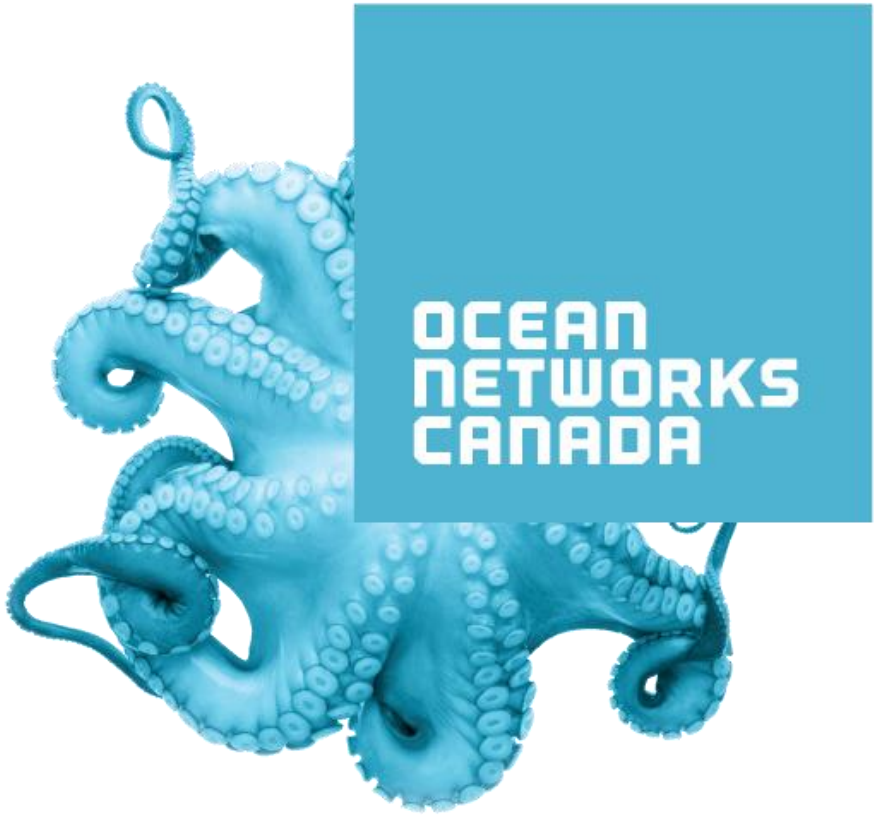


ONC HydroCal User Manual

Version 22.03.001 11 April 2022

Table of Contents

1 Warnings and Cautions

1.1 Safety Warnings

HAZARD! Shock hazard.

Use caution, the transmit (Tx) signal can generate 80 Volts.

1.2 Equipment Cautions

Warning! Sensor damage.

Do not over-pressure the VLF calibration system reference pressure sensor. This is a differential pressure sensor with a ± 1240 Pa operating range and 4900 Pa safe limit.

- Open the valve on the VLF calibration chamber when adding or removing a hydrophone.
- When the VLF calibration system is not in use, always leave the valve open.
- Do not leave the system unattended when the valve is closed. Very small temperature changes can generate high pressures in the constrained volume within the chamber.

Warning! Projector damage.

The M18-2.5C projector will generate a large internal voltage sufficient to depole the projector if the projector leads are not shorted together or plugged into the HydroCal case.

Warning! Battery damage.

Always turn the HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

Caution! Inaccurate data.

Any air bubbles trapped in the VLF calibration chamber will; reduce the maximum acoustic pressure within the jig, and create resonant and anti-resonant frequency problems.

Caution! Inaccurate data.

The battery charger contains two switching power supplies. Although the charger meets the UL standard it generates enough electromagnetic interference to affect the hydrophone calibration. Disconnect the charger from the AC mains power supply as well as the HydroCal case prior to running a calibration.

Caution! Communications failure

The USB cable between the computer and the HydroCal case must be connected prior to launching MATLAB or MATLAB will not detect the MCC digitizer board in the HydroCal case.

Caution! Communications failure

The MCC digitizer board in the HydroCal case must be configured to board #0 and single ended input prior to using the MATLAB HydroCal software. The configuration is accomplished with the InstaCal program.

2 Introduction

Ocean Networks Canada Hydrophone Calibration System, known as **ONC HydroCal**, is designed to perform two types of hydrophone calibrations; very low frequency (VLF) calibrations and high frequency (HF) calibrations.

	VLF Calibration	HF Calibration
Bandwidth	0.1 Hz to 1000 Hz	2 kHz to 100 kHz
Accuracy	± 0.5 dB re 1 μPa^2	± 2 dB re 1 μPa^2
Location	Laboratory (ashore or on ship)	Boat in quiet water ≥ 40m of water depth
HydroCal Power	Internal rechargeable lead acid batteries	
Software	HydroCal installer Or MATLAB 2017a+ with: Instrument control toolbox, data acquisition toolbox, MCC toolbox MCC driver and InstaCal Software 50 GB drive hard space, 8 GB RAM	
Hardware	ONC HydroCal case Computer VLF calibration chamber Chamber Cables Light mineral oil Hydrophone adapters	ONC HydroCal case Computer (laptop) HF calibration jig Frame Reference hydrophone Projector Cables Spar buoy Drogue

It is possible to configure the HF calibration system to perform in-situ hydrophone calibrations if a reference hydrophone can be co-located with the deployed hydrophone being calibrated. The hydrophone under test and the reference hydrophone must have their acoustic centres collocated within $1/10^{th}$ of the wavelength of the highest frequency used in the calibration. In seawater at 32 kHz this would be less than 47 mm on centre. This will allow an accuracy of 3 dB for the calibration.

ONC HydroCal is a comparison calibration system. Short monotonic acoustic bursts are generated and the response of the hydrophone under test is compared to the response of a reference sensor. The VLF system compares the hydrophone under test with a calibrated differential pressure sensor. The HF system compares the hydrophone under test with a calibrated reference hydrophone.

3 Calibration Procedure Checklists

Ensure the ONC HydroCal batteries are charged. It is best to start with both batteries > 12 volts. Do not run calibrations if either battery is below 11.5 volts.

If this is the first time use of ONC HydroCal with a specific computer follow the First Time Set Up procedures in the getting started section of this manual, Section 4.

3.1 VLF Calibration

- ☐ Choose a quiet location with a table area of approximately 70 cm by 1.5 m.
- ☐ Disconnect the battery charger from the ONC HydroCal case and the AC mains. The charger generates electrical noise which will affect the calibration.
- ☐ When calibrating a hydrophone with an internal battery (such as an icListen) the charging circuit generates heat, this temperature rise will cause pressure to build up when the chamber valve is closed. It is better to allow the hydrophone to charge for at least 5 hours prior to running a calibration.
- ☐ Ensure the VLF chamber is filled with light mineral oil and that there are no bubbles in the chamber.
- ☐ Chose the appropriate hydrophone adapter for the Unit Under Test (UUT). Some adapters must be clamped to the hydrophone prior to insertion into the chamber.
- ☐ With the chamber valve open, slowly insert the hydrophone into the chamber without trapping any air bubbles.
- ☐ Clamp the hydrophone in place with the appropriate hardware. Section 7.1.
- ☐ For a wav calibration set up the hydrophone logger (≤5 min files, deployment sample rate). For analog hydrophones connect the hydrophone to the ONC HydroCal case. Apply power to the hydrophone as required.
- ☐ Connect the two VLF chamber cables to the ONC HydroCal case.
- ☐ Connect the ONC HydroCal case to the computer with the USB cable.
- ☐ Launch the ydroCal software. The USB cable must be connected first.
- ☐ Choose the settings for
    - Output folder,
    - Calibration type,
    - Calibration mode.
- ☐ Fill in and verify all metadata fields in the ONC HydroCal interface.
- ☐ Turn the ONC HydroCal case rotary switch to the VLF position.
- ☐ Gently close the chamber valve. It does not need to be tight.
- ☐ Monitor the chamber pressure with the ONC HydroCal case display. If the chamber pressure is rising or falling, open the valve and allow the chamber to thermally stabilize. Try again in ½ hour.
- ☐ Click on the 'Run' button to start the calibration.
- ☐ Monitor the 'Messages' window for calibration progress and error messages.
- ☐ Monitor the pressure plot. The plot should be smooth and relatively flat, falling slightly at low frequencies. If there are peaks, troughs or steps in the pressure plot, stop the calibration and check for bubbles in the tank or improper clamping of the hydrophone.

- If the ONC HydroCal case alarm or the HydroCal software alarm is triggered. Open the chamber valve to relieve the differential pressure on the reference sensor. When the pressure is relieved, close the valve and resume the calibration.
- When the calibration runs are complete, open the chamber valve.
- If performing a wav calibration, retrieve the wav file(s) from the hydrophone logger, and complete the calibration processing in HydroCal.
- Turn the ONC HydroCal rotary switch to the 'Off/Charge' position.
- When the calibration processing is complete, open the calibration certificate and verify all fields are accurate.

3.2 HF Calibration

- Prior to departure:
  - Charge:
    - ONC HydroCal case
    - Computer
    - Hydrophone data logger
  - If the unit under test has a large pressure case, ensure the buoyancy is not positive.
  - For a wav calibration, program the unit under test for the log file length and desired sampling rate.
  - Check the weather forecast.
  - Assemble the gear:
    - ONC HydroCal HF jig
    - ONC HydroCal cable reel with connector plugs
    - ONC HydroCal drogue
    - ONC HydroCal spar buoy
    - ONC HydroCal Case (with USB cable)
    - Reference hydrophone
    - Acoustic projector with shorting plug
    - Rinse water
    - Paper towels
    - Connector grease
    - Three rubber acoustic isolation pads
    - Cable ties
    - Side cutters
    - Electrical tape
    - Hydrophone to be calibrated (Hydrophone, cable, dummy plug, shorting plug, logger, power supply, special tools)
- Take the boat to a quiet location with > 40 m of water depth.
- Assemble the reference hydrophone, projector, and unit under test on the HF jig. Refer to Section 7.2.
- Measure the centre to centre distances between the reference and projector and between the hydrophone under test and projector, both should be 1 m ± 1 cm.
- Grease and connect the cables to the hydrophones and projector and secure the cable reel rope to the HF jig.
- Lower the HF jig over the side to the 10 m mark (rope ties). And attach the drogue around the cables.
- Lower the HF jig to the 20 m mark and secure the spar buoy to the cable rope.
- Secure the cable rope to the boat.
- Connect the underwater cables to the ONC HydroCal case.
- Connect the ONC HydroCal case to the computer with the USB cable.
- Launch the ONC HydroCal software. The USB cable must be connected first.
- Choose the settings for:
  - Output folder,
  - Calibration type,

- Calibration mode,
- For wav calibrations, the unit under test sample rate is set by the digital hydrophone

- Load the reference calibration file. The software can handle three file types: mat files and m-file scripts that loads / returns the variables 'freq' and 'sensitivity' in column-major arrays or an m-file script that returns 'freq' and 'sensitivity', and a column-major delimited ascii file with a one row header, for example:

```
Frequency  Sensitivity (dB re V/uPa)
100        -173.123
200        -174.555
```

  You can find an example script m-file here: C:\Program Files\OceanNetworksCanada\HydroCal\application\reference_hydrophone_M36_calibration.m.
  Trick: If any the metadata values for Freq Low, Freq High or # of Freq Points is NaN or out of range when the reference calibration file is loaded, the calibration points are taken from the reference calibration file directly and Freq Low / High are set to the limits of the calibration and the # of Freq Points is set to 40. The messages field will tell you if this happened.
- Fill in and verify all metadata fields in the ONC HydroCal interface.
- Turn the ONC HydroCal case rotary switch to the HF position.
- Click on the 'Run' button to start the calibration.
- Monitor the 'Messages' window for calibration progress and error messages.
- When the calibration run is complete recover the underwater gear.
- Rinse the underwater gear before undoing any connectors.
- Dry the connectors before disconnecting them.
- If performing a wav calibration, retrieve the wav file(s) from the hydrophone logger, and complete the calibration processing in HydroCal.
- Turn the ONC HydroCal rotary switch to the 'Off/Charge' position.
- When the calibration processing is complete, open the calibration certificate and verify all fields are accurate.

4 Getting Started

4.1 Initial Downloads and Installations

Prior to using ONC HydroCal for the first time with any specific computer, some set up is required. There are two options: run from source code or use the installer. The installed versions have the benefit of not requiring a MATLAB installation and license.

If using the ONC HydroCal installer:

You can choose the fully stand-alone installer: *HydroCal_Installer_mcr_<version>_release.exe* which will install the MATLAB runtime library as well as HydroCal, or install *HydroCal_Installer_web_<version>_release.exe*, which will download the MATLAB runtime library. The former is better for the first install, the latter will speed up updates. In both cases, if the MATLAB runtime library is already available, its installation is skipped. Follow the normal installation, default parameters, except you will probably want to check the box that adds a shortcut to the desktop. See the troubleshooting section and/or contact ONC support if it fails.

The installers will be maintained here: https://drive.google.com/open?id=149IUuXCIwG26E8QqE406372nERcSGy5S Updates will be provided there. Browsers may not want to download/keep this file, be sure to override this. Security/malware software may also need to be overridden to run the installer.

If running from ONC HydroCal source code:

First ensure that MATLAB (2017a or higher) is installed on your computer, with a suitable license. MATLAB will also need to be installed with the following toolboxes:

- Data Acquisition Toolbox
- Instrument Control Toolbox

Add the MATLAB toolbox Data Acquisition Toolbox Support Package for Measurement Computing Hardware. From within MATLAB, on the Home tab, choose "Add-Ons" and "Get Add-Ons":

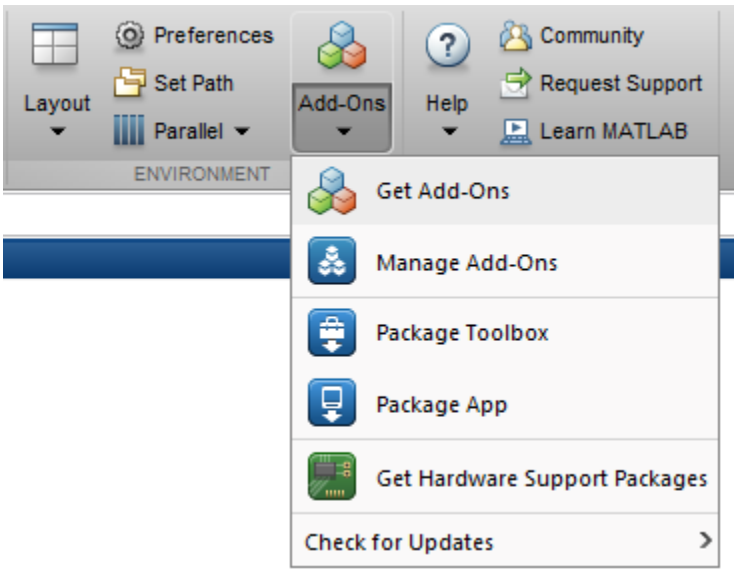


Figure 4-1: MATLAB Add-Ons menu.

Search in the Add-On Explorer for "measurement computing hardware":

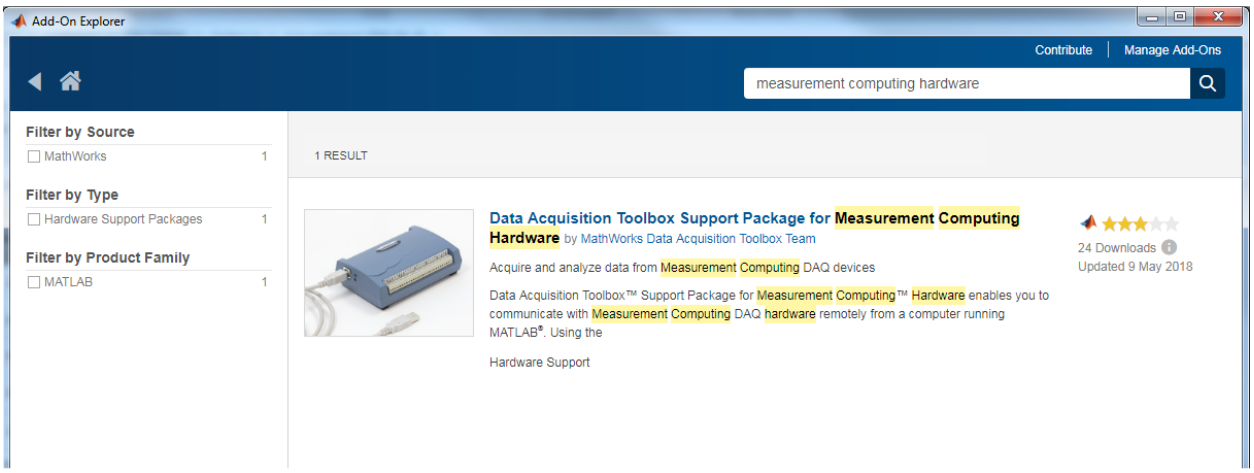


Figure 4-2: Searching for the MCC support toolbox in MATLAB.

Alternatively, the third party toolbox "Measurement Computing (MCC) MATLAB data acquisition toolbox" will need to be installed. The latter can be installed from: https://www.mccdaq.com/downloads/DTSoftware/DAQAdapterMATLAB/64bitSessions/

Copy the ONC HydroCal source code directory to your computer and add it to MATLAB's path – use the "Set Path" button on the MATLAB Home toolbar. If you type the command "*which HydroCal*", one version of HydroCal.m should be listed. Launch HydroCal, by typing the command "*HydroCal*" or running the HydroCal.m function.

<u>For both stand-alone installed or running from source code:</u>

Install the MCC drivers. Go here: https://www.mccdaq.com/Software-Downloads.aspx and log in with these credentials: calhydro@mailinator.com, password: hydrophone, download the

software package "MCC DAQ Software". Install the software with typical options. This will include MCC InstaCal, which is also accessible here: https://www.mccdaq.com/daq-software/instacal.aspx

Connect the ONC HydroCal case to the computer via the USB cable. This will power the ONC HydroCal digitizer and allow communications with the computer, regardless of the HydroCal rotary switch setting. Launch InstaCal on the computer and configure the MCC board to board #0 and for single ended input (8 channel). HydroCal/MATLAB will not communicate properly with the digitizer without these settings.

Caution! Communications failure

The MCC digitizer board in the ONC HydroCal case must be configured to board #0 and single ended input prior to using the MATLAB HydroCal software. The configuration is accomplished with the InstaCal program.

4.2 Battery Voltage and Charging

Always turn the rotary switch to the Off/Charge position when the ONC HydroCal system is not in use. The batteries will drain and can be damaged if the ONC HydroCal system is left on.

Caution! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

There are two internal 12 Volt 4.5 AHr sealed lead acid batteries in the ONC HydroCal case. Battery-1 provides power for the ONC HydroCal system and 12 VDC power to the Unit Under Test power plugs. Battery-2 is applied in series with Battery-1 when the rotary switch is in the VLF or HF positions, to provide 24 VDC power to the Unit Under Test power plugs. Due to the difference in power drain, the two batteries are charged independently via a two channel, isolated, lead acid battery charger. Battery 1 is protected with a low voltage disconnect set to 11.2 volts. If the ONC HydroCal power is inadvertently left on, the disconnect circuit will disconnect the battery from the power amplifier to prevent damage to the battery.

Table 4-1 Battery voltages

Voltage	Condition
12.6	Fully charged, 7 hours remaining
12.5	5 hours remaining
12.0	2 hours remaining
11.5	Minimum recommended starting voltage
11.2	HydroCal low voltage disconnect
10.8	Fully discharged battery
<10.5	Damage occurs

Quiescent drain on Battery-1 when HydroCal is switched on is 100 mA. While sending calibration signals the drain on Battery-1 is < 400 mA, there is an additional drain on Battery-1 if the 24V or 12V Unit Under Test power is used. Battery-2 is only drained if the 24V Unit Under Test power is used. The 5V Unit Under Test power is supplied by the USB connection and does not draw on the ONC HydroCal batteries.

To test the battery voltage levels, turn the ONC HydroCal rotary switch to the VLF or HF position. To test Battery-1 connect the multimeter ground lead to the HydroCal ground terminal plug (black) and the red voltage lead to the HydroCal 12V terminal plug (orange). To test Battery-2 connect the multimeter ground lead to the HydroCal 12V terminal plug (orange) and the red voltage lead to the HydroCal 24V terminal plug (red). Turn the HydroCal rotary switch to Off/Charge when finished.

If the Battery-1 voltage drops below 11.2 volts for more than 60 seconds, the battery will be disconnected. The battery voltage must be raised above 12.2 volts for 60 seconds for the battery to be reset to normal operations.

To charge the ONC HydroCal batteries, remove the battery charger from the HydroCal case. Plug the battery charger into the charge connector in the HydroCal case. Ensure the HydroCal rotary switch is in the Off/Charge position. Plug the battery charger into 120VAC power. Flashing red and green charger indicator lights indicates no connection to the battery, check the connector and the rotary switch position. The charger will test the batteries and the charger indicator lights will cycle between red and green twice. When fast charging, the charger indicator light will be solid red. Charge the ONC HydroCal batteries until both charger indicator lights are solid green. The charger will float the batteries after charging is complete. Disconnect the battery charger from the HydroCal case and from AC mains before performing a calibration.

There is a yellow locking ring on the charger connector to the ONC HydroCal case. The connector cannot be disengaged if the locking ring is in the locked position. It is not necessary to lock the connector during use.

4.3 User Interface Overviews

4.3.1 ONC HydroCal Case

The primary interface components of the ONC HydroCal Case are shown in Figure 4-3.

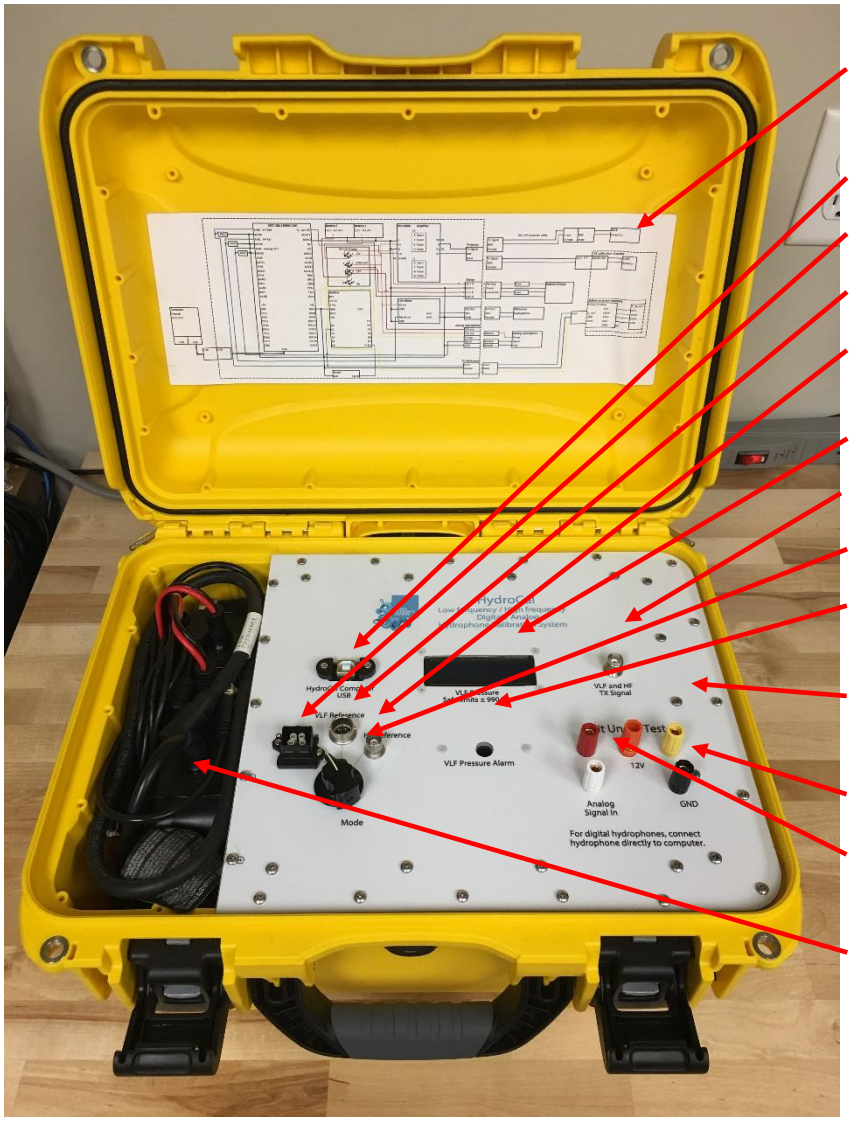


Figure 4-3 HydroCal Case Interface

4.3.2 ONC HydroCal User Interface

The primary interface components of the ONC HydroCal software interface are shown in Figure 4-5.

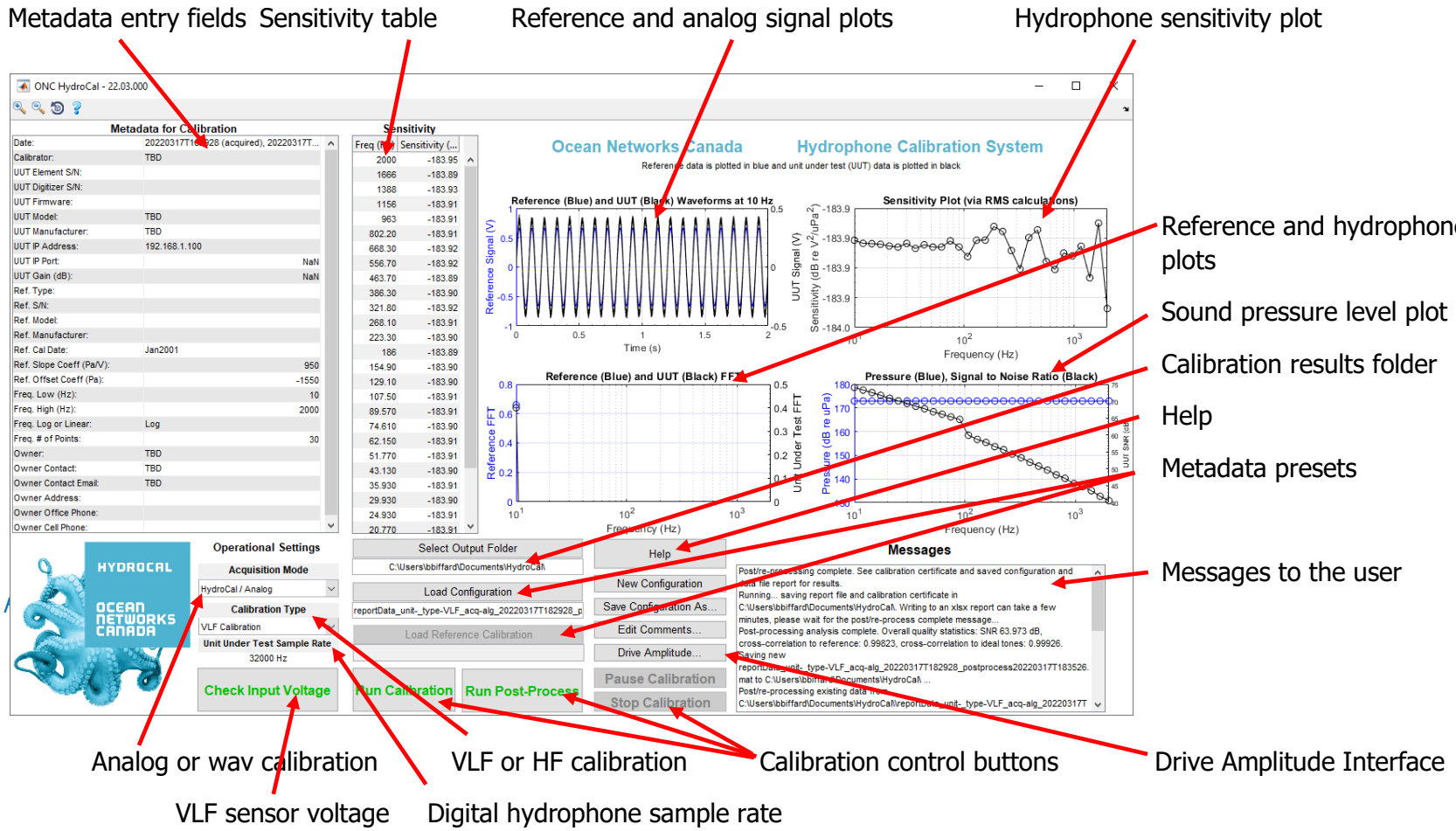


Figure 4-5 ONC HydroCal software interface

4.4 VLF Calibration Hardware Setup

Set up the VLF calibration system in a location which has the following properties:

- A stable room temperature
- AC mains for charging the ONC HydroCal case batteries and computer
- A nearby place to wash the hydrophone with soapy water after the calibration
- Is free from frequent ambient air pressure fluctuations such as opening and closing doors, and open windows in winding conditions
- Minimizes exposure to acoustic noise above the level of normal person to person conversation
- Minimizes exposure to vibration
- A table area of approximately 70 cm by 1.5 m

Charge the ONC HydroCal batteries before using HydroCal. To do this, remove the battery charger from the ONC HydroCal case. Plug the battery charger into the charge connector in the ONC HydroCal case. Ensure the ONC HydroCal rotary switch is in the off/charge position. Plug the battery charger into 120VAC power. Charge the ONC HydroCal batteries until both charger lights are solid green. When not in use the charger can continue to trickle charge the ONC HydroCal case batteries.

Warning! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

Caution! Inaccurate data.

The battery charger contains two switching power supplies. Although the charger meets the UL standard it generates enough electromagnetic interference to affect the hydrophone calibration. Disconnect the charger from the AC mains power supply as well as the ONC HydroCal case prior to running a calibration.

Prior to use disconnect the battery charger from the ONC HydroCal case and the AC mains. The charger generates electrical noise which will affect the calibration.

If calibrating a hydrophone with internal rechargeable batteries (such as an icListen) note that the hydrophone internal battery charging circuit generates heat. This temperature rise will cause pressure to build up when the chamber valve is closed. It is better to allow the hydrophone to charge for at least 5 hours prior to running a calibration.

Ensure the VLF chamber is filled with light mineral oil and that there are no bubbles in the chamber. Fill the chamber so that there is oil covering the bottom of the overflow reservoir.

Connect the two VLF chamber cables to the ONC HydroCal case. The cables have different connectors to ensure they cannot be connected incorrectly.

Connect the ONC HydroCal case to the computer with the USB cable.

Caution! Communications failure

The USB cable between the computer and the ONC HydroCal case must be connected prior to launching MATLAB or MATLAB will not detect the MCC digitizer board in the ONC HydroCal case.

Choose the appropriate hydrophone adapter for the Unit Under Test (UUT). Drawings for the various hydrophone configurations are presented in Section 7.1. Some adapters must be clamped to the hydrophone prior to insertion into the chamber.

When clamping the hydrophone under test care must be taken to avoid applying compression near the hydrophone piezoceramic element. If the hydrophone element is loaded (i.e. by o-ring compression) the hydrophone sensitivity will be affected.

Turn the ONC HydroCal rotary switch to the VLF position, so the display and alarm are active. With the chamber valve open, slowly insert the hydrophone into the chamber without trapping any air bubbles. Any air bubble in the chamber will cause resonant and anti-resonant modes in the chamber and this can affect the calibration. Anti-resonant modes typically affect the calibration more than the resonant modes. If you suspect an air bubble refer to the troubleshooting section for steps to resolve the problem.

Caution! Inaccurate data.

Any air bubbles trapped in the VLF calibration chamber will reduce the maximum acoustic pressure within the jig, and create resonant and anti-resonant frequency problems.

It is important to insert the hydrophone into the chamber slowly to avoid over pressurizing the reference pressure sensor. The reference pressure sensor contains an extremely thin wafer of silicon which will rupture under differential pressures above about 65 cm of light mineral oil.

Warning! Sensor damage.

Do not over-pressure the VLF calibration system reference pressure sensor. This is a differential pressure sensor with a ± 1240 Pa operating range and 4900 Pa safe limit.

- Open the valve on the VLF calibration chamber when adding or removing a hydrophone.
- When the VLF calibration system is not in use, always leave the valve open.
- Do not leave the system unattended when the valve is closed. Very small temperature changes can generate high pressures in the constrained volume within the chamber.

Clamp the hydrophone in place with the appropriate hardware, refer to Section 7.1. It is important to ensure the hydrophone cannot move with the pressure variations in the chamber. It is also important to eliminate any pressure leaks around the hydrophone.

It is best to allow the chamber and hydrophone assembly time to reach a stable temperature prior to starting the calibration.

The chamber valve should always be kept wide open unless a calibration run is in progress. When closed the valve does not need to be tightly seated. Close the valve slowly with your fingers in a clockwise direction until you feel the valve seat. It helps to turn the rotary switch to the VLF Calibration position and watch the pressure display while closing the valve. If the valve

is closed too quickly or too tightly the pressure will increase in the chamber. Aim to achieve an internal pressure below 300 Pa.

Monitor the chamber pressure with the ONC HydroCal case display. If the chamber pressure is rising or falling quickly, open the valve and allow the chamber to thermally stabilize. Try again in ½ hour.

If the ONC HydroCal case alarm or the HydroCal software alarm is triggered. Open the chamber valve to relieve the differential pressure on the reference sensor. When the pressure is relieved, close the valve and resume the calibration.

When the calibration runs are complete, open the chamber valve, slowly remover the hydrophone under test, and replace the cover on the chamber.

Warning! Sensor damage.

Do not over-pressure the VLF calibration system reference pressure sensor. This is a differential pressure sensor with a ± 1240 Pa operating range and 4900 Pa safe limit.

- Open the valve on the VLF calibration chamber when adding or removing a hydrophone.
- When the VLF calibration system is not in use, always leave the valve open.
- Do not leave the system unattended when the valve is closed. Very small temperature changes can generate high pressures in the constrained volume within the chamber.

Turn the ONC HydroCal rotary switch to the 'Off/Charge' position.

Warning! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

4.5 HF Calibration Hardware Setup

The HF calibrations are performed from a boat with at least 40 meters of water depth.

4.5.1 Prior to departure:

Charge the ONC HydroCal case, computer and hydrophone under test batteries prior to departing for the boat. For the HydroCal case batteries, remove the battery charger from the HydroCal case. Plug the battery charger into the charge connector in the HydroCal case. Ensure the HydroCal rotary switch is in the off/charge position. Plug the battery charger into 120VAC power. Charge the HydroCal batteries until both charger lights are solid green. Disconnect the battery charger from the HydroCal case and from the 120 VAC mains.

Warning! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

Check the weather prior to departing. The calibration should be done in calm and quiet water.

If the unit under test has a large pressure case, ensure the buoyancy is not positive. Add weights if necessary to achieve a slightly negative buoyancy.

For a wav calibration, program the unit under test for the log file length and desired sampling rate.

Assemble the required gear as listed in the checklist in Section 3.2.

Select an appropriate site for the calibration. It should be a quiet site with minimal boat and construction noise. Aircraft can also cause noise for the calibration. The site should be protected from wind and waves. The site must have a water depth of more than 40 m.

4.5.2 On Site Setup

After arriving at the calibration site, assemble the HF hardware as shown in the diagrams in Section 7.2. Ensure the M18-2.5 acoustic projector is either protected by the shorting plug or connected to the ONC HydroCal case at all times. The piezoceramic sphere does not have a shunt resistor and can generate large voltages when subjected to temperature changes such as being immersed into cold water or sitting in direct sunlight. These pyroelectric voltages can be 1000s of volts, sufficient to depole the piezoceramic element.

Warning! Projector damage.

The M18-2.5C projector will generate a large internal voltage sufficient to depole the projector if the projector leads are not shorted together or plugged into the ONC HydroCal case.

Measure the centre to centre distances between the reference and projector and between the hydrophone under test and projector, both should be 1 m ± 1 cm.

Grease and connect the cables to the hydrophones and projector and secure the cable reel rope to the HF jig. If performing an analog calibration connect the cable (user supplied) for the hydrophone under test as well.

Caution! Communications failure

The USB cable between the computer and the ONC HydroCal case must be connected prior to launching MATLAB or MATLAB will not detect the MCC digitizer board in the HydroCal case.

Lower the HF jig over the side to the 10 m mark (rope ties) and attach the drogue around the cables. To do this open the drogue and clamp the drogue around the cables. Use the ties at the 10 m mark on the cables to secure the drogue on the cables. There are two eye bolts on the drogue for this purpose.

Lower the HF jig to the 20 m mark and secure the spar buoy to the cable rope. A threaded shackle is provided to facilitate the attachment of the buoy.

Deploy the spar buoy over the side and continue to pay out the cables until the end of the rope is reached. Secure the rope to the boat to prevent loss. There are two loops on the rope end which can be quickly looped around a rail and clipped together using a carabineer.

Connect the underwater cables to the ONC HydroCal case, and connect the HydroCal case to the computer with the USB cable.

Turn the ONC HydroCal case rotary switch to the HF position. The hardware setup for the calibration is now complete.

4.5.3 Recovery

When the calibration run is complete recover the underwater gear. Rinse the underwater gear and dry the connectors before undoing any connectors. If salt water is allowed in the connectors they will corrode and eventually cause a fault. Do not get water into the cable BNC or TNC connectors while rinsing, these connectors are not waterproof.

Turn the ONC HydroCal rotary switch to the 'Off/Charge' position.

Warning! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

Take the equipment back to shore and put the ONC HydroCal case batteries on charge.

4.6 ONC HydroCal Software Use

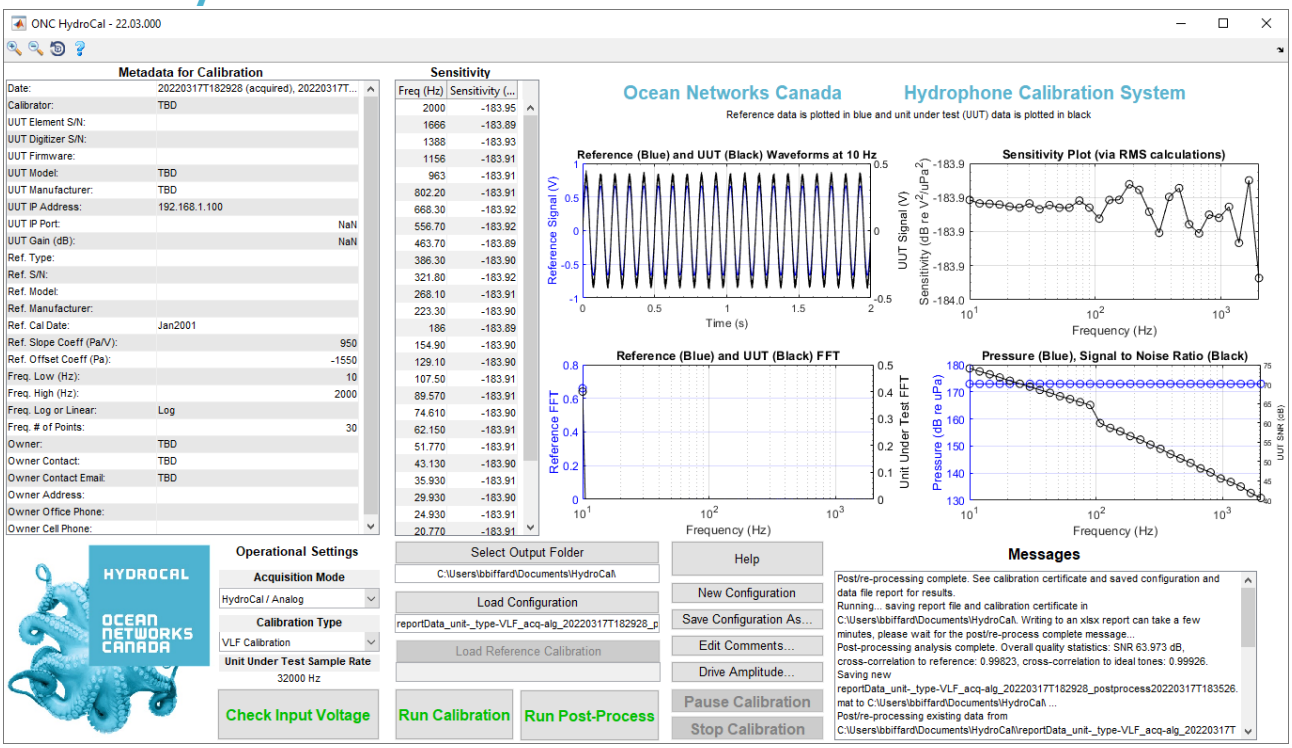


Figure 4-6 ONC HydroCal user interface

ONC HydroCal will start up with the configuration (and data) from the last calibration run. The first time HydroCal starts, it can take some time (up to 5 minutes, the runtime library is compiling), and it will load a default configuration. Select the calibration type and acquisition mode for your calibration. HydroCal will not overwrite existing calibrations; as such, it will ask you, often repeatedly, if you wish save as a new configuration or update. If user interface does not fit on the screen, try adjusting the scaling (usually down) in the Windows display settings.

The report.mat file, as we refer to it in the documentation is the main data and configuration file. It is a standard MATLAB data file, users can open it in MATLAB, octave, scipy, etc. HydroCal interacts with this file continuously. It contains two structures: 'Report' containing all of the settings, metadata and resulting calibration; 'Data', containing the data for both the reference sensor and unit under test.

Enter all the metadata for the hydrophone being calibrated. The metadata descriptions are provided in Section 4.6.1. HydroCal saves every change (give it second to do so on slower computers), so there is no save button (there used to be). When a calibration or post-process run is done, HydroCal will save the data in a new file with the following naming convention (< > indicates a metadata field):

report_model-<UUT Element Model No.>**_unit-**<UUT Element Serial No.>**_calType-**<Calibration Type: VLF or HF>**_acqMode-**<Acquisition Type: alg (analog) or wav (external digital)>_<data acquisition time>**_postprocess-**<post process time>**.mat**

On first use, ONC HydroCal will prompt users to save a new file, but users need not worry about this initial file-name or edit it, as it temporary, holding the configuration until the first calibration run. The **_postprocess**<post process time> part of the file-name is added after post-processing with *Run Post-Process* button, which becomes available whenever the loaded report.mat file has data. The same naming convention applies to the calibration result files: the .xlsx, .m and .csv files. With this file-naming and management convention, users should not have to modify file-names. HydroCal also will not overwrite existing files that have data, especially since each new run or postprocess gets a new time stamp. If the user changes the configuration of a completed calibration, the automatic save function will provide options to save as a configuration-only template (useful for a starting work on a new hydrophone), save as (keeps the data, useful to make copy to make further changes to) or update (useful to do post-processing). The configuration template is the default option as it offers a straightforward workflow: run a calibration, use the temporary template to setup the configuration for the next calibration, and then run it, which is then saved with a new permanent file, and repeat. Users should not have to use the *Save Configuration As…* or *New Configuration* buttons in normal operation. The *New Configuration* button loads the default/blank configuration, discarding any data, returning ONC HydroCal to its default directory and initial state. Users can load existing configuration report.mat files that may or may not contain data with the *Load Configuration* button. The *Select Output Folder* button can help you navigate between folders or create new folders if you want to be a bit more organized. You can also use it set a different working space other than the default <userpath>\Documents\HydroCal folder.

The *Help* button will open a PDF version of this manual. The *Edit Comments…* button brings up a small dialogue to enter comments that appear on the calibration sheet and result files. The *Drive Amplitude…* button brings up a small user interface where users can view a plot of the drive amplitude, as well as edit, add or delete the values, plus load or export these values from or to files. The drive amplitude is the strength of the broadcast calibration signals as a function of frequency. Adjusting the drive amplitude is important for compensating for the receive / transmit sensitivities of the source, reference and unit under test into order to get good signal and results. Some trial and error is often needed after inspecting the results of each run; the default values are a good starting point, they can be easily scaled up or down as whole by the scale factor, and individual values in the table are editable.

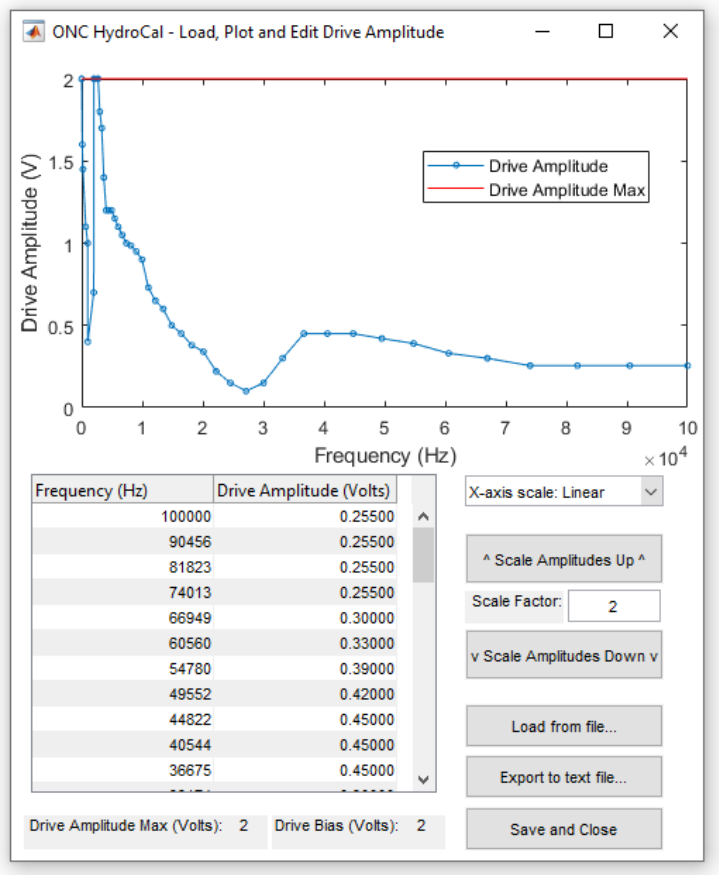


Figure 4-7 The Drive Amplitude user interface.

When all selections and metadata have been entered, the calibration can be started by selecting the *Run Calibration* button. Due to a limited amount of data that the MCC can queue, calibrations are divided into several 'runs' with each run between 20 and 30 seconds duration. An advantage of this is it allows the user to pause or stop the calibration between runs. Pressing the pause/stop buttons queues an interruption for the end of the current run. If there is only one subset or run, the buttons will no effect. VLF calibrations tend to have many runs, while HF calibrations are quicker.

After each run, the computer will update the plots and the sensitivity table with the data that has been processed to that point. The data is saved immediately upon collection and the report.mat file is renamed by the run time as described earlier. The report.mat file is also updated when the calibration analysis is complete.

In the lower right of the user interface is a Message field. This field will provide the user with an ongoing set of comments on the progress of the calibration. Any error messages may also be presented here, if they are caught and handled errors. The messages and all errors are also logged to *HydroCal.log* – a file that resides in the <user path>\Documents\HydroCal directory. A new useful feature is a sentence in the messages that reports average quality metrics for signal to noise and cross correlation between the unit under test and the reference or the ideal tones. Users can use this to decide between multiple runs and perhaps find an optimal configuration.

If there is an overpressure in the VLF calibration chamber during a calibration this will automatically be detected by HydroCal. The ONC HydroCal software will pause the calibration at the end of a run and pop up a window urging the user to open the chamber valve and relieve the pressure. The calibration can then be resumed.

For wav calibrations, the calibration software will pause after the tones have been generated and prompt the user to load the wav data from the hydrophone under test prior to completing the calibration.

For HF and in-situ calibrations, calibration data for the reference hydrophone has to be loaded from a file. ONC HydroCal will ask for this upon switching calibration type, the default source is *reference_hydrophone_M36_calibration.m* and is provided with the software. The *Load Reference Calibration* button can be used to load a new reference calibration file. Acceptable file formats are MATLAB m-files (script only) and .mat files that return variables 'freq' and 'sensitivity', plus text data files (.csv, .txt, etc) that are row-orientated delimited text files with a one-row header. See section 5.4 for the procedure to acquire reference calibration data. The Messages field will suggest an example m-file that's installed with HydroCal.

After a calibration is processed, ONC HydroCal will generate a calibration certificate in MS Excel™ format. If MS Excel™ is not installed, the certificate will be generated in a simple CSV text format. This can take a few minutes (MS Excel can be slow…), wait for the "Calibration complete." message. The user should verify the information in the certificate is correct. A .m file is also produced by default, which can be ingested directly by ONC's Oceans 3.0 system (device details page -> additional attributes -> Upload). Users can update any metadata fields and use the Run Post-Process button to regenerate the results. The post-process function is also useful for playing back the data, reloading wav files in case the wrong one was chosen or was not available immediately (often the normal procedure for HF and in-situ calibration types).

After a VLF calibration is complete, the user must open the chamber valve.

Warning! Sensor damage.

Do not over-pressure the VLF calibration system reference pressure sensor. This is a differential pressure sensor with a ± 1240 Pa operating range and 4900 Pa safe limit.

- Open the valve on the VLF calibration chamber when adding or removing a hydrophone.
- When the VLF calibration system is not in use, always leave the valve open.
- Do not leave the system unattended when the valve is closed. Very small temperature changes can generate high pressures in the constrained volume within the chamber.

After any calibration is complete the user should turn the ONC HydroCal case rotary switch to the 'Off/Charge' position.

Warning! Battery damage.

Always turn the ONC HydroCal rotary switch to the Off/Charge position when not in use. Draining either internal battery below 10.5 volts will damage the battery. HydroCal should not be operated if the battery is below 11.5 volts.

4.6.1 Metadata

Date: acquisition time and post-process time. Updated automatically, no need to edit.
Calibrator: Enter calibrator's name
UUT Element S/N: Unit under test serial number for main unit or receiving element
UUT Digitizer S/N: Unit under test serial number for separate digitizer, if applicable. A digitizer may acquire data from multiple hydrophones simultaneously and interchangeably.
UUT Model: Unit under test model number
UUT Manufacturer: Unit under test manufacturer
UUT IP Address: Future release
UUT IP Port: Future release
UUT Gain (dB): If the UUT has variable gain settings list the settings used here
Ref Type: Reference sensor type
Ref S/N: Reference sensor serial number
Ref Model: Reference sensor model number
Ref Manufacturer: Reference sensor manufacturer
Ref Cal Date: Reference sensor calibration date
Ref Slope Coeff (Pa): VLF reference pressure sensor slope coefficient in Pa
Ref Offset Coeff (Pa): VLF reference pressure sensor offset coefficient in Pa
Freq Start (Hz): Lowest frequency for calibration run
Freq End (Hz): Highest frequency for calibration run
Log/Linear: Choose Log or Linear frequency spacing and plot
# of Freq Points: The number of frequencies to be used in calibration
Owner: Organization to whom the UUT belongs.
Owner Contact: Contact person
Owner Email: Email address of the contact person.
Owner Address: Mailing address of the owner.
Owner Office Phone: Contact person's office phone number.
Owner Cell Phone: Contact person's mobile phone number.

These fields were in the table prior to version 20.09:

Drive Amplitude Max (volts): moved to the ini file and shown on the drive amplitude UI. This is a cap on the maximum amplitude (1/2 peak to peak) of all transmit signals sent to the waveform generator. The waveform is fed to a piezo amplifier in the ONC HydroCal Case which has a gain of 20. CAUTION! Stack actuator max voltage is +80 V.
Drive Bias (volts): moved to the ini file and shown on the drive amplitude UI: DC offset voltage for the waveform generator. This is typically set to 2 volts. If bias +/- amplitude exceeds +/- 4 V a warning is issued.

4.6.2 Ini File Parameters

Figure 4-8 Editing the hydrocal_setup.ini file

ONC HydroCal uses a text file it places in the user's /Documents/HydroCal folder to store parameters that don't normally change. HydroCal reads the parameters on startup and will

restore the file if it is missing or if it is from a previous version of ONC HydroCal, in which case the outdated ini file will be renamed. The restored ini file is populated with defaults. (A good troubleshooting solution is to delete this file and restart ONC HydroCal.) If a user loads a configuration report.mat file that was created with a different set of ini file parameters, the user will be prompted to update the ini file to match the loaded report.mat or save as a new report.mat with the ini file settings. The ini file update is useful if the user wants to use the parameters for new calibrations. If a user loads a configuration report.mat file from previous versions of HydroCal, HydroCal will warn the user and attempt to use it, including updating the ini file as needed. To change a value in the ini file, exit ONC HydroCal first, update the ini file, load HydroCal.

Most of the parameters are self-explanatory and relate to values visible on the user interface, or they are constants used in the processing. '|' separates the parameter name from its value and its format (l for logic, c for character array (including numerical strings), n for single number). Internally, we use the *isTestMode* to run HydroCal with a built-in simulator. Users may be interested in the *writeCSVuutCal* and *writeMfileUUTcal* parameters; turn these on to get CSV and m-file calibration output, in addition to the usual MS Excel™ calibration sheet. The three *SR* parameters are the sample rates for analog acquisition (first row) and digital acquisition (second row, after the ';'), by calibration type (VLF first column, HF second column, in-situ third column). The *cycles* parameters control how many cycles are used: *stabilization* cycles occur immediately before the *capture* cycles, *tail* cycles after; the *cycleParametersFrequencyBin* controls which frequencies go to which cycles, i.e. calibrating at 500 Hz will use 5+20+1 cycles in the generated signal. *vlfRefPressureSensor(Max/Min)Voltage* controls when an alarm will sound to prevent damage to the VLF pressure sensor, similar to the *hfRefPeakVoltageWarning* for the HF reference hydrophone. The *driveAmplitudeVoltBin* specifies the default drive amplitude voltage as a frequency dependent vector, with the frequencies defined by *driveAmplitudeFrequencyBin*. The syncTones parameters control the center frequency of the synchronizing pulses (10 cycles per 'low' and 'high' pules, see *syncToneNumCycles*). *syncTonesLowVLF* and *syncTonesHighVLF* apply in VLF calibration type, *syncTonesHigh* and *syncTonesLow* apply elsewhere. If the bias voltage is non-zero, the *rampRate* controls how fast the transmit voltage ramps from zero to the bias, but it can only take up to *maxRampRunFraction* of the run time, which is set by the *maxRunDuration* and *maxRunSamples* parameters. *maxWavDataMemory* sets the maximum size of loaded wav file data in memory: if this is exceeded, ONC HydroCal will downsample externally recorded wav audio data appropriately, to a sample rate 8 times Nyquist frequency or, if that's still too high, it will downsample further to get under the memory limit, without violating the Nyquist limit for the highest frequency bin to calibrated. If the data is still very large, warnings will be issued. On most modern PCs, with 8+ GB of ram, this should not be an issue. *refSlopeCoeff* and *refOffsetCoeff* are defaults for the metadata table values.

Comments maybe added as a new line started with # or %. These comments will get moved to the top of the file by HydroCal. Modifications that break the formatting will cause ONC HydroCal will throw errors to the HydroCal.log file and the messages box; revert or delete the ini file to fix.

5 Care and Maintenance

5.1 VLF Chamber

Always leave the VLF chamber valve open when not actively running a calibration. When the valve is closed the oil in the chamber is constrained and large pressures can be generated with small temperature changes. The reference pressure sensor is extremely fragile and can be ruptured by excess pressure. The operating range of the sensor is ± 1240 Pa and the safe limit is 4900 Pa. The ONC HydroCal Case alarm will sound when the chamber pressure exceeds ±990 Pa to ensure there is enough pressure headroom to perform a calibration.

Fill the chamber with light mineral oil. The brand of light mineral oil is not important except during calibration of the reference pressure sensor. The level of the oil should be several mm above the overflow reservoir bottom. This will ensure the sensor vent port and the chamber see the same hydrostatic pressure and ensure that bubbles are not contained in the chamber when the hydrophone is inserted.

Keep the lid on the VLF calibration chamber when it is not in use. This will keep dust and debris out of the oil.

Do not wipe the face of the reference pressure sensor. The tiny gold wires and the extremely thin silicon diaphragm can be easily damaged.

The reference pressure sensor should be calibrated annually.

5.2 Calibrating the VLF reference pressure sensor

The VLF reference sensor should be calibrated annually or whenever a large over pressure event has occurred.

For general operation the VLF chamber can be filled with any brand of light mineral oil. However, during the VLF sensor calibration it is critical to know the density of the oil used during the calibration of the pressure sensor. This is easily done by measuring the volume and mass of the oil. At ONC we typically use 'Western Family' light mineral oil purchased from the local drug store. It has a density of 0.77 g/ml.

Figure 5-1 Light Mineral Oil

The reference differential pressure sensor can be calibrated without removing it from the chamber. Connect the ONC HydroCal USB port to a computer or USB power adapter. Connect the VLF chamber to the ONC HydroCal case and turn the rotary switch to the VLF position. Clamp a metric ruler vertically, with the high numbers at the top, near the chamber, as shown in Figure 5-2. Carefully fill the 75 cm long, 0.25" OD, clear Tygon, flexible tube with light mineral oil to within a few cm of the top, suction is the best method. Attach the tube to the vent hole next to the hydrophone port within the oil reservoir. Take care not to allow the oil level to exceed

30 cm above the oil in the reservoir. When the tube has been filled, slide the meniscus down the ruler until the voltage on the ONC HydroCal display reads 1.6 volts. The oil level in the tube and the oil level in the chamber should now be the same, this is the zero level for the sensor calibration. Ensure the ruler has ±100 mm of measurement room above and below this level.

Figure 5-2 Ruler setup and 0.25" OD Tygon tube insert

Launch HydroCal and select the 'Check Input Voltage' button. Each time the button is selected HydroCal will take a 1 s average voltage measurement of the reference pressure sensor voltage and display the result as shown in Figure 5-3. Open the MS Excel™ VLF Reference Sensor Calibration spreadsheet. The sheet is protected so that only the yellow cells can be edited. Fill in the metadata. Move the tube oil meniscus in increments from +100 mm to -100 mm and accurately note the ruler measurement and the voltage on the ONC HydroCal display. Enter the mm of oil and voltage into the pressure calibration spreadsheet, as shown in Figure 5-4. It is not mandatory to fill in all the fields. The spreadsheet will compute the slope and offset coefficients for the reference sensor. Enter these coefficients into the ONC HydroCal software metadata along with the calibration date and sensor serial number.

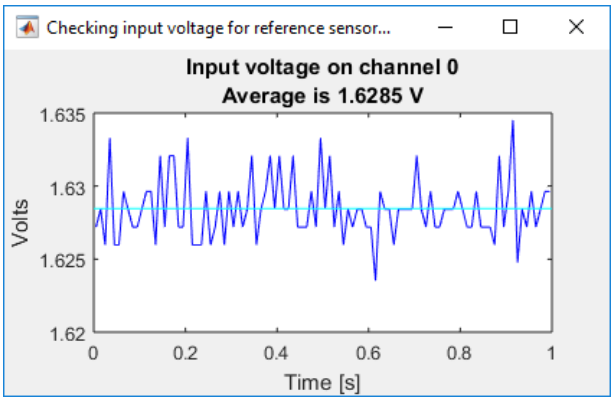


Figure 5-3 VLF Reference sensor voltage

HydroCal VLF Reference Sensor Calibration

Metadata

Date of calibration	31-Aug-18
Calibrator	TD-MM
Manufacturer	All Sensors
Model	BLVR-L05D
Serial Number	001
Range	±5 in of H_2O
Coefficients	
Slope Coeff: 950.95	
Offset Coeff: -1569.1	

Calibration Data

Ruler Pressure (mm light mineral oil)	Voltage	Corrected Ruler mm LMO	Pressure (Pa)
230	1.038	-77.0	-580.9
210	1.206	-57.0	-430.1
180	1.433	-27.0	-203.8
150	1.667	3.0	22.6
120	1.910	33.0	248.9
90	2.151	63.0	475.2
60	2.389	93.0	701.5
30	2.627	123.0	927.8

Interface parameters

Supply voltage	5	V
Internal supply	3.30	V
Bridge voltage	3.30	V
Bias	1.65	V
Span	0.024	V
Gain	50.0	X
Gain	33.98	dB

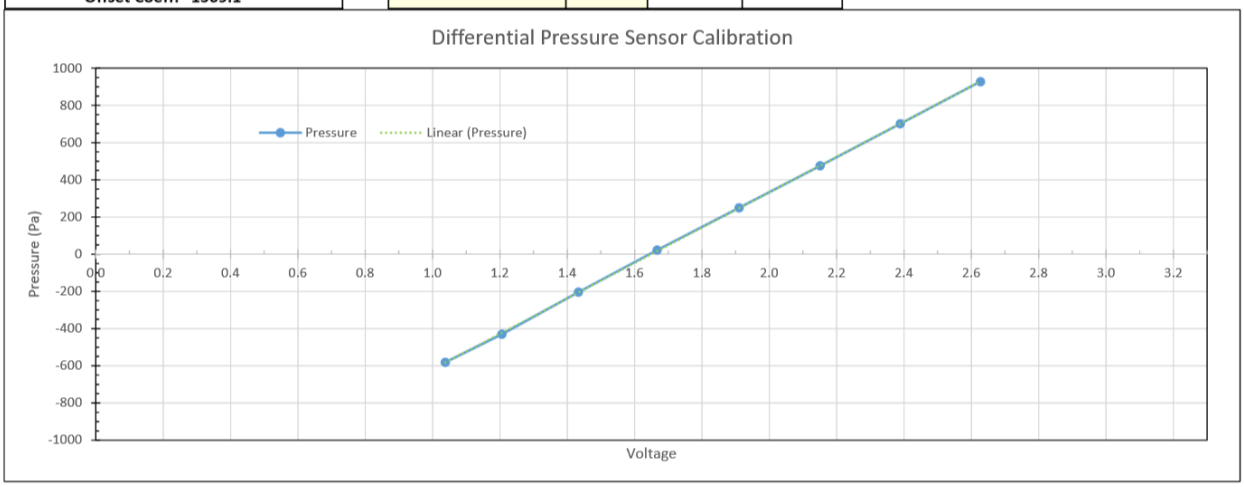


Figure 5-4 VLF Reference sensor calibration sheet

5.3 HF Equipment

The M18-2.5 acoustic projector must have the shorting plug attached at all times when not connected to the ONC HydroCal electronics.

Warning! Projector damage.

The M18-2.5C projector will generate a large internal voltage sufficient to depole the projector if the projector leads are not shorted together or plugged into the ONC HydroCal case.

Lightly grease the underwater connectors before each use. Wipe a thin layer of grease across the female connector such that there is a small amount of grease around the edges of each connector pin hole. When the male connector is inserted it will spread the grease throughout the pin holes.

Do not leave the M18-2.5 acoustic projector in direct sunlight for long periods, the projector will get hot and potentially damage the piezo element and the UV rays will degrade the polyurethane encapsulate.

Do not leave the M-36 reference hydrophone in direct sunlight for long periods, the hydrophone will get hot and potentially damage the piezo element and the UV rays will degrade the polyurethane encapsulate.

Before disconnecting any connectors which have been immersed in water, rinse the connector with fresh water and wipe dry the connect.

After use, all parts (cables, connectors, jig, drogue, spar buoy, projector, reference hydrophone, and hydrophone under test) should be rinsed with fresh water. Do not get water inside the connectors, this will damage the connectors.

The reference hydrophone and acoustic projector are fragile devices and should be stored in the protective case supplied.

Figure 5-5 Reference hydrophone and projector

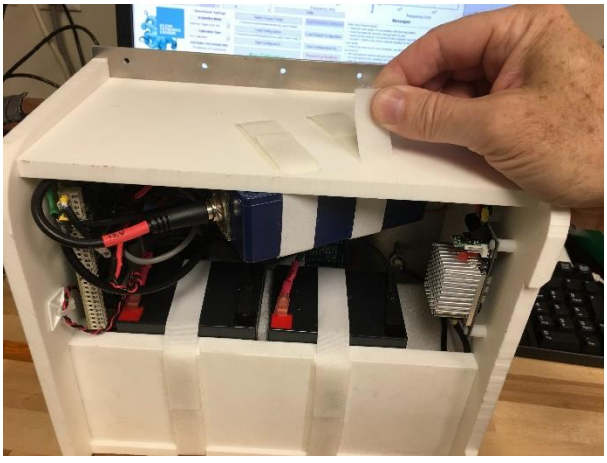
5.4 Calibrating the M36 HF reference hydrophone

The M36 reference hydrophone should be calibrated annually or after it has received a shock, such as dropping the hydrophone. This calibration should be performed by the manufacturer, GeoSpectrum Technologies Inc. in Dartmouth NS. Obtain an RMA number from GeoSpectrum prior to shipping the hydrophone for calibration. Both the hydrophone and the line driver should be returned to GeoSpectrum so they can be calibrated as a set.

Pack the hydrophone with care since it is very susceptible to damage from shock.

To remove the line driver from the ONC HydroCal case. Remove the 15 Phillips screws from the outside top, right and bottom edges of the face plate. Use the banana plug terminals to slide the faceplate to the left about 3 cm, as shown in Figure 5-6. Lift the electronics module from the case and tip backwards to expose the bottom. Undo the Velcro straps to remove the line driver as shown in Figure 5-7.

Figure 5-6 Slide the face plate to the left prior to lifting from the case.



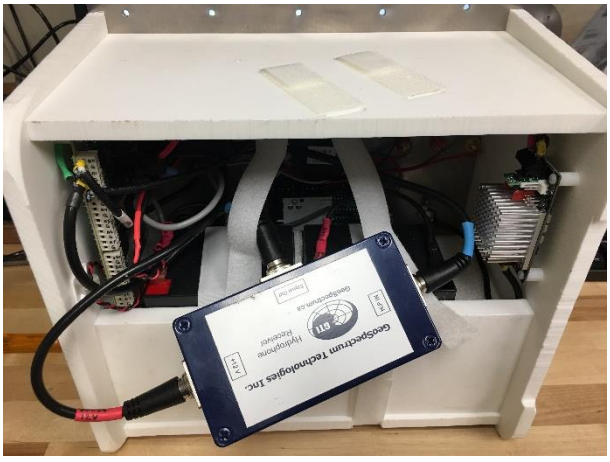


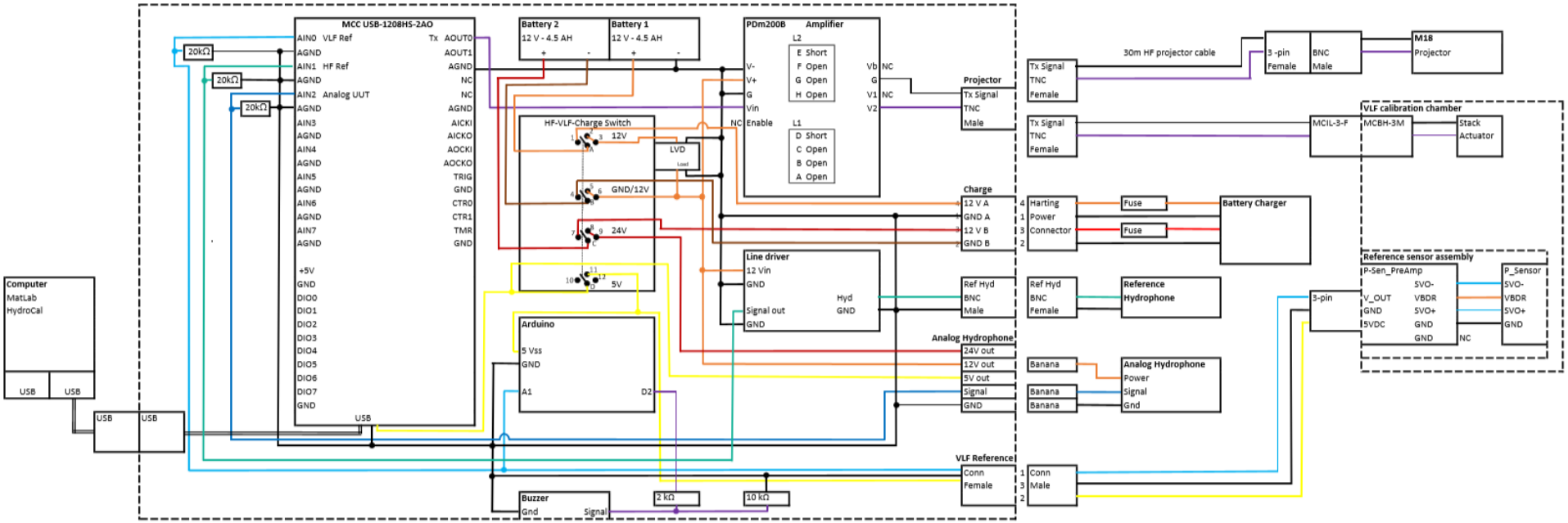
Figure 5-7 Removing the GeoSpectrum Technologies line driver

5.5 ONC HydroCal Case

Maintain a charge on the batteries in the ONC HydroCal case.

Once the ONC HydroCal case lid is open the case is no longer waterproof. Allowing water on the ONC HydroCal faceplate or inside the ONC HydroCal case will damage the electronics and connectors.

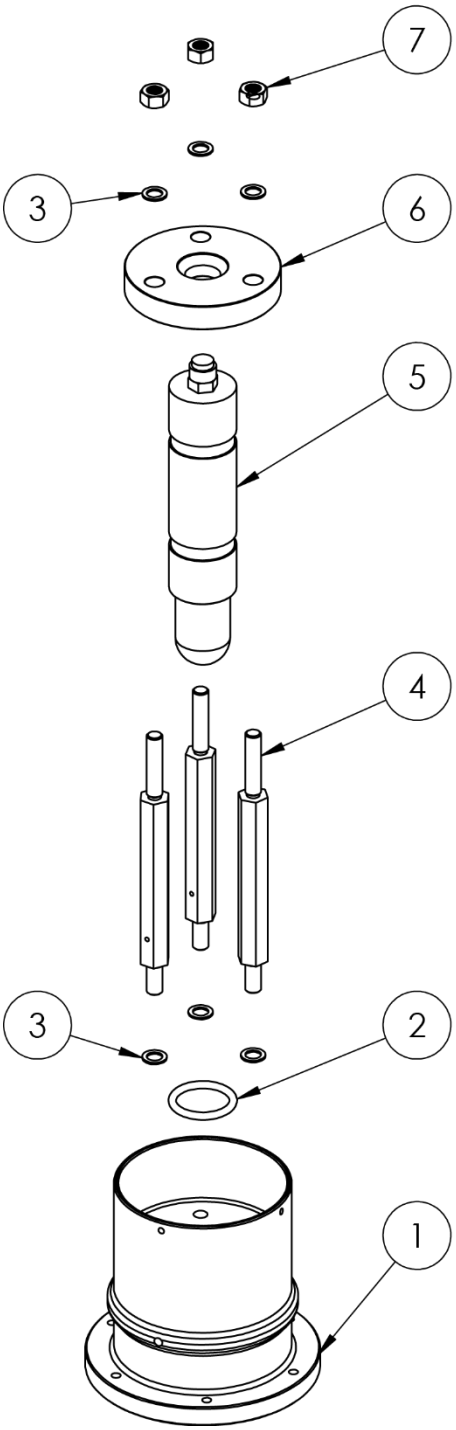
6 Wiring Diagram



7 Assemblies

7.1 VLF calibration assemblies

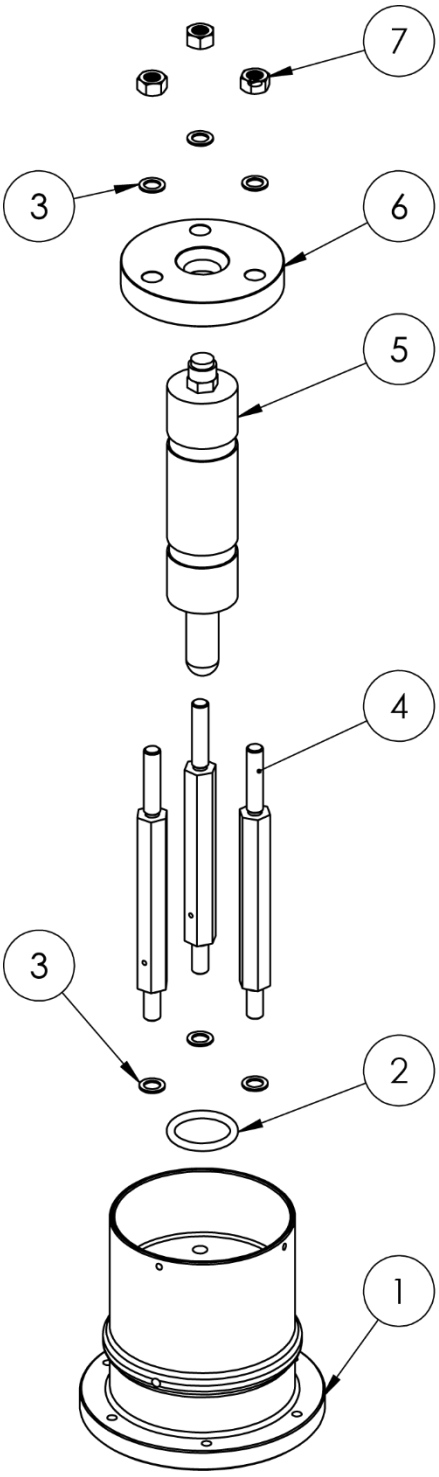
7.1.1 icListen LF and icListen AF hydrophones



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	6
4	ONC0089-24 - R0	Hex Rod - Long	3
5	IcListen AF	ICLISTEN AF HYDROPHONE	1
6	ONC0089-17 - R0	ICLISTEN ADAPTER	1
7	90670A175	ALUMINUM HEX NUT, 7/16"-20 THREAD SIZE	3

Figure 7-1 icListen LF and icListen AF hydrophone assembly

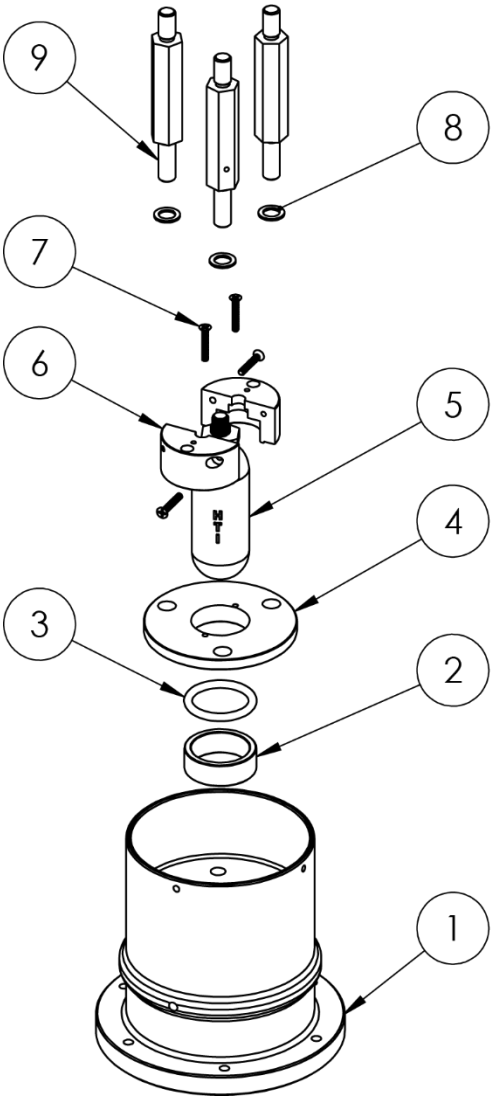
7.1.2 icListen HF



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	6
4	ONC0089-24 - R0	Hex Rod - Long	3
5	IcListen HF	ICLISTEN HF HYDROPHONE	1
6	ONC0089-17 - R0	ICLISTEN ADAPTER	1
7	90670A175	ALUMINUM HEX NUT, 7/16"-20 THREAD SIZE	3

Figure 7-2 icListen HF hydrophone assembly

7.1.3 HTI-92 Hex Bulkhead



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	ONC0089-16 - R1	ROUND ADAPTER EXTENSION	1
3	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
4	ONC0089-15 - R0	ROUND ADAPTER	1
5	HTI-92-WB_Hex	HTI 92 WB HEX HYDROPHONE	1
6	ONC0089-10 - R0	HTI92 HEX CLAMP	2
7	97124A346	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 8-32 THREAD SIZE, 1" LONG	4
8	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	3
9	ONC0089-22 - R0	HEX ROD - MEDIUM	3

Figure 7-3 HTI-92 Hex Bulkhead Hydrophone Assembly

7.1.4 HTI-92 Cable

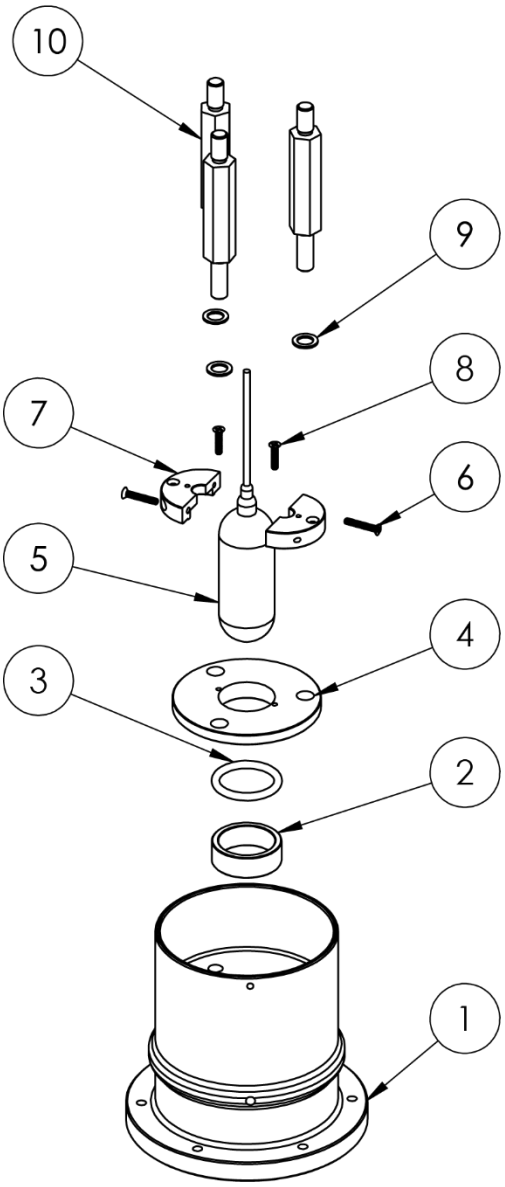
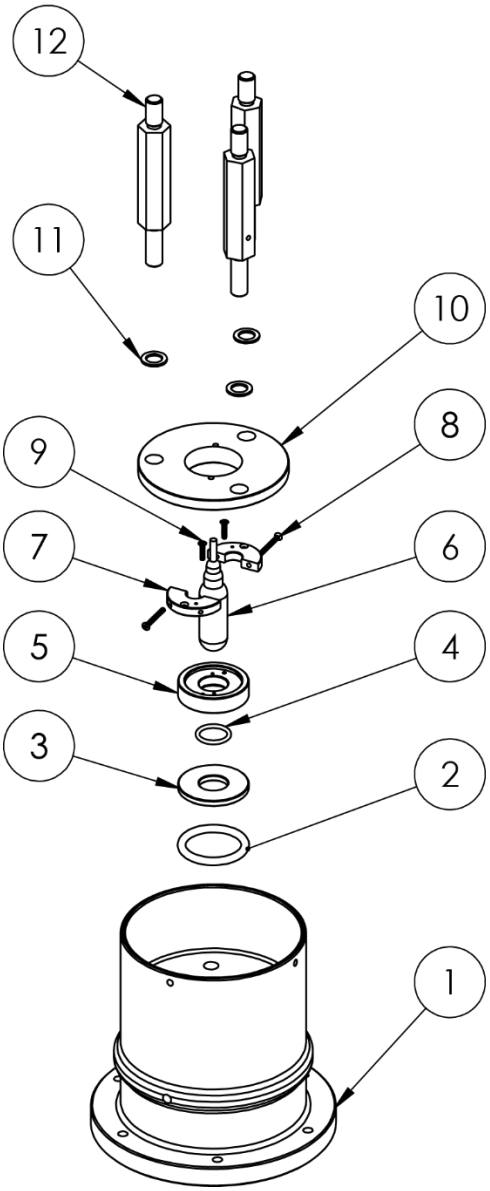


Figure 7-4HTI-92 Cabled Hydrophone Assembly

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	ONC0089-16 - R1	ROUND ADAPTER EXTENSION	1
3	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
4	ONC0089-15 - R0	ROUND ADAPTER	1
5	HTI-92-WB	HTI 92 WB HYDROPHONE	1
6	97124A346	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 8-32 THREAD SIZE, 1" LONG	2
7	ONC0089-11 - R0	HTI92 CLAMP	2
8	97124A342	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 8-32 THREAD SIZE, 3/4" LONG	2
9	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	3
10	ONC0089-22 - R0	HEX ROD - MEDIUM	3

7.1.5 HTI-96



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	ONC0089-14 - R1	HTI-96-MIN RING BOTTOM	1
4	9452K28	OIL-RESISTANT BUNA-N O-RING, 3/32 FRACTIONAL WIDTH, DASH NUMBER 116	1
5	ONC0089-13 - R1	HTI-96-MIN RING TOP	1
6	HTI-96-MIN	HTI 96 MIN HYDROPHONE	1
7	ONC0089-12 - R0	HTI-96-MIN CLAMP	2
8	97124A145	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 4-40 THREAD SIZE, 1" LONG	2
9	97124A139	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 4-40 THREAD SIZE, 1/2" LONG	2
10	ONC0089-15 - R0	ROUND ADAPTER	1
11	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	3
12	ONC0089-22 - R0	HEX ROD - MEDIUM	3

Figure 7-5HTI-96 Cabled Hydrophone Assembly

7.1.6 CRT-55

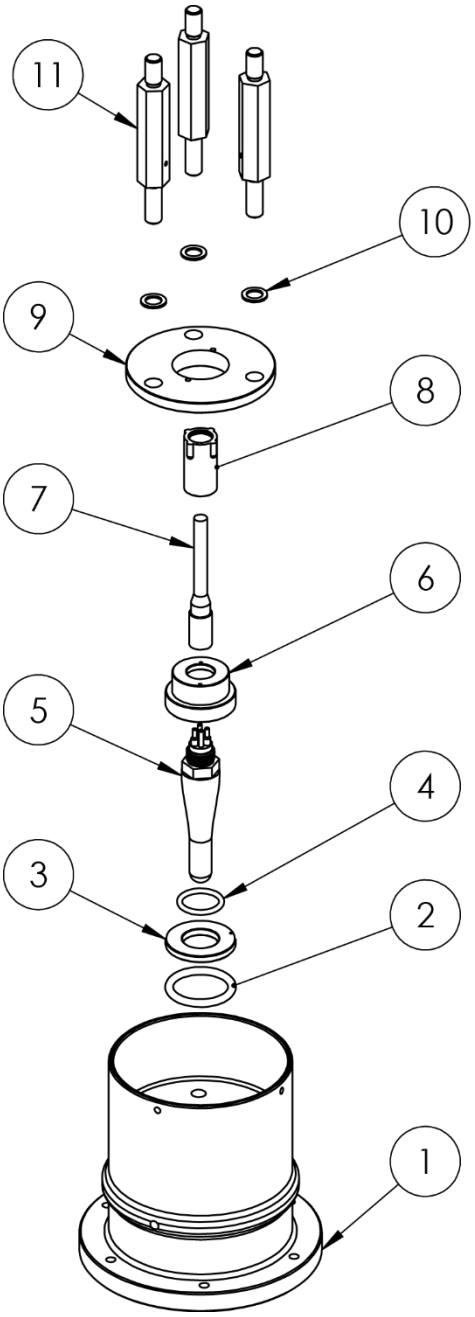
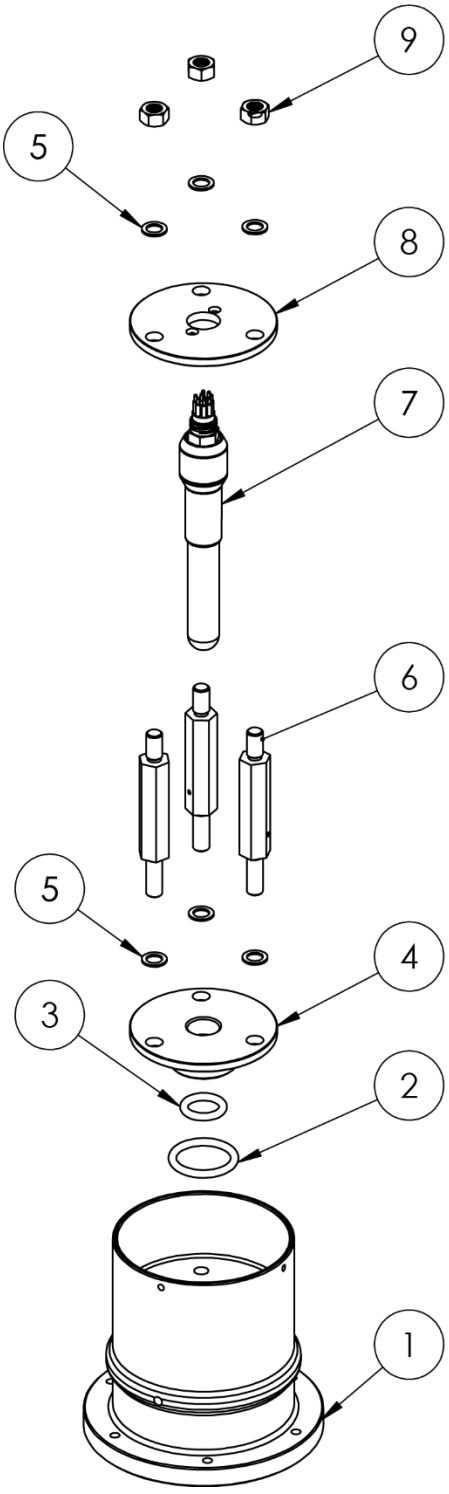


Figure 7-6 CRT-55 Hydrophone Assembly

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	ONC0089-09 - R0	C55 ADAPTER BOTTOM	1
4	9452K34	OIL-RESISTANT BUNA-N O-RING, 1/8 FRACTIONAL WIDTH, DASH NUMBER 214	1
5	C55	C55 HYDROPHONE	1
6	ONC0089-08 - R1	C55 ADAPTER TOP	1
7	MCIL3F	C55 HYDROPHONE CONNECTOR	1
8	C55 Locking Sleeve	C55 HYDROPHONE LOCKING SLEEVE	1
9	ONC0089-15 - R0	ROUND ADAPTER	1
10	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	3
11	ONC0089-22 - R0	HEX ROD - MEDIUM	3

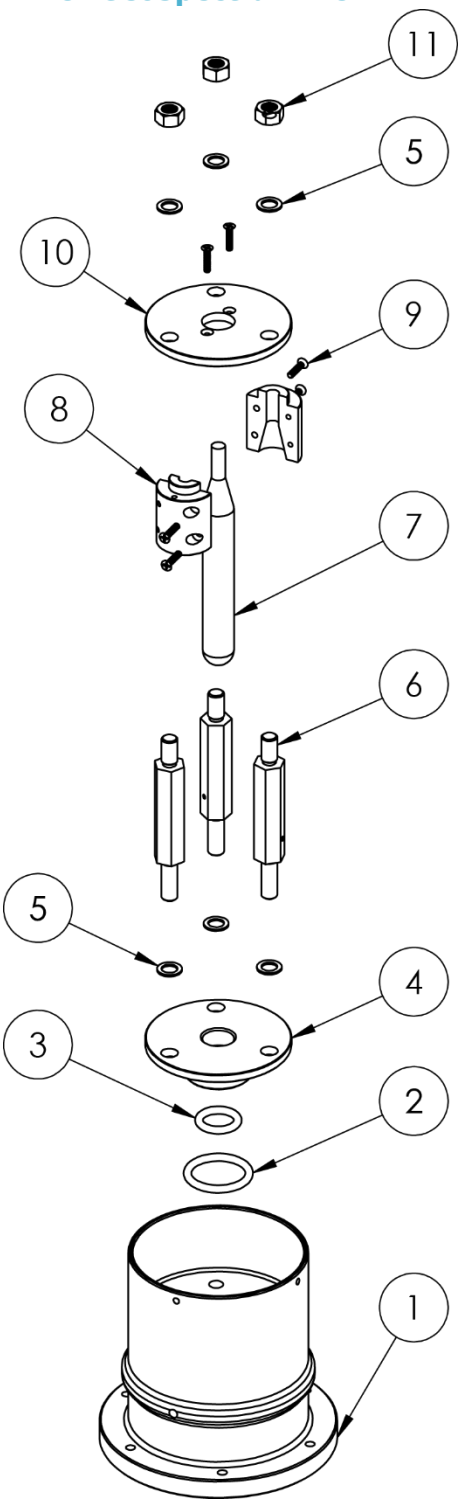
7.1.7 GeoSpectrum M36



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	9452K389	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 316	1
4	ONC0089-20 - R0	M8E ADAPTER BOTTOM	1
5	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	6
6	ONC0089-22 - R0	HEX ROD - MEDIUM	3
7	Geospectrum-M36	GEOSPECTRUM M36 HYDROPHONE	1
8	ONC0089-21 - R1	M8E ADAPTER TOP	1
9	90670A175	ALUMINUM HEX NUT, 7/16"-20 THREAD SIZE	3

Figure 7-7 GeoSpectrum M36 Hydrophone Assembly

7.1.8 GeoSpectrum M8E



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	ONC0089-04 - R1	PRESSURE FITTING CHAMBER CAP	1
2	9452K44	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 325	1
3	9452K389	OIL-RESISTANT BUNA-N O-RING, 3/16 FRACTIONAL WIDTH, DASH NUMBER 316	1
4	ONC0089-20 - R0	M8E ADAPTER BOTTOM	1
5	94589A440	ALUMINUM MIL. SPEC. WASHER FOR 7/16" SCREW SIZE, 0.443" ID, 0.683" OD, AN901-4A	6
6	ONC0089-22 - R0	HEX ROD - MEDIUM	3
7	M8E hydrophone	GEOSPECTRUM M8E HYDROPHONE	1
8	ONC0089-19 - R1	M8E CLAMP	2
9	97124A342	ALUMINUM PHILLIPS FLAT HEAD SCREWS, 8-32 THREAD SIZE, 3/4" LONG	6
10	ONC0089-21 - R1	M8E ADAPTER TOP	1
11	90670A175	ALUMINUM HEX NUT, 7/16"-20 THREAD SIZE	3

Figure 7-8 GeoSpectrum M8E Hydrophone Assembly

7.2 HF Calibration System

An overview of the high frequency calibration system is shown in Figure 7-9. The Hydrocal case and computer are on board the boat. When the boat is in quiet water of 40 m depth or more assemble the calibration jig as shown in Figure 7-10. Ensure the distances centre to centre between the projector and the two hydrophones are exactly 1 meter (±1cm). The rope and cables are then secured to the jig. Typically, only the cables for the projector and reference hydrophone are used for wav format calibrations. For analog calibrations a third cable, specific to the hydrophone under test, will be added. Lower the assembled calibration jig below the boat to about 9 m deep. Clamp the drogue around the cables at the 10 m mark and secure the drogue using the short cord ends attached to the cable. Lower the assembly over the side to approximately until the shackle at 20 m is reached. Attach the spar buoy to the shackle and deploy the buoy over the side of the boat. The spar buoy and drogue combination prevents wave motion from saturating the hydrophone. Secure the rope to the boat gunwale. Plug the cables into the ONC HydroCal case and proceed with the calibration.

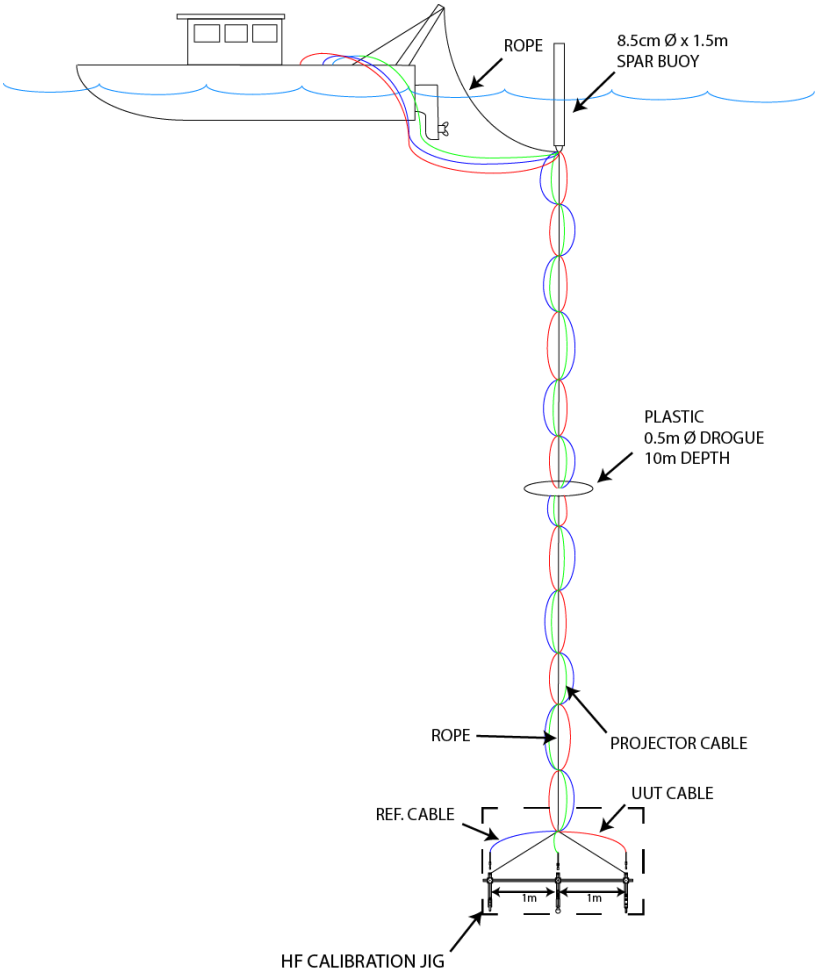
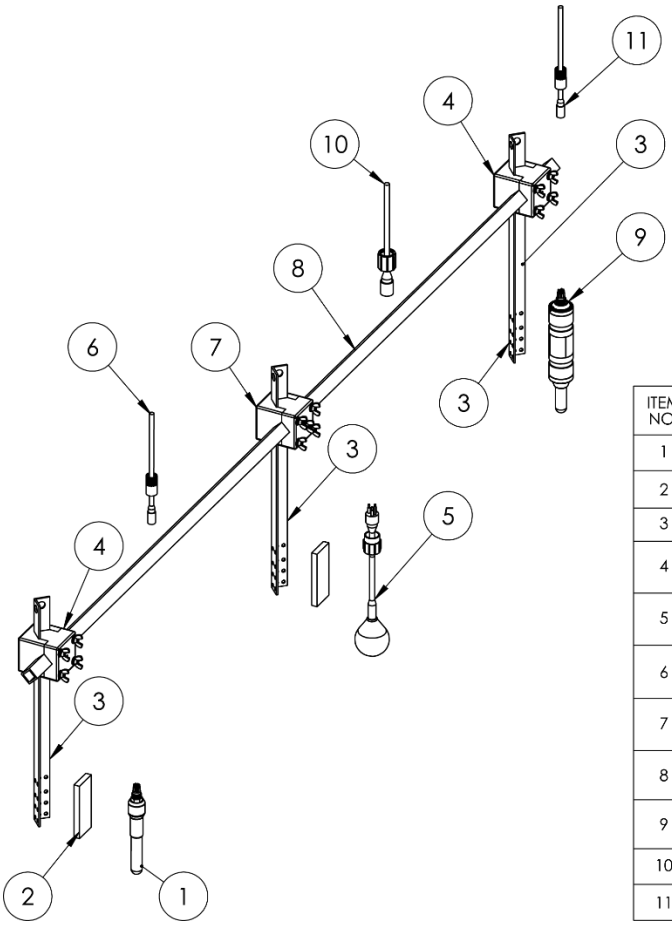
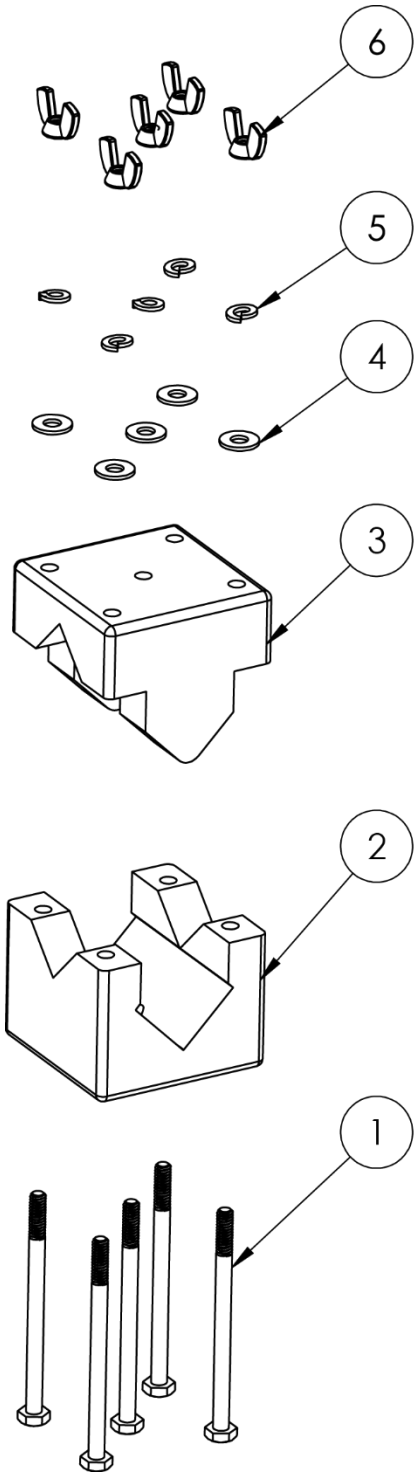


Figure 7-9 HF calibration system overview.



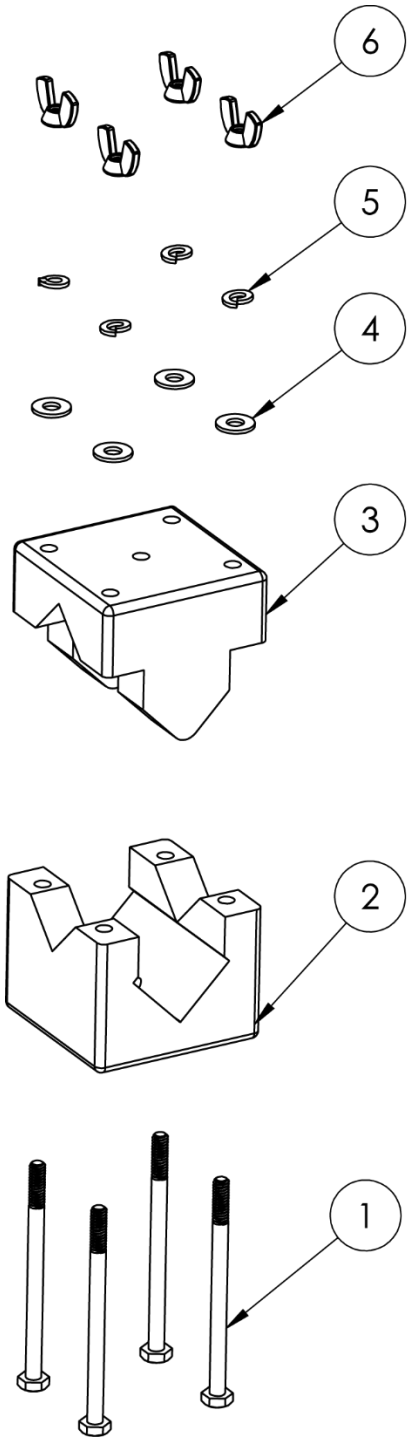
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Geospectrum-M36	REFERENCE HYDROPHONE	1
2	Foam Pad	FOAM PAD	2
3	1-25in_FG_angle_8542K77_Rev1	VERTICAL SUPPORT	3
4	Clamps Assembly (Sides)	CLAMPS ASSEMBLY (SIDES)	2
5	Geospectrum M18 Projector	GEOSPECTRUM M18 PROJECTOR	1
6	Ref. Cable	REFERENCE HYDROPHONE CABLE (30m)	1
7	Clamps Assembly (Centre)	CLAMPS ASSEMBLY (CENTRE)	1
8	1in_FG_RectTube_8548K31_Rev1	JIG BASE	1
9	IcListen - SC2-ETH-NC V2	ICLISTEN SC2-ETH HYDROPHONE	1
10	Projector Cable	PROJECTOR CABLE (30m)	1
11	UUT Cable	UUT CABLE (30m)	1

Figure 7-10 HF calibration jig assembly.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	92198A557	18-8 STAINLESS STEEL HEX HEAD SCREW, 1/4"-20 THREAD SIZE, 3-3/4" LONG	5
2	Clamp A	HF JIG CLAMP A	1
3	Clamp B	HF JIG CLAMP B	1
4	92141A029	18-8 STAINLESS STEEL WASHER FOR 1/4" SCREW SIZE, 0.281" ID, 0.625" OD	5
5	92146A029	18-8 STAINLESS STEEL SPLIT LOCK WASHER FOR 1/4" SCREW SIZE, 0.26" ID, 0.487" OD	5
6	92001A321	PRODUCT DETAIL 18-8 STAINLESS STEEL WING NUT, 1/4"-20 THREAD SIZE	5

Figure 7-11 HF calibration jig centre clamp assembly detail



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	92198A557	18-8 STAINLESS STEEL HEX HEAD SCREW, 1/4"-20 THREAD SIZE, 3-3/4" LONG	4
2	Clamp A	HF JIG CLAMP A	1
3	Clamp B	HF JIG CLAMP B	1
4	92141A029	18-8 STAINLESS STEEL WASHER FOR 1/4" SCREW SIZE, 0.281" ID, 0.625" OD	4
5	92146A029	18-8 STAINLESS STEEL SPLIT LOCK WASHER FOR 1/4" SCREW SIZE, 0.26" ID, 0.487" OD	4
6	92001A321	PRODUCT DETAIL 18-8 STAINLESS STEEL WING NUT, 1/4"-20 THREAD SIZE	4

Figure 7-12 HF calibration jig outer clamps assembly detail

8 Troubleshooting

8.1 The ONC HydroCal case has no 12 VDC power on the terminals.

- Turn the ONC HydroCal rotary switch to the VLF or HF position and test the voltage between the 12-volt terminal and the ground terminal. Turn the rotary switch to the off position.
- If the rotary switch is on and there is no voltage on the 12 VDC terminal it is likely the Battery 1 low voltage disconnect is in effect. Turn the rotary switch to the Off / Charge position and charge the batteries. Refer to Section 4.2.
- If a battery fails to charge within 5 hours the battery may have been damaged. It may be necessary to remove the battery and use a smart charger to revive the battery or replace the battery.
- If the Battery 1 charging light continues to flash green and red while the charger is connected to the ONC HydroCal case and the rotary switch is in the Off / Charge position Battery 1 may be damaged or the connections to the battery may have disconnected. Open the ONC HydroCal case by removing the outer screws along the top, right and bottom sides of the HydroCal display. Use the banana terminals to slide the display to the left by about 3 cm. Lift the ONC HydroCal display out of the case. Check the connections to the batteries. If necessary, remove batteries by first removing the Line Driver box by undoing the Velcro straps and BNC connectors. Then remove the batteries by undoing the battery connectors and Velcro straps. Repair or replace the batteries as necessary.

8.2 The ONC HydroCal case has no, or low, 24 VDC power on the terminals.

- Turn the HydroCal rotary switch to the VLF or HF position and test the voltage between the 24-volt terminal and the ground terminal. If the voltage is below 23 volts check the battery voltages of each battery separately. Test Battery 1 by testing the voltage between the 12-volt terminal and the ground terminal. Test Battery 2 by testing the voltage between the 24-volt terminal and the 12-volt terminal. Turn the rotary switch to the off position.
- If the rotary switch is on and there is no voltage on the 24 VDC terminal it is likely the Battery 1 low voltage disconnect is in effect. Turn the rotary switch to the Off / Charge position and charge the batteries. Refer to Section 4.2.
- If a battery fails to charge within 5 hours the battery may have been damaged. It may be necessary to remove the battery and use a smart charger to revive the battery or replace the battery.
- If the Battery 1 or 2 charging light continues to flash green and red while the charger is connected to the ONC HydroCal case and the rotary switch is in the Off / Charge position the battery may be damaged or the connections to the battery may have disconnected. Open the ONC HydroCal case by removing the outer screws along the top, right and bottom sides of the HydroCal display. Use the terminal to slide the display to the left by about 3 cm. Lift the ONC HydroCal display out of the case. Check the connections to the batteries. If necessary, remove batteries by first removing the Line Driver box by undoing the Velcro straps and BNC connectors. Then remove the batteries by undoing the battery connectors and Velcro straps. Repair or replace the batteries as necessary.

8.3 The batteries will not charge.

- If a battery fails to charge within 5 hours the battery may have been damaged. It may be necessary to remove the battery and use a smart charger to revive the battery or replace the battery.
- If the Battery 1 or 2 charging light continues to flash green and red while the charger is connected to the ONC HydroCal case and the rotary switch is in the Off / Charge position the battery may be damaged or the connections to the battery may have disconnected. Open the HydroCal case by removing the outer screws along the top, right and bottom sides of the HydroCal display. Use the terminal to slide the display to the left by about 3 cm. Lift the HydroCal display out of the case. Check the connections to the batteries. If necessary, remove batteries by first removing the Line Driver box by undoing the Velcro straps and BNC connectors. Then remove the batteries by undoing the battery connectors and Velcro straps. Repair or replace the batteries as necessary.

8.4 There is no signal from the HF reference hydrophone.

- Check Battery 1 voltage. Turn the rotary switch to the HF position and test the voltage between the 12V terminal and the ground terminal. If there is no voltage, charge the batteries.
- Check the connectors at the reference hydrophone and the ONC HydroCal case.
- Check the cable for nicks or cuts.

8.5 The ONC HydroCal program will not run.

- If running from source code, check that the MATLAB path includes the HydroCal source code directory and that there are no additional versions in the path, use the MATLAB command "*which HydroCal*". Only the HydroCal.m file in the source code directory should be returned. The command '*path*' should include the HydroCal source directory.
- If running from source code, ensure you are running MATLAB version 2017a or later.
- Delete the hydrocal_setup.ini file. This will return HydroCal to its default settings. The MATLAB working directory is fixed to the user's documents directory, in a sub-directory called HydroCal, for example: C:\Users\oncuser\Documents\HydroCal. The ini file will always be there and this is the default output directory, but the user can change that. A log file will also be generated in the working directory. This file, the ini-file, the report*.mat (output file) and any screenshots and descriptions will be useful for ONC support to help you troubleshoot. We like to help!
- Ensure the USB cable is securely connected to both the computer and HydroCal before the MATLAB program / HydroCal software is launched.
- Check the cable connections between the reference hydrophone and the ONC HydroCal case.
- Check the cable between the reference hydrophone and ONC HydroCal case for damage.
- If running from source code, ensure that The MCC MATLAB data acquisition toolbox has been installed in MATLAB. Otherwise, ask ONC if they forgot to include the MCC toolbox in the installer. Other acquisition software, such as NI-DAQ, could interfere, but it's unlikely. Trying uninstalling conflicting software and HydroCal, then reinstall HydroCal, with restarts at each stage.

- With the ONC HydroCal case connected to the computer, run InstaCal and check that the MCC board number is set to '0' and the inputs are configured to single ended inputs.

8.6 The sound pressure level plot for the VLF chamber is not a smooth curve.

- If there are peaks and troughs in the SPL plot above 300 Hz there is likely an air bubble trapped in the chamber. An example of this is shown in Figure 8-1. Open the VLF chamber valve, remove the hydrophone and check the chamber for bubbles. Do not wipe across the reference sensor it is extremely delicate. Ensure the oil level is above the hydrophone o-ring seal, and reinstall the hydrophone. It is very easy to trap small bubbles on the hydrophone during insertion into the oil, it helps to wet the hydrophone surfaces and keep a high level of oil in the reservoir. Re-run the calibration.

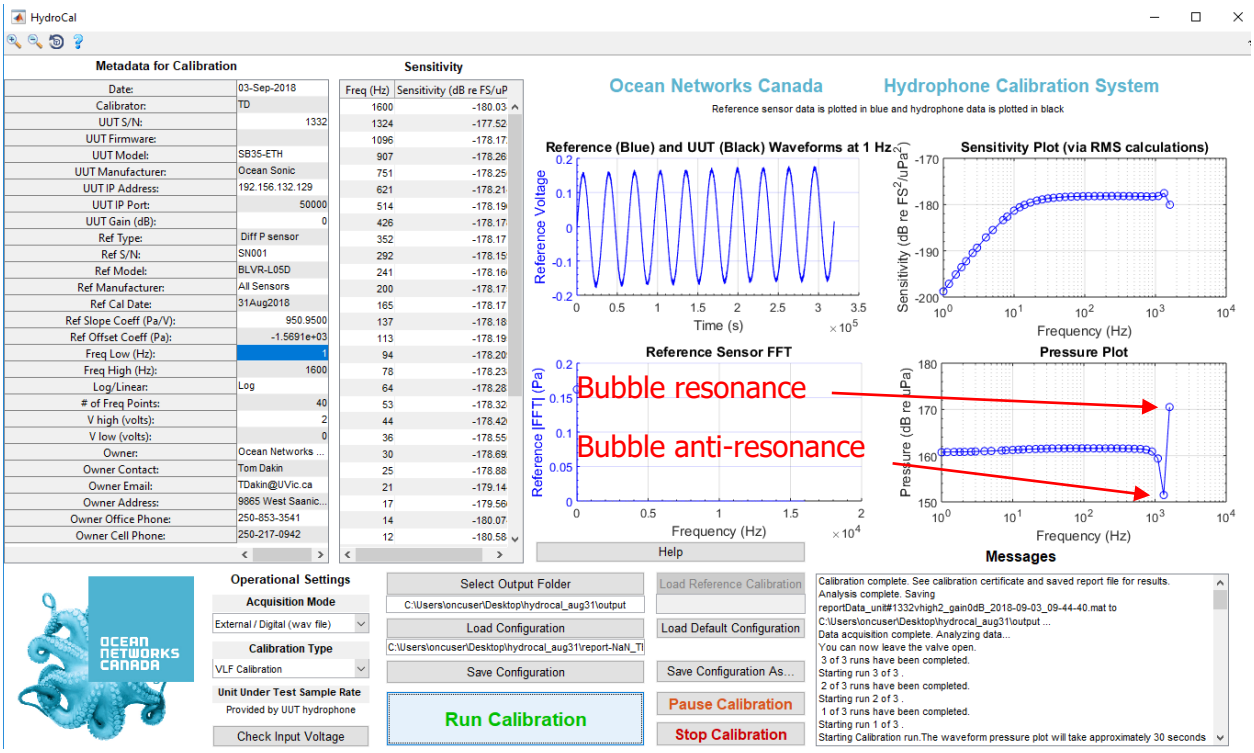


Figure 8-1 Bubble effects in the SPL plot (older version of ONC HydroCal shown)

- Ensure the VLF chamber valve was lightly closed during the calibration. Open the valve after the calibration.
- Ensure the hydrophone under test is securely clamped prior to starting the calibration.
- If the bubble resonance persists it may be necessary to vacuum degas the chamber while filled with oil. This will remove the bubbles trapped in the o-ring and gasket seals. Remove the hydrophone and ensure the VLF chamber valve is well opened. Place the VLF chamber into a vacuum chamber and apply a vacuum. At near vacuum the mineral oil will produce gas bubbles at nucleation points in the chamber, this is normal. Seal the vacuum chamber port, and turn off the vacuum pump. Allow the mineral oil to degas overnight in the sealed vacuum chamber. The vacuum chamber pressure will increase during the night due to off

gassing and leakage. In the morning slowly bleed pressure back into the vacuum chamber. The bubbles in the VLF chamber should now be eliminated.

8.7 The VLF reference sensor is not registering a pressure.

- Check the metadata fields for slope and offset for the reference sensor. They should match the calibration for the pressure sensor.
- If the voltage output from the pressure sensor is not between 1.5 and 1.8 volts on the ONC HydroCal display when the rotary switch is in the VLF position and the VLF valve is open, then the pressure sensor may be damaged. Recalibrate or replace the reference pressure sensor as necessary.

8.8 The Calibration Certificate is not complete.

- Check the metadata fields in the ONC HydroCal user interface.
- If MS Excel is not installed, the certificate will be in text (CSV) format. An m-file format is also available.
- The blank calibration certificate is stored in C:\Program Files\OceanNetworksCanada\HydroCal\application folder. Users can modify it, but if it is deleted, users can restore it be re-installing HydroCal.

8.9 The calibration data is not in the output folder.

- On the ONC HydroCal user interface, ensure the correct output folder location is selected.

8.10 When all else fails

- Contact Ocean Networks Canada for assistance:

  info@oceannetworks.ca

  or call 1-250.472.5400