SAFETY MANUAL

Equipment General and Operational Safety Precautions

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Head Office
Sonardyne International Limited
Blackbushe Business Park
Yateley, Hampshire
GU46 6GD United Kingdom

T. +44 (0) 1252 872288
F. +44 (0) 1252 876100
E. support@sonardyne.com
W. www.sonardyne.com

CONTACTING THE SONARDYNE SUPPORT TEAM

24-hour Emergency Telephone Helpline: +44 (0) 1252 877600

The Sonardyne 24-hour helpline is answered during normal office hours (08:00 to 17:00 GMT). Outside these hours, your call is automatically transferred to an agency, which logs the details of your emergency and alerts the appropriate Sonardyne personnel.

Our aim is to make sure emergency requests are dealt with immediately during office hours, and are responded to within 30 minutes at all other times.

Please note the helpline is for emergency use only.

If you require NON-EMERGENCY product support, please contact your nearest Sonardyne office. Alternatively, contact the Sonardyne Head Office:

Blackbushe Business Park

Yateley

Hampshire

GU46 6GD

England

Telephone: +44 (0) 1252 872288

Fax: +44 (0) 1252 876100

Email: support@sonardyne.com

NOTE

Email and telephone support is available during normal office hours (08:00 to 17:00 GMT)

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SECTION 1 – INTRODUCTION

1. Introduction

This Safety Manual outlines all essential operations and servicing requirements for all Sonardyne products. Sonardyne products can contain hazardous voltages and must only be opened by qualified service personnel. The products contain no operator adjustable components.

Operators and service personnel must be familiar with all information throughout this manual.

If the equipment us used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

1.1 Subsea Equipment General Operational and Safety Precautions

Operators and Service personnel must be familiar with the information detailed in this manual.

Additional information, if applicable, is included in the relevant sections of the product operating and maintenance manual.

Documentation must be consulted whenever the warning symbol is found on the equipment, in order to find out the nature of the potential hazard and any actions which have to be taken.

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SECTION 2 – SAFETY PRECAUTIONS

2. Hazard Appreciation

Subsea equipment remains safe in use when operated and handled within standard operating procedures and written guidelines, therefore in normal operation little threat is posed to the safety of individual or instruments. However all subsea units are capable of positing a threat to personnel safety, particularly when pressure housings become internally pressurised. Great care must be taken when this happens, or is even suspected to have happened, since the pressures present within the instrument are likely to be **extremely** high. Internal pressure problems may also be aggravated by unknown chemical hazards if battery breakdown has occurred.

The following non-exhaustive list gives examples of typical hazardous situations:

- a pressure housing becomes internally pressurised by water pressure, following a leak
- a pressure housing becomes internally pressurised due to battery malfunction
- attempts are made to charge non-rechargeable battery packs/cells
- using an instrument outside its design parameters
- using an instrument beyond its load bearing limits
- failing to maintain the equipment can reduce its load bearing capability
- using unauthorised components or inferior parts in critical assemblies, e.g. release systems

2.1 General Handling of Equipment

Do not allow instruments to be dropped or exposed to shock damage which can cause sensitive internal components to fail. Note that minor damage to metal finishes often creates burrs which can present a hazard to unprotected hands or other parts of the body.

Control the local environment by preventing personnel stepping into the bight of haphazardly laid ropes or cables which are attached to a unit. Do not allow an instrument to block an access or impede normal traffic flows in a gangway or on a stairway.

Water tightness of instruments depends on fine surface finishes, accurate dimensional tolerances and cleanliness of components. Generally when dismantling equipment care should always be taken, the disassembly process should be carried out in a well-ventilated area with as few personnel in the vicinity as possible.

Servicing must always be carried out by competent personnel with appropriate training.

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SECTION 3 – DISMANTLING EQUIPMENT

3. Introduction

All sub-sea equipment fitted with pressure housings are subject to a vast range of externally applied pressures and are susceptible to internal pressure rise if, for example, a leak occurs or the unit's battery destructs. Internal pressure presents a **potentially dangerous situation** and all appropriate **safety measures must be enforced**.

WARNING

⚠ Fumes given off by deteriorated batteries, particularly lithium based, pose a health hazard. Make sure the area is well ventilated and personal protective equipment such as safety goggles, face-mask and gloves are worn.

Fumes given off by deteriorated batteries, particularly lithium based types, pose a health hazard. Apply precautions as appropriate to the circumstances prevailing at the time.

WARNING

⚠ When a unit has leaked it often behaves like a valve, i.e. water pressure causes a rise in internal pressure which cannot then escape because the point of leakage becomes sealed.

There is likely to be no prior indication of the presence of a build up of internal pressure. First indications being the end-cap(s), of the unit, being forced out of the housing under pressure during the dismantling process.

Complete removal of an end-cap's retaining mechanism means it becomes unconstrained and therefore free to be discharged from its housing under high internal pressure - **an uncontrolled and potentially dangerous situation**.

Symptoms that indicate a higher risk of internal pressure include:

- Equipment that failed when deployed, in transit or storage
- Equipment stored for a long time with batteries connected
- Equipment having suffered physical damage

WARNING

⚠ Do not transport equipment which is internally pressurised.

3.1 Instruments fitted with Sprung Pressure Relief Vent Valves

Pressure Relief Vent Valves are fitted into all subsea equipment housings containing batteries. The valve comprises a red or green valve with dual O rings and a vent hole behind the second O ring. The Pressure Relief Vent Valve is designed so it can be withdrawn, using an M4 screw, to the point where the relief hole, becomes open to atmosphere and allows internal pressure to dissipate. The valve is retained to the equipment by means of a retaining spring preventing it from being completely extracted.

A normal unit may emit an audible rush of air when the Pressure Relief Vent Valve is retracted, but it will typically only last for 1 second maximum. A longer rush of air/gas indicates a pressurised unit, in which case ventilate the area, and let the remaining pressure out of the unit. Internal pressure dissipates to atmosphere in a very short time and may be accompanied by water, debris, noise etc.

WARNING

⚠ Fumes given off by deteriorated batteries, particularly lithium based, pose a health hazard. Make sure the area is well ventilated and personal protective equipment such as safety goggles, face-mask and gloves are worn.

Do not allow unnecessary personnel to enter the vicinity of the work or to be anywhere near dissipating gases and debris.

3.2 Precautions (Instrument fully functioning)

The techniques for retaining end-caps in the pressure housings differ from product to product, and detailed instructions on opening the pressure housing are given in the servicing section of the individual product manuals.

To ease dismantling and release any slight internal pressure that may have built up during normal operation, the Pressure Relief Vent Valve should be operated as described in **Section 3.1**.

WARNING

⚠ Do not stand directly in front of the end cap during removal. There is potential for the end-cap to be ejected suddenly by internal pressure.

When removing the end-cap it is recommended to stand to one side, and not inline. This will avoid potential injury if the end-cap is ejected by any remaining internal pressure.

3.3 Precautions (instrument known or suspected to be pressurised)

WARNING

⚠ Fumes given off by deteriorated batteries, particularly lithium based, pose a health hazard. Make sure the area is well ventilated and personal protective equipment such as safety goggles, face-mask and gloves are worn.

If an instrument is known, or suspected to be internally pressurised through water ingress or battery venting additional precautions must be taken.

Remove the instrument to a well - ventilated location away from other working personnel.

WARNING

⚠ Do not attempt to dismantle or perform any maintenance activity on a product that has a hot housing. The product must be cooled extensively before proceeding. Make sure personal protective equipment such as gloves, safety goggles and face-mask are worn.

If the housing is hot, indicating recent or current active internal chemical action, do not attempt to open. Lower overboard into water for several hours minimum or into a secure area away from all personnel. Do not attempt to dismantle until it has cooled.

Wear protective clothing, safety glasses and gloves, and refer to battery manufacturer's material safety data sheet (MSDS).

Release the safety vent as described in **Section 3.1**. If there is no significant pressure dissipation and no fumes indicating a battery malfunction, the unit can be dismantled using the precautions described in **Section 3.2** and the relevant product servicing manual.

If there are any chemical fumes when the vent plug is released, or signs of deposit around the vent exterior, these are signs the battery has vented due to water ingress or electronic/battery malfunction. In these circumstances the battery pack and internal electronics may have been severely damaged.

Take extreme care when removing the end cap, using any additional precautions detailed in the individual product manuals. There may be a possibility of some residual pressure remaining, within the housing, if during operation of the Pressure Relief Vent Valve, it becomes blocked with the products of the internal chemical reaction.

When the battery is removed it should be covered with dry sand, or preferably sodium carbonate, or a mixture of 1:1 soda ash and slaked lime. It should be placed in an approved container (after cooling if necessary) and disposed in accordance with local regulations.

The electronics, end caps and pressure housings should be thoroughly hosed down.

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SECTION 4 – ELECTRONIC HAZARDS

4. High Voltages

4.1 High Voltage awareness

Operation of this equipment does not present any danger to users in normal use. If the internal electronics chassis is removed from it's housing for maintenance, the user should be aware that high voltages are present, particularly on the transmitter PCB and transducer.

4.2 Storage Capacitors

Subsea equipment incorporates capacitors which are capable of storing large quantities of electrical energy. Avoid inadvertent discharge during dismantling.

4.3 Handling of Electronic Components

Most of the circuits in subsea equipment use CMOS logic, which is easily damaged by static discharge or excessive supply voltage. The best action for electronics is NO HANDLING. Field servicing cannot compare in efficiency and accuracy with the original factory calibration and therefore field servicing should be limited to checking correct calibration/operation (within the limits of the test gear available) and repair by exchange of PCB's or modules.

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SECTION 5 – BATTERIES

5. Batteries General

5.1 Use of Appropriate Battery Types

WARNING

Do not fit unauthorised battery pack types into an instrument.

Sonardyne equipment uses a variety of battery types. In some instrument designs only one type of battery pack is authorised for use but others will accommodate NiCad rechargeable, alkaline or lithium based packs. Instruments must **NOT** be fitted with alternative battery pack types unless they are specifically designed to use them.

NOTE

Damage caused by using battery packs which are not authorised or are not constructed to Sonardyne's build standards invalidates any warranty.

5.2 Safety Precautions for Lithium Batteries

WARNING

Lithium based batteries become hazardous (fire and corrosion) if exposed to air and water. If damaged they may also emit thionyl chloride. Consult the battery manufacturer's Material Safety Data Sheets (MSDS) prior to operating lithium based battery products.

Additional information applicable to lithium cells (model LSH20) is available from:

SAFT Ltd

River Drive

South Shields

TYNE AND WEAR

NE33 2TR

UK

Tel: +44 (0) 191 456 1451

Web Site: www.saftbatteries.com

5.2.1 Lithium Based Batteries - General

Special precautions and regulations apply to transport, handling and disposal of lithium based products.

Lithium batteries are powerful sources of electrical energy and should be handled with care to avoid short-circuiting.

WARNING

⚠ Use extreme caution when dismantling equipment suspected of flooding. The internal pressure increase could result in components becoming projectiles when released, causing injury.

Where a battery powered underwater instrument is suspected of flooding, extreme caution must be exercised in opening the instrument in case an internal pressure has developed, which might cause the components to fly apart, causing damage or injury. Release of cell contents within the pressure vessel is very unlikely to cause hazard but the following safety procedures should be followed.

5.2.2 Lithium Based Batteries, Storage Temperature

CAUTION

⚠ Do not expose batteries to extreme temperatures, in excess of 70°C, to prevent reduction in battery life.

Cells and batteries, and hence the whole Sonardyne instrument, should not be exposed to temperatures in excess of 70°C. Instruments should not be left on deck in strong sunlight such that they become hot to the touch.

Lithium battery packs should be stored at +20°C, and in a humidity-controlled atmosphere to prevent passivation developing, which can reduce actual operating life, and in extreme cases may cause the unit to malfunction once deployed.

Instruments should be cooled to normal room temperature or lower before being opened.

5.2.3 Opening a Lithium Powered Instrument

The normal procedure before opening any underwater instrument is to wash in fresh water, remove salt deposits and dry it. The instrument should only be opened in clean, well-ventilated, dry surroundings.

All **precautions outlined in paragraph** 3.4 above should be applied during dismantling processes if it is suspected that internal pressure is present.

5.2.4 Fault Procedures

WARNING

⚠ For Lithium battery packs, Class D fire extinguishers should be used. Water, CO2, Halon, dry chemical or foam extinguishers are not suitable.

⚠ There is a risk of burns and injury when handling hot batteries; personal protective equipment such as gloves must be worn.

If a cell or battery is shorted or starts to heat up, it should be disconnected from the transponder immediately and removed to the outdoors or to a well-ventilated area to cool down. Tongs, or a shovel, are recommended for this purpose. Once the temperature has dropped and it is deemed safe to do so, the cell or battery can be disposed of. Suitable protection clothing should be worn when handling suspect cells/batteries and if the skin has come into contact with the electrolyte, it should be washed thoroughly with water.

If a cell is ruptured, potentially flammable materials may be exposed.

5.2.5 Disposal of Lithium Based Batteries

WARNING

⚠ Do not dispose of lithium batteries in a fire. There is an explosion risk if batteries are exposed to fire.

Cells and batteries in small quantities can be disposed of in a secured landfill. If a secured landfill is not immediately available, then appropriate safety precautions should be taken to temporarily secure the items. Packaging suitable for the storage and transport of lithium cells/batteries must be used at all times when not installed in an instrument.

5.2.6 Transporting Lithium Based Products

The current regulations and information below is provided for guidance only. Note that data sheets concerning quantities of lithium per cell are available from cell manufactures and these may change without prior notice, therefore the quantities of lithium per battery pack cannot be verified by Sonardyne Ltd. When transporting lithium based products it is the operator's responsibility to comply with local, national and international regulations in force at the time of transport.

- **By Road:** ADR European Agreement concerning the International Carriage of Dangerous Good by Road Regulations.
- **By Sea:** International Maritime Dangerous Goods Code
- **By Air:** IATA Regulations UN 3090 and UN 3091

5.3 Safety Precautions for Lithium Ion Batteries

Lithium Ion batteries, also known as Li-ion, are a rechargeable battery technology. Use only approved battery chargers for the specific pack.

Additional information applicable to Li-ion cells is available from:

Saft Headquarters

12, rue Sadi Carnot

93170 Bagnolet

France

Tel: +33 (0)1 49 93 19 18

Fax: +33 (0)1 49 93 19 50

Website: www.saftbatteries.com

Special precautions and regulations apply to transport, handling and disposal of lithium ion based products.

Lithium Ion batteries are powerful sources of electrical energy and should be handled with care to avoid short circuiting.

Where a battery powered underwater instrument is suspected of flooding, caution must used when opening the instrument in case internal pressure may have developed. This may cause the components to fly apart. If a cell leaks within a pressure vessel it is very unlikely to cause a hazard if the safety precautions are followed.

5.3.1 Lithium Ion Batteries Storage Temperature

To preserve battery life, Lithium Ion Batteries should be stored at a nominal 40% state of charge.

The Sonardyne instrument should not be exposed to temperatures outside the range -20°C to +60°C (-4°F to 140°F).

Lithium Ion battery packs should be stored at +20°C (68°F) in a humidity controlled atmosphere to prevent reduction in battery life.

Instruments should be cooled to room temperature or below before being opened.

5.3.2 Shorting/Over-heating Procedures

WARNING

⚠ For Lithium battery packs, Class D fire extinguishers should be used. Water, CO2, Halon, dry chemical or foam extinguishers are not suitable.

WARNING

⚠ There is a risk of burns and injury when handling hot batteries; personal protective equipment such as gloves must be worn.

If a cell or battery is shorted or starts to heat up, it should be disconnected immediately and removed to the outdoors or to a well-ventilated area to cool down; tongs, or a shovel, are recommended for this purpose. Once the temperature has dropped and it is deemed safe to do so, the cell or battery can be disposed of. Suitable protection clothing should be worn when handling suspect cells/batteries and if the skin has come into contact with the electrolyte, it should be washed thoroughly with water.

If a cell is ruptured, potentially flammable materials may be exposed.

5.3.3 Disposal of Lithium Ion Based Batteries

WARNING

⚠ Do not dispose of lithium ion batteries in a fire. There is an explosion risk if batteries are exposed to fire.

Cells and batteries in small quantities can be disposed of in a secured landfill. If a secured landfill is not immediately available, then appropriate safety precautions should be taken to temporarily secure the items. Packaging suitable for the storage and transport of lithium cells/batteries must be used at all times when not installed in an instrument.

5.3.4 Transporting Lithium Ion Based Products

The current regulations and information below is provided for guidance only. Note that data sheets concerning quantities of lithium per cell are available from cell manufactures and these may change without prior notice, therefore the quantities of lithium per battery pack cannot be verified by Sonardyne Ltd. When transporting lithium based products it is the operator's responsibility to comply with local, national and international regulations in force at the time of transport.

- **By Road:** ADR European Agreement concerning the International Carriage of Dangerous Good by Road Regulations.
- **By Sea:** International Maritime Dangerous Goods Code
- **By Air:** IATA Regulations UN 3090 and UN 3091

5.4 Charging of Batteries in Sealed Containers

Batteries/Cells may give off gases when recharged. As a general rule, sealed containers MUST be allowed to vent to atmosphere during the charging process.

Some instruments may be fitted with safety features which prevent the possibility of problems caused by gasses vented by batteries. Detailed charging procedures for the particular instrument should be carefully followed.

5.5 Attempting to Charge Non-Rechargeable Battery Pack

WARNING

Do not attempt to charge non-rechargeable battery packs or cells.

All **PRIMARY BATTERIES**, i.e. alkaline-manganese dioxide, lithium-manganese dioxide, silver oxide, zinc air, zinc carbon and zinc chloride batteries are NOT designed to be charged.

Non-rechargeable cells exhibit a range of unpredictable characteristics if any attempt is made to charge them. **Very high pressures and temperatures** can occur in an instrument often some time after the attempt to charge them has terminated.

Attempts to charge a primary battery may lead to an imbalance within the cell potentially leading to gas generation and in extreme cases explosion.

Battery packs **MUST NOT** be reconfigured from one type to another, e.g. NiCad to alkaline or lithium. Alkaline or lithium cells may be inadvertently charged.

5.6 Handling of Used Batteries

Batteries should not be discharged below their end point voltage. To do so can lead to internal corrosion and leakage of electrolyte in certain types of sulphur dioxide cells. Although there is very little gas to cause a pressure rise under these conditions, the electrolyte leakage will cause severe corrosion.

After recovering an instrument from the sea it should be opened, and the battery voltage(s) checked while still connected to see if above the end point voltage for that type of cell. Disconnect and mark as usable or not with date of disconnection noted both on the pack and in written records. Check the instrument for signs of corrosion, such as at solder joints, as a sign of any slight leakage.

The remaining life of a battery depends on both time and, for a transponder, the number of times it has been interrogated. Normally transponders keep their own record of battery usage, but users must maintain a separate record of time elapsed whilst battery is installed and connected, plus estimates of the number of interrogations.

5.7 Re-Connecting a Partially Used Battery

Calculate if the remaining battery life will allow your next mission to be safely accomplished. If so, note the date of re-connection, both on the battery label and in written records, against the serial number of the instrument.

5.8 Fitting a New Battery

Note the date it is connected and therefore starts to supply current. Write this date on the battery label and also in your written records.

5.9 Battery Pack Fuses

A number of Sonardyne battery packs have carefully selected, high-reliability fuses soldered onto the diode-board of the pack; these are "Littlefuse" devices. If a fuse has blown due to mishandling, it may be replaced by an identical type, but the rating must not on any account be increased.

SECTION 6 – EQUIPMENT ENVIRONMENTAL LIMITATIONS

6. Environmental Limitations

6.1 Storage Temperature Limits

Equipment may be stored at temperatures in the range -20 to + 60°C. It should be noted however that lines connecting pressure transducers to a transponder may become partly filled with seawater during service. This cannot easily be expelled and may therefore freeze if transponders are stored at sub-zero temperatures after recovery from the sea.

Spare battery packs should be stored at room temperature, in an environment with a controlled humidity level.

6.2 Instrument Load Bearing Capability

Navigational Transponders are **NOT** normally designed to take in-line loads greater than the maximum upthrust applied by the floatation equipment. The carrying straps, if fitted, are for ease of manual handling and the range of transducer guards selected for their acoustic properties.

WARNING

⚠ **Do not exceed the Safe Working Load capabilities of release mechanisms, or additional lifting equipment.**

The Safe Working Load (SWL) capability of the release mechanism, built into most instruments, can only be used for in-line lifting operations if a suitably - rated, approved, lifting strap, transducer guard, buoyancy collar eyes or other safe method is selected.

It is the operators responsibility to ensure the condition of the equipment and that a safe lifting method has been devised for any particular operation.

Sonardyne's range of Oceanographic Release Transponders have been designed specifically for in-line lifting operations.

Appropriate shackles must be used in release systems to ensure freedom from corrosion. It is important to note that instruments, their release mechanisms and shackles form part of an integrated and complete system.

6.3 Floatation Equipment

6.3.1 Introduction

Floatation equipment is fitted to subsea transponders in order to aid their recovery once a deployment is complete. A nett upthrust requirement is given in manuals and technical data for any particular instrument. The following guidelines are given to assist operators in their understanding of the general requirements.

6.3.2 Minimum Nett Buoyancy of Floats

Floats are described as having a minimum nett buoyancy in seawater and this is the figure quoted in Sonardyne Float Technical Data and by the float manufacturer. Total up-thrust can be calculated by knowing this figure, e.g., a float with 30 kgs nett buoyancy in sea water supporting a load with weight in sea water of 30kgs would result in neutral buoyancy, i.e. no nett up-thrust.

6.3.3 Float Inserts

Float collar Inserts are used to allow floats of larger internal bore to be used with housings of nominal 6" diameter. The weight *in water* of an insert is usually slightly positive and this will be additional to the weight of the instrument being supported by the float. Two inserts will result in approximately 0.5kg reduction in nett up-thrust.

6.3.4 Nett Upthrust

The difference between the nett buoyancy of the float and the total weight of an object, or objects, in water that it is supporting, e.g.

Nett Upthrust =

(Minimum nett buoyancy of the Float) - (the weight of the instrument + inserts in water)

e.g. 30 kgs - (11.2+ 0.5) kgs = 17.3 kgs nett upthrust

6.3.5 Float Storage Conditions

Special storage conditions are not called for if due care and attention is applied to a float. Floats are not hygroscopic and should not therefore be affected by moisture in air.

6.3.6 Float Over-Pressure

The maximum water depth quoted for a float must not be exceeded. Over-pressured floats are forced to absorb water and their weight in air thus increases. All floats should be weighed prior to use to check that they are maintaining their original manufactured weight.

6.4 Definitions of Various Loads and Loading Terms

6.4.1 A Static Load

An unvarying long term load.

6.4.2 A Dynamic Load

A time varying load resulting from the motion and inertia of connected masses and forcing functions such as wave action on the vessel. This may include transient and steady state harmonically alternating loads.

6.4.3 Maximum Ultimate Static Load OR Breaking Load OR Parting Load

The load that induces structural failure in one or more parts of the instrument causing the load to part with the release.

6.4.4 Maximum Proof Static Load OR Maximum Rated Static Load

The maximum in-line static load the instrument can bear without suffering an unacceptable degree of permanent deformation. Ideally this should correspond with the load at which the maximum stress at any point in any component is the 0.2% proof stress for the material used in that component (in the condition that it is used).

6.4.5 Shock Load OR Snatch Load

A time transient load generally caused by the sudden acceleration (positive or negative) of the load. Examples are the sudden snatch of a load off the deck or a sudden arrest of a load falling under gravity.

6.4.6 Safe Working Load

A load set as a proportion of the Ultimate Static Load to allow for factors such as corrosion, fatigue, shock loads, harmonic loads, manufacturing defects, material defects etc. Various figures may be adopted according to the practise of the industry, risk to health and applicable legislation. Typical factors are $^1/_6$ to $^1/_3$ of the Ultimate Load.

6.4.7 Proof Load

Normally a Load that is periodically applied to the load bearing device to demonstrate that it is still safe. Generally this is 2 times the Safe Working Load.

6.4.8 Release Load

The maximum in-line load the instrument can withstand and successfully release without overloading any part of the release mechanism or demanding an unsupportable quantity of energy from the battery supply (at its specified end point).

Sonardyne
SOUND IN DEPTH

Global Headquarters, UK
T. +44 (0) 1252 872288
F. +44 (0) 1252 876100
sales@sonardyne.com

Macaé, Brazil
T. +55 22 2123 4950
F. +55 22 2123 4951
brasil.sales@sonardyne.com

Singapore, Asia
t. +65 6542 1911
f. +65 6542 6937
asia.sales@sonardyne.com

Houston, USA
T. +1 281 890 2120
F. +1 281 890 7047
usa.sales@sonardyne.com

Aberdeen, UK
T. +44 (0) 1224 707875
F. +44 (0) 1224 707876
sales@sonardyne.com

24/7 Emergency Hotline
+44 (0) 1252 877600

Email Support
support@sonardyne.com

Website
www.sonardyne.com

Twitter
@sonardyne