SVP 70/71
Sound Velocity Probe

OPERATOR'S MANUAL

Part Number 904-63-0833-00
Firmware Version 20060614164653

Version 3

July 2009

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Version July 2009 Version 3

RESON strives to maintain up-to-date information and may, as necessary, review and revise this manual. If the information contained in this manual is unclear, please contact your nearest RESON office for clarification.

Electronic File Version

This manual is available from RESON in the Adobe® Acrobat® Portable Document Format (PDF). The selected PDF process preserves the interactive index and cross-reference features of the original Microsoft Word document.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

How to Use This Manual

This manual is designed to accommodate both the first time user, who needs detailed instructions, and the experienced technician, who only requires a reference tool. It provides detailed procedures for the correct installation, operation, and maintenance of the SVP 70/71.

Read this manual thoroughly and follow the steps provided to maintain optimal safety standards and to obtain the best system performance.

Standards of Measurement

All physical measurements represented in this document are based on the metric system. All temperatures are represented in degrees Celsius.

Document Conventions

The following information will make it easier for the reader to interpret the text presented in this document.

Document Conventions

Convention	Definition
Hyperlink	Indicates a hyperlinked cross-reference. Click the word to be taken to the specified reference point.
Numbered list	Indicates stepwise instructions to be followed in a particular order.
Bulleted list	Indicates items of a list without any particular order.

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings are included in this text to provide valuable information and to help the operator prevent damage to the sonar or to personnel.

Notes, Cautions, and Warnings will be shown in the following format:

NOTE
This is a Note. Notes provide explanatory information that may be useful to the operator, but is not necessarily vital to the operation of your RESON system.

CAUTION
This is a Caution. Cautions provide important information regarding your RESON system. Disregarding information provided in a Caution box may result in accidental misuse or damage to your RESON system.

WARNING!
This is a Warning. Warnings provide important information regarding your RESON system. Disregarding information provided in a Warning box may prove harmful to personnel working with or near the system.

Chapter Arrangement

All RESON manuals are designed with the same basic structure. The following chapters are included in this document:

- **Introduction** provides a summary of the SVP 70/71 design and features.
- **Safety Precautions** provides important safety information about the SVP 70/71.
- **Getting Started** is an aid to becoming familiar with the SVP 70/71 in a few easy steps.
- **Operation** provides detailed information about the configuration and operation of the SVP 70/71.
- **SVP Principles** provides a brief overview of the fundamentals and applications of SVPs.
- **Installation** provides detailed information about the mechanical and electrical installation of the SVP 70/71.
- **Troubleshooting** provides examples of typical errors that might occur while operating the SVP 70/71, including their possible causes.

In addition to the above chapters, the following appendixes have been included for reference:

- **Appendix A**: Technical Specifications
- **Appendix B:** Drawings
- **Appendix C:** SVP 70/71 Accessories
- **Appendix D:** Warranty Information
- **Appendix E:** Conversion of Measurements
- **Appendix F:** Glossary of Terms

If you require additional information or need clarification of any part of this document, please contact RESON Customer Support for assistance at support@reson.com.

1 INTRODUCTION

This manual covers the SVP 7x series sound velocity probes, consisting of:

- **SVP 70:** The robust titanium design eases cleaning in environments with considerable marine growth, which is crucial for permanent installations.
- **SVP 71:** The anodized sea-water resistant aluminum housing, lighter than the titanium SVP 70, is recommended for semipermanent mounting on outboard rigs or UUVs, where regular maintenance is possible.

For a comparison on the two units, see *Appendix A Technical Specifications.*

The SVP 7x probes are direct reading sound velocity probes for professional applications. They employ state of the art correlation techniques in an FPGA implementation for finding the speed of sound in the medium with the highest accuracy.

The probes have a very compact design without sacrificing the length of the signal path, which is of utmost importance in returning accurate results. On an overall length of 160mm the sound transmission path is 125mm.

The novel design of the SVP allows for simpler integration with less disturbances of the water flow, yielding a low emission of noise into nearby sensors like echosounder, sonar systems, Doppler logs etc. Ping synchronization allows for low integration risk.

The electrical interface includes wide input power (9 to 55V, approx. 2W) and dual serial interfaces according to RS-232 and RS-422[1] (full standard voltage swings, >500m range). There is no galvanic connection between the power input and the serial output.

Measurements can run at a user specified sampling frequency or can be synchronized to an external trigger to ensure no acoustic interference problems, which would otherwise be present.

Selectable processing includes outlier removal and low pass filtering for use when the unfiltered measurements are not adequate.

[1] SVP 71 only has RS-232.

2 SAFETY PRECAUTIONS

2.1 Operator Safety

The sound velocity probe should be handled with attention to operator safety. General precautions include:

- **DO NOT** connect or disconnect cables with the power on.
- **DO NOT** attempt to open and service the SVP.

2.2 Equipment Safety

Each SVP 7x component is sufficiently robust for shipboard storage while in its own transit case or shipping box.

2.2.1 Safe Handling

To ensure safe handling of the equipment:

- Inspect each transit case or shipping box for physical damage prior to opening, and each component for physical damage before installation.
- Use adequate packaging and shock-absorbing materials to ship or store any equipment outside the supplied transit cases.
- Do not drop the equipment.
- Ensure that the equipment is properly secured before putting out to sea.
- Do not exceed operating and storage temperature limits.
- Use dummy plugs to protect connectors when no cables are attached.
- Do not leave the probe at voltages in the range 6 to 9V for extended periods of time, as this may cause permanent damage to the device.
- Treat cables with care:
    - Maintain the appropriate bending radius.
    - Do not pull on cables.
    - Lubricate connectors to decrease the required mating force.

2.2.2 Cleaning and Maintenance

The acoustic window molded over the front of the transducer is made of potting compounds that may be damaged by a long range of chemicals, which include, but are not limited to:

- Acids
- Automotive brake fluid
- Base
- Grease
- Halogenated hydrocarbons (carbon tetrachloride, trichloroethylene)
- Hydraulic fluids
- Ketones (MEK, acetone)
- Nitro hydrocarbons (nitrobenzene, aniline)
- Oil
- Ozone
- Petrol
- Phosphate ester

The following recommendations are made to protect the SVPs while in use or storage.

- Sand or water in the female connector should be removed with fresh water.
- Brush the zinc anode of the SVP 71 with a steel brush before deploying it.
- Make sure that the zinc anode is not coated with oil, paint or similar materials.
- Rinse the SVP with fresh water after every use.

2.3 Electrical Isolation

Electrical isolation for both titanium and aluminum components may be achieved by using nonconductive bushings, washers, and isolation plates to insulate them from the mounting brackets. Common nonconductive materials include Delrin, G-10 glass fiber sheets, or high-density polyethylene sheets.

- When mounting the SVP 71, use the insulator plate provided in the delivery (or a similar one) to ensure that the aluminum housing does not touch any metal parts.

NOTE
Contact RESON for additional information on schemes for electrical isolation.

3 GETTING STARTED

The best way to familiarize yourself with the SVP 7x is to unpack it in the office and connect it to a PC; deploy it in a bucket of water, and get readings into the PC.

For exhaustive guidance, refer to the following sections:

- *4 Operation* – includes configuration and operation modes.
- *5 SVP Principles* – includes theories and applications of SVPs.
- *6 Installation* – includes mechanical and electrical installation instructions.

3.1 Unpack the SVP 7x

Unpack the SVP 7x and make sure all accessories indicated on the packing list are included (see also *Appendix C SVP 70/71 Accessories)*.

3.2 Set Up a PC and Power Supply

In addition to the probe and accessories you will need a PC with a normal serial port connector (Sub-D 9 pin male) and, if not included in the delivery, a power supply or a fully charged 12 or 24V lead-acid battery.

3.3 Connect the Units

Connect the SVP 7x to the rubber connector of the test cable. The rubber should be slightly greased to facilitate assembly and avoid excess force.

CAUTION
Be careful not to pull on the cable.

3.3.1 SVP 70

1. Connect the serial port (also called COM port) of the PC to the black 9-pin female connector on the test cable.
2. Connect the black wire of the test cable to the negative power supply terminal.
3. For a while leave the red wire unconnected.
4. Put the probe into a bucket of water.

For SVP 70 test cable connections, see *section 6.2.4 Standard Test Cable for SVP 70*.

3.3.2 SVP 71

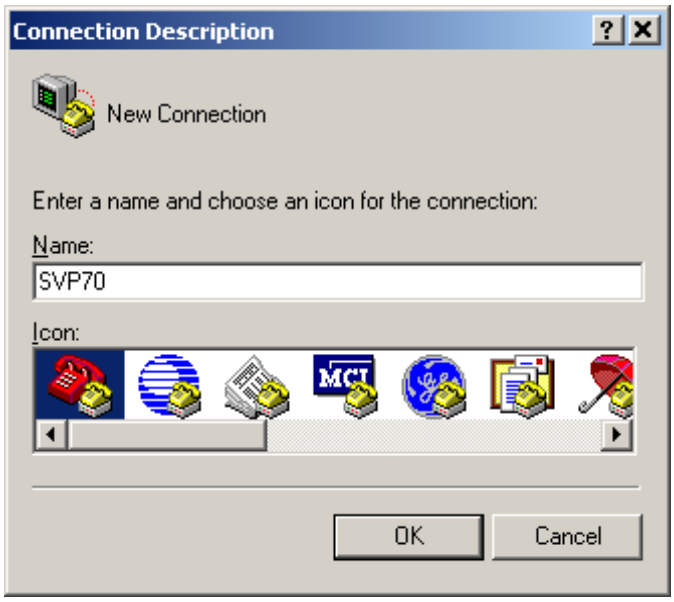
1. Fit a DB9 female connector to the pigtail test cable.
2. Connect it to the serial port of the PC.
3. Connect the power wires to the energy source.
4. Put the probe into a bucket of water.

For SVP 71 test cable connections, see *section 6.2.6 Test Cable for SVP 71*.

3.4 Start the PC Program

Users familiar with serial communications may prefer to use another program instead of HyperTerminal[2].

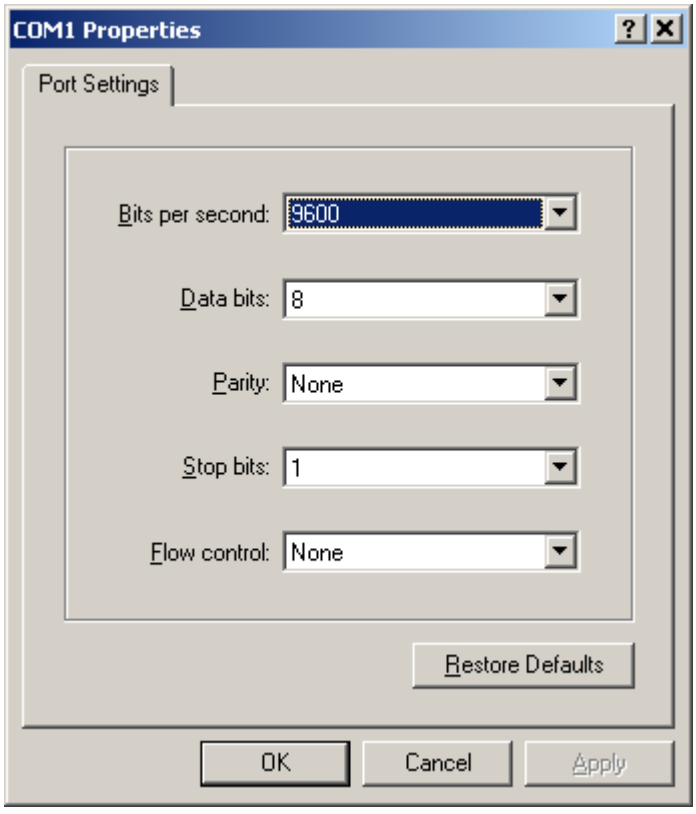
1. On the PC, click the Start button to select the program HyperTerminal: Start > All Programs > Accessories > Communications > HyperTerminal.



2. In the Connection Description dialog, enter a name (SVP70 or SVP71) and click OK.

[2] Make sure to disable handshake control (use neither hardware nor software handshake).

3. In the Connect To dialog, select the appropriate port (the one connected to the connector with the cable attached) from the Connect using drop-down menu. This is typically COM1 or COM2 on PCs.



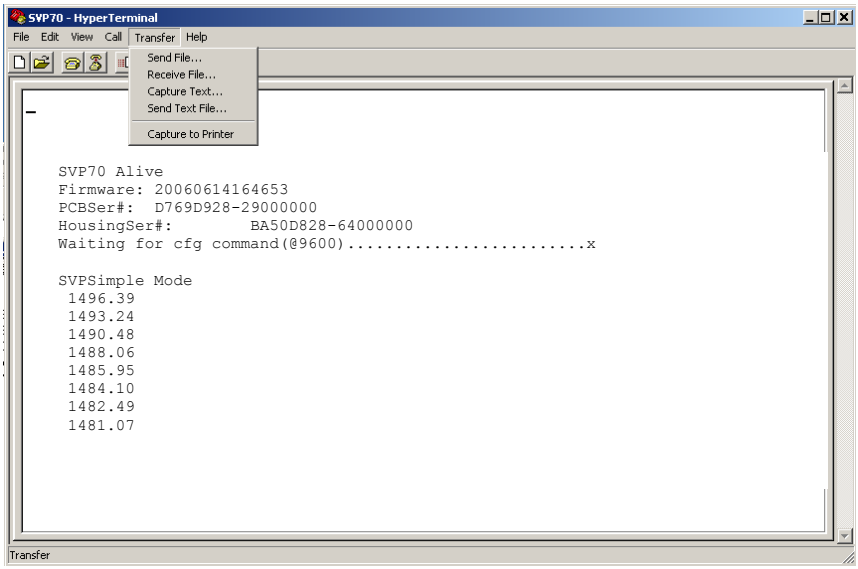
4. In the COM Properties dialog, configure the serial port as shown above and click OK.

3.5 Start the Probe

1. Now connect the red wire to the positive power supply terminal and switch it on.

   You will now see data from the SVP on the screen.

2. You can save these data to a file using the Transfer menu. (Or for now just let them scroll across the screen.)



NOTE
In the event that no sound velocity data appears on the screen, try another port. In the event that odd characters appear on the screen, try different baud rate settings in HyperTerminal. In the event that sound speed readings show 1350m/s it is likely that air bubbles are trapped on the black transducer surface. Wipe it with a finger.

3.6 Change Appearance of the SVP Data

Press Shift-m to bring up the User Menu, which allows configuration of the output format.

Selecting an item in the menu will either generate further help text with an input prompt or change the setting shown in the User Menu.

Press Shift-e to save all changes and exit the User Menu.

NOTE
Pressing e (lowercase) will discard all changes and exit the User Menu.

For details on the User Menu, see *section 4.2.4.2 User Menu*.

3.7 Change Communications Parameters (COM and Baud Rate)

On startup the probe will listen for approximately 5 seconds for the configuration command. During this time it is possible to enter the configuration menu by typing CON; (four characters).

The probe will enter configuration mode and show the CONFIG menu below.

```
SVP71 Alive
Firmware:       20060614164653
PCBSer#:        BBA6F428-1A000000
HousingSer#:    BAC74628-20000000
Waiting for cfg command(@9600).............x



*CONFIG*
E Save
e Don't Save
B Boot
a ShowAliveMsg:     1
o OpMode:    5
c ComRxDisable:     0
b Baud Rate  9600
s SerChan     0
u UserMenuCmdChar: M
t PingOnceTriggerCmd: T
****
```

NOTE
The CONFIG menu is only available on RS-232 at 9600,n,8,1.

With the CONFIG menu it is possible to change the hardware setup of the probe.

- **s** = To change the COM port from RS-232 to RS-422 press s.
  The menu item SerChan will change to 1.
  - **0** = RS-232 for operation mode communications.
  - **1** = RS-422 for operation mode communications[3].
- **b** = To change the communications baud rate for operation mode press b. A prompt will appear showing the allowable range.

[3] SVP 71 does not support RS-422. Configuring SVP 71 for RS-422 will result in no output.

```
Enter Baud Rate: in range[  110:115200] Current
Setting: 9600
```

- Select a setting and press Enter.
  The menu item Baud Rate will change to the entered value.

NOTE
The settings you have changed will only take effect when you press Shift-e to save. Once this is done the text `Config saved` will appear and the CONFIG menu will echo the new settings. To discard changes made in the CONFIG menu, press e.

To exit configuration mode you must restart the probe by cycling the power or selecting the option Boot (Shift-b) in the CONFIG menu. Approximately 5 seconds after startup the operation mode will automatically be entered.

For details on the configuration mode, see *section 4.1 Configuration Mode.*

NOTE
You will always be able to get in contact with the probe on startup on RS-232 at 9600,n,8,1. The SVP 71 does not support RS-422 output and will therefore not generate data if put in serial mode 1.

4 OPERATION

The probe has two main modes:

- **Configuration mode:** This mode can be entered just after starting the probe and is normally exited after saving parameters
- **Operation mode:** This mode is entered upon startup if the special configuration key strokes are not entered within a few seconds after power up. Additional settings are available in this mode.

It is not possible to switch directly between these modes later.

4.1 Configuration Mode

4.1.1 Enter Configuration Mode

No special software is needed, but CRT from www.vandyke.com is a good alternative to Windows® HyperTerminal for control and logging of data. Connect the probe, start your terminal program (e.g. HyperTerminal) as described in *section 3.4 Start the PC Program.*

The probe starts, optionally by transmitting a sign-on message (see *section 4.1.2 below*), and listens at RS-232 9600,n,8,1.

To enter configuration mode press CON; (4 characters). If this command is not sent to the probe within 5 seconds of startup, it automatically resumes its previous operation mode, which may use another port/baud rate for input/output!

Press the ESC key on the keyboard to start operation mode directly after startup without delay.

The CONFIG menu is shown below:

```
*CONFIG*
E Save
e Don't Save
B Boot
a ShowAliveMsg:     1
o OpMode:    5
c ComRxDisable:     0
b Baud Rate  9600
s SerChan     0
u UserMenuCmdChar: M
t PingOnceTriggerCmd: T
****
```

Figure 1: CONFIG Menu

4.1.2 Configuration Menu Options

Each menu option is prefixed by a control character, always a letter. Each character denotes the key to press on the keyboard to access the option or send a command, e.g.:

- **o** > press o (for lowercase o)
- **O** > press Shift-o (for uppercase O)

Save
Press Shift-e to save all changes. Changes will not take effect, if you exit without using this command.

Don't Save
Press e to discard all changes.

Reboot Probe (Boot)
Press Shift-b to reboot the probe. This has the same result as restarting the probe by turning the power off and on again. This option is intended to help configuration of the probe before its first use.

Sign-On Message (ShowAliveMsg)
Press a to set the probe sign-on message. The sign-on message is displayed after startup and helps identify the probe and validate a proper connection to the software.

- **0** = Sign-on message will not be shown.
- **1** = Sign-on message will be shown.

If the probe is used with survey software that does not accept the sign-on message, set the sign-on message to 0.

Operation Mode (OpMode)
Press o[4] to set the operation mode. This option selects the operation mode that will be run automatically on startup.

- **0** = Configuration mode.
- **1** = Configuration mode (same as 0).
- **2** = Emulates AML Smart Probe output format (see *section 4.2.1 below*).
- **3** = Emulates Valeport Probe standard output format (see *section 4.2.2 below*).
- **4** = Emulates old RESON standard output format (see *section 4.2.3 below)*.
- **5** = SVP 7x mode (see *section 4.2.4 below*).
- **6** = NMEA output format (see *section 4.2.5 below*).

[4] Note that o is the letter character (and not zero) on the keyboard.

Com Port Receive Disable (ComRxDisable)
Press c to set the receiver communications port. Activating this option disables all software handling of the receiver part of the serial communication. This is useful in setups where the probe is connected to a communication channel with lots of irrelevant data on it, which causes some instruments to freeze.

- **0** = Disable function not activated.
- **1** = Disable function activated.

The serial channel Rx can be re-enabled by cycling power off and back on and entering the CONFIG menu, or by sending the special command sequence “wakeup314159265” to the probe on the active communication port.

Baud Rate
Press b to set the communications baud rate for operation mode. A prompt will appear showing the allowable range.

```
Enter Baud Rate: in range[  110:115200] Current Setting: 9600
```

Select a setting (non-standard values are allowed) and press Enter. The entered value will appear in the Baud Rate setting.

Press Enter without entering a value, if you want to keep the old setting.

If you select a setting that is too big or too small the value will be set to the respective maximum or minimum value and a warning text will be shown.

NOTE
If you make a mistake and enter a value that you later forget, you can always get in contact with the probe during startup at baud 9600 on the RS-232 port.

Serial Port (SerChan)
Press s to set the serial channel to be used for operation mode.

- **0** = RS-232 will be used.
- **1** = RS-422 will be used[5].

Character To Activate User Menu (UserMenuCmdChar)
Press u to select the character that accesses the User Menu in operation mode.

Character To Trigger Measurement (PingOnceTriggerCmd)
Press t to select the character that triggers one reading when the probe is in the externally triggered mode, i.e. when Sample Period is set to zero in the User Menu.

[5] Not available for SVP 71.

4.2 Operation Modes

4.2.1 Mode 2 AML Output

In AML output mode, the probe generates data in the format:

<SPACE>SOS in m/s with 2 decimals<SPACE><CR><LF>

Example: `1543.39`

The probe does not respond to any commands and has a fixed output repetition rate of 10Hz.

4.2.2 Mode 3 Valeport Output

In Valeport output mode, the probe generates data in the format:

<SPACE><SOS in millimeters><CR><LF>

Example: `1543390`

The probe does not respond to any commands and has a fixed output repetition rate of 10Hz.

4.2.3 Mode 4 RESON Output

In RESON output mode, the probe generates data in the format used by all RESON's SVP products:

<SOS><Pressure><Temperature><Bat Voltage><Memory Count>

Pressure depth in decibars
Temperature in Celsius with one decimal
Battery voltage = 10V always
Memory count = 1010 always

Example: `0343300000277101010`

NOTE
The SVP does not have a dedicated survey grade pressure sensor, so pressure readings should therefore not be used when an accurate reference is required.

The probe does not respond to any commands and has a fixed output repetition rate of 10Hz.

4.2.4 Mode 5 SVP 7x Mode

SVP 7x mode gives the operator detailed control of all operation parameters, including the format of the output data, configurable in the User Menu (see *section 4.2.4.2 below*).

4.2.4.1 Output Configuration

By turning on and off the various fields it is possible to construct almost any desirable output format.

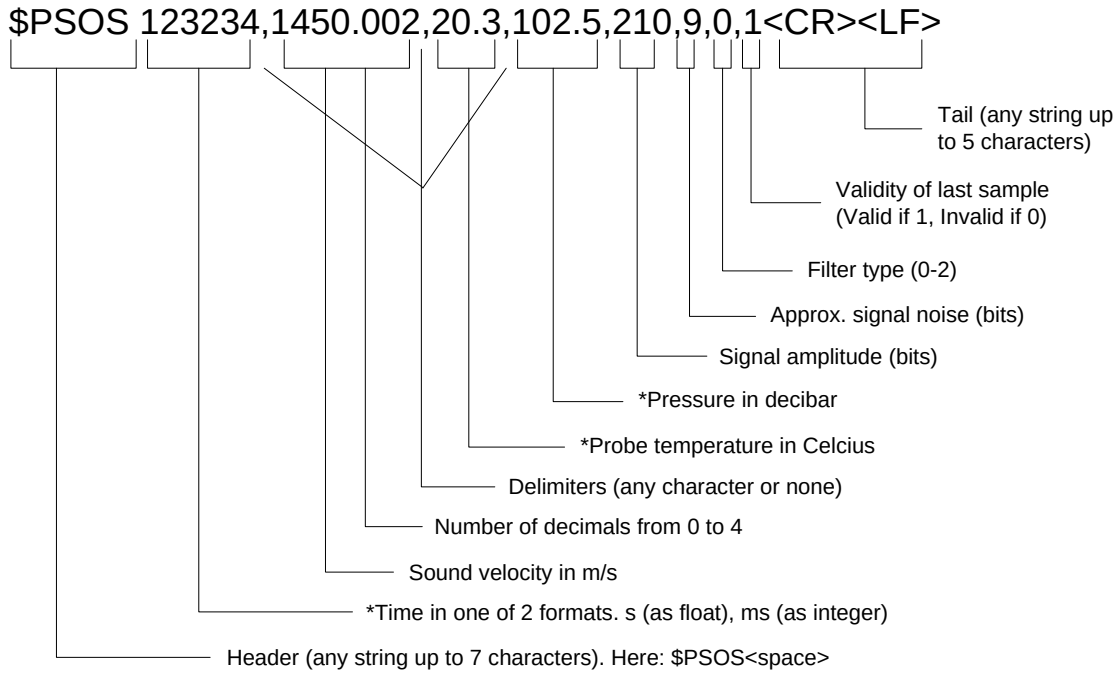


Figure 2: Output Configuration

NOTE
It is not possible to change the order of the fields.

Special character entry
The user may want to enter special characters that are easily confused with control characters (access or command characters prefixing the various menu options).

Refer to *Table 1* to enter special characters[6]:

[6] Users familiar with the C programming language will find this familiar.

Table 1: Special Character Entry

To enter	Press	Meaning	Character (ASCII decimal)
<CR>	\r	The carriage return character	
<LF>	\n	New line (line feed)	
<TAB>	\t or <TAB> key	Tabulator	
<SPACE>	<SPACE> key	Space character	
NULL	\0	No character	#00

Special characters \r and \n display “as they are” in the menu and thus may distort the menu display slightly.

4.2.4.2 User Menu Options

When the probe is running it is possible to enter the User Menu by pressing Shift-m (the access character is configurable in the CONFIG menu, see *section 4.1.2 above*). The options in this menu control the output configuration of the probe in operation mode (see *Figure 2*). All changes made will be displayed in the menu.

```
**SIMPLE MENU**
M Menu
E Save and Exit
e Exit no saving
b Baud Rate 9600
H Header $SVP
T Tail ;

D Delimiter
W Data width    3
S SOS digits    3
F Filter 0
I Time 0
r RawData    0
s Sample Period 1000
--Print flags:--
p Pres    1
t Temp    1
a Amp    1
n Noise    1
f Print Filter    1
v DataValid    1
d All delims    1
```

Figure 3: User Menu

Save and Exit
Press Shift-e to save all changes and exit the menu. Changes only take effect once the menu is exited.

Exit no saving
Press e to discard all changes and exit the menu.

Baud Rate
Press b to set the communications baud rate for operation mode. A prompt will appear showing the allowable range.

```
Enter Baud Rate: in range[  110:115200] Current Setting: 9600
```

Select a setting and press Enter. The entered value will appear in the Baud Rate setting. Press Enter without entering a value, if you want to keep the old setting.

If you select a setting that is too big or small the value will be set to the respective maximum or minimum value and a warning text will be shown.

Header
Press Shift-e to define the header. The header is a combination of any 7 characters, excluding the null character. Press Enter to terminate. The header is displayed in the menu exactly as entered. The appearance in the menu will be “confusing” if <CR> is used, as it will overwrite previous key strokes.

Examples:
```
something
$PSVP,
$PSVP <TAB>
```

Tail
Press Shift-t to define the tail. The tail is entered as the header. Make sure that the use of <CR> and <LF> is accordance with the receiving program. Some programs convert, skip, or insert extra <CR> and <LF> characters, which lead to wrong appearance. The tail may include the <TAB> character.

Delimiter
Press Shift-d to set the delimiter character. The delimiter is inserted between all the fields in the output string, except after the header[7] and in front of the tail. For easiest copy/pasting into Excel use the <TAB> character as delimiter.

Data width
Press Shift-w to set the data width. This parameter controls the minimum width of all data output fields: sound velocity, temperature, pressure, signal amplitude, and signal noise. Default value is 3.

Sound Velocity Decimals (SOS digits)
Press Shift-s to set the number of decimals to show in the sound velocity measurement reading. The available range is from 0 to 3. The decimal separator is always a decimal point (not a comma). No decimal point is shown when the parameter is set to 0 digits.

Filter
There are a number of filters available to filter the sound velocity output.

[7] If required, include the same delimiter as part of the header string.

Press Shift-f to toggle between the available filter types in the menu.

- **0** = No filtering (direct output)
- **1** = Low pass filtering (with approximately 5 second time constant)
- **2** = Median filtering (5 taps, removing up to 2 consecutive false readings)
- **3** = Combined Median and Low pass (not yet implemented)

Time Stamp (Time) (Optional)
Press Shift-i to set the time stamp. It is a millisecond counter, which starts counting when the probe is started.

Press Shift-o to toggle between the three output options:

- **0** = No time stamp
- **1** = Seconds with 3 digits
- **2** = Milliseconds (without decimals)

RawData
Press r to toggle raw data samples on and off. This option toggles the output of the raw data samples used to calculate the speed of sound.

- **0** = User-defined SVP output string
- **1** = User-defined SVP string with trailing raw sample values

This option should only be used for debugging an installation. A high baud rate will be required due to the fact that a lot of data is generated. The raw data is generated behind the Tail of the output string and is always <TAB>-delimited.

Sample Period
Press s to set the sample period. A prompt will appear showing the allowable range.

```
Enter Sample Period(ms): in range[    0:100000] Current Setting:  100
```

Select a setting and press Enter. The entered value will appear in the Sample Period setting. The value in milliseconds is the time between successive samples. Remember to increase the baud rate of the communications interface when generating data at high rates.

Pressure (Pres) (Optional)
Press p to toggle the pressure output on or off.

- **0** = Pressure not printed
- **1** = Pressure printed

The probe generates the pressure output in decibar, which corresponds to approximate depth in meters. The pressure reading is very inaccurate and should only be used for guidance.

Temperature (Temp) (Optional)
Press t to toggle the temperature output on or off.

- **0** = Temperature not printed
- **1** = Temperature printed

The probe generates its own temperature in Celsius with 2 digits. The temperature corresponds to the water temperature, but should not be used as a replacement for an accurate water temperature reading, as the sensor is mounted inside the housing of the probe.

The temperature output is NOT intended as a survey parameter due to its low pass filtered and delayed readings.

Amplitude (Amp)
Press a to toggle the output of the amplitude of the return signal on or off.

- **0** = Amplitude not printed
- **1** = Amplitude printed

Noise
Press n to toggle the noise output on and off.

- **0** = Noise not printed
- **1** = Noise printed

Print Filter
Press f to define whether or not the selected filter type is printed.

- **0** = Filter not printed
- **1** = Filter printed

It is important to realize that filtering (both low pass and median) introduces an inherent delay in the data. To avoid data being too old, the filters are turned off, if the time between samples is larger than 800ms. This can be verified by printing the filter type used in the output string.

DataValid
The Data Valid option is a validity label, which indicates the status of the current output sample.

- **0** = Sample not valid
- **1** = Sample valid within the defined speed of sound interval

This is useful when using filtering to establish the number of samples that are out of the allowed range, and can be useful for investigating installation where noise is a challenge.

All Delimiters (All delims)
Press d to toggle all delimiters on or off.

- **0** = Off
- **1** = On

When enabled, all delimiters will be printed, even if this means that some of the output fields will be empty.

4.2.5 Mode 6 NMEA Output Mode

In NMEA output mode, the probe generates data in the format:

<$PRSOS><SOS in m/s with 3 decimals><*78>

Example: `$PRSOS,1350.000*78`

The probe does not respond to any commands and has a fixed output repetition rate of 10Hz.

5 SVP PRINCIPLES

The SVP 7x measures the sound speed in a direct measurement by transmitting a sound pulse and detecting its time to travel a well-defined path length.

The transmitted signal is generated using waveform techniques that yield optimal conditions for timing the arrival of the returning signal, which is digitized at high frequency and high resolution. The timing is established using a high-stability clock oscillator.

The path length is defined by the distance from the transmission transducer to a reflector plate and back again to the transducer, which then acts as a receiver.

The traditional way of establishing a known path length is to use spacers made from a metallic alloy commonly known as INVAR. However, INVAR is not resistant to corrosion and endurance is limited, though its life can be prolonged.

The spacers of the SVP 7x are made from titanium/aluminum and compensate its temperature and pressure sensitivity by measuring its temperature and stress and applying calibrated factors for the small path length changes.

The use of titanium for the SVP 70 model limits corrosion to a great extent.

Due to the direct measurement technique used, the speed of sound echo return time result will in no way depend on formulas assuming a certain relationship between conductivity, salinity, temperature, and pressure.

5.1 SVP 7x Output

The speed of sound output is selectable between instant direct readings, outlier filtered readings, and low pass filtered (see *section 4.2.4.2 User Menu Options*).

Instant, direct readings will immediately show any change in sound velocity due to air-bubbles, objects, or marine life. Some applications may find the direct, unfiltered readings useful, but others only use the SVP to estimate speed of sound near the probe and will therefore find the filtered output useful for reducing outliers in the data.

The primary output of the SVP 7x is the instant speed of sound. To measure the sound speed the SVP 7x internally measures the temperature of the probe and the pressure. These two measurements can also be generated from the probe and give indicative values for temperature and pressure. These values are, however, not meant to satisfy regular survey requirements for pressure (depth) and temperature.

5.2 SVP Applications

5.2.1 Multibeam Correction

Multibeam sonars frequently need speed of sound input for positioning the beams (beam steering). The sound speed accuracy required for multibeam sonar correction is typically in the order of 0.25m/s to 0.5m/s.

5.2.2 Echosounder Correction

Sound velocity probes are used for calibration/correction of echosounders. As echosounders measure the time for a signal to propagate to the seabed and back and thereby calculate the distance to the seabed, it is necessary to know the speed of sound in the water.

*Sound travel Distance=2*Depth= Echo time* sound speed*

As speed of sound is greatly influenced by salinity, temperature, and pressure it is of paramount importance that an accurate speed of sound value is used as opposed to an approximate value from reference tables. Most echosounders therefore allow input of sound velocity, either by electrical connections or via keyboard entry.

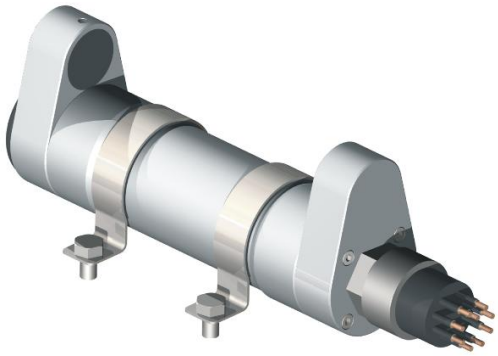
5.2.3 Positioning System Correction

Acoustic navigation systems like LBL and USBL systems use travel time of acoustic signals to determine the distance between acoustic transducers. For very accurate LBL and USBL navigation the systems typically use sophisticated (Kalman) filters for improvement of the accuracy. Adequate accuracy of the sound velocity used in these systems is typically 0.25m/s.

Doppler logs use the speed of sound for calculating the sensor speed. Accurate sound speed is mandatory for obtaining accurate sensor speed.

6 INSTALLATION

Installation of the SVP is very flexible. It must focus on ensuring that the water flows without excessive turbulence and away from any air bubbles that may be caught by vessel movement. For installation reference, see *Appendix B Drawings*.



CAUTION
When mounting the SVP 71 (aluminum housing) make sure it is not touching any metal parts. See *section 6.1.3 below*.

6.1 Mechanical Installation

The SVP 7x should be mounted using the two brackets/metal bands supplied with the unit or similar shaped bands.

CAUTION
Use brackets less than 2mm thickness and keep any suspension gear outside the acoustic path (see *Figure 4*).

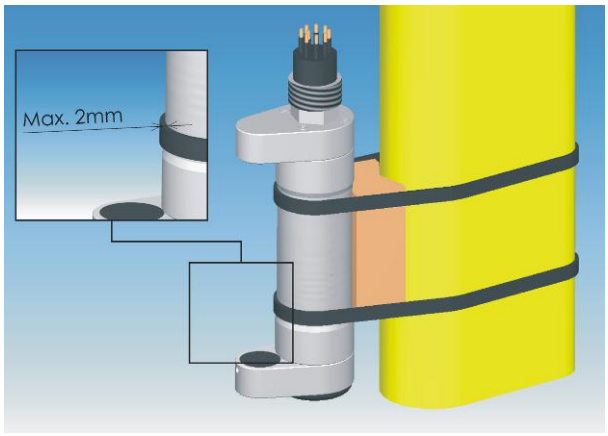


Figure 4: Pole Mounting

To reduce flow noise impacting other sensors the SVP may be retracted/buried into a sea chest as in *Figure 5*.

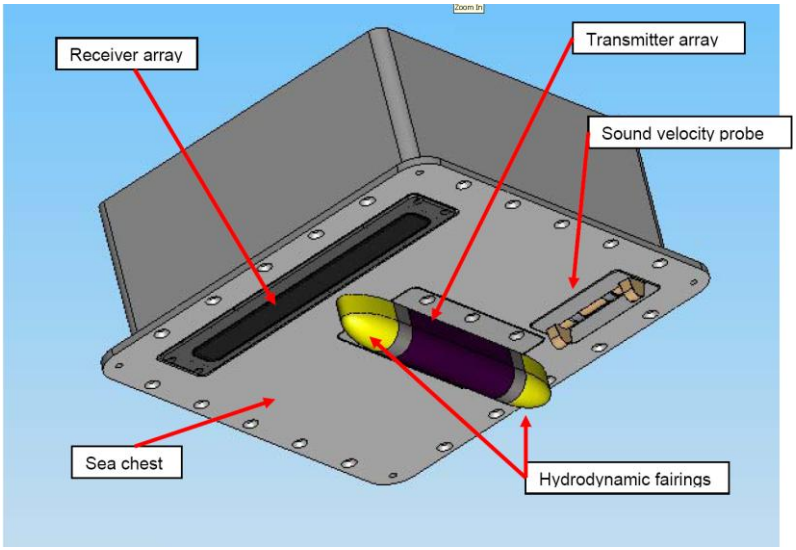


Figure 5: Example of SVP Installation

6.1.1 Sound Path

The sound path is shown in *Figure 6*. The measurement quality relies on this sound path being completely free from obstacles like mounting harness, cables, or other items, and it must be completely submerged in water without air bubbles.

NOTE
Even though it is important to ensure that the water flow to the sound path is free, it is still possible to put protection or hydrodynamic fairings around the probe as long as the sound path is not disturbed.

Figure 6: Sound Path of SVP

6.1.2 Fixing Bolts Before Mounting

To aid installation 4 O-rings included in the accessory kit can be used as retention rings for the mounting bolts. This will stop the bolts from falling off the brackets, when the SVP is mounted under water, thus making installation by divers easier.

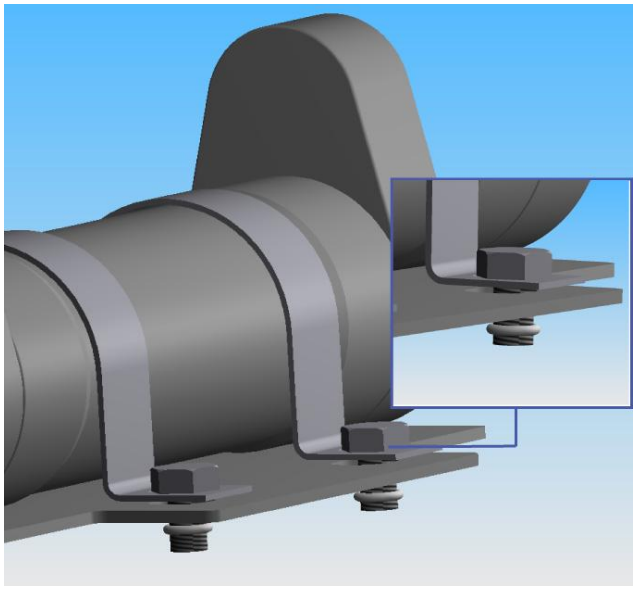


Figure 7: O-Rings Retain Mounting Bolts

6.1.3 Mechanical Installation SVP 71

The SVP 71 must be mounted without metal contact. A PVC insulator plate is delivered with the unit to ensure that the anodized housing does not touch the mounting frame as shown in *Figure 8*.

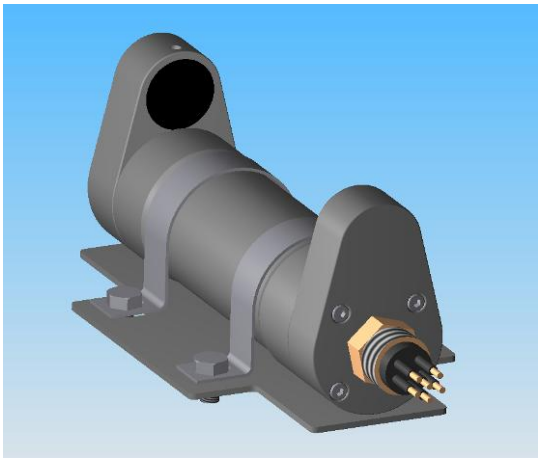


Figure 8: Insulator Plate for SVP 71 Mounting

The mounting brackets are fitted with rubber sleeves to isolate them from the probe housing. For reference, see *appendix B.3 SVP 71 Dimensions*.

6.1.4 SVP 71 Zinc Anode

The SVP 71 is equipped with a zinc anode to protect it from corrosion. Before deploying the SVP the anode must be checked and brushed with a steel brush. If less than 1/3 of the anode is left, it must be replaced. The thread is M6. Make sure that the thread is clean and the anode is not coated with oil, paint, or other films before installing it.

CAUTION
Do not apply force on the end caps as the distance between these define the length of the sound path.

6.1.5 Placement of SVP 7x

Hydrodynamics and flow must be taken into account when placing the SVP 7x.

The water flow should be perpendicular to the sound path to give the optimum performance.

The water should not come from the “back” of the housing (see *Figure 9*).

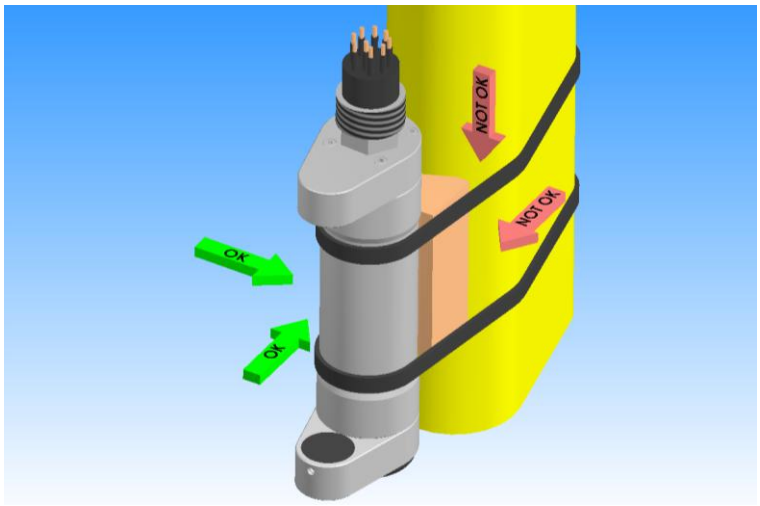


Figure 9: Water Flow

6.1.6 Cable Installation

- Hold the cable in a fixed position with a maximum of 4cm free spans between support points.

CAUTION
Be aware of the bending radius of the cable: Keep the radius above 7.5cm at any place in fixed installations. When repeated mounting/dismounting is foreseeable, keep the radius above 15cm.

- Lubricate the connector to facilitate assembly[8].
- Pull the connector straight apart from the probe when dismounting it.

CAUTION
Be careful not to pull on the cable.

6.2 Electrical Installation

6.2.1 Power Source

The requirements for the power source for the SVP 7x are flexible. The power input is compatible with DC power supplies ranging from 9V to 55V; the power supply should be rated for 2W or more.

CAUTION
The SVP 7x has under-voltage power detection, which disables the probe if the input voltage is inadequate. However, leaving the probe at voltages in the range 6 to 9V for extended periods may cause permanent damage to the device.

The SVP 70 has been specifically designed for compatibility with standard power supplies of 24V and 48V +/-10% and lead-acid batteries on nominal 12V, 24V, and 48V. A fully charged 48V lead-acid battery typically has a voltage below 52V.

CAUTION
While charging a 48V lead-acid battery its voltage can easily reach 58V, which is beyond the DC input specification of the SVP 70. Using a 10V, 1W zener diode in series with the positive supply line will allow operation from a 48V battery in both charging and discharging conditions.

6.2.2 Serial Interface

The SVP 70 is as standard fitted with two serial interfaces, RS-232 and RS-422, whereas the SVP 71 is fitted with only RS-232. Only one interface can be active at a time. Certain configuration options, including changing baud rate and serial interface, can only be accessed via the RS-232 interface. None of these options need to be changed when the probe is installed and should not influence the operator's selection of interface during installation.

The RS-232 is based on the MAX232ECSE IC, which generates true RS-232 signals with voltage swings and rise time limitations according to the RS-232 specification.

The RS-422 is based on the MAX3084ECSA IC, which generates true RS-422 signals with voltage swings and rise time limitations according to the RS-422 specification. The

[8] RESON suggest Molykote 44 Medium, but use sparingly. Half a match head dose per contact is adequate.

SVP 70 has a built-in 100 ohm termination resistor on its RS-422 input. Equipment connected to the RS-422 interface should also include a termination resistor across RXA and RXB.

Both serial interfaces are isolated from the probe power input. This prevents otherwise frequent problems with ground loops, common impedances, and it makes it possible to install the SVP 7x in systems with a power design prohibiting connection between analog (or signal) ground and power ground.

To avoid excessive voltages between the two ground systems, a surge protector connects them with high impedance at voltages up to 50V. Consequently, the voltage difference between the ground systems must NOT exceed this voltage.

6.2.2.1 Guideline for Choosing Interface

The numbers in *Table 2* are meant only as an introductory guide to the subject of selecting between RS-232 and RS-422[9]. Actual values depend on numerous factors.

Table 2: Interface Guidelines

Interface	Speed vs. cable length		Noise immunity	Cost	Complexity
	5m	500m			
RS-232	115200	2400	Bad	Low	Low
RS-422[10]	115200	115200	Excellent	Higher	Higher

For laboratory use and for setting up the probe, where only a few meters of cable is required, it is recommended that RS-232 is used because it allows interface to most regular PCs without adding extra hardware.

For use on larger ships it is recommended that RS-422 is used as it allows for longer cables and for better noise immunity.

Once the system is set up and the cable installed, it is recommended that a test is performed with the baud rate set at a higher level to ensure that there is sufficient noise margin.

6.2.2.2 Additional Hints

Some suppliers sell converters for interfacing RS-232 to the USB ports of PCs. Even though some of these devices may actually work in some circumstances, it is not recommended to use them without ensuring that they work in the application. Check both the transmitter function AND the receiver function.

Professional converters between Ethernet and RS-232 or RS-422 exist (www.nationalinstruments.com) and work with the SVP 7x. However, connection to an Ethernet used for signals other than the SVP may cause significant uncontrolled

[9] Several web sites discuss the subject. Suppliers like B&B Electronics (www.bbelectronics.com) can supply devices for the interfaces along with advice on the subject.
[10] Not available for SVP 71.

transmission delays, which ruin the overall performance of the system. Networks used for backups, servers, and printers are especially prone to major delays.

The RS-422 does not work if the P and N lines on either transmission or reception are crossed. It is a prerequisite for operation that TXP is connected to RXP and TXN is connected to RXN.

Wiring of RS-232 is often done casually without proper care resulting in accidental swapping of TX and RX.

To identify an RS-232 transmitter observe a negative voltage (more than 3V) from the transmitter pin to the signal ground pin. The receiver typically has a voltage less than 0.5V.

6.2.3 Connector SVP 70

Table 3: SVP 70 Connections

SVP 9-pole pin	MCBH9M	Wire color
1	COMMS GND	Screen/Drain wire
2	RS-232T	Black
3	RS-232R	White
4	RS-422TXP	Red
5	RS-422TXN	Green
6	RS-422RXP	Yellow
7	RS-422RXN	Blue
8	Ground (battery -)	Brown
9	Power (battery +)	Orange

- The connector is manufactured by Birns[11].
- Use mating connector MC9F.
    - Available as a pigtail from RESON.
      The pigtail is shielded, the shield being connected to pin 1.
    - Available from Birns with various cable length options.
- The connector can be submerged in (clean) sea water without being mated, and it is designed to allow mating under water.

[11] www.birns.com or www.aquamate.biz

CAUTION
Protective caps, dummy plugs, must be used if the probe is submerged for extended periods without a cable attached.

6.2.4 Standard Test Cable for SVP 70

Use this cable for setting up the SVP 70, debugging installations, and small tasks.

Only one of the computer connectors can be used at a time (restricted by the SVP 70). Both can, however, be connected at the same time.

The standard test cable consists of 1.5m PVC cable spliced onto 1.5m Neoprene cable which is molded directly to a wet mate connector. For reference, see *appendix B.2 SVP 70 Test Cable*.

Table 4: DB9 Connections on SVP 70 Test Cable

Black hooded Sub-D (DB9) female connector	
Pin	**RS-232 signal name**
1	Not connected
2	RS-232T
3	RS-232R
4	Not connected
5	COMMS GND
6	Not connected
7	Not connected
8	Not connected
9	Not connected

Red hooded Sub-D (DB9) female connector	
Pin	**RS-422 signal name**
1	RS-422TXP
2	RS-422TXN
3	RS-422RXP
4	RS-422RXN
5	COMMS GND
6	Not connected
7	Not connected
8	Not connected
9	Not connected

6.2.5 Connector SVP 71

Table 5: SVP 71 Connections

SVP 6-pole pin	MCBH6M	Wire color
1	COMMS GND	Black
2	RS-232T	Green
3	RS-232R	Brown
4	Power (9-55VDC)	Blue
5	Not connected	Yellow
6	Ground	Blue/Brown

- The connector is manufactured by Birns[12].
- Use mating connector MC6F.
    - Available as a pigtail from RESON.
      The pigtail is shielded, the shield being connected to pin 1.
    - Available from Birns with various cable length options.
- The connector can be submerged in (clean) sea water without being mated, and it is designed to allow mating under water.

CAUTION
Protective caps, dummy plugs, must be used if the probe is submerged for extended periods without a cable attached.

6.2.6 Test Cable for SVP 71

Use this cable for setting up the SVP 71, debugging installations, and small tasks.

The test cable for SVP 71 has flying leads when supplied. For reference, see *appendix B.4 SVP 71 Test Cable*.

To connect the SVP to a PC, we recommend using the connections listed in the table. If ordering the connector directly from Birns, RESON recommend that the cable colors are connected to pins as in RESON's test cable.

[12] www.birns.com or www.aquamate.biz

Table 6: Connections on SVP 71 Test Cable

Pin	RS-232 signal name	Pigtail wire color[13]	Recommended connection to DB9 female for PC connection[14]
1	COMMS GND	Black	Pin 5
2	RS-232T	Green	Pin 2
3	RS-232R	Brown	Pin 3
4	Power (9-55VDC)	Blue	To battery +
5	Not connected	Yellow	
6	Ground	Blue/Brown	To battery -

6.2.7 Recommended RS-232 Cable

- May be used for baud rates up to 9600 baud and cable lengths up to 30m in reasonably shielded conditions.
- May use straight wires, preferably (but not necessarily) shielded.
- Cable manufactured by Belden[15] type 8418 is ideally suited for submerged applications using RS-232.

6.2.8 Recommended High Grade RS-422 Cable

Use this cable for applications requiring one or more of the following characteristics:

- High baud rate
- Long cabling
- High noise immunity

Standard Ethernet cable CAT-5 is electrically well suited for RS-422 applications. Use the same wiring as for the standard test cable.

[13] These colors are only valid for the cable supplied by RESON.
[14] Not mounted from factory.
[15] www.belden.com – please obtain datasheet directly from Belden.

7 TROUBLESHOOTING

Problem	Cause
Bad characters received from SVP	SVP and receiver not set for same baud rate.
	COMMS GND connection not established between SVP pin 1 and receiver.
Nothing received from SVP	Bad connection to receiver.
	SVP not set (RS-232/RS-422) according to wiring.
Reading 1350.00m/s	Probe not properly submerged, air trapped on transducer surface, or significant amount of bubbles in sound path.
Fluctuating readings	Air bubbles trapped on the transducer surface or the reflector plate. If bubbles exist in the sound path, the SVP will at best return the average sound speed, but not the sound speed of the (air-free) medium.

APPENDIX A TECHNICAL SPECIFICATIONS

A.1 SVP 70/71 Specifications

	SVP 70	SVP 71
Range	1350 to 1800m/s	
Resolution	0.01m/s	
Accuracy (0-50m)	±0.05m/s	±0.15m/s
Accuracy (0-6000m[16])	±0.25m/s	
Sampling rate	20Hz and lower, programmable	
Sampling mode	On request, continuous	
Connector	Birns MCBH9M	Birns MCBH6M
Output	True RS-232 and RS-422	True RS-232
Baud rate	2400-115200	
Galvanic isolation	Yes	
Output options	Direct, filtered, validity	
Output formats	Programmable ASCII	
Supply	9-55VDC	
Power	2W	
Depth rating	6000m (640 bar)	2000m (210 bar)
Temperature	-20° to +55°C powered on	
Temperature for specified accuracy	-3° to +40°C	
Housing	Titanium	Hard anodized, sea water resistant aluminum
Diameter Length (excl. connector) End cap height	44mm (max) 165mm 69mm (max)	44mm (max) 160mm (excl. anode) 69mm (max)
Weight in air	1kg	650g
Weight in freshwater	740g	390g
Buoyancy due to volume	260g ±10g	260g ±10g

[16] For SVP 71: 0-2000m

A.2 SVP 70/71 Data Formats

The formats below are all supported by the SVP 7x. They are only a few examples of a multitude of possibilities. See *section 4.2 Operation Modes* for details.

In the examples the sound velocity is 1478.32m/s, and time since probe start is 12039ms.

AML output

```
 1478.32<CR><LF>
```

Valeport output

```
1478320<CR><LF>
```

Previous RESON SVPs' output

```
14783<CR><LF>
```

SVP 70 User Mode Default output[17]

```
 1478.32<CR><LF>
```

SVP 70 User Mode configurable output format

```
$PSOS<TAB>12039<TAB>1478.32<TAB><CR><LF>
```

SVP 70 NMEA-similar output formats

```
$PRSOS,1478.320*78<CR><LF>
```

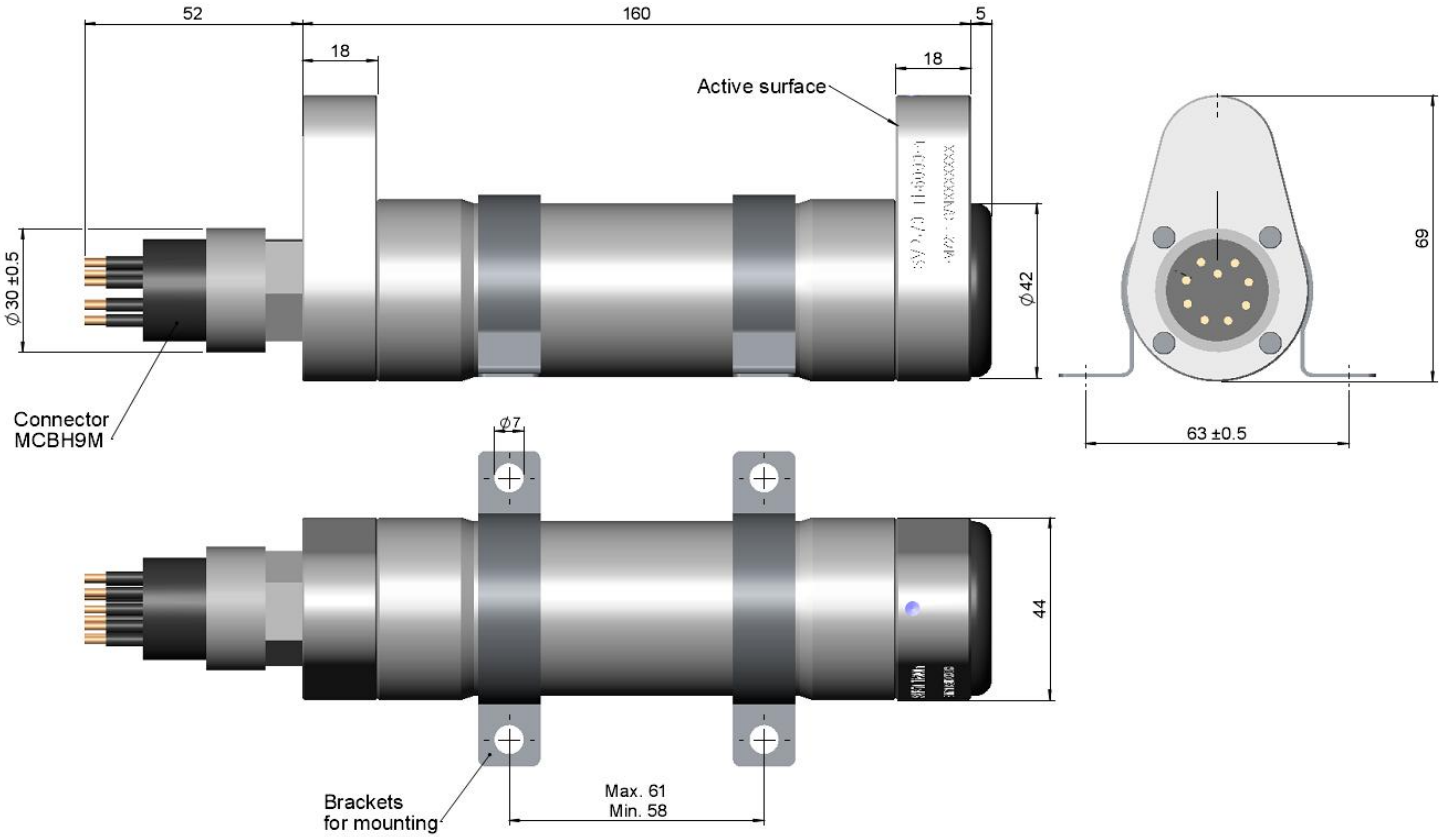
NMEA output

```
$PRSOS,1350.000*78<CR><LF>
```

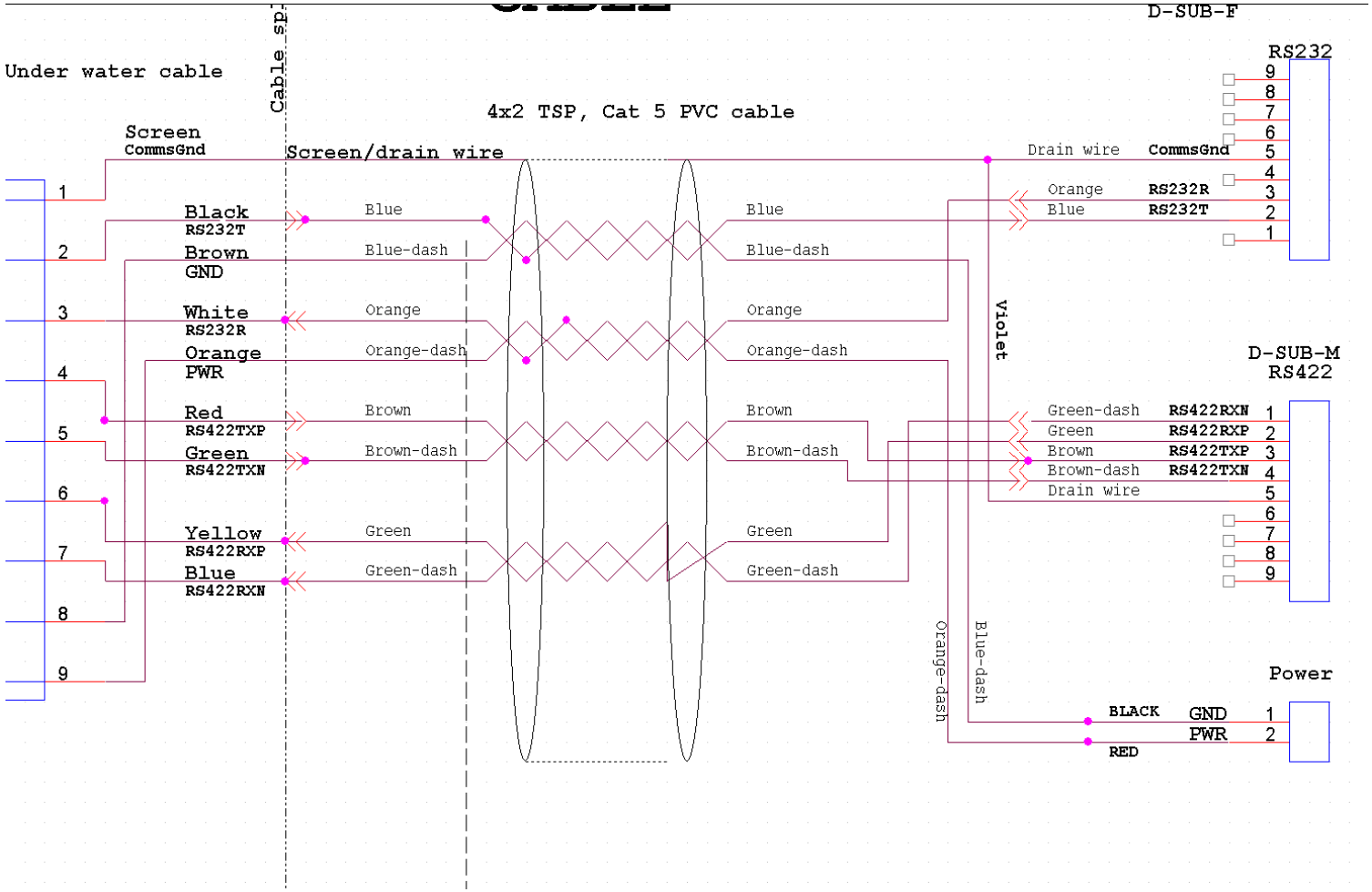
[17] Compatible with SeaBat sonar systems

APPENDIX B DRAWINGS

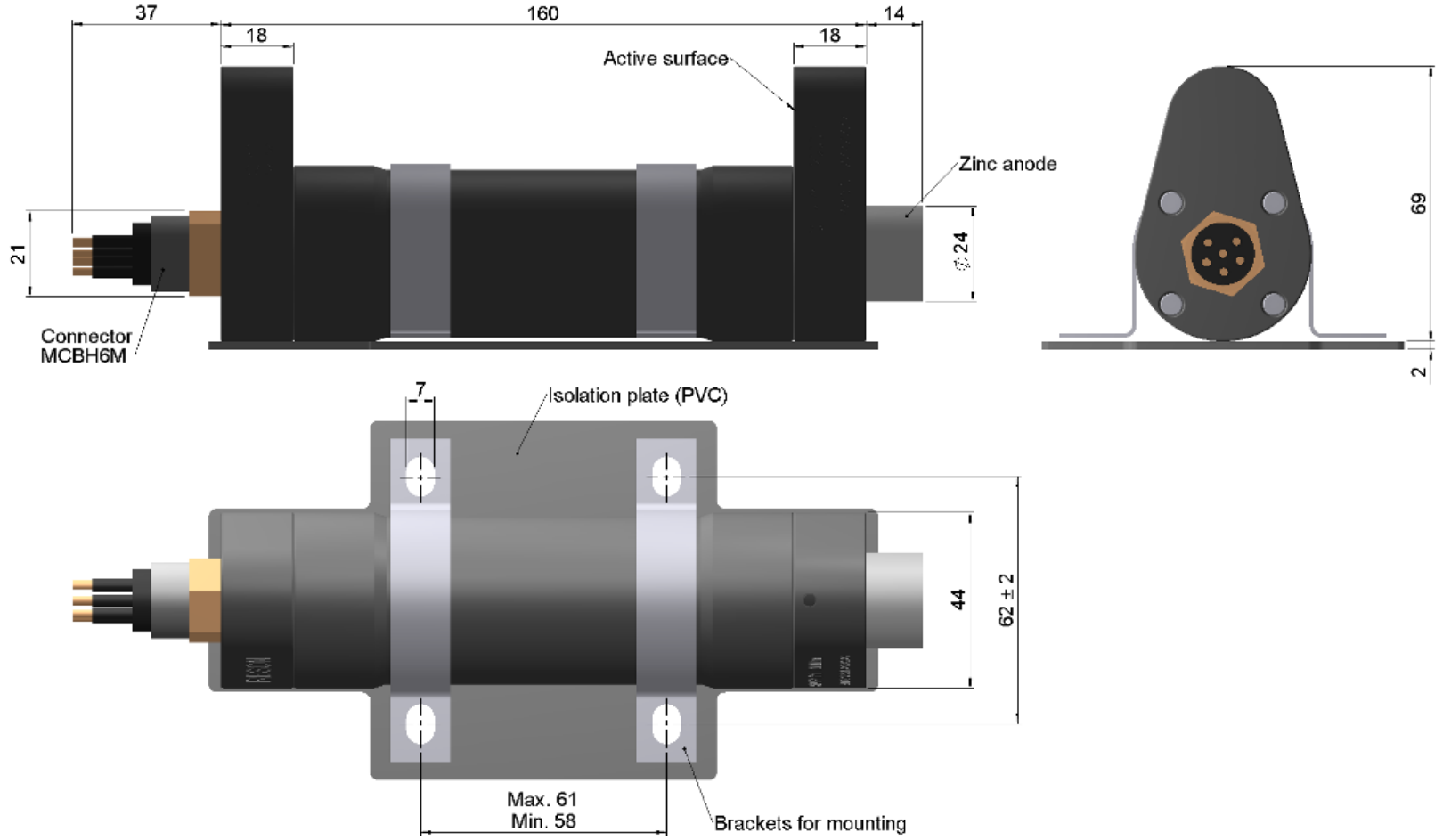
B.1 SVP 70 Dimensions



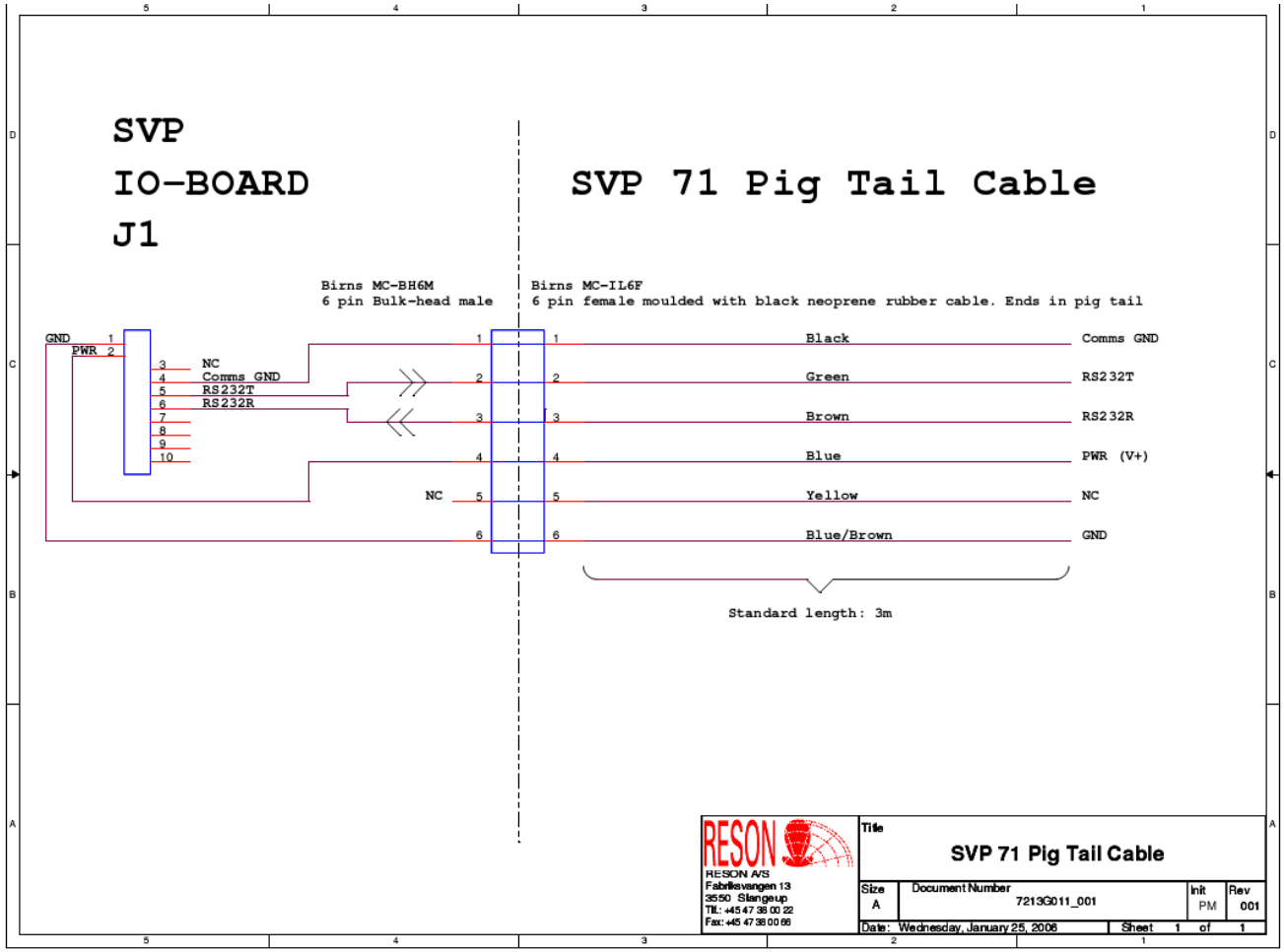
B.2 SVP 70 Test Cable



B.3 SVP 71 Dimensions



B.4 SVP 71 Test Cable



APPENDIX C SVP 70/71 ACCESSORIES

✓ = Item is included in the scope of delivery.

× = Item is not included in the scope of delivery.

optional = Item is available for purchase.

Item	SVP 70	SVP 71
Mounting brackets (pair of 2)	✓	✓
Bolts with retention O-rings	✓	✓
Test cable with Sub-D connectors	✓	×
Pigtail test cable	×	✓
Neoprene installation cable 3m	*optional*	✓
Neoprene installation cable 5m	*optional*	*optional*
Neoprene installation cable 10m	*optional*	*optional*
Neoprene installation cable 25m	✓	*optional*
Neoprene installation cable 60m	*optional*	*optional*
Dummy connector	*optional*	*optional*
Anode	×	✓
Replacement anode	×	*optional*
Isolation plate (for installations)	×	✓
Cable locking sleeves	✓	✓

APPENDIX D WARRANTY INFORMATION

D.1 One Year Limited Warranty

RESON warrants the sound velocity probe against defects in materials and workmanship for a period of one year from acceptance of the SVP. During the warranty period, RESON will, at its option, either repair or replace components which prove to be defective.

The warranty period begins on the day the SVP is accepted by the customer. The SVP must be serviced by the RESON office that sold it. The customer shall prepay shipping charges (and shall pay all duty and taxes) for products returned for service. RESON shall pay for the return of the products to the customer, not including any duty and taxes.

D.2 Exclusions

The warranty on the SVP shall not apply to defects resulting from:

- Improper or inadequate maintenance by the customer.
- Unauthorized modification or misuse.
- Opening of any parts of the equipment by anyone other than an authorized RESON representative.
- Operation outside the environmental specifications for the product.
- Improper site preparation and maintenance.
- Service provided by anyone but authorized service facilities (see *section D.6 below*).

D.3 Warranty Limitations

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. RESON specifically disclaims the implied warranties of merchantability and fitness for a purpose.

D.4 Servicing During Warranty Period

If your system should fail during the warranty period, please contact your nearest RESON representative immediately (see *section D.6 below*) to protect your warranty rights.

D.5 Equipment Return Procedure

Before returning any equipment for service, you must follow the RESON equipment return procedure stated below:

1. Contact a RESON office to obtain an approved Return Material Authorization (RMA) number.
2. Pack the equipment in the original shipping containers.
3. Ship the equipment to your RESON representative to the applicable address.
4. Ensure that the RMA number is included on all shipping documents and, most importantly, marked on the shipping container's address label.
5. Include a note with a brief, but thorough, description of the problem.

D.6 Service

If you are experiencing difficulty with your sound velocity probe, please contact RESON Service Department at one of the following addresses for further instructions:

DENMARK
RESON A/S
Fabriksvangen 13
DK-3550 Slangerup
Denmark
Tel: +45 47 38 00 22
e-mail: support@reson.com

UNITED STATES
RESON, Inc.
100 Lopez Road
Goleta, CA 93117
USA
Tel: +1 805 964 6260
e-mail: support@reson.com

APPENDIX E CONVERSION OF MEASUREMENTS

E.1 Metric Conversion

All measurements in this manual are referenced in metric terms. To convert measurements from metric (e.g. cm, m, and km) to imperial (e.g. in, ft, and yd), utilize the following reference table:

Table 7: Metric Conversion Table

Metric Unit	Imperial Unit
Millimeter (mm)	0.0394in
Centimeter (cm)	0.3937in
Meter (m)	1.0936yd
Kilometer (km)	0.6214mi
Kilogram (kg)	2.2046lb

E.2 Temperature Conversion

All temperatures in this manual are referenced in degrees Celsius. The formula for converting Celsius (°C) to Fahrenheit (°F) is as follows:

°F = 1.8 x °C + 32

Example: If Temperature = 30°C, then:

°F = 1.8 x 30° + 32

OR

°F = 86°

APPENDIX F GLOSSARY OF TERMS

Entry	Definition
7k	SeaBat 7000 series of multibeam sonars
AUV	Autonomous Underwater Vehicle
DWG	Drawing
FPGA	field-programmable gate array, a semiconductor device whose functionality can be reconfigured after manufacturing
GND	ground
LED	light-emitting diode
N/A	not available or not applicable
pcs.	pieces
PN	Part Number
RMA	Return Material Authorization
ROV	Remotely Operated Vehicle
Rx (or R)	receiver
SB	SeaBat
SOS	speed of sound
SPU	Sonar Processing (or Processor) Unit
SV	sound velocity or surface vessel
SVP	Sound Velocity Probe
TBD	To Be Defined
Tx (or T)	transmitter
UUV	Unmanned Underwater Vehicle (includes ROV and AUV)

SVP 70/71 Operator's Manual

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Document Number OM11762-3
Part Number 904-63-0833-00