User Manual
for the
3D Sand Ripple Profiling
Logging Sonar

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1.   Scope

1.1   Identification

This document is the user manual for the 3D Sand Ripple Profiling Logging Sonar (SRPLS).

1.2   Introduction

The 3D Sand Ripple Profiling Logging Sonar is a dual axis mechanically scanning sonar underwater unit with externally removable solid state memory and associated controlling computer. This system is an evolution from previous single axis systems. The SRPLS is powered by an external battery pack but is otherwise self-contained.

The sonar has an oil-filled hemi-spherical plastic "boot" providing protection for its internally rotated transducer which operates at 1.1MHz with a narrow conical beam pattern. Typically the sonar is mounted vertically, looking down at the sea-bed, and captures a sequence of profiles of the sea-bed over a pre-programmed sector and range. The sonar gathers a single swath of data in the horizontal plane and then rotates the transducer through a pre-programmed angle around the vertical axis and repeats the process until a circular area underneath the sonar has been scanned in a sequence of radial spokes.

The raw R-Theta binary data represents the signal amplitude of the envelope of the returned echoes with logarithmic compression to achieve an overall dynamic range of greater than 90dB.

The SRPLS has a collection of sensors to measure conductivity, temperature, depth, pitch and roll which are monitored for each dataset and stored in the data files.

The SRPLS is programmed prior to deployment by connecting a USB cable to a Windows compatible P.C. under control of the supplied 3D Logger Programming software package. The USB cable adaptor contains The SRPLS uses a micro-power real-time clock with battery backed up memory to store its internal program which is activated either by a scheduled clock interrupt or an external hardware trigger input. The bottom cap of the sonar has a clear window through which an LED indicator shows the current state of the system by flashing a coded sequence of green and red pulses. Even with the LED flashing the overall current consumption in sleep mode is less than 1mA. With the USB cable plugged in it is also possible to run the system directly using the 3D Profiling Sonar software. It is useful to operate the system in this mode first to establish the optimum parameters to program the system prior to a long term field deployment.

When the sonar activates it gathers a number of 3D datasets with the pre-programmed parameters and stores each dataset to a unique filename on the externally removable solid state disk drive.

As an option a "wet-switch" may be added to the sonar top-cap adjacent to the transducer which qualifies the decision to capture a sweep. If the wet-switch is not covered with liquid when the sonar attempts to sweep the unit returns to sleep to conserve power and storage space that would otherwise by wasted if the sonar is not underwater. The "wet-switch" may be enabled/disabled in software when programming the unit prior to deployment.

1.3   System Overview

The 3D Sand Ripple Profiling Logging Sonar comprises the following items as shipped from the factory:-

1.   Scanning Sonar Unit which contains the acoustic transducer, rotation motor, tilt motor, acoustic transmitter/receiver board, logger microcontroller board with real time clock and battery backup, sonar microcontroller board, sensor interface PCB, 8Gb externally removable solid-state disk drive, conductivity/temperature probe, pressure transducer, wet-switch and pitch/roll sensors.

2.   USB programming cable with battery and charger, 8-way underwater connector to USB "B" socket, to connect underwater unit to a host P.C. running Windows - recommended minimum specification for the host P.C. is Pentium 1GHz, 1Gb Ram, 1024x768 VGA graphics, CDROM, hard disk with minimum 1Gb free space, and a free USB port.

3.   3D Logger Programmming Software, 3D Profiler real-time Software and User Manual on CDROM for Windows

4.   USB A-B cable

5.   USB adaptor for connecting removable solid-state disk drive to PC to upload data

1.4   Document Overview

The purpose of this document is to provide user instructions for setting up and operating the 3D Sand Ripple Profiling Logging Sonar.

This section, Section 1, provides an overview and general introduction

Section 2 details the documents applicable to this document

Section 3 details the system hardware

Section 4 details the system software

2. Applicable Documents

The following documents are applicable to this document:-

3. System Hardware

3.1 Scanning Sonar Unit

Scanning Sonar Unit which contains the acoustic transducer, rotation motor, tilt motor, acoustic transmitter/receiver board, logger microcontroller board with real time clock and battery backup, sonar microcontroller board, sensor interface PCB, 8Gb externally removable solid-state disk drive, conductivity/temperature probe, pressure transducer, wet-switch and pitch/roll sensors.

3.1.1 Logger Microcontroller PCB FB02B0106

Power for the microcontroller PCB comes from the external 12v to 24v battery pack connected via the underwataer connector on the bottom cap of the unit to PL6. An LP2950ACDT-5.0 low power voltage regulator IC10 provides constant power to the main microcontroller IC6 as well as the sea-switch IC8, the LED flasher IC7 and the real-time clock IC5. TR4 switches the 12VPD and 5VPD power rails to the rest of the onboard electronics as well as the 12VPD to power the sonar.

The PCF8253 real time clock chip (IC5) also has a Lithium back-up battery to maintain the system program in the absence of the main battery pack. The system scheduling program is stored in the real time clock's 240 bytes of battery backed-up static ram. The real time clock interfaces to the main PIC18F452-I/L microprocessor (IC6) via an I²C serial link. The 18F452 has an 8MHz external clock which is internally multiplied by four to get a 32MHz clock which gives an instruction cycle of 125nsec or 8MHz. The quiescent state of the 18F452 is a low power "sleep mode" with the oscillator suspended and all port pins set as inputs for the lowest power consumption. In this mode the current consumption of the whole system is less than 1mA.

To wake the chip up from the sleep mode a hardware interrupt is generated from either the PCF8253 real time clock or via the external trigger input which is optically isolated by IC1. When the microcontroller wakes up it switches on the main system power via TR4 which connects the external battery to the linear regulator IC9 to generate the main +5v supply for the USB flash drive logging unit (IC4) and the rest of the sonar and sensors. The interrupt pin of the microcontroller is driven by a CD4538 monostable (IC2) and so the system can not be re-triggered until the original trigger has been removed. In the case of the clock waking the system up then this is automatically handled by the system software but if the external trigger is being used then care should be taken to follow the correct procedure. A trigger is generated by applying a voltage across the TRIGGER+ and TRIGGER- pins of the underwater connector which are joined to PL1. The voltage can be anywhere in the range 5 to 12v or higher if a resistor is added to limit the input current to 10mA maximum.

Once an external trigger is recognised (trigger is active for minimum 200msec) the system will commence a triggered sweep based on the programmed parameters. The trigger must go inactive before a new triggered sweep can be started by enabling the trigger again. If the system is performing a triggered sweep and a clock alarm occurs then the dataset associated with the

clock alarm will not be captured and the scheduled clock wake-up time will be advanced by the wake-up interval.

The second microcontroller on the pcb is a PIC12C508 (IC7) which is used solely as a very low power status indicator. A single port pin is connected to the main PIC18F452 which acts as a serial communication link between the two microcontrollers. The PIC12C508 is connected to a dual colour red/green LED via PL4 which is visible through a porthole in the end-cap of the sonar. The main microcontroller sends various status codes to the PIC12C508 which are then translated into various "flash codes" - combinations of red and green flashes - to show the user what is going on. By using a very high brightness LED with a short activation pulse and a slow clock speed for the PIC12C508 the current consumption of the LED flasher circuit can be made less than 500μA whilst retaining high visibility. The codes currently implemented show the following conditions:-

0. Single green flash - Program running unit asleep

1. Green-Green-Green-Red (0001) - Unit woken by trigger

2. Green-Green-Red-Green (0010) - Unit woken by clock

3. Green-Green-Red-Red (0011) – Unit online to host P.C.

E. Red-Red-Red-Green (1110) - Program Completed - long sleep

F. Red-Red-Red-Red (1111) - Error condition

If no LED flashes at all are visible then either the main battery is totally flat or not connected or the system has halted due to either software or hardware failure.

The third microcontroller on the pcb is a PIC16C56C (IC8) which performs the sea-switch function. The sea-switch shares the 32.768kHz low power crystal oscillator with the flasher IC7 and it divides the frequency down to generate a 1Hz pulse visible on pin 13 of IC8 as an active indicator. The sea-switch wakes up every ten minutes and then takes ten readings of the external optical sensor at one second intervals. If more than 50% of the readings show that water is covering the sensor then the sea-switch sets its output pin 18 high which is monitored by the main microcontroller. When the main microcontroller wakes up it checks if the sea-switch is active (if enabled) and goes back to sleep if water is not covering the unit to save power. The sea-switch sensor is connected to PL5 and is mounted in the bottom cap of the sonar.

IC3 is an RS485 transceiver and is used to communicate both with the host PC via the USB cable at 1M baud or to the onboard 3D sonar microcontroller PCB.

IC4 is a VDIP1 module which is connected via a parallel interface to the PIC18F452 and provides the USB flash drive interface. The flash drive itself is moulded into a polyurethane housing with a locking sleeve and connected via an external underwater connector to the bottom cap of the unit. There is thus no requirement for the user to open the sonar housing at all.

The Conductivity probe, pressure transducer and pitch/roll sensors are connected to a separate sensor PCB which is interfaced to the logger microcontroller IC6 via PL3. The S0 and S1 control lines for the conductivity probe are connected to the RB6 and RB7 port pins via the program connecter PL7.

The sonar microcontroller is connected via PL2 sharing the same RS485 interface that the logger uses to communicate with the host P.C. for programming purposes.

3.1.2 Sonar Microcontroller PCB EP01A0106

The 12VDC power for the microcontroller PCB connects to TB1 and is filtered by FL1 before being converted to +/-5VDC by PSU1. All the control functions for this PCB originate from the microcontroller IC5, a PIC18F452. The microcontroller is clocked from an 8MHz crystal XTAL1 and internally quadruples this frequency to run at 32MHz.

The logarithmically compressed envelope of the acoustic receive signal is connected to PL5 pin 4 from where it is buffered by the TL082 op-amp IC2 before being digitised by an AD775 eight bit flash A/D converter (IC1). The digital output of the AD775 is buffered by an AM7204 digital FIFO buffer (IC4) which can hold 4096 bytes. The sample clock for the A/D and write clock for the FIFO is generated by the pulse width modulated (PWM) output from the PIC18F452 and can be programmed from 1usec to 100usec which specifies the sample interval. The A/D is scaled such that a 2v peak signal on the input reaches full scale or 0xFF. Data from the FIFO is read via PortD of IC5 from where it is output from the microcontrollers internal UART via the MAX485 RS485 transceiver (IC3). Each acoustic "ping" worth of data is transmitted at 1Mb/sec via IC3 before the sonar can transmit again.

The stepper motor which rotates the acoustic transducer is connected through a 10:1 gearbox, thus 10 motor steps are needed for each acoustic transmission to give an angular resolution of 0.9°. The four phase hybrid stepper motor is driven via buffer transistors TR1 to TR4 from port RB4 to RB7 of the PIC18F452.

The Tilt stepper motor which sweeps the transducer through each swath is connected via a belt drive through a 3:1 reduction ratio, and is similarly driven via transistors TR5 to TR8 from port RB0 to RB3 of IC5. Power for the stepper motors is connected through the current limiting resistors mounted on the chassis to PL8 and PL9.

The position of the transducer head is determined by locating the transducer to a zero reference position which is determined by a metal arm containing a small magnet passing a reed switch sensor which is connected to PL7.

PL6 pin 4 is connected to the USB driver module busy signal so that data overruns are prevented when writing to the USB memory device. PL1 provides a connection for in-circuit programming of IC5 via a suitable adapter.

Two LED's are driven from the microcontroller which are mounted on the side of the EPU. The Green LED lights when the EPU is processing a command from the host computer. The Red LED lights when the EPU is

transmitting data to the host computer. Together these two LED's verify the correct operation of the RS485 data link.

PL5 connects the Transmitter/Receiver PCB.

3.1.3   Transmitter/Receiver PCB CR02A0206

The Transmitter/Receiver PCB is mounted in a 100mm by 50mm screened metal box to decouple the sensitive receive input from the microprocessor clock signals. The Transmitter oscillator frequency is generated by the 4047 astable IC5 and the frequency is adjusted to suit the acoustic transducer with VR1. Normally the oscillator is disabled by a high level at its enable pin 4. The TXGATE signal is an active high (+5v) pulse of width set by the transmit pulse width parameter applied to PL1 pin 1. The oscillator IC5 then generates anti phase clocks at pins 10 and 11 which drive the dual emitter followers TR3 to TR6. The push pull outputs of the emitter followers have their rising edge delayed by the D4/R14 and D5/R16 networks to ensure there is no overlap in the pulses fed to the gates of the MOSFET transistors TR1 and TR2. The drains of TR1/TR2 are connected to the centre tapped toroidal output transformer T1 which steps up the transmit pulse to drive the transducer. Capacitors C11, C14 and C15 and the inductance of T1 combine to tune the waveform applied across the transducer to an approximation of a sine-wave. Diode networks D7/D8 and D1/D6 provide the transmit/receive gating function such that high voltages are not applied across the receiver input and low level receive signals are not shunted by T1.

The receiver has an input low-pass filter (L6/C19) to limit the input bandwidth to less than 4MHz and a clamping circuit around TR8 to shunt the input to ground during the MUTE pulse which limits the overload caused by the transmit pulse. The receiver input pre-amplifier stage is an AD603 (IC3) which is a voltage controlled variable gain amplifier with up to 40dB of gain and very low input noise into its 100ohm input impedance. The output of the IC3 is coupled through a bandpass filter around L3,L4 and L5 to the AD8307 logarithmic amplifier. The AD8307 output is the logarithm of the signal envelope amplitude, a portion of which is tapped off via R6, R5 and R12 to provide the AGC control voltage for the AD603. The TL081 op-amp IC1 buffers the detected signal output and scales it to 20mV per dB, therefore if the input signal changes by 40dB the output voltage will change by 0.8v.

3.1.4   Sensor PCB FJ02A0106

The sensor PCB connects the conductivity probe, pressure transducer and pitch/roll sensors to the logger microcontroller.

IC4 generates a -5v d.c. power rail from the +5v supply to bias the amplifiers and A/D input.

A MAX186 12 bit 8 channel A/D converter (IC1) provides 3 analogue voltage inputs at PL1 scaled from -2v to +2v. Channel 1 is connected to the Pitch sensor (Y axis), channel 2 is connected to the Roll sensor (X axis) and channel 3 goes to the temperature transducer on the Pitch/Roll sensor. A/D input channel 0 is connected via a resistor to the 12v d.c. input to record the supply voltage. Channel 4 is connected to the conductivity probe via PL3.

Channel 5 is connected to the pressure transducer via the scaling amplifier IC3 which buffers the signal from the pressure transducer connected to PL4. The LM317LD regulator is adjusted via R29 to give10.00v to power the pressure transducer across pins 1 and 4 of PL4. R28 is used to trim the offset of the pressure transducer to read zero out of the water.

Channels 6 and 7 are not used. The MAX186 interfaces to the PIC16F877 via a serial link through PL2.

Jumper links LK1 to LK4 should be set in position 1-2 for normal operation.

3.1.5   Pitch and Roll Sensors 900T (20°)

The tilt sensor is a dual axis electrolytic type with a full scale range of +/-20° for both Pitch and Roll. Also mounted on the PCB is a temperature transducer which monitors the internal temperature of the sonar unit. The tilt sensor is powered from the switched 12v supply and its analogue voltage outputs are connected to the 12 bit A/D on the Sensor PCB.

3.2   Programming Lead

The system is supplied with a special programming lead to connect from the 8 way underwater connector to a USB port on a host P.C. The connecting lead has a diecast box with an internal 2.8AH 12v lead-acid battery to provide power to the sonar whilst it is being programmed. There are two, two position, switches on the box marked "Connect/Off" and "Trigger/Off" which should both be in the "Off" position when mating either the underwater connector or the USB port connector.

A seperate "plug-top" charger unit is supplied with the system, which connects to the die-cast box via a miniature d.c. power plug with the centre pin +ve and the outer -ve. This is a special unit for charging sealed lead-acid batteries and should only be used for this purpose. Both of the switches on the box should be in the "Off" position for charging and the sonar should not be connected.

The battery will give around two hours continuous use of the sonar for programming and testing purposes.

4.   System Software

4.1   How to Program the Sonar

The 3D Sand Ripple Profiling Logging Sonar is supplied with a Windows program which provides a means for programming the sampling schedule of the sonar and running diagnostics. To use the software the special programming lead with the internal battery should first be connected between the sonar and the P.C.

4.1.1   Connecting the Programming Cable

The Programming Cable consists of an eight way female Sub-Conn underwater connector connected to a die-cast box that contains a sealed lead-acid 2.8AH 12v battery and two switches. There is a USB type "B" connector on the box that is connected to a USB port on the host P.C. that is being used to run the programming software via an A-B USB lead (supplied). The two switches should be in the "Off" position before plugging the underwater connector into the sonar first followed by the USB cable into the P.C.

NOTE:- *When plugging either the programming lead or the main battery pack into the sonar the underwater connector should be mated with one firm push. If the connector is wobbled about whilst attempting to mate it the power connection to the sonar could be made and broken several times which may cause corruption of the stored program and require re-programming. Ensure that there is plenty of grease on the connector (either white petroleum jelly or silicon grease) before attempting to join them as this will make it easier to obtain a good connection.*

4.1.2   Powering up the system for programming or diagnostics

First operate the "Connect" switch, which is used by the sonar to verify the presence of the serial cable. Second, operate the "Trigger" switch which should wake-up the sonar and may be checked by observing that the LED "flash code" changes to "3", i.e. Green-Green-Red-Red (0003). If the "3DProgrammer" program is now run, correct operation can be verified by the sonar real time clock field updating on the main program screen regularly.

4.1.3   Powering down the system after programming

First exit from the "3DProgrammer" program and then switch the "Trigger" switch to the "Off" position. Next switch the "Connect" switch to the "Off" position and observe that the LED "flash code" changes to a single green flash about every two seconds - this indicates that a program is executing and the unit is asleep waiting until its next wake-up time. At this point the USB cable may be disconnected from the P.C. first then from the sonar at which point the LED will stop flashing as there is no battery connected. The main battery may be safely connected now or at a later date but always before the next scheduled wake-up time.

NOTE:- *If the "Start Sampling Time" of the sonar is set a long time before the current time then there could be a significant delay before the sonar will power down. It is therefore recommended for correct operation that the Start Time is always set to be later than the current.*

Before disconnecting the serial cable it is possible to manually trigger the sonar into its sampling mode to verify correct operation or this may be the desired operation mode for lab testing or live work.

4.1.4 Manually triggering the sonar with the serial cable

With the serial cable connected, both switches "Off" and the sonar in sleep mode (single green LED flash) the sonar may be triggered by operating the "Trigger" switch only. This makes it easy to test and set up the system as a program may be entered, a few sweeps triggered, and then the stored data may be examined by reading the files from the removable flash memory. The parameters may then be modified slightly and the process repeated until the user is confident that the sonar is gathering data as expected.

4.1.5 Running the sonar in real-time connected to a P.C.

Supplied with the system is a separate Windows program called "3DProfiler", which can be used to control the sonar and display the raw data live as it is captured. First connect the sonar to either the serial cable or a suitable battery pack/power supply. Switch the "Connect" switch on and then the "Trigger" switch on to wake the sonar up in remote mode. Connect the USB cable to the P.C. with the "3DProfiler" software installed and start the 3DProfiler program.

A message should appear on the left of the statusbar at the bottom of the main display window saying "sonar nn online". The sonar parameters can now be set with the onscreen control panel and a sweep manually started by pressing the green "play" button. See the instructions in section 5 for the features within the 3D Profiler program.

NOTE:- *The 3DProfiler software can also be used to post-process the .rw2 files saved by the logging sonar and convert the raw data into .xyz ASCII files for export into other applications.*

4.1.6 Data capture using external trigger

Of course the manually triggered mode described above in section 4.1.4 may be used as the primary method of data capture for the sonar instead of the real time clock wake-up intervals. The external trigger consists of two pins TRIGGER+ and TRIGGER- on the underwater connector which are connected to the LED of an optical isolator via a 1kohm resistor. To activate the trigger a voltage must be applied across the trigger pins such that the positive is connected to TRIGGER+ and the negative to TRIGGER-. If the externally applied voltage is greater than 12v then a series resistor should be added to limit the current drawn by the opto-isolator to around 10mA, noting that there is an internal 1k resistor already.

The external voltage must be applied for at least 200msec for the sonar to wake-up correctly at which point the voltage may be removed and the sonar will only perform one sweep.

If a clock alarm occurs during a triggered sweep period then the dataset associated with the clock alarm will be lost and the wake-up interval added to advance the alarm to the next wake-up time.

4.2 Software Installation

The logger programmer software is supplied on CDROM. There is a setup.exe program in the root directory which should be executed using the "Run..." option from the "Start" button on the Taskbar. The setup program will suggest an installation directory which may be modified if really necessary but should not conflict with any other software if the default is selected. When the setup program completes the program may be run by selecting the "3DProgrammer" program via "Start" then "Programs" from the Taskbar.

NOTE:- *The 3DProgrammer software requires that Windows has a version of DirectX installed which is no lower than version 7. If this is not the case then there is a copy of DirectX7 on the supplied CDROM, which should be run prior to running the 3DProgrammer software.*

4.3   Main Program Screen

The main program screen is shown below and is where all the scanning, sampling and scheduling parameters are entered.
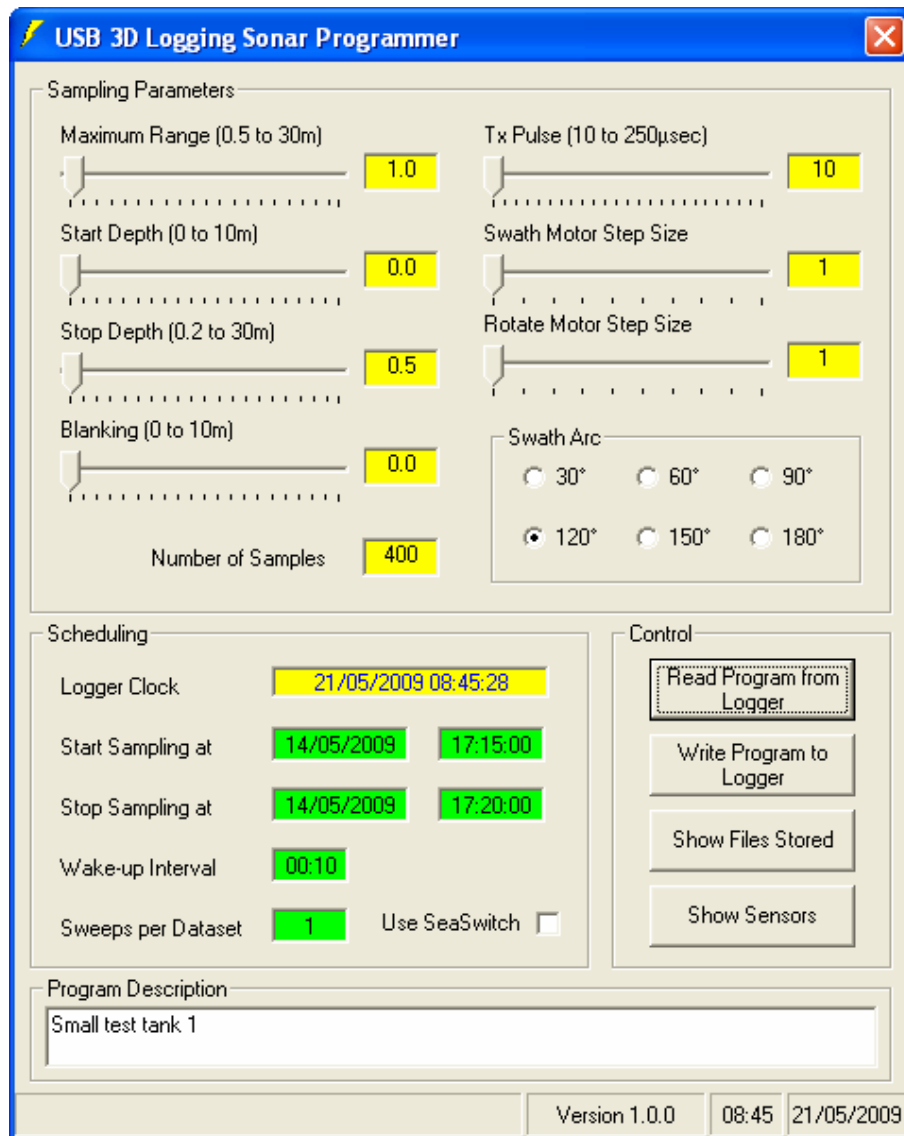
The general principle for modifying the on-screen values is to first select the data field to be modified by either left clicking the mouse once on the data field or using the TAB key to advance to the required field. The data may then be modified by overtyping a new value and/or using the BACKSPACE or DELETE keys to modify the data. When finished with a particular field use either the ENTER key to register the change or move to a different data field. The data entered is checked when another field is selected or ENTER is pressed and if it is outside the acceptable range a message-box will be displayed showing the limits of the parameter and the entered value will be reset. The boxes coloured yellow on the setup screen represent parameters that can not be edited but are calculated and displayed as a result of the other settings.

4.3.1 Maximum Range

The Maximum Range setting limits the radial coverage of the sonar and mainly comes into play when the 180° swath width is selected. The easiest way to think of the effect that this control has, is to imagine a cylinder of this radius centred on the sonar beyond which no data is gathered. The Maximum range of this control is 30.0m

4.3.2 Start Depth

The Start Depth specifies the depth below the transducer at which sampling starts and is mainly used to reduce multipath caused by the proximity of the transducer head to the surface or other objects. The limits of the Start Depth are 0.0m to 10.0m.

NOTE:- *The Start Depth is referenced to the transducer not the water surface.*

4.3.3 Stop Depth

The Stop Depth specifies the depth below the transducer beyond which data is not captured and is used with the Start Depth to reduce multipath caused by the proximity of the transducer head to the surface or other objects. The limits of the Stop Depth are 0.2m to 30.0m.

NOTE:- *The Stop Depth is restricted by the on-screen controls to be at least 0.2m greater than the Start Depth.*

4.3.4 Blanking

The Blanking range parameter is sent to the logger and stored within the data file headers, however, it only comes into play when the data file is post-processed by the 3D Profiler software. The Blanking range is the radial distance from the transducer head up to which the sonar signal is not processed for the sea bed profile. Because the sonar uses the same transducer for transmit and receive, every transmit pulse causes the transducer to carry on vibrating after the transmit pulse ends. As a result there is a residual signal at the receiver which lasts for approximately 200mm in range terms after the transmit pulse ends. The blanking control masks off the data for up to the value set on the control so that false data points are not processed when calaculating the sea bed profile. The blanking control can also be used to mask off echoes from nearby objects or mounting structures close to the sonar.

4.3.5 Transmit Pulse

The acoustic Transmit Pulse may be set in the range 10μsec to 250μsec with shorter pulses generally giving higher resolution but the trade-off is that the gain is less with shorter pulses. The Transmit Pulse is adjusted in increments of 10μsec. For short ranges (up to 1m) it is unlikely that a transmit pulse of more than 20usec is required.

4.3.6 Swath Motor Step Size

The Swath Motor Step Size specifies how many discrete 0.9° tilt motor steps are performed for each "ping" of the sonar. For the finest detail the Swath Step Size should be set to 1, but by increasing this setting the scan speed may be

increased and the dataset size reduced. The range of values that may be set is from 1 to 10.

4.3.7 Rotation Motor Step Size

The Rotation Step Size specifies how many discrete 0.9° rotation motor steps are performed after each swath gathered by the sonar. For the finest detail the Rotation Step Size should be set to 1, but by increasing this setting the dataset capture speed may be increased and the dataset size reduced. The range of values that may be set is from 1 to 10.

4.3.8 Swath Arc

The Swath Arc control specifies the angle over which the each sonar swath is captured, centered about the vertical axis of the sonar body. The swath width is set by clicking on one of the "radio buttons".

4.3.9 Logger Real Time Clock

This data field can not be modified by the user. When the sonar is connected and powered up the current value of the Real Time Clock integrated circuit on the Logger Microcontroller board is displayed in this field. The time is updated approximately every second but may jump a few seconds every now and then as it is not synchronised to the timer loop of the host P.C. that is displaying the data. The clock display is very useful for checking that the system is connected together correctly and as it polls the sonar over the USB link every second this activity can also be monitored with an oscilloscope if a fault is suspected with the communications.

The logger real time clock chip is re-programmed to match the local time on the host P.C. whenever the "Write Program" button is clicked. Therefore it is important that the host P.C. clock is set to the correct time when programming the sonar.

The clock operates in 24 hour mode and the display format is as shown below:-

<p style="text-align:center">dd/mm/yyyy hh:mm:ss</p>

4.3.10 Start Sampling At

There are two data fields for entering the date in dd/mm/yyyy format and the time in hh:mm:ss format at which the sonar starts its sampling sequence. This date and time may be set up to a year from the current date/time and the main battery pack disconnected after the sonar enters its "sleep mode" as long as the battery is reconnected before the sampling starts. This allows the equipment to be set up in the laboratory and then deployed some time later.

NOTE:- *When entering the date or time be careful to preserve the separator characters "/" and ":" in the date and time fields as the software relies on these to decode the date/times. If the formatting is not maintained then the clock may be corrupted requiring re-programming otherwise the system may not record any data.*

4.3.11 Stop Sampling At

There are two data fields for entering the date in dd/mm/yyyy format and the time in hh:mm:ss format at which the sonar stops sampling and shuts down into its low power "sleep mode". If the sonar real time clock reaches the Stop Sampling time then the "flash code" on the LED visible through the end-cap changes to "E", i.e. Red-Red-Red-Green or 1110 to signal that the program has ended. It is good practice to use the Stop Time to shut the system down cleanly and prevent unpredictable operation as the battery voltage falters.

4.3.12 Wake-up Interval

The Wake-up Interval specifies the time that is added to the Start Sampling Time to generate the next wake-up time and subsequently added to the next wake-up time and so on. The Wake-up Interval is programmed in units of hours and minutes and so the range of values that can be set are from one minute to 23 hours and 59 minutes.

4.3.13 Sweeps per Dataset

The number of Sweeps per Dataset specifies how many sweeps are gathered with the programmed parameters every time that the sonar wakes-up from its sleep mode. The range of acceptable values are from 1 to 100.

NOTE:- *Care MUST be taken to choose sensible values for the Sweeps per Dataset and the Wake-up Interval as the sonar can not intelligently guess what the user has in mind. For example, if the Wake-up interval is set to one minute and the number of Sweeps per Dataset to 100 this would not be sensible. It should be remembered that the time taken to perform a single dataset could be fifteen minutes or more at maximum range and resolution.*

4.3.14 Use Sea Switch

The Use Sea Switch check-box allows enabling/disabling of the Sea Switch function. If enabled (check-box is ticked) then when the sonar is woken from sleep the system will only gather data if the sea switch sensor is immersed in water, otherwise it will go back to sleep immediately. If the box is unchecked then the sonar will gather data whenever it is woken up regardless of whether it is in water or not.

NOTE:- *The Sea Switch is located on the bottom cap of the sonar, therefore the sonar head would be 600mm below the water surface before the Sea Switch would be triggered.*

4.3.15 Program Description

A text string may be entered here which is stored in the header of each data file on the hard disk to help in identifying the dataset. Spaces may be used in the string for clarity but avoid inserting any control characters. Delete and Backspace may be used to edit the string which may be up to 100 characters long.

4.3.16 Control Buttons

There are four control buttons to the right and bottom of the main program screen. The buttons may be selected by a single left click of the mouse or by

using the Tab or Shift Tab key combination to highlight the required button and press ENTER to select it.

4.3.16.1 Read Program Button

The Read Program button uploads the program that is currently stored in the sonar and updates all the data fields on the main program screen. This option may be used to give a starting point for the next program schedule or to verify that the latest Write Program was correctly stored by the sonar. The sonar real time clock display is briefly suspended whilst the program data is uploaded.

4.3.16.2 Write Program Button

The Write Program button downloads the current contents of the main program screen to the sonar and stores it as the next program to be executed when the Start Sampling time is reached by the real time clock. As with the Read Program button the sonar real time clock display is briefly suspended whilst the data is downloaded.

NOTE:- *It is recommended that after every press of the Write Program button that the Read Program button is pressed to confirm that the data has been successfully downloaded. Wait until the sonar real time clock resumes updating between button presses though to ensure there is no data conflict. When the Write Program button is pressed the date and time from the Windows operating system is sent to the sonar to reset the sonar real time clock. Therefore it is VERY IMPORTANT that the date and time are set up correctly in Windows before pressing the Write Button otherwise the sonar may not wake-up when expected to. Always confirming the correct program settings by using the Read Button should avoid expense mistakes with incorrect time settings.*

4.3.16.3 Show Files Stored Button

The Show Files Stored button opens a directory and file dialogue window, which shows the directories stored on the USB flash drive plugged into the sonar. If one of the directories is clicked on then the files stored in that directory are listed.

NOTE:- *It is not possible to display the contents of the files using the programmer software. To display the data it is necessary to remove the flash drive from the sonar and connect it to a P.C. running the 3D Profiler software.*

4.3.16.4 Show Sensors Button

When the Status Display button is pressed the main program screen closes and control passes to the Status Display screen which is described below.

4.5   Status Display Screen

The Status Display screen graphically shows the eight channel outputs of the 12 bit A/D on the Microcontroller PCB in the sonar. The format of the display is as shown below and the readings update dynamically approximately every 0.5 seconds which is most obvious if the body of the sonar is moved to modify the Pitch and Roll values.
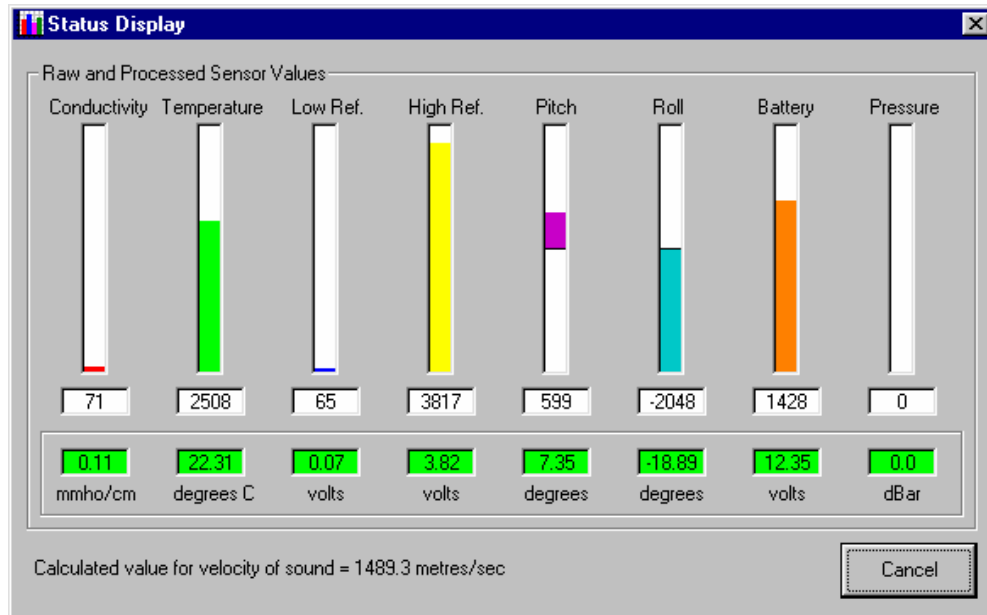
The Status Display screen is closed by pressing either the Cancel button or the cross in the top right corner of the window which will return control to the main program window.

5.   Stored File Format

5.1   File Names

The names of the data files stored on the hard disk by the logging sonar are generated automatically and the directory structure organised according to the date and time that the data file was created.

For every day that the sonar stores data a new sub-directory is created with the following name:-

ddmmyyyy   where dd are two day digits 1 to 31
mm are two month digits 01 to 12
and yyyy are four year digits.

Within the current day directory the sonar stores files with the following naming convention:-

hhmmssii.nnn where hh are two hour digits 00 to 23
mm are two minute digits 00 to 59
ss are two second digits 00 to 59
ii are two sweep index digits 01 to 99

nnn is either xyz or rw2 depending on file type

5.2   XYZ Data File Structure

The xyz data files are made up of two distinct elements, the first being an ASCII header containing the sonar parameters and the second being the comma separated variable data captured by the sonar. The data format lends itself to being imported into many third party software applications such as spreadsheets and CAD software packages.

5.2.1   ASCII Header

The ASCII header is separated from the ASCII xyz data by a blank line to make it easy to extract just the xyz data when re-processing the file with third party software. The start of a typical data file is shown over.

The header should be read by third party software on a line by line basis. The first line of the file is an identifier for the file type and the second line is a time and date stamp when the file was recorded by the sonar. The following 15 lines are the setup parameters of the sonar. The next 8 lines are the raw outputs from the various sensors in the system followed by the calculated velocity of sound based on this sensor data before the blank line signalling the start of the xyz data.

5.2.2   ASCII XYZ data

The ASCII data is stored in three columns per line with comma separators and a carriage return, linefeed at the end of each line. The data is ordered x, y, z and each of the xyz values are in mm. Note that the z value is the distance BELOW the transducer at which the seabed was detected NOT the actual seabed height relative to any charted datum.

5.2.3 Sample XYZ file

```
3D_Profiler_XYZ
21/05/09  10:55:40
MaxRange = 800
Arc = 100
SwathStep = 1
RotateStep = 1
Tx Pulse = 10
Mute Pulse = 10
Delay = 267
Sample Interval = 1
No. of Samples = 488
Threshold = 20
Blanking = 200
Start Range = 200
Stop Range = 400
Filter = 10
Capture VoS = 1500
Conductivity = 00072
Temperature = 02358
Low Reference = 00062
High Reference = 03899
Pitch = 00109
Roll = 00076
Battery Voltage = 02055
Pressure = 00000
Measured VoS = 00000

000005,000258,000243
000005,000256,000248
000005,000251,000251
000005,000247,000255
000005,000235,000250
000005,000230,000254
000005,000217,000247
000005,000214,000251
000005,000208,000252
000005,000202,000253
000005,000197,000254
000005,000195,000260
etc., etc...
```

5.3 Raw data file structure .RW2

The .RW2 data files are made up of two distinct elements, the first being an ASCII header and the second being the binary data captured by the sonar which is only readable with an appropriate software program.

5.3.1 Header

The ASCII header is separated from the binary data by a blank line to make it easy to extract just the binary data when re-processing the file with third party software. The start of a typical RW2 data file is shown below.

The header should be read by third party software on a line by line basis. The first line of the file is an identifier for the file type and the second line is a time and date stamp when the file was recorded by the sonar. The third line contains the comment field and the following 15 lines are the setup parameters of the sonar. The next 8 lines are the raw outputs from the various sensors in the system before the blank line signalling the start of the binary data.

5.3.2 Binary Data Block

The binary data is then stored sequentially on a ping by ping basis for each swath. The first ping of data will be at the swath start angle and will be "No. of Samples" of consecutive bytes followed by the next ping at the swath start angle + 1 and so on up to the swath stop angle, where the next ping of data will be the first ping of swath 2 and so on until all swaths are complete. The size of a raw data file can thus be estimated from the following formula.

Raw file size in bytes =

Header + (Arc/SwathStep) * (200/RotateStep) * No. of Samples

For example, assume that 600 samples per ping are taken and that the swath arc is 150° (168 gradians) and that the sweep_step and rotate_step are 1. Thus the raw file size in bytes will be:-

Header + (168) * (200) * 600 = 20,160,000 bytes or approx 20Mb!

```
3D_Profiler_RW2
14/05/2009 17:15:14
Small test tank 1
Maximum Range in mm = 800
Arc in 0.9° steps = 100
SwathStep in 0.9° steps = 1
RotateStep in 0.9° steps = 1
Tx Pulse in µsec = 10
Mute Pulse in µsec = 10
Delay in µsec = 267
Sample Interval in µsec = 1
No. of Samples = 488
Threshold % = 20
Blanking in mm = 500
Start Range in mm = 200
Stop Range in mm = 400
Filter = 10
Capture VoS = 1500
Conductivity = 72
Temperature = 2358
Low Reference = 62
```

```
High Reference = 3899
Pitch = 109
Roll = 76
Battery Voltage = 2055
Pressure = 0
```

omg___]UUO]gou}☐}uuuouw☐☐……☐☐wwoe]]]mu}☐‡………☐ww☐☐…………☐me]_
___WG?=5//7?MU____]_W]_]WOMOUWUUU_]_UOMGMUU]gmuw}}wo]MGM]
emoo}…‡☐}oeeoo_UU__]]emommmume_]_]UUWUU]eu}☐}}}wmmee]OOU]
gm}‡☐—☐•☐☐……☐☐—
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ÿÿÿÿõ÷õõïïííïïïïïïíïççåßßÝÕÕÏÇÅ¿·-☐—
•☐☐☐‡‡‡☐☐☐☐☐…}☐‡‡☐‡…wmoowww}}……☐☐••—…etc…etc…

6.   Connection Details
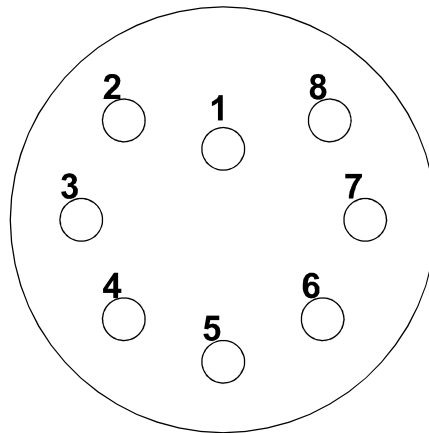
6.1   8 way Underwater Connector

6.1.1   Connector Type

IL-8-FSX (on 5 metres of 18/8 SO Cable)

6.1.2   Connector Supplier

Sea Connection Systems Ltd.,
Unit 8,
Bessemer Way,
Harferys Industrial Estate,
Great Yarmouth,
Norfolk,
NR31 0LX
Tel.   01493 652733
Fax.   01493 652840

6.1.3   Pin Connections

Pin view looking into socket

Black	Pin 1	+12v to +24v d.c. Battery Input
White	Pin 2	Trigger +ve
Red	Pin 3	Trigger -ve
Green	Pin 4	RS485 data +
Orange	Pin 5	RS485 data -
Blue	Pin 6	0v (Battery return)
White/Black	Pin 7	Online input (online = joined to pin 8)
Red/Black	Pin 8	0v return for online input