OCEAN SONICS

icListen Log File Formats

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Contents

Introduction

The icListen is capable of recording acoustic data in both the time domain (waveform data), and in the frequency domain (power spectrum data). Also, Ocean Sonics' Lucy software and HCI products are capable of logging both waveform and spectrum data that is scanned from icListen devices. This document details the formats in which this data is stored.

Overview of Log Files

This section gives a brief overview of the file types used by Ocean Sonics products for data storage. For more detailed information on each file type, please refer to the ***Detailed File Format Description*** sections.

File Formats

Currently Ocean Sonics products produce 3 different file formats. Waveform data is stored in standard WAV files, while power spectrum data is stored in a proprietary FFT file format (icListen LF only), or a tab separated values (TSV) format in a TXT file. Lucy can store data as standard WAV files, or as TSV format TXT files. Lucy is also capable of replaying all 3 data storage file formats.

Additional sensor data may also be retrieved from these file formats in some cases (See WAV, FFT and TXT file sections for more details).

File Storage Options

The following table outlines the file storage options for each Ocean Sonics product. For a more detailed look at what is stored by each model, refer to the ***Detailed File Storage Capabilities*** section.

File Format	icListen HF	icListen AF	icListen LF	Lucy	HCI
WAV	All	All	All	v2.1 and higher	All
FFT	None	None	All	None	None
TXT (spectrum)	All	All	None	All	All

File Naming

Files generated by Lucy, will have a user configurable prefix, with either a date or index added to them (as per the user configuration). Files generated by icListen or HCI devices follow specific naming conventions, which vary between models and firmware releases. See the following table for file naming conventions

icListen HF (R20 and newer)

Logging Folder:	/home/icListen/Data
WAV File Name:	SBW[serial#]_[date]_[time].wav or RBW[serial#]_[date]_[time].wav (for R-type series) (ex: SBW1234_20130731_093500.wav)
TXT File Name:	SBF[serial#]_[date]_[time].txt or RBF[serial#]_[date]_[time].txt (for R-type series) (ex: SBF1234_20130731_101202.txt)

icListen HF (R19 and older)

Logging Folder:	/home/icListen/Data
WAV File Name:	SB_[date]T[time].wav (ex: SB_20130731T09-35-00.wav)
TXT File Name:	Fft_[date]T[time].txt (ex: Fft_20130731T10-12-02.txt)

icListen AF

Logging Folder:	/home/icListen/Data
WAV File Name:	SAW[serial#]_[date]_[time].wav (ex: SAW2501_20140112_093500.wav)
TXT File Name:	SAF[serial#]_[date]_[time].txt (ex: SAF2501_20140112_101202.txt)

icListen LF

Logging Folder:	/DATA/Y[year]/[month]/DAY[day]/HOUR[hour] (ex: /DATA/Y2013/AUG/DAY07/HOUR14)
WAV File Name:	M[minute]S[second].WAV (ex: M00S14.WAV)
TXT File Name:	M[minute]S[second].FFT (ex: M26S00.FFT)

HCI

Logging Folder:	/home/HCI/Data Sub-folders are created based on the attached drive, and the date (ex: /home/HCI/Data/Drive2.1_1/20170117)
WAV File Name:	HCW[serial#]_[date]_[time].wav (ex: HCW4200_20130731_093500.wav)
TXT File Name:	These files follow the naming scheme of the attached devices (spectrum data channels are not combined). (ex: SBF1234_20130731_101202.txt)

Detailed File Format Descriptions

This section describes the formats of all files used by Ocean Sonics products in detail. All icListen devices will produce waveform data in standard WAV files. icListen LF devices will produce spectrum data in a proprietary FFT file format, while icListen HF and icListen AF devices will store spectrum data in TXT format.

The HCI will store waveform data in standard WAV files, and spectrum data in the TXT format.

Lucy will store waveform data in standard WAV files, and spectrum data in the TXT format.

All files produced by icListen or Lucy may be opened for playback using Ocean Sonics' Lucy Software (which may also be used for command/control and data collection for icListen devices). WAV files may also be opened in any software capable of dealing with standard WAV files. TXT files may be opened by virtually any spreadsheet or text editing program.

WAV File Structure

WAV files use the standard RIFF file structure, which groups the contents of the file into separate chunks. Each chunk contains a header, which contains a 4-byte string indicating the ID/type of chunk, and 32bit unsigned number indicating the size of that chunk in bytes (excluding the 8 header bytes). All chunks must be word aligned (size must be a multiple of 16bits). All data fields in WAV files are in little endian format.

Chunk ID ("RIFF")	**4 Bytes**
Chunk Size	**4 Bytes**
Chunk Format ("WAVE")	**4 Bytes**
"LIST" Chunk (optional) **icListen uses the "INFO" format of the "LIST" chunk to store additional data.**	**Variable**
"fmt " Sub Chunk **Describes the format of the waveform data.**	**Variable**
"data" Sub Chunk **Contains waveform data**	**Variable**

Every WAV file will contain a RIFF chunk of type “WAVE“. This chunk will at minimum will contain 2 sub-chunks (the “fmt “ chunk, and “data” chunk). WAV files may contain additional chunks providing more information about the file. Files created by **Ocean Sonics** products also contain an “INFO” type “LIST” chunk, which contains an “ICMT” sub-chunk, and in some cases “IART”, “IPRD”, “ICRD”, “ISFT”, and “INAM” sub-chunks.

“fmt “ Sub Chunk

Chunk ID (“fmt ”)	**4 Bytes**
Chunk Size	**4 Bytes**
Compression Code	**2 Bytes**
Number of Channels	**2 Bytes**
Sample Rate	**4 Bytes**
Bytes Per Second	**4 Bytes**
Block Alignment	**2 Bytes**
Bits Per Sample	**2 Bytes**
# of Extra Format Bytes	**0/2 Bytes**
Extra Format Bytes	**Variable**

The “fmt “ sub chunk describes the format of the waveform data in the “data” sub chunk. The following table describes each field in this chunk.

Field	Description
Compression Code	The compression type used by the waveform data. All **Ocean Sonics** products use type 1 (PCM/Uncompressed)
Number of Channels	The number of channels represented in the “data” chunk.
Sample Rate	The sample rate of the waveform data in Hz
Bytes Per Second(BPS)	This is the number of bytes of data per second (# Channels x Sample Rate x Bytes Per Sample)
Block Alignment	This value is the number of bytes per sample multiplied by the number of channels
Bits Per Sample	The number of bits per data point.
# of Extra Format Bytes	This field specifies the number of Extra Format Bytes will follow. This field does not exist for PCM/Uncompressed WAV files, and therefore does not apply to **Ocean Sonics** products.
Extra Format Bytes	The number and meaning of these bytes varies depending on the compression used. These bytes do not exist for PCM/uncompressed WAV files, and therefore are not present in **Ocean Sonics** generated files.

The following table shows the settings for these bytes for each device that can store WAV files:

Model	Compression	Channels	Sample Rate	BPS	Alignment	Bits Per Sample
HF	1	1	Varies	Varies	3 or 2	24 or 16
AF	1	1	Varies	Varies	3 or 2	24 or 16
LF	1	1	Varies	Varies	3	24
HCI	1	Varies	Varies	Varies	3 or 2	24 or 16

“data” Sub Chunk

Chunk ID (“data”)	**4 Bytes**
Chunk Size	**4 Bytes**
Data	**Variable**

The data sub chunk contains the actual waveform data in the file, in the format described by the preceding “fmt “ sub chunk. If the data is 8-bits per data point, it is considered unsigned data. Otherwise the data is considered signed. If the data contains more than one channel, the data is interlaced (each sample contains data from each channel). See the figure below for a stereo data example.

Chunk ID (“data”)	**4 Bytes**
Chunk Size (12)	**4 Bytes**
Left Channel	**2 Bytes**
Right Channel	**2 Bytes**
Left Channel	**2 Bytes**
Right Channel	**2 Bytes**
Left Channel	**2 Bytes**
Right Channel	**2 Bytes**

"INFO" Chunk

Chunk ID ("LIST")	4 Bytes
Chunk Size	4 Bytes
Chunk Format ("INFO")	4 Bytes
Sub Chunk ID ("IART")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable
Sub Chunk ID ("IPRD")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable
Sub Chunk ID ("ICRD")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable
Sub Chunk ID ("ISFT")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable
Sub Chunk ID ("INAM")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable
Sub Chunk ID ("ICMT")	4 Bytes
Sub Chunk Size	4 Bytes
ASCII String	Variable

The "INFO" chunk is a standard RIFF chunk, which may be used to add additional information to a WAV file. **icListen/HCI** devices make use of the "IART", "IPRD", "ICRD", "ISFT", "INAM" and vsub chunks for this purpose.

Each sub chunk contains a NULL terminated ASCII string. Not all of these sub chunks will be recorded by every device type. For more detail on which strings are stored by each Ocean Sonics product, refer to the ***Detailed File Storage Capabilities*** section.

The contents of the chunks are as follows:

IART: This field is for the "Artist" responsible for the waveform data. For **icListen** devices this will indicate the device type and serial number (ie: "icListen HF #1234"). For **HCI** devices, this field contains a comma separated list of devices in the array, starting with the **HCI** creating the file (ie: "HCI #4200,icListen HF #1234,icListen HF #1235").

IPRD: This field is for the "Product" that the data was recorded for. For **icListen**, this field is used to indicate the model of instrument used (ie: "SBx-ETH R3" for **icListen HF** Ethernet hardware release 3). For HCI devices, this field contains a comma separated list of the models of devices in the array, starting with the **HCI** creating the file (ie: "HC-24V R1,SBx-ETH R3, SBx-ETH R3").

ICRD: This field is for the file "Creation Date". This field indicates both the date and time of the first sample in the file. The string is an ISO 8601 format string: "YYYY-MM-DDThh:mm:ss+tz (ie: "2015-02-26T14:30:00+00" for February 26, 2015 at 14:30:00 UTC).

YYYY = 4 digit year
MM = 2 digit month
DD = 2 digit day
hh = 2 digit hour (24 hour format)
mm = 2 digit minute
ss = 2 digit second
tz = timezone offset (+00 = UTC, -04:30 = UTC – 4:30, etc)

ISFT: This field is the "Software" which recorded the data. For **icListen/HCI** devices this will indicate the device type and firmware release (ie: "icListen AF R23", "HCI R0.19" or "Lucy v4.x.x").

INAM: This is the name/title of the subject of the file. In **icListen**, this field is used to store the original file name, which has the date, time, and serial number encoded within it (ie: "SBW1234_20130822_121314").

ICMT: This field is used for additional comments related to the recording. For **icListen**, this is a list of comma separated fields. For the **HCI**, this is made up of semicolon separated fields, each of which is of the form tag=value, or tag=list (the list is a comma separated list of values, one for the HCI and one for each attached hydrophone, with no entry for fields when data is not available). Fields used by **icListen/HCI** are shown in the following table.

"ICMT" String Values used by icListen

Field	Example String
Peak Voltage	"3.000000 V pk"
Hydrophone Sensitivity	"-169 dBV re 1uPa"
Humidity*	"22.7% RH"
Temperature*	"22.8 deg C"
Accelerometer Readings (X, Y, Z)+	"Acc(-995,10,-190)"
Magnetometer Readings (X, Y, Z)+	"Mag(302,214,-725)"
Count At Peak Voltage	"8388608 = Max Count"
Sequence Number of First Sample in File	"4000 = Seq #"

*This field may be padded with spaces depending on the magnitude of the value in the field

+Please see "Interpreting Accelerometer and Magnetometer Data" on page 25 for important information on interpreting this data correctly

The ICMT string that encodes the information in the table above would look like this:

"3.000000 V pk, -169 dBV re 1uPa, 22.7% RH, 22.8 deg C, Acc(-995,10,-190), Mag(302,214,-725),8388608 = Max Count, 4000 = Seq #"

"ICMT" String Values used by HCI

Field	Example String
Peak Voltage	"Vpk=3.000000"
Hydrophone Sensitivity	"V re 1uPa=,-169,-170"
Humidity	"%RH=,22,24"
Temperature	"deg C=,33,32"
Sequence Number of First Sample in File	"Seq #=5528064"

*This field may be padded with spaces depending on the magnitude of the value in the field

The ICMT string that encodes the information in the table above would look like this:

"Vpk=3.000000;V re 1uPa=,-169,-170;%RH=,22,24;deg C=,33,32,Seq #=5528064"

FFT File Structure

The FFT file format used by **icListen LF** devices is similar to that of WAV files.

The first 8 bytes of the FFT file contain a 4 bytes ASCII string ("FFT_"), used to indicate the file type, and an unsigned 32bit number indicating the length of the file in bytes(excluding the first 8 bytes). Following this, individual chunk headers are placed. Each chunk header contains a 32bit chunk ID indicating the chunk type, and a 32bit unsigned value indicating the number of bytes in that chunk (excluding the 8 header bytes).

The following table describes the different chunk types found in FFT files produced by **icListen** units:

FFT File Chunk Types

ID	Chunk Type	Description
0	FFT data	Frequency data, with formatting details
1	Temperature/Humidity Data	Temperature and humidity data

All data in the FFT file is little endian. All files produced by **icListen** units contain a Temperature/Humidity chunk followed by an FFT data chunk.

FFT File Structure Overview

File Type ("FFT_")	**4 Bytes**
File Size	**4 Bytes**
Temperature/Humidity Chunk	**12 Bytes**
FFT Data Chunk	**Variable**

FFT Data Chunk

Chunk ID (0)	4 Bytes
Chunk Size	4 Bytes
Sample Rate	4 Bytes
Gain	2 Bytes
FFT Averaging Type	2 bytes
Processing Parameters	Variable
Hydrophone Sensitivity	2 Bytes
Data Per FFT	2 Bytes
Bits Per Datum	2 Bytes
Number of Data Sets	2 Bytes
Data	Variable

This chunk contains the raw power spectrum data, as well as the information required to analyze this data. This table gives a description of each field:

FFT Data Chunk Field Descriptions

Sample Rate	Sample rate in Hz at which raw data was collected
Gain	Applied gain in dB
FFT Averaging Type	Type of FFT averaging performed (see options below)
Processing Parameters	Parameters vary based on FFT Type
Hydrophone Sensitivity	Sensitivity of the hydrophone in dB relative to 1µPa
Data Per FFT	Data points per FFT data set (ie: 1024pt FFT would yield 512 data points)
Bits Per Datum	Bits per data point
Number of Data Sets	Number of FFT data sets represented in the “Data” field
Data	Data in ½ dB units(ie: 20 counts = 10 dB) relative to 1µV

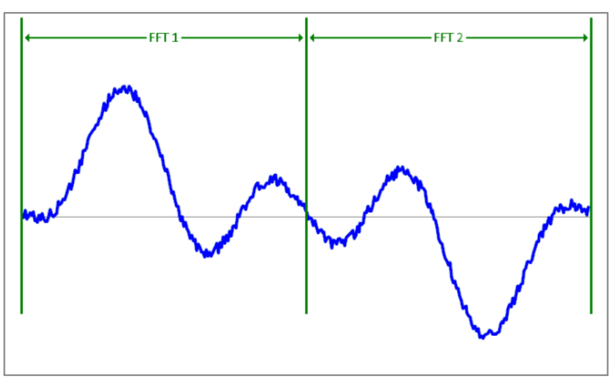
The following table shows the available FFT processing types. See the following sections for more detail. For details on what processing types are available to each **icListen** model, refer to the ***Detailed File Storage Capabilities*** section. All processing is performed on the data prior to conversion to dB.

FFT Processing Types

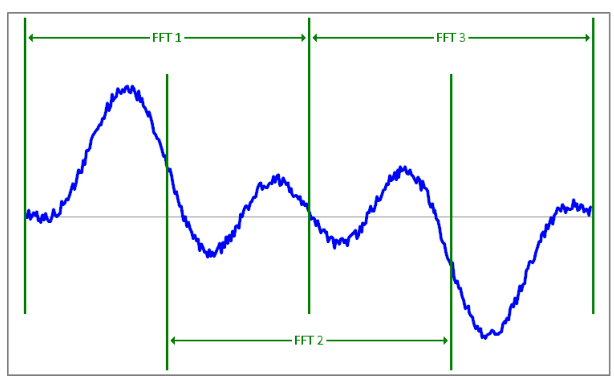
Type Code	Type of Processing
0	Mean Average
1	Overlap
2	Peak Value Detect
3	Exponential Moving Average (IIR Filter)
4	Mean Average with Overlap
5	Peak Value Detect with Overlap
6	Exponential Moving Average with Overlap

Overlap

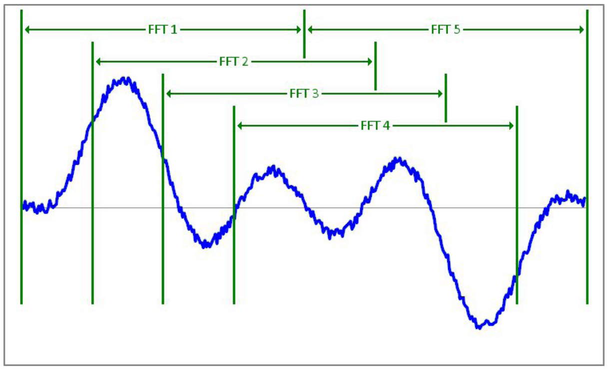
Overlap processing is when there is an overlap in the waveform data used to calculate FFTs. The following figures illustrate how data is shared between FFT calculations based on the percent overlap.



FFT's with 0% Overlap



FFT's with 50% Overlap



FFT's with 75% Overlap

This processing type contains two parameters, which are used to calculate the overlap as follows:

$$\%\ Overlap = \left(1 - \frac{Parameter\ 1}{Parameter\ 2}\right) \times 100\%$$

Each data set in overlapped FFT data represents a single FFT calculation converted to power spectrum data in dB.

Mean Average

For mean averaged FFT data, the stored data is FFT data that has been averaged over 'N' FFTs. There are two unsigned 16bit type parameters for this FFT type. The first is the 'N' value used in the mean calculation, and the second indicates the overlap (in FFT data sets) of data used between this mean calculation and the previous mean calculation.

The mean value for each frequency bin is calculated as follows:

$$Y_i{}^2 = \frac{1}{N}\sum_{j=0}^{N-1}\left|C_{i,j}\right|^2$$

Where:

N = Averaging Period

Y_i^2 = Signal Power of frequency bin

$C_{i,j}$ = FFT Coefficient

i = Frequency Bin Number

j = FFT Data Set Number

Peak Value Detect

When the FFT type is peak value, the stored data contains the maximum value found for each frequency bin over 'N' FFT data sets. This type also has two 16bit unsigned parameters. The first is 'N', which represents the number of FFT data sets the peak was found over. The second parameter represents the overlap in FFT data sets used to find the peak values.

Exponential Moving Average (IIR Filter)

When this processing type is used, the stored data represents the exponential moving average of all preceding FFTs performed. Two unsigned 16bit type parameters are included with this type. The first is the weighting factor (N) used in the calculation. The second value represents number of FFT's calculated between reported FFT data sets.

The exponential moving average is calculated for each frequency bin using the formula:

$$Y_{i,j}{}^2 = \frac{(N-1) \times Y_{i,j-1}{}^2 + \left|C_{i,j}\right|^2}{N}$$

Where:

N = Weighting Factor

$Y_{i,j}^2$ = Signal Power of frequency bin

$C_{i,j}$ = FFT Coefficient

i = Frequency Bin Number

j = FFT Data Set Number

Mean Average with Overlap

This processing type performs a mean average on FFT data calculated with an overlap. There are 4 parameters with this processing type. The first 2 parameters are the same as those used by the Mean Average processing type. The second 2 parameters are the same as those used by the Overlap processing type.

Peak Value with Overlap Detect

This processing type calculates FFT data using an overlap, and then retains the maximum value detected for each frequency bin over 'N' FFT data sets. There are 4 parameters with this processing type. The first 2 parameters are the same as those used by the Peak Value Detect processing type. The second 2 parameters are the same as those used by the Overlap processing type.

Exponential Moving Average with Overlap

This processing type performs an exponential moving average of FFT data calculated with an overlap. There are 4 parameters with this processing type. The first 2 parameters are the same as those used by the Exponential Moving Average processing type. The second 2 parameters are the same as those used by the Overlap processing type.

Temperature/Humidity Chunk

Chunk ID (1)	**4 Bytes**
Chunk Size (4)	**4 Bytes**
Temperature	**2 Bytes**
Humidity	**2 Bytes**

This chunk contains two values, the first represents the temperature, and the second represents humidity at the time of logging. Temperature is a signed 16bit value measured in tenths of degrees Celsius. Humidity is an unsigned 16bit value measured in tenths of percent of relative humidity.

TXT File Structure

TXT files contain ASCII variables separated by tabs. These files may be read by virtually any text editor or spreadsheet program. When interpreted as tabular/spreadsheet data, tabs are equivalent to column divisions, and newline characters are row divisions.

All TXT files generated by **Ocean Sonics** products contain several rows of header information at the start of the file, followed by rows of power spectrum data. This file type is created by **icListen AF**, **icListen HF**, **HCI**'s and **Lucy**.

The contents of the header rows, and data contained within each data row will vary with the version of TXT file logged. The current version of TXT logs produced by **cListen**, the **HCI**, and **Lucy** is version 5 (as of **Lucy** version 3.6, and **icListen HF** release 20). Files recorded using the older format may still be replayed using newer versions of **Lucy**.

Current TXT File Format (version 5)

Each row in the TXT log contains one of 5 things: empty lines, section headers, a single tag/ value pair, column headings, or log data.

Empty lines are used to separate sections within the file header. They are inserted to make visual inspection of the file easier, but can be deleted without loss of information in the file. Section headers are always a single column, ending in a colon. Tag/value pairs will contain the tag name in the first column, and the value in the second column. Each TXT log contains only one row with column headings, which is always the first row following the header for the data section. Log data contains several columns of data, corresponding to the headings in the column headings row.

TXT logs are broken up into 5 sections:

- File Details
- HCI Details
- Device Details
- Setup
- Data

TXT Log File Details Section

This section is used to store information on the file's creation time and purpose and always begins with a section header row ("File Details:"). Each following row will contain a tag/value pair. The number of rows in this section will vary depending on if the file was created by **icListen**, **HCI** or **Lucy**, and which optional fields were used in **Lucy**. The following tags may be written in this section:

TXT Log File Details Tags

Tag	Description of Value	Example
File Type	The type of data stored in this file.	Spectrum
File Version	The version of file this is. This field can assist in what data columns should be expected.	5
Start Date	Date at which this file started writing (yyyy-mm-dd)	2013-08-03
Start Time	Time at which this file started writing (hh:mm:ss)	15:16:17
Time Zone	Time zone that all times in the file are recorded in	UTC +4
Author	The creator of this file (icListen HF/AF #X or Lucy vX.X.X)	icListen HF #1234
Computer	The name of the computer the file was recorded on.	Alan-desktop
User	The name of the user on the computer the file was recorded on.	Alan
Client	The client that the recording was done for. (optional)	Company A
Job	The job ID that the recording was done for. (optional)	August 3 Test
Personnel	Personnel performing the operations. (optional)	John Smith
Starting Sample	This is the sample sequence number of the first sample used for FFT calculations.	30720000

TXT Log HCI Details Section

This section is used to hold information related to the **HCI** device used to gather data and always begins with a section header row ("HCI Details:"), and is only present in files created by an **HCI**. Each following row contains a tag/value pair. The following tags may be written in this section:

TXT Log Device Details Tags

Tag	Description of Value	Example
Device	This is the name of the device used	HCI
Model	This is the model code for the device.	HC-24V
S/N	This is the serial number of the device used	4200
FW Release	This is the release package that this firmware was part of.	0.19
Firmware	This is the version of the firmware on the HCI that generated the data.	v1.0.19
HW Release	This is the hardware release of the HCI that generated the data.	3

TXT Log Device Details Section

This section is used to hold information related to the **icListen** device used to gather data and always begins with a section header row ("Device Details:"). Each following row will contain a tag/value pair. The following tags may be written in this section:

TXT Log Device Details Tags

Tag	Description of Value	Example
Device	This is the name of the device used	icListen HF
Model	This is the model code for the device.	RB9-SER
S/N	This is the serial number of the device used	1234
FW Release	This is the release package that this icListen firmware was part of. This field may not be available in files generated by Lucy.	20

Firmware	This is the version of the firmware on the icListen that generated the data.	v1.8.00
HW Release	This is the hardware release of the icListen that generated the data.	3

TXT Log Setup Section

This section is used to hold the data collection settings that were used when recording and always begins with a section header row ("Setup:"). Each following row will contain a tag/value pair. The following tags may be written in this section:

TXT Log Setup Tags

Tag	Description of Value	Example
dB Ref re 1V	This is the offset in dB that must be added to the data to move its reference to dB re 1 Volt.	-120
dB Ref re 1uPa	This is the offset in dB that must be added to the data to move its reference to dB re 1 micro Pascal.	49
Sample Rate [S/s]	This is the sample rate that the data was collected at in samples per second	32000
FFT Size	This is the number of data points used for each N-point FFT calculation.	1024
Bin Width [Hz]	This is the frequency spanned by each bin of data in Hz.	31.25
Window Function	This is the window function used on the data prior to the FFT calculation.	Hann
Overlap [%]	The percent overlap of data used for FFT calculations.	50
Power Calculation	This is the method used to calculate spectrum power data. Averaging options are Mean, Peak, and Moving Average. All averaging is performed on the linear power values.	Mean
Accumulations	This is the number of FFT results that are averaged together to form the final spectral results.	32
Weighting	This field is only recorded when averaging is set to "Moving Average". This is the weighting given to new samples in the IIR average.	11
Accel(x,y,z)+	Readings from built-in accelerometer	45 0 180
Magnetom(x,y,z)+	Readings from built-in magnetometer	70 -96 -15

+Please see "Interpreting Accelerometer and Magnetometer Data" on page 25 for important information on interpreting this data correctly

TXT Log Data Section

This section contains the actual logged data values and always begins with a section header row ("Data:"), followed by a row of column headings. All following rows contain the data described by the column heading row. The following table shows the column headings used, and example data for each:

TXT Log Data Column Headings

Column Heading	Description of Value	Example
Time	This is the time that this row of data started being calculated at in the form hh:mm:ss.	12:16:04
Comment	This field contains an ASCII string containing comments about the data. This field may be left empty	Start of test
Temperature [C]	This is the internal temperature of the instrument in degrees Celsius.	10.5
Humidity [%]	This is the internal relative humidity of the instrument in percent.	26.3
Sequence	This is the sequence number of the spectrum data.	240
Data Points	The number of bins of frequency data to follow	410
Bin Frequency	This is the frequency at the center of the data bin in Hz. There is one Bin Frequency heading for each spectral data point returned.	62.5

All spectrum data logged in the file is in dB units. The offsets required for converting the reference of the values to dB relative to 1V or 1 µPa can be found within the Setup section of the header.

Example column heading and row of data (only the first 4 of 410 data points shown):

```
Time     Comment  Temperature [C]  Humidity [%]     Sequence Data Points      0        31.25    62.5     125
12:16:04 Test     10.5     26.3     240      410      50       54       55       58
```

Old TXT File Format (v1 – v4)

For file formats 1 through 4, there were 9 rows of header information before the logged data rows. Versions 1 and 2 also contained an empty line following the column headers. Files using these older formats are no longer produced by the most recent releases of **Lucy** or **icListen**, but can still be replayed using **Lucy**. The following table shows the information contained in each row.

Old TXT Log File Header Rows

Row	**Description**
1	Software/firmware responsible for creating the file.
2	File version and type.
3	File name.
4	Computer/user information.
5	Date/Time of file creation.
6	Client, Job ID, and Personnel.
7	Device type, serial number, and firmware version for the icListen used to gather the data.
8	Setup information related to the data collection process (sample rate, data reference, hydrophone sensitivity, and FFT playback rate)
9	Column headers for the logged data.
10	Empty row (version 1 and 2 files only)

Here is an example header for an FFT log:

FFT file header section:

```
icListenHF        v1.2.00

File Version: 4   File Type: FFT

This file name:   /home/icListen/Data/Fft_20120307T02-05-44.txt

Computer Id:      icListenHF        User Id:           "1205"

Data Log File Created: 2012-03-28 2:05:44

CLIENT   icListenHF         ID      icListenHF         PERSONNEL       icListenHF

icListenHF

Sample Rate: 512000       Data Reference: -120dBV   Phone Sensitivity (dBV re 1uPa): -169      FFT Rate: 125.0

Time     Comment  Guest    Temperature      Humidity Gain     Sequence FFT..
```

The following table shows example fields contained in a row of data after the header:

Example TXT data row contents

	Time	Comment	Guest	Temperature	Humidity	Gain	Sequence	Data
Example	hh:mm:ss	"Test"	5.50	22.0	27.3	12dB	1002	98 89…

The units of data for TXT logs created by Lucy are whole dB relative to the reference level specified in the header. Data in icListen HF log files (prior to release 20), is in half dB counts (a value of 20 is equal to 10dB relative to the reference provided in the header).

Interpreting Accelerometer and Magnetometer Data

As icListen hydrophones have improved their design over time, different sensor models with different internal orientations have been employed. As a result, the data reported by various hardware versions must be interpreted slightly differently in order to calculate orientation and heading correctly. The following shows how sensor readings should be interpreted for hardware versions 4, 7, and 8. No other hardware revisions support these sensors.

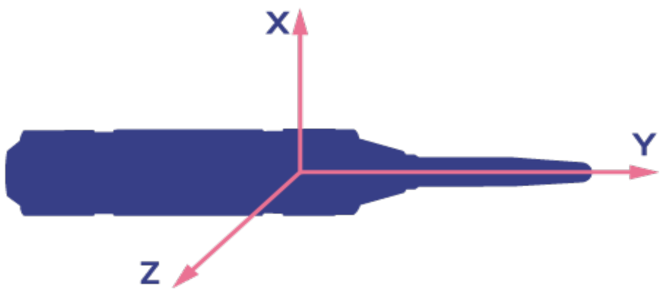
In the following tables please note that:

- +1g/-1g represents that the accelerometer sensor axis is pointing up/down according to each stationary position
- +Mxyz/-Mxyz represents the magnetometer sensor is responsive to the vertical component from earth's magnetic field when aligned with the corresponding axis

Each table is accompanied by a graphic showing the relationship between sensor readings and hydrophone orientation.

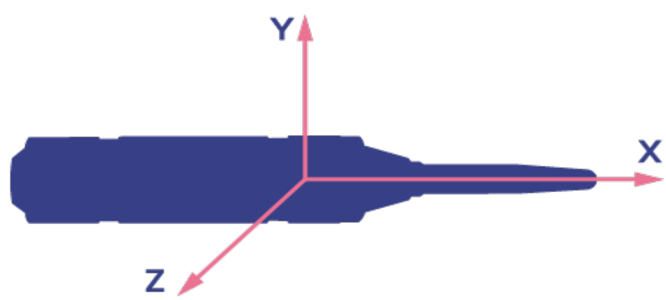
Hardware Version 4

Stationary position	Accelerometer			Magnetometer		
	X	Y	Z	X	Y	Z
Z down	0	0	-1g	+/-	+/-	-Mz
Z up	0	0	+1g	+/-	+/-	+Mz
Y down	0	+1g	0	+/-	-My	+/-
Y up	0	-1g	0	+/-	+My	+/-
X down	-1g	0	0	-Mx	+/-	+/-
X up	+1g	0	0	+Mx	+/-	+/-



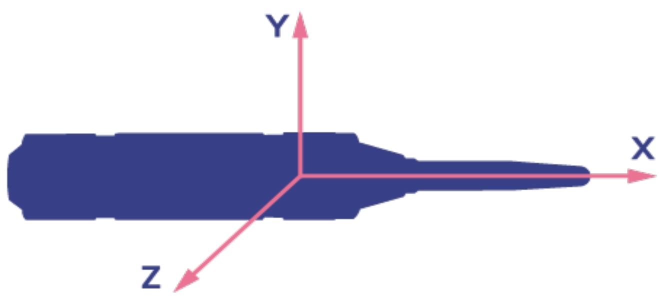
Hardware Version 7

Stationary position	Accelerometer			Magnetometer		
	X	Y	Z	X	Y	Z
Z down	0	0	-1g	+/-	+/-	-Mz
Z up	0	0	+1g	+/-	+/-	+Mz
Y down	0	-1g	0	+/-	-My	+/-
Y up	0	+1g	0	+/-	+My	+/-
X down	-1g	0	0	+Mx	+/-	+/-
X up	+1g	0	0	-Mx	+/-	+/-



Hardware Version 8

Stationary position	Accelerometer			Magnetometer		
	X	Y	Z	X	Y	Z
Z down	0	0	-1g	+/-	+/-	+Mz
Z up	0	0	+1g	+/-	+/-	-Mz
Y down	0	-1g	0	+/-	+My	+/-
Y up	0	+1g	0	+/-	-My	+/-
X down	+1g	0	0	-Mx	+/-	+/-
X up	-1g	0	0	+Mx	+/-	+/-



Scaling Data

All files produced by **icListen** contain the necessary information required for scaling the raw data into either voltage or pressure units.

Scaling Waveform Data

For waveform data, the required pieces of information are the maximum count, the peak voltage, and the hydrophone sensitivity. These fields are found within the ICMT field of the INFO chunk (see the "WAV File Structure" section for information on retrieving these values. The maximum count may also be calculated based on the bit depth of the data (24bit data will have a max count of 2^{23}, 16bit data will have a max count of 2^{15}, etc). All raw count values in the waveform data are signed.

Please be aware that some 3rd party software may scale values from integer counts to +/- 1. Should this be the case, the 'Max Count' value will be 1.

Waveform data can be scaled to volts using the following formula:

$$Volts = Count\,\frac{Peak\,Voltage}{Max\,Count}$$

After the waveform data has been converted from raw counts to volts, we can use these values to calculate the RMS voltage. The RMS voltage can then be converted to dB and then the hydrophone sensitivity (which is given in dB volts relative to µPa) subtracted in order to give the dB relative to µPa.

$$V_{RMS} = \sqrt{\frac{1}{n}\left(\sum_{i=0}^{n} Volts_i^2\right)}$$

$$dB\ re\ 1\ \mu\text{Pa} = 20 \times \log(V_{RMS}) - Hydrophone\ Sensitivity$$

Scaling Spectrum Data

There are a few different formats used by different models and versions of **Ocean Sonics** products, which must be scaled by slightly different means.

Scaling Current TXT File Data (icListen AF/HF and Lucy)

Values in the current TXT file format (v5) are stored in whole dB. Two offsets are supplied in the file header which can be used to scale data either to dB relative to Volts or dB relative to µPa. These are the “dB Ref re 1V” and “dB Ref re 1uPa” values described in the “Current TXT File Format” section.

To convert to the desired unit, simply add the appropriate reference offset to the data:

dB re 1 µPA=Count+dB Ref re 1uPa

dB re 1 v=Count+dB Ref re 1V

Scaling Older TXT File Data (icListen HF R19 and below, Lucy v3.5 and below)

In older versions of **icListen HF** and **Lucy**, the TXT file formats required different scaling (no **icListen AF** version was released using the older formats). To scale this data, the gain and hydrophone sensitivity must be known. See the “Old TXT File Format” to see how to retrieve these values.

The data points stored by **icListen** for this file format were in ½ dB counts (ie: 20 counts = 10dB) relative to the reference provided in the header. In **Lucy** these data points were stored in full dB relative to the reference provided in the header.

Data is scaled for **icListen** files to dB relative to µPA or V using the following formulas:

dB re 1 µPA=(Count/2)-Gain-Hydrophone Sensitivity-Reference

dB re 1 V=(Count/2)-Gain- Reference

Data is scaled for **Lucy** files to dB relative to µPA or V using the following formulas:

dB re 1 µPA=Count-Gain-Hydrophone Sensitivity-Reference

dB re 1 V=Count-Gain-Reference

Scaling FFT File Data (icListen LF)

This format is used **by icListen LF.** To scale the data stored in this format, the gain applied to the data as well as the hydrophone sensitivity must be known. See the "FFT File Structure" section for details on how to retrieve these values. All raw values within the file are stored as ½ dB counts (ie: 20 counts = 10dB) relative to 1 µV.

Data is scaled to dB relative to µPA using the following formula:

dB re 1 µPA=(Count/2)-Gain-Hydrophone Sensitivity - 120

Data is scaled to dB relative to Volts using the following formula:

dB re 1 V=(Count/2)-Gain- 120

Detailed File Storage Capabilities

Some comments in the WAV header, and certain types of FFT data, may not be stored by all **Ocean Sonics** products. The following table outlines in detail, what is stored in each field, by each **Ocean Sonics** product

File Type	Field	icListen			Lucy	HCI
		HF	AF	LF		
WAV	ICMT: Peak Voltage	All	All	All	v2.1 and up	All
	ICMT: Phone Sensitivity	All	All	All	v2.1 and up	All
	ICMT: Humidity	All	All	All	v3.0 and up	All
	ICMT: Temperature	All	All	All	v3.0 and up	All
	ICMT: Count at Peak Voltage	All	All	None	v3.0 and up	None
	ICMT: Sequence # of First Sample	R20 and up	All	None	None	All
	IART	R20 and up	All	None	v4.2 and up	All
	IPRD	R20 and up	All	None	v4.2 and up	All
	ICRD	R30 and up	R30 and up	None	v4.2 and up	All
	ISFT	R20 and up	All	None	v4.2 and up	All
	INAM	R20 and up	All	None	v4.2 and up	None
FFT	Mean Average	N/A	N/A	All	N/A	N/A
	Window Overlap			All		
	Peak Value Detect			All		
	Exponential Moving Average			All		
	Overlap + Mean Average			All		
	Overlap + Peak Value Detect			All		
	Overlap + Exponential Moving Average			All		
TXT	v5	R20 and up	All	N/A	v3.6 and up	All
	v4	R1 to R19	None		None	None
	v2	None	None		v2.0 to v3.5	None