read the following instructions carefully and ensure that you have all the necessary parts and tools available before you attempt to install the System.

The following instructions apply only to the standard components of the sub-sea installation.

3.2.1 SEP and PSU

The sub-sea pods have hard, anodised aluminium housings to ensure their depth rating. Do not open either pod during the installation procedure unless you need to change the communication method used by the System. Refer to sub-section 4.2.2.1 for instructions to change the communication method. You do not need to open the PSU to change the communication method.



If you need to open the SEP to set a different communication method, do this *before* you install the SEP on board the ROV. To preserve the seals, always follow the instructions carefully to disassemble and reassemble the housings. You will find these instructions in sub-section 10.2.2.

There is a nylon mounting block attached to each of the housings. These blocks provide a safe and secure method to mount the housings to the ROV frame.

CAUTION



You might damage the anodised surface of the housings if you attempt to secure them to the ROV without using their proper mounting blocks. Corrosion will occur rapidly if you damage the protective anodising of the housings.

Do not remove the mounting blocks from the housings. Do not attempt to secure the housings directly to the ROV framework without using the mounting blocks.

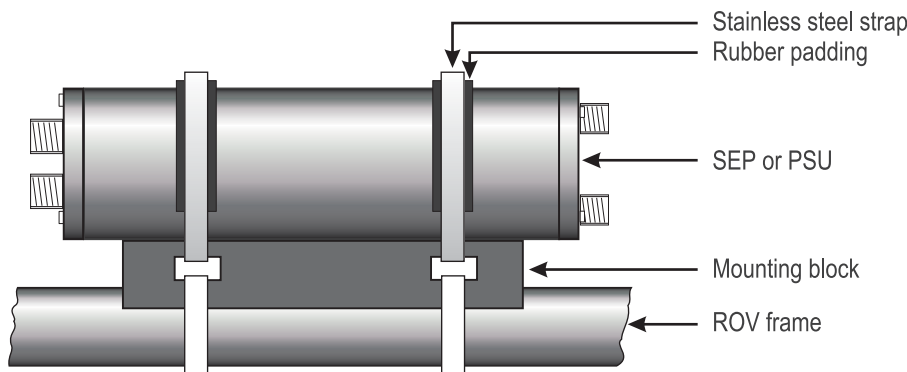
The mounting blocks each have machined slots that allow you to strap the complete housing and block assembly firmly to the ROV frame. Stainless steel strapping is ideal for this purpose. See Figure 3–1 below for details.

It is safe to mount the SEP and the PSU in any orientation.

Mount the housings according to the following guidelines:

- ❑ Eliminate any possibility of snagging or damage to the housings by installing them at a protected position on the ROV.
- ❑ Locate the housings so that you may route the cables easily between the sub-assemblies of the 440 System.
- ❑ Do not apply sharp bends or other mechanical stresses to the cables during installation or operation. Route the cables between the components of the sub-sea installation, and use plastic clips to secure them to the ROV frame.
- ❑ On small ROVs, position the housings close to the centre of buoyancy to avoid upsetting the trim of the ROV.
- ❑ Tighten the mounting straps firmly so that the housings cannot move under the influence of ROV vibration or currents in the water.
- ❑ Refer to sub-section 4.1 for instructions to make the electrical connections between the sub-sea components.

Figure 3-1: SEP and PSU mounting arrangement



3.2.2 Coil Array



You should read this sub-section *before* you attempt to install the array of search-coils. These details are *critical* to the successful operation and performance of the 440 System. Follow these instructions carefully to obtain the best performance from the System and to avoid interference with other equipment on board the ROV.

The TSS 440 system has much more stringent requirements than its predecessor in terms of the coils and their mounting arrangements. The seawater signals can be almost completely excluded, therefore the performance of the system is limited mainly by the stability of the background compensation values (see sub-section 6.2.2.4).

The background compensation values must be absolutely stable and repeatable if good quality survey information is to be obtained. The coils must be mounted a sufficient distance from the ROV, and clamped tightly. Further, the metalwork of the ROV must not interfere with the compensation levels. This means that any manipulators must be tightly stowed during both survey and compensation.

3.2.2.1 Search-coil Configuration

The standard 440 System uses three search-coils of dimension 1.0m × 0.94m × 0.03m. They must be mounted so that the sides with no mounting holes point in a fore-aft direction.



Versions of the 340 System used search-coils of different dimension. Do not use type 41 or other old coils types with the 440 System.

To protect the coils, mount them on the ROV with their potting compound uppermost.

Where necessary, after you have installed the coils you may restore a neutral ROV trim by firmly attaching a small non-conductive buoyancy aid to the front of the coil array.

3.2.2.2 Positioning the Search-coils



The Search-coils must be firmly secured, so that there is no movement during the survey. A poor Search-coil mounting arrangement will reduce the performance of the system.

Consider these factors carefully when you choose a position to mount the coil array, and then read the following paragraphs for an explanation of these factors.

- 1. Coil separation distance.**

This is the distance between the coils and the body of the ROV after installation.

- 2. Mounting position.**

Consider whether you will mount the coils on the front or the rear of the ROV.

- 3. Height of coils.**

This is the vertical distance between the coils and the lowest point on the ROV. Mount the coils so they are parallel with the horizontal axis of the ROV.

1. Coil separation distance

This is the shortest distance between the edge of the search-coils and the region of the ROV where significant conductive material begins (see Figure 3–2). It is the most important consideration you must make when you plan your installation. There are conflicting requirements when you make this decision, and so you may have to make a compromise:

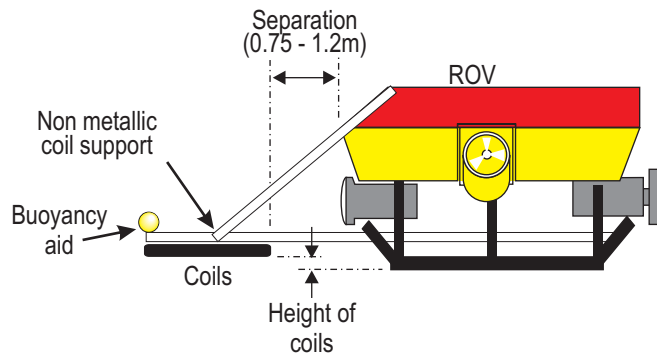
- Mounting far away from the ROV:**

A large coil separation distance will reduce the size of the background signal caused by the ROV body. This will reduce any tendency for the coils to saturate when they are over an exposed section of the target.

- Mounting close to the ROV:**

A small coil separation distance will allow you to deploy, manoeuvre and recover the ROV more easily.

Figure 3–2: Coil separation distance



Small ROVs will tend to generate a comparatively weak background signal. This allows you to mount the coils closer to the ROV body.

Larger ROVs would generate a stronger background signal. To avoid this having too great an effect on System operation, you should mount the coils farther from the body of a large ROV. This requirement should not present a problem because larger ROVs usually possess greater manoeuvring power, and so will be able to overcome the additional manoeuvring resistance caused by the coil mounting position.



The separation distance should be such that the background compensation signal for any channel does not exceed $1000\mu V$ – see sub-section 6.2.2.4 for a description of background compensation. For most installations, a coil separation distance of between 0.75 and 1.2 metres will usually achieve this.

Loose metalwork on the ROV can cause changing eddy currents and hence changing background compensation levels as the vehicle lifts off the seabed. This is easily mistaken for a problem with the seawater rejection. It is best cured by moving the coils further away from the ROV. Fixing any loose metalwork securely and ensuring a good earth connection (at seawater potential) to the SEP may also help.

2. Coil mounting position

□ Front Mounting



Based upon considerable field experience, TSS recommends a front-mounting location for the coils of the 440 System. This is both effective and practical for the majority of installations.

The preferred position to mount the coil array is on the front of the ROV. This will help the pilot to follow the most effective course along the target by using the DeepView Run Window. It will also reduce the risk of an umbilical snag. With coils mounted on the front of the ROV you must make certain that they do not obstruct or interfere with camera and lighting systems, scanning sonar systems, or other forward-looking sensors and probes.



You must stow manipulator arms securely while you survey with the 440 System. Any free movement in the manipulators might cause unexpected changes in the background signal that could affect or invalidate survey data.

If you have to use the manipulators during a survey, you must check the background compensation immediately after you have stowed the manipulator arms.

□ Rear Mounting

Rear mounting of the coil array avoids interference with manipulator arms, camera and lighting installations, etc. However, in this position the coils could detect the trailing ROV umbilical and show it as a false target. If this happens, your survey results will include errors of indeterminate size.

If you must mount the coils at the rear of the ROV, arrange to monitor them with a video camera so that you may detect and correct this condition if it occurs.

3. Height of Coils

Ideally, you should mount the search-coils so that they are no lower than 0.1m above the lowest point on the ROV. This position is a compromise between the need to mount them low down to extend their operating range, and the need to protect them from damage by maintaining a safe distance from the seabed.

There is a danger that signal saturation may occur when a large target is very close to the coil array. When surveying such a target therefore, select a higher mounting position on the ROV.

Make certain you mount the coils so they are parallel with the horizontal axis of the ROV. The System measures the distance from the coil centres to the target, and these measurements would contain errors if the coils were not horizontal. Be particularly careful if your system uses rams to lower and deploy the coil array after you have launched the ROV.

3.2.2.3 Coil Assembly and Installation

You must use the correct non-conductive mounting components supplied with the 440 System to fix the search-coils to the ROV frame. These mounting components include six pre-drilled cast nylon beams and nylon threaded stud, nuts and washers.

When assembled, the nylon components should support the search-coils rigidly in position. You may degrade System performance if you have to cut or modify the mounting components to establish a successful installation.



IMPORTANT

Apart from relevant components of the 440 sub-sea installation, do not place any conductive material, however small or apparently insignificant, any closer to the search-coils than 0.6m. Note that, to the 440 System, a conductive bolt near the coils can look like a target at 1 metre range.

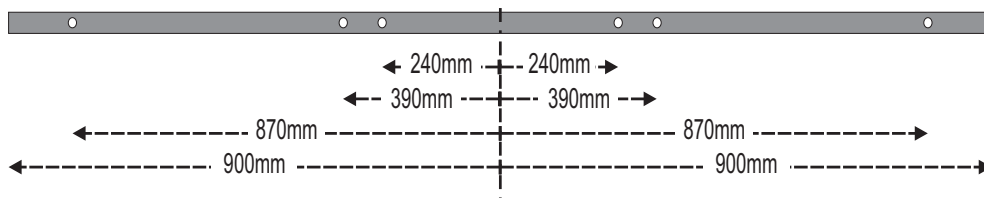
All fastenings, for example cable clips and screws, must be non-conductive.

The System includes three pairs of pre-drilled nylon beams to support the coils on the ROV. Figure 3-3 shows each type of nylon supporting beam:

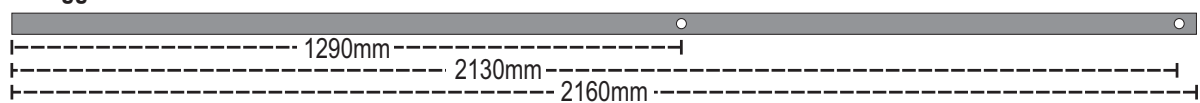
- Two coil mounting strips
- Two outriggers
- Two tie-bars

Figure 3-3: Components of the coil frame

Mounting Strip



Outrigger



Tie Bar

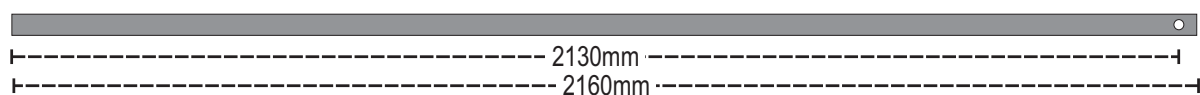
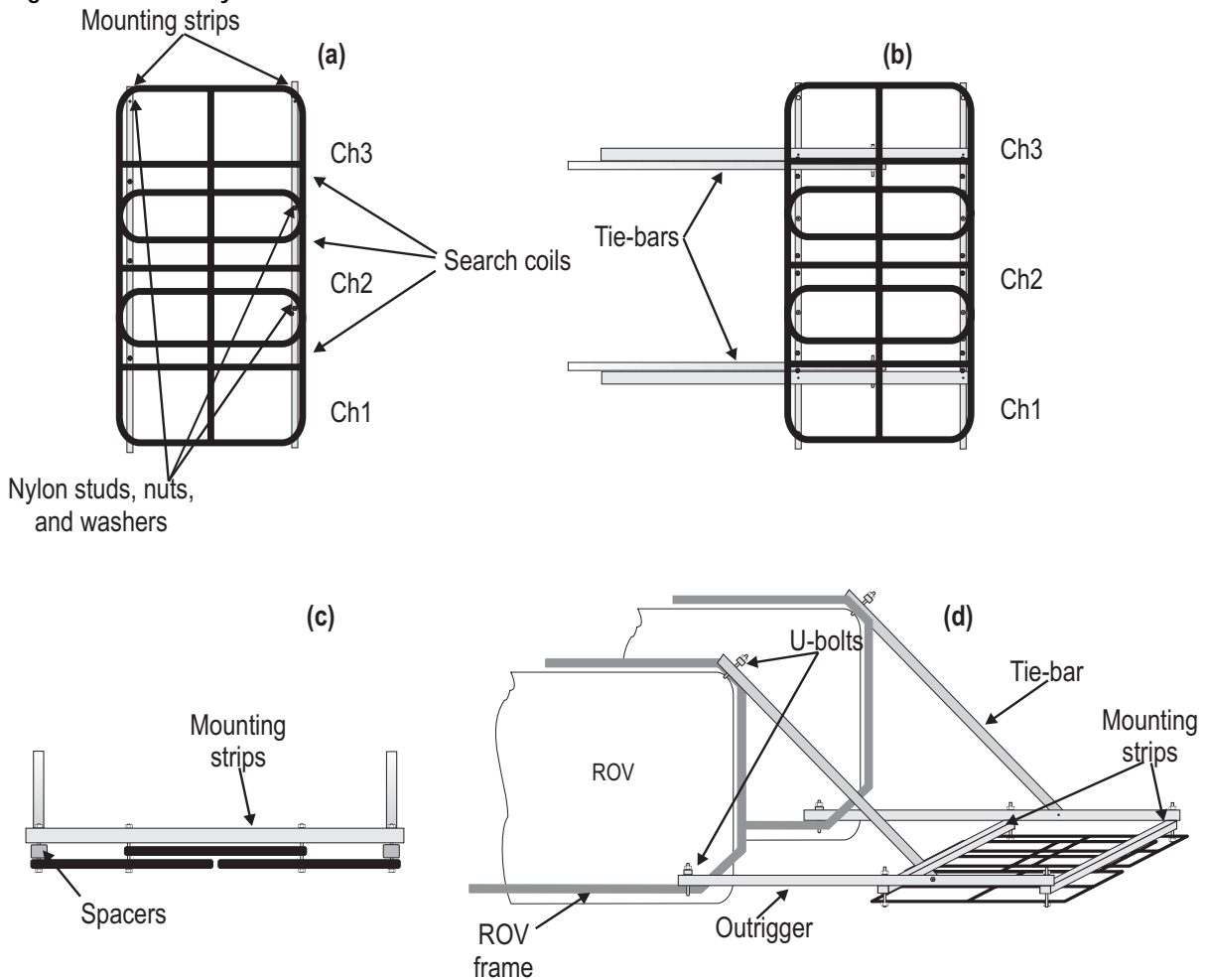


Figure 3–4 shows how to construct the coil frame.

Figure 3–4: Assembly of the coil frame



Note that the centre coil is mounted above the other two coils, making it further away from the target. The System will not function correctly if it is below the other two coils. The port and starboard coils must be mounted such that there is a gap of 5-10 mm between them as defined by the mounting holes in the coil mounting frame.

It is important for accurate readings and continued functionality that the Coils are not bent and that the mounting frame is rigid.

Attach the coil frame to the ROV

To construct the coil frame and assemble the coils to the ROV you will need the following facilities, components and items:

- All the components and fixings of the coil frame supplied by TSS.
- A clear space where you may assemble the coils and the frame to the ROV.
- Stainless steel bolts or U-bolts to fix the coil frame to the ROV.
- A drill together with 16.5mm and 5mm drill bits.

- A measuring tape.
- A spanner for M16 nuts.
- A hacksaw to cut the lengths of nylon studding.
- Plastic cable clips.

There are holes pre-drilled in the mounting strips, outriggers and tie-bars. Note however that you may have to drill additional 16.5mm holes in these components to fit the frame to your specific ROV. Try to avoid this if possible, because you may degrade the System performance.



Do not drill holes in the search-coils.

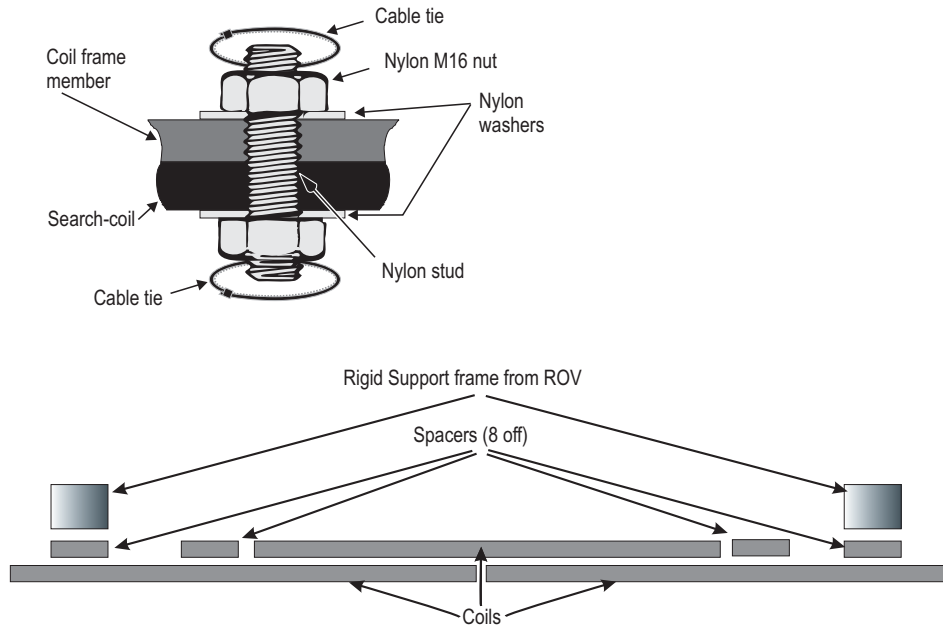
Plan the installation carefully before you assemble the frame components and bolt them together. The following instructions assume you will be installing the coils at the front of the ROV. You may install the coils at the rear of the ROV if you take the proper precautions explained in sub-section 3.2.2.2.

Do not fully tighten the nylon fixing nuts until you have completed all the assembly work on the sub-sea installation.

1. Place the coils on the deck near the ROV. Arrange the coils so that their potting compound is on the top, and all their connectors face towards the ROV. There should be a 5-10mm gap between the port and starboard coils after the nuts have been tightened.
2. Lay the coil mounting-strips on top of the coils and bolt the assembly together using M16 nylon studding through each of the locating holes— see Figure 3–4(a). Secure the studding on each side with a nylon washer and nut.

Ensure that the fixing studs do not project too far below the bottom M16 nut (see Figure 3–5). Also, after you assemble each stud, it is a sensible precaution to drill 5mm diameter holes through the stud above and below the fixing nuts and use cable ties to lock the nuts into position.

Figure 3-5: Coil fixing and use of spacers for coil arrangement



Where there is the possibility of damage to the search-coils from contact with a rocky or abrasive seabed, you may mount the coils on top of the outrigger bars.

3. Use stainless steel bolts or U-bolts to secure the outriggers to suitable parts of the ROV frame. Ensure that the outriggers are parallel with the ROV skids. This precaution gives a small relative angle of pitch between the ROV and the search-coils. Pitch angles greater than $\pm 15^\circ$ between the coils and the target will affect measurement accuracy.
4. If necessary, you may drill new 16.5mm diameter holes in the mounting strips to help assemble the frame. When you assemble the frame, make certain you do not place excessive mechanical stress on any of the fixing studs.

CAUTION

Take care to protect the coils when you drill holes in the frame components. Do not drill holes into any part of the coils. Do not machine the coils in any way.

5. Use four lengths of nylon stud and attach the coil array to the two outrigger bars as shown in Figure 3-4(b). **Make certain you support the coils while you do this.**
6. Use nylon stud inserted through the lateral holes to attach the ends of the tie-bars to the outriggers – see Figure 3-4(c). If no suitable 16.5mm diameter holes exist in the outriggers, drill them.

Use stainless-steel bolts or U-bolts to secure the free ends of the tie-bars to the ROV frame as shown in Figure 3-4(d). You may have to shorten the tie-bars so that they do not snag the ROV umbilical.

7. Finally, ensure that all nylon studs have washers fitted. Tighten the nuts fully. Check that the outriggers and tie-bars are secure and that there is minimal free movement in the completed coil assembly.

3.2.3 Altimeter

The Altimeter needs to be mounted such that it has a free view of the seabed and avoids acoustic interference. If possible the altimeter should also be aligned with the centre of the search coil array.

The minimum range of the Altimeter is approximately 1 metre. It is important that the Altimeter is mounted 1 metre above the lowest point of the vehicle.

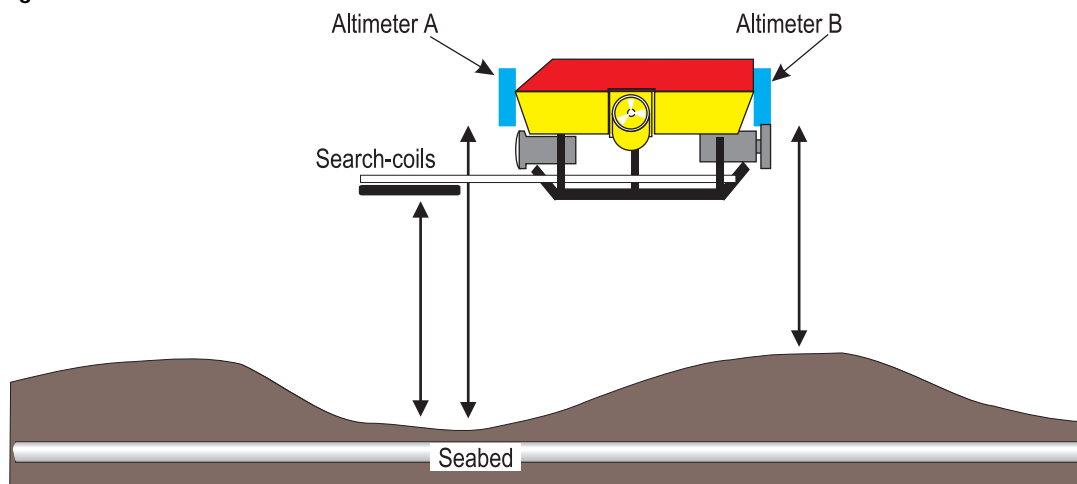
Any horizontal offset between the altimeter and the coil will cause errors in depth of cover measurements made by the 440 System. The example in Figure 3–6 shows how the two altimeters 'A' and 'B' will supply totally different readings at the ROV location. When used by the SDC, these readings would show entirely different measurements for target cover. The magnitude of these errors will vary according to the seabed topography and the relative positions of the altimeter and the coil array.

Note that it is the position of the altimeter that causes these errors. Measurements of vertical range made by the 440 System will retain their accuracy under all normal conditions.



Do not place the altimeter at the opposite end of the ROV to the coils. If you do not follow this advice, it is possible that the survey data might contain errors caused by pitch of the ROV or uneven seabed topography.

Figure 3–6: Effects of altimeter horizontal offset



When you select a position for the altimeter, make allowance for its *minimum* measurement range capability.



IMPORTANT

The altimeter provides information valid only for a point directly below its transducer face but parallel to its axis. When you operate the ROV over uneven seabed, or where the target is in a trench, TSS strongly recommends that you use a separate profiling system to measure the accurate seabed level. See sub-section 8.2.1.4 for further information.

3.3 INSTALLATION CHECK-LIST

- Follow all the installation instructions in this Manual carefully.

- ❑ Ensure the centre coil is mounted further away from the seabed, i.e. above the port and starboard coils.
- ❑ Ensure the array is central on the ROV and that it aligns with the fore-aft direction of travel.
- ❑ Mount the coil array so that its lowest point is more than 0.1m above the lowest point on the ROV. Use a higher mounting location if coil saturation is likely during survey operations on a large target.
- ❑ Mount the coils so they are parallel with the horizontal axis of the ROV.
- ❑ Make certain there is sufficient separation between the coils and the ROV body. The background signal from the ROV should be less than 1000 μ V for successful operations. Usually, this requires a separation distance of 0.75 to 1.2 metres between the coil array and the ROV body.
- ❑ If you intend to install the 440 System on the same ROV as a TSS 350 System, follow the instructions and recommendations concerning coil installation in Appendix B.
- ❑ Do not install the coil array closer than 1m to any conductive materials. Do not use any metal fixings and fastenings within the coil frame.
- ❑ Do not allow any free movement in the coil array or the cables. Poor mounting will reduce the quality of the survey information.
- ❑ Always use the nylon mounting blocks when you install the SEP and the PSU.
- ❑ When you select a location to install the altimeter, consider its minimum range measurement specification.
- ❑ Avoid installing your altimeter where there is a significant horizontal offset distance between it and the coil array.
- ❑ Record all installation-specific configuration details in the Survey Log.



4 ELECTRICAL INSTALLATION

This section of the Manual explains how to connect the SDC and the sub-sea components of the standard 440 System. You should attempt the electrical installation only after you have followed the instructions in Section 3 to install the sub-assemblies of the 440 System.

Also included in this section are detailed instructions that tell you how to change the communication method used between the SDC and the SEP.



The standard 440 System uses 2-wire current-loop communications. To select an alternative communication method you must change the settings of links inside the SEP and the SDC.

If you need to change the communication method you *must* make the necessary link adjustments inside the SEP *before* you mount it onto the ROV.

4.1 Sub-sea Components

Page 2

To gain the best performance from the 440 System, you must interconnect the sub-sea components of the System properly. This sub-section explains how to do this.

Refer to Appendix B for instructions to connect the System as part of a Dualtrack installation.

4.2 Surface Display Computer

Page 9

The SDC includes the DeepView for Windows graphical display and logging software that allows you to configure and control the 440 System. This sub-section explains the mandatory and optional connections to the SDC. It also explains how to change the communication method between the surface and the sub-sea components of the 440 System.



The SDC provided with the 440 Pipe and Cable Survey System is provided with Windows 2000. DeepView for Windows can be installed on an additional machine, but TSS stress that the operating system must have a minimum specification of Windows 2000.

The specification of the SDC provided can be found in Section 9. This should be used as a guideline if you are planning to use DeepView for Windows on an alternative PC.

4.1 SUB-SEA COMPONENTS



WARNING

There is a risk of death or serious injury by electric shock when you work on the electrical distribution system. Only a competent engineer who has the relevant training and experience should make the connection to the ROV electrical distribution system.

Power-off the ROV and isolate the mains supply voltages before you connect the 440 System to the electrical distribution system. Observe all relevant local and national safety regulations while you work on the ROV and on the 440 System.

Do not reconnect the mains electrical supply to the ROV or to the 440 System until you have completed all work and you have fitted all safety covers and ground connections.

This sub-section explains how to complete the electrical installation of the sub-sea components.

Figure 4-1: System interconnection diagram

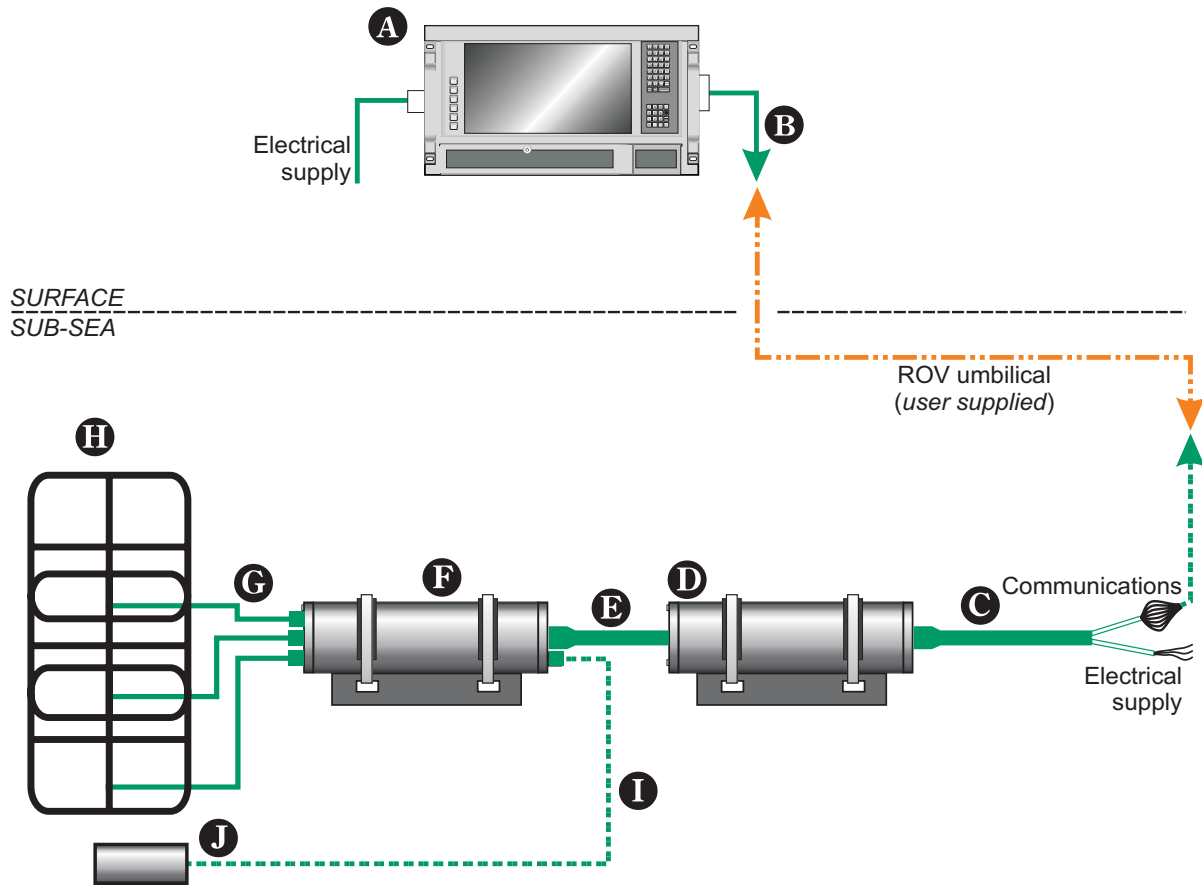


Table 4-1: System interconnection details

A	The SDC accepts an AC electrical supply in the range 85 to 265V (47 to 63Hz). The power demand is a maximum of 250VA.
B	Data communications from the SDC to the ROV umbilical. These can be 2-wire or 4-wire 20mA digital current loop, or RS232. The default configuration is 2-wire 20mA digital current-loop.
C	Power and communications cable (or 'ROV Tail') from the ROV to the PSU. This cable has cores to carry the communication signals that pass between the SEP and the SDC, and power cores that supply mains electrical power to operate the PSU. Refer to Table 4-2 for details of the cable.
D	The PSU accepts AC power from the ROV electrical distribution system through the ROV tail. The maximum current drawn from the supply is approximately 2.8A (at 100V to 120V). As an option, TSS can supply a PSU that accepts AC power at 230V instead.
E	Connection between the PSU and the SEP is through a single cable. The cable has a 12-way connector that connects to the SEP.
F	The SEP accepts power from the PSU and communicates with the SDC through the PSU to SEP cable. The SEP provides power to, and communicates with the sub-sea altimeter through the sub-sea altimeter cable. The SEP drives the search coils through the coil search cables.
G	Three coil connection cables
H	Three TSS search coils arranged as shown with connections to Channels 1 to 3 on the SEP.
I	Power and data cable that connects the altimeter to the SEP
J	Sub-sea altimeter

4.1.1 Ground Connections



CAUTION

To prevent severe corrosion of the sub-sea components, you *must* make adequate grounding provisions for them. If corrosion occurs throughout the System, performance will degrade and eventual catastrophic failure will occur.

You must provide a good ground connection at sea water potential on pin number 2 of the 8-way 'Power/Comms' port of the SEP. Use good waterproof connectors or splices to make the connections.

If you provide the 440 System with an inadequate ground connection, parts of the System will act as 'sacrificial anodes' and will slowly decay during sub-sea operations. This will occur whether or not you use the 440 System.

To prevent corrosion affecting the System in this way, you must connect pin 2 of the 8-way SEP 'Power/Comms' port locally to the ROV using a ground connection at sea water potential.



IMPORTANT

To ground the SEP use only a local grounding point on the ROV frame. Do not use a core within the umbilical to ground the 440 System because there will inevitably be a potential difference between the ROV and the surface vessel.

These grounding provisions hold the 440 System at the same electrical potential as the sea water. This prevents the occurrence of electro-chemical action between the System and sea water and minimises galvanic corrosion.

4.1.2 Care of Sub-sea Connectors

To ensure reliable operation and to extend the life of the sub-sea installation, take the following precautions to care for the sub-sea connectors used throughout the 440 System:

1. Keep both the connector and socket free from debris and salt build up.
2. Use soap and clean fresh water to wash the connectors, and then rinse them with isopropyl alcohol (IPA). Allow the connectors to dry thoroughly in air before you reassemble them.
3. Lubricate the mating face of the connectors with a very light spray of **3M Silicone Oil** or **Dow Corning #111** valve lubricant or equivalent. **Do not use grease.**



CAUTION

Some silicone lubricants will crystallise when you subject them to sea water under pressure. When this happens, the seals of the connector will degrade and allow water to penetrate.

To avoid damage to the connectors, use only the lubricant oils mentioned above, or equivalent oils that the manufacturer approves specifically for use on deep-sea connectors and seals. When you apply the lubricant oil, use a very thin coating only.

4.1.3 Power Supply Pod

The PSU 'Power/Comms' port accepts the AC electrical supply from the ROV and passes the bi-directional communications between the SEP and the SDC. All electrical and communications connections to the sub-sea installation are through the Power and Communications cable, or 'ROV Tail'. Table 4–2 lists the pins of the connector on the Power and Communications cable, together with the relevant core colours. Refer to this table as you make the connection to the ROV electrical distribution system. All cores in the cable are 1.25mm² cross-section. Refer to sub-section 4.2.2 and the cable drawing number 601108 in Section 11 for further details.

Table 4–2: Power and Communications cable

Connector Pin Number (and Wire number)	Function	Core colours
1 (N)	Supply neutral line/L2	Blue
2 (E)	ROV ground (refer to sub-section 4.1.1)	Dark Green
3 (L)	Supply 110V live/L1 (or +140 to +170V DC)	Brown
Pin 4 (wire number 1)	Comms 1	Orange
Pin 5 (wire number 2)	Comms 2	White
Pin 6 (wire number 3)	Comms 3	Red
Pin 7 (wire number 4)	Comms 4	Yellow
8 (no connection)	Linked internally to the cable screen	Screen

Lay the Power and Communications cable from the ROV electrical distribution system to the PSU. Route the cable along fixed ROV frame members and use cable clips to secure it at regular intervals. Avoid applying any sharp bends or other points of mechanical stress along the cable.

Connect the Power and Communications cable to the 8-way male ‘Power/Comms’ port on the PSU. Tighten the knurled locking collar by hand only. **Do not overtighten this connector.**

Before you assemble any electrical coupling in the sub-sea installation, inspect the pins and receptacles of all connectors for signs of damage, contamination or corrosion. Follow the instructions in sub-section 4.1.2 to clean and care for the connectors.



CAUTION

It is very important to provide a good ground connection on pin number 2 of the cable. A poor or a missing connection will severely degrade the performance of the 440 System. You must make all connections to the ROV using waterproof connectors or splices of good quality.

4.1.3.1 Power Requirement

The standard PSU operates from an AC electrical supply in the range 100 to 120V AC, 45 to 65Hz. The System draws approximately 2.8A at 110V nominal supply voltage. The same PSU can operate from a DC supply in the range 140 to 170V with no further adjustments necessary.

Refer to Table 4–2 and make the correct power connections from the ROV electrical distribution system to your PSU.

4.1.4 Sub-sea Electronics Pod

The SEP performs all the following functions:

- ❑ Signal processing
- ❑ Communicating with a sub-sea altimeter connected directly to the SEP
- ❑ Communicating with the SDC through the ROV umbilical
- ❑ Interfacing with the TSS 350 Cable Survey System (when you use the 440 System within a Dualtrack installation)



CAUTION

Water could enter the SEP through any port that does not have a connector fitted. To avoid damage from water ingress, you must fit the correct blanking plug supplied by TSS to protect any unused port on the SEP.

The SEP has six ports that allow connection to the various sub-sea components of the installation.

On one end cap:

- ❑ Connection ports for coil channels 1 to 4. A label identifies the four coil channels. The 440 System uses only three channels during a survey. You *must* ensure the unused port has a blanking plug fitted to protect it during sub-sea operations.

On the other end cap:

- ❑ Connection port for the 12-core cable from the PSU
- ❑ Altimeter connection

Before you assemble any electrical couplings in the sub-sea installation, inspect the pins and receptacles of all connectors for signs of damage, contamination or corrosion. Follow the instructions in sub-section 4.1.2 to clean and care for the connectors.

Tighten the connector locking collars by hand only – **do not overtighten these connectors.**

4.1.5 Search-coils



CAUTION

You must fit a blanking plug to the unused channel on the SEP. The System includes four of these plugs and further can be obtained if required (TSS P/N 202207).

If you do not fit this blanking plug, rapid corrosion of the port will occur and the port will fail. Sea water will then enter the SEP through the corroded port to cause total failure of the SEP.

You must use one of the cables supplied with the System to connect each search-coil to its correct channel on the SEP. The cables have a waterproof connector fitted to each end.



Route the cables from the coils to the SEP by securing them along the ROV body using plastic cable clips. Avoid introducing any sharp bends or other points of stress, and ensure the cables are safe from potential damage from manipulators, thrusters or other equipment on the ROV.

Before you assemble any electrical coupling in the sub-sea installation, inspect the pins and receptacles of all connectors for signs of damage, contamination or corrosion. Follow the instructions in sub-section 4.1.2 to clean and care for the connectors, and to sub-section 7.3.2.1 for instructions to perform an electrical insulation test on the coils.

Tighten the connector locking collars by hand only – **do not overtighten these connectors.**

For the System to operate correctly, you must connect the search-coils to their correct input channels on the SEP. Labels identify the four SEP input channels:

- ❑ Connect the starboard coil to SEP Channel 1
- ❑ Connect the centre coil to SEP Channel 2

- Connect the port coil to SEP Channel 3
- Make certain you fit the supplied blanking plug to SEP Channel 4 to protect it from contact with sea water.



The above coil-to-channel relationship is valid both for front and for rear mounting coil arrangements on the ROV.

4.1.6 Sub-sea Altimeter



CAUTION

If you do not use the 'Altimeter' port on the SEP, you must fit the correct blanking plug supplied with the System to protect it from contact with sea water. Further plugs can be obtained if required (TSS P/N 202208).

If you do not fit this blanking plug, rapid corrosion of the port will occur and the port will fail. Sea water will enter the SEP through the corroded port to cause total failure of the SEP.

Choose one of the two available methods that you may use to connect the altimeter:

1. **Direct connection to the SEP.** Refer to sub-section 4.1.6.1.
To be used for the TSS sub-sea altimeter or either of the Datasonics units. The SEP provides power to drive these altimeters.
2. **Connection through the umbilical to the SDC.** Refer to sub-section 4.1.6.2.
To be used for remote connections of all other types of altimeter compatible for use with the 440 System.

These altimeters use RS232 communications. To send their signals through the umbilical, you must add them to the ROV multiplex unit and extract them at the surface. You must also provide a separate power supply for the altimeter.

Generally, these types of altimeter have different data formats. Refer to sub-section 7.6 for details of these formats.

4.1.6.1 Direct Connection to the SEP

Route the cable from the altimeter to the SEP. Secure the cable at regular intervals along fixed frame members of the ROV. Avoid introducing any sharp bends or other points of mechanical stress along the cable.



Follow the important advice listed in sub-section 4.1.2 concerning the care of connectors.

Connect the cable to the 6-way 'Altimeter' port of the SEP. Tighten the knurled locking collar by hand only. **Do not overtighten this connector.**

Use the DeepView for Windows software to configure the 440 System for use with an altimeter connected directly to the SEP. Refer to Section 5 and 6 for appropriate instructions.

4.1.6.2 Connection to the SDC

Make the following provisions if you intend to use one of the compatible alternative altimeters with the 440 System:

- Connect the altimeter to an available serial port. This will normally be the ‘ALTIMETER’ (COM2) port. Note that, because the altimeters use RS232 communications, they cannot transmit their signals farther than approximately 15 metres. Therefore, you must add the altimeter signals to the ROV multiplexer and then extract them at the surface. You must then convert the signals to RS232 for application to the SDC.
- Provide a separate power supply to drive the altimeter.

Refer to the manual supplied by the altimeter manufacturer for relevant connection details.

Connect the RS232 altimeter signals to the SDC through the 9-way D-type male serial communication port labelled ‘ALTIMETER’ (COM2) on the rear connector panel of the SDC. The pin designations for the 9-way D-type ports are as follows:

Table 4-3: RS232 connections for the altimeter (9-way D-type female cable)

Altimeter signal	Pin Number	SDC Altimeter pin connections
RS232 data from altimeter	2	Receive
RS232 Comms to altimeter	3	Transmit. <i>Necessary for use only with the OSEL Bathymetric System, where communications must be bi-directional.</i>
RS232 common	5	Ground

Use the DeepView for Windows software to configure the 440 System for use with the appropriate type of altimeter. Refer to Section 5 and 6 for relevant instructions.

4.2 SURFACE DISPLAY COMPUTER

Refer to sub-section 2.3 for a description of the SDC and Section 9 for a minimum specification.

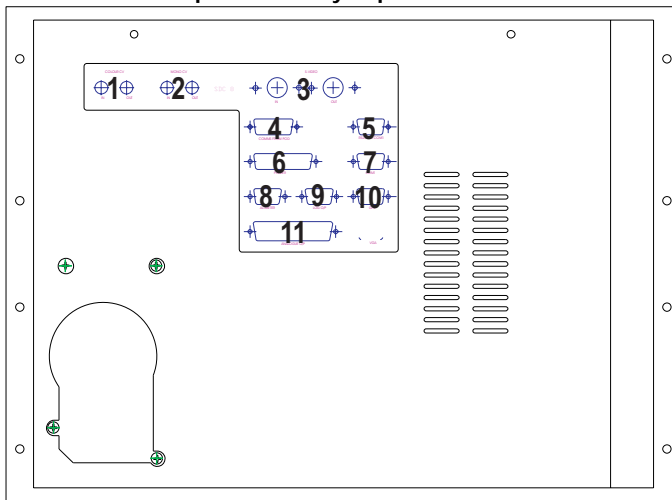
The following sub-sections 4.2.2 to 4.2.4 explain the various connections that you may make to the SDC.



CAUTION

You must route all cables to the SDC through the rear of the transit case. You must open and remove the rear panel of the case to allow this.

Figure 4-2: SDC Rear panel with key to ports



- 1: Colour CV IN and OUT
- 2: Mono CV IN and OUT
- 3: S-Video IN and OUT
- 4: Comms from SEP
- 5: RS-232 to COM1
- 6: Printer
- 7: COM1
- 8: Altimeter
- 9: External log o/p
- 10: Not used (GPS)
- 11: Analogue o/p

4.2.1 Power Connection

Connect AC electrical power to the SDC through the 3-core electrical supply cable and standard 3-pin IEC electrical inlet.

The SDC has an auto ranging power supply unit that configures itself automatically to use an electrical supply in its acceptable range 85 to 265V AC (47 to 63Hz).

4.2.2 Communication Link SEP to SDC

Use the SDC port – ‘COMMS FROM POD’

The standard communication link between the SDC and the sub-sea installation of the 440 System uses a 2-wire 20mA digital current-loop carried on a twisted pair within the ROV umbilical. To avoid possible communication contentions, the SDC acts as the ‘Master’ and the SEP acts as the ‘Slave’ in this link.

If the umbilical cable is of good quality, experience has shown that you may use this communication method successfully through transmission distances up to 1000 metres. To ensure

reliable communications through the umbilical, select a twisted pair that has the following characteristics:

Table 4-4: Ideal twisted pair characteristics for successful communication

Twisted pair characteristic	Ideal value
Overall resistance	Less than 200Ω
Core size	0.5 to 1.0mm ²
Inter-conductor capacitance	Less than 100pF per metre

There are two further methods that you may use to establish successful communication between the SDC and the sub-sea components of the 440 System:

□ 4-wire 20mA digital current-loop

You should select this method when the umbilical link to the ROV is longer than 1000 metres, or where you cannot establish reliable communication using a 2-wire current-loop.

You will need to reconfigure the SDC and the SEP to use this communication method. Refer to sub-section 4.2.2.1 for instructions to do this.

After you have made the necessary changes in the SEP and the SDC, perform a simple communication check.

□ RS232

This is a 3-wire link suitable only for communication over distances up to 15 metres. You may use this method to transmit data to the survey control room using the ROV multiplexer and an existing data link to the survey control room.

You will need to reconfigure the SDC and the SEP to use this communication method. Refer to sub-section 4.2.2.1 for instructions to do this.

The Systems default parameters for communication between the SDC and the SEP are 9600 baud with 8 data bits, 2 stop bits and no parity.



These communication settings are valid even when you use 2-wire or 4-wire current-loop communications. This is because the SDC converts between current-loop and RS232 communications through a special converter card. All communication between the SDC and the sub-sea installation passes through the relevant SDC serial port.

Communication lines between the SDC and the sub-sea components are opto-isolated at both ends.

The following tables show the connections that you must make between the SEP and the SDC for each of the three communication methods. Refer to sub-section 4.1.3 and Table 4-2 for

details of the connections that you must make between the SEP and the ROV electrical distribution system.

Table 4-5: Power and Communications cable – 2-wire current loop connections

SEP Power/Comms port Pin number	Function		SDC 'COMMS FROM POD' (15 way) pin connection
4	CL-	↔	3
5	CL+	ROV umbilical	4

Table 4-6: Power and Communications cable – 4-wire current-loop connections

SEP Power/Comms port Pin number	Function		SDC 'COMMS FROM POD' (15-way) Pin connection
4	CL+ Input	↔	3
5	CL- Input	ROV umbilical (Tx in SDC)	4
6	CL+ Output	(Tx in SEP)	5
7	CL- Output		6

Table 4-7: Power and Communications cable – RS232 connections

SEP Power/Comms port Pin number	Function		SDC 'COMMS FROM POD' (15-way) Pin connection*
4	Tx output from SEP	↔	3
5	Rx input to SEP	Data cable	4
6	Common		5

* You may connect RS232 communications directly to the 9-way D-type serial communication port COM1 on the SDC.

To use current-loop communications you must reserve either one or two conductor pairs in the ROV umbilical for the exclusive use of the 440 System. The System includes a cable that you should use to connect the 'COMMS FROM POD' port on the SDC to the twisted pairs in the ROV umbilical. The cable has a 15-way D-type connector for connection to the SDC 'COMMS FROM POD' port, and open tails for connection to the umbilical at a junction box.

See Tables 4-5 to 4-7 for the connection details of the 15-way D-type connector fitted to this cable.

When you connect the communication cable to the SDC, ensure that the supplied jumper cable is fitted between the 'RS232 TO COM1' and the 'COM1' port on the SDC.

If you use RS232 communications through an existing multiplexed link, you may connect directly from your de-multiplexer to the SDC 'COM1' at the 9-way D-type connector.

4.2.2.1 Alternative Communication Methods



WARNING

There is a risk of death or serious injury by electric shock when you work inside the SDC, the SEP or the PSU.

Only a competent engineer who has the relevant training and experience should open any part of the 440 System.

Power-off and isolate the equipment from the mains supply voltage before you open any part of the 440 System. Observe all relevant local and national safety regulations while you perform any maintenance work on the 440 System.

Re-fit all safety covers and ground connections to the 440 System before you re-connect the equipment to the mains electrical supply.

Many components within the SDC are susceptible to damage due to electrostatic discharge. You must take precautions against such damage: These precautions include the use of a grounded conductive mat and wrist-strap. TSS will not accept responsibility for any damage caused by failure to take such precautionary measures.



The following instructions are valid for the SDC Type 8 that the 440 Pipe and Cable Survey System is shipped with. The 440 System will not work with earlier versions of our SDCs due to this being the first system to operate under the Windows™ environment. Contact TSS for advice if necessary.

The standard communication link between the SDC and the sub-sea installations of the 440 System uses a 2-wire 20mA digital current-loop carried on a twisted pair within the ROV umbilical. To configure the 440 System so that it uses an alternative communication method, you must change link settings inside the SEP and the SDC.

The alternative communication methods are:

- 4-wire 20mA digital current-loop

Suitable for use with umbilical cables longer than 1000 metres, or where the quality of the umbilical cable prevents effective use of the standard 2-wire method.

In practice, the 4-wire method should be suitable for use with umbilical cables up to 4000 metres long if the umbilical is of good quality.

- RS232

Suitable for communication up to distances of 15 metres. This method is practical where a multiplexed communication link already exists between the ROV and the surface vessel, for example where you use a fibre-optic umbilical cable.

Configure the SEP

CAUTION

Many components inside the SEP are susceptible to damage due to electrostatic discharge. You must take precautions to prevent such damage whenever you open the SEP. These precautions include the use of a grounded conductive mat and wrist-strap.

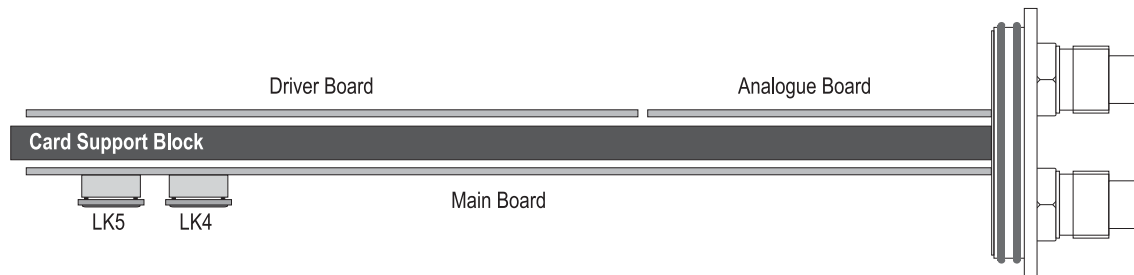
TSS will not accept responsibility for any damage caused by failure to take such measures.



If you need to select a different communication method, change the settings of links inside the SEP *before* you install it on board the ROV.

Follow the instructions in sub-section 10.2.2.1 to open the SEP and gain access to the circuit cards. The SEP card support block, shown in Figure 4–3, carries the Analogue Board, the Driver Board, and the Main Board. The Main Board is the largest of the three.

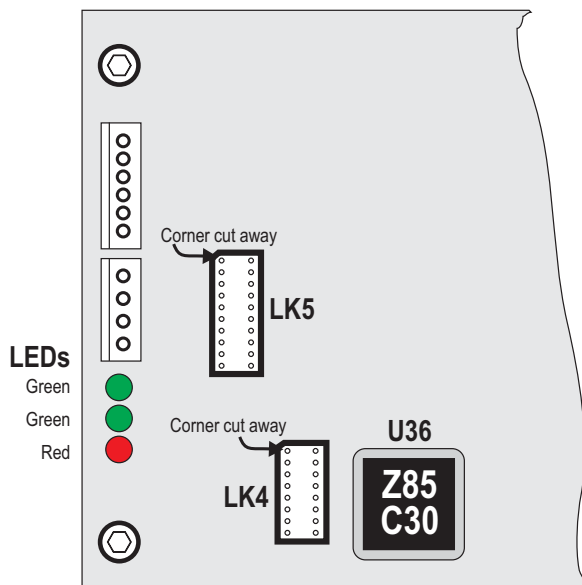
Figure 4–3: SEP card support block



The Main Board includes two plug-in DIL ‘headers’, LK4 and LK5. Figure 4–4 shows the location of these links on the Main Board.

To change the communication setting used by the SEP, you must change the plug-in headers in LK4 and LK5.

Figure 4–4: Link location on the SEP Main Board



Make certain that you have the correct link headers for your chosen communication method. Carefully remove the existing link headers from their sockets and store them safely in the field support kit. **The header pins are thin and you might damage them if you handle the link carelessly.**

Align the pins of the replacement header with the receptacles in the socket. The socket has a corner cut off to ensure that the orientation is correct as shown in Figure 4–4. Press the link header carefully into position until it seats properly in the socket. Check that none of the pins has become bent or damaged and that all are inserted fully into the socket.

Each of the headers has a different TSS part number and establishes a different communications protocol. You may order a complete set of SEP and SDC headers from TSS if you need to change the communication method. Table 4-8 lists the correct part numbers for the SEP headers.

Table 4-8: SEP link header part numbers

SEP Link	2-wire Current-loop (Standard fit)	4-wire Current-loop	3-wire RS232
LK5	465002	465008	465005
LK4	465010	465011	465004

Once you have set both links, follow the instructions in sub-section 10.2.2.1 to re-assemble the SEP.



NOTE

It is a good idea to keep the links on the spare Main Board set identically to those in the SEP. This avoids potential communication problems if you need to replace the Main Board from the field support kit during a survey.

Configure the SDC

WARNING



There is a risk of death or serious injury by electric shock when you work inside the SDC, the SEP or the PSU.

Only a competent engineer who has the relevant training and experience should open any part of the 440 System.

Power-off and isolate the equipment from the mains supply voltage before you open any part of the 440 System. Observe all relevant local and national safety regulations while you perform any maintenance work on the 440 System.

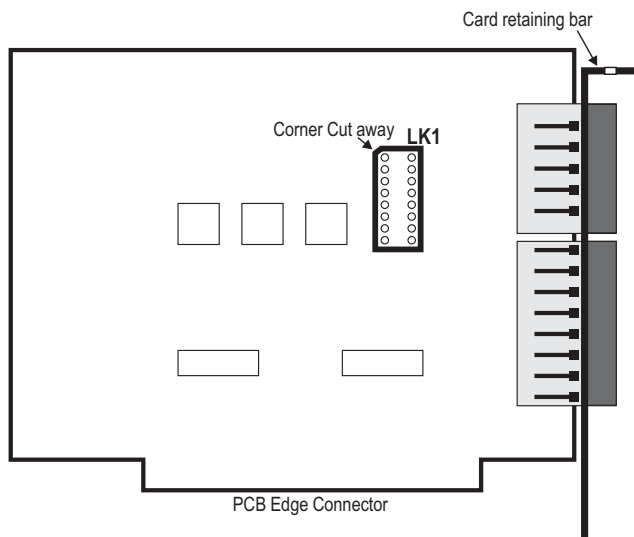
Re-fit all safety covers and ground connections to the 440 System before you re-connect the equipment to the mains electrical supply.

To change the communication method you will need to set a link on the Converter Card of the SDC. Follow the instructions below carefully:

1. Follow the instructions in sub-section 10.2.1 to open the SDC and remove the converter card.
 Identify the Converter Card by the fact that it holds the 15-way and 9-way D-type ports. The ports are not labelled but the respective cables used are labelled with 'COMMS TO POD' (15-way) and 'RS232 TO COM1' (9-way).
2. Remove and retain the side connector panel cover screws, and remove the side connector panel cover.
3. Unscrew and remove any connectors to the expansion card on the side connector panel. Disconnect any internal connections to the expansion card making a note of the connections removed.

Figure 4–5 shows the location of the link LK1 on the SDC Converter Card.

Figure 4-5: Location of link LK1 on the SDC Converter Card



Link LK1 in the SDC is a plug-in header that locates into a 16-pin DIL socket. The header configures the Converter Card to the appropriate communication method.

You may insert any of three substitute headers to select the communication method. Table 4–9 lists the part numbers for the three header types:

Table 4-9: SDC Converter Card link headers

2-wire current-loop (standard fit)	4-wire current-loop	RS232
465003	465009	465006

1. Make certain that you have the correct link header for your chosen communication method. Carefully remove the existing link header from the socket and store it safely in the field support kit. **The pins of the header are thin and you might damage them if you handle the link carelessly.**

2. Align the pins of the new link header with the receptacles in the socket. The socket has a corner cut off to ensure that the orientation is correct as shown in Figure 4–5. Press the link header carefully into position until it seats properly in the socket. Check that none of the pins has become bent or damaged and that all are inserted fully into the socket.
3. Follow the instructions in sub-section 10.2.1 insert the converter card and reassemble the SDC.



After you have changed the communication method. You must run the configuration wizard from DeepView for Windows or comms errors will occur.

You must perform a communication check as part of the pre-dive tests. Refer to sub-section 7.3.2 for details of the recommended pre-dive test procedure.

4.2.3 Interface to Data Logger

Use the SDC port 'LOG O/P'

During normal survey operations, the 440 System acquires data at a rate of up to 1MB per hour. You should arrange to record the official survey log on a suitable data logger.

For your convenience and for test purposes, the 440 System can also create a logged record internally on the SDC hard disk. Data stored using the internal logging facility does not possess the same format as that transmitted to the external data logger, and you should not use it as the primary survey log. Internal logging allows you to record sections of the survey and then to 'replay' them subsequently using the graphical display facilities of the SDC. You cannot replay external logging files through the SDC in this way.



The internal logging facility on the 440 System is for your convenience and for test purposes only. Do not use it as the principal survey logging tool.

Unless otherwise stated, this Manual describes the external logging facility of the 440 System.

Refer to sub-section 7.4.1.1 for a description of the format that the 440 System uses to log data.

Make a connection between the 440 System and an external data logger using the 9-way D-type 'LOG O/P' (COM3) port on the SDC. The pin designations for this port are as follows:

Table 4–10: RS232 connection to SDC 'LOG O/P' (COM3)

Signal to Data Logger	SDC 'LOG O/P' (COM3) Pin connections
RS232 input to data logger	3 (transmit)
RS232 common	5 (ground)

4.2.4 Interface to Video

Use the SDC ports 'COLOUR CV IN' and 'COLOUR CV OUT', or 'MONO CV IN' and 'MONO CV OUT', or 'S-VIDEO IN' and 'S-VIDEO OUT'

1. Video input – Use appropriate input port for your format (COLOUR CV IN, MONO CV IN, or S-VIDEO IN) These are clearly marked on the reverse panel of the SDC.
The standard SDC accepts video input in PAL or NTSC format from a camera mounted on the ROV. Apply the video signal to the SDC through the appropriate video input port. TSS supplies CV cables (dual phono to phono) and a pair of BNC to phono adapters to assist video connection with the 440 System.

Note that you cannot display the video channel on the SDC screen.

The SDC mixes video images from the sub-sea camera with graphical information generated by the SEP. You may view the composite image through the appropriate video output port.

2. Video output – Use appropriate output port for your format (COLOUR CV OUT, MONO CV OUT, or S-VIDEO OUT)
The format of the SDC video output signal will match that of the input video signal. That is if your input is PAL, then the output will be PAL. Similarly if your input is NTSC then the output will be NTSC. Further the video output will reflect the specific connections used i.e if the video input is monochrome CV, the output will be monochrome CV and will be provided via the 'MONO CV O/P' port (similarly colour CV input will provide via the 'COLOUR CV O/P', and S-Video output will be provided via the 'S-VIDEO O/P').



Note A monochrome CV input may be applied to the 'COLOUR CV IN' to allow the colours of the overlay graphics to be viewed, however colour aberrations in the video output may be visible.

You may connect this signal to a standard video monitor using 75Ω screened cable. The output can drive a single monitor or multiple monitors if you add a suitable video drive amplifier.



5 SYSTEM CONFIGURATION



Before you power-on the SDC and the sub-sea components of the 440 System, make certain that:

- You have installed the surface and sub-sea components correctly as instructed in Section 3.
- You have made all electrical connections within the System using the correct cables as instructed in Section 4.
- You have established an appropriate communication method between the surface and the sub-sea components.

The SDC has all the software that you will need to operate the 440 System already installed. This section of the Manual describes the features of this ‘DeepView for Windows’ display software that you must use to configure the 440 System.

Although you may access the majority of commands by using an appropriate sequence of key presses on the SDC key pads, you will find it easier to use the software if you use a suitable pointing device such as a mouse or the trackpad supplied with the System.

In these instructions, key press sequences appear in square brackets. For example, ‘press [SHIFT]+[F4]’ means to press the Shift key and the function key F4 together.

These instructions assume you are reasonably familiar with the Microsoft Windows 2000 operating environment and that you know how to select commands and options by clicking with the buttons on the pointing device.

This section of the Manual explains how to start the SDC and use the DeepView System Configuration Wizard to establish the correct operating configuration for the 440 System.

5.1 Software Installation **Page 2**

How to install DeepView for Windows on an additional PC.

5.2 Power-on Procedure **Page 3**

How to start operation of the sub-sea and surface installations of the 440 System.

5.3 DeepView For Windows - System Configuration **Page 5**

How to use DeepView for Windows to configure the 440 System for a survey operation.

5.4 Print Configuration **Page 7**

It is important to print details of the 440 System configuration at the start and end of a survey.

5.1 SOFTWARE INSTALLATION

The SDC supplied with the 440 System already has the DeepView for Windows software installed on its hard disk together with the Microsoft Windows 2000 operating system needed to run it.

TSS supplies a CD containing the DeepView for Windows software with the 440 System. You may install this software, under licence, on a separate PC to support the main installation on the SDC or to replay an internally logged data file. The following instructions explain how to install the software on a separate PC.



If you do not need to install the software on a PC or on the SDC, go directly to sub-section 5.2 for instructions to begin using the 440 System and DeepView for Windows.

To install the software it is recommended that you read the readme.txt file on the CD provided which will be updated with any enhancements or issues to be aware of prior to installing the software:

1. Insert the supplied CD into the CD-ROM drive of your PC.
2. The software should start automatically. If it does not, within the Windows environment select 'My Computer' and the respective drive for your CD-ROM drive. Within the contents of the CD-ROM you will find a README file and a setup program which automatically installs the software.
3. To use DeepView for Windows, double click on the TSS icon that the Install Shield places on your Windows 2000 desktop.



Take the following precautionary measures to maintain the SDC and your PC in optimal condition:

- Check all the drives on your PC for viruses using current versions of an approved anti-virus program.
- Perform a Windows Scandisk and a Defrag session regularly.
- Follow the correct procedures to close down Windows and power-off the SDC and your PC.
- NEVER install unauthorised software on the SDC.
- NEVER make any alterations to the Windows registry unless you are entirely certain that you know what you are doing, and have backed up the registry files 'system.dat' and 'user.dat'. Inappropriate modifications to the Windows registry can prevent the SDC from operating.

5.2 POWER-ON PROCEDURE



During its initialisation, DeepView for Windows searches for a valid initialisation file on the SDC hard disk. If the file exists and the SDC receives compatible data packets from the SEP, DeepView for Windows will begin to operate using the configuration details stored in the initialisation file. If DeepView for Windows does not find the initialisation file or if there are no compatible data packets arriving from the SEP, it will start the System Configuration Wizard to help you establish reliable communications.

For this reason it is usually better to power-on the sub-sea installation before you power-on the SDC.

If the SEP is powered up with DeepView already running, a banner "Subsea pods overheating" will appear for a few seconds. This is normal, and does not indicate a problem with the subsea electronics.

Power-on the sub-sea components of the 440 System:

All electrical power for the sub-sea components arrives through a single cable into the PSU, which generates the following stabilised and conditioned DC supplies:

- All supplies necessary to operate the SEP
- Power for a suitable sub-sea altimeter connected directly to the SEP. If you connect your altimeter to the SDC instead then you must provide a separate power supply for it.
- Drive current for the 20mA digital current-loop

Refer to sub-section 4.1 for instructions to make the electrical connections to and between the sub-sea components of the 440 System. The System starts to operate when you provide the correct electrical supply to the PSU.

Power-on the sub-sea components of the 440 System. At the SDC, release the lock and open the hinged access panel on the SDC front panel to reveal the rocker type power switch, the CD-ROM drive and the 3½-inch floppy disk drive.

Check that the 'C/LOOP' LED shows red to indicate the presence of the 20mA drive current in the communication current-loop. Because the SEP generates this drive current, the LED should show red even before you power-on the SDC. By showing red, the LED provides two important visual checks on the System:

- It confirms that the SEP is receiving electrical power from the ROV.
- Because the LED is in series with the current-loop, it proves the loop is intact. *Note that the LED shows only that the current-loop is intact – it does NOT indicate that there are successful communications passing between the SDC and the SEP.*



The 'C/LOOP' LED will show red only if you use either of the two available current-loop communication methods – it will not illuminate if you use the RS232 communication method.

Power-on the SDC:

Check that you have connected an AC electrical supply of the correct rating to the three-pin IEC mains inlet on the SDC (refer to sub-section 4.2.1 for instructions to connect power to the SDC).

Remove any disks that might be loaded into the drives. Operate the power switch to power-on the SDC.

After you power-on the SDC, the 'POWER' LED should show green and the 'HDD' LED should flicker amber as the SDC begins an initialisation sequence that lasts approximately a minute. The SDC will launch Microsoft Windows and the DeepView for Windows display software automatically after it has completed the initialisation sequence.

Provided the software launches successfully, you will see the DeepView for Windows opening splash screen. DeepView for Windows will then search for an initialisation file on the SDC that includes details of the previous operating configuration. If the software finds the initialisation file and the SDC receives data packets from the SEP that are compatible with that file, then it will begin to operate using the same configuration. Otherwise, DeepView for Windows will launch the System Configuration Wizard that allows you to define the operating parameters used by the System.

Close and secure the hinged access panel.



To start the display software from Windows, select Start → PROGRAMS → DeepView for Windows → DeepView for Windows.

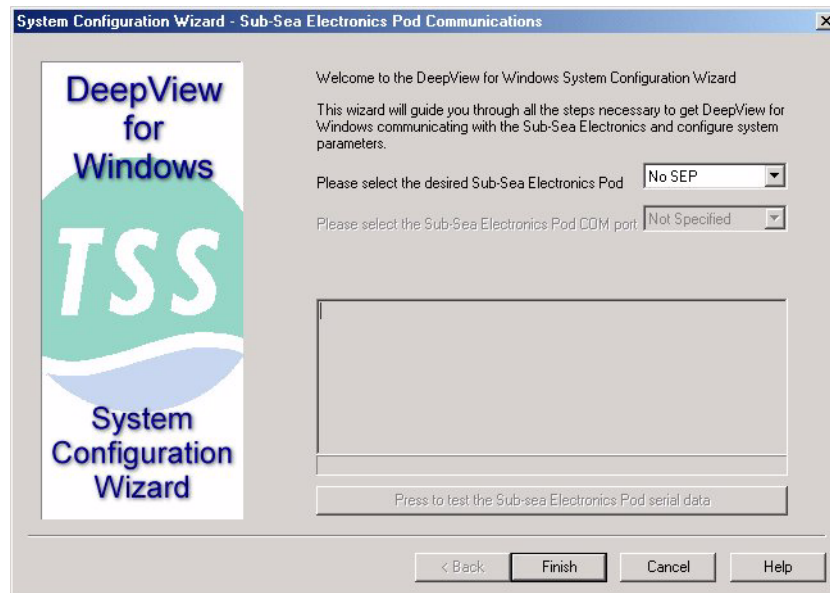
The SDC has tactile membrane keypads for alphanumeric, function-key. You may use a mouse or the supplied trackpad to select commands and options from within DeepView for Windows, and you may use the keypads to enter commands.

Under some circumstances, DeepView for Windows may not be able to communicate with the SEP even though the 'C/LOOP' LED is showing red. This might occur, for example, if the characteristics of the umbilical cable are unsuitable for use with 2-wire current-loop communications. You may then have to reconfigure the 440 System to use a different communication method – see sub-section 4.2.2.1. See also the fault identification sequences described in sub-section 10.3.

5.3 DEEPVIEW FOR WINDOWS - SYSTEM CONFIGURATION

Before you can use the 440 System for the first time you must configure the software. This procedure can be enabled to run every time you open DeepView for Windows or if your setup is consistent it can be disabled and accessed via “System Configuration Wizard” from the configuration menu when DeepView is operational. The options that you are able to configure are the following:

Figure 5-1: DeepView for Windows - System Configuration Wizard



5.3.1 SEP type

Define whether there is no SEP, a stand alone 440, 350, or whether it is part of a Dualtrack System. This setting determines the data format that DeepView for Windows expects to receive from the sub-sea installation and sets the style of Run Window that the software will use to display the System measurements.

There are four options for setting the SEP type:

- ❑ **No SEP**
Use this option to operate DeepView for Windows with no SEP connected. This might be necessary, for example, if you wish to use DeepView for Windows to replay data on a separate PC.
- ❑ **440**
Use this option to control a stand-alone 440 System.
- ❑ **350**
Use this option to control a stand-alone 350 System.
- ❑ **Dualtrack**
Use this option to control a Dualtrack System comprising an interconnected 440 and 350 System controlled from the same SDC. You should use this option even if you intend to use only one of the Systems during the survey.

5.3.2 Communication ports

Define the serial communication ports and their communication parameters. The SDC uses the serial communication ports to communicate with the SEP and with external devices such as the sub-sea altimeter and a data logger.



During System Configuration the only port that you have to specify is the Communication to the Sub Sea Electronic Pod (or SEP). Below is outlined a list of the COM Ports and their default assignments.

The SDC has five serial communication ports that it uses to communicate with external and peripheral equipment. The standard assignments for these ports are as follows. You may change these if necessary.

- COM1 is used to pass serial communications between the SEP and the SDC. DeepView uses a serial port for this purpose even if you set the 440 System to use current-loop communications. The SDC includes the hardware necessary to convert between these standards.



Note that the current-loop communications connects through a jumper link from the current-loop converter card. If you decide to use an alternative serial communications port for the primary communications circuit, then you must also move the link connection to the alternative serial port.

- COM2 (labelled 'ALTIMETER' on the rear connector panel of the SDC) is used to accept serial data from any compatible altimeter that is not connected directly to the SEP. The maximum range for RS232 communications is 15 metres. Therefore, to connect an altimeter to the SDC you must add its signals to an existing multiplexed data link in the ROV umbilical and then extract them at the surface. Refer to sub-section 6.2.2.1 for instructions to configure an altimeter and set its communication parameters.
- COM3 (labelled 'LOG O/P' on the rear connector panel of the SDC) is used to connect the SDC to a separate user-supplied data logger. You should use a data logger to record the survey measurements acquired by the 440 System. Refer to sub-section 6.2.2.2 for instructions to configure DeepView for data logging and to set appropriate communication parameters.
- COM4 (labelled 'GPS' on the rear connector panel of the SDC) is not used.
- COM5 (is not available on the rear connector panel of the SDC) is used by the SDC to communicate with the video overlay card.

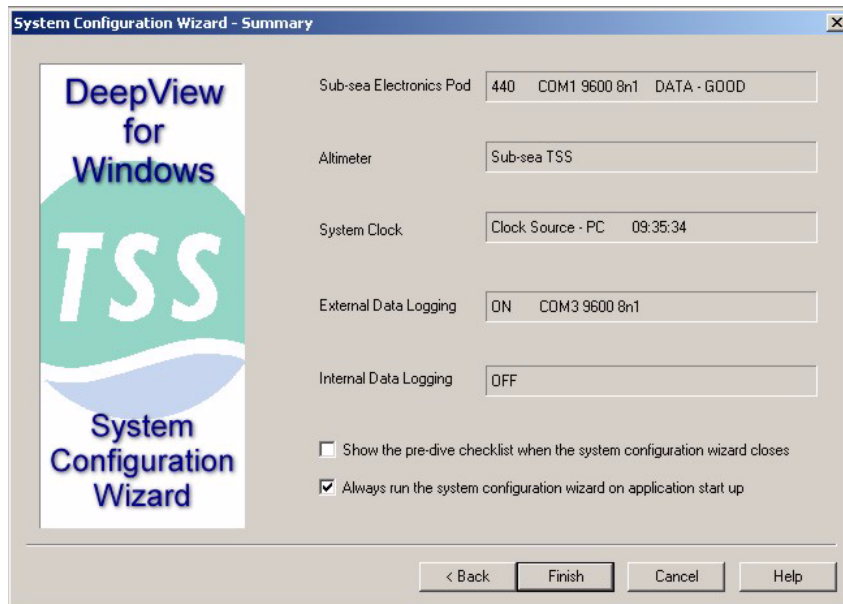
DeepView for Windows allows you to set the communication parameters for each of the serial ports. Choose settings that are appropriate for the connected equipment – refer to the technical manuals of the attached equipment if necessary. Note that the standard communication parameters for COM1, the communication link between the SDC and the SEP, set it to operate at 9600 baud using 8 data bits, two stop bits and no parity.



The update rate for your System will reduce if you set a lower baud rate for this communication link. You should consider reducing the baud rate for this link only if you experience persistent communication problems caused by an umbilical cable of poor

quality. Ideally, in these circumstances you should swap to using an umbilical cable of good quality instead.

At this point the software will provide an analysis of the data status and will provide you with a summary screen of the findings that it has established.



DeepView will now be configured to operate with the 440 System.

Before clicking on 'Finish' you have tick options to select:-

- Show the pre-dive checklist when the System Configuration Window is closed.
- Whether the System Configuration Wizard runs when DeepView for Windows starts.

If the box is checked, the System Configuration Wizard will be run when DeepView for Windows starts. If the box is not checked and if a configuration file is available, the configuration file will be used to configure DeepView for Windows.

DeepView stores the configuration details automatically in an initialisation file when DeepView is closing down. This allows the System to establish the same configuration when you next power-on the SDC – provided it recognises the data format arriving from the SEP as being compatible with the stored configuration details. This means that you should power-on the SEP before you power-on the SDC.

5.4 PRINT CONFIGURATION

It is important to print details of the 440 System configuration at the start and end of a survey. This section is also duplicated in section 6.2.1, which outlines the operating of DeepView for Windows.

Select File → Print Configuration to send a copy of the System Configuration to the Windows Notepad application. You may edit the details and print them from this application.

Figure 5-2: An example of the print configuration via Windows notepad

```

deepview - Notepad
File Edit Format Help
Information and Configuration Sheet      04-12-2002  20:48:52

DeepView Version      2.0.8
Database Version      2.0.8

Sep Type              440
Comms                 COM1 9600 8n1

Altimeter             Sub-sea TSS 200 cms
Comms                 Serial port not configured
Offset               +000

Clock Source          PC Clock
Comms                 Serial port not configured

External Data         Disabled
Comms                 Serial port not configured

Analogue Output Card  Not Initialised

===== SEP 440 Parameters =====

Coil Drive            Disabled
Target Diameter       27 cm
Target Scaling        1300 uV
Weight Coating        1 cm
Signal Threshold      25 uV
Coil Mapping          1234
BG Comp Reminder      30 mins
BG Comp Values        0 0 0
  
```



The ability to print the configuration is an important feature of DeepView. It allows you to create a permanent written record of the configuration to supplement the survey logs.

Full analysis and post-processing of the raw data can be effective only if you retain a record of the 440 System configuration at the time of the survey. Appendix C includes a suitable form for you to record these details.

6 OPERATION SOFTWARE

The SDC has all the software that you will need to operate the 440 System already installed and configured to start automatically when you power-on the SDC. This section of the Manual describes the features of this display software that you must use to operate the 440 System.



Before you attempt to use the 440 System during a survey, make certain you have followed all the instructions in this Manual to install, connect and configure the System properly. You cannot acquire valid survey data unless you have carried out these operations correctly.

This section of the Manual explains how to use the 440 System to conduct a survey. The instructions consist of a sequence of suggested procedures that begins with the pre-dive checks that you should complete and finishes with some suggested procedures to close down the 440 System safely and efficiently.



Refer to sub-section 5.2 for instructions to power-on the 440 System.

6.1 Configuration

Page 2

An overview of configuring DeepView for Windows and parameters that are used during a survey.

6.2 DeepView for Windows Operating Controls

Page 3

A detailed explanation of the menu functions, toolbar controls and display features of the DeepView for Windows 'Run Window'.

6.3 After the Dive

Page 29

How to close DeepView for Windows and power-off the 440 System correctly after completion of the survey. This is important – if you do not follow the correct procedure to close DeepView and Windows you might corrupt some of the data files on the SDC hard disk.

6.4 Replaying a Log File

Page 31

An explanation of how to replay an internal log file through the SDC, and an explanation of the additional toolbar facility.

6.1 CONFIGURATION

TSS has designed the 440 System and Deepview for Windows to be easy to use. A System Configuration Wizard guides you quickly through the procedure to choose the SEP type and communication parameters. However, some important parameters must be entered before the survey can begin.

6.1.1 Survey Parameters

To follow we have listed some key parameters that will be required to be set prior to and during the survey. Details of setting these parameters are covered in the software details in section 6.2.

6.1.1.1 Target Scaling

Configure the 440 SEP with the following target information:

- ❑ **Set the target diameter.**
Measure the outside diameter of the conductive part of the target. Do not include any non-conductive coating in the measurement of diameter. This value, together with the target scaling is used to compute range.
- ❑ **Weight coating.**
Enter the thickness of any non-conductive weight coating that surrounds the target. DeepView for Windows will allow for this thickness when it displays measurements of target co-ordinates.

DeepView for Windows uses a specially developed algorithm to determine an appropriate target scaling factor based on the diameter of the target. For most applications this is the correct method to use for setting a target scaling factor.

The target scaling value is designed to be as close as possible as that used for the previous 340 System. However for maximum accuracy, it is recommended that you have TSS determine an exact target scaling factor from a sample of your target.

6.1.1.2 Threshold

Set an appropriate value for threshold.

High settings will make the 440 System less sensitive to noise but will also decrease its operating range. The default setting of 15 μ V has proved to be suitable for the majority of survey operations.

If you are in any doubt about threshold, leave the setting at its default value.

6.1.1.3 Seawater Compensation

The 440 System uses a compensation method to distinguish signals arising from seawater and the target.

To do this, it is necessary for the software to know the conductivity of the seawater surrounding the coils and ROV during the survey. The conductivity is strongly determined by the water temperature, and for convenience this has been grouped into bands of 0-10°C, 10-25°C and >25°C.

Select a suitable band.

This assures that salinity is between 30 and 33 psu, in areas where salinity is high (e.g. Mediterranean) or river outfalls reduce salinity (e.g. Black Sea) then manual compensation may be necessary. Refer to Appendix A for further details.

Note that surface water temperature may be considerably higher than the temperature at depth. Below 200m, the water temperature is typically 4°C.



The seawater rejection algorithm only functions correctly for ROV altitudes below approximately 4m. Above this height the target signal may 'jump' even if no target is present.

This is not a deficiency in the system or its calibration.

The seawater rejection algorithm has proven reliable, and gives only small (30µV at 3m altitude) if the incorrect temperature band is selected. However, in shallow or fresh water, performing a manual seawater compensation as explained in appendix A may be beneficial.

Range Determination

Once the seawater signal has been removed, the target voltage is interpreted to give the distance between the coil and the target. This voltage falls off according to an approximate sixth root law. The voltage is first divided by the target scaling value. The exact algorithm used to determine range is beyond the scope of this manual, since correcting for the exact nature of the coil response is complex.

6.2 DEEPVIEW FOR WINDOWS OPERATING CONTROLS

TSS has designed DeepView for Windows to provide full functionality when you use a pointing device, such as a mouse or the supplied trackball, to select commands and controls. You may also access many software features by using the SDC keypads.



The instructions that follow assume you to be reasonably familiar with the Microsoft Windows operating environment. If necessary, refer to a relevant Windows user guide, such as the one that accompanies the SDC, for instructions to use Windows.

6.2.1 How to Use DeepView for Windows

This sub-section explains how to use the software commands and tools during a survey. The instructions refer to the Run Window and to the various secondary windows described throughout this section. DeepView includes an on-line Help structure that summarises the advice and instructions included here. There is also a simple 'Help' panel, accessible by pressing function key [F1] from the Run Window, to list the function key short cuts that select some of the commands and tools described below. Sub-section 6.2.4 lists the function keys available for use in the 440 mode.

Follow the advice throughout Section 7 for a survey procedure using the 440 System.

Menu commands

Table 6–1 lists the commands available on the DeepView Menu Bar, together with their hot key access codes and function keys if applicable.

Table 6–1: DeepView Menu Commands

Menu item	Sub-menu, [hot key access] and Function key	Description
File	Open /Close Replay File [F2]	Specify the name and location of an existing internally logged file that you wish to replay through DeepView for Windows. The Replay Window includes the same features and as the Run Window and operates in a similar way. A button on the DeepView for Windows toolbar performs the same function as this command. You cannot use DeepView for Windows to replay externally logged files in this way.
	New Log File [F3]	Specify the name and location of a new file to accept the internal logging record. File names can have up to 255 characters. They can include spaces but must exclude the characters \ / : * ? " < > and . A button on the DeepView for Windows toolbar also performs the same function as this command. Refer to sub-section 4.2.3. for a description of data logging.
	Close Log File [Ctrl + F3]	If you have an internal logging file open, use this command to close it. Once you have closed the file, you cannot open it again to add more data.
	Backup Configuration	This will prompt you with a dialogue box to provide a name to save the current parameters set to a file that can be accessed at a later date.
	Restore Configuration	This will provide you with a list of any previously saved configuration files that you can load.
	Print Configuration	Use this command to send a copy of the 440 System configuration to windows Notepad. You should print the configuration details from that application at the start of the survey and again at the end of the survey. Retain the hard copy prints with the survey records.
	Exit	Use this command to exit the DeepView program and return to the Windows operating environment.

It is recommended that you save a configuration file for each survey. You can then restore this configuration file to give the settings for the next job.



Table 6-1: DeepView Menu Commands (Continued)

Menu item	Sub-menu, [hot key access] and Function key	Description
View	Run Window [Ctrl + R]	Select this command to open or close the DeepView Run Window. You may resize and move the Run Window on the SDC screen after you open it. The normal condition is for the Run Window to be closed when you start DeepView. A button on the DeepView for Windows toolbar performs the same function as this command.
	Forward Search Window [Ctrl + F]	<i>This command is valid only when you use DeepView for Windows to control a 350 System. It is not available when you use the software with a 440 alone.</i>
	Toggle Height Scale [Ctrl + H]	<p><i>Use this command to modify the available selection of displayable vertical ranges. The vertical ranges vary between the 440 and the 350 systems and are as follows:</i></p> <p><i>440 mode: 0m to 2m and 0m to 5m.</i></p> <p><i>350 mode: 0m to 5m, 0m to 15m and 0m to 30m</i></p>
	Toggle Swath Width [Ctrl + W]	<i>Use this command to alter the swath range for the 350 system. This command is unavailable to the 440 system, which has a fixed swath range of 0m +/-2m. The available ranges of the 350 system are 0m +/-2m, 0m to +/-5m and 0m to +/-15m.</i>
	Scope and Spectrum Analyser Window	Use this command to open or close the Scope and Spectrum Analyser Window. A button on the DeepView for Windows toolbar performs the same function as this command. The normal condition is for the Scope and Spectrum Analyser Window to be closed when you start DeepView for Windows. Note that the data string transmitted from the SEP to the SDC extends significantly in length when you open the Scope and Spectrum Analyser Window. This will reduce the data update rate. You should therefore keep this window closed unless you require it.
	System Errors Window	Use this command to open or close the System Errors Window described in sub-section 6.2.1.2. A button on the DeepView for Windows toolbar performs the same function as this command. The normal condition is for the System Errors Window to be closed when you start DeepView for Windows.
	Terminal Window [TAB]	Use this command to open or close the Terminal Window described in sub-section 6.2.1.2. A button on the DeepView for Windows toolbar performs the same function as this command. The normal condition is for the Terminal Window to be closed when you start DeepView for Windows.
	Video Overlay Enable [Ctrl + V]	Use this command to select the Video Overlay function. A button on the DeepView for Windows toolbar performs the same function as this command. The video overlay feature allows the SDC to accept input from a video camera and to output the video image overlaid with the target co-ordinates and steering information.

Table 6-1: DeepView Menu Commands (Continued)

Menu item	Sub-menu, [hot key access] and Function key	Description
Configuration	System parameters [Shift + F2]	This command displays a dialog panel that allows you to establish the type of SEP and the serial communications parameters. Refer to the following sections for relevant details and instructions.
	Altimeter [Shift + F3]	This command displays a dialog panel that allows you to establish the physical and serial communications parameters of an altimeter used with the 440 System. Refer to sub-section 6.2.2.1 for relevant details and instructions. The System Configuration Wizard also displays a similar dialog panel.
	External Output [Shift + F5]	This command displays a dialog panel that allows you to configure the SDC output to an external data logger. Set the type of data packet and its update rate, and the serial port communication parameters. Note that you must establish appropriate parameters for the external output if you wish to use the video overlay option, even if you do not intend to use the external data logging features.
	Analogue Output [Shift + F6]	Use this command to configure the optional analogue output feature. Refer to appendix B.1 for a description of the analogue output option.
	Run Background Compensation [Shift + F7]	Use this command to start a background compensation procedure. Refer to sub-section 6.2.2.4 for details of this very important feature of the 440 System. A button on the DeepView toolbar performs the same function as this command.
	Seawater Compensation	Use this item to select the water temperature at the survey site, or perform manual compensation.
	Load factory Defaults [Shift + F9]	This will prompt you with a caution box to confirm that you would like to reset the software back to the original factory defaults. This will eliminate any user parameters that have been previously configured.
	Video Overlay Setup [Shift + F10]	Refer to sub-section 6.2.2.7 for a description of the video overlay feature.
	System Configuration Wizard [Ctrl + F10]	This selection will return you to the set-up options screen that you have viewed when opening up the software. Use of this option will result in all of the parameters being reset to default.
Window	Cascade [ALT][W][C]	Use this command to arrange the various operating windows so that they overlap but with their title bars visible. This does not affect the Diagnostics Window or the Target Tracking Window.
	Tile Horizontally [ALT][W][H]	Use this command to arrange the various operating windows so that they are next to each other horizontally. This arrangement allows you to see the entire area of each window, although DeepView might resize the windows to fit the available area. This does not affect the Diagnostics Window or the Target Tracking Window.
	Tile Vertically [ALT][W][V]	Use this command to arrange the various operating windows so that they are next to each other vertically. This arrangement allows you to see the entire area of each window, although DeepView might resize the windows to fit the available area. This does not affect the Diagnostics Window or the Target Tracking Window.

Table 6-1: DeepView Menu Commands (Continued)

Menu item	Sub-menu, [hot key access] and Function key	Description
<u>H</u> elp	DeepView [ALT][H][D]	Use this command to open the on-line Help structure that explains the features of DeepView. The Help structure also includes some simple fault finding advice for the sub-sea components.
	Pre-dive Checklist [ALT][H][P]	Use this command to open the on-line Help structure that explains the checks you should make on the 440 System before you start a survey. Sub-section 7.3.2 also lists and explains these checks. You may access the checklist from within the DeepView Help structure.
	About DeepView [ALT][H][A]	This command displays the version number of DeepView.

6.2.1.1 DeepView File Menu Options

This section outlines the various displays that have been explained in the previous tables.

File Options

Open/Close, New Log File, Backup and Restore Configuration options bring up a standard windows file location box. In the example used is the Open Log Menu.

Figure 6-1: An example of a File Option menu

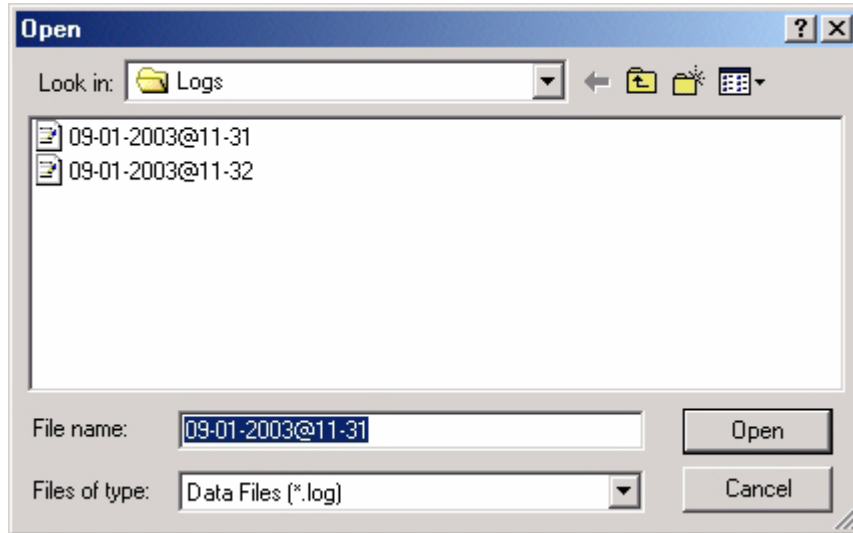


Table 6-2: Internal Data Logging

B) Internal Data-logging

Note that, when enabled, internal logging must record up to approximately 1MB of data per hour. Ensure that the receiving disk has sufficient free space to accept this volume of data.

Logging Enable: You must enable internal logging before you can use it. This is done by selecting 'New Log File' from the File options. The factory default is for internal logging to be disabled. Logging should also be turned off when the survey is complete.

Logging Format: The records of the internal logging format include alternately the co-ordinates and the signals data (see sub-section 7.4.1.2) When you enable internal logging, by default the SDC logs all records. The SDC adds a 'time' field to the start of logging and updates this at intervals of one minute. It obtains this information from the SDC system clock.

You may add short comments (up to 40 characters in length) to the internal logged record by pressing from the Run Display screen. The SDC time-tags and includes the comments in the internal log. Annotations logged in this way will not appear on the display screen during replay. The external logging record is unaffected by these annotations.

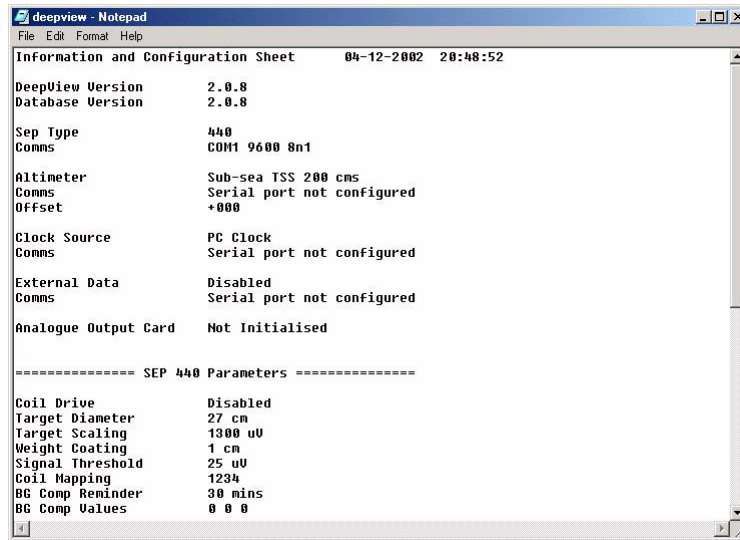


Note that you may measure how much disk space is available on the SDC by going to 'My Computer' selecting the hard disk and right clicking on the trackpad button or pointing device and selecting 'properties'.

Print Configuration

Select File➔Print Configuration to send a copy of the System Configuration to the Windows Notepad application. You may edit the details and print them from this application.

Figure 6–2: An example of the Print Configuration via Windows Notepad



```

deepview - Notepad
File Edit Format Help
Information and Configuration Sheet      04-12-2002  20:48:52

DeepView Version      2.0.8
Database Version      2.0.8

Sep Type              440
Comms                 COM1 9600 8n1

Altimeter             Sub-sea TSS 200 cms
Comms                 Serial port not configured
Offset               +000

Clock Source          PC Clock
Comms                 Serial port not configured

External Data         Disabled
Comms                 Serial port not configured

Analogue Output Card  Not Initialised

----- SEP 440 Parameters -----

Coil Drive            Disabled
Target Diameter       27 cm
Target Scaling        1300 uV
Weight Coating        1 cm
Signal Threshold      25 uV
Coil Mapping          1234
BG Comp Reminder      30 mins
BG Comp Values        0 0 0
    
```



The ability to print the configuration is an important feature of DeepView. It allows you to create a permanent written record of the configuration to supplement the survey logs.

Full analysis and post-processing of the raw data can be effective only if you retain a record of the 440 System configuration at the time of the survey. Appendix C includes a suitable form for you to record these details.

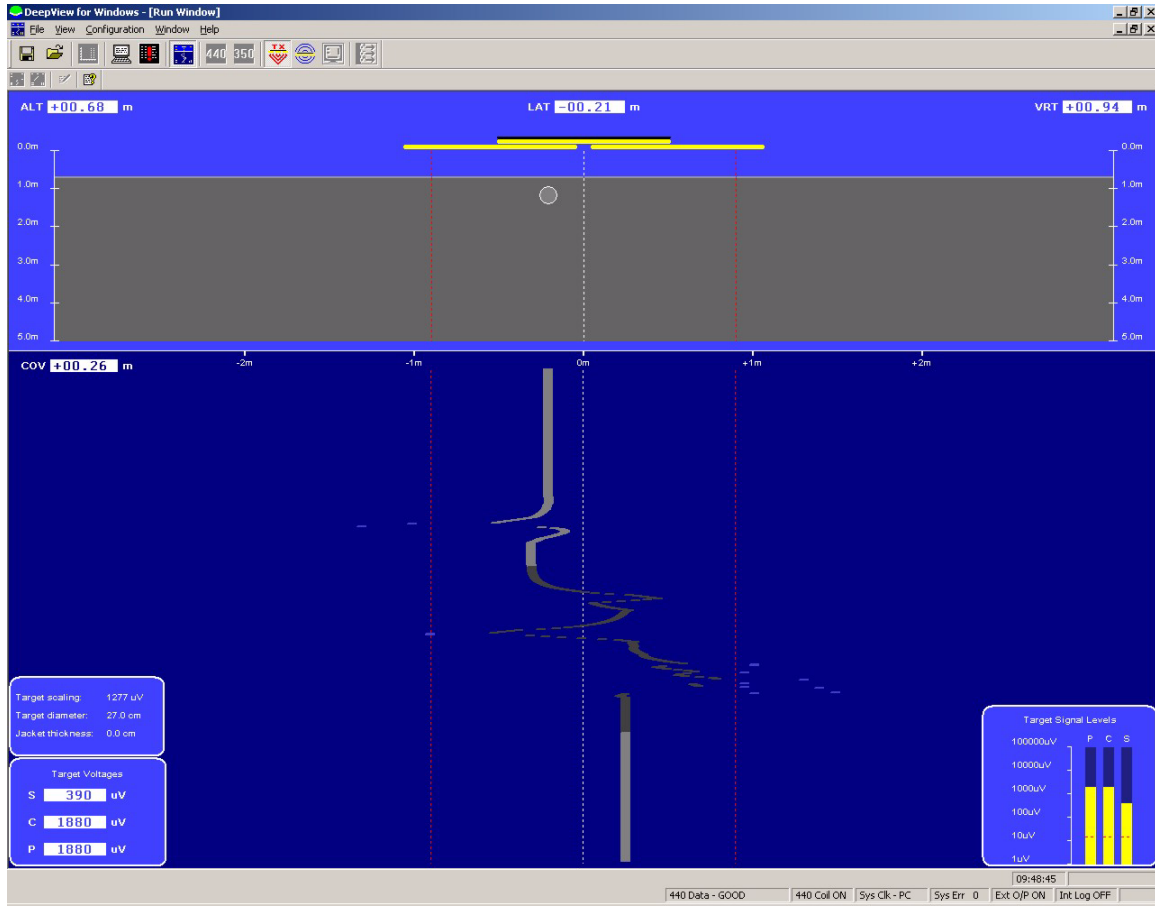
6.2.1.2 View Options

Run Window

The Run Window is the most important and informative display of the 440 System. Anyone who will operate or maintain the System should therefore spend some time to make themselves familiar with the layout of the window and the information that it shows.

Appendix C includes a fold-out drawing of the Run Window. Open the drawing and refer to it as you read the following description.

Figure 6-3: DeepView - Run Window



Controls and Features of the Run Window

Controls

- ❑ The **Title Bar** shows the names of the program and of the window. The right-hand end includes the standard buttons to minimise, maximise and close the main DeepView window.
- ❑ The **Menu Bar** includes the five menu headers described under ‘Menu commands’ on page 4. To access the menu and sub-menu commands, click on them or use the appropriate hot-key combination – [ALT]+[underlined hot-key characters]. The Menu Bar also includes buttons to minimise, maximise and close the Run Window.
- ❑ The **DeepView Toolbar** includes the buttons described in section 6.2.3. This section outlines the various displays that have been explained in the previous tables. These tools control the functions of the DeepView for Windows program.
- ❑ The **Run Window Toolbar** includes the buttons described under ‘Run Window tools’ on page 28. These tools control functions within the Run Window only.

Features – Rear Elevation pane

The rear elevation pane is immediately below the Run Window Toolbar and occupies approximately 30% of the area with the window fully maximised. It has a light blue background and shows the target **A** as a circle of fixed diameter, a vertical broken white line **B** that represents the fixed centre-line of the ROV and the three search-coils **C**.

The 440 has an adaptive range algorithm which determines range from two of the three search coils. The coil is coloured red when its voltage is too low to determine range.

The circle **A** moves horizontally and vertically in the pane as the relative position of the target changes. The scale **D** provides a visual reference so that you may estimate the distance between the coil array and the target. CTRL H switches between 5 and 2 metre vertical display scales.

When the 440 System includes a properly configured altimeter, the top edge **E** of the solid grey area shows the position of the seabed relative to the coil array. This area expands and contracts vertically with changes in ROV altitude above the seabed. If the design of the ROV allows you to configure the 440 System with a fixed coil height, the seabed indicator will remain fixed at this altitude.

The Run Window includes a series of data fields **F** that indicate the instantaneous measurements of coil altitude (ALT) above the seabed, lateral offset (LAT) of the target relative to the centre line, vertical range to the target (VRT) and target depth of cover (COV). The 440 System measures VRT and LAT directly, with positive measurements of LAT representing a starboard offset relative to the centre line. Measurements of ALT arrive from an altimeter, or represent the fixed coil height if this is applicable. DeepView calculates the value displayed in the COV field using $COV = VRT - ALT$ so that positive values indicate a target that is buried. All measurement are in units of centimetres.

The solid white line **G** that separates the rear elevation pane from the ‘snail trail’ pane (described below) has gradations fixed at zero, $\pm 1m$ and $\pm 2m$ to show the lateral offset.

Two broken red lines **H** extend down the window at $\pm 0.9m$ of lateral offset. These show the lateral limits of a quality control envelope applied by DeepView. To support efficient post-processing on data acquired by the 440 System, the software the quality control code in the data output when the target is outside this envelope. Refer to sub-section 7.4 for a complete description of the quality control features.

Features – ‘Snail Trail’ pane

The snail trail pane is immediately below the rear elevation pane and occupies approximately 60% of the screen area with the window fully maximised. It has a dark blue background and indicates the lateral offset of the target, relative to the ROV centre line **B**, for the most recent updates.

Two data panels **L** and **M** show the signal strength; the dotted lines on **L** show the threshold. Panel **L** displays the SEP details, Coil Status, System Clock, System Errors, External Output, Internal log status, and panel **J** displays the Target Scaling, Diameter and Jacket Thickness.

A thick coloured line **K** indicates the target position relative to the ROV centre line. As the survey starts, this line extends upwards from the bottom of the screen until it reaches a point near the top of the snail trail pane. The top of the line then continues to move to the left and right as the lateral offset of the target changes while the remainder of the line scrolls vertically downwards in a ‘waterfall’ style of display.

Segments of the line **K** can have any of three colours:

Light grey Good signals supplied by the coils. The target is covered.

Dark grey Good signals supplied by the coils. The target is exposed.

If the System receives no altitude information, a good target signal will always appear as a light grey line.

Dark blue The lateral range is outside 0.9m.

Features – Status bar

The status bar, located directly below the snail trail pane, alerts you to the operating status of DeepView and the 440 System. It includes the following information:

❑ **Communication status.**

This shows the DeepView operating mode (440 or 350) and the validity of serial communications between the SDC and the SEP. For successful operations in the 440 mode this should always show ‘440 Data GOOD’.

❑ **Coil drive condition.**

For safety it is important to be able to switch off coil drive easily so that the 440 System does not present a hazard to personnel working close to the coil array. The status bar indicates the coil drive status as either ‘440 Coil OFF’ (in blue text) or ‘440 Coil ON’ (in red text). Note that certain fault conditions might disable drive to the coil array even though the status bar continues to indicate that coil drive is present. A button on the Run Window toolbar allows you to toggle the coil drive on and off. The function key [F5] also allows you to toggle the coil drive.



WARNING

During operation, the 440 System generates strong electromagnetic fields that radiate from the array of search-coils. There is evidence to support the claim that strong electromagnetic fields might present a hazard to nearby personnel.



To avoid any risk from electromagnetic radiation, do not allow personnel within 1.5 metres of the coil array with drive applied to the coils. Switch off the coil drive from the Run Window when there are personnel close to the ROV.

❑ **System time.**

The system time is derived from the SDC system clock.

❑ **System errors.**

The status bar shows the total number of uncleared system errors registered by DeepView. Use the System Errors Window, described in sub-section , to see details of all the system errors registered since you powered-on the SDC, up to a maximum of 600 lines.

Logging status.

Two fields in the status bar indicate the ON/OFF condition of the external output (used for logging to a user-supplied data logger and to provide information for use by the optional video overlay feature) and the internal logging.

Forward Search

Forward Search is valid only when you use DeepView for Windows to control a 350 System. It has no purpose when you use the software with the 440 System

Toggle Height Scale

Dependent upon specific survey requirements, the Height Scale Display on the Run Window can be modified. For example, if a small target is being tracked a reduced height scale may be required. This feature provides the user with control over the displayed height range.

The vertical ranges for the 440 System are either 0m to 2m or 0m to 5m.

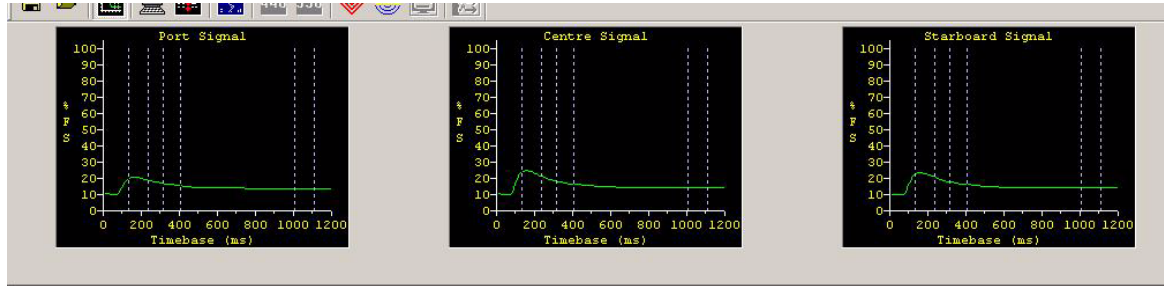
Toggle Swath Width

Availability only to the 350 System, the Swath Width Display on the Run Window can be modified to meet specific survey requirements. This allows the user to alter the swath scale display dependent upon their needs.

Scope and Spectrum Analyser Window

Deepview for Windows can show signal data received using different styles of ‘oscilloscope’ and ‘spectrum analyser’ displays.

Figure 6-4: Scope and Spectrum Analyser Window



The above screen shows an example of the 440 Oscilloscope Window with panels for the three active channels, Port, Centre and Starboard.

During operation each of these display panels shows the signal voltage measured on their respective channels against a horizontal time scale and a vertical scale of percentage of full scale.

Each of the scope panels shows the three measurement windows, defined in vertical broken white lines. These are from left to right:

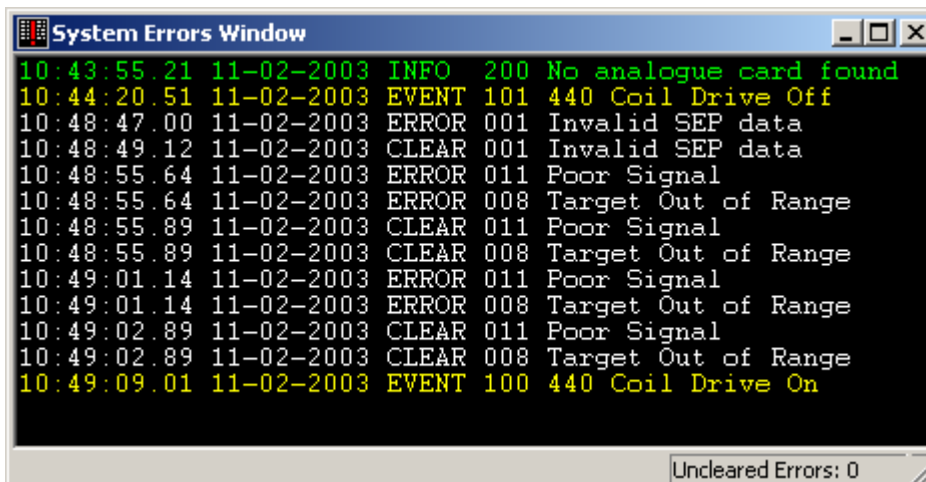
- The early signal window, which is used in the seawater compensation algorithm
- The standard window, and
- The zero window.

As explained in this manual, the 440 System uses the difference between the average values measured during the standard window and the zero window as the channel signal voltage. Based on the signal voltages on the measurement channels and the target scaling factor supplied in the System Parameters window, the system then calculates the target range from each of the coils and, from that, determines the relative position of the target.

System errors

The System Errors window, shown in Figure 6-5, displays a list of all errors and events reported by the 440 System. The list includes cleared and uncleared errors. The window can include up to 600 lines of text, with a scroll bar that allows you to search through the list. When the list includes 600 lines of text, DeepView for Windows will delete the oldest message in the list to provide room for any new ones.

Figure 6-5: System Errors window



The lines of text always have the format described in Table 6-3.

Table 6-3: System errors format

hh:mm:ss.ss	dd-mm-yyyy	SSSSS	NNN	{Error description}
Time of the message line (Note 1)	Date of the message line (Note 1)	Error status field = either ERROR or CLEAR (Note 2)	Three-digit error number with leading zeros as needed	Text field containing up to 40 characters containing a description of the error or of the error being cleared

Notes:

1. Time and date information in the message line comes from the SDC system clock.
2. The five character Error Status field can contain ERROR, CLEAR or EVENT.
3. The message line can have any of four colours against the black background:
 - White indicates a cleared error.
 - Red indicates an uncleared error.
 - Yellow indicates an event.
 - Green indicates an information message.

The System Errors window includes a status line that has two data fields. These show the total number of cleared and uncleared errors since you started DeepView for Windows.

Terminal Window

The Terminal Window, shown in Figure 6-5, allows you to send and view data to and from the SEP and the altimeter. It has a toolbar, a client area that displays black text against a white background, and a status bar.

Figure 6-5 shows the Terminal Window displaying data packets from the 440 SEP in the client area. If you select the altimeter as the active serial device, the client area will show data packets from this device instead.

Figure 6-6: Terminal window

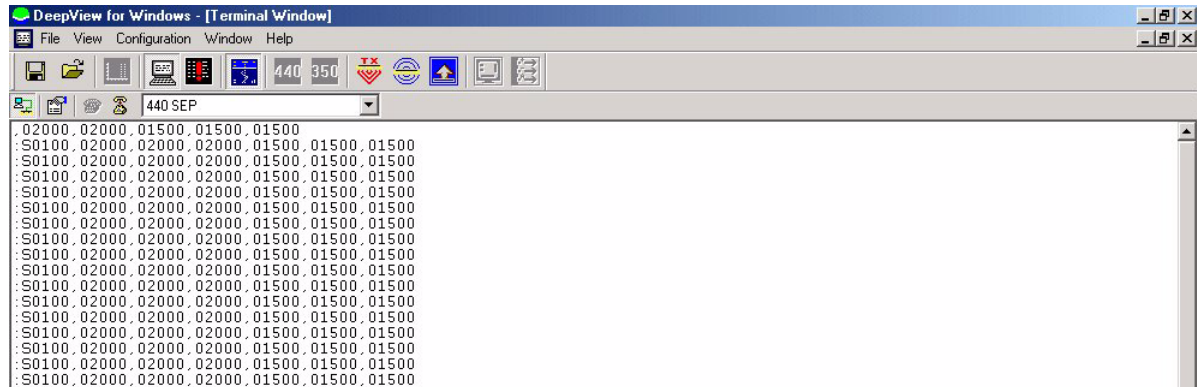


Table 6-4: Terminal Window toolbar

Button	Function	Explanation
	Enable/Disable SEP polling	This button has a toggle action that pauses and resumes SEP polling with alternate presses. With this button deselected, DeepView does not send the necessary characters that request data packets from the SEP.
	Terminal properties [ALT][T]	Use this button to set the serial communication parameters for the active serial device.
	Connect	This button allows you to connect the terminal to the active serial device.
	Hang Up	This button allows you to disconnect the terminal from the active serial device.

There is also a drop-down box that allows you to select the active serial device from among those available. This box includes the option to use the Terminal Window as a 'dumb terminal' if necessary (also accessible by pressing [ALT][Down arrow] then release [ALT]).

The status line shows the communication port settings for the active serial device.

Video Overlay Enable

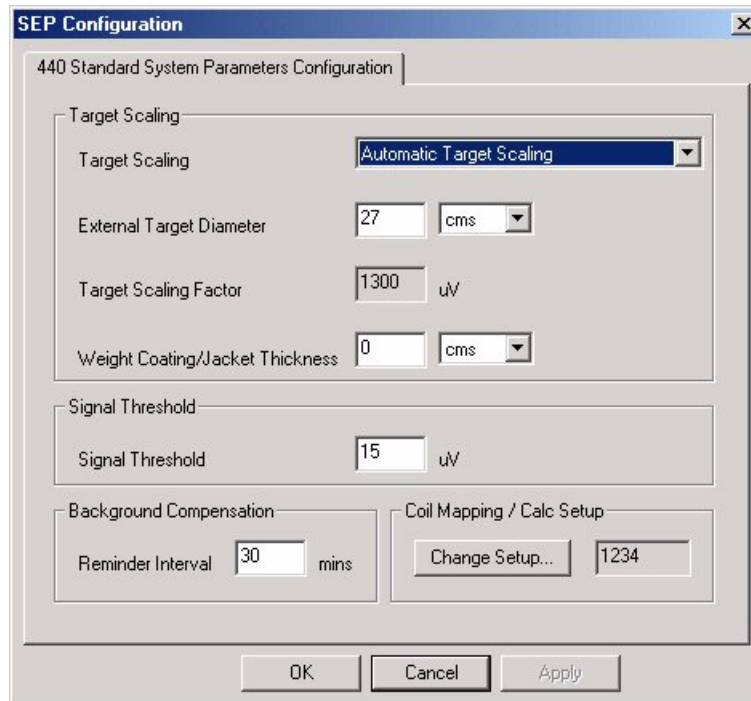
Enabling Video Overlay is covered in section 6.2.2.7 along with details of the configuration options available.

6.2.1.3 Configuration Options

Standard parameters

This option should be selected to configure the system parameters information.

Figure 6–7: System Configuration



Target scaling factor

Pulse induction generates a signal whose amplitude depends on the size of the target and its distance from the search coil. This means that the signal from a small target close to the coil appears identical to the signal from a large target at a greater range. A target scaling factor characterises the target by its size and diameter and allows the 440 System to relate the signal amplitude directly to range.

TSS has conducted an exhaustive series of tests to characterise a variety of target types encountered in a marine environment. As a result of these tests, TSS has developed a special algorithm that the 440 System uses to compute an approximate target scaling factor for your survey application based on the diameter of the conductive part of the target.

The System Parameter Menu allows you to enter these details so that it can determine an appropriate scaling factor for the target.

There may be circumstances when this method is not appropriate because, for example, the target does not fall easily into one of the standard categories. In these circumstances, Deep-View for Windows allows you to enter a known target scaling factor that you have determined from a series of tests conducted using a sample of the target at some date before the survey begins.

6.2.2 Survey Parameters

Once the seawater signal has been removed, the target voltage is interpreted to give the distance between the coil and the target. This voltage falls off according to an approximate sixth root law. The voltage is first divided by the target scaling value. The exact algorithm used to determine range is beyond the scope of this manual, since correcting for the exact nature of the coil response is complex.

The position of the target is derived from the voltages on two of the three coils. When the target is below the centre of the coil array, the position is derived from the outer two coils. At larger lateral offsets, the position is determined from the centre coil and either the port or starboard coil, depending which side the target is on.

Threshold Adjustment

Signals produced by the System are inversely proportionate to the sixth power of the target range. The response of the System to small signal levels is therefore crucial to maximising the target detection range. In practice, this means that you should keep the setting for Threshold as low as possible without incurring a loss in performance due to noise.

Experience has shown that a setting of 15 μ V is suitable for most surveys, and this is the default setting for the System.

Background compensation reminder

To avoid potential deterioration in the quality and accuracy of survey data you should perform a regular check on the background signal level. Do this by moving the coil array away from the target to a distance of 10 metres or more and then check that the signal levels on all channels fall to within 5 μ V of zero volts.

Failure of this test might mean that the ROV has changed its conductive characteristics, or that a manipulator or a probe has moved. Potentially, such a failure might introduce large errors into the survey measurements.

To help you avoid this serious problem, you may set DeepView to remind you to check the background signal at regular intervals. When used, this facility displays a warning message on the Run Window and sounds an alarm at intervals of up to 360 minutes. Press the [ENTER] key to clear the warning.

Refer to sub-section 6.2.2.4 for instructions to perform the background compensation procedure and to check the background signal.

Use the System Parameters to set a suitable value for the reminder interval. The default setting is 30 minutes. A setting of zero switches off the reminder facility, but you should not use this setting.

Coil mapping

This function displays the association between the individual search-coils and their input channels on the SEP, and allows you to modify this relationship if necessary.

The default condition is for starboard to connect to Channel 1, centre to connect to Channel 2, and port to connect to Channel 3. The standard 440 System does not use the fourth channel.

The default mapping sequence is therefore ‘1234’.

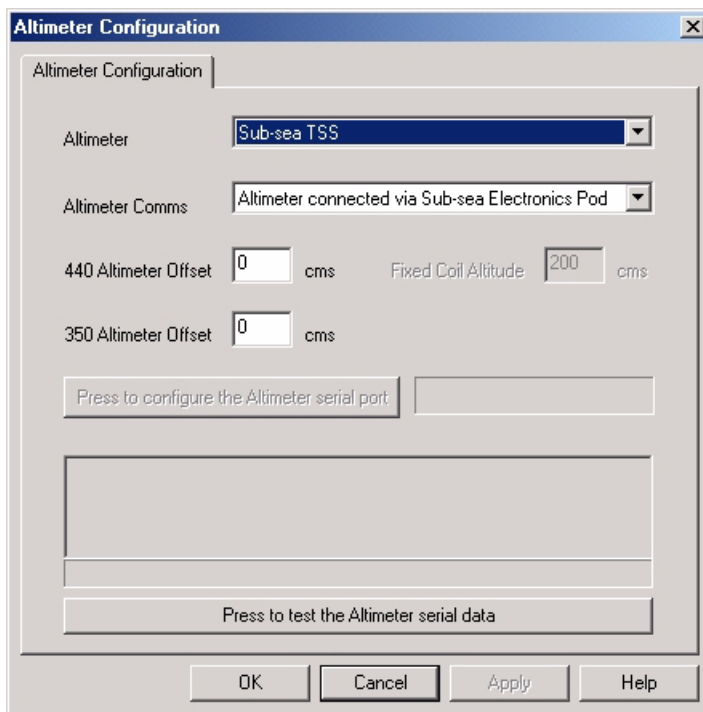
In special circumstances, for example if one of the normal channels fails, you may change the mapping sequence so that the System uses the fourth channel instead. Refer to Section 10 for maintenance and fault identification instructions. The System parameter allows you to set the coil mapping sequence using a simple graphical window.

6.2.2.1 Altimeter

The Altimeter option allows you to change the altimeter configuration for specific installations and to view data transmitted by an altimeter connected directly to the SEP.

To view data transmitted by an altimeter connected to an SDC serial communication port, use the Terminal Window described in sub-section 6.2.1.2.

Figure 6–8: Altimeter Configuration



Use the Altimeter Configuration Window to set appropriate parameters for your altimeter:

- | | |
|------------------|---|
| Altimeter | <input type="checkbox"/> Disabled
<input type="checkbox"/> Fixed coil height
<input type="checkbox"/> Sub-sea TSS* (see <i>altimeter comms below</i>)
<input type="checkbox"/> PSA 900**
<input type="checkbox"/> PSA 900 + depth**
<input type="checkbox"/> PSA 9000**
<input type="checkbox"/> Ulvertech Bathy
<input type="checkbox"/> Simrad UK90
<input type="checkbox"/> OSEL Bathy
<input type="checkbox"/> SeaKing Bathy 704
<input type="checkbox"/> Hyspec 305 |
|------------------|---|

Altimeter Comms Altimeter connected via Sub-sea Electronics Pod (for altimeters marked * and ** above)
 Altimeter connected direct to a COM port (for altimeters marked ** and all other altimeters above)

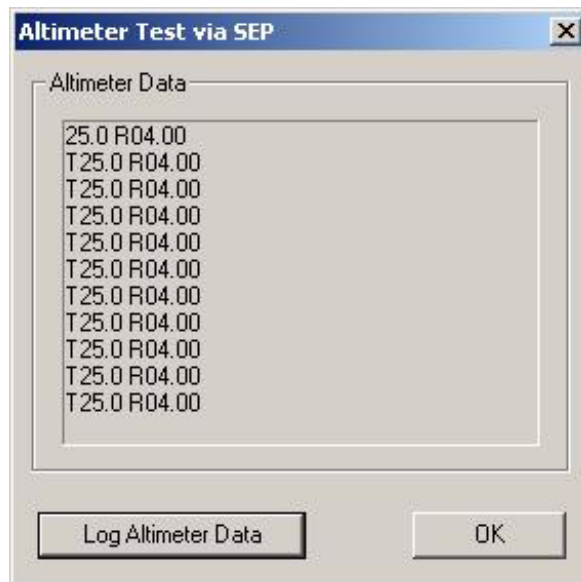
Fixed coil altitude If there is no altimeter fitted and the design of the ROV allows the coils to remain at a fixed altitude above the seabed, enter this altitude in centimetres.

Altimeter offset Set the height difference, in centimetres, between the bottom of the 440 search-coils and the transducer face of the altimeter. **Use a positive value if the altimeter is above the coils.** If you are using the 440 System within a Dualtrack installation, enter the height difference, in centimetres, between the reference line of the 350 coil array (explained in the 350 System Manual) and the transducer face of the altimeter.

The Altimeter Configuration Window allows you to select an SDC serial communication port that you will use to accept data from the altimeter and to set its communication parameters.

The altimeter test allows you to see the serial data transmitted by an altimeter connected to the SDC. The values shown will not have any meaning until the altimeter is immersed in water.

Figure 6-9: Altimeter Test



Refer to sub-section 7.5 for a description of the data formats supplied by the compatible altimeters.

6.2.2.2 External Data Logging

DeepView for Windows allows you to record the survey data acquired by the 440 System in two ways:

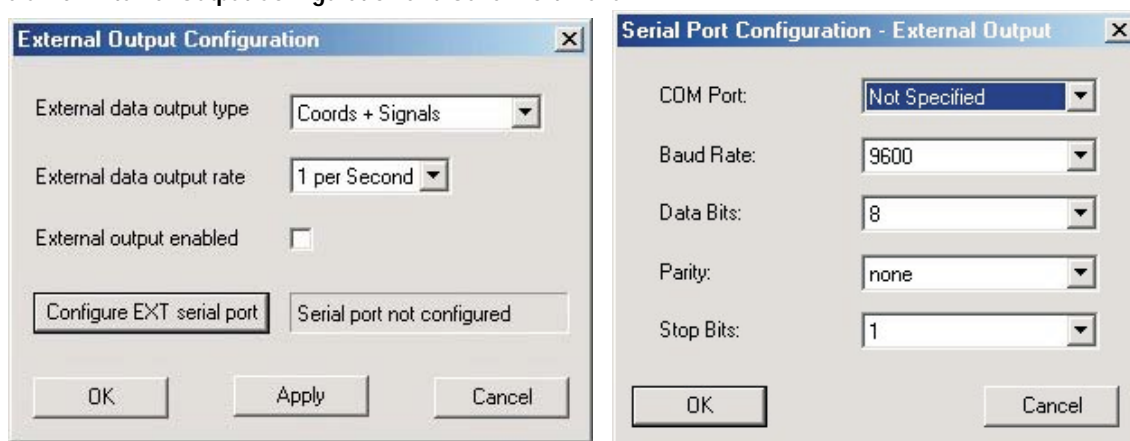
A) External Output Configuration

Note that external logging is defaulted to off.

Output type: You may choose between transmitting only the co-ordinates data (VRT and LAT, etc.), or the co-ordinates and the signals data (S1, S2, S3 and S4) together. The factory default is 'Co-ordinates plus Signals'. See sub-section 7.4.1.1 for a description of these data formats.

A) External Output Configuration <i>Note that external logging is defaulted to off.</i>	
Output Rate:	The SDC can transmit data to the data logger at either four records or one record per second. The default setting is four records per second. You should consider the available storage space and the desired linear track resolution for the survey before you decide between these alternatives.
External Output Enabled	Tick box to confirm on. Defaults set to off
Configure External Serial Port	Options to configure, COM Port, Baud Rate, Data Bits, Parity and Stop Bits. See Figure 5-2.

Figure 6–10: External Output Configuration and Serial Port menu



6.2.2.3 Analogue Output

Refer to Appendix B.1 for a full explanation of this feature.

6.2.2.4 Background Compensation

Before it can acquire accurate survey data, the 440 System must know what level of background signal exists when there is no target nearby. Subsequently the System will consider any received signals, whose magnitude is greater than this background level, to originate from a valid target.

The major part of the background signal is produced by the ROV body and by sea water. Provided the ROV is properly constructed so that it does not deform or flex during operation, the background signals will not change significantly during a survey. The System can therefore measure them and compensate for their effects. This is the process of ‘Background Compensation’.

You *must* complete a full background compensation before the survey begins and before you perform any manual target scaling procedures. Sub-section 7.3.3 includes instructions for performing a full background compensation and for performing a background compensation check.

Press the Background Compensation button in the DeepView for Windows toolbar to start the background compensation procedure. DeepView for Windows then displays the Background Compensation window shown in Figure 6-12 that allows you to start the procedure or to quit if necessary. The same window also displays the compensation results as they become available.

After you press the button to start the background compensation, lines of data will appear on the window at intervals of approximately ten seconds. DeepView for Windows also sends the same information to a file called 'background_comp.txt' to allow creation of a hard copy print that you may retain with the survey records. These lines of data represent the background reference levels for the coil signals on each channel.

The figures may appear in either white or red against the black background:

- White figures indicate that the System has achieved successful compensation
- Red figures indicate a saturating channel.

If saturation occurs, consider re-mounting the coil assembly farther from the ROV body. Ideally, the coil separation distance should be such that the background compensation signal does not exceed 1000 μ V (see sub-section 3.2.2 for coil mounting instructions).

You may use the Background Compensation window to confirm stable operation of the 440 System. Although a single cycle of compensation is sufficient for the System to provide accurate results, by allowing the routine to continue you may assess the degree of signal variation from one cycle to the next.

Variations between consecutive cycles on any channel should be less than 5 μ V. Differences greater than this suggest the presence of a problem that you should investigate before you start the survey. It does not matter if the values in one column are different from those in another.

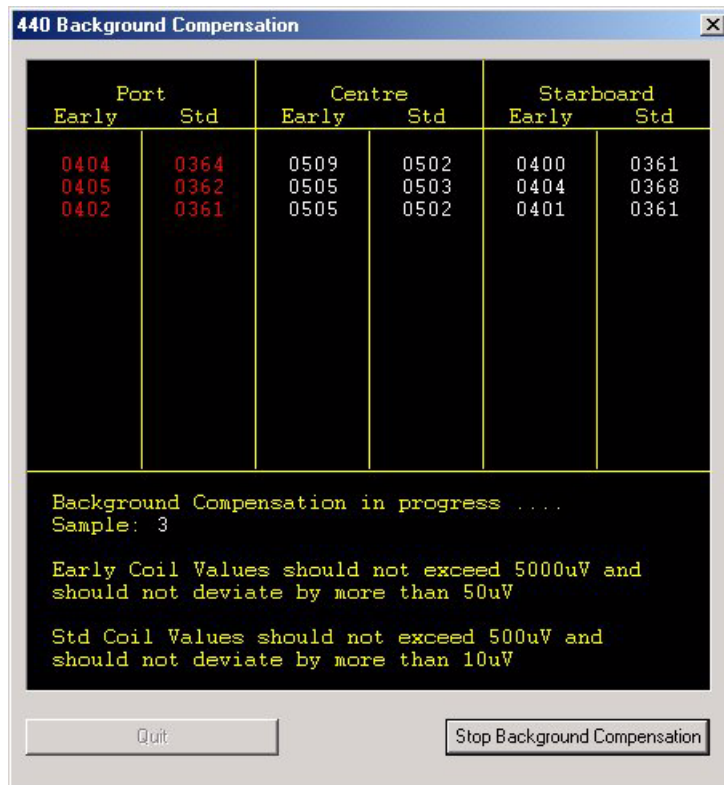


The 440 system has much more stringent requirements than its predecessor, the 340, in terms of background compensation stability. If good quality survey information is to be obtained, then the background compensation levels must be absolutely stable and repeatable. Variation in the compensation levels indicates that the system is not performing correctly. Any problems must be rectified before the survey is performed.

You must check the background compensation regularly by moving the ROV off the target and confirming that all signal levels fall to within 5 μ V of zero volts.

WITHIN THE STANDARD PARAMETERS WINDOW THERE IS AN OPTION TO SET THE BACKGROUND COMPENSATION REMINDER

Figure 6–11: Background Compensation window



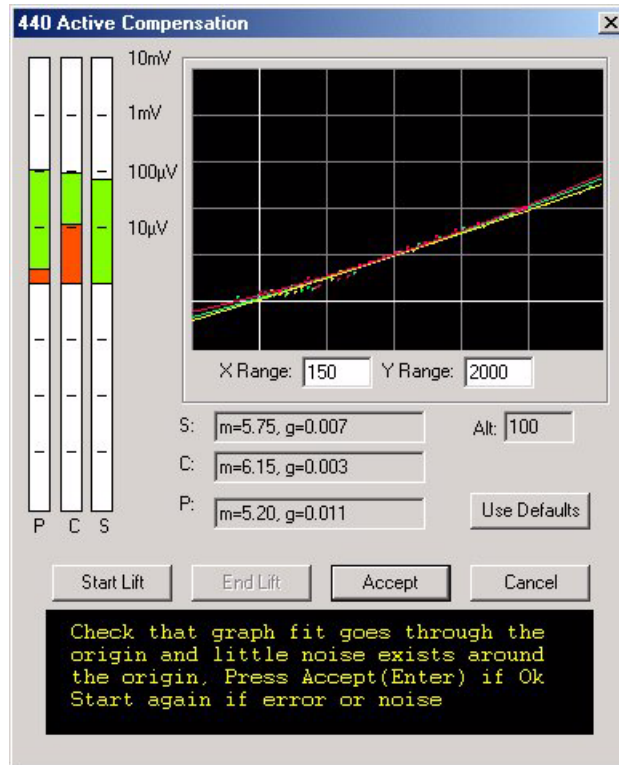
6.2.2.5 Seawater 'Active' Compensation

This dialog is used to perform a manual seawater compensation. It will only be required in unusual circumstances, for example extremes of salinity. It shows the relation between the early and standard voltages as the vehicle is lifted from the seabed, and allows the user to automatically determine the compensation rate.

The meter bars to the left show the standard (red) and early (green) signal voltages. They will increase as the vehicle lifts from the seabed. Press the 'start lift' button with the vehicle on the seabed, then lift the vehicle slowly (over about 30s) to 5m altitude. Then press the 'end lift' button. The compensation values will then appear in the three grey boxes below the graph. Press 'accept' to use these values, or cancel to go back.

Refer to Appendix A for an explanation on Seawater Temperature and setting it correctly.

Figure 6–12: Active Compensation



6.2.2.6 Load Factory Defaults

Selecting this option will present a dialogue box. Acceptance of this dialog will result in the SEP settings being returned to their factory defaults. Certain parameters within DeepView will also be returned to their default states (see table 6–5).

Table 6–5: Factory System Defaults

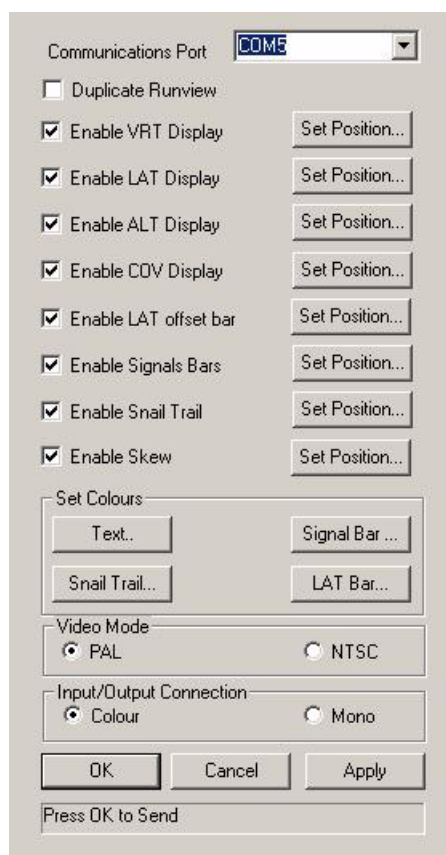
Parameter	Default Value
Target Weight Coating	1 cm
Target Diameter	27cm
Pipe Coefficient	1
Background compensation interval	30 mins
Video Overlay Parameters	COM5, 9600, 8, n, 2
External Output Comms Parameters	COM3, 9600, 8, n, 2
External Output Packet	Coords + signal, 4/second
Altimeter Comms Parameters	COM port not specified, 9600, 8, n, 2
Altimeter Type	Disabled
Altimeter Offset	0 cm
Seawater Rejection	Enabled, 10-25C

6.2.2.7 Video Overlay Setup

The video overlay feature has been updated for the 440 System. It operates in the similar way as the previous overlay by receiving a video signal arriving from a user supplied subsea camera and overlaying it with the DeepView for Windows information specified by the user via the Video Overlay Configuration. The Video Overlay Setup menu is available via the Configuration options and provides the options illustrated below in Figure 6-14.

The video overlay has two possible modes. The first mode is where a copy of the SDC screen (the Runview) is overlaid on the video output. This is selected with the "Duplicate Runview" checkbox. The other mode is where selected information, for example the VRT and target position, are overlaid. The positions and colours of each of these elements can be fully controlled by the user.

Figure 6-13: Video Overlay Setup



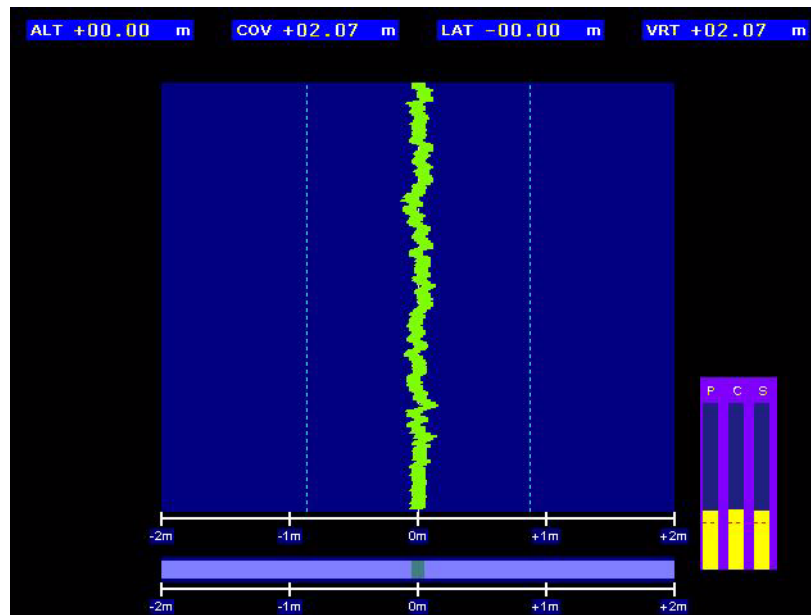
Dependent upon the user's requirements they can enable/disable specific information.

As shown, they are also able to set the colours of Text, Signal Bars, Signal Trail and LAT Bar, modify video mode and input/output connection.

These additional options provide the user with more control over the display to improve ease of use.

The display overlaid on the external monitor from the DeepView software is shown in Figure 16-15. The video signal will be displayed behind this survey information where the black background is currently shown.

Figure 6–14: Video Overlay Signal



The Overlay feature can be enabled/disabled either from the View options or by using the icon on the toolbar.

Figure 6–15: Video Overlay Enable/Disable button










6.2.3 DeepView for Windows Icon Tools

Table 6–6 shows and explains the command buttons on the DeepView for Windows toolbar. You may access these command buttons by clicking on them with the trackpad or external pointing device. A tooltip appears to remind you of the button functions if you hover the pointer over a button, with the same information also appearing in the status bar. You may also access some of the button functions by pressing the appropriate function key from the Run Window. Sub-section 6.2.4 lists all the available function keys that you may use in the 440 mode.

Table 6–6: DeepView Toolbar

Button	Function and Function key	Explanation
	Terminal Window	This button performs the same function as the <u>V</u> iew → Terminal Window command described above. The button has a toggle action so that the window will open and close with alternate presses. The normal condition is for the Terminal Window to be closed when you start to use DeepView. Refer to sub-section 6.2.1.2 for a full description of the Terminal Window.



Table 6–6: DeepView Toolbar (Continued)

Button	Function and Function key	Explanation
	System Errors Window	This button performs the same function as the <u>V</u> iew➔System Errors Window command described above. The button has a toggle action so that the window will open and close with alternate presses. The normal condition is for the System Errors Window to be closed when you start to use DeepView. Refer to sub-section for a full description of the System Errors Window.
	Run Window	This button performs the same function as the <u>V</u> iew➔Run Window command described above. The button has a toggle action so that the window will open and close with alternate presses. The normal condition is for the Run Window to be closed when you start to use DeepView.
	440/350 mode	These buttons are available only if you operate the 440 System as part of a Dualtrack installation when you may use them to select the operating mode. When you press either of these buttons, Dualtrack enables the relevant SEP and disables the other. The Run Window changes to suit the selected operating mode. Refer to appendix B.2 for a description of Dualtrack.
	440 coil drive Function key [F5]	This button and function key have a toggle action that enables and disables drive to the 440 coil array with alternate presses. A field in the status bar indicates either '440 Coil OFF' in blue or '440 Coil ON' in red as appropriate. For safety you should always ensure coil drive is OFF unless you are using the 440 System to acquire survey measurements. For users of Dualtrack: Note that DeepView will disable the 440 coil drive automatically when you change to the 350 mode. When you change back to 440 mode, you must enable the coil drive manually. This is a safety feature.
	Background compensation	This button performs the same function as the <u>C</u> onfiguration➔Run Background Compensation command described above. Refer to sub-section 6.2.2.4 for a full description of background compensation.
	Video overlay Function key [F3]	This button has a toggle action that enables and disables the video overlay with alternate presses. Refer to sub-section 6.2.2.7 for details of the video overlay option.
	Analogue output	This button has a toggle action that enables and disables the analogue output with alternate presses. Refer to appendix B.1 for details of the analogue output option.

Run Window tools

Table 6–7 shows and explains the command buttons on the Run Window toolbar. Some of the buttons in this toolbar have no function with DeepView operating in the 440 mode. These buttons are greyed-out and are not described below. You may also access some of the button functions by pressing the appropriate function key from the Run Window. Sub-section 6.2.4 lists all the available function keys that you may use in the 440 mode.

Table 6–7: Run Window Toolbar

Button	Function	Explanation
	Annotations Function key	This button opens the text annotation feature available when you are creating an internal logging file. You may use the feature to add text comments, of up to 40 characters in length, to the file. The comments will appear in the status bar during replay of the file. The feature will not be available unless you have configured DeepView to generate an internal logging file.
	Function help Function key	This button has a toggle action that opens and closes the DeepView function help panel described in sub-section 6.2.4.

6.2.4 DeepView for Windows Function Keys

Sub-section explains the menu commands and toolbar buttons available from within DeepView for Windows. You may access some of these commands and tools directly by pressing the appropriate function key on the SDC. As a simple memory aid, press the function key [F1] to see the help dialogue panel shown in Figure 6–16. Note that this dialogue panel is NOT part of the DeepView for Windows on-line Help support.

Click on the OK button to close the help dialogue panel.

Figure 6–16: DeepView function keys

Run Window Function Keys	
F1	Show Function Key Help
F2	Open/Close Replay File
Shift+F2	System Parameters Configuration
F3	Create New Internal Log File
Shift+F3	Altimeter Configuration
Ctrl+F3	Close Internal Log File
Shift+F4	System Time Configuration
F5	440 Coil Drive On/Off
Shift+F5	External Output Configuration
F6	350 Toggle Fwd Search/ Run View
Shift+F6	Analogue Output Configuration
Ctrl+F6	Toggle 440/350 SEP (Dualtrack Mode)
Shift+F7	440 Run Background Compensation
Shift+F8	Seawater Compensation
Shift+F9	Load Defaults
Shift+F10	Video Overlay Configuration
Ctrl+F10	System Configuration Wizard
Ctrl+F	Toggle Forward Search On/Off (350)
Ctrl+H	Toggle SEP Height Range
Ctrl+R	Toggle Run View On/Off
Ctrl+V	Toggle Video Overlay On/Off
Ctrl+W	Toggle SEP Width Range (350)

Press any key to dismiss

Notes:

1. Function key combination [Shift]+[F6] has no effect unless the optional analogue output option is fitted.
2. Function keys [F6], [Ctrl]+[F] and [Ctrl]+[W] are valid only when you use DeepView for Windows in the 350 mode.
3. Function key combination [Ctrl]+[F6] is valid only when you use the 440 System in a Dualtrack installation.

6.3 AFTER THE DIVE

Perform the following tasks after you complete a survey using the 440 System:

1. **Switch off coil drive.**
Use the button on the DeepView for Windows toolbar (explained in Table 6–6) or press the function key [F5] to toggle the coil drive on and off with alternate presses. The status bar shows the current condition of coil drive.
2. **Print the configuration.**
Select File➔Print Configuration to send a copy of the 440 System configuration details to Window Notepad. Use this separate application to print the details so that you may retain them with the survey records.

3. Close the logging files.

Select File→Close Log File to close the internal log file (if you have made one during the survey). Command the external data logger to stop logging data from the 440 System.

4. Exit DeepView for Windows.

Select File→Exit to exit the program. If necessary, use Windows Explorer to copy the internally logged file to a separate disk to accompany the survey records. You might need to compress the file using a separate program before you can transfer it to a diskette.

5. Exit Windows and power-off the SDC.

Select Start→Shut Down..., then choose 'Shut down' and press OK to close the Windows operating environment. Wait while Windows closes and then power-off the SDC when the screen tells you that it is safe to do so.



CAUTION

DO NOT power-off the SDC until it is safe to do so otherwise Windows™ will log the fact that it was incorrectly closed. This will cause the SDC to enter a diagnostic check automatically when you next operate it, extending the time that it takes for the 440 System to become operational after power-on.

If you power-off the SDC before Windows has closed properly, you might corrupt some of the data logging files from the survey.

6. Power-off the sub-sea installation.

If you power-off the sub-sea installation before you close DeepView for Windows, the program will register a communications failure.

7. Check the 440 System.

After you recover the ROV, perform all the post-survey checks and make any necessary repairs to the 440 System before you store it. This helps to ensure the System will be ready for immediate deployment when needed again. Use a fresh water hose to wash deposits of salt and debris off the System.

Refer to Section 7 for a suggested survey procedure using the 440 System.

6.4 REPLAYING A LOG FILE

When you start to replay a log file an additional tool bar appears at the top of the run window.

Figure 6-17: Replay a log file screen

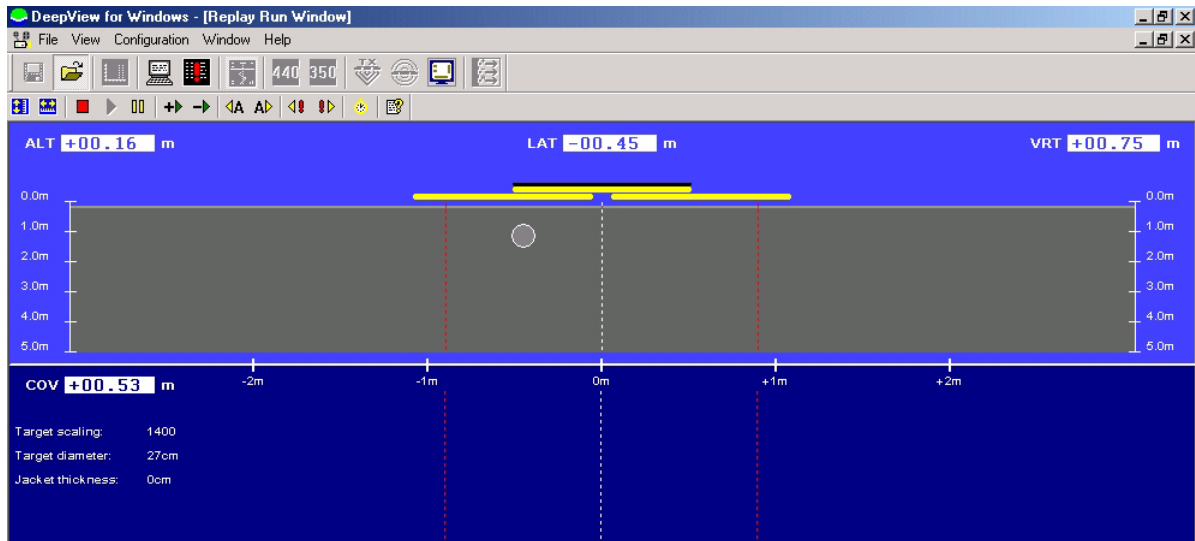




Figure 6-18: Replay toolbar keys



Table 6-8: Replay toolbar function keys

Button	Function	Explanation
	Toggle height scale Function key	
	Toggle swath width Function key	This is not used in the operation of the 440 System
	Stop / Play / Pause Function keys	
	Increase / Slow down replay speed Function keys	
	Jump to previous / next annotation Function keys	
	Jump to previous / next event Function keys	

Button	Function	Explanation
	Goto time Function key	
	Help button	Same as ctrl-F1

7 OPERATING PROCEDURE

In common with other items of precision equipment, you may rely on the quality of data gathered by the 440 System only if you follow the correct operating procedures when you use it.

This section of the Manual considers the role that the 440 System plays within an overall survey operation. It includes several checklists together with the related explanations to assist with each of the major stages of any survey that uses the System.



This is an important section of the 440 Manual. On request, TSS can supply additional copies to the survey planning team to provide guidance during the early stages of Project Management.

7.1 Pre-Survey Preparation **Page 2**

Details that must be considered during the period leading up to a survey. **This sub-section will be of particular interest to Survey Planners and their clients.**

7.3 Survey Operations **Page 8**

The correct operating procedure for the 440 System during a survey. **The level of System-specific information included in this sub-section will be useful to Survey Engineers and the ROV Pilot.**

7.4 Data Quality **Page 23**

The Quality Control code included in the data output from the 440 System allows Survey Engineers to identify more easily those areas of the survey where the data may need more detailed examination.

7.5 Target Scaling **Page 30**

Manual procedures allow the determination of a target scaling factor valid for a specific target. This operation is particularly useful if you are planning a survey on a target that does not fall easily into one of the four standard target categories.

7.6 Altimeter Data Format **Page 33**

Details of the different data formats used by the supported altimeters.



To allow for meaningful analysis of the acquired data, the 440 System allows you to keep a record of the System configuration during a survey. When DeepView for Windows is configured a file is created that can be accessed by File, and 'Print Configuration' option. this presents a text file on screen in wordpad format that can then be printed out via the normal windows process to a connected printer.

Variables included in the configuration file are of great value during data analysis, and TSS recommend you should always keep a written record of their settings with the survey log.

7.1 PRE-SURVEY PREPARATION

At an early stage during the planning procedure, the survey planning team should decide whether to use a 440 System. By making this decision early in the planning procedure, they can assign the proper equipment and personnel to the operation.

Contact TSS for advice if you are unsure whether the 440 System is suitable for use in a particular survey application.

Pre-Survey Check List

Training and availability

1. Check the availability of a 440 System and a TSS-trained operator for the period of the survey.

Target scaling

2. Determine the diameter, and weight-coating or jacket thickness of the intended survey target.
3. Will an automatically generated target scaling rate give sufficient accuracy?
4. Establish the scope of survey data acquisition, for example the maximum vertical range, required accuracy of data, etc. You may be able to use the examples in Section 9 or you may test a sample of the target on dry land.
5. Determine the maximum tolerable limits of roll, pitch and skew between the ROV and the target during the survey.

Data Collection

6. Define the type of data you will need to collect during the survey.

System Installation Requirements

7. Determine whether the ROV will be suitable for all the survey requirements.
8. Decide which communications method to use from among 2-wire current-loop, 4-wire current-loop, or RS232.
9. Decide whether to use an altimeter or a rapid update profiler. Determine which type of altimeter you will use and where you will install it. Contact TSS for advice if necessary.
10. Determine what facilities will be available for logging the survey data.
11. Provide a printer for connection to the SDC.
12. Determine the requirements for maintaining a video record of the survey.
13. If you will use a tracked ROV, decide whether to use automatic steering. If you choose this option you will require the Analogue Output option on the SDC. Contact TSS for advice.

7.1.1 Training and Availability

When used properly, the TSS 440 System is a precision survey tool that provides valuable and detailed survey data to describe the track of a conductive target through the survey area.



It is in the interest of the Survey Planners to ensure that appropriate personnel attend one of the TSS Training Courses.

Two levels of 440 Training Course are available. Refer to Appendix B for a description of each course.

Ensure that a 440 System in good working order will be available at the time of the survey operation.

7.1.2 Target Scaling

The 440 System features a simple and quick method to set the target scaling factor automatically for a particular target type and size. To achieve this, the System includes a comprehensive database of information acquired for a very wide range of target type and size.

Use the auto-scaling procedure to select the target diameter. After you have done this, the System refers to its database of target characteristics and selects a value appropriate for the survey.

The range and accuracy of measurements available from the 440 System varies with the type of target and its size. This Manual cannot therefore include precise specifications to cover all possible targets. However, Section 9 includes a series of tables that show the degree of measurement accuracy that you may expect from the System *if you follow the correct operating procedures*. These tables provide guidance on the vertical range and measurement accuracy that you may expect for the targets listed. **DO NOT** use the tables as correction tables to refine survey results after you have completed the survey.

Where the information contained in Section 9 does not provide sufficient coverage, you may make a series of manual measurements using a sample of the target on dry land to derive a table that is valid for a specific target. By prior arrangement, TSS can perform this service before the survey using a suitable 5-metre sample length of target.

The ideal condition during the survey is for the ROV to be located centrally over the target with no roll, pitch or skew present. Where this is impossible to achieve, you may simulate the roll, pitch and skew conditions during tests on land and assess their effects on measurement accuracy.

7.1.3 Data Collection

During the early stages, the survey planning team will need to define the type of data required from the survey:

The System can complete a quick and simple check on the track and depth of cover of a target by making a series of widely spaced measurements.

Alternatively, to work to the highest achievable accuracy (for example to perform an out-of-straightness survey), you may need to stop the ROV at closely spaced intervals to perform accurate measurements on the target and to measure the mean seabed level with a separate profiling system.

7.1.4 System Installation Requirements

Before starting a survey the survey planning team should define the installation requirements of the 440 System. They should consider:

- The type of ROV to be used and where the SEP, the PSU and the coils will be mounted. The 440 System is suitable for use on most types of ROV, including towed sleds. TSS can offer further advice if necessary.
- Which communication method to use between the SEP and the SDC. This will depend upon the characteristics of the umbilical cable. See Section 4 for guidance.
- Whether to use an altimeter or a rapid update profiler, and their location on the ROV.
- The type and capacity of data logger, and its connection and communication requirements.
- Whether to use an external printer with the 440 System. TSS recommends that you should generate a written or printed copy of the System configuration before and after the survey. This will be useful source of reference during the data analysis phase of the survey.
- The on board facilities for creating, displaying and recording video images from a sub-sea camera mounted on the ROV. Consider using the video facilities to record the installation procedure of the 440 System.

The standard 440 System includes a field support kit (FSK) for use with the sub-sea installation. Only engineers who have attended Part 2 of the relevant TSS training course should use the FSK.

As an option, TSS can provide an Analogue Output capability on the SDC. This option provides an output voltage, proportional to the lateral offset of the target, for the control of a tracked ROV that has an automatic steering facility.

7.2 PRE-DIVE CHECKS



DeepView for Windows has a comprehensive Help structure written specially for it. The Help structure includes a set of pre-dive checks that you should perform before you deploy the 440 System underwater. You may configure DeepView for Windows to display a summary of these checks automatically after you complete in the System Configuration Wizard. The following sub-sections 7.2.1 to 7.2.2 explain the pre-dive checks for the mechanical and electrical aspects.

The pre-dive procedure requires you to check the mechanical installation, the electrical and communications connections throughout the System, and its configuration. You should perform these simple and sensible checks on the System as a routine part of every survey deployment. They should not take long to complete and will help to prevent expensive mistakes.

7.2.1 Mechanical

7.2.1.1 Depth rating

Note that the depth rating of sub-sea components will be impaired if the housings suffer from damage or corrosion, or if they have been disassembled and reassembled carelessly.

To maintain the depth rating of your 440 System:

- ❑ Wash the sub-sea installation with clean fresh water and inspect the sub-sea housings for damage after each survey operation. Make any necessary repairs as soon as possible. Never deploy the System on a survey if any of the sub-sea housings show signs of damage.
- ❑ Install the housings where there is no danger of damage from snagging on debris or contact with other equipment on the ROV. Secure the housings so that they cannot move or vibrate against the ROV frame.
- ❑ Follow the instructions in sub-section 4.1.1 concerning the electrical grounding of the 440 System.
- ❑ Do not open the sub-sea housings without good reason. Follow the instructions in sub-section 10.2.2 to disassemble and reassemble the sub-sea housings. Check the condition of the O-ring seals and apply a very thin coating of the same silicone oil that you use to maintain the connectors – refer to sub-section 4.1.2.



When opening the sub-sea housing TSS recommend that you use screws inserted into the drilled holes to jack the endcap off. Under no circumstances should a screwdriver (or similar) be used to lever the endcap off as this will result in damage to the o-ring seal and the casing.

WARNING

There have been reports of pressure building up within the Sub-sea unit if water has been able to seep into the housing. Caution must be taken when opening the SEP unit.



7.2.1.2 Coil Installation

- ❑ **Electrical characteristics.**

Check the coil continuity and insulation resistance. Do not use coils that fail the insulation test. Refer to sub-section 7.3.2.1

□ **Coil configuration.**

Install the coils so that there is a 5-10mm gap between the port and starboard coils and the centre coil lies flat on top (see Figure 3-4). Align the coils so that their connectors all face towards the ROV.

□ **Coil separation distance.**

Allow sufficient distance between the coil array and the vehicle body so that the background signal (with no target) is less than 1000 μ V. Usually this requires a coil separation distance of between 0.6m and 1.0m, depending on the size of the ROV.

□ **Coil mounting.**

Make certain the coils are mounted rigidly on the ROV. If the ROV uses a system that lowers the coil array to its normal operating position after deployment, make certain this locks into the correct position before you start the first background compensation procedure. Refer to sub-section 6.2.2.4 for a description of background compensation.

Never drill holes in the coils.

You may install the coils either at the front or the rear of the ROV. If you use a rear mounting position, arrange a subsea camera to check that the umbilical does not drag near them and create a false target.

□ **Coil height.**

For a small target – Install the coils low on the ROV to extend the detection range as deeply as possible into the seabed. Operate the ROV carefully to avoid collisions between the coils and debris on the seabed.

For a large target – Install the coils higher on the ROV to reduce the likelihood of coil saturation. This position also provides better protection for the coils.

□ **Cables.**

Use plastic cable ties to secure the cables to the ROV frame. Make certain the cables cannot move and provide a false target during survey operations.

□ **ROV body.**

Do not operate manipulators or other movable items near to the coils during survey operations. If you must use the manipulators during a survey, stow them securely and perform a full background compensation procedure before you resume the survey.

□ **Conductive material.**

Do not place conductive metal fixings, straps or other items near the coils during operation. Use only the supplied nylon fixings and frame components to secure the coil array to the ROV.

□ **Altimeter.**

Do not attach any altimeter to the coil array.

Measure the vertical offset distance between the coils and the transducer face of the altimeter. Use this distance to configure the 440 SEP.

7.2.2 Electrical

7.2.2.1 Power

Check the operating voltage for your sub-sea installation:

- The standard sub-sea PSU operates from a nominal 110V AC electrical supply. Refer to sub-section 9.1.3 for full details of the PSU power requirements.

Check the power supply rating for your PSU, which should be marked on the PSU label.



For Dualtrack installations, both sub-sea installations MUST operate from the same electrical supply. If necessary, obtain a new 440 PSU or 350 SEP so that you may establish this very important condition. Refer to Appendix B.2 for a description of Dualtrack.

7.2.2.2 Cables, Connectors and Coils

Cables and connectors

- Check that you have installed the cables correctly. Refer to sub-section 4.1 for instructions to make connections within the sub-sea installation.
- Check the coil and cable continuity and insulation resistance as instructed in section 7.3.2.1.
- Inspect the cables and connectors visually for signs of damage, contamination or degradation. Make any repairs necessary before you use the cables. If necessary, fit new cables.
- Secure all cables to the ROV frame so that they cannot move or snag during survey operations. Do not apply sharp bends to the cables or expose them to other mechanical stresses.
- Follow the advice in sub-section 4.1.2 about caring for connectors.
- Connect the coils to their correct channels on the SEP.
- Fit proper blanking plugs to any SEP port that will not be used during system deployment.
- Hand tighten the connectors when you reassemble them. Do not use additional leverage or apply excessive force to the connectors.

7.3 SURVEY OPERATIONS

This sub-section is of special interest to personnel who will operate the 440 System during a survey. It explains how to use the System correctly.



Complete the mechanical and electrical installation procedures according to the instructions contained in Sections 3 and 4 of this Manual. A summary of the checklist is in section 7.2.

Before you start a survey that uses the 440 System:

- ❑ Check that you have established the correct communication method in the SEP and in the SDC. Refer to Section 4.
- ❑ Check that you have connected the coil cables in the correct sequence (Starboard to Channel 1, etc.).
- ❑ At the SDC ensure that you have attached all necessary connections from the SEP/PSU, the data logger, the altimeter, the video system and the printer as required.
- ❑ Check that you have installed and secured the SDC safely so that it will not move or fall with movements of the survey vessel.
- ❑ Check and connect a noise-free power supply of the correct voltage to the SDC.
- ❑ Check the power supply connection from the ROV to the PSU. The standard PSU accepts AC electrical power at a nominal supply voltage 110V.
- ❑ Set the correct format for external data logging.
- ❑ Set the RS232 parameters of the SDC 'ALTIMETER' (COM2) and 'LOG O/P' (COM3) ports to match any equipment connected to them.
- ❑ If you are using a current-loop communication method, check on the SDC to see whether the 'C/LOOP' LED shows red when you power-on the sub-sea installation. Select the Run Display screen and check that it updates correctly. Use the SDC oscilloscope display to check for correct waveforms on all channels.

Operations Check List

Installation

1. Check that you have installed the 440 System correctly.
2. Set the internal clock of the SDC to the correct date and time.

Establishing the Start-of-Survey Configuration

3. Set the target scaling factor to the correct value.
4. Set the correct altimeter parameters, including any vertical offset measurements.
5. Set the Analogue Output parameters (if applicable).
6. Set the threshold according to requirements.
7. Check that coil mapping correctly matches the specific installation.
8. Set the background compensation reminder interval.
9. Upon completion of 3 – 8 above, save the configuration to the SDC hard disk.
10. Print the configuration and retain a copy with the survey records.

Pre-dive Checks

11. Power-on the 440 System thirty minutes before you deploy the ROV. If practical, perform a target detection test.
12. Use the SDC oscilloscope display and check for correct waveforms on all channels.
13. If your System has an altimeter fitted, perform an Altimeter Test and check that the System receives data strings from the altimeter.
14. With the ROV in the water, check again for correct waveforms from the SEP using the SDC oscilloscope function, and for correct data strings from the altimeter.

Press [F5] from the Operation Menu to display a full set of pre-dive checks.

Background and Seawater (Active) Compensation Monitoring

15. Perform a background compensation procedure at the start of the dive with the ROV on the seabed. It is common for the background characteristics of the ROV to change during the first 20 minutes of deployment, possibly due to thermal effects. Survey measurements made during this period may include errors caused by such changes in ROV characteristics. Repeat the background compensation procedure 30 minutes after you deploy the ROV. Create a hard copy of the results and attach it to the survey records.

16. Perform regular background and seawater compensation checks during the survey to ensure that no changes or shifts have occurred. Use the internal logging facility to record these checks.
17. To perform a background compensation check, steer the ROV away from the target to a distance of approximately 10 metres. At this position check that all the signal voltages fall to zero $\pm 5\mu\text{V}$. If any signal voltage is greater than $5\mu\text{V}$ at a distance of 10 metres from the target, repeat the full background compensation procedure. Otherwise, if all signals are close to zero, return to the target and continue the survey.
18. Check the Seawater compensation. Lift the vehicle to 3m off the seabed. The target voltages should be less than $10\mu\text{V}$. If they vary, check the water temperature is set correctly. If good rejection cannot be obtained then consider using Manual Compensation.

A “Flick” in the target voltages occurs at approx. 4m above the seabed, this is not a fault in the 440 System or its configuration.

Data Logging

19. Log all survey data including the regular background and seawater compensation checks.
20. Maintain a written record of any events that occur during the survey (for example a collision between the ROV and debris, etc.). Describe any corrective actions taken.

End of Survey

21. Print another copy of the System configuration and retain it with the survey records.
22. Wash the sub-sea installation carefully using a fresh-water hose to remove all deposits of salt and debris. Check the sub-sea installation visually for signs of damage or corrosion. Repair any damage to the equipment before you stow the ROV.

7.3.1 Establishing the Survey Configuration

7.3.1.1 Target Scaling

Target scaling is the method used by the 440 System to determine the relationship between the coil signal strength and the range to the target. It allows the System to know whether a specific signal level comes from a small target close to the coils or a larger one farther away.

The value you use for the target scaling factor depends upon the nature of the target itself – particularly its diameter and its physical characteristics. You may establish this using one of two methods that you may access by ‘System parameters’ Menu:

1. Auto Scaling
2. Entry of a known value for the Target Scaling factor.

Use of the correct value will allow accurate measurements on the target. However, due to the influence of a sixth-root term in the calculation, absolute accuracy is not necessary when you

enter a target scaling factor. Trials have shown that, when using a target scaling factor that is 100% too high, errors in the measured range to target will not exceed 20%.

Auto Scaling

This is the preferred method for setting a target scaling factor. It uses the stored database of target characteristics to determine a suitable value for the target scaling factor for use in the range calculation formula.

Before the System can determine the correct Target Scaling factor, you must supply the following information about the target:

Target Diameter	Enter the external diameter of the conductive part of the target. Note: If you select Flexible Pipeline as the target type, you must set the <i>internal</i> diameter.
Weight Coating / Jacket Thickness	Enter a value between zero and 20cm for the thickness of any non-conductive coating on the target.

Upon completion, press OK to determine the correct value for target scaling factor. The SDC will display this value and allow you to accept or reject it. Press [OK] to use the displayed value.

This completes the Auto Scaling process.

Key In Known Target Scaling factor

This menu option allows you to enter a target scaling factor that you have determined by performing a separate series of tests for a specific or unusual target.

The target scaling value is designed to be as close as possible to that used for the previous 340 system. However, for maximum accuracy it is recommended TSS determine an exact target scaling factor from a sample of your target.

Refer to sub-section 7.5 for the full procedure to measure the scaling factor of a target.

7.3.1.2 Threshold

High settings will make the 440 System less sensitive to noise but will also decrease its operating range. The default setting of 15 μ V has proved to be suitable for the majority of survey operations.

Check the threshold setting by opening the system parameters window [Shift+F2] from the Configuration options. If necessary, the number can be modified from this menu.

7.3.1.3 External Logging Format

The 440 System provides two alternative formats for logging data externally. The default conditions is to log the co-ordinates, signals and quality check-code information simultaneously (see sub-section 6.2.2.2). You should not need to alter this setting.

Select the external logging format using the External Output option from the Configuration options.

7.3.1.4 Serial Port Parameters

An overview of the default port configurations and use can be found in section 5.3.2. Any changes in configuration to any of the ports used with the SDC is covered in the respective subsections related to the operation and connections required.

7.3.1.5 Background Compensation Reminder

During normal operation, you should perform a background compensation check at regular intervals to detect and compensate for any variations in the background signal from the ROV.

The background compensation reminder allows you to set a pre-determined interval of between 1 and 360 minutes. After the completion of the pre-set interval, the SDC will display a message banner as a reminder to perform this important check. You may clear this panel by pressing [ENTER] after making the check, or by performing a background compensation.

You may adjust the interval from within the System Parameter Window [Shift+F2] from the Configuration options. The default setting is 30 minutes. It is possible to disable this reminder feature by setting the interval to zero. TSS does NOT recommend that you disable the reminder interval.

7.3.1.6 Altimeter Parameters

You may gain access to the altimeter parameters by selecting the Altimeter Window [Shift+F3] from the Configuration options.

If you have connected an altimeter to the 440 System, select the appropriate model in the first field by selecting the available options.

Enter the vertical distance between the bottom face of the search-coils and the transducer face of the altimeter. Enter a positive value if the altimeter is higher on the ROV than the search-coils.

If you have no altimeter fitted to the 440 System and your ROV allows you to set the coils at a fixed altitude above the seabed, enter the fixed altitude value. **Note that you must still enable the altimeter for the System to use the value for fixed altitude.**

7.3.1.7 Coil Mapping

For normal operations, you should leave coil mapping set to its default configuration '1234'. However, if you change the connections between the coils and the SEP channels, you will have to change the coil mapping configuration accordingly. To do this, enter the System Parameters Window [Shift+F2] from the Configuration options.

7.3.1.8 Analogue Output Parameters

If your SDC has the optional Analogue Output card fitted, configure the Installation via the Analogue Output Menu (under Configuration) to modify the analogue parameters. Note that the SDC will not display the option as available in the menu unless it has this card fitted.

Refer to Appendix B for a description of the analogue output option.

7.3.1.9 Save and Print the Configuration

After the display software completes its initialisation sequence, it will search for a file that contains the initial System configuration. You may modify this file by saving a new start-up configuration that is more appropriate to the requirements of your survey.

After you have established the correct survey configuration for the System, select 'Print Configuration' from the 'File' Menu. If you do not have a printer connected to the SDC, you may use this screen and then write the details onto a suitable form.

Whether you create a hard copy of the configuration by hand or whether you print the details, you should keep a record of the System configuration with the survey log.

7.3.2 Pre-dive Checks

You should perform these important functional checks on the 440 System *before* you deploy the ROV. Note that you may display a list of the recommended pre-dive checks by pressing [F8] from the Operation Menu.

1. Coil insulation test
2. Target detection test
3. Oscilloscope test (in air and in water)
4. Altimeter test



WARNING

Draft proposals have been issued by the National Radiological Protection Board (NRPB) that restrict personal exposure to Electric and Magnetic fields. Users of the TSS 440 System should therefore note the following:

Although the search-coils generate intermittent strong magnetic fields while operating, beyond a distance of 1.5 metres from the coil surface the field strength is below the maximum level recommended within the NRPB guidelines.

- 1. Do not handle the search-coils when they are powered-on.**
- 2. When power is applied to the search-coils, all persons must be at least 1.5 metres from the coil surface.**

These restrictions apply only to the search-coils, and only when they are under power.

TSS recommends that you press [F5] from the Run Display screen to switch off coil drive while working close to the coils.

7.3.2.1 Coil Insulation Test

Damage can occur to the search-coils from collisions with debris on the seabed or from other causes. Usually, damage to the coils appears as a degraded coil insulation resistance rather than a short circuit. Under these circumstances, the 440 System may continue to work without

damage to the SEP Driver Board, but there will be some loss of accuracy in survey measurements delivered by the System.

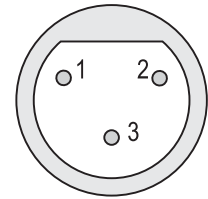
To reduce the possibility of damage to the Driver Board or a loss of survey accuracy due to a partial insulation breakdown, check each coil before you connect it to the SEP.



Sub-standard coils will show improved insulation resistance if they dry out in air before you test them. To reveal any insulation breakdown, connect a cable to the coil and then immerse the coil in one metre of water for at least two hours before you perform the insulation test. Perform the test with the coil immersed. Always keep the free end of the cable dry during this procedure.

Use a sensitive digital meter to measure the DC continuity of each coil between pins 1 and 2 of the coil connector. This resistance should be 0.25Ω .

Use a 500V digital insulation tester to measure the insulation resistance of the coil. Each coil should show an insulation resistance greater than $999M\Omega$ between pin 3 and either pin 1 or pin 2 of the coil connector.



Renew any coils that show high resistance, short-circuited windings or an insulation breakdown.

7.3.2.2 Target Detection Test



Perform this test only if there is a convenient and safe method for lifting and suspending the ROV off the deck.

Power-on the 440 System and allow a period of about five minutes for the System to settle.

If the ROV is resting on the deck of the survey vessel, the proximity of the deck and other metal fittings will cause the search-coils to saturate. Therefore, use whatever safe means are available to lift the ROV off the deck and suspend it in the air so that the coils are at least two metres from any metallic object.

At the SDC, perform a background compensation routine by pressing [Shift +F7] from the Configuration Menu. Wait ten seconds until the SDC displays a single line of measurements and then press any key to stop the routine.

Switch off coil drive by pressing [F5] from the Run Display screen and then place a metallic test target (for example, a spanner) on one of the search-coils. Switch on coil drive by pressing [F5] from the Run Display screen and check that the display shows a strong signal on the relevant channel. Repeat this test for all three search-coils, switching off coil drive while you move the test target from one coil to the next.

7.3.2.3 Oscilloscope Test

Use the SDC oscilloscope display function and check that waveforms are being displayed correctly.

Repeat this test when the ROV is in the water.

7.3.2.4 Altimeter Test

Perform an altimeter test and check that the SEP or the SDC is receiving data packets correctly from the altimeter.

7.3.3 Background Compensation and Monitoring

To ensure that information acquired by the 440 System is accurate, you must perform the full background compensation 20 minutes after you immerse the System in water and turn on the for the dive. Do not use the measurements made by the System until you have performed the background compensation.



The 440 system has much more stringent requirements than its predecessor, the 340, in terms of background compensation stability. If good quality survey information is to be obtained, then the background compensation levels must be absolutely stable and repeatable. Variation in the compensation levels indicates that the system is not performing correctly. Any problems must be rectified before the survey is performed.

The full background compensation procedure is different from the background compensation check described on page Page 16. You must perform the background compensation check at regular intervals throughout the survey operation.

These procedures and checks should not introduce significant delays into the survey operation, yet will allow greater confidence in the accuracy of survey measurements.

You should consider them an important part of the survey operation.

What Is Background Compensation?

The 'Background Compensation' process starts and proceeds after you enter the 'Background Compensation' Menu and click on 'start' from the Configuration Menu. It allows the 440 System to measure any constant signal level caused by the proximity of the ROV, and by the conductive effects of sea water.

The System measures the background signal on each channel and calculates the average value during a 10 second period. The average values derived for each channel then represent a 'zero reference' against which signals supplied by the search-coils will be compared. The System considers any received signals that are greater than this reference as originating from a target.

A sudden and significant change in the results of a background compensation check affecting one channel could indicate a partial failure of coil insulation. Refer to sub-section 10.3.1 for details.

Background Compensation Procedure

Place the ROV on the seabed so that the search-coils are at least 10 metres from the target and are located in an area that is clear of conductive debris.

The 'Background Compensation' process starts and proceeds after you enter the 'Background Compensation' Menu and click on 'start' from the Configuration Menu. If a printer is on-line and connected to the SDC, it will print a header that includes the date and time.

Wait approximately one minute until the System has completed at least five measurement cycles. The results will appear on the SDC screen. Check that all the measurements appear in black – red figures on any channel indicate signal saturation.

As the System completes each measurement cycle, the background compensation measurements appear on the screen and on a printer if one is connected.

Press any key to stop the background compensation process. There will be a delay of about ten seconds while the System completes its final set of measurements. The background compensation results used by the 440 System are those included in the last line on the display.

Examine the columns of figures that appear under each of the three channels. Within each of the used channels, the column of figures should all be the same within $\pm 5\mu\text{V}$. If they are not, then there may be a fault on the System. Refer to Section 10.3.1 for fault identification procedures.

It does not matter if the figures in one channel are different from those in another.

Ideally, the figures for channels 1–3 should all be below $1000\mu\text{V}$. If any channel shows a background compensation figure significantly above this level, do the following:

1. Move the ROV to another area of clear ground and repeat the background compensation process. If the values fall to below $0\mu\text{V}$ this means that the original site had some hidden conductive debris near the coils.
2. Refer to sub-section 3.2.2.2 and reposition the search-coils farther from the ROV body.

Upon successful completion of the background compensation procedure, include a written or printed copy of the compensation values with the survey log and return to the Run Display screen. Examine the coil voltage displayed for each channel and note that they should all show values close to zero. The display should also show a large red 'Target Out of Range' banner to indicate that there is no target within the detection range of the search-coils.

Move the ROV by two metres and confirm that the displayed signal strength values *do not go negative*. If they do, this indicates that you conducted the background compensation procedure in the presence of conductive debris on the seabed. In this event, move the ROV to another clear area and repeat the background compensation procedure.

Background Compensation Check



The background compensation check is a different procedure from the full background compensation described on page 15. You must perform the check at regular intervals (at least once every hour), and after every deployment of the manipulator arms. You may configure the SDC to show a message banner that reminds you to perform this operation at pre-set intervals.

At regular intervals, move the ROV approximately 10 metres away from the target. Confirm that the signals on each channel fall to within $\pm 5\mu\text{V}$ of zero. You may resume the survey if the signals fall to an acceptable value.

If the signal strength on any channel exceeds $5\mu\text{V}$, perform another background compensation procedure as detailed on page 15 and then continue the survey.

7.3.4 Seawater Compensation

The 440 system is based on being able to separate the different signals arising from seawater and target. This allows the range to the target to be determined from two coils.

This is achieved by means of a signal processing routine, which differentiates the target signal from the unwanted seawater signal on the basis of its slower decay rate. This process requires the provision of two calibration parameters by the user. For convenience, they are pre-programmed into DeepView and are selected on the basis of the approximate water temperature.

The seawater algorithm can reject the signals arising from the seawater to level of approximately $5\mu\text{V}$. If the incorrect temperature band is selected, then this rejection worsens to perhaps $20\mu\text{V}$. This error voltage is still small in relation to target voltages at all but the most extreme ranges, so the impact of selecting the incorrect band is not great. Further, the seawater error voltage increases as the ROV is lifted off the sea floor. Generally, when tracking a target which is deeply buried the vehicle will be close to the seabed, reducing the error voltage still further.

Select a band based on the approximate water temperature at the survey depth. Although surface water temperature varies widely, below 200m the temperature is usually 4°C .

A manual compensation routine is available (see 6.2.2.5 and Appendix A). This may be used if there is reason to suspect that the pre-programmed parameters are not giving sufficient performance. This may occur in regions of atypical salinity (such as the Black Sea) or in the presence of fresh water outfalls or vents. TSS recommends the use of the pre-programmed bands for the majority of surveys.

The parameters can also be affected slightly by the total water column depth. In situations where the water depth is shallow and changing, manual compensation may be required. Please contact VT TSS for advice on this point.

7.3.5 The Survey Operation

Normally, survey operations conducted using the 440 System will require only the Run Display screen and other selections from the Operation Menu.

The following paragraphs describe how you should use the facilities of the 440 System during a survey. They assume that you have completed the full target scaling and background compensation procedures successfully.

7.3.5.1 Interpreting the Run Display Screen

The Run Display screen is the most informative screen available from the 440 System and would normally be on permanent view during a survey operation.

It is important that you should possess a full understanding of the information presented on this screen so that you may interpret its displayed information correctly.

Signal Strength

The two information boxes in the bottom left and right-hand corners of the Run Display screen show the signal strength received from each of the search-coils. Digital information appears in the left-hand box, while vertical bar graphs show the same information in the right-hand panel.

Once you have completed the background compensation correctly, both panels should indicate a value of zero $\pm 5\mu\text{V}$ when there is no target near the coils.

As the ROV moves towards the target, the signal strength measured by one of the outer search-coils will increase. Signals on the other coils will then increase in strength until all three search-coils return a signal.

As the signal strength from each channel increases and the signal differences exceed the threshold setting, the red bars will change to yellow and the 'Target Out of Range' warning will be switched off.

The logarithmic scale used for the vertical bar graphs reacts clearly to weak signals while simultaneously displaying strong signals. An experienced operator will be able to detect the presence of a target and guide the ROV towards it using this graphical display, even when there is no target visible on the main region of the Run Display screen.

Target Track

The main region of the Run Display screen shows the track of the target relative to the centre of the coil array. This clear and simple graphical display style helps you to manoeuvre the ROV over and along the target.

On the bottom region of the screen, a thick line represents the track of the target relative to the centre-line of the coil array. The top of this line moves from side to side and scrolls downward to create a 'waterfall' display showing the relative position of the target over the previous 200 updates.

The colour of the target line changes according to the nature of the received signal:

Light grey Good signals supplied by the coils. The target is covered.

Dark grey Good signals supplied by the coils. The target is exposed.

If the System receives no altitude information, a good target signal will *always* appear as a light grey line.

Blue The quality control flag is set. The display will not show VRT or COV measurements in these circumstances. This could be for any of the following reasons:

- The System is receiving signals from one coil only
- The lateral offset is greater than $\pm 0.9\text{m}$. See section 7.4.1.1 for more information on quality control.

If you have connected an altimeter to the System, the SDC determines the state of target burial by performing the simple calculation:

$$\text{COV} = \text{VRT} - \text{ALT}$$

A positive value for COV indicates that the target is covered.

Signal saturation may occur if the target is too close to the coil array. Whenever this happens, an automatic gain facility immediately reduces the voltage gain of the System by a factor of 10.

If the target is very close to the search-coils, it is likely that saturation will continue even with a reduced the System voltage gain. Under these circumstances saturation will persist until the target moves farther from the search-coil array, and the target track shown on the Run Display screen will appear as a solid red line.

The top region of the Run Display screen represents a cross-sectional rear view of the coil array, the target and the seabed. The coil array appears at the top edge of the screen and a vertical broken white line extends down from its centre.

A hollow white circle represents the target. This circle moves to the left and right, and up and down as the position of the target moves relative to the coil array. Note that the *diameter* of this circle does not change with different target sizes.

Whenever the System cannot measure the vertical range to target, for example during signal saturation or when the target falls within the range of one coil only, the circle that represents the target will disappear from the screen.

The seabed appears on the Run Display screen as a horizontal white line. This line moves up and down in response to measurements made by the altimeter if you have one connected to the System.

If your System has no altimeter, the position of the seabed line will show the fixed coil height. You should configure the SDC with a fixed coil height if your System does not use an altimeter.



The seabed line will disappear from the screen whenever the altitude exceeds 5m.

Near the right-hand edge of the top region, there is a scale of vertical range. You may estimate the vertical range to the target and the coil altitude against this scale. Press [CTRL]+[H] or use the 'Toggle Height Scale' from the 'View' to toggle between the 5 metre and the 2 metre scale range.

There are other data fields presented on the screen. These provide a digital indication of:

- Altitude of the search-coils above the seabed (ALT).
- Vertical range to the target (VRT).
- Depth of target cover (COV).
- Lateral offset between the target and the centre-line of the coil array (LAT). A positive value indicates that the target is to starboard of the centre-line.

There is also a scale of lateral offset distance displayed between the top and the bottom regions of the Run Display screen, with gradations at zero, ± 1.0 and ± 2.0 metres. You cannot change the range of this scale.

All measurements of distance are in units of metres to two decimal places.

Oscilloscope Display



There is a fold-out drawing in Appendix C that shows examples of signals on a single oscilloscope channel. Fold out and examine this drawing while you read the following explanation.

Although not part of the Run Display screen, you may select the oscilloscope from within this screen by selecting 'Scope and Spectrum Analyser Window' from the View option. Correct interpretation of the oscilloscope can assist in the understanding and operation of the System.

The oscilloscope display includes three 'panels'. These panels represent the signals on star-board, centre and port. The oscilloscope displays the coil signals as green traces. It updates the traces using average values taken over eight consecutive sample cycles. This process removes most noise, although any significant noise levels will remain visible. Provided the noise does not encroach on either of the sample regions, as shown in example (h) of the fold-out drawing, the measurement process should not be affected. You should investigate and remove any severe causes of noise pick-up.

For each of the oscilloscope panels, the left-hand edge corresponds to a time immediately after the end of the voltage drive pulse and pre-sample period (see Appendix A for a full description of the measurement cycle timing). The width of each panel represents a timebase period of either 1200 μ s or 600 μ s from the start of the trace, as indicated by scale gradations on the x-axis of each panel.

There are three critical regions on the oscilloscope display, with their boundaries marked by vertical broken white lines. Example (a) in the fold-out drawing shows these:

- The first, called the 'Early region', lies between 130 μ s and 230 μ s on the timebase scale. During this period, the System makes 25 measurements of the signal and calculates an average value for these.
- The second, called the 'Standard region', lies between 300 μ s and 400 μ s on the timebase scale. During this period, the System makes 25 measurements of the signal and calculates an average value for these.
- The second, called the 'Zero region', lies between 1000 μ s and 1100 μ s on the timebase scale. The System averages the 25 measurements that it makes during this period and uses the result as the zero reference against which the System compares the measurement made during the both the 'Standard region' and 'Early region' periods.

The two differences between these three averages is the derived signal strength is used to determine the target voltages for the channels on the Run Display screen.

The y-axis has gradations from zero to 100%, with the absolute signal voltage represented by 100% on this axis appearing at the bottom centre of the oscilloscope screen. Saturation occurs when the signal voltage exceeds 100% on this scale. Provided the saturation does not extend into the 'Sample region', the measurement will not be affected. The fold-out drawing shows examples of slight saturation (f) and full saturation (g).

7.3.6 Data Logging

To provide the post-processing engineers with a detailed account of the survey it is important to maintain a full log of events as they occur during a survey.

The survey log should therefore include:

- The data logged to an external logger
- The video recording of the 440 System installation and configuration procedures (if one has been made)
- The video recordings from cameras on board the ROV
- Details of any events, such as ROV collisions, that may have occurred during the survey, and the effect that they may have had upon the survey. You should also record any corrective action taken.
- Printed or hand-written sheets containing the System configuration details that were taken at the start and at the end of the survey
- Any other information requested by the survey planning team

7.3.7 Replay Logged Data

You cannot use the display software on the SDC to replay externally logged files.

To replay a previously logged data file you have to select Open/Close Replay file [F2] from the file option from within DeepView for Windows. This will provide you with the following dialog box to select the file you require. The location of these files by default is a Logs folder within the DeepView for Windows directory, but this can be changed by the user to another directory, or to a floppy disk in drive A of the SDC.

- Externally logged data files include data packets of fixed length that supply all the information required for a full analysis of the survey. The file includes target co-ordinates, signal values and important quality control information generated by the 440 System during the survey. You should use this logging method to generate the primary survey recording.

Externally logged files will usually be stored on a separate data logger along with files generated by other items of survey equipment. The data logger will time stamp data packets that it receives so that the records may be synchronised accurately during the analysis operation. For this reason, DeepView does not include a time field in the external data packets. Refer to sub-section 7.4.1.1 for a description of the external logging format.

- Internally logged files are of variable length and include all data transmitted to the SDC by the SEP (target co-ordinates, signal values and, possibly, information needed by the Scope and Spectrum Analyser window). The data packets also include comment lines that describe the SEP type and other System information, a time stamp and any text annotations supplied by the user. The internal logging format does NOT include the quality control information.

Internal log files contain all the information required to determine all the information require to determine the position of the pipe, i.e. the complete raw data. TSS can regener-

ate the coordinate information which may be of use if a survey is undertaken with an incorrect target scaling parameter. Please ask TSS for further information.

Refer to sub-section 7.4.1.2 for a description of the internal logging format.



The internal logging facility is for test purposes and for the convenience of operators only. You should not use it to record the main survey log.

External logging and internal logging use different data formats that are not compatible with each other. You cannot use the SDC to 'replay' an externally logged file.

DeepView for Windows allows you to configure an SDC serial port for communication with the external data logger. This option is covered in Section 6.2.2.2. Refer to the technical manual of your data logger for the correct communication parameters.

7.4 DATA QUALITY

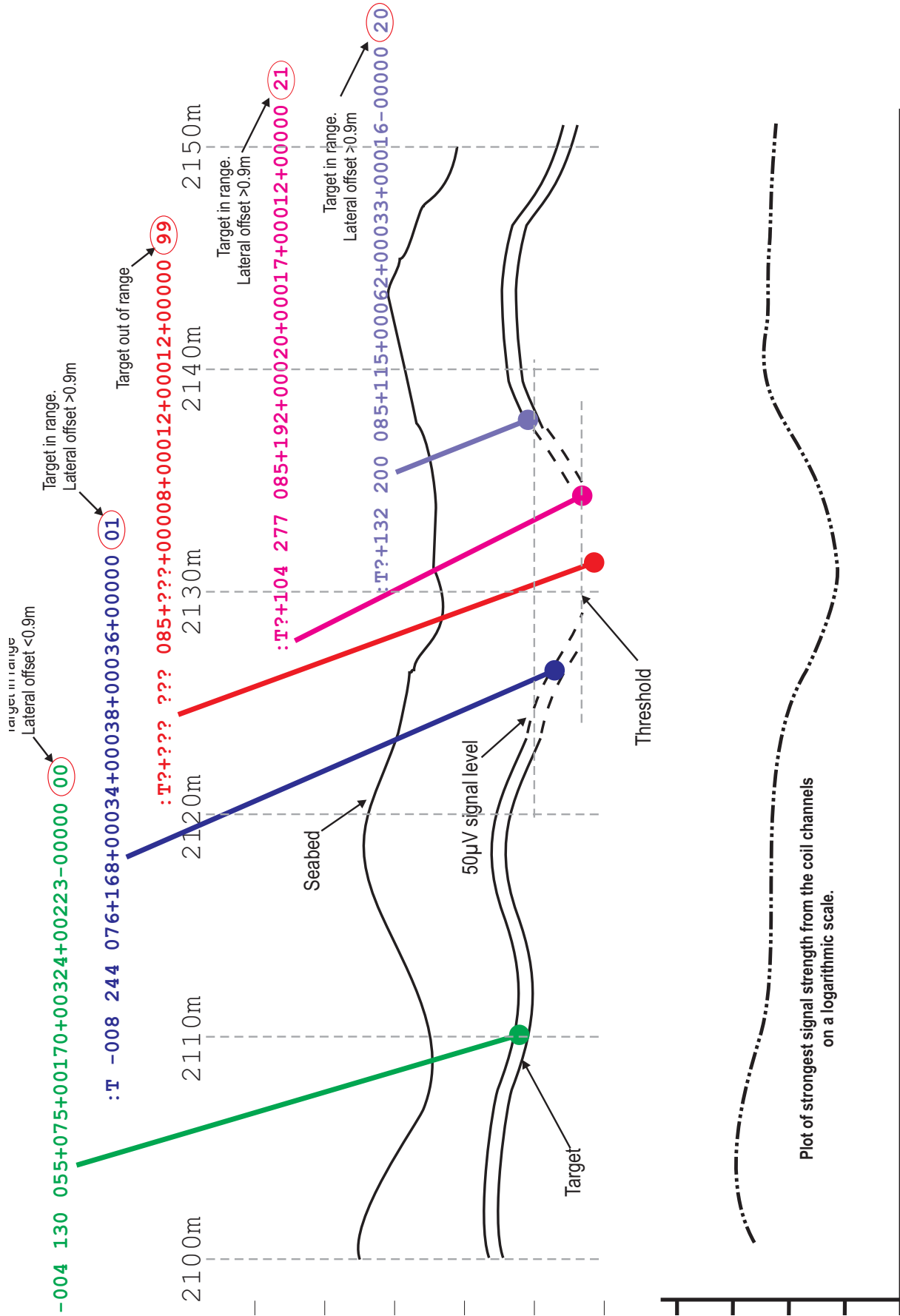
7.4.1 Profile

During post-processing you may use the data acquired by the 440 System to plot additional information onto the target profile. Similarly, you may use the additional quality control information contained in the data packets to modify the way that the profile of the target appears on the chart:

- The data packets include, by default, the co-ordinates of the target, the raw signals data, and a quality control check-code. An example profile appears in Figure 7–1.

Also in this example, the profile disappears completely whenever the target is out of range.

Figure 7-1: Example of a target profile modified using quality control information



7.4.1.1 External Logging Format

A) Co-ordinates and Signals Format

The string is 48 characters long with individual fields definitions as follows. The SDC logs all distances in units of centimetres and signal voltages in units of microvolts. The values in the packet are rounded and it is possible that they will not precisely match those on the Run Display screen.

Table 7-1: External Co-ordinates and signals format

Start character (Note 1)	:	TO	+	LLL		VVV		AAA	+	CCC	+	11111	+	22222	+	33333	+	00000		QQ	[CR]	[LF]
Packet identifier (Note 2)																						
QC flag (Note 3)																						
Lateral offset (Note 4)																						
Space character																						
Vertical range to target (Note 5)																						
Space character																						
Coil altitude (Note 6)																						
Target depth of cover (Note 7)																						
Signal strength on Starboard (Note 8)																						
Signal strength on Centre (Note 8)																						
Signal strength on Port (Note 8)																						
Fixed data '+0000' (Note 9)																						
Space character																						
QC check code (Note 10)																						
Carriage return line-feed termination																						

Notes:

1. The Start character is a colon – ASCII 3Ah.
2. ‘T’ (ASCII 54h) identifies a co-ordinates and signals data packet.
3. The Quality Control (QC) flag will be a space character when RESET, or a question mark (? – ASCII 3Fh) if the target is out of range or saturation or >90 cm LAT. See also the QC check code later in this packet.
4. The lateral offset (LAT) is measured from the centre of the coil array. Positive values indicate a target to starboard of the centre line. The field will contain question marks if the target is out of range or saturation or >90 cm LAT.
5. The vertical range to target (VRT) is the distance between the bottom face of the coil array and the top of the conductive part of the target. If you have entered a weight coating thickness using the ‘Target Scaling’ feature of the software, VRT measurements will be to the top of the weight coating. There are several conditions that will cause the field to contain question marks:
 - ❑ The target is out of range
 - ❑ The 440 System cannot compute an accurate position for the target
 - ❑ Coil saturation has occurred



Although the VRT measurements displayed and logged will be valid to the top of the weight coating, the 440 System always measures to the top of the conductive part of the target. The SDC compensates for the thickness of any weight coating and outputs the corrected value. See Figures 7-2 and 7-3.

6. Coil altitude (ALT) information comes from an altimeter if the System includes one. Otherwise, the information in this field will be the fixed coil height if available. The field will contain question marks if there is no fixed height or altimeter information available.
7. The SDC calculates the target depth of cover (COV) using $COV = VRT - ALT$. A positive value indicates the target is covered. Zero or negative values indicate an exposed target. There are several conditions that will cause the field to contain question marks:
 - ❑ The target is out of range
 - ❑ The 440 System cannot compute an accurate position for the target
 - ❑ Coil saturation has occurred
 - ❑ There is no fixed coil height or information available to the SDC from an altimeter
8. The signal strengths, in microvolts (μV) measured on Starboard coil, Centre coil, Port coil)
9. This fixed data of '+0000' represents the redundant channel.
10. The QC check code provides additional status information that explains any occurrence of the QC flag being set. The code consists of a two-digit number in the range 00 to 04 and 99 with the meaning defined in Table 7-2. Where possible, the third coil is used to assist the lateral offset calculation. This makes the LAT more stable and can make the VRT more accurate. For this reason, the most accurate survey information is available when all three coils are in range. This is indicated by codes 00 and 20.

Table 7-2: QC check code meaning – External logging format

QC Check Code	Meaning
00	Target in range. Lateral offset of target is $<\pm 0.9m$.
01	Target in range. Lateral offset of target is $<\pm 0.9m$.
02	Target in range. Lateral offset of target is $<\pm 0.9m$.
03	Target in range. Lateral offset of target is $<\pm 0.9m$.
20	Target in range. Lateral offset of target is $>\pm 0.9m$.
21	Target in range. Lateral offset of target is $>\pm 0.9m$.
22	Target in range. Lateral offset of target is $>\pm 0.9m$.
23	Target in range. Lateral offset of target is $>\pm 0.9m$.
30	Saturation of 1 or more coils. Quality flag is SET.
99	Target out of range. Quality flag is SET.

Figure 7-2: Vertical range and offset distances

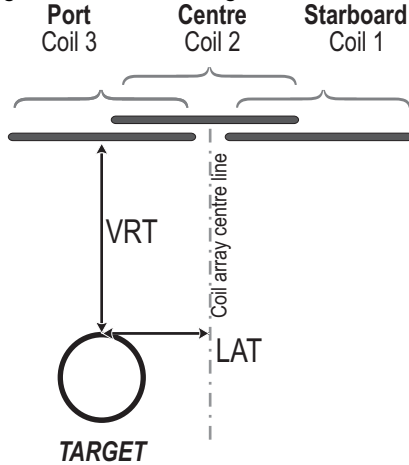
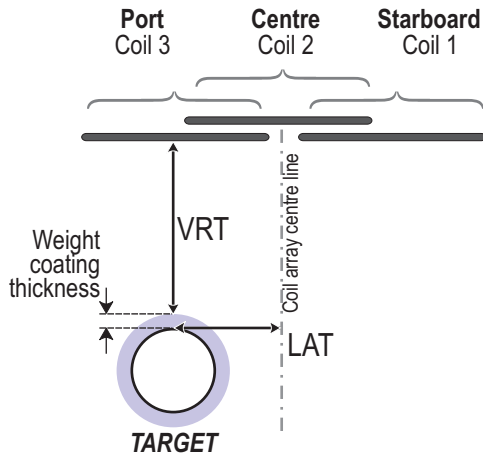


Figure 7-3: Vertical range with weight coating thickness



B) Co-ordinates Format

The string is 20 characters long with individual fields definitions as follows. The SDC logs all distances in units of centimetres. The values in the packet are rounded and it is possible that they will not precisely match those on the Run Display screen.

Table 7-3: External Co-ordinates format

	:	I	+	LLL		VVV		AAA	+	CCC		[CR]		[LF]
Start character (Note 1)														
Packet identifier (Note 2)														
Lateral offset (Note 3)														
Space character														
Vertical range to target (Note 4)														
Space character														
Coil altitude (Note 5)														
Target depth of cover (Note 6)														
Carriage return line-feed termination														

Notes:

1. The Start character is a colon – ASCII 3Ah.

2. 'I' (ASCII 49h) identifies a co-ordinates data packet.
3. The lateral offset (LAT) is measured from the centre of the coil array. Positive values indicate a target to starboard of the centre line. The field will contain question marks if the target is out of range.
4. The vertical range to target (VRT) is the distance between the bottom face of the coil array and the top of the conductive part of the target. If you have entered a weight coating thickness using the 'Target Scaling' feature of the software, VRT measurements will be to the top of the weight coating. There are several conditions that will cause the field to contain question marks:
 - The target is out of range
 - The 440 System cannot compute an accurate position for the target
 - Coil saturation has occurred



Although the VRT measurements displayed and logged will be valid to the top of the weight coating, the 440 System always measures to the top of the conductive part of the target. The SDC compensates for the thickness of any weight coating and outputs the corrected value. See Figures 7-2 and 7-3.

5. Coil altitude (ALT) information comes from an altimeter if the System includes one. Otherwise, the information in this field will be the fixed coil height if available. The field will contain question marks if there is no fixed height or altimeter information available.
6. The SDC calculates the target depth of cover (COV) using $COV = VRT - ALT$. A positive value indicates the target is covered. Zero or negative values indicate an exposed target. There are several conditions that will cause the field to contain question marks:
 - The target is out of range
 - The 440 System cannot compute an accurate position for the target
 - Coil saturation has occurred
 - There is no fixed coil height or information available to the SDC from an altimeter

7.4.1.2 Internal Logging Format

The format used for internal logging is identical to that used by the SEP to transmit data packets. These data packets fall into two categories – ‘Co-ordinates’ and ‘Signals’. The SEP transmits them alternately.

A) ‘Co-ordinates’ Data Packet

The string is 24 characters long with individual fields definitions as follows. The SDC logs all distances in units of centimetres. The values in the packet are rounded and it is possible that they will not precisely match those on the Run Display screen.

Table 7-4: Internal Co-ordinates format

	:	N	A	A	A	A	±	B	B	B		C	C	C		D	D	D	±	E	E	E	[C	R]	[L	F]	
Start character (Note 1)		Number of coils (Note 2)			Coil altitude (Note 3)				Lateral offset (Note 4)				Space character				Vertical range to target (Note 5)				Slant range to target (Note 6)				Target depth of cover (Note 7)				Carriage return line-feed termination		

Notes:

1. The Start character is a colon – ASCII 3Ah.
2. The number of coils fitted to the 440 System is always 3.
3. Coil altitude (ALT) information comes from an altimeter if the System includes one. Otherwise this field will contain three space characters and a zero.
4. The lateral offset (LAT) is measured from the centre of the coil array. Positive values indicate a target to starboard of the centre line. The field will contain question marks if the target is out of range.
5. The vertical range to target (VRT) is the distance between the bottom face of the coil array and the top of the conductive part of the target. The field will contain question marks if the target is out of range.
6. The slant range is the straight-line distance between the centre of the coil array to the top of the conductive part of the target:

$$ddd = \sqrt{((bbb^2) + (ccc^2))}$$

7. The target depth of cover COV = VRT – ALT. A positive value indicates the target is covered. Zero or negative values indicate an exposed target. The field will contain question marks if the target is out of range.

B) Signals Data Packet

The individual fields definitions for the Signals Data Packet are as follows. The SDC logs all signals in units of microvolts. The values in the packet are rounded and it is possible that they will not precisely match those on the Run Display screen.

Table 7-5: Internal signals format

Event identification (Note 2)	:	S	0000	,	1111	,	2222	,	3333	,	1111	,	2222	,	3333	[CR]	[LF]
Space character																	
Altimeter height above seabed (Note 3)																	
Signal strength of Starboard coil (early) (Note 4)																	
Signal strength of centre coil (early) (Note 4)																	
Signal strength of port coil (early) (Note 4)																	
Signal strength of Starboard coil (standard) (Note 4)																	
Signal strength of Centre coil (standard) (Note 4)																	
Signal strength of Port coil (standard) (Note 4)																	
Carriage return line-feed termination																	

Notes:

1. The Start character is a colon – ASCII 3Ah.
2. The identifier character can be either upper or lower case. The two have exactly the same meaning except that a lower case character indicates that the coil drive is switched off. The letters are "H": overheating, "O": coil saturation/overrange, "U": under threshold and "S": normal operation.
3. Altimeter height in cm above the seabed. Note that '0' indicates that altimeter is not connected. When altimeter is running, reading is padded with zeros to fill the 4 spaces.
4. The signal strengths, in microvolts (μV) measured +99999 to -9999. Always padded with zeros to fill at least four spaces. The sequence of values is Starboard coil (early), Centre coil (early), Port coil (early) Starboard coil (standard), Centre coil (standard), Port coil (standard).

7.5 TARGET SCALING



The preferred method for determining a target scaling factor is to use the Auto Scaling feature of the 440 System described in sub-section 7.3.1.1.

You should perform the following procedure whenever dry-land testing is necessary on a specific target. This might be, for example, when the target does not fall easily into one of the four standard categories.

For most applications, it will be sufficient to determine the target scaling factor only. However, if you must define the complete performance envelope of the System for a specific target, you may need to extend the procedure to include a full assessment of the vertical range accuracy,

based upon a large number of measurements. Section 9 includes some typical charts of this type.

7.5.1 Target Scaling Procedure

System configuration

Establish the 440 System on dry land so that, while keeping the coil array level, you may move it easily to various heights above the sample target. A suitable arrangement could include two adjustable vertical props holding a wooden support frame on which you mount the coils.

The sample of target must be no shorter than 5 metres.

Power-on the 440 System and allow a period of 15 to 20 minutes for the System to stabilise. Then, with the target removed from the immediate test area, perform a background compensation with the coils supported 1 metre above ground level.

Position the coil array so that, when you move it through a range of heights, the background level does not change by more than $5\mu\text{V}$ – use the Run Display screen to observe the signals from the three channels.

Estimate the Target Scaling factor

Use the Auto-scaling feature and choose a target type, diameter, and weight-coating that matches the specific target as closely as possible. Record the values on Form D1 – the Target Scaling Procedure form in Appendix D.

Note the value suggested by the 440 System for the target scaling factor and use this as the *first* estimate in the scaling process.

Determining the nominal Target Scaling factor

Position the target under the centre of the search-coils, and ensure that the target and the coil array are mutually at right angles.

Using the first estimate of the target scaling factor, record the true vertical range to target against that shown on the Run Display screen of the 440 System for a number of different vertical ranges. Also, record the signal strengths measured by each of the search-coils.

Use Form D2 – the Target Scaling Results form in Appendix D to record the test results.

If the vertical ranges shown by the 440 System are greater than the actual vertical range, reduce the value for target scaling factor, and vice versa. Repeat the tests using the new value for target scaling factor – enter the new value using the option ‘Key in known Target Scaling Factor’ in the target scaling menu.

Continue repeating the measurements and adjusting the value for target scaling factor until you obtain a satisfactory set of results.

At each stage, complete the Target Scaling Results form (Form D2).

Defining the performance envelope of the System

If you require a full assessment of the vertical and lateral range performance, follow the procedure detailed below using the nominal value for target scaling factor determined previously. Note that you must check the background compensation before you continue.

With the target placed under the centre of the coil array, establish the System with a vertical range measured to be 0.2m above the target. Record the results on the 440 Accuracy Results form (Form D3 in Appendix D).

Move the target to a lateral offset of 0.2m and record the vertical range. Note that you may make measurements on the target to either port or to starboard of the centre-line since experiments have confirmed that the performance of the 440 System is symmetrical.

Repeat the measurement, increasing the lateral offset in 0.2m increments until a 'Target Out of Range' warning occurs. Record each measurement.

Return the target to the centre of the coil array and increase the vertical range by 0.2m. If practicable, perform a background compensation.

Repeat the measurements of vertical range moving the target laterally every 0.2m. Record each measurement.

Increase the vertical height by 0.2m and, if practicable, perform a background compensation.

Repeat the above procedure until 'Target Out of Range' occurs with the target placed centrally under the coil array.

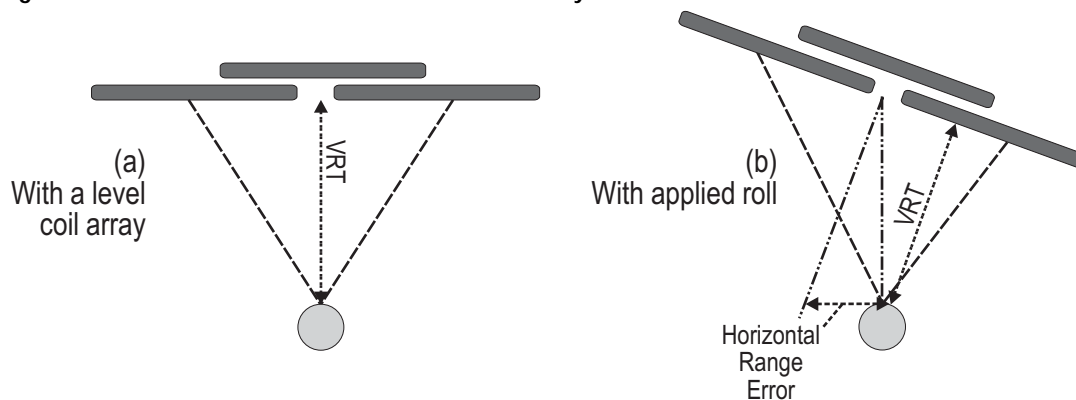
The effects of roll, pitch, and skew

Generally, where roll, pitch and skew are less than 15° , the measurements of vertical range delivered by the 440 System will not degrade by more than $\pm 50\text{mm}$.

Under some conditions, it may be possible to perform a survey only with some angle of skew between the target and the ROV. If this is a possibility, repeat the target scaling process described above with an equivalent skew applied to the coil-array. You may then measure any deviation in accuracy and make appropriate allowance at a later stage.

You may calculate the effects of roll on measurement accuracy:

Figure 7-4: The effects of roll on measurement accuracy



For a target located centrally under the coil array as shown, the displayed value for lateral offset will contain an error as follows:

$$\text{Error} = Z \sin(\text{Roll angle})$$

Where Z = the vertical distance between the centre of the coil array and the top of the target.

For example, measurements on a target located 1.0m below the centre of the coil array will include a lateral offset error of 0.17m with 10° of roll applied to the ROV.

Vertical measurements made by the 440 System are relatively unaffected by small angles of roll. Under the conditions described in the above example, the vertical measurement will contain an error of only 15mm.

7.6 ALTIMETER DATA FORMAT

You may use certain types of altimeter manufactured by Datasonics, Ulvertech, Simrad and OSEL with the 440 System.

Refer to sub-section 4.1.6.2 for instructions to connect one of these alternative types of altimeter to the SDC. You may connect the Datasonics unit either to the SDC 'ALTIMETER' COM2 port or directly to the SEP 'Altimeter' port.

You must configure the display software to use your altimeter type. Refer to the instructions in sub-section 6.2.2.1 for instructions to do this.

The descriptions below include the individual data formats and the RS232 parameters for each type of altimeter that you may use with the 440 System. Except for the OSEL altimeter, transmission starts immediately after power-on.

Note that DeepView removes all spaces present in the altimeter string before interpretation. This is because the UK90 format sometimes includes extra spaces which are not defined in its specification. This removal of spaces applies to all types of altimeters which are connected directly to the SDC.

1. Datasonics PSA 900 and PSA 9000

The transmission formats for the TSS altimeter, and the Datasonics PSA 900 and PSA 9000 are identical. They transmit data at 2400 baud using 7 data bits, 1 start bit, 1 mark bit and 1 stop bit.

Table 7-6: Altimeter output format – TSS and Datasonics

Txx.x	Ryy.yy	[CR]	[LF]
Altimeter temperature °C	Space character	Altitude (metres) above the seabed	Carriage return line-feed termination

If the Datasonics PSA 900 includes the optional pressure transducer, the data string becomes:

Table 7-7: Altimeter output format – Datasonics with pressure transducer

Dnn.n	Txx.x	Ryy.yy	[CR]	[LF]
Altimeter depth (metres)	Space character	Altimeter temperature °C	Space character	Altitude (metres) above the seabed
				Carriage return line-feed termination

2. Ulvertech Bathymetric System

The Ulvertech Bathymetric system transmits data at 9600 baud using 8 data bits, 1 stop bit and no parity.

Table 7-8: Altimeter output format – Ulvertech Bathymetric system

xxxxxx	,	yyyy	[CR]	[LF]
Water column depth of altimeter (centimetres)	Comma character	Altitude (centimetres) above the seabed	Carriage return line-feed termination	

3. Simrad UK90

The Simrad UK90 transmits data at 4800 baud using 8 data bits, 2 stop bits and no parity.

Table 7-9: Altimeter output format – Simrad UK90

Daaa	.aa	Abb.bb	Abb.bb	Tcc	Pdddd	Veeee	Wffff	Hgg	[CR]	[LF]			
Water column depth of altimeter (metres)	Space character	Altitude (metres) above the seabed (Note 1)	Space character	Sea water temperature °C	Space character	Surface air pressure	Space character	Sound velocity in sea water	Space character	Relative density of the sea water	Space character	Surface installation height above sea level	Carriage return line-feed termination
					(Note 2)								

Notes:

1. The Simrad UK90 altimeter measures altitude at twice the rate that it measures depth. It therefore includes the altitude field twice in each data packet, separated by a space character. Both altitude fields will contain similar values because it is unlikely the altitude will change significantly during the short interval between the two measurements.
2. The contents of these output data fields are set externally and have no effect on operation of the 440 System.

4. OSEL Bathymetric System

The OSEL Bathymetric system transmits data at 9600 baud using 8 data bits, 1 stop bit and no parity.

Table 7-10: Altimeter output format – OSEL bathymetric system

xxxxxxx	,	yyy	[CR]	[LF]
Water column depth of altimeter (centimetres)		Comma character		
		Altitude (centimetres) above the seabed		
			Carriage return line-feed termination	



The OSEL altimeter must receive the interrogating character uppercase 'D' from the SDC before it transmits each data string. The communication link between the OSEL altimeter and the SDC must therefore be bi-directional. The SDC transmits the interrogating character automatically when configured to use the OSEL altimeter.



5. Tritech SeaKing Bathy 704

The SeaKing Bathy system transmits data continuously using RS232 communications at 9600 baud.

Table 7-11: Tritech SeaKing Bathy format

+AAAA	BBBBBBBBBB	+CCCC	DDDDDDDD	DEEEEEEEEE	-FFFF	GGGGG
Internal temperature (×0.1°C)	Digiquartz pressure (×10 ⁻⁵ PSIa)	Digiquartz temperature (×0.01°C)	Raw digiquartz pressure (counts)	Raw digiquartz temperature (counts)	Local oscillator calibration (Hz)	Conductivity (×100 µmhos)
→ +HHHHH	JJJJJ	KKKKK	+LLLLLLLL	LLLLMM	NNNNNNNN	PPPPPPPP
Conductivity temperature (×0.01°C)	Conductivity salinity (parts per 10 ⁷)	Velocity of sound (× 10 ⁻¹ m/s)	Altimeter reading (20ns clock counts) (Note 1)	Bathymetric system devices – Refer to altimeter manual	Depth (mm)	Time at start of scan (hhmmss.cc)

Notes:

1. The SDC performs the following calculation to calculate the altitude above the seabed:

$$\text{Altitude} = ((\text{Altimeter reading} \times 200\text{ns}) \times \text{velocity of sound}) \div 2$$

For example, if the count were 162712, then:

$$\text{Altitude} = ((162712 \times 200\text{ns}) \times 1475) \div 2 = \mathbf{24.000 \text{ metres}}$$

This is the true distance from the transducer face of the altimeter to the seabed.



8 OPERATIONAL CONSIDERATIONS

There are some operating circumstances when the performance and accuracy of the 440 System may degrade. This section of the Manual describes some of the major causes of performance degradation so that you may avoid them or compensate for their effects.

8.1 Operating Performance

Page 2

The SDC provides a range of features that will improve the performance of the System and allow you to identify the causes of any degradation.

8.2 Sources of Error

Page 2

Some sources of error relate to the environment and the way in which you operate the ROV. You should make yourself aware of these causes so that you may avoid them or reduce their influence.

8.3 ROVs

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The 440 System is suitable for installation and use on board a wide range of ROV types.

8.1 OPERATING PERFORMANCE

Together with the skilful operation of the 440 System, two major factors influence the response and the performance of the System during survey operations:

1. Target size and conductivity

The System detects any conductive target close to the coil array. Targets that have a larger conductive mass will return a stronger signal than smaller targets. It follows therefore that the System can detect large targets at a considerably greater range than small ones.

2. Coil arrangement on the ROV

The performance of the 440 System depends heavily on the mounting arrangements of the coil array. The standard System is optimised for use with three search-coils having dimensions 1.0m × 0.94m × 0.03m. Considerable field experience confirms the ability of this coil arrangement to provide the best combination of accuracy, detection range and ease of deployment.

Refer to sub-section 7.4.1.1 for a full description of the external logging format to a data logger. The SDC includes a indication of the quality of the measurement.



The Quality Control feature eases quality control review during subsequent post-processing and data analysis.

The minimum operating range of the System depends on the tendency for the search-coils to saturate when they are too close to a conductive mass. Since the strength of signals relates to the size of the target, saturation occurs more readily for large targets and their minimum detection range is therefore greater than for small targets.

Summary:

The logged data packets include a Quality Control flag to identify data that might show degraded accuracy.

You may use all the information and facilities available from the 440 System to identify any drop in System performance so that you may take effective and appropriate corrective action.

8.2 SOURCES OF ERROR

There are other error sources that might degrade System performance. You should make yourself aware of these so that you may take action to avoid them or to reduce their effect on survey results.

These error sources fall within two categories:

- ROV handling
- Electrical interference

8.2.1 ROV Handling

The following paragraphs describe the potential sources of error that might arise as a result of unskilled or inappropriate operation of the ROV.

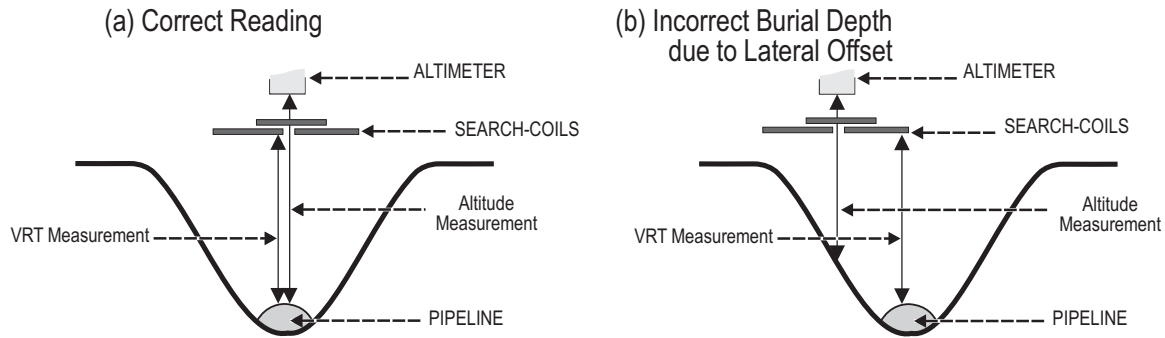
8.2.1.1 ROV Position over the Target

Figure 8–1 illustrates how errors in the measurement of depth of cover might occur when you survey a target that is partially buried beneath an uneven seabed.



Note that errors such as these arise from inaccuracies in measurements made by the altimeter and not to any errors in measuring the vertical range to target.

Figure 8–1: Altimeter errors during trench surveys



Flying with no lateral offset

Figure 8–1(a) shows the best condition achievable when you use a single altimeter: The ROV is level and is flying with the altimeter directly over the target.

Under these conditions the depth of cover measurements are accurate.

Flying with Lateral Offset

In Figure 8–1(b), the lateral offset of the ROV has placed the altimeter to one side of the target so that it measures its altitude above one of the trench walls. Consequently, the altimeter delivers information that will not allow accurate assessment of the depth of target cover.

It is therefore important to ensure that:

- ❑ You install the altimeter correctly according to the instructions in sub-section 3.2.3.
- ❑ You locate the altimeter near the centre of the coil array.
- ❑ You operate the ROV so that, as far as possible, the target remains positioned centrally beneath the coil array.

It is important also to recognise that, under the above conditions, these errors affect only the *depth of cover* measurements.

Summary:

1. Install the altimeter correctly near the centre of the coil array.
2. Pay careful attention to the relative position of the ROV over the target.
3. Be aware of any errors that may arise from the local seabed topography.
4. For surveys where the depth-of-cover information is critical, consider using a scanning profiler to survey the seabed on either side of the target. You may then merge information

from the profiler with measurements from the 440 System during the survey analysis operation.

8.2.1.2 Trim

In severe cases of roll such as shown in Figure 8–2, errors might appear in the vertical range and lateral offset measurements on the target.

Figure 8–2: ROV roll errors

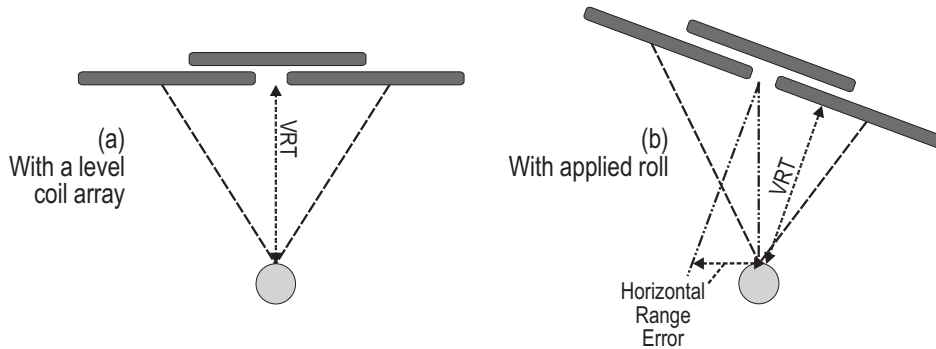


Figure 8–2(a) shows the ideal condition where the ROV is level over the target. In these conditions, the measurements for VRT and LAT will be accurate and valid.

Figure 8–2(b) shows the same situation, but with 15° roll applied to the ROV. If left uncorrected, under these conditions, errors will exist in the measurements of both the vertical range and the lateral offset.

For a target located centrally beneath the coil array as shown, the displayed value for lateral offset will contain an error as follows:

$$\text{Error} = Z \sin(\text{Roll angle})$$

Where Z is the vertical distance between the coils and the target.

For example, measurements on a target located 1.0 metre below the centre of the coil array will include a lateral offset error of 0.17 metres with 10° of roll applied to the ROV.

Measurements of VRT performed by the 440 System will remain relatively unaffected by small angles of roll. Under the conditions described in the above example, the vertical measurement will contain an error of only 15mm caused by the ROV attitude.

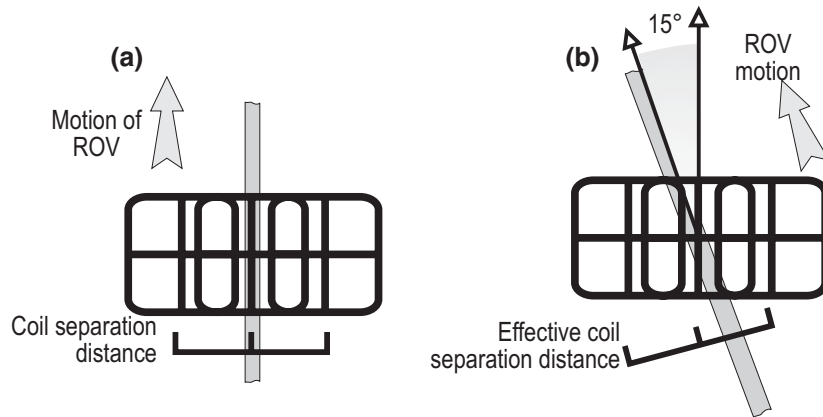
Summary:

1. Inaccuracies in vertical range measurements made by the System increase by no more than 3.5% for roll angles up to $\pm 15^\circ$.
2. Where possible operate the ROV with an even trim throughout a survey

8.2.1.3 Skew

Figure 8–3(a) shows the ideal aspect between the coil array and the target.

Figure 8–3: ROV skew errors



The accuracy of vertical range and lateral offset measurements may degrade if large angles of skew exist between the coil array and the target. This is because the effective coil separation distance decreases as the angle opens as shown in Figure 8–3(b).

If there is a slight crosscurrent in the survey area, it may be possible to perform the survey only with a small angle of skew present.

Under these circumstances, the System will continue to supply valid data with skew angles up to $\pm 15^\circ$. If you know that this condition will prevail in the survey area, assess the degree of error by conducting dry-land test measurements on a sample of the target with applied skew. See sub-section 7.5 for instructions.

Summary:

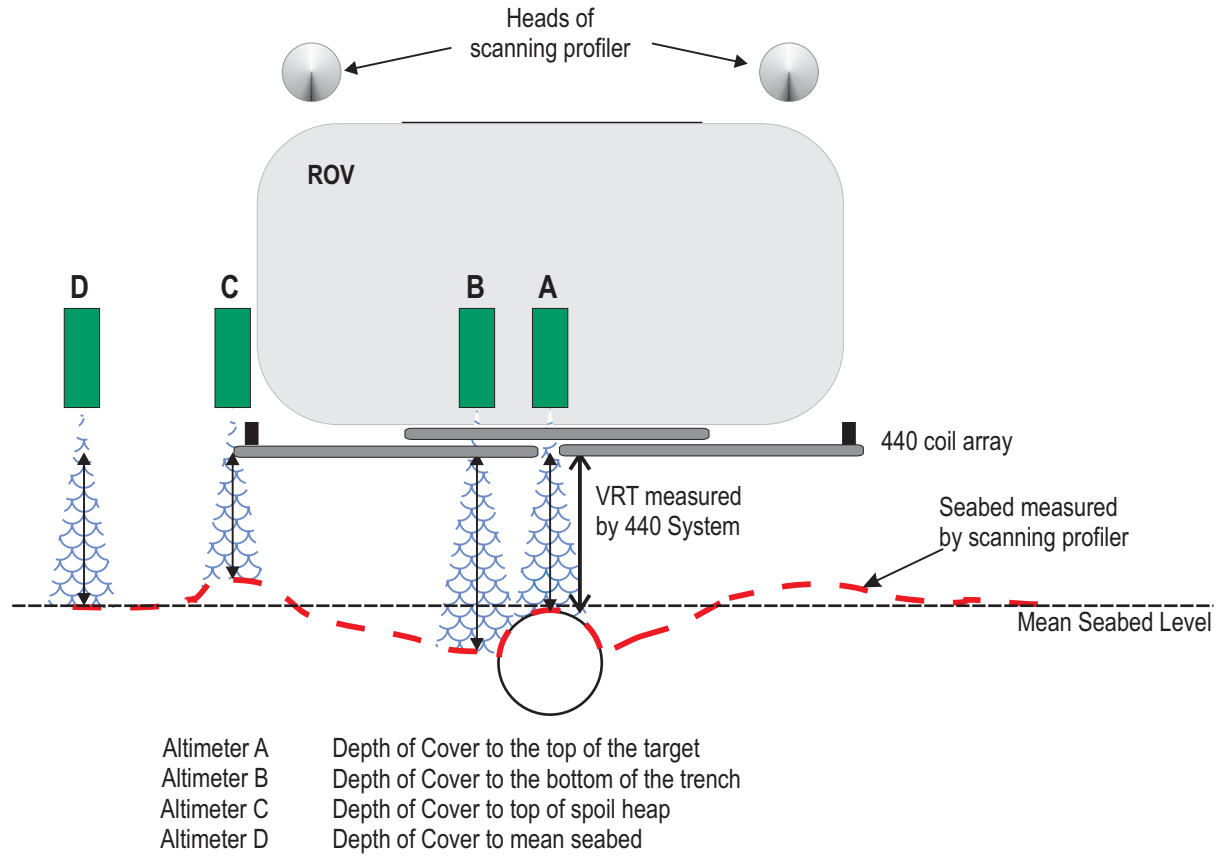
1. Avoid operating the ROV with angles of skew greater than $\pm 15^\circ$.
2. Sometimes you may conduct a survey only with an angle of skew present (for example, because of crosscurrents in the survey area). If this is the case, perform a series of dry-land tests to determine the effect that the predicted angle of skew will have on measurement accuracy.

8.2.1.4 Altimeter Positioning

A simple altimeter measures the ROV altitude above a single point on the seabed. Unless the local seabed topography is essentially flat, this measurement may not be precisely the same as the true altitude of the ROV above the mean seabed level.

Figure 8–4 shows an ROV with four altimeters mounted at various points on its body. In this example, the ROV is surveying a partially covered pipe at the bottom of a shallow trench. Low spoil heaps created by the action of a trenching plough mark the two sides of the trench.

Figure 8-4: Effects of altimeter mounting position



In Figure 8–4 the measurements made by the four altimeters are all different:

Altimeter A:	is located vertically above the centre of the coil array. With the ROV positioned as shown directly over the target, the narrow beamwidth of the altimeter (10°) measures to the top of the target. The depth of cover information supplied by the 440 System would show the target to be slightly exposed.
Altimeter B:	is located slightly to one side of the coil-array centre line. The measurements of altitude delivered by this unit are valid for the seabed immediately to one side of the target. The 440 display would show the target exposed by several centimetres.
Altimeter C:	is located at one end of the coil array and, in the example shown, measures the altitude above the top of the spoil heap. Because this heap is higher than the surrounding seabed, the 440 display would indicate the target to be covered by several centimetres.
Altimeter D:	is located on a boom and is measuring to an area of the seabed that has not been disturbed by the trenching process. The 440 display would show the target covered by a few centimetres.

The 440 System supplies measurements of the vertical distance between the search-coils and the top of the conductive part of the target. The System calculates depth of target cover using this accurate vertical range information and measurements supplied by the altimeter.

The example in Figure 8–4 illustrates that the altimeter position can affect the depth of cover information supplied by the 440 System.

Summary:

1. Where depth of cover measurements are critical to the requirements of the survey, TSS recommends that you use an independent scanning profiler system to determine the mean seabed level. Subsequent post-processing will then allow you to plot an accurate target profile using merged data from the 440 System and from the profiler.

8.2.2 Electrical Interference

The 440 System is **unaffected** by the following factors:

- ❑ Changes of ROV heading
- ❑ Any local static magnetic field
- ❑ Acoustic noise
- ❑ The presence of platforms, rigs, or other vessels in the vicinity, provided they are further than 6m from the coil array

This sub-section describes the sources of interference that might affect the 440 System.

8.2.2.1 ROV Body

Appendix A describes the principle of Pulse Induction used by the 440 System. This method detects and locates any conductive material within range of the coil array. Normally, the conductive material will be a valid target and the 440 System will supply data concerning its location and depth of cover with no loss of accuracy.

The System will also detect manipulators and other conductive parts of the ROV body that lie within range of the search-coils. However, provided these objects remain stationary relative to the coils during the survey, the System can measure and then compensate for their effects using the Background Compensation facility.

Summary:

1. Perform the Background Compensation procedure described in sub-section 7.3.3 before the survey commences and then at intervals of 30 minutes.
2. Avoid using manipulators and probes during a survey, and ensure that those parts of the ROV close to the coil array cannot move.

8.2.2.2 Power-carrying Cables

If you use the 440 System to survey power cables that are carrying high currents, the coils might experience some interference. If this occurs, random errors may appear in measurements supplied by the System.

The most effective way to cure this problem is to remove power from the target cable.

Summary:

1. Perform regular checks on signal quality by using the SDC oscilloscope function. Determine whether any electrical noise is present on the received signal. If the noise does not enter either of the sampling regions shown on the oscilloscope display you may ignore its effects.
2. If noise is present on the oscilloscope display and it is affecting measurements, arrange to remove power from the cable before you continue the survey.

8.2.2.3 Impressed-current Cathodic Protection

The 440 System may suffer from noise pick-up if you use it to survey pipes that use single-phase impressed-current cathodic protection. This will generate random errors in the range and offset data.

Use the SDC oscilloscope function to check whether there is noise on the signal from this source.

Three-phase impressed current protection and pipes protected by sacrificial anodes do not affect the 440 System in this way.

Summary:

1. Use the SDC oscilloscope function to make regular checks on signal quality.
2. If necessary, arrange to switch off the impressed-current protection. The interference will disappear immediately but the protection afforded by the current will remain for several days.

8.3 ROVs

You may use the 440 System with most types and size of ROV, and you may operate it at depths down to its specified depth rating listed in Section 9. The standard installation described in this Manual provides a high degree of accuracy and a useful measurement range, together with ease of deployment.

It is important to install the 440 System properly by following the instructions included in Sections 3 and 4 of this Manual. The System will supply valid survey data only if you follow the installation and operating instructions in this Manual. Provided you follow these instructions, you may install the System on most types of ROV.



Remember that the 440 System detects the presence of *any* conductive material nearby. When you install the System on an ROV therefore, avoid the presence of any conductive material within range of the search-coils.

During a survey, you must avoid using any manipulator arms, probes, or other items that can move while you are operating the 440 System. To guarantee the accuracy of your data throughout the survey, you must perform regular checks on background compensation.

8.3.1 Speed of Operation

The 440 System delivers measurements to a data logger continuously at a rate that allows deployment on the faster ROVs. This is sufficient to maintain a high track resolution under all normal operating conditions.

8.3.2 Altitude above the Seabed

The vertical detection range of the 440 System is limited by the characteristics of the target, in particular its size.

The low signal strength that the System receives from a small target will reduce its detection range. If you use the System to survey a small target you should therefore operate the ROV as near as possible to the seabed, while avoiding damage. If your ROV has an automatic facility for maintaining altitude, you may use it.

Larger targets will cause stronger signals in the search-coils so that you may operate the ROV at a greater altitude above the seabed.

8.3.3 Manipulators and Probes

Any manipulators or probes deployed on the ROV during a survey will present moving targets that the 440 System will detect. These movements might therefore introduce errors to the survey measurements.

You should avoid using such tools during a survey unless circumstances demand their deployment.



After you have used any such tools during a survey, stow and secure them properly. You *must* then perform a background compensation procedure before you continue the survey.

8.3.4 Automatic Steering

You may fit an Analogue Output card to the SDC. This facility supplies an output voltage that varies in amplitude and polarity with the lateral offset of the target relative to the ROV. You may use this option to supply a control signal to the automatic steering system of a tracked ROV.

8.3.5 Tracked ROV

You may install the 440 System on tracked ROVs. This type of ROV should allow you to set a fixed coil height.

9 SYSTEM SPECIFICATIONS

Along with a detailed specification of the 440 System and its major assemblies, this section of the Manual also includes examples to show the measurement performance that the System can deliver under ideal operating conditions.



While revising this 440 System Manual, TSS has made every effort to ensure that the specifications included are correct. However, in line with the TSS policy of continual product development and improvement, TSS reserves the right to change equipment specifications without notice.

Refer to TSS for advice if necessary.

9.1 Specifications

Page 2

Detailed hardware specifications for the major components of the 440 System.

9.2 Performance

Page 4

Tables showing the range capability and measurement accuracy available from the 440 System for a variety of target type and size. These tables show what the System can achieve when you follow the correct operating procedures under ideal operating conditions.

9.3 Update Rate

Page 8

You must take care when you merge data supplied by the 440 System with information from other sources.

9.1 SPECIFICATIONS

Where included, UK Imperial measurements are accurate to two decimal places only.

9.1.1 Surface Display Computer

SDC-Type 8:



To take advantage of developments in computer technology, TSS has updated the design of the SDC since the first introduction of the original 340 Pipe and cable Survey System. The software used by the 440 System is the first in the series to operate in the Windows 2000 environment, therefore earlier SDCs will not have the capability to operate this system correctly.

Processor:	VIA C3 Samuel 2 733MHz processor running Windows 2000
RAM size:	128 MB PC133 SDRAM
Hard disk size:	Minimum 20 GB
CD-ROM:	x52 speed
Floppy disk size:	3½" DS-HD 1.44 MB
Ports:	Five serial RS232 One parallel LPT1 Mono composite video in/out Colour composite video in/out S-video in/out TSS current loop in/out Optional analogue output VGA from SDC LDC.
Keyboard:	Sealed-membrane keypad + Touch pad.
Monitor:	Integral 15 inch flat-panel XGA colour display.
Overall size:	483(w) × 354(h) × 265(d) mm (excluding transit case) {19.02 × 13.94 × 10.43 inches}
Weight:	Circa. 20kg {44 pounds} (excluding transit case)
Weight:	Circa. 33kg {73 pounds} (including transit case)
Power input voltage:	85 - 265V (47 to 63Hz) auto-ranging
Power consumption:	250W maximum
Temperature range:	(Operating) 0° to 50°C {32°F to 122°F}
Relative humidity:	10% to 95% R.H. non-condensing at 40°C

Vibration resistance: 5 to 17Hz
2.5mm double amplitude displacement.
17 to 500Hz 1.5g peak-to-peak

Ingress protection: IP60 (Front panel IP65)

9.1.2 Sub-sea Electronics Pod

Size: Ø140 × 460mm* {Ø5.51 × 18.11 inches*}

Weight: In air 10kg {22.05 pounds}
In water 2kg {4.41 pounds}

Operating temperature 0° to 30°C {32°F to 86°F}

Communication: 2-wire 20mA digital current-loop.
4-wire 20mA digital current-loop.
RS232.
Selectable by internal links.

Depth rating: 3000 metres {9842 feet}

Finish: Hard black anodised aluminium

Connections: Search-coils Three cables of length 4 metres
To PSU Single 12-way cable 2.5 metres length.

**Allow up to 300mm {*11.81 inches} extra for connector clearance.*

9.1.3 Sub-sea Power Supply Pod

Size: Ø140 × 440mm* {Ø5.51 × 17.32 inches*}

Weight: In air 10kg {22.05 pounds}
In water 2kg {4.41 pounds}

Input voltage: 100 to 120V AC 45 to 65Hz
Maximum power demand 2.8A

Operating temperature 0° to 30°C {32°F to 86°F}

Depth rating: 3000 metres {9842 feet}

Finish: Hard black anodised aluminium

Connections: ROV 3 metres cable length
Umbilical One or two twisted pairs, or multiplexer.

**Allow up to 300mm {*11.81 inches} extra for connector clearance.*

9.1.4 Search Coil Array

Size:	1000 × 940 × 30mm {39.37 × 37 × 1.18 inches}	
Quantity:	3	
Weight:	In air	8kg {17.64 pounds} each
	In water	2.5kg {5.51 pounds} each
Depth rating:	3000 metres {9842 feet}	
Material:	High density polyethylene (HDPE)	
SEP connection cable:	4 metres (6 metre option available)	

9.2 PERFORMANCE

The following tables show the results of tests performed by TSS using 5 metre lengths of sample targets. They illustrate the range and accuracy that you may achieve under ideal conditions by following the procedures described in Section 7 carefully.

The charts show:

Horizontal axis	the true lateral offset of the target relative to the centre-line of the coil array. <i>Note that the response of the coil array is symmetrical and accuracy is the same to port and starboard of the centre-line. The values are valid for positive and negative lateral offset.</i>
Vertical axis	increments of increasing true vertical range to the target.
Data table	the difference between the measurement of VRT shown on the 440 and the actual vertical range.



IMPORTANT NOTE:

You should not use these charts as correction tables. They provide an indication only of what you could achieve under ideal operating conditions if you follow the correct operating procedures for the 440 System.

Note also that each table applies to one type and size of target *only*.

Table 9-1: Standard pipeline diameter = 0.27m (10 inch)

True Lateral Offset (±cm)										
	0	10	20	30	40	50	60	70	80	90
50	-3	-2	-2	3	4	4	6	7	8	8
60	-1	-2	-2	2	2	3	4	6	6	5
70	-1	-1	-1	1	2	2	3	3	4	4
80	-2	-2	-2	-1	0	1	2	2	3	3
90	-1	-2	-1	-1	0	0	0	1	1	2
100	-1	-2	-1	-1	0	0	0	1	1	2
110	-1	-1	-1	-1	-1	-1	0	-1	0	-1
120	0	-1	-1	-2	-1	-1	-1	-1	0	-2
130	0	-1	-1	0	-1	-1	-1	-1	0	-2
140	0	-1	0	-1	0	-1	-1	-1	-1	-1
150	1	0	-1	-2	-1	-1	-1	-1	-1	-2
160	1	0	-1	-1	-1	-1	-1	-1	-2	-3
170	1	-1	-1	-1	-1	-2	-2	-3	-2	-3
180	1	0	-1	-1	-1	-2	-2	-4	-2	-3
190	2	-1	-1	-2	-2	-3	-2	-4	-4	-4
200	1	-2	-1	-2	-2	-3	-3	-7	-9	-8
210	2	-4	-1	-2	-2	-5	-5	-13	-10	-5
220	3	-4	-3	-5	-4	-8	-8	-16	-14	-13
230	-4	-3	-2	-4	-3	-10	-6	-11	-10	-14
240	-4	-8	-3	-6	-6	-11	-6	-12	-23	-16
250	-1	-11	1-3	-8	-8	-13	-13	-21	-21	-16
260	6	-7	1	-5	-5	-14	-9	-9	-17	-24
270	8	0	6	-5	-4	-11	-10	-38	-38	-56
280	11	-15	3	-2	-4	-11	-1	-42	-9	25
290	16	-5	11	-12	1	-17	-7	TOR	TOR	TOR
300	4	-12	8	-3	7	TOR	TOR	TOR	TOR	TOR

Target Scaling = 1400µV

Threshold = 15µV



Table 9-2: Standard pipeline diameter = 0.11m (4 inch)

True Lateral Offset (\pm cm)										
	0	10	20	30	40	50	60	70	80	90
50	TOR	-1	4	4	5	6	7	8	7	4
60	-3	-2	1	1	2	3	4	5	4	1
70	-1	-1	-1	0	2	2	3	3	2	1
80	-1	0	0	0	1	1	1	1	1	0
90	0	-1	-1	0	0	0	0	0	0	0
100	0	0	0	2	0	1	1	1	1	1
110	1	0	0	0	0	0	0	1	0	0
120	1	-7	0	-1	0	0	0	0	0	1
130	1	-7	0	-1	0	0	-1	-1	0	1
140	1	-1	-1	-1	0	-1	-1	-1	0	0
150	3	-1	-2	-2	-1	-1	-2	-1	-1	2
160	1	-2	-3	-3	-1	-1	-2	-1	-1	-1
170	2	-1	-2	-3	0	-2	-2	-1	-1	-2
180	2	-3	-2	-3	0	-1	-4	-2	-2	-3
190	-1	-3	-4	-4	-1	5	-1	-2	-3	-2
200	-4	-3	-2	-4	1	0	-2	-3	1	3
210	-6	-7	-5	-5	6	2	3	0	1	-7
220	-5	4	-9	-7	TOR	3	-14	2	TOR	3

Target Scaling = 420 μ V

Threshold = 15 μ V

Table 9-3: Cable diameter = 0.025m (1 inch)

True Lateral Offset (±cm)										
	0	10	20	30	40	50	60	70	80	90
50	9	8	9	9	9	10	6	2	-12	-55
60	6	6	5	7	8	8	-2	0	-10	-6
70	4	3	4	4	6	6	TOR	-7	-13	2
80	2	0	2	3	4	4	TOR	-30	-18	TOR
90	2	0	2	3	4	4	TOR	TOR	TOR	TOR
100	-2	-3	1	-3	-2	-1	TOR	TOR	TOR	TOR
110	-1	-3	-4	-5	-4	-5	TOR	TOR	TOR	TOR
120	2	-11	-8	-10	-7	-5	TOR	TOR	TOR	TOR

Target Scaling = 26µV

Threshold = 15µV

Table 9-4: Umbilical diameter = 0.11m (4 inch)

True Lateral Offset (±cm)										
	0	10	20	30	40	50	60	70	80	90
50	2	4	3	3	4	5	5	3	-8	-6
60	1	1	1	2	3	4	4	1	-6	-10
70	1	2	0	0	1	2	2	-1	-70	-8
80	0	1	0	-1	0	1	0	-2	-5	-7
90	0	1	0	-1	-1	0	-1	-2	-5	-6
100	1	1	0	-1	-2	-2	-2	-3	-4	-4
110	1	1	0	-1	-1	-1	-1	-2	-3	-3
120	1	0	0	-1	-2	-1	-2	-2	-2	-3
130	1	0	-1	-1	-2	-2	-2	-2	-3	-3
140	0	0	-1	-2	-3	-3	-2	-2	-2	-3
150	0	-1	-2	-3	-4	-4	-3	-3	-2	-3
160	0	-2	-3	-4	-5	-4	-4	-2	-3	-2
170	1	4	-3	-6	-7	-6	-6	-5	-4	-5
180	-1	-2	-3	-5	-6	-6	-4	-2	-2	-4
190	-10	-4	-6	-9	-9	-8	-6	-6	-3	-3
200	-2	-7	-8	-13	-11	-10	-7	-4	-17	-11
210	1	-7	-14	-7	-8	-9	-4	-3	-7	-9
220	4	2	2	-9	-7	-4	0	-1	-2	-7

Target Scaling = 550µV

Threshold = 15µV



9.3 UPDATE RATE

You may set the rate at which the 440 System supplies measurements to an external data logger to either one or four records per second.

Update rates available from independent seabed profiling systems may be different from the update rate you have set for the 440 System. If your ROV includes both these systems, you must allow for their different update rates when you analyse the survey data.

10 MAINTENANCE

You will find it easier to identify and clear a fault on the 440 System if you have a full understanding of the location of the individual sub-assemblies, and of the way they interact. This section helps you to maintain and service the System by describing the main internal components of the sub-sea installation.



WARNING
ELECTRICAL HAZARD

Mains power supply voltages can cause death or serious injury by electric shock.

Only a competent engineer who has received the relevant training and experience should perform maintenance work on electrical equipment.

Power-off and isolate the equipment from the electrical supply before you work on any equipment that uses a mains power supply. Arrange to discharge any power supply storage capacitors safely.

Observe all relevant local and national safety regulations while you perform any maintenance work on electrically powered equipment.

Do not connect the equipment to an electrical supply until you have refitted all safety covers and ground connections.

10.1 Circuit Description

Page 2

The simple descriptions of circuit boards in the SEP assist you in the identification of a potential fault. Refer to the circuit diagrams in Section 11 while you read the descriptions.

10.2 Disassembly and Reassembly

Page 6

To maintain the depth rating of the sub-sea installation, follow these instructions carefully to disassemble and reassemble the sub-sea pods.

10.3 Fault Identification

Page 12

These flow charts should help engineers to identify and correct a fault condition on the SEP quickly and efficiently. The standard System includes a field support kit with replacement circuit boards and components to help reduce downtime if a fault develops.

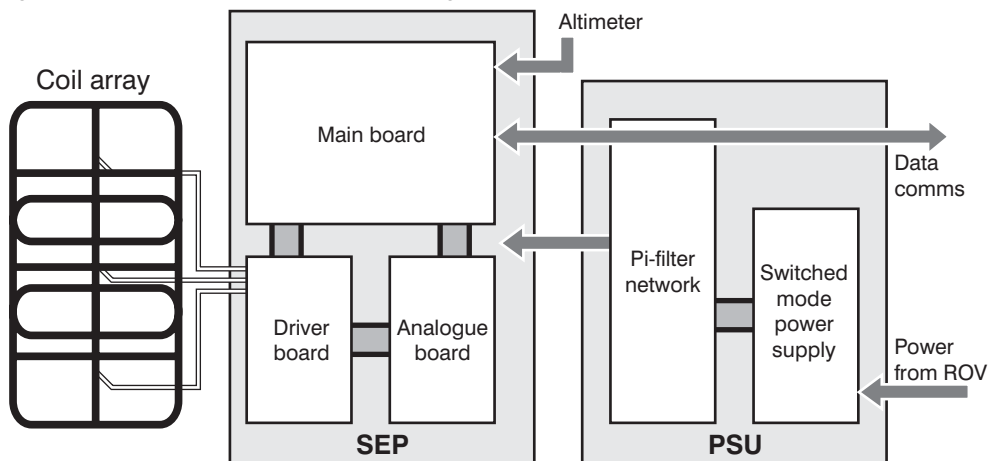
10.1 CIRCUIT DESCRIPTION

The sub-sea installation consists of three principal parts:

- The coil array
- The Sub-sea Power Supply Pod (PSU)
- The Sub-sea Electronics Pod (SEP)

Figure 10–1 shows how these are interconnected.

Figure 10–1: Simplified interconnection diagram

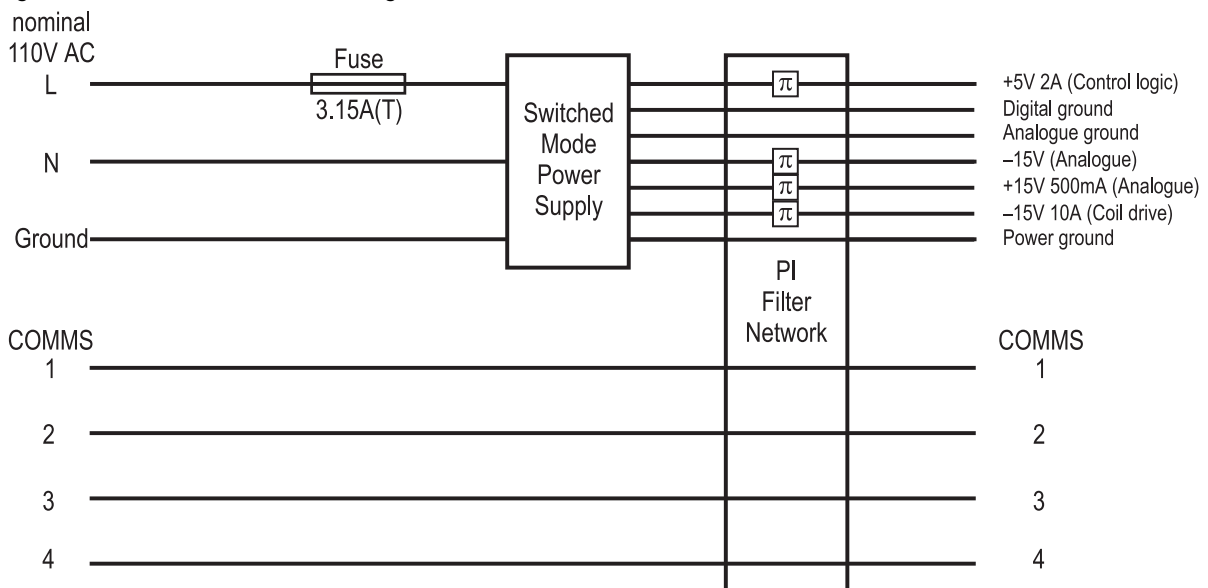


Section 11 includes the drawings for the System.

10.1.1 Power Supply Pod

The PSU contains the Power Supply PCB assembly and the π -Filter Assembly – see Figure 10–2.

Figure 10–2: PSU interconnection diagram



10.1.1.1 Power Supply PCB

(See drawing 490228 in Section 11)

Power for the sub-sea installation comes from the ROV electrical supply. Normally this will be nominal 110V single phase AC rated at 350VA. For special applications, TSS can supply the 440 System with a PSU that accepts nominal 240V AC instead.

The PSU uses switched-mode circuitry to convert the electrical supply from the ROV into the four conditioned and stabilised DC supplies required by the SEP. These are:

- +5V (2A) for use by the control logic.
- +15V (500mA) for use by the analogue electronics.
- -15V (500mA) for use by the analogue electronics.
- -15V (10A) to drive the search-coils.

Cooling of the supply is by direct thermal conduction to the PSU housing assisted by a small fan.



WARNING

There is a danger of electric shock from electrical voltages in the PSU. Do not open the PSU with power connected.

Except for the fuse on the input, the Power Supply board is NOT repairable in the field. You must renew the board as a complete unit if you suspect it has developed a fault condition.



When opening the sub-sea housing TSS recommend that you use screws inserted into the drilled holes to jack the endcap off. Under no circumstances should a screwdriver (or similar) be used to lever the endcap off as this will result in damage to the o-ring seal and the casing.



WARNING

There have been reports of pressure building up within the Sub-sea units if water has been able to seep into the housing. Caution must be taken when opening the SEP unit.

10.1.1.2 Filter Assembly

(See drawing 400654 in Section 11)

The output from a switched-mode power supply is inherently noisy. To prevent this electrical noise from disturbing the sensitive analogue circuits within the SEP, all outputs from the PSU pass through a π -filter network. The filters are contained within a metal screening can with inputs via feed-through capacitors.

10.1.2 Sub-sea Electronics Pod

The SEP includes three circuit boards:

- Main Board
- Driver Board
- Analogue Board

10.1.2.1 Main Board

(See drawing 401178 in Section 11)

The SEP drives the coil channels sequentially with control exercised through a Programmable Timer under the direction of a high-performance Digital Signal Processor (DSP) on the Main Board.

After amplification, the signals from each channel pass to the analogue-to-digital converter (ADC) and then to the DSP. The DSP performs the complex signal analysis necessary to determine the target position.

Finally, the Main Board sends the target co-ordinates to the SDC through an optically isolated serial communications link.

10.1.2.2 Driver Board

(See drawing 401040 in Section 11)

Under the control of the Main Board, the Driver Board drives the coil channels using four power MOSFET switches.

A current limiter allows coil current to rise to a maximum value of 20A during each drive pulse. The action of the limiter ensures that the amplitude of the current pulse is substantially independent of any variations in the supply voltage arriving at the PSU.

At the correct moment during each measurement cycle, the Driver Board switches off coil drive current. At this moment, the current in the coil falls very rapidly towards zero causing a back e.m.f. that drives the associated MOSFET briefly into avalanche breakdown at 250V.

Refer to Appendix A for details of the operating theory and the timing for each measurement cycle.

An LC filter smoothes the current drawn from the PSU to an approximately continuous level (*not* RMS) of 7A (with three search-coils attached).

10.1.2.3 Analogue Board

(See drawing 401041 in Section 11)

After the initial 250V spike, the signal returned from the search-coil represents the voltage induced in the target by the original current pulse.

The Analogue Board applies two stages of pre-amplification to each signal channel with an overall gain of 200. If the SEP receives a signal that is too strong, the DSP removes the second stage of amplification to reduce the overall gain to 10.

The Analogue Board removes noise using an intelligent filter that clamps the signal to zero until the end of the 250V spike.

The conditioned signal then passes to the Main Board for processing and analysis.

10.1.3 Communications Loop

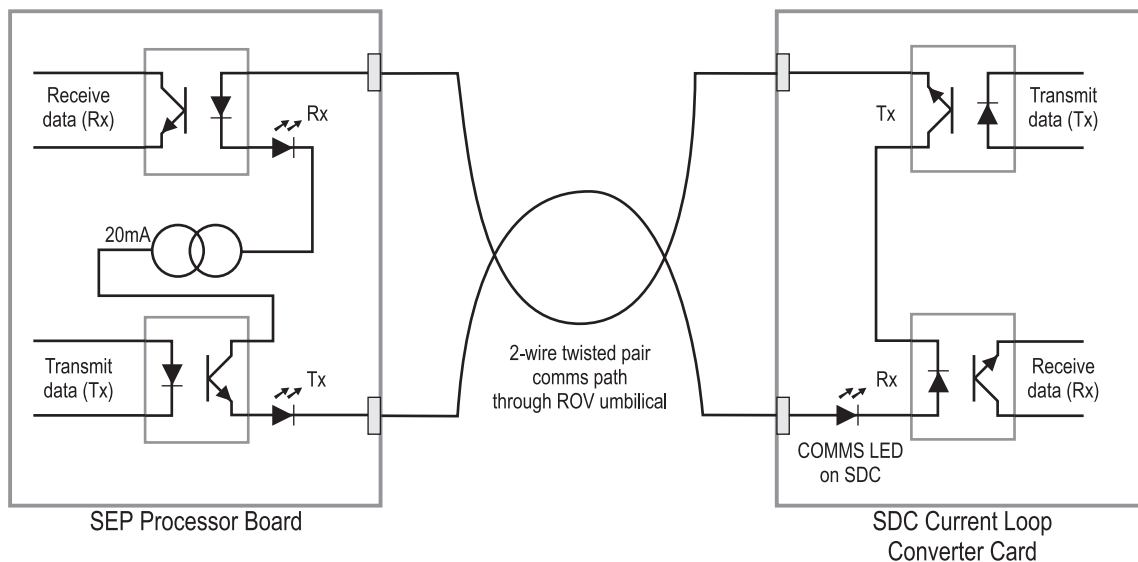
When you configure the System to use the 2-wire current-loop communications method, the SEP and the SDC share a twisted pair in the umbilical. To avoid possible contention, the 440 System assigns ‘Master’ status to the SDC, and ‘Slave’ status to the SEP.

Immediately after you power-on the 440 System, the SEP transmits a short ‘banner’ message to the SDC and then waits for commands to arrive. Other than its initial banner message, the SEP will not transmit any data until it receives a carriage-return signal from the SDC.

The SEP Main Board generates current at 20mA for the communication loop. The ‘COMMS’ LED on the SDC is in series with the current-loop and therefore confirms that the communication loop is intact when it shows red. Note that the COMMS LED does NOT confirm successful communication between the SEP and SDC, but shows only that the loop is intact.

Figure 10–3 shows a simplified schematic of the current-loop, including the optically isolated I/O ports at both ends of the umbilical cable.

Figure 10–3: Simplified schematic of the current-loop



10.2 DISASSEMBLY AND REASSEMBLY



WARNING ELECTRICAL HAZARD

Mains power supply voltages can cause death or serious injury by electric shock.

Only a competent engineer who has received the relevant training and experience should perform maintenance work on electrical equipment.

Power-off and isolate the equipment from the electrical supply before you work on any equipment that uses a mains power supply. Arrange to discharge any power supply storage capacitors safely.

Observe all relevant local and national safety regulations while you perform any maintenance work on electrically powered equipment.

Do not connect the equipment to an electrical supply until you have refitted all safety covers and ground connections.

10.2.1 Surface Display Computer



CAUTION

Many components within the SDC are susceptible to damage due to electrostatic discharge. You must take precautions against such damage: These precautions include the use of a grounded conductive mat and wrist-strap. TSS will not accept responsibility for any damage caused by failure to take such precautionary measures.



The following instructions are valid for the SDC Type 8 that the 440 Pipe and Cable Survey System is shipped with. The 440 System will not work with earlier versions of our SDCs due to this being the first system to operate under the Windows™ environment. Contact TSS for advice if necessary.

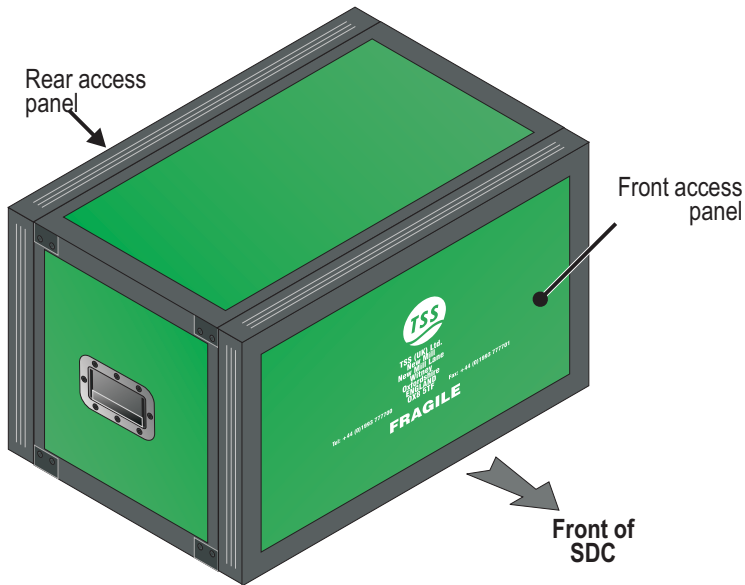
You will need to disassemble the SDC if you must change the communication link settings or if you must change one of the TSS circuit boards. To remove an expansion card:

1. Power-off the SDC and disconnect all power and communication cables.
2. Remove the SDC from its mounting. If you have installed your SDC inside its transit case, detach the front access panel from the case. Remove the eight chrome-plated cross-head screws and plastic washers that secure the SDC to the support frame. Lift the SDC from the transit case and place it on a clear level surface. Figure 10-4 shows the SDC transit case with front and rear access panels. Take precautions to prevent the SDC sliding and falling with movements of the vessel.



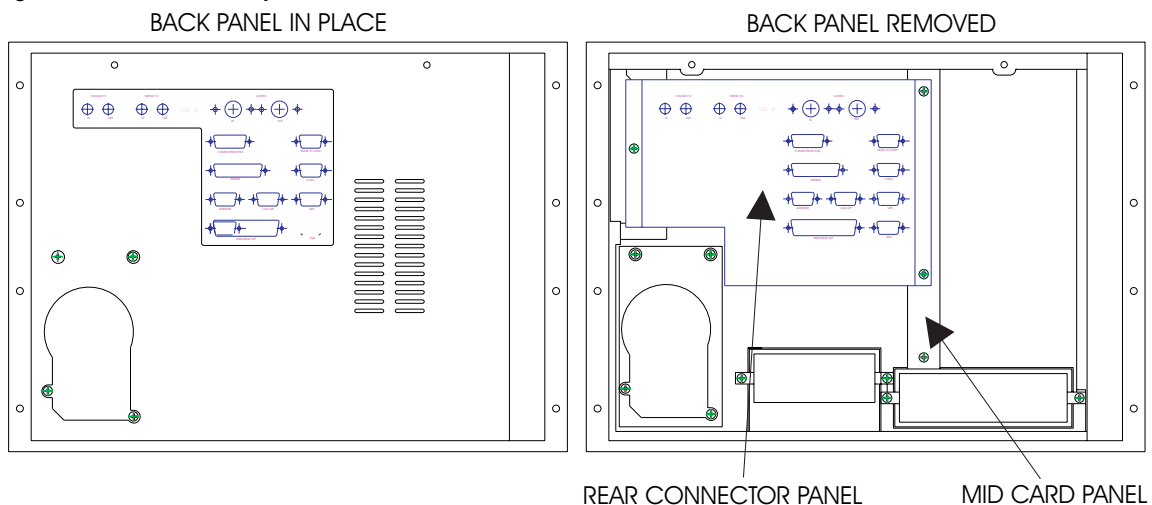
Care must be taken to protect the display panel and the keypads of the SDC.

Figure 10-4: SDC transit case



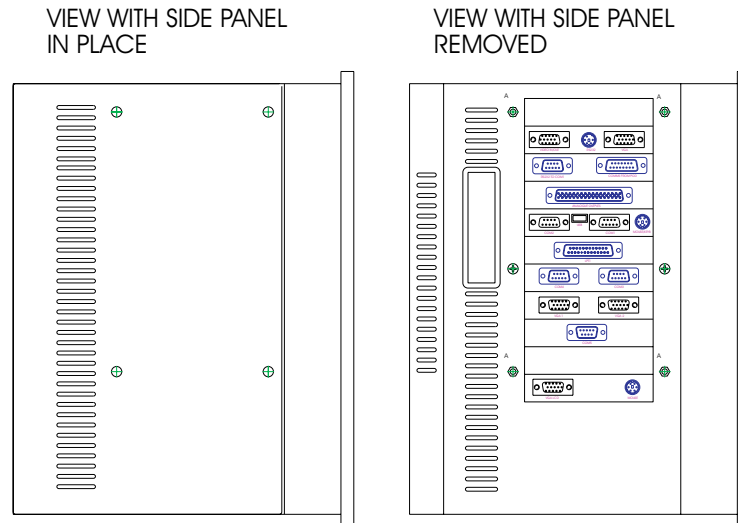
3. Unscrew the two knurled retaining bolts on the rear fold down panel of the SDC and lower the panel.
4. Inside the SDC, remove the mid card rail and the rear connector panel by removing the retaining screws and any washers at the base of the mid card rail and on the left hand side of the rear connector panel, and un-clipping the rail at the top. Retain the screws and washers for re-fitting the mid card rail and the rear connector panel.
5. Remove and retain the side connector panel cover screws, and remove the side connector panel cover.
6. Unscrew and remove any connectors to the expansion card on the side connector panel. Disconnect any internal connections to the expansion card making a note of the connections removed.

Figure 10-5: Rear access panels of the SDC



7. Identify the relevant expansion card in the backplane. Release and remove the screw and any washers that secure its bracket to the mounting bar. Retain the screws and any washers for later use.
8. Pull the card carefully from the backplane socket. Avoid damaging or bending any components on the card during this procedure.

Figure 10-6: Side access panel of the SDC



To insert an expansion card:

9. Carefully align the card and insert its edge connector into the relevant backplane socket. Taking care to avoid any component damage, press the card fully home. Refit the retained screw and any washers, and secure the card bracket to the mounting bar.
10. Reconnect any internal connections to the expansion card according to the notes made in instruction 6. Reconnect and screw lock any connections to the expansion card on the side connector panel.
11. Replace the side connector panel cover and refit with the retained screws.
12. Make certain that there are no trapped wires or cables and refit the mid rail and rear connector panel using the retained screws and any washers. Lift the rear fold down panel back into place and tighten up the knurled retaining bolts.
13. Re-install the SDC and re-connect all cables. If you install the SDC in its transit case, pass all cables through the rear of the case.

10.2.2 Sub-sea Installation



CAUTION

Many components within the sub-sea pods are susceptible to damage due to electro-static discharge. You must take precautions against such damage: These precautions include the use of a grounded conductive mat and wrist-strap. TSS will not accept responsibility for any damage caused by failure to take such precautionary measures.

To complete the disassembly of the sub-sea pods you will need the following tools and facilities:

- A clean anti-static work area
- A 3mm hexagonal key
- A 2mm hexagonal key

10.2.2.1 Sub-sea Electronics Pod

(See drawing 490232 in Section 11).

Remove the 'Power/Comms' end-cap:



Note that this end-cap has two ports. Its correct orientation is for the 12-way port to align with the SEP identification label.

1. Use the 3mm hexagonal key to release and remove the four M4 × 12mm A4 stainless-steel screws that secure the end-cap to the housing.
2. Use the 2mm hexagonal key to remove the two grub-screws from the threaded holes near the edge of the end-cap.
3. Insert two of the M4 × 12mm screws into the holes vacated by the grub-screws and tighten them by hand until you feel resistance.
4. Use the 3mm hexagonal key to tighten the two M4 × 12mm screws alternately so that they lift the end-cap away from the SEP housing.
5. After you have screwed the two jacking screws home, use your fingers to ease the end-cap away from the SEP housing. Note that a partial vacuum may form inside the housing and this may make it difficult to remove the end-cap. **Do not insert any hard or sharp instruments into the gap to act as a lever because this may scratch the surface, following which corrosion will occur.**
6. Remove the two jacking screws from the end-cap.
7. Do not allow strain to develop on the internal connectors as you ease the end-cap away from the SEP housing. Disconnect the 12-way and the 6-way internal connectors by pressing their two side-clips together and pulling the plugs and sockets apart.
8. Disconnect the ground strap by pulling the spade connector and receptacle apart.

Remove the coil connector end-cap:



Note that this end-cap has four ports. Its correct orientation is for channels 1 and 2 to be at the top of the SEP.

9. Remove the four M4 × 12mm A4 stainless-steel screws as before. Substitute two of these screws in place of the two grub screws to jack the end-cap away from the SEP housing. Remove the jacking screws from the end-cap.
10. Remove the end-cap carefully – note that it carries all the circuit board assemblies. Handle this assembly with care. Pull the end-cap carefully until the entire assembly is free of the SEP housing and place it on the clean anti-static work surface. Save the pack of desiccant that is wedged underneath the circuit-board assembly and store it in a warm dry place while you work on the circuitry.
11. The Main Board is located on one side of the central support block, and the Driver Board and the Analogue Board are located together on the other side.

To remove any of the boards:

- Note their positions and carefully disconnect all the plugs and connectors that link the board to the main assembly.
- Use the 3mm hexagonal key to remove the M4 × 16mm bolts that secure the board to the support and remove the board from the assembly.
- On completion of repair work refit the board and reconnect the cables and connectors correctly.

Reassemble the SEP:

12. Check the condition of the two rubber O-rings that seal each of the end-caps. Clean or renew them if necessary. Apply a thin smear of approved lubricant to the rings to ensure they make an efficient seal when you reassemble the SEP. **For this purpose, use the same type of lubricant that you use for the sub-sea electrical connectors – refer to sub-section 4.1.2 for these important instructions.**
13. Place the desiccant pack inside so that it fits between the Main Board and the SEP housing. Make certain that there are no trapped wires or components, and push the end-cap home. This end-cap must be opposite the end of the SEP that has the ground strap attached inside.
14. Carefully align the end-cap to the SEP housing so that the four securing screws will engage properly. If necessary, turn the end-cap slightly to achieve perfect alignment. Ensure that both holes for the grub screws align with the hardened stainless steel inserts on the end of the SEP housing.
15. Insert the four M4 × 12mm A4 stainless steel screws and use the 3mm hexagonal key to tighten them evenly. Insert both grub-screws and tighten them lightly.
16. Reconnect the ground wires, the 8-way and the 6-way connectors on the ‘Power/Comms’ end-cap. Make certain both locking clips on each of the multi-way connectors engage properly.

17. Align and engage the 'Power/Comms' end-cap into the SEP housing. Make certain both holes for the grub screws align with the hardened stainless steel inserts in the end of the SEP housing.
18. Make certain there are no trapped wires and press the end-cap home. If necessary, twist the end-cap slightly to achieve perfect alignment of the screw holes. As you replace the end-cap, the SEP housing may become slightly pressurised which may make the cap difficult to replace. **Do not apply excessive force.**
19. Insert the four M4 × 12mm A4 stainless steel screws and use the 3mm hexagonal key to tighten them evenly. Insert both grub-screws and tighten them lightly.

10.2.2.2 Power Supply Pod

Neither of the PSU end-caps has an obvious point of reference to use for orientation when you reassemble the pod.

Remove the end-cap that has the moulded cable attached:

1. Jack the end-cap off the housing by following the same procedure described above for the SEP. Note that a partial vacuum may form inside the PSU as you remove the end-cap and this may make removal difficult. **Do not insert any hard or sharp instruments into the gap to act as a lever.**
2. Release the single 12-way internal connector by pressing its two side-clips together. Remove the end-cap.
3. Follow the same procedure to remove the other PSU end-cap.
4. Pull the end-cap forward and disconnect the single ground connection at the spade terminal.
5. Pull the end-cap carefully from the body. Save the desiccant pack.

Reassemble the PSU:

6. Check the condition of the two rubber O-rings that seal each of the end-caps. Clean or renew them if necessary. Apply a thin smear of approved lubricant to the rings to ensure they make an efficient seal when you reassemble the PSU. **For this purpose, use the same type of lubricant that you use for the sub-sea electrical connectors – refer to sub-section 4.1.2 for these important instructions.**
7. Insert the end-cap that carries the circuit board first.
8. Reconnect the ground strap at the spade connector and receptacle.
9. Place the desiccant pack inside so that it fits between the card carrier and the PSU housing. Make certain that there are no trapped wires or components and push the end-cap and card carrier home. Ensure that there is nothing to obstruct the free rotation of the small board-mounted fan.

10. Carefully align the end-cap to the PSU housing so that the four securing screws will engage properly. If necessary, turn the end-cap slightly to achieve perfect alignment. Ensure that the two holes for the grub screws align with the hardened stainless steel inserts on the end of the PSU housing.
11. Reconnect the 12-way connector to the other end-cap. Make certain both locking clips engage properly on the connector.
12. Align the end-cap with the PSU housing and push it home. If necessary, twist the end-cap slightly to achieve perfect alignment of the screw holes. As you replace the end-cap, the PSU housing may become slightly pressurised which may make the cap difficult to replace. **Do not apply excessive force.**
13. Insert the four M4 × 12mm A4 stainless steel screws and use the 3mm hexagonal key to tighten them evenly. Insert both grub-screws and tighten them lightly.

10.3 FAULT IDENTIFICATION

The remainder of this section includes advice and a series of flow charts to help you locate a fault in the sub-sea components of the 440 System. The SDC oscilloscope function is a powerful fault identification tool. Refer to the fold-out drawing of Appendix C for some examples of typical waveforms.



TSS has gathered considerable experience with the 440 System in many survey operations and under a variety of conditions and has used this experience to compose the following flow charts.

If your System fails, perform the following checks *before* you call TSS engineers for assistance.

1. Check that you have installed the 440 System correctly according to the instructions in Sections 3 and 4.
2. Check that the configuration of the 440 System is correct. Refer to sub-section 5.3 for details of the System Configuration display.
3. Check that you have connected all cables correctly.
4. Check that the correct electrical supplies are available to the SDC and the PSU.
5. Identify the fault symptoms as clearly as possible, and apply the appropriate fault identification routine from the following list:
 - ❑ Fault on a single channel only – see sub-section 10.3.1.
 - ❑ Communications failure – see sub-section 10.3.2.
 - ❑ Altimeter failure – see sub-section 10.3.3.
 - ❑ Unexpected signal variation during normal operation – see sub-section 10.3.4.

10.3.1 Fault on Single Channel Only

Figure 10-7: Single channel failure – CHART 1

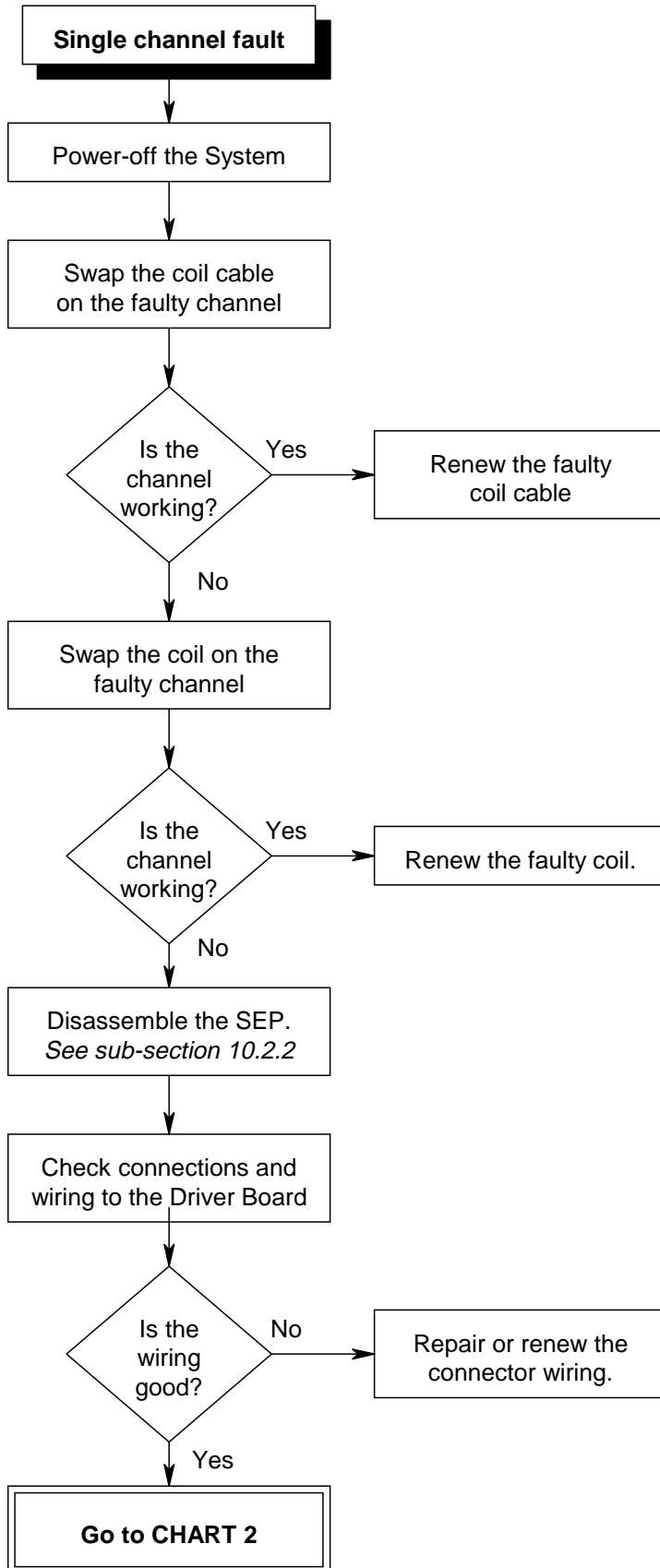
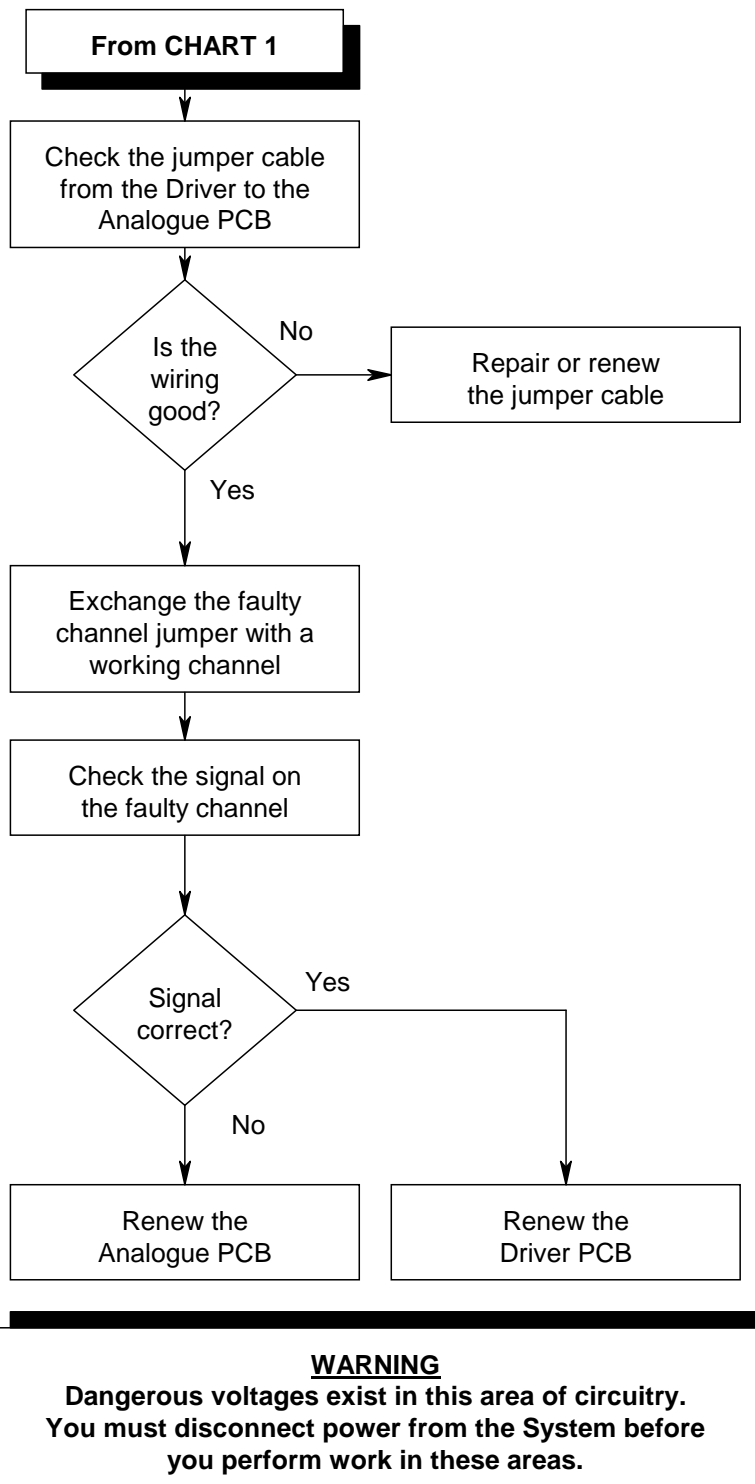


Figure 10-8: Single channel failure – CHART 2



10.3.2 Current Loop Communications Failure

Figure 10-9: Communications failure – CHART 1

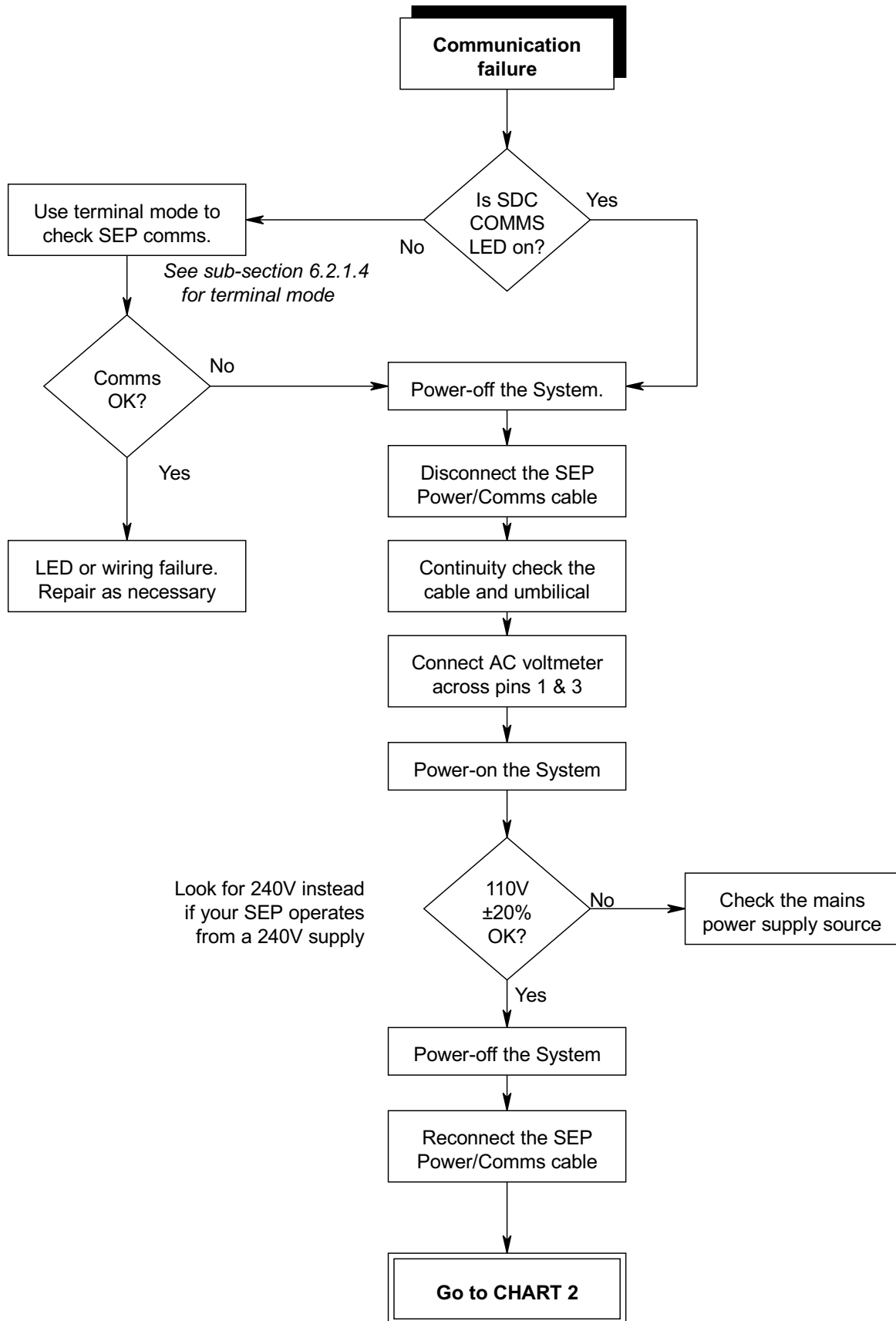


Figure 10-10: Communications failure – CHART 2

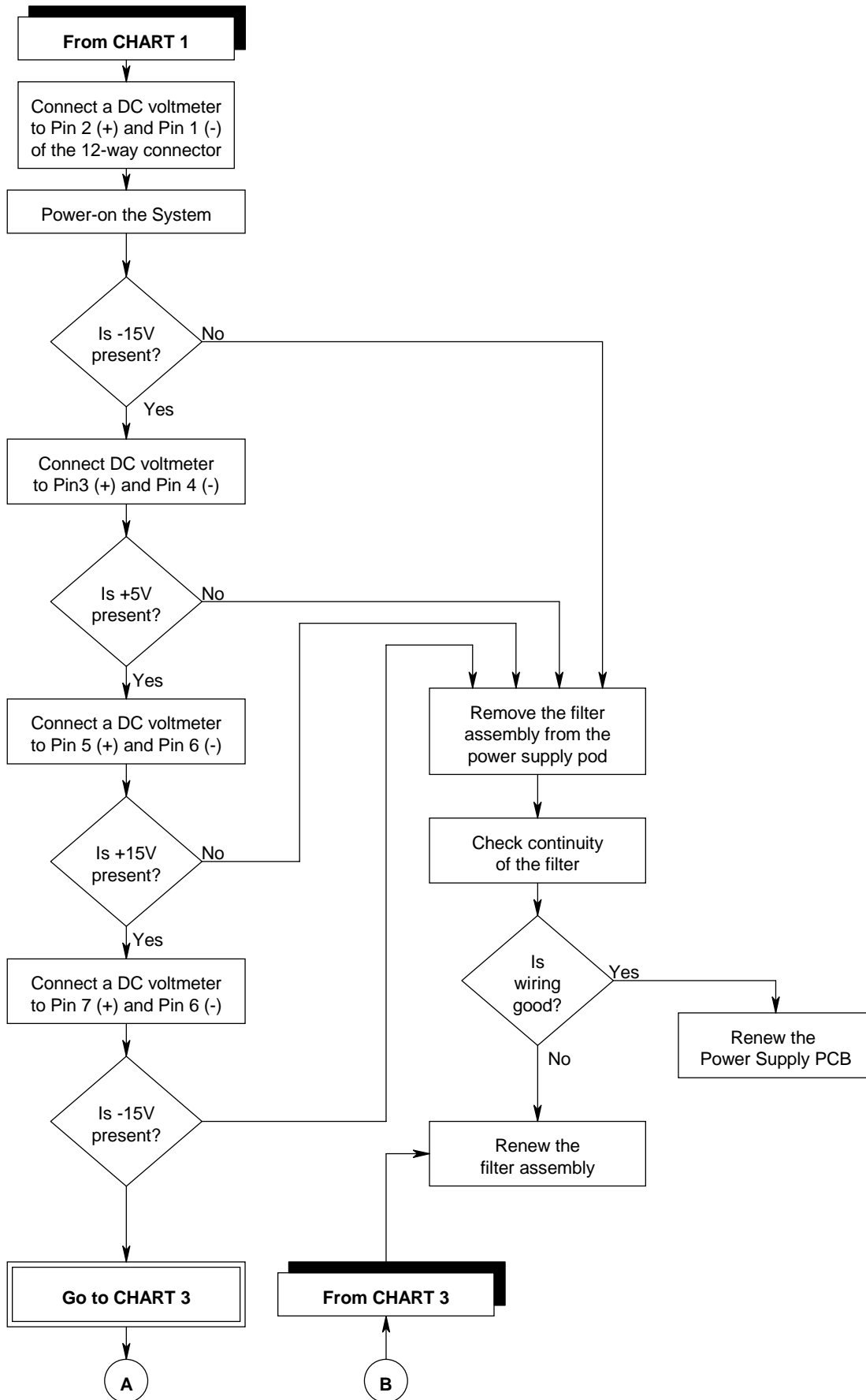


Figure 10-11: Communications failure – CHART 3

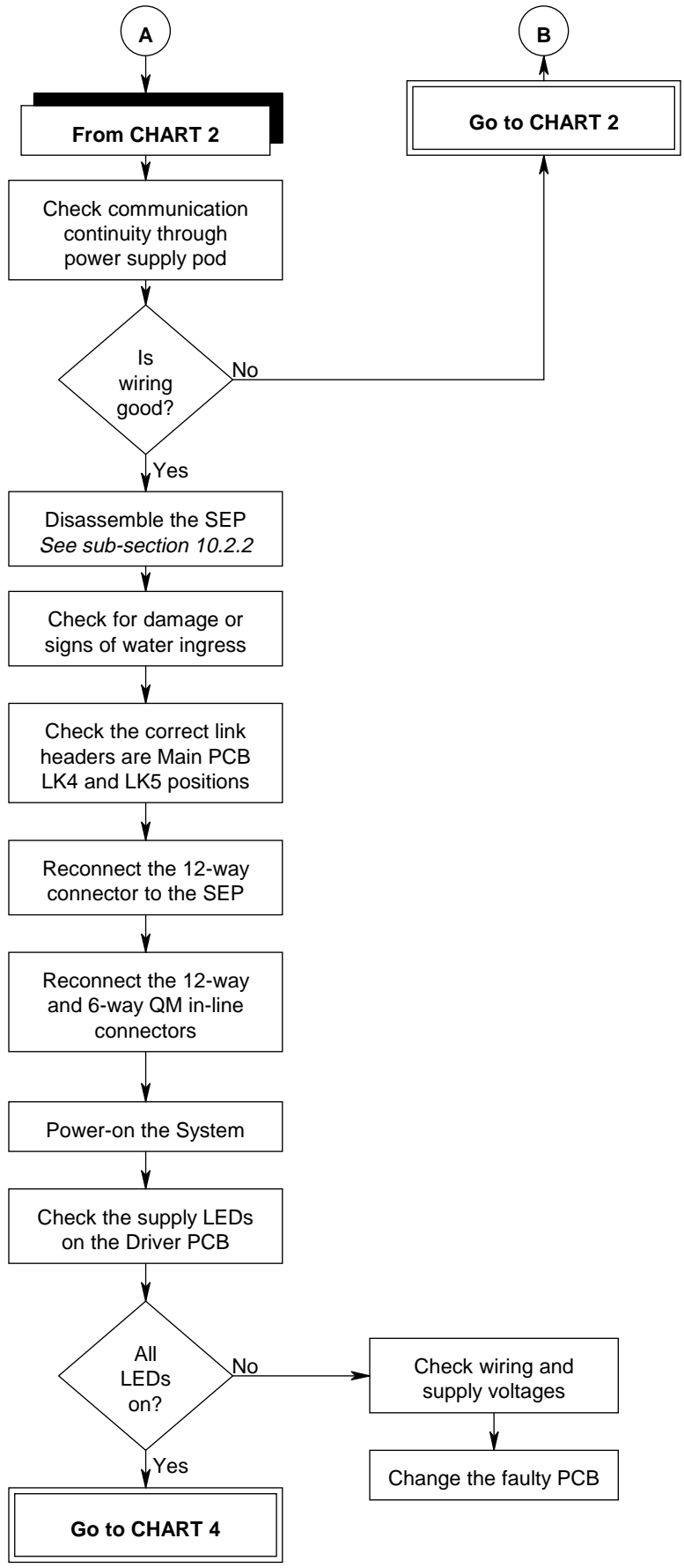


Figure 10-12: Communications failure – CHART 4

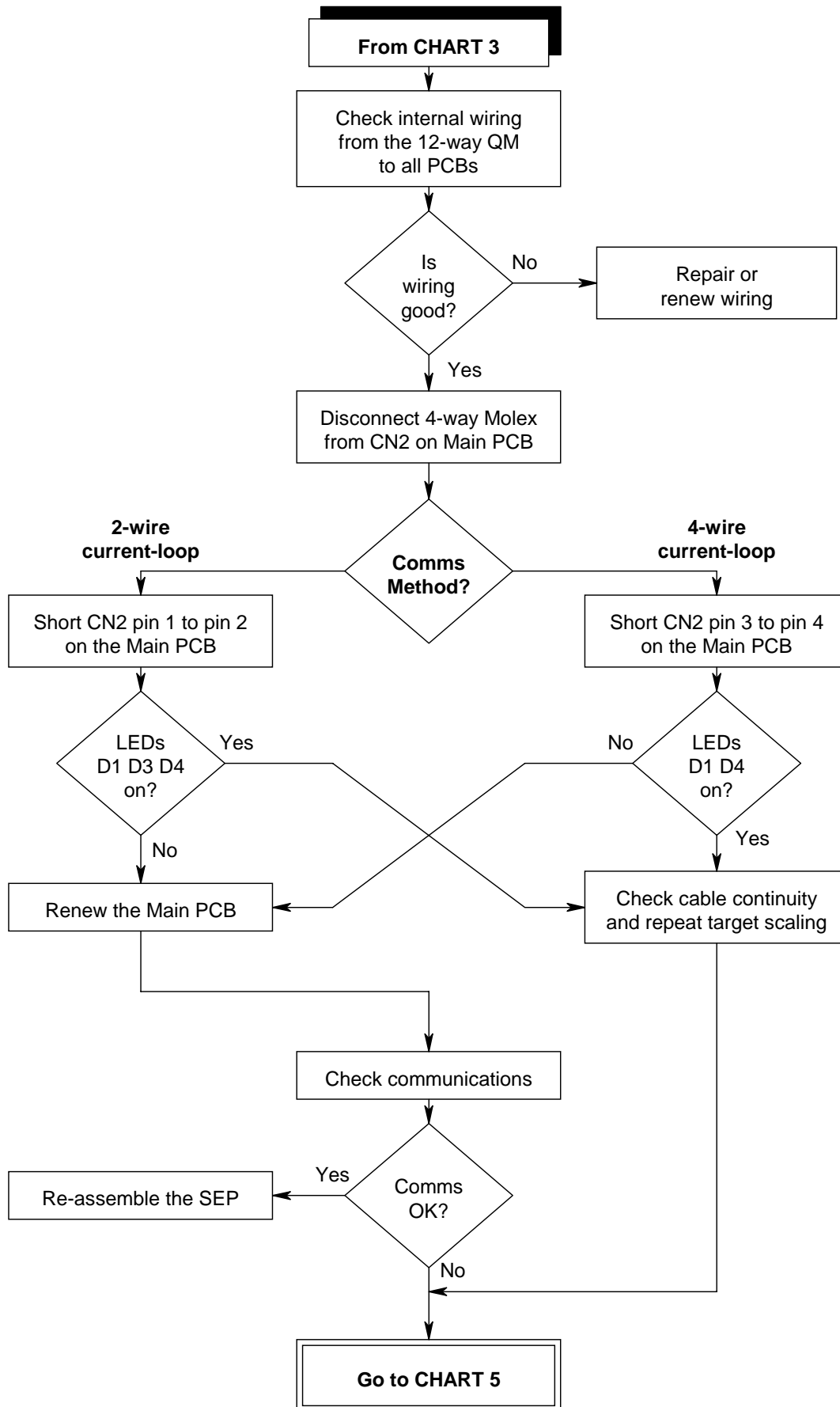
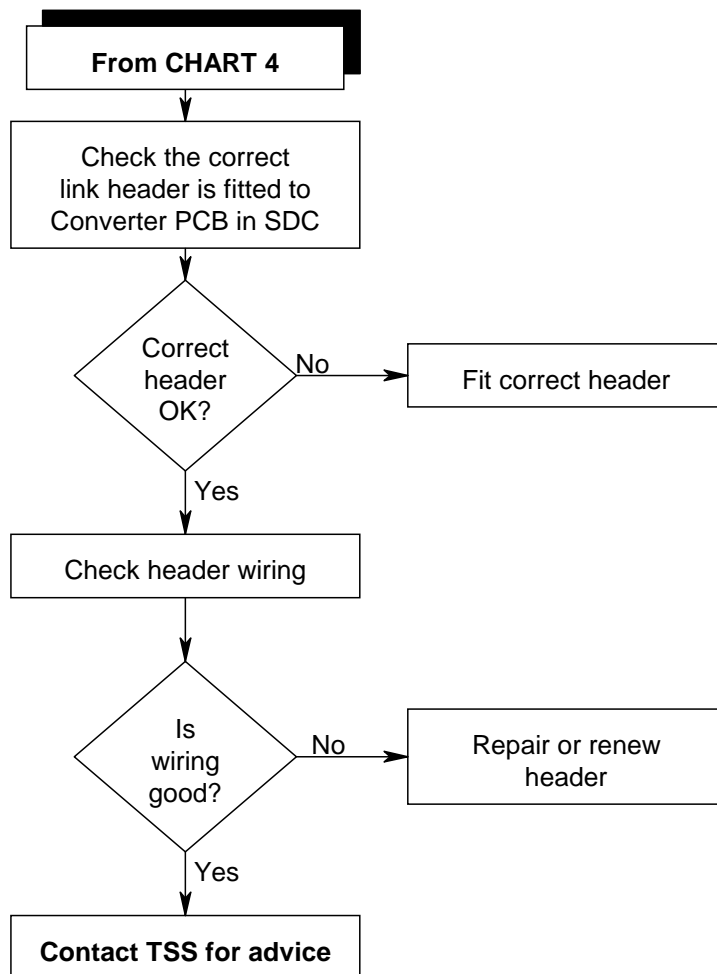


Figure 10-13: Communications failure – CHART 5



10.3.3 Altimeter failure.

These flow charts should help you to identify a fault with the TSS ALT250 altimeter connected directly to the SEP.

If a fault develops when you use an alternative altimeter connected to SDC ‘ALTIMETER’ (COM2), select COM2 from the terminal mode and check the data strings against those listed in sub-section 7.6. Refer to sub-section 6.2.1.2 for details of the terminal mode.

If there are no data strings from the altimeter, check the RS232 parameters and the wiring. Refer to the altimeter manual for specific servicing details.

Figure 10-14: Altimeter failure – CHART 1

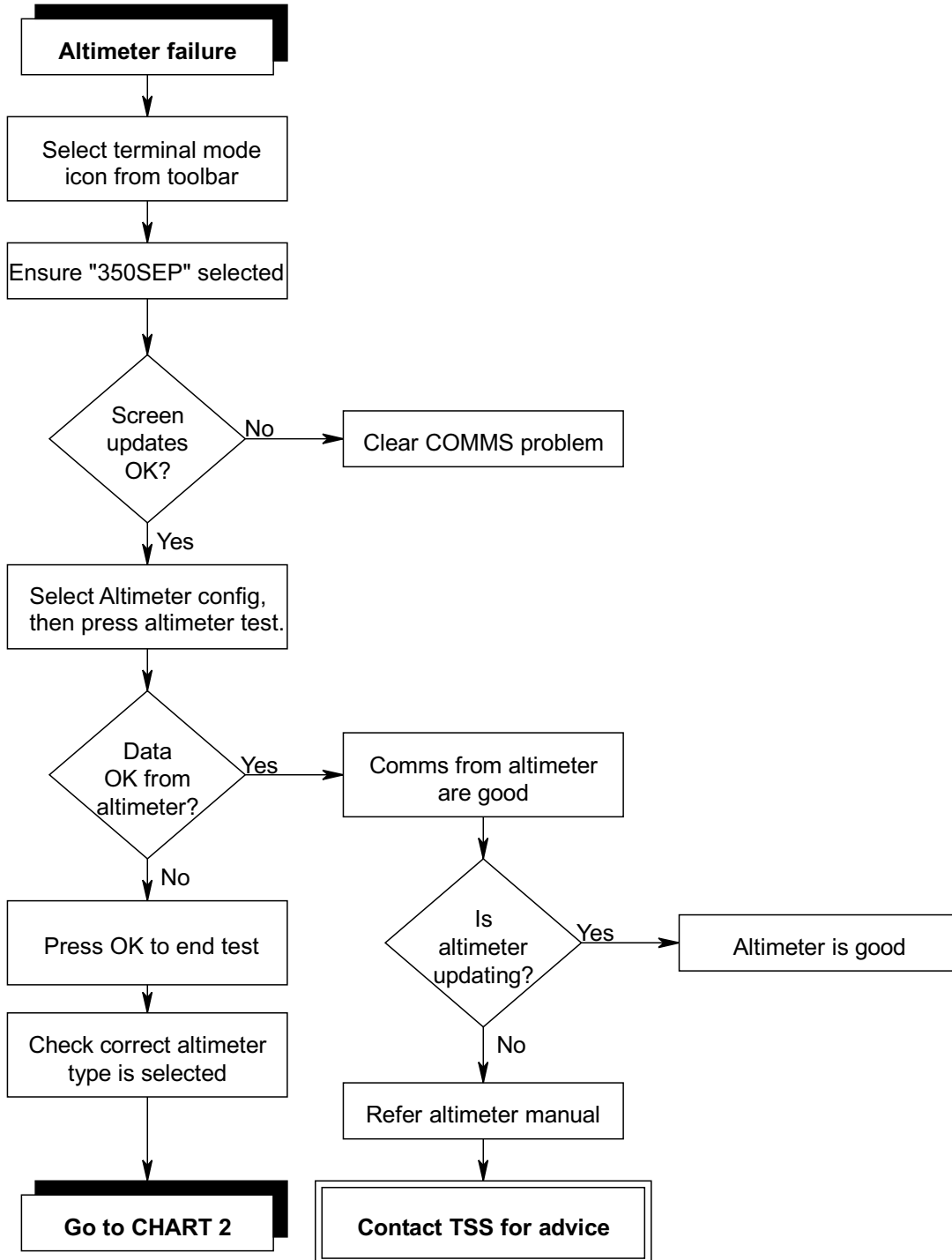
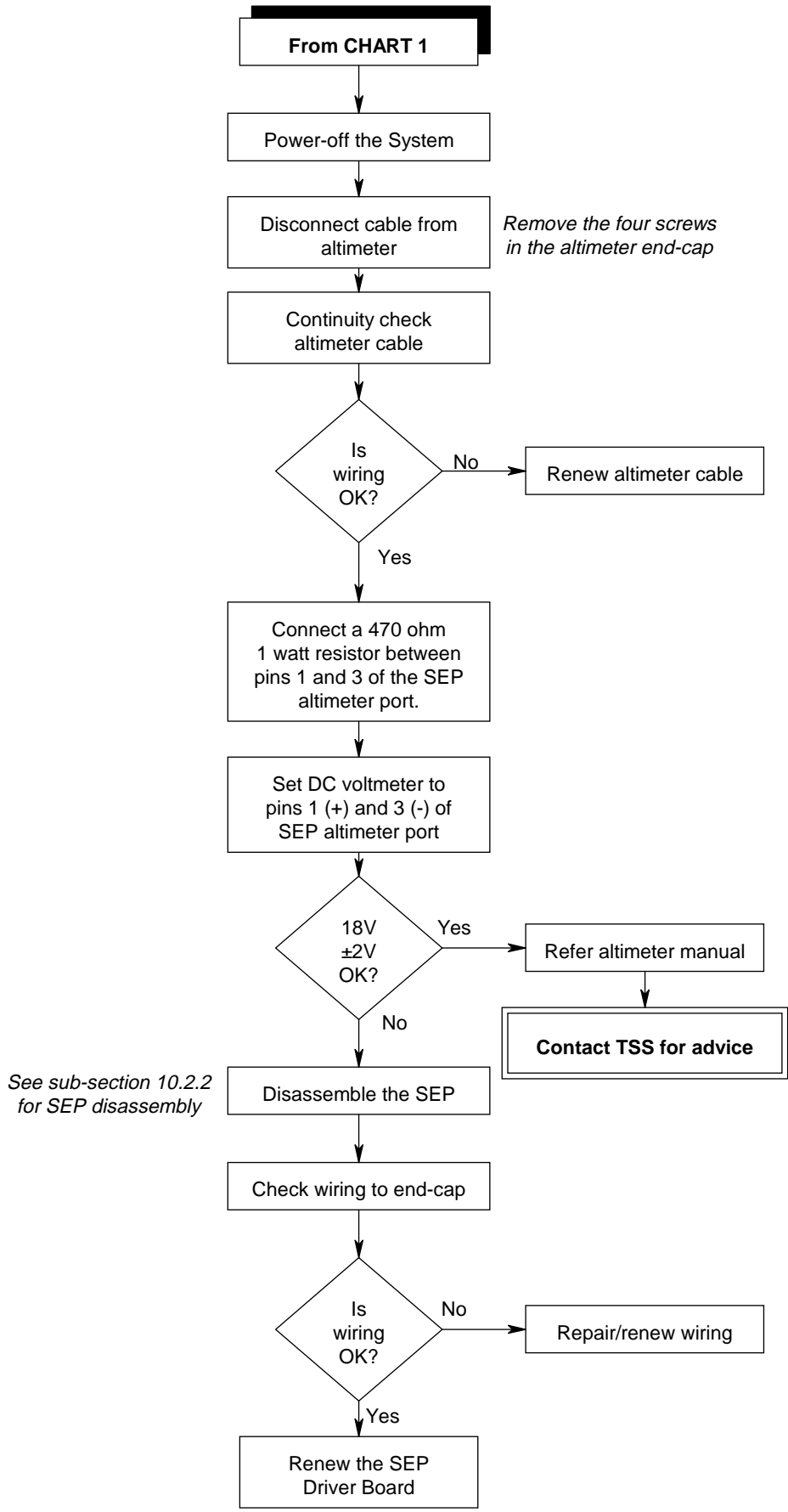


Figure 10-15: Altimeter failure – CHART 2



10.3.4 Unexpected Signal Variation During Normal Operation

Figure 10-16: Signal shifts – CHART 1

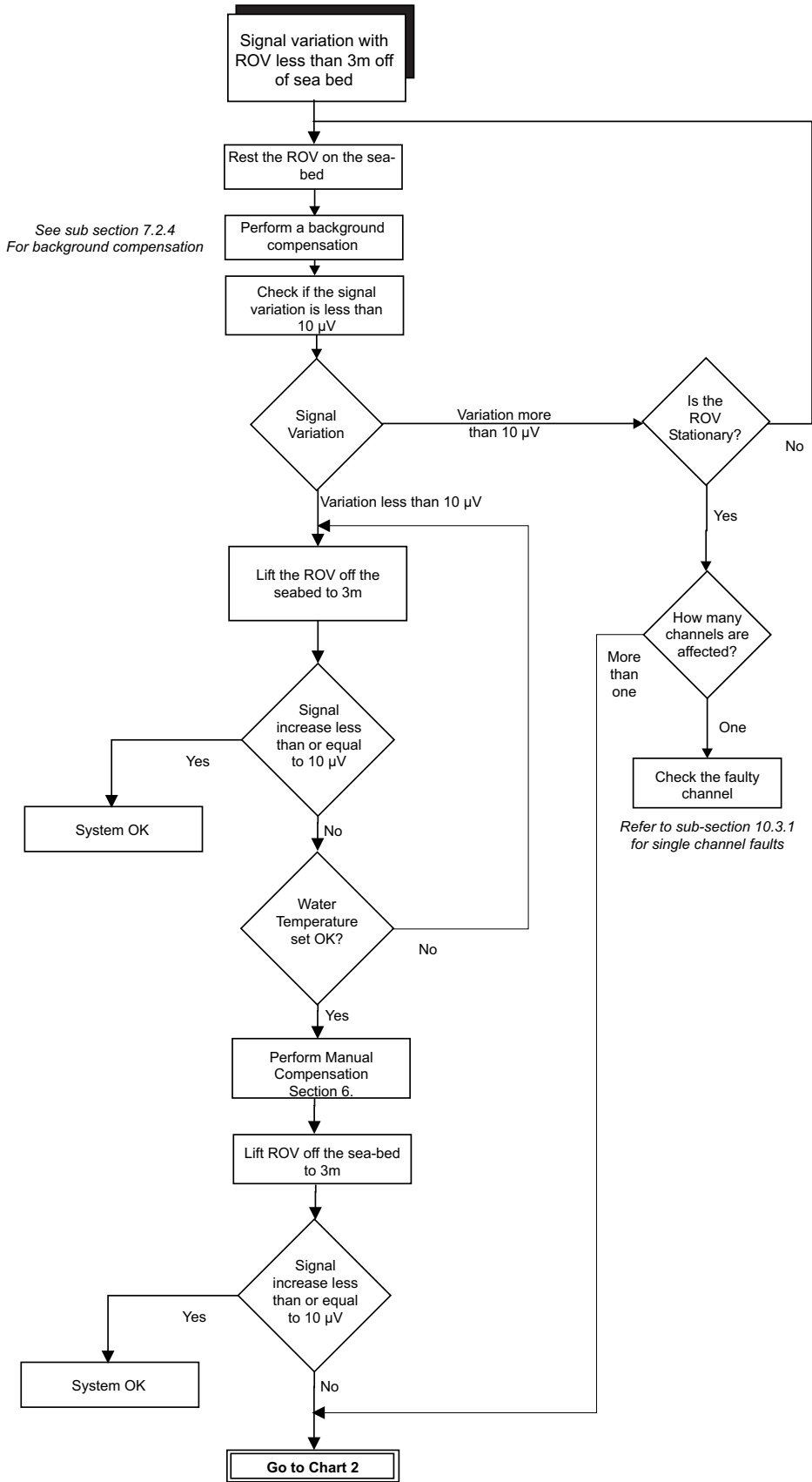


Figure 10-17: Signal shifts – CHART 2

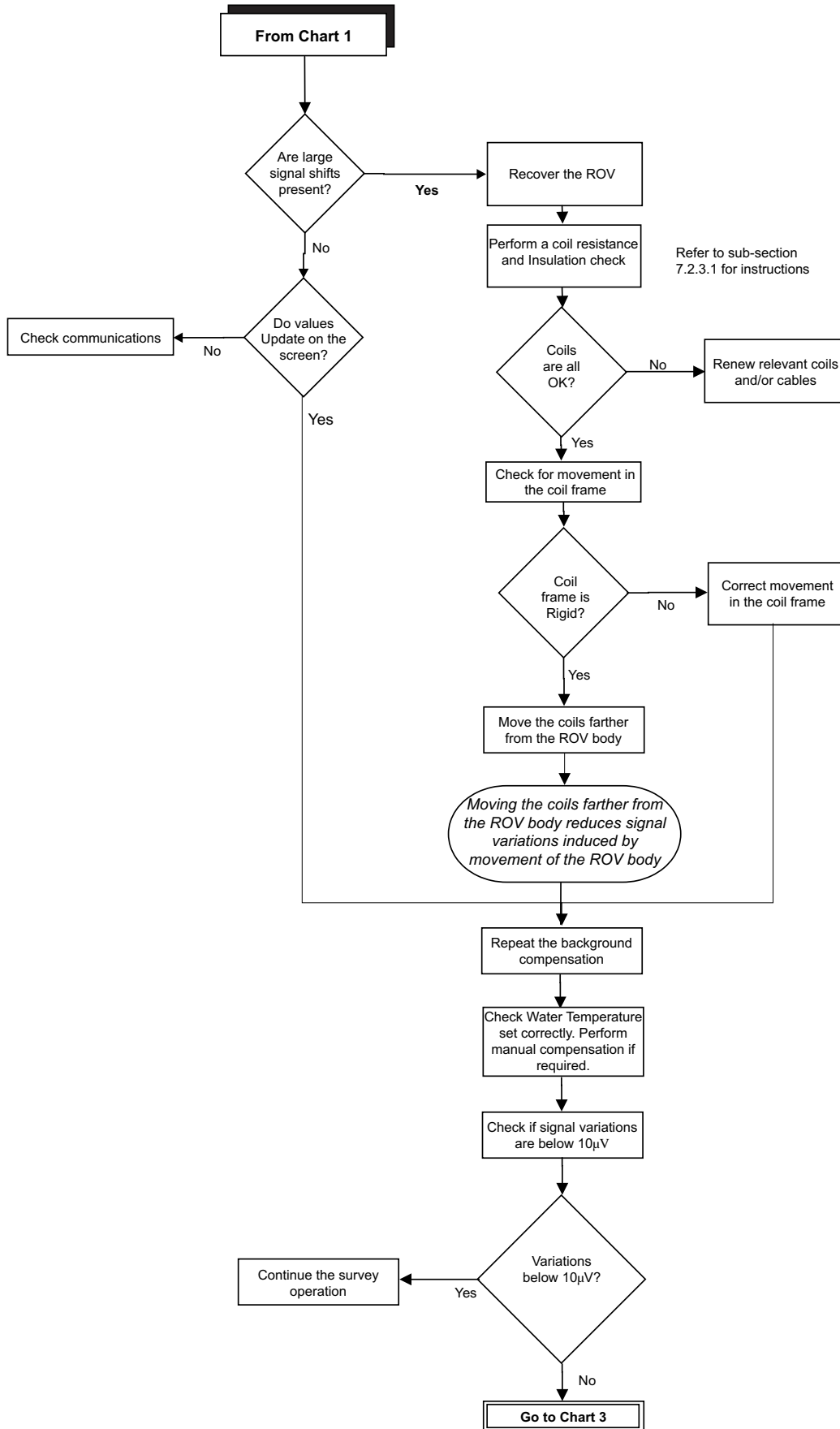
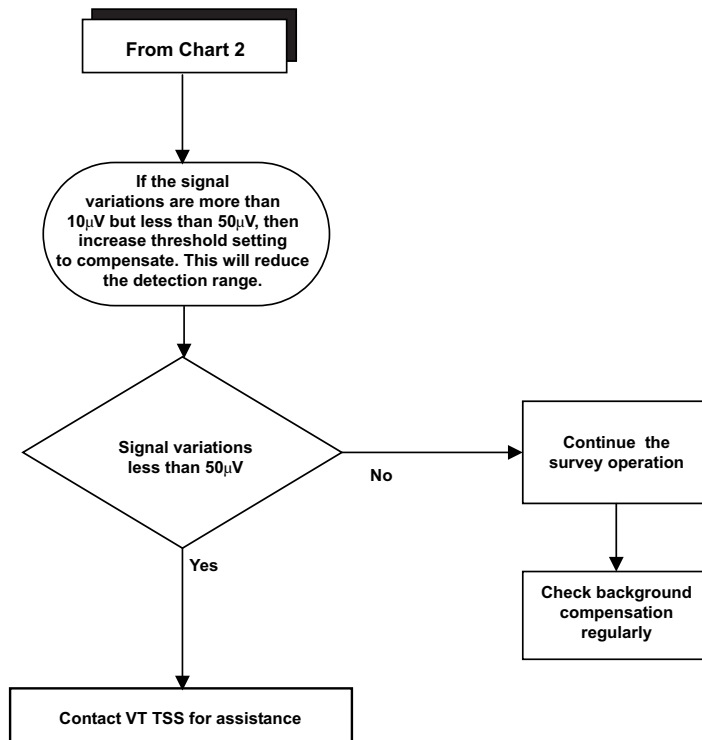


Figure 10-18: Signal shifts – CHART 3



11 SYSTEM DRAWINGS

ELECTRICAL DRAWINGS

Drawing Number	Description
490232 – 1	Sub-sea Electronics Pod
401178 – 1	Main Board
401178 – 2	Main Board – Processor
401178 – 3	Main Board – Analogue AD & DA
401178 – 4	Main Board – Timing & Comms.
401039 – 1	20mA – RS232 Converter PCB
401039 – 2	20mA – RS232 Converter PCB
401086 – 1	Driver Board
401086 – 2	Driver Board – Control
401086 – 3	Driver Board – MOSFETs
401087 – 1	Analogue Board
401087 – 2	Analogue Board – Control
401087 – 3	Analogue Board – Pre-amps
401050 – 1	PSU Filter Assembly
490228 – 1	Power Supply Pod - 110 Volt version

MECHANICAL DRAWINGS

Standard Product Drawing Number	Description	Stainless Steel Drawing Number*
400604 – 1	Power Supply Chassis Assembly	400646 – 1
400667 – 1	Main Chassis Assembly	400668 – 1
400667 – 2	Main Chassis Assembly	400668 – 2
401086 – 1	Driver PCB Assembly	
401087 – 1	Analogue PCB Assembly	
400654 – 1	PSU Filter Assembly	400655
490232 – 1	Processor Pod Assembly	490233
490228 – 1	Power Supply Pod Assembly - 110 Volt version	490230
500045 – 1	Coil Mounting Frame	
503009 – 1	Coil Assembly	
601004 – 1	Coil Cable Assembly – 4.0m standard	
601108 – 1	ROV Tail Assembly – 3.0m standard	
601824 – 1	TSS Altimeter 250Cable Assembly – 3.0m standard	
601203 - 1	Benthos Altimeter Cable Assembly – 3.0m standard	
500268 - 1	440 Pipe and Cable Survey System Complete Assembly	

* Stainless Steel Drawing Numbers included in this table for information only. For details and specification see the corresponding Standard Product Drawing Number.

A OPERATING THEORY

The 440 System locates a target by:

1. Inducing a pulse of current in the conductive material of the target.
2. Using three independent coils to detect the magnetic fields associated with the currents induced in the target.
3. Calculating the position of the target from the relative strengths of the signals on each channel.

The Pulse Induction method of target detection, used by the TSS 440 System, provides considerable advantages over alternative magnetometer-based systems:

- ❑ Pulse induction can detect almost any type of conductive material – not just ferrous metals.
- ❑ Terrestrial magnetism has no effect upon the measurements.
- ❑ The System can compensate electronically for the proximity of the ROV body, regardless of its magnetic heading.
- ❑ The System uses a simplified scaling procedure that allows a high degree of measurement accuracy and stability.

This appendix describes the technique of Pulse Induction, and the method used by the 440 System to derive the signal strength and the target co-ordinates.

A.1 Pulse Induction

Page 2

The 440 System uses pulse induction techniques to cause a momentary current to flow in the target.

A.2 Waveform Measurement

Page 3

Once the System has induced the current pulse into the target, it applies powerful signal processing techniques to detect and locate the target relative to the coil array.



A.1 PULSE INDUCTION

Because of the special characteristics of 316 stainless steel, it is very difficult to establish strong eddy currents in this material. For this reason, you would experience considerable difficulties in detecting targets made exclusively from 316 stainless steel.

A current flowing through any coil will create a surrounding magnetic field. The strength of that field at any instant in time will be proportional to the instantaneous magnitude of current. If the current in the coil changes, the strength of the magnetic field will vary in proportion to the changes in magnitude of coil current.

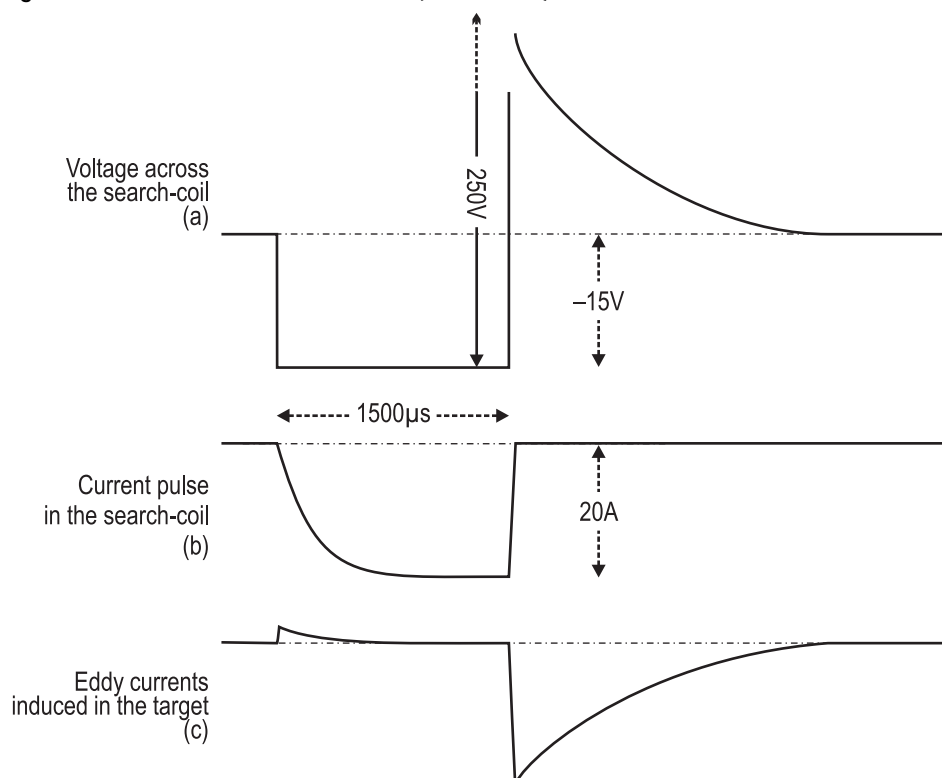
These variations in magnetic field strength will induce voltages in conductive targets that lie near the coil. The magnitude of eddy currents that flow in the target because of these induced voltages will depend upon two factors:

- The electrical characteristics of the target material.
- The rate at which the current in the coil changes.

Any eddy currents flowing in the target material will produce magnetic fields of their own and these 'secondary' fields will induce a measurable voltage in the coil as they change.

The 440 System uses this principle to detect the presence of conductive material near the search-coils. See Figure A-1, which shows a single cycle of measurement on one channel:

Figure A-1: Pulse induction waveforms (not to scale)



In Figure A-1(a) a voltage pulse of amplitude -15V and width $1500\mu\text{s}$ drives current into a single search-coil. The polarity is not important for the purposes of this explanation.

The current flowing in the coil rises in a logarithmic manner, as shown in Figure A–1(b). The SEP limits this current to a maximum of 20A.

At the end of the 1500µs ‘drive’ period, the SEP removes the voltage drive to the coil and the current begins to fall rapidly – though not instantaneously – towards zero as shown in Figure A–1(b).

The surrounding magnetic field collapses very quickly as the coil current falls towards zero. This rapid change of magnetic field induces eddy currents in nearby conductive targets, and the magnetic fields associated with these eddy currents induce a voltage in the coil. See Figure A–1(c).

Because the current changes at a much higher rate at the end of the drive pulse than at the start, the eddy currents are much stronger while the current decays to zero.

The initial high voltage peak (250V) that occurs in the coil immediately after the end of the drive pulse is due largely to the self inductance of the coil.

After the initial voltage peak, the shape of the decaying waveform will depend upon the nature and the proximity of any nearby conductive material. The 440 System uses this feature to determine the range between the coil and the target.

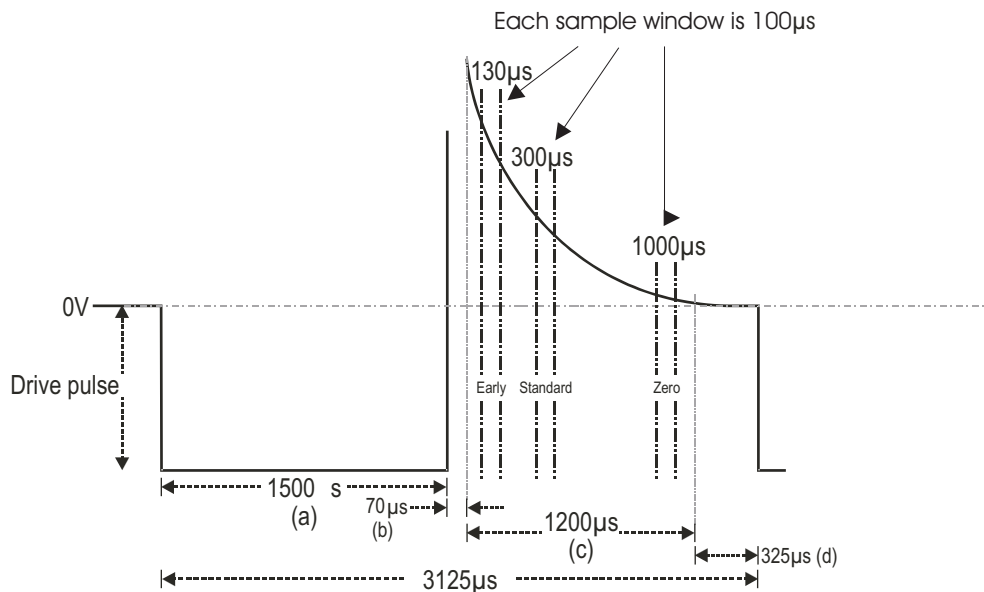
A.2 WAVEFORM MEASUREMENT

By making measurements upon the decaying part of the voltage waveform, the 440 System measures the range between each search-coil and any conductive target nearby.

A.2.1 Timing

Timing during each cycle of measurement is an important consideration:

Figure A–2: Timing relationship for a single cycle of measurement



Each measurement cycle starts at the beginning of the voltage drive pulse – see Figure A–2. This pulse lasts for 1500µs while the current flowing through the coil rises as shown in Fig A–1(b).

At the end of the 1500 μ s pulse, the SEP removes drive voltage from the coil. As the magnetic field collapses with the current, self-inductance causes a 250V spike to appear across the coil windings with a polarity opposite from that of the original drive pulse.

The 440 System waits for a further 100 μ s to allow the voltage spike to decay and to allow the effects of sea water to dissipate. The System then begins a 1200 μ s sampling period as shown at Figure A–2(c). During this period the SEP makes 300 measurements at intervals of 4 μ s and digitises these to 12-bit accuracy before storing them in a buffer memory.

Within the sampling period there are three regions, each of which is 100 μ s wide:

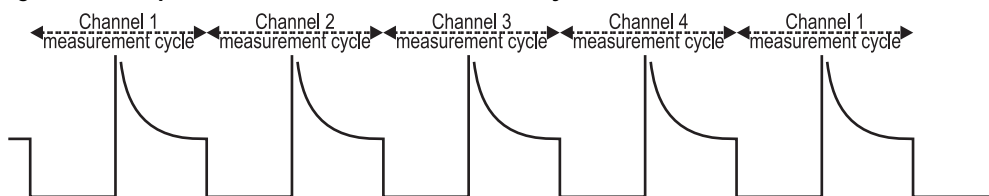
- **Sample Region 1 – ‘Early’**
This region begins 130 μ s after the beginning of the sample period and provides the ‘early’ level for the channel. The SEP calculates and stores the average value of the 25 individual samples taken within this region
- **Sample Region 2 – ‘Standard’**
This region begins 300 μ s after the beginning of the sample period and provides the ‘stand-ard’ level for the channel. The SEP calculates and stores the average value of the 25 individual samples taken within this region.
- **Sample Region 3 – ‘Zero’**
This region begins 1000 μ s after the beginning of the sample period and provides the ‘zero reference’ level. The SEP calculates and stores the average value of the 25 individual samples taken within this region.

At the end of the sampling period, there is an interval of 325 μ s while the SEP performs calculations on its measurements. Sub-section A.2.2 explains how the 440 System derives the signal voltage from these measurements for use in the calculation process.

The SEP applies this measurement cycle to each channel sequentially as shown in Figure A–3.

The measurement cycle for each channel lasts a total of 3125 μ s. With measurements repeated on four channels, it follows that the SEP measures each channel every 12500 μ s, or 80 times per second.

Figure A-3: Sequence of consecutive measurement cycles



A.2.2 Derivation of Signal Voltage

After the SEP has measured each channel eight times, it determines the mean value for the eight preceding occurrences of Sample Region 1 and Sample Region 2. It then subtracts the mean value for Sample Region 3 from the mean values for Sample Region 1 and 2, and this final figure represents the two signal voltages for the specific channel.

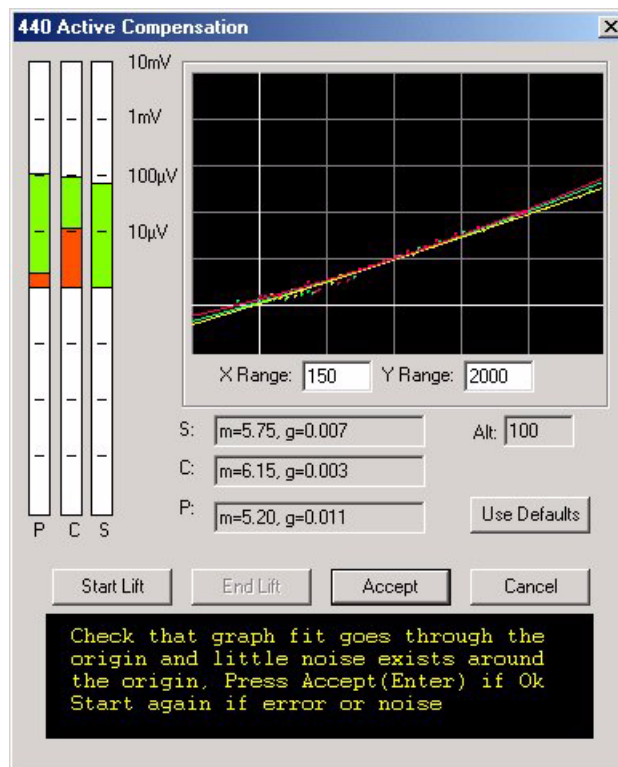
Each channel therefore has its signal strength values updated ten times per second.

A.2.3 Seawater Rejection

A.2.3.1 Introduction

The TSS 440 system represents a considerable advance over the familiar 340 system in that signal processing routines are used which can discriminate between seawater and metallic targets. This discrimination is important, because the seawater response seen by the coils varies with the height of the vehicle above the sea bed. This variability means that it cannot be rejected by the simple background compensation routines used in the 340.

Refer to Section 7.3.4 for an explanation on Seawater Temperature and setting it correctly.



The seawater signal, to the 340's search coils, looks similar to a target. This means that as the vehicle is lifted off the seabed, a voltage over and above the target signal is seen. This voltage could easily be interpreted as a change in the target's position. To correctly interpret the coil signals, it is assumed that this extra seawater signal affects all three coils equally. By comparing voltages between the centre and starboard, and centre and port pairs of coils, the effect of the seawater can be minimised. The main drawback of this approach is that it limits range.

The TSS 440 system uses an active compensation method to remove the seawater signal from the coil voltages. This allows a more flexible means of determining range to be used, which provides both increased accuracy at short ranges and up to a 40% improvement in ultimate range. Also, effects due to the three coils receiving different seawater signals are minimised.

A.2.4 Compensation: How it Works

The TSS 440 uses two separate methods of compensation: background and seawater (active). Background compensation removes contributions to the signals which do not vary with altitude, for example the ROV and the metal in the coil connectors. These effects are accounted

for by a compensation procedure with the vehicle on the sea bed. The coil voltages reported at the SDC also provide a useful check as to whether the system is operating correctly.

Technically, background compensation is the recording of the coil voltages with the vehicle stationary. These voltages are then subtracted from subsequent readings.

The system measures the coil voltage at three points. This yields two voltages, termed "early" and "standard". The "early" voltage will be more sensitive to both target and seawater than the "standard" voltage. The "early" voltage will be approximately 20 times more sensitive to seawater than the "standard" voltage. However, it will be only three times more sensitive target signals. It is this different sensitivity is exploited to remove the seawater signals.

To remove the seawater contributions from the coil signals, two calibration constants are needed. The first of these is a linear correction (typically 17-20) which states how much more sensitive the "early" window is to seawater. A second (quadratic) correction is also needed, and has a value of perhaps -0.05.

The determination of the seawater calibration factors is known as "active compensation". It is a similar process to the ground compensation used in some metal detectors. The coil voltages are recorded as the vehicle is lifted up from the seabed and plotted on a graph. The calibration values are determined from the shape of this graph.

The system is supplied with three sets of constants suitable for most regions of the world. Since the water conductivity is determined mainly by temperature, the user need select only the approximate water temperature.

A.2.4.1 Background Compensation

The first stage after deploying the vehicle is to place it on the seabed. The area chosen should be flat and well away from any trenches, vertical rock faces. It is imperative that area chosen is completely free of any metallic debris or buried objects. Any manipulators or moveable items should be folded away from the coils, and not moved until the survey is complete.

Then, the background compensation is begun. The subsea system averages the two coil voltages and reports them to the SDC. They are then stored and automatically subtracted from the reported coil voltages.

When performing this compensation, the "standard" sample voltages should be less than $1000\mu\text{V}$, and not vary by more than $200\mu\text{V}$ between coils. Excessive voltages, or large differences between coils can indicate that the coils are mounted close to the vehicle, the presence of metallic objects in the sea bed, or a failure of one of the detection coils. The "early" coil voltages will be typically 5 times greater due to the increased sensitivity.

Once the background compensation is completed, then the coil voltages should all be reported as zero. This indicates that the subtraction has been carried out correctly. Then, the active compensation can be performed.

A.2.4.2 Active Compensation

The SDC software provides an "Active Compensation" dialog which can perform this procedure if required. The screen has three main areas: the coil voltage indicators, the graph and the results. The coil voltage indicators show the actual signals coming from the coils in real time;

both the "early" and "sample" voltages are represented as green and red respectively. These voltages are quite distinct from those presented on the run/display screen which show the remaining target voltage after the seawater signals have been removed.

At this stage, the voltage indicators should all read zero. If they do not, then the background compensation was not carried out correctly, or the vehicle has moved since the compensation was carried out.

The graph area shows the relation between the "early" (y- axis) and "standard" (x- axis). After pressing the "Start" button, the vehicle is then lifted from the sea bed to an altitude of approximately 5m. This height need not be accurately measured: if an altimeter is not available the vehicle is merely lifted until the "standard" voltage reaches $120\mu\text{V}$ in temperate regions and $250\mu\text{V}$ in the tropics. The vehicle should be lifted as smoothly as possible, and the lift should take approximately 30s to reach 5m. As the vehicle moves, points will be plotted on the graph.

The scale of the graph can be changed by the user. The routines only analyse the data which is visible within the black area of the graph. The "x scale" and "y scale" values can be decreased to zoom in on the graph, but should immediately returned to 150 and $1000\mu\text{V}$ respectively. This ensures that the complete lift curve will be analysed. In conditions of increased seawater conductivity, this scale may not be sufficient to assess the whole curve, and must be increased.

When the vehicle has reached sufficient height, the "stop" button can be pressed. Then, the graph can be assessed. It should show a smoothly rising curve which passes through the origin, as shown in Figure A-4. If the background compensation was not correctly carried out, then the graph will not meet the origin, as shown in Figure A-5. A small y- intercept ($50\mu\text{V}$) can be tolerated, since it is the gradient of the curve which is important.

Figure A-4: A perfect lift with the results passing through the origin

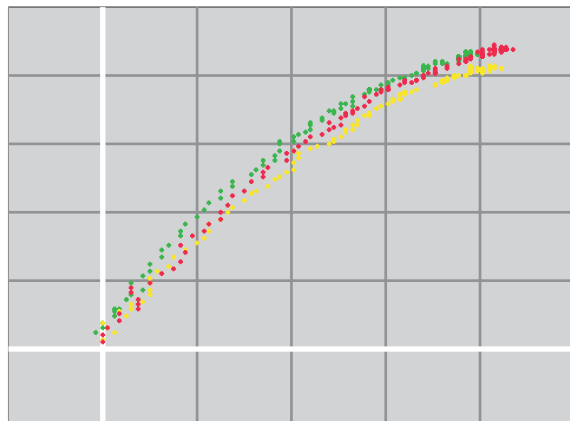
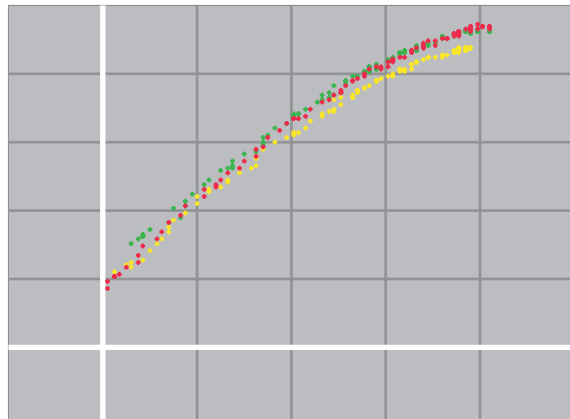


Figure A-5: Example of poor background compensation



If metal is present on the sea bed, then the graph will not move smoothly away from the origin as the vehicle is lifted. This is shown in Figure A-6. This will have a detrimental affect on the accuracy of the calibration values and could ultimately lead to incorrect survey data. More importantly, it indicates that the background calibration will not be valid, and must be repeated. Figure A-7 shows another effect due to the coils moving as the vehicle was lifted. The vehicle was not lifted smoothly, resulting in missing points in the middle of the graph.

Figure A-6: Example with metal present on the seabed during compensation

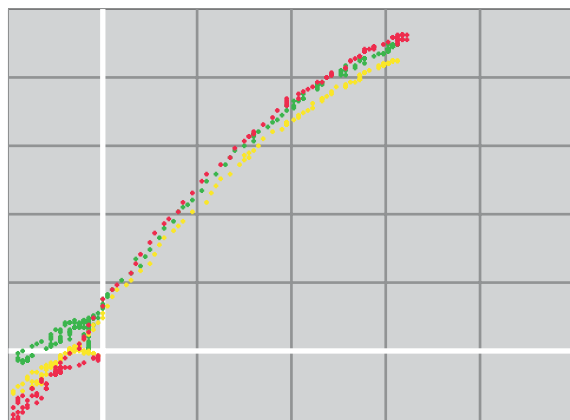
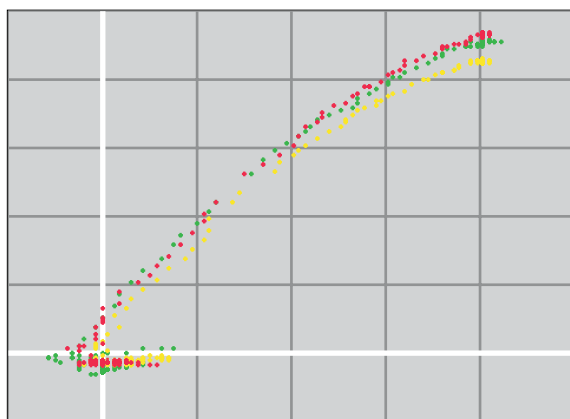


Figure A-7: Example where the vehicle was not moved smoothly



The "active compensation" window will automatically make a best fit to the vehicle data. This curve will be overlaid on the scattered points. The resulting parameters in the results section at the bottom of the screen. The linear parameter, m , should be in the region 10-20, and the quadratic parameter should be approximately -0.05. A curvature opposite to that shown in Figure A-4 or an unexpected value of m indicates that the calibration was not carried out correctly or the subsea electronics have failed in some way.

A.2.4.3 Checking the Rejection

If desired, the system's rejection of seawater can now be seen. Returning to the run/display screen, the target voltages are displayed. With the vehicle still 3m above the sea bed, these should be within a few μV of zero. If the vehicle is now slowly dropped to the seabed, then the target voltages should remain close to zero. They may deviate slightly in either a positive or negative sense, but should remain much less than the signal threshold of $15\mu\text{V}$.

If the voltages change suddenly when the vehicle lands on the sea bed, then this may be due to either detection of a metal object, or the coils not being firmly attached to the vehicle. Significant changes will reduce the accuracy of the survey data when operating close to the ultimate range of the system. The TSS 440 system operates at much greater survey ranges and this places stringent requirements on the background compensation and the rigidity of the coil mounting frame.

If the voltages vary when the vehicle is some way above the sea bed, then this is most likely due to an error in the active compensation procedure. It must be repeated, perhaps on a slightly different area of the seabed.

A.2.4.4 Rejection Parameters

The rejection values, once determined, should last the length of the survey. However, it is sensible to check that seawater signals are correctly rejected in the way described above once every half hour. The SDC software will generate a reminder every half hour. The background compensation must be repeated, but is sufficient merely to check that the active compensation is still correct.

The rejection values are determined by many factors, but the most important of contributions are due to the conductivity of the seawater and the overall water depth. The relations between the values and water depth is non linear, and changes more steeply at shallow water depths. For this reason, if the survey begins in deep water but moves into shallow water (e.g. when following a pipeline inshore) the calibration must be more frequent. However, at water depths of 50m or greater, the values will no longer be affected by depth.

The effect of seawater conductivity is more difficult to compensate for, since it can vary in an unpredictable way. In deep water (>100m) the conductivity (determined by salinity and temperature) will be nearly constant, and should have little effect. However, if the survey crosses the thermocline or will approach areas of different conductivity such as vents or fresh water outfalls, then the active compensation will need to be checked more frequently.

If a conductivity probe is available on the vehicle, then any changes will be apparent to the users. A change of more than a few mS/cm may necessitate recompensation. If it believed that the conductivity has changed, then the rejection can be checked as described above.

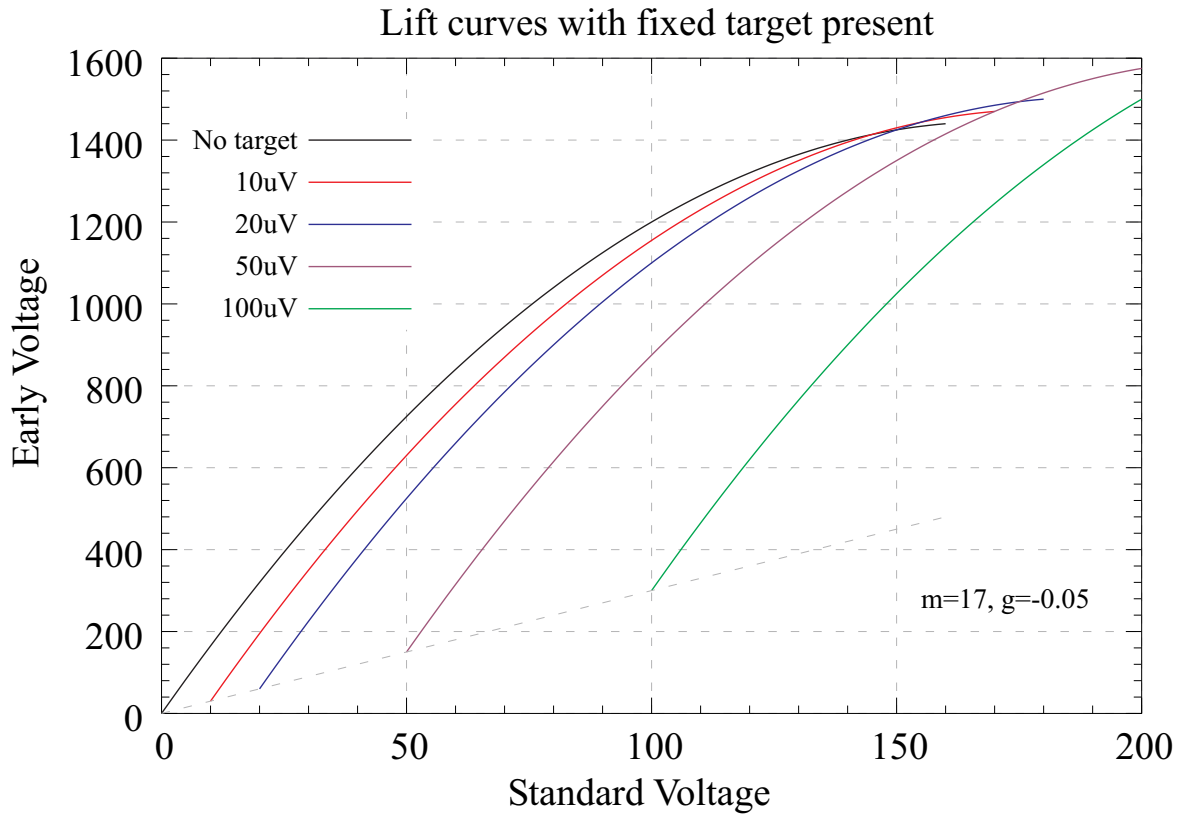
A.2.5 Trenching Vehicles

In the case of a crawling ROV, it may not be possible to lift the vehicle off the seabed. However, very good survey information can still be obtained merely by selecting the correct water temperature.

A.2.6 Limitations

Figure A-8 shows typical lift curves with a fixed target is present. Although this situation does not appear when surveying, it shows how the software has to separate the seawater and target components of the returned voltages. The solid curve ("No target") shows a seawater lift curve with only seawater present. If a $10\mu\text{V}$ target signal is present, then this curve will be repeated, but shifted $10\mu\text{V}$ to the right, and $30\mu\text{V}$ upwards. At an early voltage of approximately $140\mu\text{V}$, this curve crosses the "No target" curve.

Figure A-8: Typical lift curves with a fixed target present



This means that if the seawater rejection mechanism is faced with early and standard voltages of 140 and 1450 μ V, it will be unable to decide if a target is present or not. This means that at 140 μ V of seawater, the algorithm will not work correctly and return a less accurate value for range. However, this point occurs only when the ROV is approximately 4m above the seabed, well beyond the range of a typical survey.

In more conductive water, the seawater parameters change, and the crossing point moves to perhaps 250 μ V. The increase in seawater signal means that the point where the algorithm begins to break down remains at roughly 4m.

A sudden jump in the target voltages when the ROV is lifted is to be expected, and is not due to a deficiency in the system or its configuration.

A.2.7 Range Determination

Once the seawater signal has been removed, the target voltage is interpreted to give the distance between the coil and the target. This voltage falls off according to an approximate sixth root law. The voltage is first divided by the target scaling value. The exact algorithm used to determine range is beyond the scope of this manual, since correcting for the exact nature of the coil response is complex.

When the target is close to the coils, all three coils are used to determine the position. The differences between the port and centre, and starboard and centre coils are taken then used to compute range. If the sum of these differences is less than the threshold, or any coil is less than the threshold, then only two coils are used to make the calculation. The two coil calculation is also able to adapt to the position of the target, using the centre and one other coil at larger lateral ranges.



B OPTIONS

The description throughout the main part of this Manual relates to the standard 440 Pipe and Cable Survey System. Such a System provides all the facilities you will need to survey a target lying on or buried beneath the seabed.

For some applications, the 440 System may be more effective if you specify it with one or more of the available options.

This appendix describes the options that TSS can supply for use with the 440 Pipe and Cable Survey System:

- ❑ Analogue output feature
- ❑ Combined ‘Dualtrack’ installation with a TSS 350 System
- ❑ Engineer training

B.1 Analogue Output

Page 2

An analogue output option is available for use with ROVs that have an automatic steering facility.

B.2 Dualtrack System

Page 6

To provide a survey system that has greater flexibility, the 440 System can be connected to a TSS 350 Cable Survey System. Combined operation of the two Systems extends the range of applications for which either System can be used.

B.3 Training

Page 16

TSS offers comprehensive operator and engineer training for the 440 Pipe and Cable Survey System.

B.1 ANALOGUE OUTPUT

The Analogue Output option allows the 440 System to produce an analogue output voltage that varies in amplitude and polarity with the lateral offset of the target. You may use the analogue signals from the SDC as the input to an automatic steering control system on a tracked ROV.

The option comprises the following items:

- An analogue output card installed inside the SDC.
- An internal cable to take the analogue output to the rear connector panel
- An output connector and cable. One end of the cable has open tails to allow connection to the ROV control system.

B.1.1 Analogue Output Specification

- User programmable scaling with a default value of 1V/m.
- User programmable trim configuration, in metres. The SDC adds this automatically to the lateral offset of the target *before* it applies scaling.
- User programmable polarity – a positive output voltage may represent either port or starboard steering as required.
- The analogue output updates five times per second.
- Analogue resolution of 5mV from a 12-bit DAC.
- The System can suppress analogue output channel 'A' automatically if it receives bad data. If configured in this way, on receipt of bad data, output 'A' will be zero whatever the trim setting.
- A second analogue output channel 'B' is available. It is identical to output 'A' except that on receipt of bad data, it is not set to zero and continues to provide an analogue output voltage.
- An auxiliary two-state output is available, which indicates whether the received data is good (+5V) or bad (0V).
- The trimmable analogue output voltage range is $\pm 10V$ maximum, with the capacity to deliver up to 10mA.

B.1.2 Analogue Output Installation



WARNING
ELECTRICAL HAZARD

Mains power supply voltages can cause death or serious injury by electric shock.

Only a competent engineer who has received the relevant training and experience should perform maintenance work on electrical equipment.

Power-off and isolate the equipment from the electrical supply before you work on any equipment that uses a mains power supply. Arrange to discharge any power supply storage capacitors safely.

Observe all relevant local and national safety regulations while you perform any maintenance work on electrically powered equipment.

Do not connect the equipment to an electrical supply until you have refitted all safety covers and ground connections.

You should use the spare ISA backplane socket between the Converter Card and the single board computer to fit the analogue output card inside the SDC. Follow the instructions in sub-section 10.2.1 to open the SDC and remove the relevant blanking bracket.

- Follow the instructions in sub-section 10.2.1 to insert the Analogue O/P Card.

Installing the internal cable is as follows:

- Feed the internal cable through the side panel cable cut out. Attach slide lock 50-way connector to the analogue output card. Fix the 50 way convertor on the other end of the cable to the rear connector panel using the supplied screw lock posts.

The output from the analogue card is through a 50-way female D-type port. Refer to Table B-1 and make connections from the Analogue Output port to the steering control system.

Table B-1: Analogue output port details

Function	50-way D-type port pin designation	Wire colour
Analogue output A	15	Red
Analogue output B	32	Blue
Output common	14	Green
Good/bad data flag	48	Yellow
Screen (SDC ground)	1	

B.1.3 DeepView for Windows Operation

DeepView for Windows will detect whether your SDC has the analogue output card fitted. If the card is present, the analogue output icon will be available on the toolbar: see sub-section 6.2.1 for a description of the icons. To set the analogue output configuration, select Analogue output from the Configuration drop down menu in DeepView for Windows. The following sub-sections describe the analogue parameters that you may modify. The SDC saves their status in the configuration file.

B.1.3.1 Analogue Scaling

Set the analogue scaling in volts per metre. The default value is 1V/m.

You may use any positive floating-point value – the software will reject any negative numbers.

B.1.3.2 Analogue Trim

This value should be the lateral offset distance in metres between the centre line of the coil array and the centre line of the ROV. It allows the analogue output function to operate correctly if you have installed the coils so they are offset to one side of the ROV centre line.

You may use any floating-point number or polarity to configure the System. Use a positive value when the centre of the coil array is to starboard of the ROV centre line.

B.1.3.3 Analogue Polarity

Use the radio button keys to select polarity, defined as follows:

Positive polarity	Lateral offset negative = Output voltage negative = target to port
Negative polarity	Lateral offset negative = Output voltage positive = target to port

B.1.3.4 Analogue Output

Use the Analogue Output icon (see section 6.2.3) to toggle between ON and OFF. This function enables and disables the analogue outputs respectively.

B.1.4 Output Voltages

All outputs are trimmable, factory set to $\pm 0.2\% \pm 20\text{mV}$.

Output A is active whenever:

- Outputs are enabled
- Signals are not in saturation
- The target is in range and the 440 System can determine an accurate target position.

Output B is active whenever:

- Outputs are enabled
- Signals are not in saturation
- The target is in range but the 440 System cannot determine an accurate target position.

The ‘Good Data’ Flag is set (+5V) whenever:

- Outputs are enabled
- Signals are not in saturation
- The target is in range and the 440 System can determine an accurate target position.

The ‘Good Data’ set output = +5V

Otherwise ‘Good Data’ = 0V

B.2 DUALTRACK SYSTEM

CAUTION



You might cause permanent damage to the sub-sea installations of the 440 or the 350 System if you operate them from an incorrect electrical supply voltage.

The standard sub-sea components of both Systems operate from a nominal 110V AC electrical supply. Both Systems are available with the option to operate from a nominal 240V AC electrical supply. When you interconnect the 440 and the 350 Systems within a Dualtrack installation you must operate both from the same electrical supply.

Throughout this sub-section, 'the 350 Manual' refers to the TSS 350 Cable Survey System Manual (TSS document P/N 402197).

This part of Appendix B describes the features of a TSS 'Dualtrack' System that combines the 440 and the 350 Survey Systems on board an ROV. It includes all information specific to a Dualtrack installation and provides cross references that help you locate more detailed information in the relevant product Manual.



You must consider the Manuals for the TSS 440 and the 350 Systems valid in all respects except for those areas listed in sub-section B.2.2 below. TSS recommends that all personnel who will install, use and maintain the equipment should read and thoroughly understand the 440 System Manual and the 350 Manual.

B.2.1 The Equipment

The Dualtrack equipment described in this sub-section consists of the following:

- Sub-sea components of a TSS 440 Pipe and Cable Survey System.
- Sub-sea components of a TSS 350 Cable Survey System.
- A single SDC to provide configuration, control and communications functions for both sets of sub-sea components.
- Product Manuals, interconnection cables and mounting components for all three sub-sea electronics pods.



The 350 requires to have the latest firmware (version 3.7 or later) EPROM. This can be confirmed in the terminal mode of DeepView for Windows, when the System is initiated a banner is displayed that will identify the version number.

TSS supplies the System with Microsoft Windows 2000 and the DeepView for Windows graphical display software already installed and configured to run automatically when you power-on the SDC. DeepView for Windows can operate in all modes necessary to use the Dualtrack System.

The sub-sea components and the SDC supplied with the Dualtrack System are exactly as described in the relevant parts of the 440 System Manual and the 350 Manual, except for those differences listed in sub-section B.2.2 below.

B.2.2 The Differences

Note the following important issues when you install the Dualtrack System:

1 Scope of Delivery

Sub-section B.2.3 lists the standard items supplied with the Dualtrack System.

2 Physical installation

Refer to sub-section 3.2 of this Manual for instructions to install the sub-sea components of the TSS 440 System.

Refer to Section 3 of the 350 Manual for instructions to install the sub-sea components of the 350 System.

You must take special precautions regarding the placement of the search coils when you install the Dualtrack System on board an ROV.

Sub-section B.2.4 describes the special precautions you must make when you install the Dualtrack System.

3 Electrical connection

To make the most efficient use of the ROV umbilical, the Dualtrack System uses only two wires for all communications between the surface and the sub-sea installations. See sub-section B.2.5 for details of the special electrical connection requirements necessary to support this communication arrangement.

Where necessary, you may use 4-wire or RS232 communications instead.

Note that, in a Dualtrack System, you *must* connect the altimeter *only* to the ALTIMETER port of the 440 SEP, or to an SDC serial port. **Do not connect the altimeter to the 350 SEP.**

4 Operation



In a Dualtrack installation, you cannot operate the 440 and the 350 Systems simultaneously.

DeepView for Windows allows you to switch between the 440 and the 350 operating mode easily and quickly. The Run Window and its status bar will show the current operating mode.

5 Power requirement

Sub-section B.2.6 includes details of the power supply requirements for the sub-sea components of the Dualtrack System.

B.2.3 Scope of Delivery

Dualtrack includes the following major sub-assemblies:

Figure B-1: Surface Display Computer

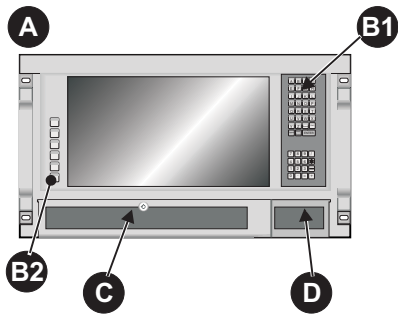


Figure B-2: Sub-sea components of the TSS 350 System

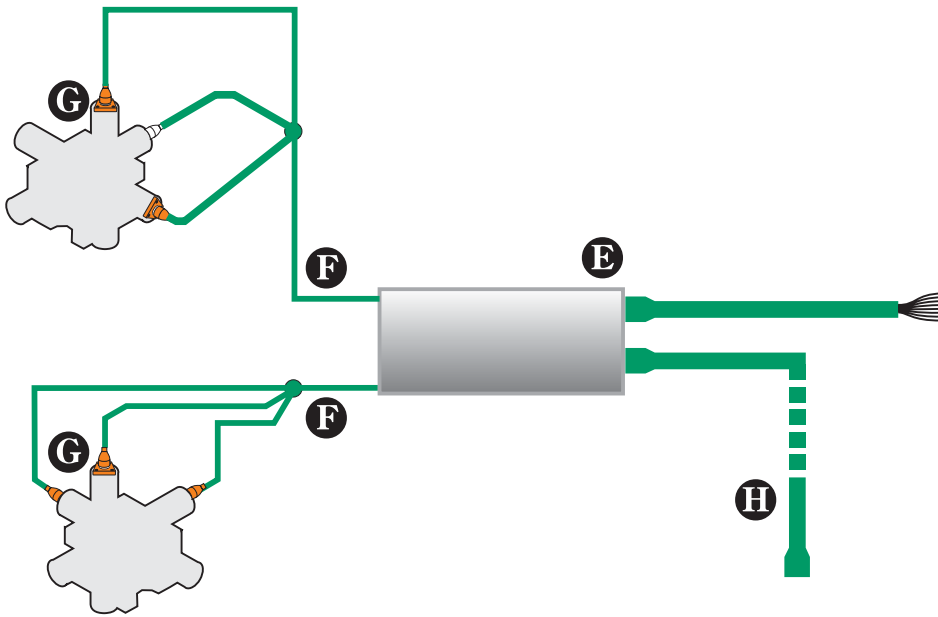


Figure B-3: Sub-sea components of the TSS 440 System

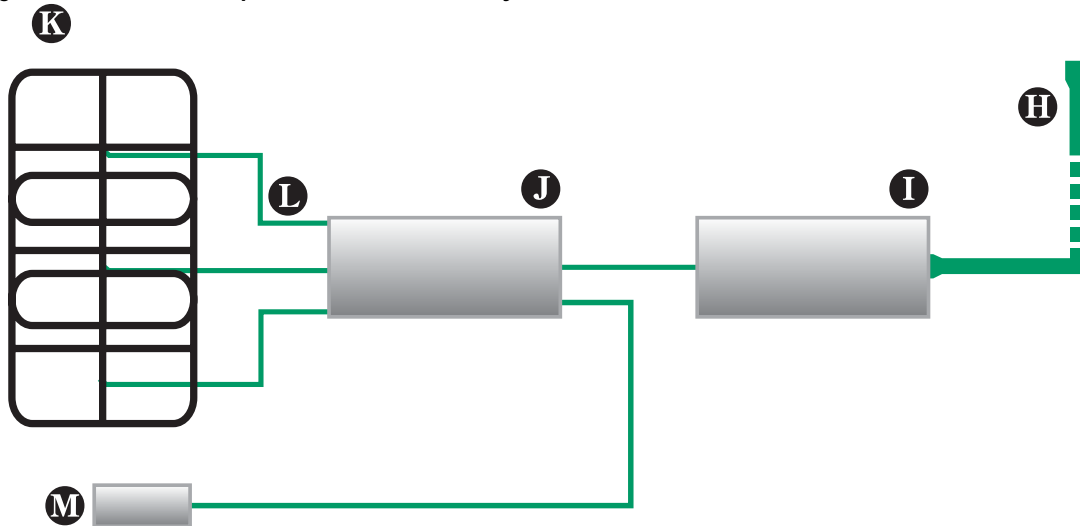


Table B-2: Components of the Dualtrack System

Item	Description
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Refer to Figure B-1:

A	Surface Display Computer (SDC) pre-loaded with Microsoft Windows™ 2000 and the DeepView for Windows display software.
B	1- includes Integral alphanumeric and Function keypad. 2- integral LCD operational keys such as LCD on/off, Exit, Up, Down, Menu, etc. and also a Power light for the LCD
C	Fold-down access panel hiding the Power switch, CD-ROM and the 3½-inch floppy disk drive, external keyboard connection and USB port, LEDs for POWER (motherboard), HDD and C/LOOP.
D	Integral trackpad.

Refer to Figure B-2:

E	Sub-sea Electronics Pod (350 SEP) for the TSS 350 Cable Survey System.
F	Two connection cables with waterproof connectors for the port and the starboard coil triads.
G	Port and starboard coil triads.
H	TSS 440-to-350 link cable (TSS P/N 601814). The cable is 2.5 metres long and has waterproof connectors at both ends.

Refer to Figure B-3:

I	Sub-sea Power Supply Pod (440 PSU) for the 440 Pipe and Cable Survey System.
J	Sub-sea Electronics Pod (440 SEP) for the 440 Pipe and Cable Survey System.
K	Coil array comprising three TSS search-coils.
L	Three connection cables with waterproof connectors for the array of search-coils.
M	Sub-sea altimeter with connection cable and waterproof connector. <i>This altimeter provides information for use by the entire Dualtrack System.</i>

Also included with the Dualtrack System but not shown are:

- Trackball for use with the SDC and the DeepView for Windows software.
- TSS 440 Pipe and Cable Survey System Manual – *TSS P/N 402196 current issue.*
- TSS 350 Cable Survey System Manual – *TSS P/N 402197 current issue.*
- Mounting components for the search-coils of the 440 System (see Section 3.2.2 of this Manual for details).
- Mounting components for the coil triads of the 350 System (see Section 3 of the 350 Manual for details).
- Mounting components for all three electronics housings of the Dualtrack System.

B.2.4 Physical Installation

B.2.4.1 Search-coils

Follow the instructions in sub-section 3.2.2 of the 350 Manual to install the mounting bar and coil triads of the TSS 350 System.

Follow the instructions included in sub-section 3.2.2 of this Manual to install the mounting frame and the coil array of the 440 System.



CAUTION

With drive current applied to the coils of the 440 System, large induced voltages can appear across the coils of the 350 System. Later versions of the 350 search coils, stamped with the letters 'DT' on the end cap, include diodes to protect them from damage caused by these induced voltages.

If your System includes coils that have no diode protection, you should ensure that there is a clearance of more than 0.75 metres between the coils of the 440 System and the coils of the 350 System. Contact TSS for advice if necessary.

B.2.4.2 Sub-sea Pods

The Dualtrack System includes three sub-sea pods:

- The PSU for the 440 System.
- The SEP for the 440 System.
- The SEP for the 350 System.

Follow the instructions in sub-section 3.2.1 of the 350 Manual to install the 350 SEP.

Follow the instructions included in sub-section 3.2.1 of this Manual to install the 440 SEP and the 440 PSU.

B.2.5 Electrical Connection

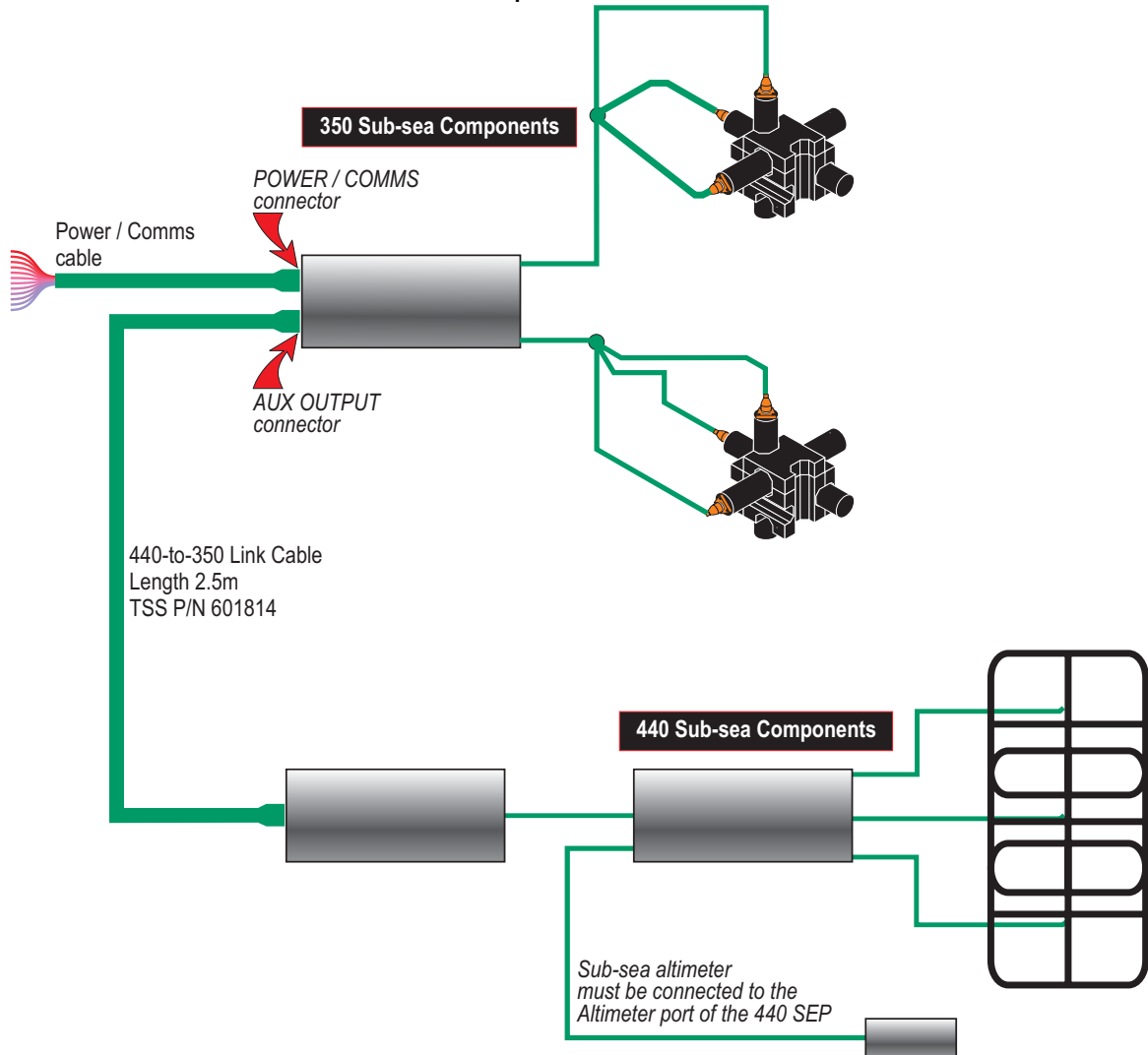
It is very important that you should interconnect the sub-sea components exactly as described in Figure B-4 and the instructions below.



IMPORTANT

If the Dualtrack System is an upgrade to an existing 440 System, you must open the 440 SEP and set it to use RS232 communications. Refer to sub-section 4.2.2.1 of the 440 Manual for instructions to change the communication method used by the 440 SEP.

Figure B-4: Electrical interconnection of sub-sea components



CAUTION

To avoid damage to either of the SEPs, make certain that you fit the blanking plugs supplied by TSS to any unused ports.

Failure to take this precaution might allow water to penetrate the SEP housings, following which total circuit failure will occur.

Connect the TSS 440 sub-sea components:

1. Complete the physical installation of the 440 search-coils as described in sub-section 3.2.2 of this Manual. Route the coil connection cables to the correct ports on the 440 SEP. Use plastic cable clips to secure the cables to the fixed framework of the ROV.
2. Install the altimeter near the centre of the 440 search-coil array as described in sub-section 3.2.3 of this Manual. Route the cable from the altimeter to the 440 SEP and follow the instructions in sub-section 4.1.6.1 of this Manual to connect it. Use plastic cable clips to secure the cable to the ROV frame.

**IMPORTANT**

The Dualtrack System uses one altimeter only. You *must* connect the altimeter to the **ALTIMETER** port on the 440 SEP, or to an SDC serial port.

If you connect the altimeter to the **ALTIMETER** port of the 350 SEP the Dualtrack System will not operate correctly.

3. Connect the 440 SEP to its PSU as described in this Manual.

Connect the TSS 350 sub-sea components:

4. Complete the physical installation of the 350 coil triads as described in sub-section 3.2 of the 350 Manual. Route the coil connection cables to the correct ports on the 350 SEP. Use plastic cable clips to secure the cables to the ROV framework.
5. Connect the 350 SEP to the ROV electrical supply by following the instructions in sub-section 4.1.3 of the 350 Manual.

**CAUTION**

You might cause permanent damage to the sub-sea installations of the 440 or the 350 System if you operate them from an incorrect electrical supply.

The standard sub-sea components of both Systems operate from a nominal 110V AC electrical supply. Optionally, both Systems are available for operation from a nominal 240V AC electrical supply.

When you interconnect the 350 and the 440 Systems within a Dualtrack installation, you must operate both Systems from the same electrical supply.

6. Connect the communications conductors of the 350 Power/Comms cable to the ROV umbilical. Note that the Dualtrack System would normally use 2-wire current-loop communications to the SDC to reduce the demand for twisted pairs in the umbilical. However, where necessary, you may use 4-wire or RS232 communications instead. Refer to Tables 4-5, 4-6 or 4-7 in this Manual for appropriate connection details.

Connect the 440 System to the 350 System:

7. Use the 440-to-350 Link Cable (TSS P/N 601814) to connect the 8-way ‘Power/Comms’ connector on the 440 PSU to the AUX OUTPUT port on the 350 SEP. This link uses RS232 communications at 9600 baud.

Note that the connectors at each end of the cable are of a different design. You cannot reverse the cable when you make this connection.

Refer to sub-section 4.1.2 in this Manual for instructions to care for and assemble the sub-sea connectors. Make all interconnections between the sub-sea assemblies and tighten the locking collars by hand. Do not over tighten the sub-sea connectors.

Connect the SDC to the umbilical cable:

8. Refer either to sub-section 4.2.2 of this Manual or to the 350 Manual for instructions to complete the connection using the selected communication method.

B.2.5.1 System Configuration

The DeepView for Windows software allows you to configure and control both Systems in a Dualtrack installation.



If you are installing Dualtrack operation as an upgrade to an existing 440 or 350 System:

- ❑ **Ensure your SDC is capable of running Microsoft Windows™ 2000 and the DeepView for Windows software. Contact TSS for advice if necessary.**
- ❑ **In a Dualtrack System, the 440 SEP must communicate using RS232. If your 440 SEP uses 2-wire or 4-wire communications, refer to sub-section 4.2.2.1 of this Manual and set RS232 communications *before* you install the SEP on the ROV.**
- ❑ **Follow the instructions in sub-section 5.1 of this Manual to install the software onto your SDC.**

To configure the Dualtrack System properly you must complete the following actions.

1. Use the DeepView for Windows System Configuration Wizard to configure the 440 and the 350 Systems correctly. Select Dualtrack for the SEP type. Refer to sub-section 5.3 of this Manual for instructions to configure the 440 System. Refer to the 350 Manual for instructions to configure that System.



IMPORTANT

You *must* select Dualtrack as the SEP type even if you intend to use only one of the Systems during the survey.

2. Take care to enter all details completely and correctly. Set appropriate altimeter offsets for the 440 and the 350 Systems.

B.2.5.2 System Operation

When supplied as part of a complete Dualtrack System the SDC will have all the software necessary to operate already installed and tested. After power-on the SDC will perform an initialisation sequence and DeepView for Windows will then start automatically.

Contact TSS for advice if you wish to upgrade an existing 440 or 350 System to a Dualtrack.

1. Refer to this Manual and the 350 Manual for instructions to use DeepView for Windows in its 440 and 350 modes.
2. Use the selection buttons on the DeepView for Windows tool bar to select either the 440 or the 350 operating mode. These buttons are available for use only if you select Dualtrack as the SEP type in the System Configuration Wizard. The buttons are mutually exclusive – you cannot operate the installation with the 440 System and the 350 System operating simultaneously.
3. DeepView for Windows annotates the internal logging file with the operating mode so that it can replay the file correctly.

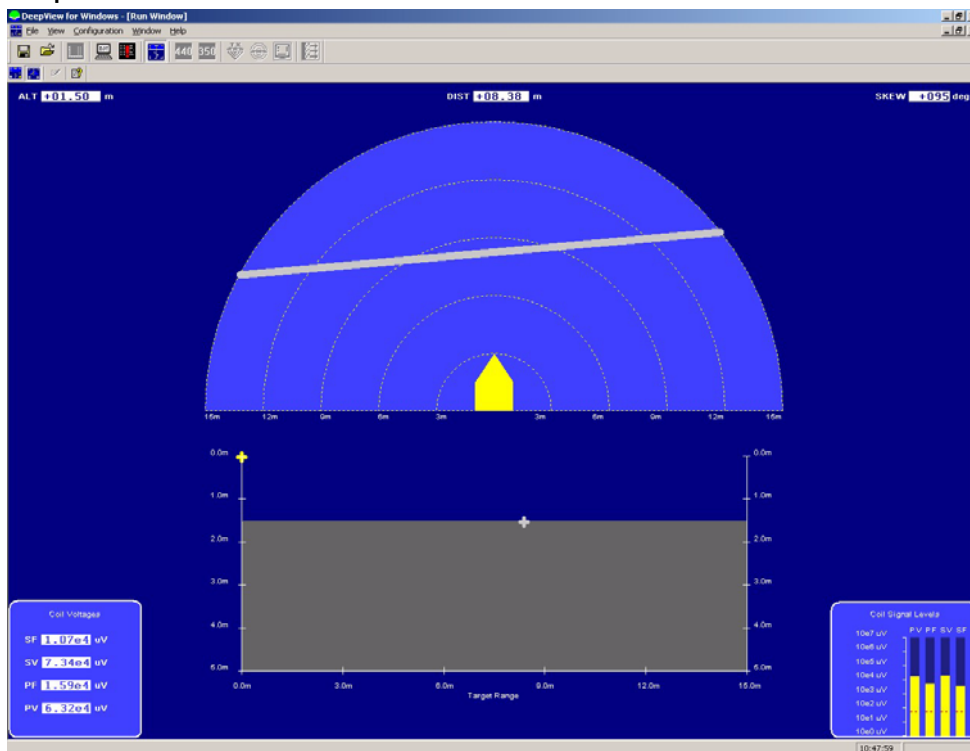


Note that the external logging file changes its format when you switch between the 440 and the 350 mode. Be aware that this might cause problems with the data logger and its software.

B.2.5.3 Forward Search Window

In addition to the DeepView for Windows information outlined in Section 6 of this manual. The Forward Search Window [Ctrl + F] (or via the View Drop down menu) is available for use with the 350 and Dualtrack options.

Figure B-5: DeepView for Windows: Forward Search Window



B.2.6 Power Supply Requirement



CAUTION

You might cause permanent damage to the sub-sea installations of the 440 or the 350 System if you operate them from an incorrect electrical supply.

The standard sub-sea components of both Systems operate from a nominal 110V AC electrical supply. Optionally, both Systems are available for operation from a nominal 240V AC electrical supply.

When you interconnect the 440 and the 350 Systems within a Dualtrack installation, you must operate both Systems from the same electrical supply.

Specifications for the Dualtrack System are as listed in Section 8.1 of the relevant Manual for the 440 and 350 Systems.

Note however that the sub-sea components of the Dualtrack System must operate from the same nominal supply voltage (either 110V or 240V AC as appropriate).

The maximum current consumption for the Dualtrack System is 3.1A at 110V AC nominal electrical supply or 1.8A at 240V AC nominal electrical supply.

B.3 TRAINING

The TSS 440 Pipe and Cable Survey System is a precision ‘front line’ survey tool. To exploit the full potential of the System, all personnel involved with a survey that uses the 440 System – from the initial planning stages to final data presentation – should possess a sound understanding of the performance of the System and its application.

To support this recommendation, TSS has developed two levels of training course to provide for the needs of those who will be involved with a survey that uses the 440 System. For efficiency, TSS limits the maximum number of participants for each course to four.

On successful completion of the training course, the participants will be asked to complete a written test. Provided they demonstrate an acceptable level of understanding at this test, they will receive a numbered Training Certificate.

B.3.1 Part 1: Foundation Course

The Foundation Course meets the needs of all personnel who will be involved with the 440 System, such as Survey Managers, Operation Managers, ROV Managers, Surveyors, Party Chiefs, Data Processors and Clients’ Representatives.

Participants will receive comprehensive course notes. The course duration is approximately four hours and covers the following:

- ❑ System overview
- ❑ Principles of operation
- ❑ Initial installation
- ❑ Software overview and interfacing with other equipment
- ❑ Operational considerations and limitations
- ❑ Practical demonstration

On completion of the Foundation Course, participants will have gained an understanding of the operating theory of the 440 System. They will also be aware of the considerations necessary at the pre-survey, operations, data acquisition and data processing phases of a survey that uses the 440 System.

B.3.2 Part 2: Operators and Engineers Course

This course is a continuation of the Foundation Course and provides for operators and engineers who use the 440 System during a survey, for example ROV Supervisors, ROV Pilots and Offshore Technicians.

The course duration is approximately two hours and covers the following:

- Use of the System as part of a Dualtrack installation
- Pod disassembly and reassembly
- Circuit board functions
- Signal analysis within the SEP
- Advanced fault finding
- Regular maintenance procedures
- System test procedures

Participants in this part of the training course should possess a basic understanding of electronics.

On completion of this part of the training course, participants should have gained a good understanding of the hardware and circuit functions of the 440 System. To demonstrate that they have understood the technical training, there will be an opportunity for course participants to find realistic sample faults introduced by the engineer who is running the course.





C ALTIMETER

C.1 OVERVIEW

This appendix contains operating and service instructions for the ALT-250 sonar altimeter. The ALT-250 is a high resolution sub-sea echo sounder designed to accurately determine the height of sub sea instrumentation from the seabed.

The unit is supplied ready configured to use with TSS detection products.

The unit produces a narrow beam acoustic sonar pulse that “illuminates” a small section of the seabed. The travel time for the pulse to be reflected from the seabed is measured using a high stability timer and converted to distance in meters for output to the serial port where can be recorded by the SEP, or transmitted to the SDC. Noise rejection algorithms allow the altimeter to be used for short range measurements even in areas of high suspended sediment.

The electronics are housed in a corrosion resistant hard anodised aluminium pressure case which can withstand depths up to 3000 metres dependent on the model.

A PRT100 temperature sensor is offered as standard and the reading is appended to the output data string. A 7 way connector provides power and data to and from the altimeter.

Table C-1: Altimeter Specification

Transmit Frequency	250kHz
Transmit pulse width	40 microseconds
Beam width	9°, conical
Pulse repetition rate	5/second
Maximum range	30m
Minimum range	0.8m
Digital output	RS232 with switchable baud rates of 2400 or 9600 (other options available if required)
Resolution	1cm
Power requirement	8 TO 24 VDC (24VDC for modem option)
Supply current	50mA @ 17VDC
Maximum depth	3000m (dependent on depth sensor if fitted)
Mating connector	Impulse LPMIL-7-MP Inline
Distance accuracy	76.2mm diameter, (87mm max) X 205mm
Temperature accuracy	±0.5°C standard.

C.2 INSTALLATION

C.2.1 Electrical Connection

The 7 way bulkhead connector is protected by the plastic end cap which also prevents the connector turning and loosening the pressure seal between the connector and the pressure housing face.

The in-line connector, (male), must first be lubricated by smearing silicone lubricant or other compatible silicone grease on all the pins. Ensure the lubricant does not cover any part of the acoustic transducer encapsulation as this will have a detrimental effect on the acoustic properties of the transducer. If silicone grease is inadvertently splashed over the transducer face, remove with a clean rag and wash with a mild detergent.

Ensure the connector pins are aligned correctly with the mating bulkhead connector before applying force as the connectors can be damaged if incorrectly mated. If resistance is felt when mating the connectors this means the pins are not aligned correctly in which case start again.

When the connector is disconnected; insert dummy plugs or smear with silicone grease if the connector is likely to be exposed to sea water or other corrosive element.

C.2.2 Serial Output

The connector supplies power and data between the altimeter and a terminal or other device which can receive RS232 signal levels, for example the SEP. The internal switch, S1/3 allows the option of two different baud rates to be chosen. The standard baud rate options are 2400, (switch off) or 9600, (switch on) both with no parity, 8 data bits and one stop bit. For use with the 440 or 350 system, leave switch S1/3 in the off position for 2400 baud.

The output format is the standard TSS/Datasonics string: see section 7.6 for details.

Table C-2: Power/ data connector pinout

Pin No	Wire Colour	Function
1	Black	Power 0V
2	White	Aux input ground (optional)
3	Red	+24VDC Power input
4	Green	RS-232 Ground
5	Blue	External trigger in (optional)
6	Brown	RS-232 Transmit output
7	Yellow	Aux signal (optional)

C.2.3 Mounting

Position the altimeter away from other acoustic instruments that may cause interference, this may be necessary even if the other instrumentation is operating at a different frequency due to the “near field” effect of the acoustic transmission.

Make sure the altimeter is positioned away from turbulence such as propeller noise or anything that could cause aeration in the water, (acoustic signals are greatly attenuated by the interface between sea water and air bubbles).

Figure C-1: Mounting arrangement

Mount the altimeter using part number 305676, as shown in figure C-1, or a secure mounting bracket with, rubber protective sleeve around the altimeter body, making sure the altimeter transducer is the nearest point to the seabed, in other words there must be no metal work that could conduct the acoustic signal to the transducer by-passing the water column. Remember the minimum range is 0.8 metres therefore if an under range data output is to be avoided mount the altimeter at least 0.8 metres above the bottom.

Make sure the altimeter is mounted perpendicular to the horizontal flying position of the sub sea vehicle, the beam angle is limited to 9° therefore any misalignment has a detrimental effect on the operation of the altimeter. Ensure the mounting is secure and not liable to vibration or movement.

Although the specification quotes 9° beam width the coverage area may increase at minimum range due to the “side lobes” produced by the acoustic transducer. This can be caused by a strong reflector close to the altimeter being reflected before the main beam echo is received thus causing the object to be seen before the main beam is reflected off the seabed. This situation would cause a reduced range to be recorded.

Make sure the anodised aluminium finish is not damaged as this will cause corrosion when the instrument is next deployed.

Connect an optional safety leash from the altimeter end cap using a stainless steel 8mm bolt and two washers. Make sure the M8 bolt does not protrude to the aluminium bulkhead as this will damage the anodising.

C.2.4 Maintenance

The altimeter should be immersed in fresh water if it is not to be used in the next couple of days then placed in a dry environment. Inspect the transducer face and clean with a mild detergent if the transducer face is not clean. It is important to ensure the transducer face is clean to ensure maximum efficiency of acoustic energy into seawater. Ensure no silicone grease from the connector is allowed to come into contact with the transducer face.

C.2.5 Test in Air

The altimeter should first be tested in air to ensure its correct operation. This can be done by connecting the unit to +24VDC, or 8-24VDC if switch mode operation is selected, and reading the serial output data with a PC terminal emulation program such as Hyper Terminal.

The range data output should read R99.99E when the unit is in air whilst temperature, (Txx.x), should read air temperature. The altimeter should emit a “ticking” sound at a rate of 5 per second thus confirming the transmitter is working and that the power supply is sufficient to power the altimeter. If the voltage is too low to power the altimeter the serial data will still output data but there will be no ticking sound.

The high frequency used for the altimeter is greatly attenuated in air therefore the signal is not able to travel more than approximately 1 metre, (indicated) in air, although the signal can be seen on an oscilloscope at TP7. The pre-deployment check should consist of rubbing the transducer face when the range serial output should change from 99.99 to an erratically changing value.

C.2.6 Internal Settings

Ensure the internal switch is in the correct position: this should already be set for 2400 baud for use with the TSS 440 and 350.

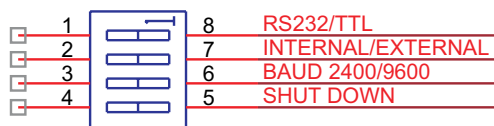
If the internal switch needs changing, make sure the housing is clean and free from debris before unscrewing the captive retaining ring ensuring water or debris does not enter the pressure housing when the transducer and electronics are separated.

As the electronics board is lifted from the housing make sure the interconnecting cable is free and is not caught on components causing strain on the connector and wires.

Table C-3: Switch S1 settings

1	Internal input select On: TTL input, Off: RS-232 level input
2	Internal/ external trigger On: External, Off: Internal (default)
3	Baud rate select On: 9600, Off: 2400 (default)
4	Step-up power supply disable On: 17-24V input, Off: 8-24V input (default)

Figure C-2: Switch S1 layout



When the switch has been switched to the correct position the electronics board can be inserted into the pressure housing first ensuring the interconnecting cable is free alongside the printed circuit board. Ensure the board is slid down so the end of the board sits to one side of the internal cable at the bulkhead connector taking care not to damage the internal anodised finish of the O ring seal area as the PCB is slid down, (see figure C-3).

Figure C-3: Reassembly of the unit.



Ensure the rubber “O” rings are free from contamination and if necessary remove and clean the O rings and grooves before re-greasing with silicone or compatible O ring grease.

The area around the O rings must be meticulously clean to ensure a good pressure seal when the unit enters the water. Inspect with a magnifying glass to make sure the surface of the O ring and housing are clean.

C.3 THEORY OF OPERATION

This section describes the operation of the ALT250. The theory describes the general principles of acoustics and the technical description covers the basic operation of the altimeter. Do not attempt to repair the altimeter unless you are an experienced electronics technician used to working with surface mount components.

C.3.1 Operating Principles

The altimeter determines the round trip time of the Sonar pulse travelling from the transducer through the water column then reflected off the seabed and received back at the transducer. The time the Sonar pulse takes to make this journey equates to the two way distance. The distance can be determined by comparing the measured time to the known speed of sound in water then dividing by 2 to get the one way distance.

The speed of sound in water varies according to conditions, (due mainly to salinity and temperature). The altimeter defaults to 1480 metres/second which is a default average for speed of sound in sea water.

C.3.1.1 Speed of Sound

The altimeter uses a high accuracy timer to measure the flight time of an acoustic pulse. The timer is accurate to 1 μ s, (0.74mm @ 1480metres/second), which is the speed of sound, (SOS), default value, however this speed of sound value is dependent on many factors and requires an accurate “VP” meter or CTD instrument to determine the exact value during the operation, (see figure C-4).

Figure C-4: Speed of Sound meter



The change in SOS is mainly due to temperature where a change of $\pm 1^{\circ}\text{C}$ in sea water temperature causes a change of approximately $\pm (0.0018 \times \text{SOS})$ metres/second, e.g. a SOS measurement taken at 10°C is 1480m/s but would change to $\sim 1506.64\text{m/s}$ at 20°C . Note: this is a very approximate calculation and is included only to demonstrate the effect that temperature has on VP.

The SOS is also affected, to a lesser extent, by changes in salinity and depth. There are many different formulae for calculating SOS; for more information consult one of the many books on this subject for example Robert J. Urick's "Principles of Underwater Sound".

The Altimeter temperature reading is not used in the SOS calculation. The default SOS is 1480m/s ; if a different value is required simply apply a correction to the serial output as follows: $(\text{SOS}/1480) \times \text{Range reading}$.

C.3.1.2 Terminology

There are many acoustic terms associated with underwater acoustics and associated technology; here are just some of them:

- Sonar Equation: The transmitter sound source should be greater than all the losses due to range, reflector, and sea water absorption plus the threshold value required at the receiver. The altimeter is designed for losses over 30 metres.
- Transducer: Converts electrical energy into sound or sound into electrical energy. This is housed within the potting compound of the altimeter.
- Transducer beam width: The area of sound when plotted to the half power point in front of the transducer. This applies both to transmit and receive modes.
- VP: Velocity of propagation or speed of sound
- Noise level: Acoustic sounds in sea water due to ships, hydraulics, or other sonar equipment.
- Reflectivity: the attenuation of the transmitted sonar pulse due to the material/angle of the reflector, (in this case the seabed).
- DB: This is the term Decibel which is used to express sound level in relation to a reference level, usually 1 micro Pascal at 1 metre. This can be negative when expressing receiver sensitivity or positive if expressing transmitted sound level.

- Absorption: The loss due to sea water which increases for higher frequency.
- Reverberation: Received signals due to various scatterers of sonar signals such as sea surface, tiny particles in the sea water and bottom reflections. This can be heard on old war films as the slowly decaying quivering tonal blast following the ping of an echo sounder. The altimeter locks on to the first signal and rejects the following reverb.
- PRT100: Platinum Resistance Thermometer which consists of a platinum wire calibrated for 100 ohms at 0°C and 138.5 ohms at 100°C. Accuracy is $\pm 0.15^\circ\text{C}$ for a class A device as used in the altimeter.
- Pressure sensor: Device for measuring depth in sea water. Consists of a strain gauge element which converts pressure to an electrical signal.
- Switch mode power supply: Circuitry within the altimeter which boosts the supply voltage to the required level.
- TVG: Time Varying Gain. This is applied to the sonar signal to compensate for range and absorption losses in sea water. The altimeter TVG signature is stored in the non-volatile memory of the microcontroller.

C.3.1.3 Propagation Loss

The propagation loss describes the weakening of sound between a point 1 metre from the surface of the transducer and a point at distance from that point in the water column.

The propagation loss consists of spreading or ranging loss and loss due to attenuation in sea water. The altimeter is designed to normalise these losses by applying a varying gain, (TVG), to the sonar receiver.

Circuitry within the altimeter rejects near field signals from transducer side lobes to enable detection of minimum range values.

C.3.1.4 Limitations

The altimeter must not be used alongside instruments operating at or near the same frequency. The power supply should be DC with good regulation; the altimeter is designed for worst case power supply electrical noise by the use of analogue filters at the DC power input, however, noise at or near the Sonar frequency may cause problems.

The altimeter housing is hard anodised to protect from corrosion in sea water and for limited protection from mishandling. The anodised surface must not be damaged as this will cause corrosion to develop leading to eventual failure of the pressure housing.

The altimeter can be affected by transmission of sound through the supporting structure leading to an erroneous range value that is less than the correct range therefore to ensure this does not happen make sure the altimeter is de-coupled mechanically from the structure by using rubber inserts or similar.

The range of the unit is limited; however, it is possible to pick up reflections which are called “multiples”. These multiple reflections give the impression of a good range being received by the altimeter but are, in fact, pulses received from the previous transmission that have travelled

to the bottom or sea surface and been reflected in time for the reception time of the latest transmission. The result is a range that should be outside the range of the altimeter appearing as a good range.

The ships echo sounder should be checked to determine if ranges from the altimeter are multiples from an over range water column.

Mount the altimeter at least 0.8m from the bottom of the sub sea vehicle; any range less than 0.8m will show as an error; however multiples can still be received.

C.3.2 Technical Description

The altimeter circuitry is divided into several sub systems to enable a clearer understanding of the system. The sub systems are all manufactured on one printed circuit board.

Test points are available to aid faultfinding and commissioning. The circuitry uses miniature surface mount components therefore great care must be taken to avoid damaging the circuitry. Do not short connections as probes are inserted. The following points are present:.

Table C-4: Testpoints

TP 1	Spare connection for MONO8 interface.
TP 2	Timer input to micro from sensor/ sonar receiver MUX.
TP 3	Raw sonar signal before bandpass but after sonar receiver.
TP 4	Sonar receiver output signal (positive pulse).
TP 5	Detected sonar signal (negative pulse).
TP 6	High voltage Tx signal across acoustic transducer.
TP 7	Transmitter Tx pulse TTL drive.

C.3.2.1 Power Supply

Input voltage can range between 8-24VDC providing the SHDN signal is high; (S1/5 is off). If the power supply is known to be constantly above 17VDC switch S1/5 can be switched on thus disabling the dc-dc converter to conserve power.

The dc-dc converter is also controlled by an automatic switch which puts the circuit in SHDN mode if the DC input is higher than 15.7VDC.

The transmitter voltage is regulated to 12.9VDC to allow operation of the transmitter driver chip which requires at least 12VDC to operate, (the driver output will go open circuit if the voltage falls below this).

The digital 5Vsupply is fed from a normal linear regulator. This supply inhibits the dc-dc converter if it falls below approximately 4.5VDC.

Smoothing reservoir capacitors are used at the DC input and also at the +5VDC line to eliminate any noise that is passed from the power supply.

C.3.2.2 Transmitter

The microcontroller generates a TTL signal pulse at TP7 which determines operating frequency and pulse length, both these parameters are programmed into the microcontroller's flash memory and can be altered if necessary, by the manufacturer, using the programming input header J4.

The transmitter power section is interfaced to the microcontroller signal level by a power driver which is designed to switch high current signals via the two MOSFET transistors IC15 & IC17 through the step up transformer T1 or optionally T2.

The secondary inductance of the transformer and the capacitance of the transducer components form a tuned circuit at the operating frequency thus forming a high amplitude sine wave. Fine tuning of the transmitter output is achieved by adding capacitors to C43 and C47, (working voltage of the capacitors are 1000VDC).

The transmitter is inhibited if the +5VDC supply falls below 4.5VDC.

The transformer secondary inductance and tuning capacitors are kept out of the receiver path by steering diodes. A damping resistor R45 reduces ringing from the transducer when the transmitter pulse is removed.

C.3.2.3 Receiver

The same transducer is used to receive and transmit therefore protection diodes in series with a resistor protect the sensitive receiver circuit when transmission occurs.

TVG is applied to the signal before being fed to a band pass filter set to the operating frequency. The signal is then demodulated and fed to a threshold detector.

Gain control lines GAIN1-8 are fed from the microcontroller and provide TVG control of the receiver; this enables received signals varying over a wide dynamic range to be received. The initial sensitivity of the system is controlled by the microcontroller which switches an attenuator into circuit reducing the amplitude of the signal before reaching the receiver.

Signal BLANK, from the microcontroller controls the attenuator for the initial reception period which is set at a nominal 1 metre during which period high amplitude signals from side lobes and near field objects are attenuated.

The output of the receiver is fed to a comparator which has two threshold settings set by the microcontroller. The initial threshold is set approximately 4dB higher for this period thus allowing echo signals to be received even when direct signals are still being received from the effect of transducer ringing.

The detected receiver signal is fed to a capture timer on the microcontroller which stops the timer on the negative edge of the received pulse.

The same timer channel is also used to read the temperature/depth transducer; this is carried out by a multiplexer connected to both circuits and controlled by the microcontroller.

C.3.2.4 Sensor Circuitry

The sensor circuitry is a complete front end for the measurement of passive sensors such as temperature and pressure using an advanced chopping technique to remove low frequency interference. The analogue sensor signal is converted into a digital format and read by the microcontroller. The sensor interface converts to 12 bit accuracy.

A three phase technique is used to measure system offset, reference and finally the sensor signal. Good long term stability is assured by the auto calibration process carried out by the microcontroller to determine changes in offset and reference for each measurement period.

The sensor circuitry is located close to the sensor to reduce resistance between sensor and electronics; however, even the small resistance changes due to temperature effect etc. are corrected by software using the offset and reference measurements.

The chopping technique filters out any spurious noise generated by internal or external circuits.

The accuracy of the sensor is determined by the accuracy of the temperature or depth sensor itself and the reference resistor R1. Corrections can also be made in the microcontroller to achieve greater accuracy. The reference resistor is currently a 100R resistor 0.01% < 0.6ppm/°C accuracy which equates to an initial accuracy of $\pm 0.01R$ or 0.026°C plus temperature drift which is negligible.

C.3.2.5 Digital Circuitry

The digital circuitry comprises the microcontroller and serial communication plus associated circuitry. The microcontroller operates at a speed of 8MHz and is used to process all transmission and receive functions in conjunction with the associated hardware.

The firmware for the microcontroller, (68HC908KX8), can be programmed using the mini “MONO8” connector at J4. This connector allows the micro to be programmed in-situ using its flash memory to retain the data when power is removed.

Standard tools from Motorola are available that allow the manufacturer to program via this connection without the need to connect to the power supply.

The serial data is converted to RS232 levels in the digital section where the usual protection diodes etc. are situated.

The +12VDC for the RS232 interface is derived from the transmitter +12VDC and the minus -12VDC from a +12VDC to -12V DC-DC converter circuit.

C.3.2.6 Averaging Algorithm

The microcontroller uses a moving weighted averaging algorithm to ensure that any momentary noise or interference from the Sonar signal does not appear as a range at the data output. This is achieved by giving each new range a weight of 25% while the previous range is given a weight of 75%. If the new range differs significantly from the old the new range will be replaced with the old. If more than two unacceptable ranges are received the next new range is accepted. Each new range occurs approximately 0.2 second apart.

C.3.2.7 Optional Modem

Position IC1 is for an optional modem module. This module receives the serial data from the altimeter and superimposes the data on to the +24VDC power cable; this allows the altimeter to connect using just two cable cores over long cables using FSK modem technology. To use this option the power supply must be +24VDC. Switch S1 switch 3 and switch 4 to the on position to select 9600 baud and dc-dc converter inhibit.

C.4 PART NUMBERS

Table C-5: Part numbers

500292	Altimeter, subsea TSS-ALT-250 (no cable or accessories)
500294	As above, detection kit (includes bracket 601824A)
500295	Altimeter, including 3m pigtail 601826A
601824A	Cable ALT-250 to TSS 350/440 SEP (3m)
601825A	Cable ALT-250 to TSS 350/440 SEP (7m)
601826A	Pigtail (3m)
601827A	Pigtail (7m)
402321	Separate manual
307558	O-Ring
402608	Carton
200809	Mini wet-pluggable free lead, LPMIL-7-MP200809
305676	Mounting kit

C.5 DRAWINGS

Figure C-5: Block Diagram

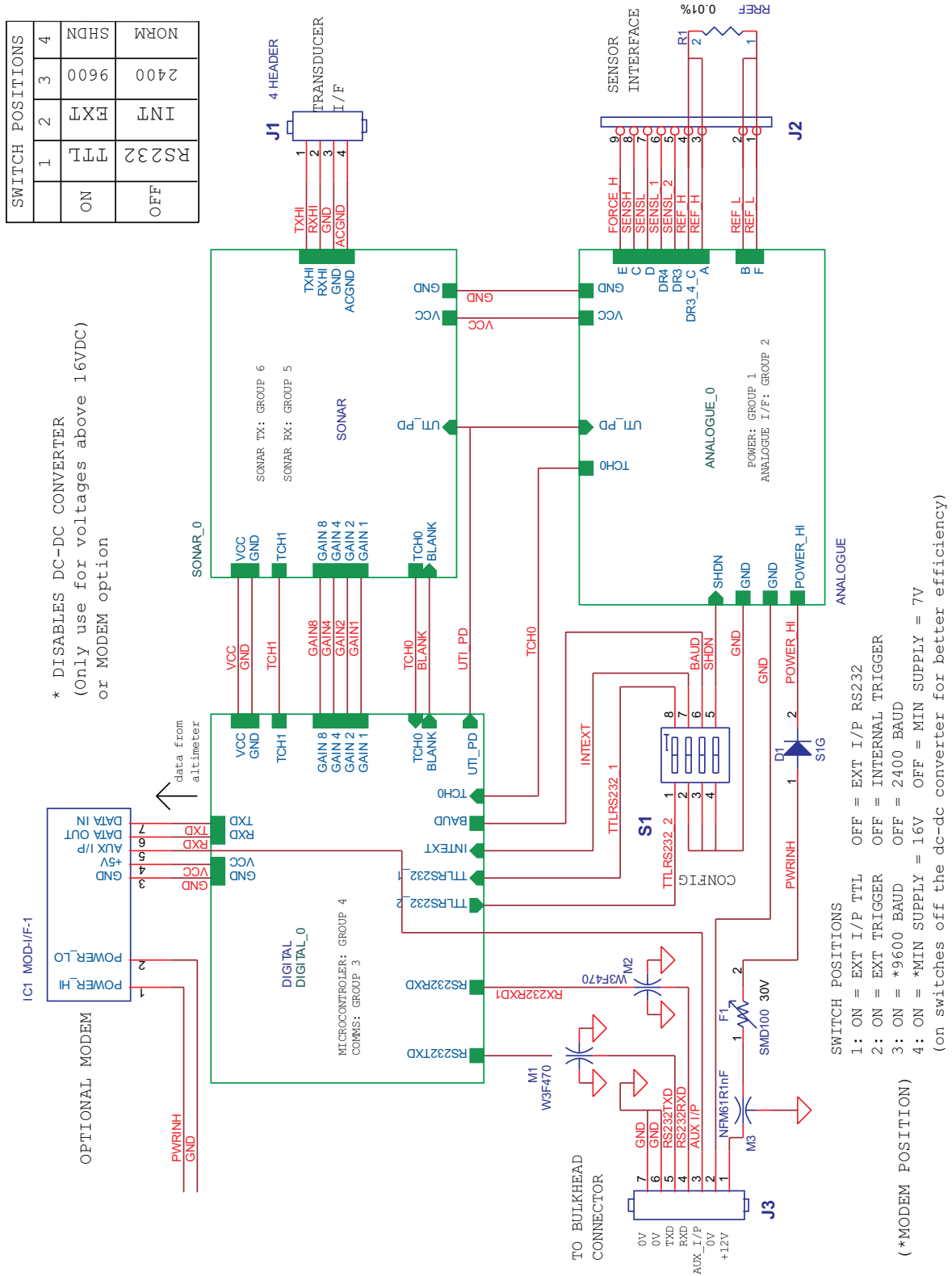


Figure C-6: Internal wiring

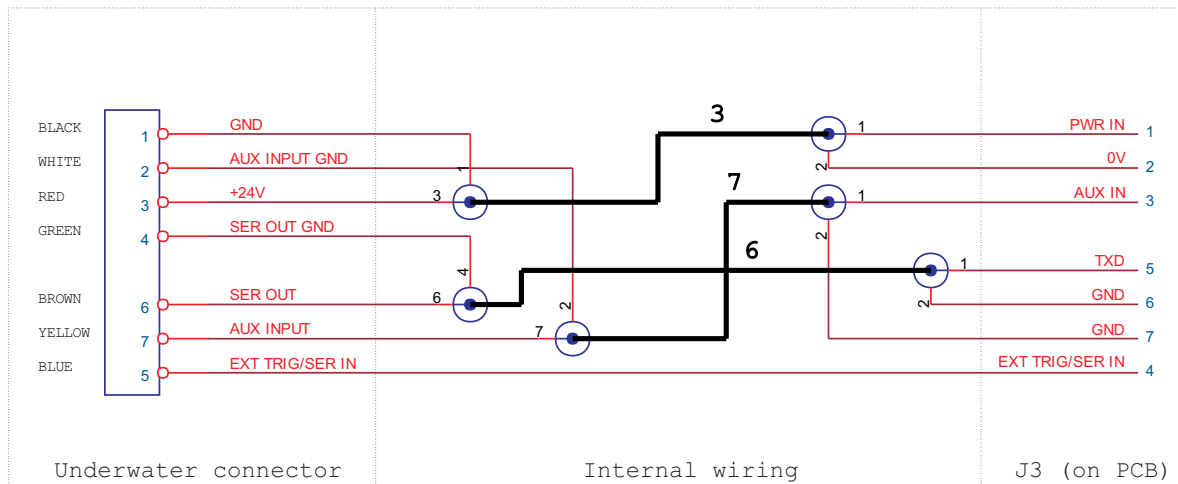


Figure C-7: Temperature sensor wiring

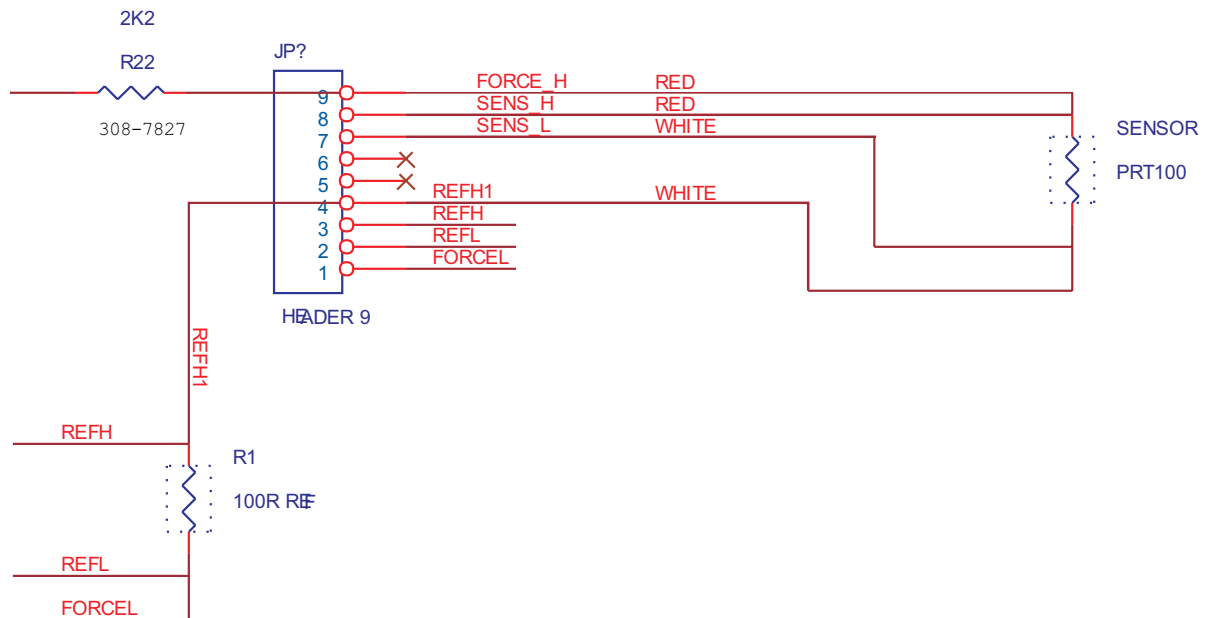


Figure C-8: ALT-250 / TSS underwater splice p/n 601824A

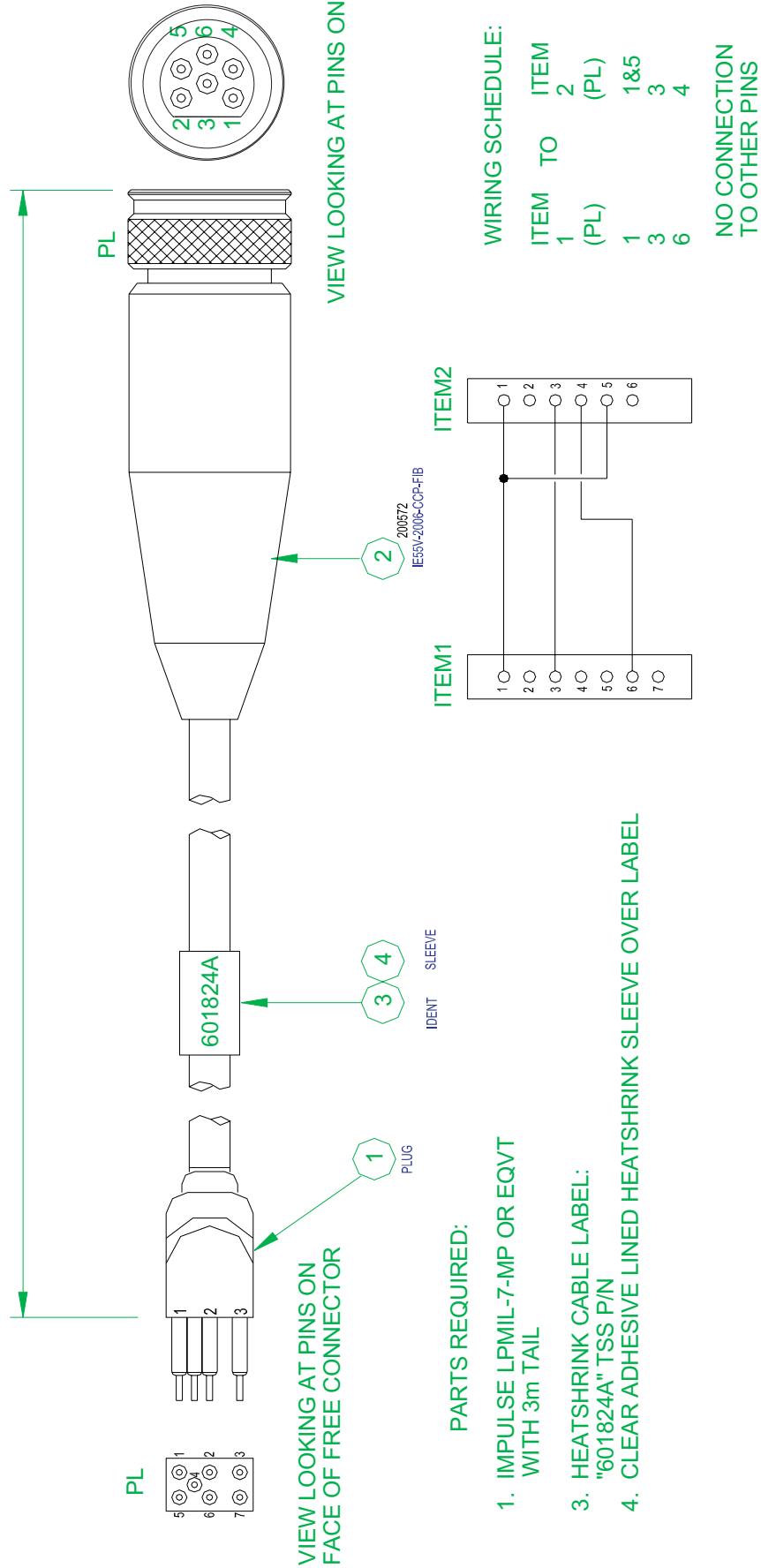


Figure C-9: ALT-250 free cable

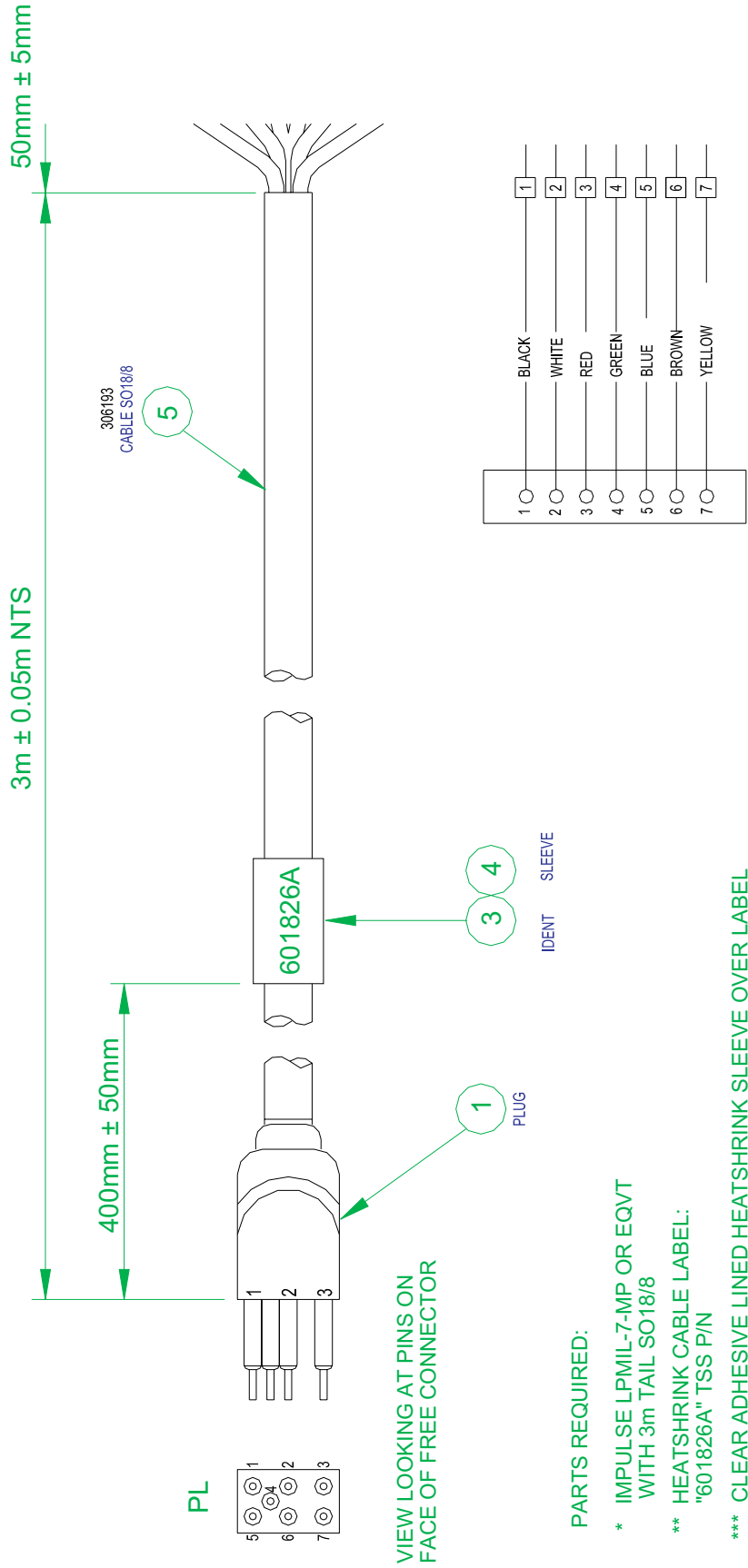


Figure C-10: PCB layout - top

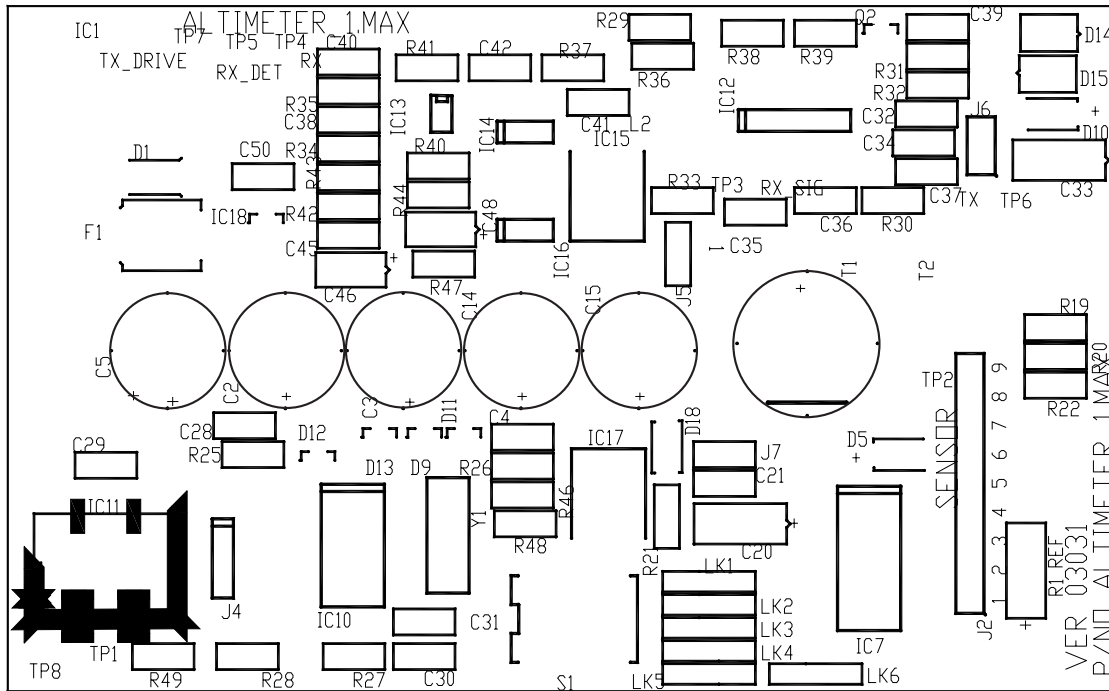


Figure C-11: PCB - top

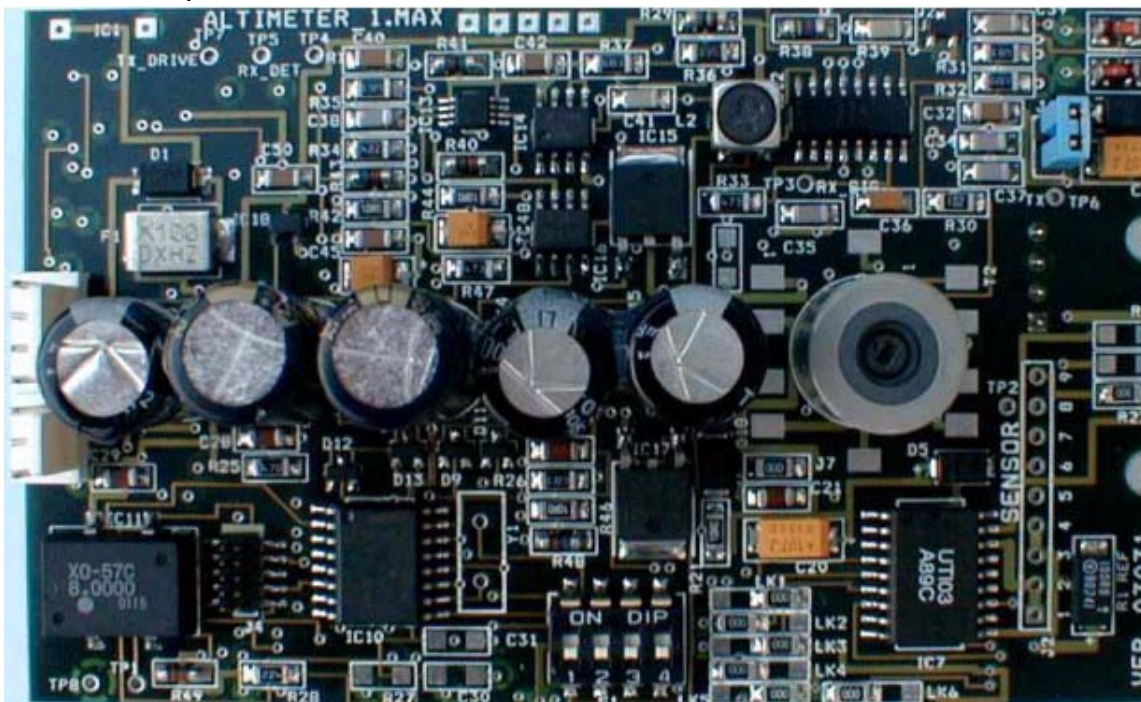


Figure C-12: PCB layout - bottom

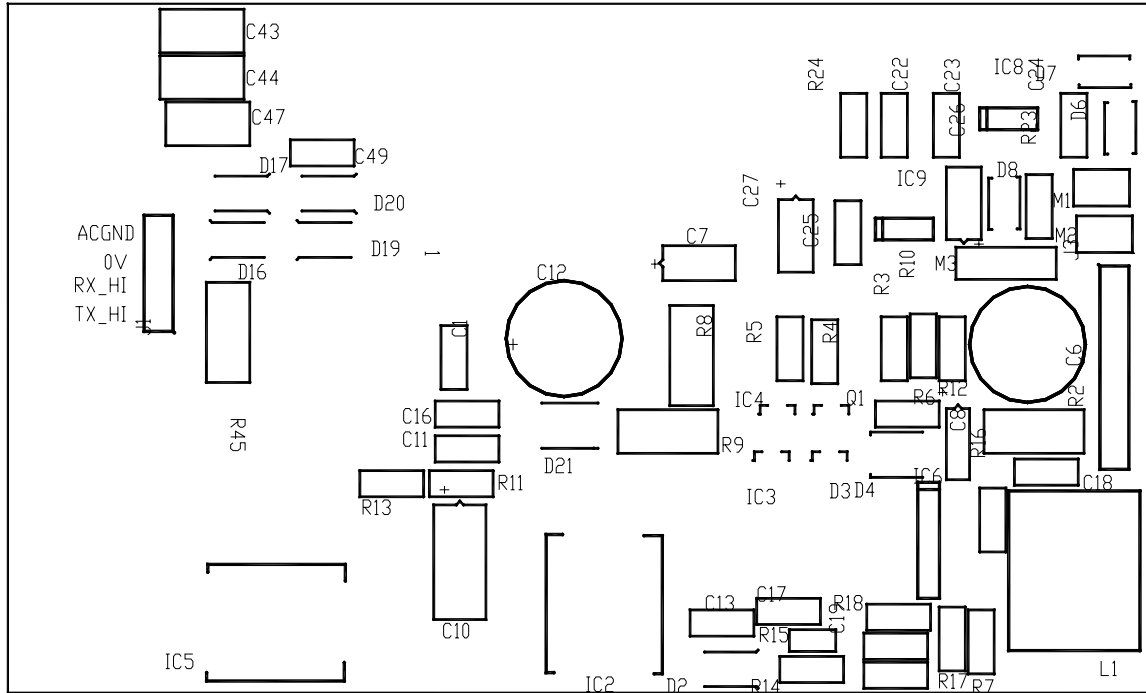
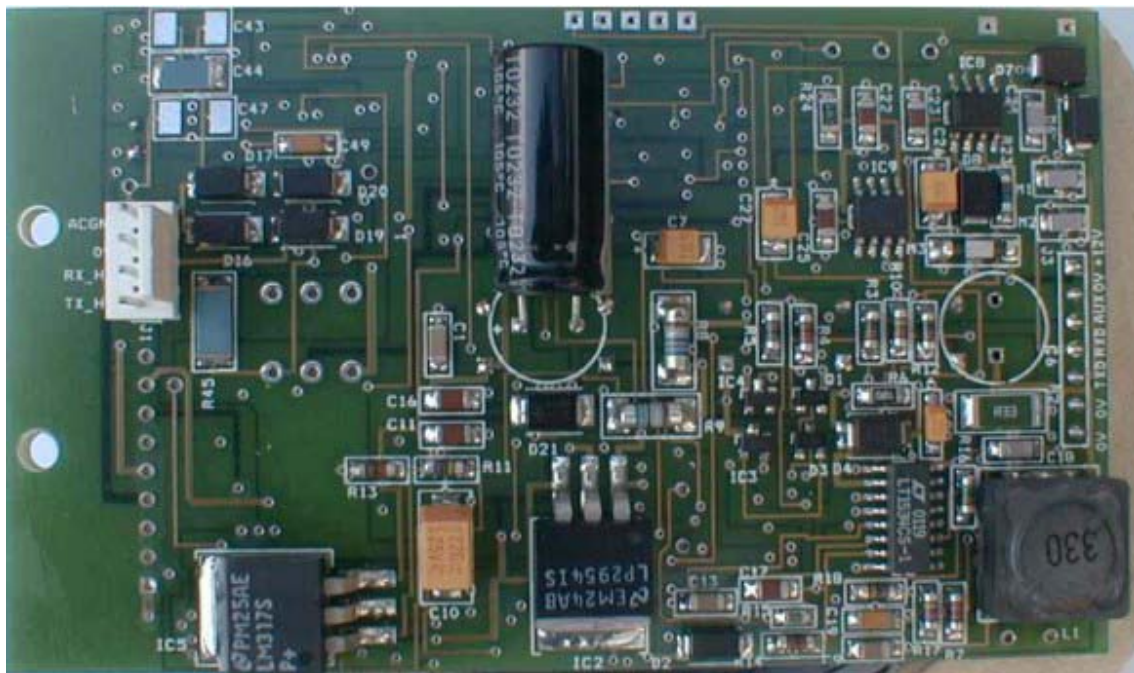


Figure C-13: PCB bottom





D REFERENCE

The following pages contain blank sample copies of forms that you may use to record details about the 440 System before and during a survey. You should complete these forms and include copies with the final survey results to help the post-processing engineers with their survey analyses.

These are master copies of the forms. Make copies of them when necessary.







D.2 TARGET SCALING RESULTS

Automatic target scaling factor: [] μV

Nominal VRT (cm)	True VRT COL 1	440 VRT COL 2	Range error COL 1 – COL 2	Channel signals (μV)		
				Starboard	Centre	Port
40						
60						
80						
100						
120						
140						
160						
180						
200						
210						
220						
230						
240						

Optimised target scaling factor: [] μV

Nominal VRT (cm)	True VRT COL 1	440 VRT COL 2	Range error COL 1 – COL 2	Channel signals (μV)		
				Starboard	Centre	Port
40						
60						
80						
100						
120						
140						
160						
180						
200						
210						
220						
230						
240						





D.3 PERFORMANCE ENVELOPE RESULTS

Target scaling factor; [] μV

True VRT (cm)	VRT VALUES DISPLAYED BY SDC															
	Lateral offset (cm) to port [] or to starboard []															
	300	280	260	240	220	200	180	160	140	120	100	80	60	40	20	0
20																
40																
60																
80																
100																
120																
140																
160																
180																
200																
220																
240																
260																



D.4 SURVEY DETAILS



This Log must be completed before every survey and must be filed with the Survey Records.

Survey vessel: [.....]

Survey vehicle: [.....]

Site: [.....]

Project number: [.....]

Client: [.....]

Date: [.....]

SDC Serial number: [.....] Software version: [.....]

SEP Serial number: [.....] Firmware version: [.....]

PSU Serial number: [.....]

Search-coils Serial numbers: [] [] [] []

Altimeter type: [.....] Serial number: [.....]

Analogue option fitted? [Y] [N]

440 System Configuration

Coil Mapping [.....] Threshold setting [.....] μ V

Target type [.....] Internal/External target diameter [.....]

Weight coating thickness [.....] Target scaling factor [.....] μ V

Altimeter source [.....] Altimeter enabled? [Y] [N]

Altimeter offset [.....] cm Fixed coil altitude [.....] cm

External Data Logger type [.....] Logging rate [1] [4]

Compensation reminder interval [.....] Audible alarm enabled? [Y] [N]

Initial compensation values early: Port [] Centre [] Strb []

Initial compensation values standard: Port [] Centre [] Strb []

Water Temperature Hot [] Medium [] Cold []

Compensation Manual [] M [] G []

Survey completed by: [.....]

Training certificate number: [.....] Date of TSS training: [.....]



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