

Applying Calibration to icListen Hydrophones

icListen Background

The icListen is a digital hydrophone system that combines the standard aspects of an acoustics recorder and implements them in a single small package. This is demonstrated in the image below. The icListen has the option to save data in a raw data format (.wav) or in a processed spectral form (.txt). The process of converting the data outputs into physical units is outlined below.



Wav Data Interpretation

The icListen hydrophone outputs wav data in a depth of either 16 or 24. Given a sample of value $x[n]$, the voltage at the input to the ADC is

$$V_{ADC}[n] = x[n] \times \frac{V_{PPK}}{2} \times \frac{1}{2^{N-1}}$$

Where $V_{PPK} = 6V$ and $N = 16$ or 24 .

In some programs, such as Audacity and MATLAB/OCTAVE, wav files are read as a full-scale value [-1.00,1.00]. If this is the case $N = 1$.

With the values in Voltage, to convert to μPa requires the open circuit voltage response or OCVR. This value is on the calibration sheet as *Sensitivity @ 26 Hz* or in wav file metadata as the second number in the comments field. Using this to convert to μPa

$$P[n] = V_{ADC}[n] \times \frac{1}{10^{-20}} \times \frac{OCVR}{10^{-20}} \mu Pa$$

Or for Pa

$$P[n] = V_{ADC}[n] \times \frac{1}{10^{-20}} \times \frac{1}{10^6} Pa$$

This value can be converted to an SPL in dB by

$$SPL = 20 \log_{10} \left(\frac{P[n]}{1 \mu Pa} \right) dB$$

FFT Data Interpretation

Value in the FFT text file are stored as counts in whole dB increments. In the header of the text file there are two offset values that can be used to convert the dB values into physical units. The first converts from count (dB) to dB re 1 μPa and the other from counts (dB) to dBV. The relevant formulae are

$$SPL_{RMS}(dB \text{ re } 1 \mu Pa) = Counts(dB) + offset_{\mu Pa}(dB \text{ re } 1 \mu Pa)$$

$$SPL_{RMS}(dB \text{ re } 1 V) = Counts(dB) + offset_V(dB \text{ re } 1 V)$$

Where the values in brackets are the units

Additionally, using the calibration sensitivities provided on the Ocean Sonics calibration sheet. You can find the SPL at a frequency f using the formula

$$SPL_{RMS}(f) = Counts + offset_V - SENS(f)$$

Where $SENS(f)$ is the sensitivity from the calibration sheet at frequency f in units of $dB \text{ re } V/\mu Pa$