

3D Monitoring Sonar Operators Manual

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1.0 Introduction

1.1 Principle of operation

The 3D Scour Monitoring Sonar is a solar powered 4G connected sonar. The sonar is a dual axis mechanically scanning underwater unit connected via an underwater umbilical cable to a surface installed electronics cabinet. A +12VDC battery fitted to the inside of the cabinet provides power to the sonar. The battery is charged from a solar panel connected to the cabinet. A 4G router and an antenna on the cabinet means the sonar can be communicated with remotely from an internet connected PC.

The sonar has an oil-filled hemi-spherical plastic "boot" providing protection for its internally rotated transducer which operates at 1MHz with a narrow conical beam pattern. The sonar is mounted vertically with the sonar dome at the bottom, looking down at the sea-bed, and captures a sequence of profiles of the sea-bed over a preprogrammed 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 movement of the sonar head and the saving of the acoustic data is performed by the internal sonar electronics acting as a slave to a remote PC. The sonar is configured via the cloud using the 3D Remote Profiler Configuration Editor software. The captured raw acoustic data is uploaded by the system to the cloud periodically at a rate specified by the user. The raw 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 3D Profiler software processes the raw data to generate a line profile for each swath and then combines the swaths to construct a 3D model of the area scanned. The model data may be saved in an ASCII x,y,z format for importing into other third party software such as CAD or spreadsheet programs.

1.2 The System Hardware

The complete system comprises the following items as shipped from the factory:-

1. 3D Profiling Sonar which comprises the acoustic transducer, rotation motor, tilt motor, and conductivity probe. There are four PCB's in the sonar head, namely the Logic PCB, Rx/Tx PCB, Sensor PCB, and Pitch and Roll PCB. An eight pin underwater connector provides a connection for the umbilical cable to connect to the surface installed electronics cabinet.
2. Electronics Cabinet which contains the 4G router, antenna, PC, solar charger, 2A and 10A fuses, ON/OFF switch and Scheduling Box. A three pin and two pin connector provide a connection for a solar panel and battery charger, respectively.
3. 50m underwater cable to join the 3D Profiling Sonar to the Electronics Cabinet.
4. 3m lead for connecting a Solar Panel to the Electronics Cabinet.
5. 0.5m lead for connecting a battery charger to the Electronics Cabinet.
6. 3D Remote Profiler Configuration Editor software for Windows.
7. 3D Profiler software for Windows.
8. User Manual.



3D Profiling Sonar



Electronics Cabinet



50m Underwater Cable



3m Solar Panel Cable



0.5m Battery Charger Cable

2.0 Specification

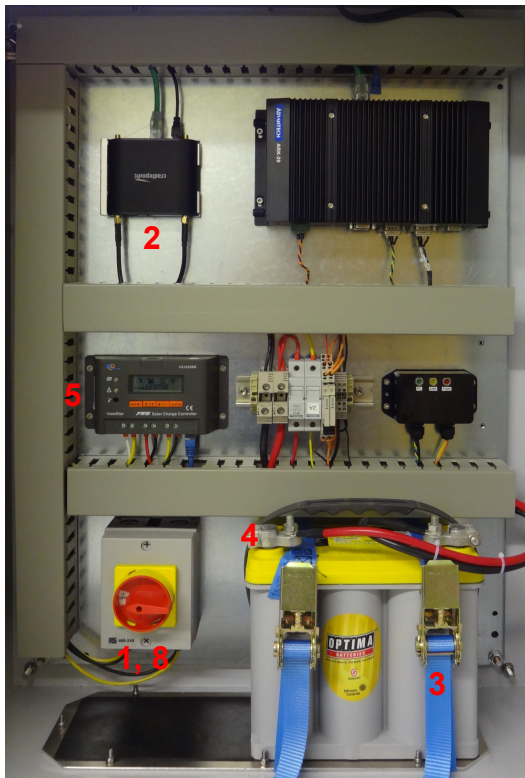
2.1 3D Scanning Sonar Unit

Mechanical & Environmental	
Overall Length	557mm
Diameter	100mm
Finish	Black Acetal
Maximum Operating Depth	50m
Operating Temperature	0 to +35°C
Storage Temperature	-10 to +60°C
Weight in air	4.2 kg
Weight in water	0.06 kg
Acoustical	
Acoustic Frequency	1MHz
Beam Width	1.8 deg. (+/- 3dB) (Conical beam)
Range Resolution	<1mm
Range Settings	0.5m to 20m in 0.1m steps
Transmit Pulse Width	10 to 250µsec
Swath Resolution	0.45° to 4.5° in 0.45° steps
Rotational Resolution	0.9° to 9° in 0.9° steps
Interface and Cable	
Communications	Ethernet 10/100 Base-T
Connectors	8-way Subconn (BH8M)
Maximum cable attenuation	40dB at 2MHz
Power Requirements	12VDC 15W Maximum

2.2 Electronics Cabinet

Cabinet	
Electrical	
Power Requirements	+12VDC 15W Maximum < 0.2W Sleep Mode
Communications	4G LTE
Connectors	8-way Subconn (BH8F) 3-way Subconn (BHB3M) 2-way Subconn (BH2F)
Solar Charger	
4G LTE Router	
PC	

3.0 System Setup



3.1 Installation

- (1) Ensure the ON/OFF rotary switch is in the OFF position.
- (2) Insert a SIM card in the 4G wireless router.
- (3) Securely fasten the battery to the inside of the cabinet using the webbing straps.
- (4) Fix the black and red battery cables to the negative and positive battery posts, respectively.
- (5) Although not mandatory, the solar charger's settings may be adjusted at this point.
- (6) Plug the solar panel into the 3-way connector on the side of the Electronics Cabinet.



Connect the battery cables FIRST then connect the solar panel. Never connect the solar panel before the battery.

- (7) Connect one end of the underwater cable to the 3D sonar and the other end to the 8-way connector on the side of the Electronics Cabinet.
- (8) The system is now ready to be powered on. Turn the rotary switch to the ON position and the red “PWR” LED on the black Scheduling box will blink to indicate the system is fully powered.

3.2 Connecting a Battery Charger

- (9) Connect the battery charger to the 2-way connector on the side of the Electronics Cabinet.
- (10) Power on the battery charger to begin the battery charging process.

4.0 Operating the System

4.1 Normal System Operation



Power up the system by turning the large red rotary switch to the ON position. The PC and the 3D Profiling Sonar will turn on. The PC will then boot and run its software tasks before putting the sonar to sleep and shutting itself down ready for its first scheduled wakeup time.

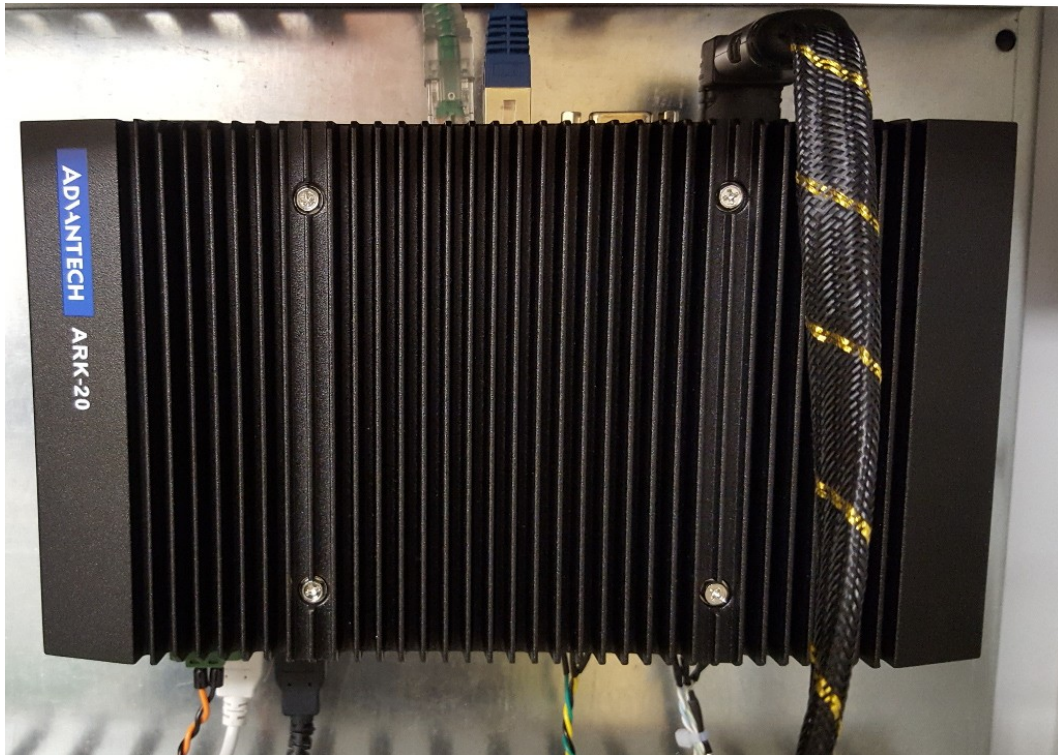
The software starts by downloading any new data files from the sonar and saves them to a cloud folder on the disk. The time taken to download the new data files varies greatly depending on the scanning parameters used to collect the data and the number of new data files that exist. It may take as little as 1 minute for a few small data files or as much as 20 minutes for 4 or 5 large data files.

Next the software checks the configuration file. The configuration is applied if there is a new configuration file or on first boot after powering up the system with the rotary switch. The configuration file is an XML file created by the 3D Remote Profiler Configuration Editor software. It is named 'config.xml' and can be found in the cloud storage folder.

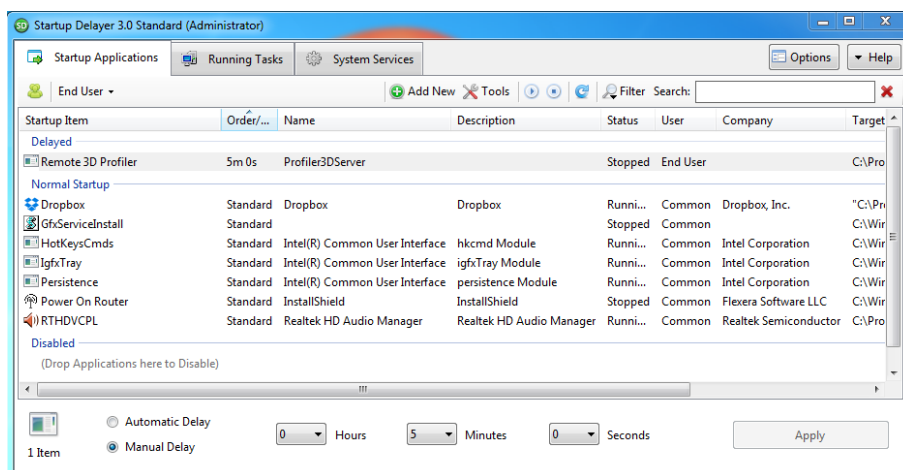
Finally the software puts the sonar to sleep to allow it to start up on schedule before waiting some time to allow newly downloaded files to synchronise with the cloud. It then shuts itself down ready for the next PC wakeup time.

4.2 Performing administration on the PC

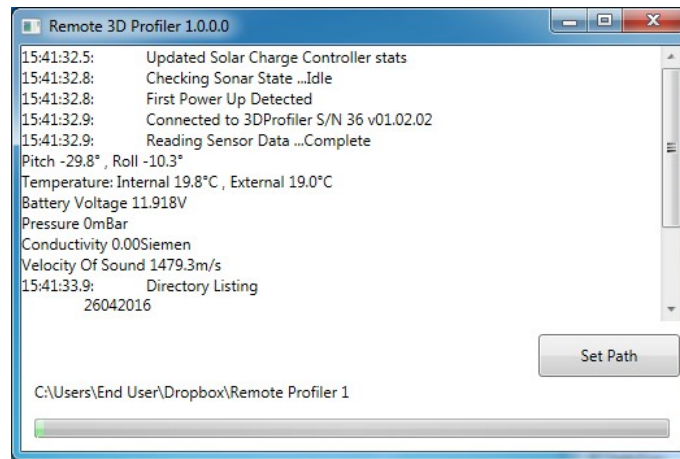
With the system turned off, connect an HDMI cable for an external monitor, a USB keyboard and a USB mouse.



Turn on the system and wait while the PC boots into windows. The control software consists of 2 separate programs. The first one starts up immediately and just sends a message to turn the 4G router on. The main software then starts up after a delay. The delay is to ensure that the 4G router has finished its power on routine and connected to a network before the main software starts.



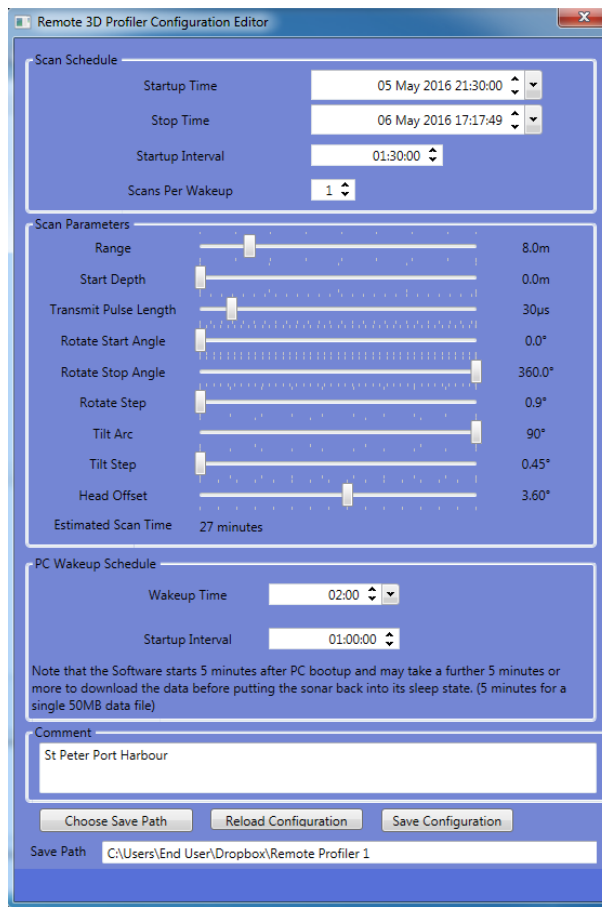
The software used to create the delay is accessible by clicking on the 'SD' button on the taskbar. You can see above that the Remote 3D Profiler software is delayed by 5 minutes.



Once the main software has started, you can use the 'Set Path' button to change the save directory. Note that this path is also used to update the configuration so it should be mirrored in the Configuration Software. Any changes to the save path will take effect the next time that the program is run. Close the program down by left mouse clicking on the cross in the top right corner. Note that if the software is not closed down, then it will automatically shut down the PC once it has completed its tasks. When the administration tasks have been finished, shut down the PC then power the system off by turning the large red rotary switch anti-clockwise.

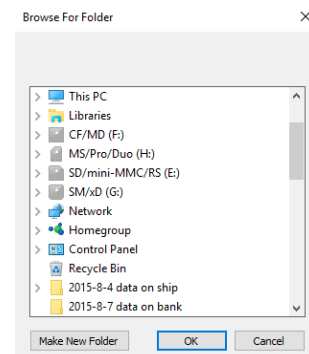
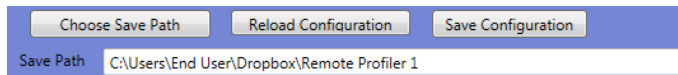
Note : The first boot after switching the system on is the only time that the PC stays on indefinitely (once the Remote 3D Profiler software is manually closed down). When the PC boots up as part of its wakeup schedule, there is a watchdog timer which will cut power to the PC after 10 minutes have elapsed without serial communication on COM3.

4.3 Configuration Software



The Configuration Software creates the config.xml file used to configure the 3D Remote Profiler hardware. The Configuration Software can be run on any PC with access to the same cloud storage used by the main control software.

In order for the system to use the newly created configuration file, the save path should be configured to be the same directory used by the main control software. The current save path can be seen at the bottom of the program window. Change the path by clicking on the 'Choose Save Path' button.

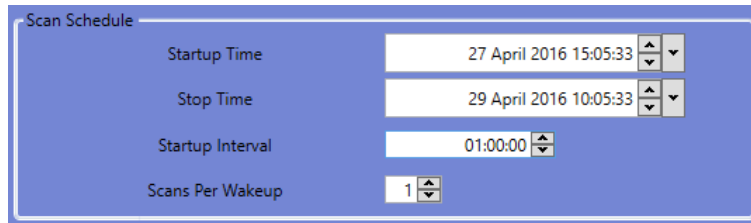


The 'Reload Configuration' button reverts any changes made to the parameters or schedule back to those stored in the last saved configuration.

The 'Save Configuration' button saves the current scan parameters and schedule to a file 'config.xml' in the save path directory. Provided the save path is set to the correct cloud storage directory then the new configuration file will be synchronised with the

cloud and used to configure the hardware the next time the control PC boots up.

Scan Schedule



Parameter	Value
Startup Time	27 April 2016 15:05:33
Stop Time	29 April 2016 10:05:33
Startup Interval	01:00:00
Scans Per Wakeup	1

Startup Time

The Startup Time specifies the date and time the sonar will wake up and perform its first scan. When the sonar isn't scanning the system is typically in sleep mode and consumes minimal power.

Stop Time

The Stop Time specifies the date and time the sonar will stop scanning indefinitely. After this time the system enters sleep mode and consumes minimal power.

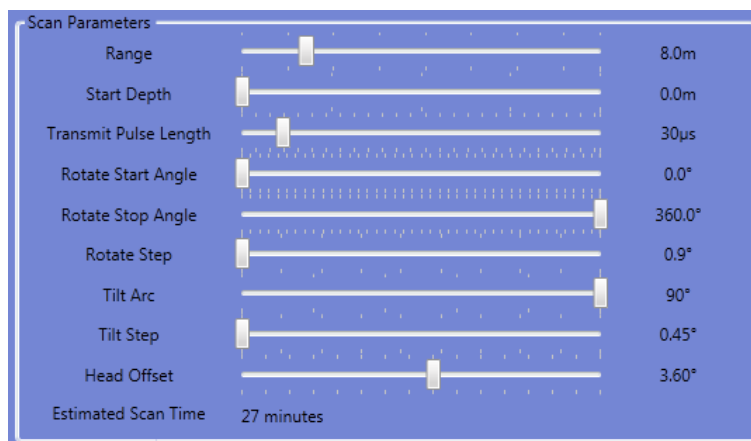
Startup Interval

The Startup Interval sets the time between sonar wakes. Its format is 'dd.hh:mm:ss', where 'dd' is days, 'hh' is hours, 'mm' is minutes and 'ss' is in seconds.

Scans Per Wakeup

The Scans Per Wakeup specifies the number of scans the sonar performs after waking up.

Scan Parameters



Parameter	Value
Range	8.0m
Start Depth	0.0m
Transmit Pulse Length	30µs
Rotate Start Angle	0.0°
Rotate Stop Angle	360.0°
Rotate Step	0.9°
Tilt Arc	90°
Tilt Step	0.45°
Head Offset	3.60°
Estimated Scan Time	27 minutes

Range

The Range specifies the depth below the transducer beyond which data is not captured and is configured in combination with the Start Depth in such a way as to reduce multipath caused by the proximity of the transducer head to the surface or other objects.



The Range setting is restricted to always being at least 0.1m more than the Start Depth.

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 Start Depth is restricted to always being at least 0.1m less than the Range setting.

Transmit Pulse Length

The acoustic Transmit Pulse may be set with shorter pulses generally giving higher resolution but the trade-off is that the gain is less with shorter pulses. The Transmit Pulse should always be larger than the sample interval otherwise received echoes may be missed. This equates to the following transmit pulse lengths:

<u>Range</u>	<u>Transmit Pulse Length</u>
5m	15µs+
10m	28µs+
15m	40µs+

Rotate Start Angle

Normally the Rotation Start Angle would be set to 0 degrees and the Rotation Stop Angle set to 360 degrees so that a full sweep is executed. However, in the case where only a small arc of data is of interest it is possible to offset the start angle by clicking one of the other start angles. The sonar will sweep from the Rotation Start Angle to the Rotation Stop Angle.

Rotate Stop Angle

Normally the Rotation Stop Angle would be set to 360 degrees and the Start Rotation Angle set to 0 degrees so that a full sweep is executed. However, in the case where only a small arc of data is of interest it is possible to offset the stop angle by clicking one of the other stop angles. The sonar will sweep from the Rotation Start Angle to the Rotation Stop Angle.

Rotate Step

The Rotate Step specifies how many discrete 0.9 degree rotation motor steps are performed after each swath gathered by the sonar. For the finest detail the Rotate Step should be set to 0.9 degrees, but by increasing this setting the dataset capture speed may be increased and the dataset size reduced.

Tilt Arc

The Tilt Arc specifies the arc swept beneath the sonar in degrees as it gathers the data.

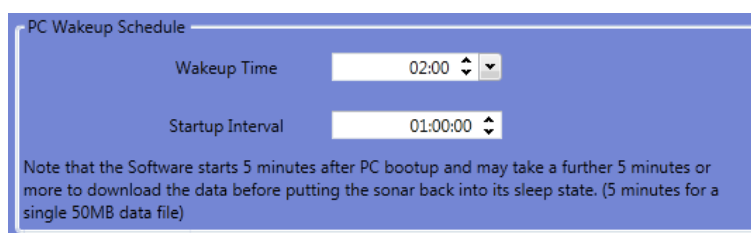
Tilt Step

The Tilt Step specifies how many discrete 0.45 degree tilt motor steps are performed for each “ping” of the sonar. For the finest detail the Tilt Step should be set to 0.45 degrees, but by increasing this the scan speed may be increased and the dataset size reduced.

Head Offset

Because the transducer is scanned through a swath and then rotated it is necessary that the transducer should start from an accurate horizontal position. If the transducer start position is not perfectly horizontal then the data set will represent a flat floor as a shallow cone either pointing up or down. The transducer positioning method relies on being able to detect the stall position of the stepper motor when the back EMF drops below a threshold. Therefore for different sonar units the offset has to be individually trimmed to get the most accurate data. The procedure for calibrating the Head Offset is to first mount the sonar in a tank of water perpendicularly above a flat surface as accurately as possible using a spirit level or similar on the outer housing to ensure verticality in orthogonal planes. Perform a normal 3D scan and examine the resulting data using the cursor tools to verify that the image from the flat surface is horizontal. Adjust the Head Offset value slightly and repeat until the target is as near horizontal as possible. Note that the Head Offset is restricted to 0.45 degree steps in the tilt angle so if the flat target is tilted by 1.4° then a change of three steps should correct it.

PC Wakeup Schedule



PC Wakeup Schedule

Wakeup Time 02:00

Startup Interval 01:00:00

Note that the Software starts 5 minutes after PC bootup and may take a further 5 minutes or more to download the data before putting the sonar back into its sleep state. (5 minutes for a single 50MB data file)

Wakeup Time

The Wakeup Time sets the time of day the system will wake up. This is the time of the first wakeup after programming the configuration. Subsequent wake up times depend on the startup interval value. When the system is awake the saved acoustic data in the sonar is uploaded to the cloud and the latest configuration settings are adopted by the sonar. Its format is “hh.mm”, where “hh” is hours (0 to 23) and “mm” is minutes.

Startup Interval

The Startup Interval sets the time between PC system wakes. Its format is 'dd.hh:mm:ss', where 'dd' is days, 'hh' is hours, 'mm' is minutes and 'ss' is seconds. The maximum interval is 31 days.

In the above image, the PC is scheduled to wakeup at 2:00 am for the first time after the configuration is programmed into the system. It then starts up again every hour until the configuration is changed again or the system is switched off.

If the PC wakeup time overlaps with the scan schedule then the PC cannot talk to the sonar. It will shutdown without reconfiguring the schedule or collecting any data files. The PC wakeup schedule however can still be reconfigured even if the sonar is performing a scan.

Comment

The Comment section is a text field for notes. The comment text is saved in the header of each sonar data file.

5.0 Data Files

Name	Date modified	Type
07042016	08/04/2016 08:36	File Folder
08042016	08/04/2016 12:41	File Folder
21042016	22/04/2016 09:28	File Folder
22042016	22/04/2016 12:24	File Folder
25042016	26/04/2016 08:39	File Folder
26042016	26/04/2016 08:39	File Folder
AppLog0.txt	08/04/2016 05:59	Text Document
AppLog1.txt	26/04/2016 09:01	Text Document
ChargeController0.txt	26/04/2016 09:00	Text Document
config.xml	25/04/2016 12:52	XML Document

After using the system to collect data the save path will contains log files, the latest system configuration and recorded data files.

The data files are saved in a directory with the scan date as the directory name. The directory name format is ddmmyyyy where dd is the day, mm is the month and yyyy is the year. Data files have the extension '.RW3'. One file is saved for each scan. The data file name format is hhmmss.RW3 where hh is the hour, mm is the minute and sss is in tenths of a second.

Name	Date modified	Type
00505200.RW3	26/04/2016 01:34	RW3 File
01505200.RW3	26/04/2016 02:34	RW3 File
02505200.RW3	26/04/2016 03:34	RW3 File
03505200.RW3	26/04/2016 04:34	RW3 File
04505200.RW3	26/04/2016 05:35	RW3 File
05505200.RW3	26/04/2016 06:34	RW3 File
06505200.RW3	26/04/2016 07:34	RW3 File
07505100.RW3	26/04/2016 08:35	RW3 File

The AppLog files are logs for the PC software. Each time the PC wakes up and runs through its software, a log is appended to the latest AppLog file. There is a size limit on the AppLog files. Each time the size limit is reached a new file is created. The latest file is appended with the highest number. See below for an example of an entry in an AppLog file:

```

----- Log for 26/04/2016 08:40:55 v1.0.0.0-----
08:31:23.5: Updated Solar Charge Controller stats
08:31:38.9: Sending Sonar Wake Message ...Complete
08:32:09.2: Connected to 3DProfiler S/N 36 v01.02.02
08:32:09.2: Reading Sensor Data ...Complete
Pitch 1.0° , Roll -1.4°
Temperature: Internal 21.1°C , External 18.2°C
Battery Voltage 12.474V
Pressure 0mBar
Conductivity 0.00Siemen
Velocity Of Sound 1476.9m/s

```



```
08:32:10.3: Directory Listing
            26042016
            .
            ..
            07505100.RW3
1 new files(s) found out of a total of 1 file(s)

08:32:10.8: Copying file 1 of 1 26042016\07505100.RW3...Complete
08:35:01.0: File Copying Complete. 32.1006 MB copied
08:35:01.5: Deleting 26042016 ...Complete
08:35:01.7: No New Configuration Found. Synchronizing Schedule Clock ...Complete
08:35:01.8: Putting Sonar to Sleep ...Complete
08:35:01.8: Synchronising Logic Board's Clock ...Complete
08:35:02.0: Pause for upload 293 seconds
08:39:55.5: 60 second shutdown pause
08:40:55.5: Closing Program
```

ChargeController files are logs of parameters read from the Solar Charge Controller. Each time the PC software runs it appends to the log file. Below is an example of a single entry in the log file:


```
28/04/2016 15:45:26
MinPVPVVoltageToday 0.25
MaxPVPVVoltageToday 0.26
MinBatVoltageToday 12.43
MaxBatVoltageToday 12.77
ConsumedEnergyToday 0.02
ConsumedEnergyThisMonth 0.18
ConsumedEnergyThisYear 0.18
TotalConsumedEnergy 0.44
GeneratedEnergyToday 0
GeneratedEnergyThisMonth 0
GeneratedEnergyThisYear 0
TotalGeneratedEnergy 0
BatteryVoltage 12.47
PVInputVoltage 0.25
PVInputCurrent 0
```

The first line is a time stamp indicating when the parameters were read. All parameters with 'Voltage' in the name are in Volts. All parameters with 'Current' in the name are in Amps. All parameters with 'Energy' in the name are in kWh. 'PV' refers to the PhotoVoltaic array (solar panel). 'Bat' refers to the battery.

The 'config.xml' file is the system configuration file generated by the Configuration Software.


6.0 Connection Details

6.1 Sonar Connector

Pin	Function	
1	+12VDC	
2	TX+	
3	TX-	
4	Trigger	
5	0VDC	
6	0VDC	
7	RX+	
8	RX-	


Subconn BH8F Face View (female)

6.2 Solar Panel Connector

Pin	Function	
1	PV+	
2	PV-	
3	NC	

Subconn BHB3M Face View (male)

6.3 Battery Connector

Pin	Function	
1	BAT+	
2	BAT-	Subconn BH2F Face View (female)