SV*PLUS*

Sound Velocity, Temperature, and Depth Profiler

User's Manual

Revision 1.23
April 2005

1 INTRODUCTION

1.1 System Description

The SV*PLUS* is a multi-parameter, self-contained, intelligent instrument, designed for the measurement of sound velocity, temperature, and pressure.

The SV*PLUS* features microprocessor based CMOS circuitry, two A/D converters (1 part in 40,000, 1 part in 16,000) and 128 Kbytes of battery backed-up random access memory (RAM) for data storage. Optional RAM modules of up to 40 Mbytes are also available.

The SV*PLUS* is designed to be used with an IBM compatible computer. The instrument's output is standard ASCII RS-232, permitting data transfer via a 3-conductor cable. The baud rate is automatically selected with the maximum being 19,200. The data output may be configured to display either unprocessed integers, or computed engineering values. The SV*PLUS* has the options of logging data continuously, by depth increments, by time increments, by sound velocity increments, or logging individual scans.

The aluminium pressure case and sensor protection cages are hard-anodised for corrosion resistance and durability. Nylon bumpers on each end of the instrument provide additional protection.

1.2 About the User

This manual has been written with the following assumptions:

- The user has had some exposure to IBM compatible computers running MS Windows, and is moderately computer literate with a working knowledge of computer operation and terminology.

- The user is familiar with the operation and function of standard communications (terminal) packages.

While it is possible to operate the SV*PLUS* without these qualifications, some computer experience will greatly assist the user to pass through the learning curve more rapidly.

1.3 Instrument Specifications

Sensors:

Pressure:

Type:	Keller stainless steel pressure transducer.
Range:	Assorted pressure ranges up to 5000 dBars.
Accuracy:	0.15% of Full Scale.
Resolution:	0.005% of Full Scale.

Response Time: 10 ms

Temperature:

Type:	Pressure protected precision aged thermistor.
Range:	-2°C to 32°C.
Accuracy:	±0.05°C
Resolution:	0.001°C
Response Time:	1 s (Optional: 350ms and 100ms)

Sound Velocity:

Type:	1 Mega Hertz piezoelectric transducer INVAR stabilised path length (± 5.5 nm/°C)
Range:	1400 - 1550 m/s
Accuracy:	< 0.06 m/s (R.M.S.)
Resolution:	0.015 m/s

Memory:

128k battery backed-up RAM, expandable to 40 MBytes. The standard RAM can record 6,400 scans of date, time, pressure, temperature, sound velocity, and battery.

Output:

RS-232C, 300 to 19200 baud, ASCII, 8 data bits, no parity, 1 stop bit. The baud rate is automatically determined and selected.

Sample Rate:

When recording internally without sending data, the scan rate is selectable from 10 scans/second to one every 24 hours. If a scan rate is chosen which is faster than the scan rate capability of the instrument the instrument will default to its maximum scan rate.

Time Code:

Real Time Clock. Accuracy: ±1 minute/month at 25°C.

Power:

Standard:	9 Alkaline D-Cells, 6 Amp-hours
Optional:	9 Nickel Cadmium D-Cells, 4.4 Amp-hours 3 Lithium D-Cells, 14 Amp-hours

4 Alkaline 9 Volt Cells, 2 Amp-hours
External power 8 to 16 V DC

The Amp-hour ratings are approximate and will vary.

Battery Level:	Indicates the battery voltage.
Under Water Connectors:	Impulse^{tm} #IL-2S-BC and IL-5S-BC
Shorting Plug:	Impulse^{tm} Connector #IL-2P-MPD
Dummy Plug:	Impulse^{tm} Connector #IL-5P-MPD
Mating Connector:	Impulse^{tm} (Data link cable connector) #IL-5P-MP-Custom (consult factory)
Pressure Housing:	6061-T6 aluminium, hard anodised. All other external parts are type 316 stainless steel. Submersible to 5000 meters of water depth (dependent on installed pressure sensor).

1.4 Warranty

Warranty and Limitation of Liability

AML warrants the instrument for a period of ***one year*** from the date of delivery. AML will repair or replace, at its option and at no charge, components which prove to be defective. The warranty applies only to the original purchaser of the instruments. The warranty does not apply if the instrument has been damaged, by accident or misuse, and is void if repairs or modifications are made by other than authorized personnel.

This warranty is the only warranty given by AML. No warranties implied by law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose shall apply. In no event will AML be liable for any direct, indirect, consequential or incidental damages resulting from any defects or failure of performance of any instrument supplied by AML.

Disclaimer

AML reserves the right to make any changes in design or specifications at any time without incurring any obligation to modify previously delivered instruments. Manuals are produced for information and reference purposes and are subject to change without notice.

2 GETTING STARTED

This section describes unpacking, inspecting and connecting the SV^{PLUS} to an IBM compatible computer.

2.1 Inspecting the Instrument

An inspection of the SV^{PLUS} before each use will assist in spotting problems that could lead to inaccurate data or possible system failure. Examine the outside of the shipping case for evidence of heavy impacts during transport. If signs of damage are visible continue with the inspection as follows and notify the carrier and the factory of any damage found.

Remove the SV^{PLUS} to a clean and dry location for close examination. Inspect the top end cap of the instrument for signs of damage. Ensure that the shackle is securely fastened to the top end cap. Check that the communications and power connectors are not loose and that there is no dirt or grit on the surfaces or in the holes.

The most fragile parts of the instrument are the sensors and so they require the closest inspection. Examine the sensors for signs of obvious damage.

It is also important to check the condition of the related items in the system such as cables, plugs, and battery charger. Examine any cables for cuts or wear and check the connector ends for visible damage. Pay close attention to the area of the plugs where the metal tips protrude from the rubber housing. Wear in this area is accelerated by lack of lubrication.

Observe the general condition of the battery charger and check the line cord for fraying. Do not attempt to recharge batteries without first reading the instructions in the Maintenance section.

2.2 Switching the SV^{PLUS} On/Off

The SV^{PLUS} is configured with an external on/off switch and a communication port as shown in *Figure 2-1*.

The external on/off switch consists of a shorting plug and the three hole connector (one hole serves as a guide only) located on the top end cap. To turn the instrument on, the shorting plug (a red, two pins plus one guide pin plug) is inserted into the connector. A light coating of silicone grease on the metal pins is recommended prior to insertion. The instrument is now ready for programming and deployment. Turning the instrument off is achieved by removing the shorting plug.

WARNING: A plug or cable must be installed in both connectors at all times when the instrument is immersed in water. Failure to do so will cause damage to the connectors and a possible flood in the electronics housing.

2.3 Connection to a Computer

The user communicates with the SV*PLUS* via any IBM or compatible computer. A data cable is supplied that links the two. At one end of the cable is a DB9 female connector that plugs into the computer's serial port and at the other end is a five pin plug that is inserted into the communications port of the SV*PLUS*. The communications port (the six hole connector located on the top end cap) is used to program the instrument for deployment as well as recover the recorded data. To program the SV*PLUS* or for the real time data display, insert the five pin data cable into the six hole connector and initiate a communications program such as Procomm. Insert the red shorting plug into the three hole connector. The instrument is now powered up and ready to communicate. When the data cable is not being used, the dummy plug (the black, five pin plug) must be inserted into the connector.

See the SV*PLUS* Wiring Diagram in *Appendix A.*

3 COMMUNICATING WITH THE SV*PLUS*

There are three ways to communicate with the SV*PLUS*. The first way is through the use of Applied Microsystems Ltd's Smarttalk. This program is used for instrument configuration, log file management and viewing as well as realtime data monitoring and capture. Please refer to the Smarttalk manual (located in the manuals folder on the distribution CD) for instructions on its use and install it if you have not already done so.

The second way is through the use of Applied Microsystems Ltd's Integrated System Software. This program gives the same functionality as Smarttalk, but adds data manipulation and graphing. There is no manual for ISS, as all help is built into the program. Install it if you have not already done so.

The third way is through HyperTerminal, which is supplied with Windows.

This section describes the use of HyperTerminal as a method of communicating with the SV*PLUS*. This section also includes a complete reference for the commands used with the SV*PLUS* and an explanation of command syntax.

3.1 Configuring HyperTerminal

Please do the following:

1. Use the Start button on the Desktop to access the Programs Folder.
2. Open the Accessories menu.
3. Click on the HyperTerminal program to start the program.
4. Double click on the HyperTerminal Icon. (*Figure 3-1*).

Figure 3-1

5. Fill in the name and choose the Icon. (*Figure 3-2*)

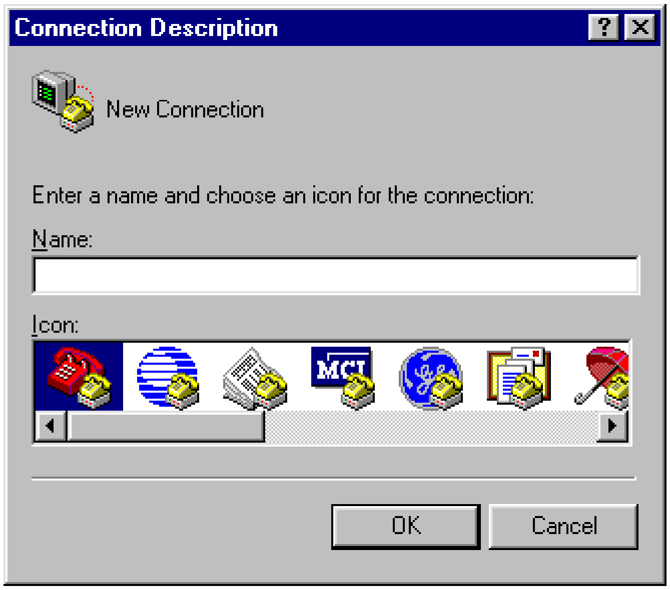


Figure 3-2

6. Choose the correct communications port. (*Figure 3-3*)

Figure 3-3

7. Choose the Baud rate (19200), 8 Data bits, No Parity, 1 Stop bit and no Flow control as shown in *Figure 3-4*.

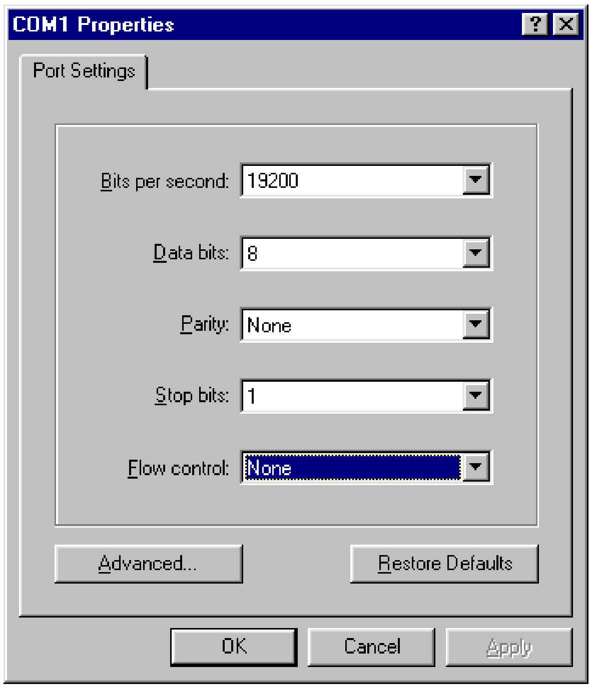


Figure 3-4

8. Press <Return> to start communicating with the instrument. (*Figure 3-5*)

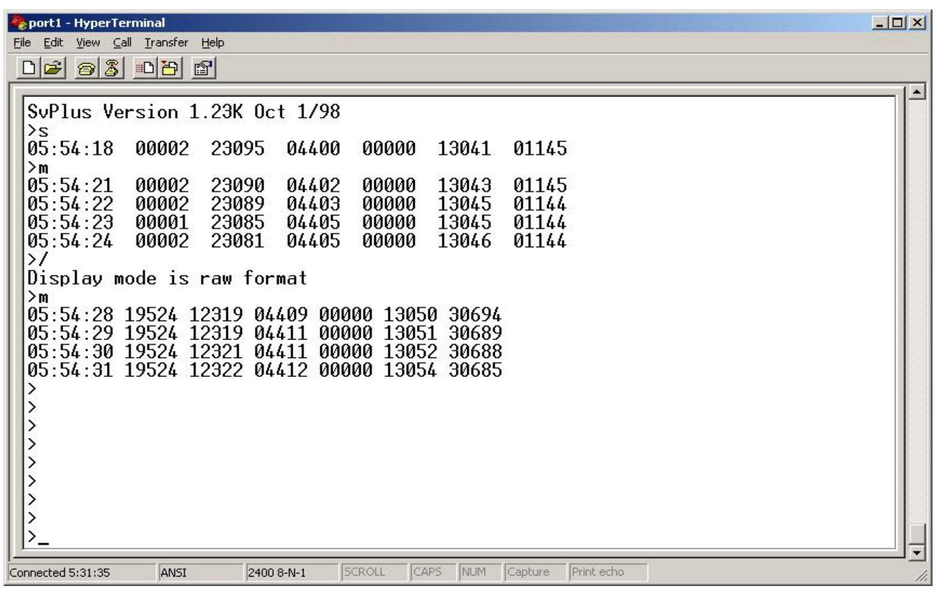


Figure 3-5

3.2 RAW/REAL Parameter Values

The SV^{PLUS} can display data in two modes, real or raw. Real mode displays data that has been calculated to produce engineering units. Data displayed in raw mode is strictly a numeric representation of the sensor readings.
Figure 3-2 depicts the raw data channel order of an SV^{PLUS}.

```
  Time
   |    Pressure
   |        | Temperature
   |        |      |    N Low
   |        |      |      | Sound Velocity
   |        |      |      |      |    N High
   |        |      |      |      |      |  Battery
   |        |      |      |      |      |      |
   |        |      |      |      |      |      |
   |        |      |      |      |      |      |
09:17:23  29990  21550  02500  10000  14500  31466
09:17:25  29990  21551  02503  10004  14500  31463
09:17:27  29990  21562  02066  10010  14509  31460
09:17:29  29989  21571  02567  10012  14510  31459
```

Figure 3-2 Raw Data Output Format

1. Time	This is displayed in a 24 hour military format.
2. Pressure	This is a five digit integer in the range of 20000 to 40000.
3. Temperature	This is a five digit integer in the range of 0 to 40000.
4. N Low	This is a reference number used for calibrating sound velocity.
5. Sound Velocity	This is a five digit integer in the range of 1 to 16000.
6. N High	This is a reference number used for calibrating sound velocity.
7. Battery	This is a five digit integer in the range of 20000 to 40000.

Figure 3-3 depicts the real data channel order of an SV*PLUS*.

```
 Time
   |    Pressure
   |       | Temperature
   |       |     |  N Low
   |       |     |     | Sound Velocity
   |       |     |     |     |   N High
   |       |     |     |     |      |  Battery
   |       |     |     |     |      |     |
   |       |     |     |     |      |     |
   |       |     |     |     |      |     |
   |       |     |     |     |      |     |
13:11:32 04990 21566 02500 154327 14500 01266
13:11:42 05050 21551 02502 154321 14502 01261
```

Figure 3-3 Real Data Output Format

The REAL parameters are described as follows:

1. Time — This is displayed in a 24 hour military format.

2. Pressure — This number gives absolute pressure in tenths of deciBars e.g. 01035 means 103.5 ±0.05 dBar.

3. Temperature — This number gives temperature in thousandths of a degree Celsius e.g. 21046 means 21.046 ±0.005 degrees Celsius.

4. N Low — This is a reference number used for calibrating sound velocity.

5. Sound Velocity — This number gives sound velocity in hundredths of metres per second. e.g. 154327 means 1543.27 m/s ±0.06 m/s.

6. N High — This is a reference number used for calibrating sound velocity.

7. Battery — This number gives the battery voltage to one hundredth of a volt. e.g. 01266 means 12.66 volts ±0.05 volts.

3.3 SV*PLUS* Command Summary

All commands are in the form of standard English words. Commands can be entered in upper or lower case letters. The minimum letters of the command that the instrument will recognise are enclosed in brackets.

Command: **DATE [DA]**

This command sets the date for the real time clock. The format of the command is
DATE mm-dd-yy.

Command: **DIRECTORY [D]**

This command gives a directory listing of all the files contained in the instrument. It will mimic a standard MS-DOS directory output.

Command: **DISPLAY [DIS]**

This command will display the current value of a variable or all variables associated with a sensor. e.g.:

DISPLAY S	This command will display the current sample rate.
DIS DATE TIME	This will display the current date and time.
DISPLAY LOG	This will display the current log file.
DIS P	This will display all variables associated with the pressure sensor.
DIS P T SNDVEL	This will display all variables associated with pressure, temperature and sound velocity.
DIS BATT	This will display all variables associated with the battery including the instruments voltage shutdown level. (Refer to section *`5.1.2 Batteries'* for details)

Command: **DUMP [DU] <filename>**

This command outputs data from a file gathered by the instrument during a logging session. The RAW and REAL commands select which data format will be displayed.

The purpose of this command is to allow the transfer of data obtained with the instrument. The type of communication software used (and its commands) will control the method of receiving the data.

Command: **ERASE [ERA]**

This command is used in conjunction with a file name, (eg. ERASE {file name}).This command will erase a file from the instrument's RAM disk.

Command: **INITIALIZE [INIT]**

This command initialises the Random Access Memory (RAM) of the SV*PLUS* and creates a blank RAM disk.

WARNING: This command will erase all data in the instrument's memory.

Command: **LOG [L]**

This command sets the current log file name. This will be the file name under which all new data will be stored. The file name can be new or an existing one. The format of the command is LOG {filename}. Where {filename} represents a standard MS-DOS file name format.

Command: **MONITOR [M]**

This command sets the instrument to output continuous scans at the instrument's current sample rate. Depressing any key on the computer keyboard can halt it.

Command: **RAW [RA]**

This command will set the instrument to output RAW uncorrected data when using the MONITOR, SCAN or DUMP commands.

Command: **REAL [RE]**

This command will set the instrument to output Real corrected engineering data when using the MONITOR, SCAN, or DUMP commands.

Command: **SCAN [S]**

This command outputs one scan of data.

Command: **SET [SE]**

In order to define the operation of the instrument certain parameters must be set. These parameters are contained in variables. The SET command is used to assign a value to these variables. Examples:

SET S 1 MINUTE	Sets the sample rate to 1 minute.
SET SNDVEL 0.25	Sets the sound velocity logging increment to 0.25 m/s.

Command: **TIME [T]**

This command sets the real time clock. The time may be entered using either military or standard format. Time will always be displayed in military format.

Examples:

TIME 4:35:00	Sets time to 4:35 AM
TIME 16:35:00	Sets time to 16:35
T 4:35:00P	Sets time to 16:35

Command: **/ [/]**

This command is used to toggle RAW and REAL modes of operation.

Variable: **BAUD [B]**

This variable, used with the set command, allows the user to change the baud rate of the instrument. It is important that the baud rate setting of the communications software matches the instruments. The following baud rates are supported:

300 600 1200 2400 4800 9600 19200

SET BAUD 19200 Sets the baud rate to 19200.

Variable: **SAMPLE RATE [S]**

This variable, used with the set command, sets the rate at which the instrument will take samples (or scans). The sample rate is in the form of a number followed by the time units. The allowable time units are listed below.

SECONDS [S]	/SECOND [/S]
MINUTES [M]	/MINUTE [/M]
HOURS [H]	/HOUR [/H]

The Following examples demonstrate some of the possible permutations of this variable.

SET SAMPLE 6 HOUR	This will set the sample rate for one sample every 6 hours.
SET SA 30 SEC	This will set the sample rate for one sample every 30 seconds.
SET S 4/HOUR	Sets the sample rate at 4 samples per hour (or every 15 minutes).
SET S CONTINUOUS	Sets the sample rate at the maximum of 15 per second.

Variable: **SENSORS**

Each instrument comes equipped with a selected number of sensors. Some of these sensors have variables associated with them. To display the variables associated with a specific sensor the display command can be used as follows:

DIS PRESSURE

The instrument will display the variables in the following format (variables will vary depending on the sensor):

Sensor: Pressure

Channel 1

Precision 1

A=-5.541342E+02 B=2.838234E-02 C=1.784541E-08 D=0.000000E+00

Atmospheric offset 0.00

Depth increment 0.00

To alter the variables associated with a sensor the following format must be used:

SET {sensor name} {sensor variable}

In the example above {sensor name} is one of the SV^PLUS' sensors and {variable} is a specific variable associated with the sensor.

Sensor Variable: PLACE [PL] This variable sets the displayed precision of the REAL data.

Examples:

SET T PLACE 2	Sets the displayed precision to 2 decimal places.
SET P PL 1	Sets the displayed precision to 1 decimal place.

The following are examples of sensor names, associated variables and recognised abbreviations.

PRESSURE [P]
INCREMENT [I]
OFFSET [O]
TEMPERATURE [T]

SOUND VELOCITY [SNDVEL]
BATTERY [BAT]

Examples:

SET PRESSURE OFFSET 2	Sets the pressure sensor atmospheric offset to 2 dBars. This will subtract 2 dBars from the displayed pressure value of the instrument.
SET P INCREMENT .1	Sets the pressure logging increment to 0.1 dBars.

4 DEPLOYMENT AND RETRIEVAL

The Process of acquiring accurate data requires that the instrument be properly prepared for deployment. This section describes deployment, preparation, and recovery procedures.

4.1 Configuring the SV^{PLUS} for Deployment

The SV^{PLUS} user must program the instrument to sample data within chosen parameters. The battery backed up memory in the SV^{PLUS} will retain all the programmed settings. Data can be logged in increments of time, sound velocity, pressure, or may be viewed in real time. The instrument must be connected to a computer (described in *Section 2.3*) to commence programming.

The instrument is capable of logging multiple casts without being reprogrammed. The SV^{PLUS} will mark each new cast to allow for separation of the data being down loaded. Please refer to *Figure 4-1*.

```
SV PLUS S/N 0000-3200
New cast started on 07-24-95 at 14:23:02

Sample rate is 1 second
Depth increment  0.00
00004 11793 02600 150012 14654 01212
00011 11790 02602 149956 14655 01210
00017 11790 02606 150000 14657 01210
00022 11786 02607 149523 14659 01208
SV PLUS S/N 0000-3200
New cast started on 07-25-95 at 8:02:11

Sample rate is 1 second
Depth increment  0.00
00001 13630 02792 152049 14333 01202
00011 13521 02794 151487 14345 01200
00022 13499 02795 151054 14350 01199
```

Figure 4-1 Example of Cast Data Display in Real Mode

The instrument will flag a new cast each time it is submerged in the water or when power is applied. To begin logging data the shorting plug is inserted with the locking sleeve and the communications cable is disconnected (and the dummy plug installed). The instrument begins scanning the sound velocity sensor to detect when it is immersed in water. When the instrument receives a valid sound velocity value it begins recording the data. Debris, marine life, or muddy bottoms can temporarily obstruct the sound velocity sensor. To avoid initiating a false new cast header during a cast the instrument will allow up to ten scans without a sound velocity signal. If after ten scans the instrument cannot detect a sound velocity signal it will assume it is out of the water and flag a new cast.

NOTE: **The SV*PLUS* will only log data and save it to a file when the communications cable is disconnected from the instrument.**

4.1.1 Logging by Pressure

The following procedures are listed as examples only.

This example will program the instrument to sample continuously and log data when pressure has changed by 2 dBars. The instrument must be set to sample continuously to monitor the pressure channel. Data will be logged to the file named TEST1.RW when the instrument detects a 2 dBar change from the previously logged sample.

LOG TEST1.RW	Set the current log file to TEST1.RW
SET P I 2	Set the pressure increment to 2 dBars
SET S CONT	Set the sample rate to continuous

In order to check that the SV*PLUS* has received the instructions the following commands may be entered.

DIS LOG	Displays the current log file.
DIS P	Displays information regarding the pressure sensor including the pressure logging increment.
DIS S	Displays the current sample interval.

4.1.2 Logging by Time

This example will program the instrument to sample data at 10 minute intervals and save the data to a file named TEST2.RW .

LOG TEST2.RW	Set the current log file to TEST2.RW
SET S 10 MIN	Set the sample rate to 10 minutes
SET P I 0	Set the pressure increment to 0

NOTE: The instrument will store a data scan only when time and pressure parameters are met. e.g. If the sampling rate (time) is set to ten seconds and the pressure increment is set to one meter the instrument will take a scan every ten seconds. If the depth has changed one meter or more from the previously stored scan the data will be stored. If the depth has not changed by one meter or more the scan is not recorded.

4.1.3 Logging by Sound Velocity

This example will program the instrument to sample continuously and save a data scan to memory at every 0.5 m/s sound velocity change. Sampling data continuously allows the instrument to detect the 0.5 m/s change most accurately.

SET S CONT	Set the sample rate to continuous.
SET SNDVEL I 0.5	Set the sound velocity increment to 0.5 m/s.

4.2 Preparation

Once the SV*PLUS* has been programmed, the probe must undergo some final physical preparation before deployment.

WARNING: During immersion in seawater, the SV*PLUS* must have the shorting plug inserted in the power connector and the dummy plug, or the communication cable inserted into the communications connector. Failure to have plugs in these connectors will cause corrosive damage to the connector.

Keep the plugs and cable connectors lightly coated with silicone grease to prevent water seepage into the connectors.

4.2.1 Deployment Lines

The SV^{PLUS} may be lowered with any good quality load bearing cable, rope, or line. Be sure to use a line of sufficient strength to pull the instrument free should it become fouled in weeds or other hidden underwater materials.

When the instrument is to be deployed with the data transmitted to the surface for Real Time viewing to a monitor, an electronic deployment cable will be required. This cable must have three conducting wires, and can be ordered from the factory.

WARNING: Underwater communication cables supplied by Applied Microsystems Ltd. are not load bearing.

4.2.2 Use of the Protection Cage and Drop Weight

AML has developed an optional protective cage, which easily attaches to the instrument. It allows for the installation of a wide range of accessories including a drop weight. The use of a drop weight or ballast is recommended to keep the SV^{PLUS} vertical when deploying the instrument in waters where currents are causing difficulties in obtaining perpendicular profiles. See the Instrument Mounting Diagram in Appendix 'D'.

CAUTION: Never attempt to suspend a drop weight from the instrument's sensor cage.

A drop weight can also be useful when deploying the instrument in unknown or shallow waters. When lowered into a body of water, the drop weight should land on the bottom first. The user should feel the deployment line go slack, and will then know how far the instrument is from the bottom. The sensor end of the instrument is then less likely to be fouled or damaged by contact with submerged objects.

4.3 Thermal Stabilisation

In order to minimise temperature induced measurement errors associated with the internal electronics of the SV^{PLUS}, the instrument should be acclimatised prior to deployment (if a temperature difference of 10 C or more exists between the instrument and the water). This can be achieved by immersing the instrument in the water for 10 to 20 minutes. The instrument need not be powered up during this procedure but the dummy plugs must be inserted in both bulkhead connectors. Refer to Appendix D for the bulkhead connector locations.

4.4 Retrieving the Instrument

When the SV^{PLUS}'s profiling session has been completed the instrument should be well rinsed in fresh water as soon as it is convenient, otherwise dirt and salt deposits will accumulate on the sensors and bulkhead connectors.

5 MAINTENANCE

The SV*PLUS* has been designed to minimise user maintenance. To keep the instrument in top condition the following maintenance is required:

- Battery replacement or recharging
- End cap O-Ring seal inspection
- Underwater bulkhead connector maintenance
- Sensor maintenance
- Zinc replacement

NOTE: After each deployment, the SV*PLUS* case and sensors should be thoroughly flushed with fresh water.

The instrument's pressure case must be opened to replace and recharge the batteries. In all cases when opening the instrument care must be taken as both end caps are connected together via a wiring harness.

5.1 Batteries

The SV*PLUS* is available with four different battery configurations. They are 3 lithium D-cells, 9 alkaline D-cells, 9 nickel cadmium rechargeable D-cells and 4 alkaline 9 volt cells.

The SV*PLUS* is equipped with a battery voltage channel, which displays the voltage level of the batteries. The battery channel is monitored by an automatic instrument shutdown routine. This routine will automatically stop all activity and initiate a deep sleep mode when the battery voltage drops below 8.0 volts. The deep sleep mode prevents the batteries from being deeply discharged (if they are rechargeable) and also prevents the instrument from corrupting or losing data. The batteries must be replaced or in the case of nickel cadmium batteries, recharged, before the instrument can be re-activated.

- It is recommended that lithium batteries be replaced when their voltage level drops below 9.6 volts.

- It is recommended that alkaline D-cells be replaced when their voltage level drops below 8.0 volts.

- It is recommended that alkaline 9 volt cells be replaced when their voltage level drops below 8.0 volts.

- It is recommended that the nickel cadmium batteries be recharged when their voltage level drops below 8.0 volts.

5.1.1 Recharging Batteries

WARNING: Do not attempt to recharge alkaline or lithium batteries. Explosion causing personal injury and damage to the instrument may result. It is recommended that alkaline and lithium batteries be removed if the instrument is not in use for an extended period of time.

Remove the communications cable and shorting plug from the connectors. Lay the SV*PLUS* on its side and unscrew the shackle end cap-retaining ring. Dry the area where the end cap meets the pressure case to reduce the chance of water splashing on the batteries. Grasp the shackle, and pull it straight out. A slight rocking motion will aid in the removal of the end cap. The instrument needs only to be opened a few inches to allow for release of gases during the recharging process.

Insert the three pin plug on the recharging cable into the power connector of the SV*PLUS*. Insert the red plug in the red connector and the black plug in the black connector of the battery charger. Plug the battery charger into a suitable AC power source and turn the power switch on. The yellow charging light should light to indicate the batteries are charging. The charge time on completely discharged batteries is approximately 24 hours. The charging light will go out when the batteries have been completely charged. The charger will automatically drop its charging current to a trickle charge to maintain the full charge of the batteries without overcharging them.

Closing the instrument is the reverse of the above operation while observing the following special precautions.

- Make sure the O-ring and O-ring surface are clean and lubricated with silicone grease.
- Take care not to pinch the wiring harness when sliding the batteries into the housing.

5.1.2 Replacing Batteries

Rinse the instrument with fresh water and dry it.

Remove the communications cable and shorting plug from the connectors. Lay the SV*PLUS* on its side and unscrew the shackle end cap-retaining ring. The battery pack is connected to the bottom of the shackle end cap. Dry the area where the end cap meets the pressure case to reduce the chance of water splashing on the batteries. Grasp the shackle and pull it straight out. A slight rocking motion will aid in the removal of the end cap.

To replace lithium or alkaline D-cells remove the black electricians tape that holds the batteries in place. Remove the old batteries and install new ones of the same type. Take care to observe the correct polarities when installing the fresh batteries. Wrap the battery pack with electrician’s tape to help hold the batteries in place. Please refer to Figure 5-1 Battery Pack General View on the following page.

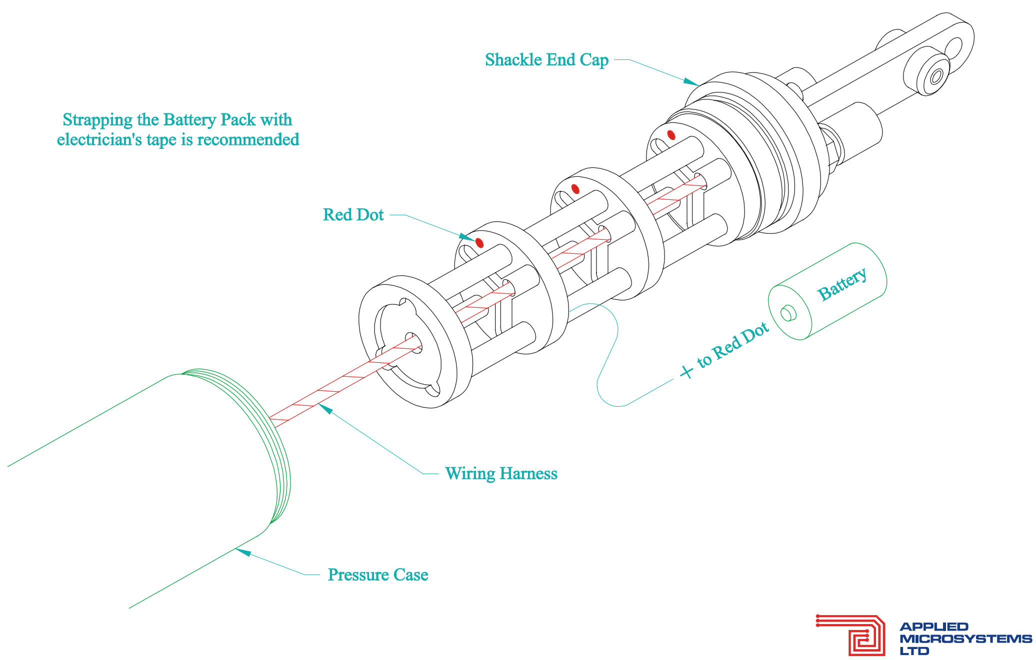
NOTE:

Lithium D-cells contain a fuse, which will blow if the battery is short circuited or experiences excessive current draw. The fuse is non-replaceable and so the battery must be replaced.

Closing the instrument is the reverse of the above operation while observing the following special precautions.

- Make sure the O-ring and O-ring surface are clean and lubricated with silicone grease.
- Take care not to pinch the wiring harness when sliding the batteries into the housing.

BATTERY PACK - GENERAL VIEW



CAUTION:

The sensor cage is screwed on to the pressure case. When the cage is removed the sensor end cap and electronics may slide out if the instrument is held at an angle. Please remove the cage carefully.

• Lay the SV*PLUS* on its side and unscrew the sensor protection cage. If the threads are encrusted with salt deposits soaking the cage end of the instrument in hot water for an hour should remedy this problem.

• Dry the area where the end cap meets the pressure case to reduce the chance of water splashing on the electronics.

• Grasp the end cap, not any of the sensors, and pull straight out. If the SV*PLUS* is cold it may be difficult to break the single O-ring piston seal. Inserting a plastic wedge between the end cap and pressure case will assist in opening the instrument.

CAUTION: If it sticks, do not use any metal tool (such as a screwdriver) to pry it open. This could result in damage to the anodised coating. Use the plastic wedge provided to gently push between the cap and the pressure case, until the cap comes loose.

5.2 O-Ring Seal Checks

The SV*PLUS*'s electronics/battery compartment is protected with a single O-ring static piston seal (Parker O-ring #2-233). Whenever the sensor end cap is removed to access the batteries, the O-ring should be carefully inspected for cuts, abrasions or other damage to its surface. Use the following O-ring seal precautions.

• Do not allow the O-rings or O-ring surfaces to come in contact with sharp tools or materials.

• Do not allow the O-rings or O-ring surfaces to come in contact with abrasive tools or materials.

• Do not allow the O-rings or O-ring surfaces to be contaminated with dirt or fibres.

• Do not allow the O-rings or O-ring surfaces to come in contact with chemicals that could harm the BUNA-N rubber O-rings.

• Do not excessively stretch the O-rings when installing them.

• Do not over grease the O-rings or O-ring surfaces. A thin coating of the recommended grease is sufficient.

• When replacing the O-ring, lubricate it with a skim of silicone grease. (Vaseline can be used but tends to harden over time in seawater.) O-ring replacements may be obtained from Applied Microsystems Ltd. (Part Number 12-2-233).

5.3 Underwater Signal and Power Connector

Signal input/output and power-up is accomplished via SEA CON™ bulkhead connectors. When inserting the communication cable, shorting plug, or dummy plug, a light smearing of silicone grease is recommended on the pins. Connectors should be kept free of dirt and grit to extend their life.

Connectors should be lightly lubricated. Insertion should be accomplished with as little flexing as possible. Separation of multi-conductor connectors can be aided by 10 - 15 degrees flexing of the connector heads to help break the contacts to start the separation process. Extreme flexing should be avoided as it puts unnecessary strain on the wires inside the connector.

Periodically check that the connectors are still tightly threaded into the top end cap. The connectors use a standard right hand thread (tighten clock-wise). If the connectors are found to be very loose the instrument should be opened and checked for signs of flooding. Please consult the factory for instructions if flooding is suspected.

5.5 Zinc Anodes

The SV^{PLUS} is equipped with two zinc anodes to deter seawater corrosion. The zincs should be inspected on a regular basis and the screws checked for tightness. An ohmmeter should be used to confirm continuity between the zincs and any exposed aluminium of the instrument. This resistance should be less than 10 ohms. It is not necessary to have continuity between the zincs and the stainless steel components of the SV^{PLUS}.

The life of the zinc is dependent on the environment in which the SV^{PLUS} is used, and therefore should be replaced at the users discretion. Any concerns about corrosion can be Directed to the factory.

6 SENSORS

The SV*PLUS* 's sensors must be calibrated occasionally. Different sensors will require calibration with varying degrees of frequency. The sound velocity, temperature, and pressure sensors were calibrated at the factory at the time of manufacture. These should remain within published specifications for periods of 1 - 2 years, depending on the amount of use, depth of deployment, and other conditions occurring in the deployment environment. The sensor accuracies are also dependent upon proper care and maintenance by the user. Re-calibration of these sensors must be done at the factory.

Sensors are calibrated by recording the instrument's raw data at known reference points. This data is applied to a curve-fitting algorithm to produce calibration coefficients. Each set of coefficients are permanently stored in the instrument's memory.

Calibration coefficients are not interchangeable. Each set is unique to each instrument. The calibration coefficients for the instrument to which this manual belongs are listed in *Appendix `A'*. The user will need these coefficients if the instrument is to be used in the RAW mode.

6.1 Pressure

6.1.1 Specifications

Keller stainless steel pressure transducer, ±0.1% F.S. accuracy
Capable of 0.005% of F.S. resolution
Assorted pressure ranges up to 5000 dBars
Response time: 10 ms

6.1.2 Maintenance

CAUTION:

The pressure sensor is fragile. Contact with a sharp object to the pressure sensor face could damage it.

The pressure sensor is protected from the environment by an oil filled bladder. Should damage occur to the bladder the bladder should be replaced.

• Lay the instrument on its side and remove the protective cage.

• Protect the C-Cell from oil spillage by wrapping it with a cloth.

• Unscrew the bladder holder taking care not to damage the other sensors (it may be necessary to use pliers).

• Flush the pressure cavity with fresh water, and then with methyl hydrate to remove moisture. A hypodermic syringe, fitted with a thin plastic tube, will be useful for this operation (see figure 6-1).

• Remove the O-Ring holding the bladder, then remove the bladder. Place the new bladder on the holder. Roll the O-Ring over the bladder until it seats itself in the groove.

• Fill the bladder with heavy mineral oil. (Figure 6-1)

• Invert the instrument and fill the pressure sensor cavity with heavy mineral oil using the hypodermic syringe. Avoid injecting air bubbles into the cavity. (Figure 6-1-1)

• Stand the instrument upright in the protective cage.

• Screw the bladder holder onto the fitting finger tight. (Figure 6-1)

• Lay the instrument on its side and remove the protective cage.

• Tighten the bladder holder if necessary.

• Attach protective cage.

• Wash the instrument in warm, soapy water to remove any oil.

6.1.3 Theory

Pressure is calculated from the following formula:

$$P = A + Bn_p + Cn_p^2 + Dn_p^3$$

A, B, C and D are calibration coefficients, which are determined at the factory.

n_p is the raw value for pressure, as measured by the SV*PLUS*.

P is the pressure, in deciBars, as calculated by the SV*PLUS*.

6.1.4 Calibration

The SV*PLUS* pressure sensor must be re-calibrated at the factory.

6.1.5 Pressure Offset

After the data logging parameters (sample rate, depth increment, etc.) have been specified and just prior to deploying the instrument, the user should calibrate the pressure reading to zero at sea level. This can vary for four reasons:

1. Sensor accuracies. The SV*PLUS* pressure sensor has an accuracy of ±0.1% of full scale. With a range of 0 to 2000 meters, the accuracy is ±2.0 meters. This means that at sea level, the real time pressure output could range anywhere between -2.0 and +2.0 meters.

2. Atmospheric Pressure. The pressure (depth) sensor is sensitive to changes in the actual atmospheric pressure. Although it is calibrated at sea level in the factory, chances are the atmospheric pressure will not be the same when the SV^{PLUS} is deployed by the user.

3. Temperature effects. Pressure sensors (among others) are affected by large, rapid changes in temperature. Placing an SV^{PLUS} whose electronics are at room temperature into ice water can thermally shock the sensor into reading inaccurately until the entire SV^{PLUS} temperature has equalised. To minimise this problem, the instrument should be acclimatised by immersing it in water for twenty minutes before sampling.

4. Hysteresis - Pressure sensors have a stainless steel diaphragm, which deflects under pressure. It is this bending action that is measured. When these diaphragms are strained, they do not always return to their original position and this shows as an offset.

The pressure offset is the value that must be added or subtracted to the reading at the water surface to produce zero. This is accomplished by using the SET command, the sensor variable P, and the pressure offset variable O. Two examples are shown below. Refer also to section 3.4 SV^{PLUS} Command Summary. The pressure offset should be set just prior to deployment.

SET P O 2 Set the pressure offset to 2 dBars. This will subtract 2 dBars from the displayed pressure value of the instrument.
SET P O –4 Set the pressure offset to -4 dBars. This will add 4 dBars to the displayed pressure value of the instrument

6.2 Temperature

6.2.1 Specification

A precision thermistor sensor that is capable of 0.001 Celsius resolution. Range -2 C to 32 C. Accuracy ±0.005 C. Response time is 100 milliseconds.

6.2.2 Maintenance

The temperature sensor should not require maintenance. Keep it free of mud and debris. If cleaning is necessary, soak the sensor end of the instrument in fresh water. Gently remove any dirt and debris with a cotton swab, taking care not to bend the sensor tube.6.2.3 Theory
The Applied Microsystems temperature sensor consists of a precision thermistor encapsulated within a small bore capillary tube. The thermistor exhibits a nominal resistance of 100K ohms at 25 Degrees C and exhibits a typical time constant of 100 milliseconds.

Temperature is calculated from the following formula:

$$T = A + Bn_t + Cn_t^2 + Dn_t^3$$

T = Temperature in degrees Celsius, as calculated by the SV^{PLUS}.

n_t= is the raw value for temperature, as measured by the SV^{PLUS}.

The coefficients A, B, C and D are, again, determined by the factory.

6.2.3 Calibration

The SV*PLUS* temperature sensor must be recalibrated at the factory.

6.3 Sound Velocity

6.3.1 Specifications

The sound velocity sensor is capable of operating from 1400 to 1550 m/s in water with an accuracy of ±0.06 m/s RMS and a resolution of 0.015 m/s. Response time for the sensor is 1 millisecond.

An extended range (1400 to 1600 m/s) version of the sensor is available and has accuracies as follows, between 1400 to 1550 m/s ±0.06 m/s, between 1550 to 1570 m/s ±0.25 m/s, between 1570 to 1600 m/s ±0.6 m/s.

6.3.2 Maintenance

The sound velocity sensor must be kept clean to be accurate. After each deployment the sensor should be rinsed with fresh water to remove any foreign material or salt which could cake on to the sensor as it dries.

Any obstruction or bio-fouling within the sensing volume, on the reflector plate, or on the transducer, will effect the sensor's performance. If bio-fouling occurs, clean the sensor as well as possible without abrading the reflector plate or transducer, remove the zinc anode, then soak the sensor in a weak acid solution to dissolve any calcium deposits, wipe the sensor clean, flush the sensor with fresh water and replace the zinc anode. The acid will attack the invar rods as well as the calcium deposits but minor corrosion and pitting of the rods will not effect the sensor's accuracy.

6.3.3 Theory

The speed of sound is measured by injecting an acoustic pulse into the water and measuring the time taken for that pulse to travel across a fixed distance. The sound speed is calculated from two sets of coefficients. The Low coefficients calculate sound speed using the raw number of the instrument up to a value of 8192. The high coefficients calculate sound speed above the raw number value of 8192. Both sets of coefficients use the following formula to calculate sound speed:

$$SV = A+B(n_{sv})+C(n_{sv}^2)+D(n_{sv}^3)$$

where SV is the calculated sound velocity in m/s,
n_{sv} is the raw number from the instrument, and
A, B, C, and D are calibration coefficients determined by the factory.

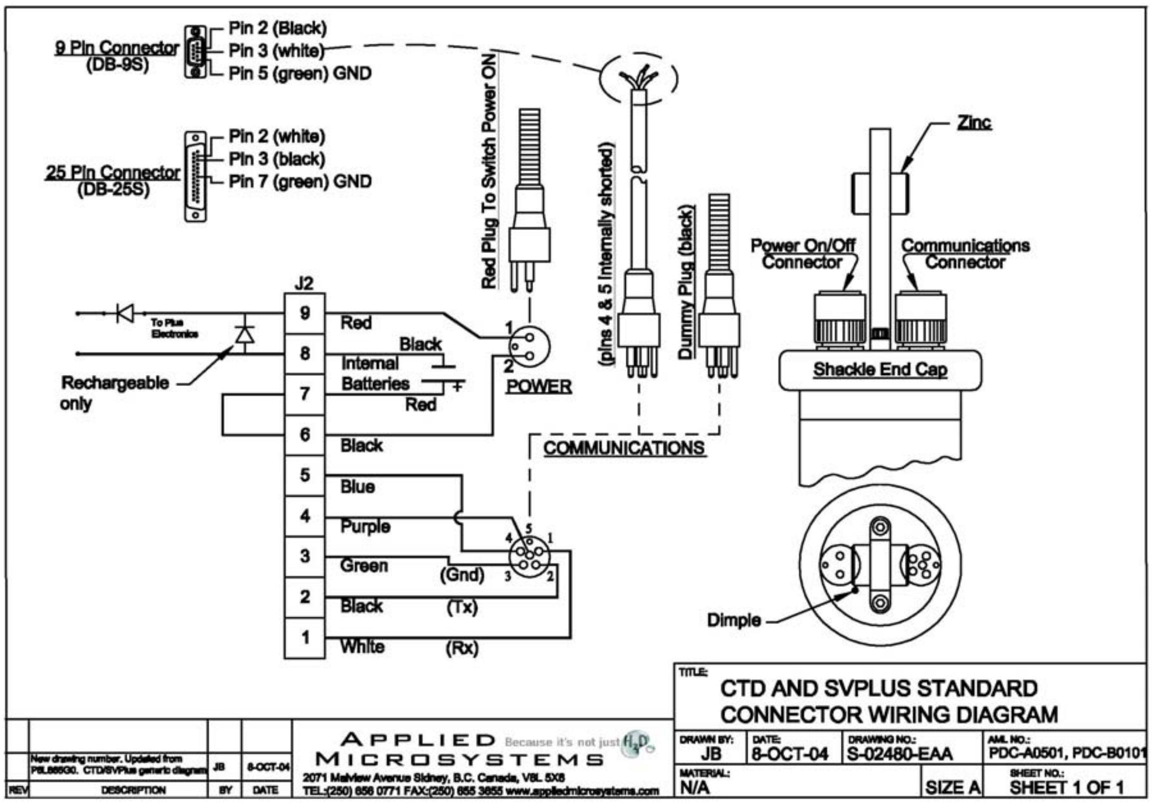
6.3.4 Calibration

The SV*PLUS* sound speed must be re-calibrated at the factory.

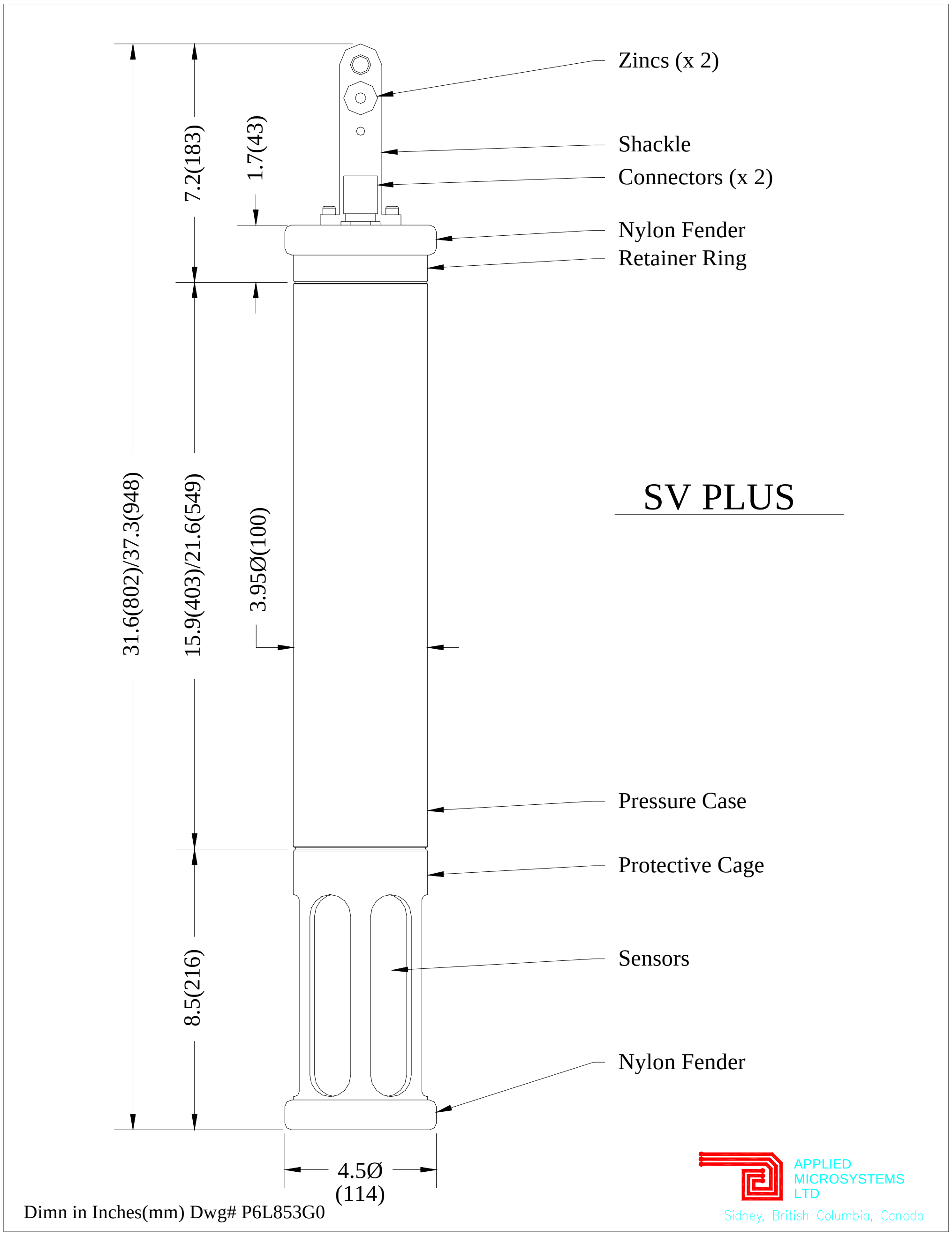
NOTE: APPLIED MICROSYSTEMS LTD. is not responsible for accuracies of calibrations for the above sensors performed outside the factory.

APPENDIX A Wiring Diagram

NOTE: Recharge cable is for use on NICAD battery packs only. Use of recharge cable on any battery option other than NICAD can result in severe damage to the instrument and pose a danger to the user.



APPENDIX B General Layout



APPENDIX C Troubleshooting Guide

The following section outlines some of the most common problems encountered by users of the SV*PLUS*. A brief list of suggested solutions has been provided. If the difficulties persist, please do not hesitate to contact the **Applied Microsystems Ltd.** service staff.

Problem:

SV*PLUS* does not communicate with the computer.

Solutions:

• The SV*PLUS* batteries are dead. This is unlikely if the instrument is fresh from the factory. However, if the SV*PLUS* has been left to sit for an extended period of time (especially if the red shorting plug has been inserted), it is possible. The minimum voltage required to operate the SV*PLUS* is 8.0 V.

• The serial port chosen is incorrect. Most IBM computers have only one serial port, therefore the user should choose one of the COM1 settings. However, if a COM2 port exists, the user must take care in determining which port the cable has been connected to and choose the appropriate baud rate/port combination.

• The communications set up of the computer is incorrect. The SV*PLUS* will automatically choose the correct baud rate up to and including 19200 baud(no parity, 1 stop, 8 bits).

• The communications cable has been inserted incorrectly.

Problem:

The instrument has been dropped or received a heavy shock and will not respond.

Solution:

• Open the instrument and check that the circuit boards are still securely positioned in their side rails and are not shorting together. Also inspect the circuit boards for any possible damage. Consult the factory if damage is detected.

• Verify the EPROM has not been dislodged from its socket. Observe the proper orientation when reinserting the EPROM and that none of the pins are bent.

• Check the battery pack to ensure the batteries are securely in place and are making proper contact. Also check the voltage level. Under certain conditions, the internal fuse of a lithium battery will blow if it is momentarily shorted.

Note: A full and thorough inspection should be performed if the instrument has been subjected to a heavy shock or been dropped. See section 2.1 for further information.

Problem:

The instrument will not respond after replacing the batteries.

Solution:

• If the batteries have just been replaced, ensure that they have been installed with the correct polarity as indicated on the battery holder.
• Check that the spring clips are making contact with the batteries. If not, carefully bend the clip out to ensure good contact.
• Measure the voltage of each battery separately to determine if any are defective. Also measure the voltage of the pack to verify that they have been installed correctly. If lithium batteries are being used, check that the cells internal fuses have not been blown. This can be verified by measuring the voltage. If it is a new battery and the voltage is 0, then the fuse has blown.

Problem:

The instrument will not respond after it has been opened.

Solution:

• Check that the batteries are still securely installed.

• Look for a broken or pinched wire.

• Inspect the circuit boards to ensure that water or heavy moisture has not come into contact with the electronics.

• Verify that the EPROM is secure and properly installed.

Problem:

The Data stream from the SV^{PLUS} is interrupted or garbled when monitoring or downloading.

Solutions:

• Check the continuity of the communication cable and underwater connector as follows:

a) Run the terminal program of your choice (i.e. PROCOMM) and observe the `>' prompt.

b) Enter `M<cr>' (the monitor command). The SV^{PLUS} will then start sending data continuously to the computer.

c) While observing the data output, gently wiggle the top bulkhead connectors, shorting plug, and communications cable. If the data output is interrupted or garbled, it is likely there is a faulty connection.

• Check the SV^{PLUS}'s battery voltage.

• Check the baud rate.

Problem:

After deploying the SV*PLUS*, no data can be downloaded.

Solutions:

• Check the underwater connector and shorting plug for proper connection.

• Check the SV*PLUS*'s battery voltage.

• Check for clogged, dirty, or damaged sound velocity sensor. The SV*PLUS* will not log data until the sound velocity sensor is immersed in water.

Problem:

SV*PLUS* no longer gives accurate readings after changing or re-calibrating one or more sensors.

Solution:

The calibration coefficients for the new sensor(s) must be entered into the EPROM for the proper conversion of data. **Applied Microsystems Ltd.** changes the calibration coefficients as part of its recalibration service. Please contact the factory for information on changing the coefficients for user performed recalibrations. In the meantime, any data collected should be downloaded in RAW mode and stored. The new calibration coefficients can be applied to this data at a later date.

Problem:

The sound velocity channel is erratic and the values given are incorrect.

Solution:

• Examine the sound velocity sensor for damage or fouling of the reflector plate and transducer. Also, check the invar rods to ensure they have not been bent. Consult the factory if the sensor is damaged.

• Inspect the circuit boards for any corrosion that might be shorting or bridging the electronic components. This could be a result of salt-water splashes or flooding. Also check the following problem scenarios for additional solutions.

Problem:

Most or all of the data channels are erratic and the values given are grossly incorrect.

Solution:

This problem is indicative of an electrical leak or short to the instrument housing. Look for the following:

• Open the instrument to gain access to the electronics and look for a pinched or broken wire that might be making contact with the pressure housing.

• Inspect the circuit boards for any corrosion that might be shorting or bridging the electronic components. This could be a result of salt-water splashes or flooding.
• Using an ohm meter, check for any electrical connection between the electronics, sensors

or connectors and the pressure housing. This can be done by applying one probe from the meter to the terminal pin where the sensor or connector wires are attached and the other probe to a bare or exposed part of the external housing. The small screws holding the side rails to the sensor end cap would be a good point to use.

Consult the factory if an electrical short is discovered or if the problem persists and you are unable to discover the source.

Problem:

One or both of the bulkhead connectors on the top end cap have become loose.

Solution:

Using an open ended or adjustable wrench, turn the connector clockwise until the connector is tight without using excessive force. Caution should be exercised to avoid scratching the anodised surface of the end cap. If the connectors are found to be very loose the instrument should be opened and checked for signs of flooding. Please consult the factory for instructions if flooding is suspected.

Problem:

The external housing shows signs of heavy corrosion or electrolysis.

Solution:

• Inspect the zinc anodes located on or near the lifting shackle on the top end cap to ensure they are in good condition. Replace the zincs if they are in advanced stages of depletion.

• Ensure that the zincs have good electrical continuity with the external mechanical parts. This can be done by following the steps in section 5.4.

• Accelerated electrolysis or corrosion can be caused by the presence of a stray electrical current. Using an ohmmeter, check for any electrical connection between the electronics, seniors or connectors and the pressure housing. This can be done by applying one probe from the meter to the terminal pin where the sensor or connector wires are attached and the other probe to a bare or exposed part of the external housing. The small screws holding the side rails to the sensor end cap would be a good point to use.

Problem:

Oil is leaking from the pressure bladder area.

Solution:

• Inspect the pressure bladder to determine its general condition. If any cracks, tears or cuts are found in the bladder or "O" rings, replace them as described in section 6.1.2.

Problem:

The instrument has been flooded or a battery has vented.

Solution:

If a flood or battery venting occurs, open the instrument immediately and remove the batteries. Disconnect the wires running from the on/off and the communication connectors to the terminal strip on the circuit board. Thoroughly rinse the electronics and mechanical housing (inside and out) with fresh water to flush any salt water or corrosive substance away. Use methyl hydrate or similar product to dissipate the water from the electronics. A hair drier will also work to dry the electronics. Then contact the factory for further instructions.