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1 Using the Lucy™ Software

The software used to talk to the icListen family of instruments is called Lucy. It is a PC program that presents data to the operator in a graphical and numerical format.

The interaction of the software has been designed for field operations personnel, making it highly task focused.

This document outlines the operation of the Lucy 4.1 software.
2  Getting started
This section describes how to start the program and connect to an icListen unit.

2.1  Starting the Program
If the software is not yet installed, run the Lucy installer provided with your icListen.

Start-up of Lucy, as with other Windows applications, can be done from the Windows Start menu, or a shortcut can be created to start directly from the desktop. It can be found on the start menu under:
   Start-&gt;All Programs-&gt;Ocean Sonics-&gt;Lucy.

It is important to note that Lucy remembers the state of the program as it is being used. This means that if the program must be stopped for some reason, settings and options are remembered. This saves the operator from the worry of having to reconfigure those settings each time the program is started.

One or two settings are not remembered, by design, at startup to prevent possible confusion. Currently the ambient noise filter is turned off at startup, regardless of its previous status.

2.2  Using Lucy
Lucy can be used in both online and offline mode.

The main mode is online mode, which includes a connection to an icListen instrument. In this mode all options applicable to the connected instrument are available, including: collecting, logging and triggering from live data in real time. For instructions on how to connect to an icListen see the Link Setup section.

Offline mode is used to replay previously logged files, logged either by Lucy or by an icListen unit. All data viewing options are available while replaying files. Epoch triggering is also available on replayed data. For more details on offline operation, see the File Replay – Offline Operation section.
3 Main Display
The main display contains two charts, and the controls needed during offline/online operation. This is the screen that appears at program start-up. This section details the display options and their controls.

Figure 3-1: Lucy Main Display
3.1 Charts
The display contains up to two charts. There are dropdown menus to the right of each chart position, to select which charts are visible. There are multiple chart options in Lucy. The upper chart can be set to Wave, Single FFT, Click Detector, or RMS/pk-pk and the lower chart displays FFT spectrogram data. If either of the charts is set to off, the other chart will fill the display. All charts are updated at the refresh rate specified in the Lucy Setup panel.

3.1.1 Waveform Chart

The waveform chart shows recent waveform data in volts. The waveform corresponds to the sound pressure sensed at the hydrophone, at the sample rate shown in the upper left corner. The time scale of the chart is also shown in the upper left corner in milliseconds per division. This chart is made up of 10 divisions.

The Waveform chart options are seen in the figure below. The Scan box enables the collection of waveform data from the icListen.

There are two options for the y-axis size

- Auto Scale
- Manually Scale

The advantage of auto scale is that the displayed data is never clipped. However this can make interpreting the data difficult, since the scale may change every time the display is refreshed.

Manually Scaling makes the y-axis scale constant, allowing for better comparative readings.
The AC field displays the average AC voltage component of the measured signal, in RMS Volts.

**Advanced:** The DC field must be enabled on the **Lucy** Setup panel in advanced mode. This displays the DC offset (in volts) which has been removed from the displayed data.

This chart will display the fading history of the previous waveform data results. The most recent data is plotted in green, and as the data ages it fades to dark blue before disappearing.

### 3.1.2 Single FFT Chart

The Single FFT chart displays the most recently received FFT data. This data corresponds to the most recent data on the **Spectrum Chart**.

The x-axis of this chart is the frequency range, which varies based on the sample rate selected. Frequency may also be plotted on a logarithmic scale, by using the log scale option to the right of the spectrum chart.

The y-axis of the chart is the amplitude. This is scaled using the reference scaling options in the lower left of the display. These scaling options are detailed in the **Spectrum Reference** section. There is also an auto-scale option selectable on the right of the chart.

Like the Waveform chart, this chart will display the fading history of the previous FFT results. New data is plotted in green, and it fades to dark blue before disappearing.

The Single FFT chart will also display thresholds for epoch triggers if configured in **Lucy** as shown below. For more information on epoch triggers, see **Epoch Triggering**.
3.1.3 Click Detector Chart

The click detector chart shows the result of the Spectrum (FFT) data normalized and compared with the click model loaded into Lucy. The higher the resulting value, the closer the data is to the model. A small or negative result means the data is very different from the model. The x-axis of the chart is time, and is aligned with the Spectrum chart below. The new data points correspond with the comparison of the new spectrum data, seen on the spectrum chart. See Click Detector for more details.

3.1.4 RMS/pk-pk Chart

The RMS/pk-pk chart shows the RMS and Peak to Peak (pk-pk) amplitude of the waveform data. The data is displayed in dB relative to the spectrum reference as detailed in the Spectrum Reference section. The x-axis is time and is aligned with the spectrum chart. The most recent values of the RMS and pk-pk data are found to the right of the chart. An example of this display is shown below.
3.1.5 Spectrum Chart

The Spectrum chart is a waterfall display of the power spectrum data returned by icListen. This is a 3D chart showing time on the x-axis, frequency on the y-axis, and intensity of the signal on the z-axis.
3.2 View the Spectrum Chart
This section describes how to optimize the Spectrum Chart display settings.

3.2.1 Size
The x-axis (time axis) of the spectrum chart is controlled by the Size fields, to the bottom right of the chart. There are 2 settings for the size: the resolution of the axis (Minutes, Hours, or Days), and the amount of data shown at the selected resolution. Data is averaged to allow the longer durations to be displayed.

![Figure 3-10: Spectrum Size Options](image)

The maximum size for this value varies depending on the FFT averaging settings and the sample rate, to a maximum of 1 week (7 days) of data.

3.2.2 Spectrum Reference
The Spectrum chart lets the operator make detailed measurements from the display. The chart can display spectral data in V or µPa, and as spectral density data in V²/Hz and µPa²/Hz, as required.

The baseline reference can be adjusted to avoid cluttering the display with data below the noise floor. The arrows adjust by the colour step size, and specific values may be typed in.

![Figure 3-11: Spectrum Reference Options](image)

The transition from one colour to the next is assigned a value, according to the coloured numbers in the lower left. The range can be changed by clicking the up or down arrows to give the best display of events in the chart.

Note that once selected, the arrow keys on the PC keyboard can be used to “animate” the chart and help identify subtle events.

When viewing large time spans of data, the display will be averaged. The peak (maximum) values will be displayed when the Pk (Peak) checkbox is checked, and the mean averaged values will be displayed if it is not checked. The full display may be toggled at any time without data loss.

3.2.3 Ambient Noise Cancellation
A powerful operational tool comes with Lucy that allows the operator to model the ambient noise environment, and then remove that noise while looking for a specific signal.

When enabled, the current ambient noise model is used to remove unwanted signal. The noise model is stored, allowing it to be used over extended periods.
To create a new ambient noise model, click the **Start Cal** button, and watch the elapsed time display. When at least 30 seconds of time has passed, click the **Stop Cal** button.

This new noise model is stored, and used for noise cancellation. This calibration is remembered and reloaded when **Lucy** is started, which allows the same model to be used through multiple jobs if desired.

### 3.2.4 Spectrum Control Box

To the right of the Spectrum Chart is the control box that controls some of the chart’s settings. This is shown in the following figure.

Checking the **Scan** box enables collection of the Spectrum data for **icListen LF**.

The frequency axis can be displayed logarithmically by checking the **Log Scale** box. This provides greater resolution at low frequencies.

The **Signal Power** is calculated by combining the spectral data for each sample over the full spectrum. This represents the total power over any sample.
3.3 General Controls
This section describes the general controls of Lucy.

3.3.1 Scanning Controls
The data collection process begins when the Start button is clicked. Note that whenever scanning starts, the charts are cleared.

When scanning is inactive, the Start button is visible, and the Pause and Stop buttons are hidden. When scanning is active, the Stop and Pause buttons are visible, and the start button is hidden.

![Figure 3-15: Scanning Inactive](image1)

When scanning is paused and resumed, a black section is added to the display equal to the duration of the pause, and the chart is continued at the appropriate point in the chart.

The Reset Charts button is used to clear the displays.

3.3.2 Unit Status Controls
The Unit Status shows the status of icListen, and any link issues that occur when active.

When testing icListen, clicking the Enquire button returns the status of the link and the instrument. This is the most direct way of testing the instrument.

All units report the Temperature and Humidity in the status field. icListen AF/HF (hardware rev. 2 and newer) also report the battery charge, and charging state (a lightning bolt through the battery indicates that the battery is charging).

![Figure 3-17: Enquire Response Example](image2)
3.3.3 Screenshot Controls
To the right of the unit status controls is the screenshot area, shown in the figure below.

![Screenshot Controls](image)

Figure 3-18: Screenshot Controls

The screenshot controls have two parts. The folder button (left) selects the folder for the screenshots to be placed, and the camera button (right) takes the screenshot.

The name of the screenshot file is Screenshot_YYMMDD_hhmmss.png, where:

- YY = Year
- MM = Month
- DD = Day
- hh = Hour
- mm = Minute
- ss = Second

The camera icon will appear green when data is being collected and auto screenshots are enabled. See Auto Screenshots for more details.

3.3.4 Audio Playback
This section describes the audio playback function of Lucy.

Lucy has the ability to play the audio contained in live waveform data, as well as replayed WAV files. Audio playback can be enabled by clicking the Audio Enabled check box. Audio playback in Lucy is always 16 bit, regardless of the original waveform data resolution.

The volume of the audio playback is controlled by the Spectrum Reference controls. The red value in the FFT display corresponds to the maximum audio amplitude which can be played back. To maintain accurate audio playback, the FFT display should be adjusted so that all displayed spectrum data is below the red level. The speaker volume in Windows will also affect the playback volume.
3.3.5 Other Displays
This section describes the remaining items on the main panel.

![Figure 3-19: Current Details]

In the top right corner there is a Current Details box (shown in the figure above), which displays the current date, time and the connected unit’s serial number.

![Figure 3-20: Job Details]

Along the top of the main display there are the job details *(Client, Job ID and Personnel)*, which are shown in the figure above. These are filled in on the Lucy Setup tab (see Lucy Setup).

![Figure 3-21: Logging Comment and File]

Below the lower right corner of the spectrum chart, are the Logging Comment and the Log Data File fields. The logging comment is entered by the user, and is written into the Lucy TXT log files. The log data file displays the current file being logged or replayed by Lucy.
4 Setup

At the beginning of each project or job, the setup of the program and instrument should be checked and changed as required. The setup buttons are found in the lower right corner of the display. This is shown in the following figure.

![Setup Options](image)

**Figure 4-1: Setup Options**

The setup panel is divided into tabs for individual configuration types. Only configurations tabs applicable to the connected unit are displayed.

**Advanced Settings:** Many setup tabs also contain some settings for advanced users. These options can be revealed by selecting **Advanced** mode, in the lower left corner of the setup panel. All advanced settings will be indicated as such throughout this section.

This section covers:

- Link Setup
- Lucy Setup
- icListen LF Setup
- icListen AF/HF Setup

For Epoch event setup see the *Epoch Triggering chapter*. 
4.1 Lucy Setup

The Lucy setup panel is split into 3 tabs. These tabs are Lucy Logging, Lucy Setup, and Epoch Setup.

4.1.1 Lucy Logging

![Figure 4-2: Lucy Logging Tab](image)

The Lucy Logging tab is responsible for the configuration of logging and details which are entered in logs, within Lucy.

The job details consist of the Client Name, Job ID, and Personnel. These values, once accepted, update the values along the top of the main display. These are useful for keeping track of the details of a job, as they appear in both the screenshots and Lucy txt log files.

The Logging options relate to Lucy logging only. For instrument logging options see icListen LF Setup or icListen AF/HF Setup.

Lucy can perform three types of logging simultaneously:

- Spectrum Data (FFT)
- Waveform Data (Time Series)
- Epoch Message Data for icListen and Lucy

The FFT logging stores data as a human readable TXT log format, which can be imported into a spreadsheet. These files also include temperature, and humidity data.

Waveform data is logged as standard WAV audio files. These files are playable in any standard audio player, such as Audacity.
Epoch message data is logged as human readable TXT logs, which can be imported into a spreadsheet. There are two types of epoch message logs which can be configured on the Lucy setup panel. These are the icListen epoch stream log and the Lucy epoch message log. The icListen epoch stream consists of the epoch messages that arrive from a connected icListen AF/HF. The Lucy epoch message log consists of the epoch messages and active time messages from the Lucy configured epoch triggers.

4.1.2 Lucy Setup

![Lucy Setup Tab](image)

The Lucy setup tab is used for setting up the click detector, screenshots, charts and also session storing.

Click Detector: The **Select Click Detector File** button is used to load a click model file. When a click file is loaded, the file name is shown beside the select button, as seen with “Click.txt” in the screenshot above. For more details on the use of this file see **Click Detector**.

Chart & Data: The refresh rate option allows users to reduce the CPU resources used, by reducing the number of display updates performed by Lucy. Reducing the refresh rate does not cause any data to be lost or discarded.

Lucy allows the user to save their current session, which includes the display and connection settings. Sessions may be saved and loaded using the **Save** and **Load** buttons in the **Session Files** area. This allows the user to store different Lucy configurations for different test environments or jobs.

Screenshots: The screenshot options allow users to set the path of the Lucy screenshots, and configure auto screenshots. If auto screenshots are enabled, screenshots will be taken of the main display at the configured rate (set in minutes).
**Advanced**: The scan rate option adjusts the rate at which Lucy requests data from an icListen. Lucy typically sets this to an optimal rate for the current instrument configuration. This option overrides the calculated rate. It is important to note that if the scan rate is set lower than the incoming data rate, then data will be lost.

**Advanced**: The option to show the DC voltage, when checked, enables the DC offset display for Time Trace data on the main Lucy display.

### 4.1.3 Lucy Epoch Setup

Lucy epoch triggers are configured from the Epoch setup tab. Epoch trigger files may also be loaded or saved. For more details on configuring epoch triggers see *Epoch Triggering*. 
4.2 icListen Setup

The icListen Setup panel is split into 4 tabs. The available tabs vary depending on the type of hydrophone connected. The Link Setup tab is always available and is used to connect to a hydrophone. The icListen Setup tab changes based on the connected unit. The Epoch Setup tab is available for all units which support epoch triggering. The Special Features tab is available for icListen AF/HF units which support these features.

4.2.1 Link Setup

To connect to an icListen instrument, press the icListen button in the Setup area of the main panel, and select the Link Setup tab. There are two selectable connection types: Serial/USB and Ethernet, shown respectively below.

![Figure 4-4: Serial/USB Link Tab](image)
Link setup can either be done manually, or automatically.

### 4.2.1.1 Manual Link Setup
If the connection information for your instrument is known, enter the details and press **Manual Connect**. If successful, the details of the connected instrument will be displayed beneath the setup.

### 4.2.1.2 Find All Units
**Find All Units** is used to automatically discover the units available.

For Serial/USB connections, port search scans from port 1 to port 100, at all available baud rates, and displays all of the discovered units in the box on the right of the display.

For Ethernet connections, this sends a broadcast message out on the network, to which the hydrophones respond.

For either connection type, the available units will appear in the unit list. These units can be connected to by double clicking on the entry in the list. Ethernet units may also be reconfigured using the buttons to the right of the unit list.

### 4.2.1.3 Port Search (Advanced)
Port Search is used to search for multiple Ethernet units at the same IP Address.

Port Search searches the ports commonly used for icListen at the entered IP/Web address. Ports 23, 50000, 50100, 50200, 50300, 50400, and 50500 are searched. Port 50000 is the default command and control ports for icListen. Older icListen LF units use port 23. The remaining ports are commonly used when connecting to multiple units at the same IP/Web address via the port forwarding settings of a router. See the FAQ for more details on this configuration.
4.2.1.4 Additional options

Reset/Standby: When a connection is established to a unit which supports the reboot command (all icListen AF/HF units, and icListen LF units with firmware 2.5 or greater), these options are available. When this option is selected and the icListen is externally powered, the unit will reset. If the unit is not externally powered, the unit will enter standby mode until the next time external power is applied.

Instrument Time: The Set Using PC button syncs the time of the connected icListen to the PC time. Note that icListen uses UTC for all logged files and timestamps. Also note that if Lucy detects that icListen has not been set to the correct time, the time will be set automatically.

Disconnect: When a connection is established to a unit, there is an option to disconnect from the unit. This closes Lucy’s connection to the unit.

Reconfigure: Ethernet units may have their network settings reconfigured in order to become connectable under certain network conditions. This can be done by selecting the unit you would like to reconfigure on the unit list, and then clicking one of the reconfigure buttons. Auto searches for an address which is compatible with the computer’s network configuration, while Manual brings up a panel resembling the Windows network reconfigure panel to allow the user to set their desired settings.

Open Webserver: This button opens the web interface of Ethernet hydrophones, in the default web browser. The web interface may be used to view/configure hydrophone settings, and in icListen AF/HF can view live spectrum data and retrieve logged data.

Advanced: Custom timeouts may be set for Serial/USB units. Typically Lucy selects the timeout value which is judged to be appropriate. However, when communicating over long distances, or running at a very fast data rate, it may be necessary to adjust the timeout for better performance.

Advanced: Serial icListen units have the ability to change the baud rate of the connection. With a connection established at the current baud rate, select the new baud rate and click update. This will change the baud rate of the unit and reconnect at the new baud rate. If a connection is not established at the new baud rate, both the icListen and Lucy will revert to the previous baud rate and re-establish a connection.
4.2.2 icListen LF Setup

The icListen LF Setup tab displays the current configuration of icListen LF, and allows this configuration to be updated.

The current configuration of the connected icListen is displayed as soon as the tab is opened.

The following icListen LF settings can be changed:

- Data Collection
- Gain
- Bandwidth
- Internal Logging
- Internal Time
- FFT Processing
4.2.2.1 Data Collection
The Data collection setting has three options, which can be set independently for both waveform and spectrum data. Note that if FFT data is set to "Data Off" and waveform data is being collected, Lucy will take FFTs of the waveform data to display.

These options are:

- Always
  - Data of this type is always sent to Lucy when scanned.
- On Epoch Trigger
  - Data of this type is sent to Lucy when scanned, but only when an Epoch event has triggered (see Epoch Triggering).
- Data Off
  - Data of this type will not be collected by Lucy.

4.2.2.2 Gain
The Gain is used to increase the sensitivity of the icListen. Gain values are in steps of 6 decibels (dB) and range from 12 to 24. For best performance, Ocean Sonics recommends using a gain value of 12dB.

**Advanced:** Gain options in advanced mode range from 0-72dB.

4.2.2.3 Bandwidth
The bandwidth is the range of frequencies available. The higher the desired bandwidth, the higher the sample rate required. The possible values are:

<table>
<thead>
<tr>
<th>Bandwidth (Hz)</th>
<th>Sample Rate (S/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>400</td>
<td>1000</td>
</tr>
<tr>
<td>800</td>
<td>2000</td>
</tr>
<tr>
<td>1600</td>
<td>4000</td>
</tr>
<tr>
<td>3200</td>
<td>8000</td>
</tr>
<tr>
<td>6400</td>
<td>16000</td>
</tr>
</tbody>
</table>
4.2.2.4 Internal Logging

The internal logging selection allows the user to set the type of logs that icListen will create.

The options are:

- .wav files
  - Standard audio file format.Playable in most 3rd party audio players.
  - **Note:** .wav logging can only be performed up to 1600Hz bandwidth setting.

- .FFT logs
  - Ocean Sonics FFT format files. The format of these files can be found in the icListen Log File Formats document.

- Triggered logging
  - Logging is done based on Epoch event triggers.
  - **Note:** Triggered logging is only available up to 1600Hz bandwidth setting.

All logged files can be replayed in Lucy (see File Replay).

4.2.2.5 Instrument Time (UTC)

Using the Set Using PC button, the internal time of the icListen can be set to match that of the PC running Lucy. Setting the time is required, for accurate file creation times of the internal logs.
4.2.2.6 FFT Processing

The processing performed on frequency domain data can be configured by adjusting the accumulation type, and the sliding window overlap.

Three types of FFT processing are available to icListen LF. These are “Mean”, “Peak”, and “Filter”. The sliding window overlap can be adjusted for any of these processing types.

For “Mean” and “Peak” processing, the Num Strings field indicates the number of FFT data sets that are used for each processed result. For “Filter” processing, the Num Strings field is used to determine how many FFT data sets must be processed before returning a result, and the weighting factor (Num Strings / 3). If FFT accumulation mode is set to “Off”, no averaging is performed. Switching the accumulation mode to “Off” does not affect the sliding window overlap.

For a more detailed description of how the FFT processing works, please refer to the icListen LF User Guide.
4.2.3 icListen AF/HF Setup

The icListen AF/HF Setup tab displays the current configuration of icListen AF/HF, and allows this configuration to be updated.

The current configuration of the connected icListen is displayed on the icListen AF/HF setup tab as soon as the tab is opened.

The following icListen AF/HF settings can be changed:

- Data Collection Mode
- Log File Length
- Internal time
- Bandwidth
- Duty Cycling
- Data Format (Advanced) *
- Gain (Advanced) *
- Spectrum Processing
- Spectrum Reference Level (Advanced)
- Logging Delay

*Note: Data Format and Gain are available for HF release 14 and newer.
4.2.3.1 **Data Collection Mode**

There are many available data collection modes. Waveform and spectrum data collection modes are set independently, and not all modes are available to each type of data. Note that if waveform data is streamed and FFT is set to "Data Off", Lucy will take FFTs of the waveform data to display.

Available options are:

- **Data Off**
  - Data of this type is not sent to **Lucy**.

- **Scan**
  - Only available for spectrum data.
  - Data is available to be scanned over the command and control port, but is sent only by request.

- **Stream**
  - Available for both waveform and spectrum data.
  - Live data is streamed from **icListen AF/HF**'s Streaming TCP ports.

- **Log Continuous**
  - Available for both waveform and spectrum data.
  - All data of selected type is logged internally.
  - Spectrum data is also available to be scanned from the command and control port when logging is enabled.

- **Log Duty Cycle**
  - Only available for waveform data.
  - Data is logged internally for the selected duration, and then for the remainder of the cycle duration data is skipped. This cycle repeats continuously.

- **Epoch**
  - Available for both waveform and spectrum data.
  - Data is logged based on epoch trigger settings.

- **Epoch & Log Duty Cycle**
  - Available for waveform data only.
  - Data is logged based on epoch triggers and the duty cycle. This means data will be logged both during the cycle time, and if a trigger occurs.

4.2.3.2 **Log File Length**

This feature allows the user to configure the length (in minutes) of files internally logged by the **icListen** unit.

4.2.3.3 **Instrument Time (UTC)**

Using the **Set Using PC** button, the internal time of the **icListen** can be set to match that of the PC running **Lucy**.
Time synchronization should always be performed prior to applying the rest of the setup, as changing the time could affect when logging begins if a start delay is set. This is only an issue prior to firmware release 16.

4.2.3.4 Bandwidth
The bandwidth is the range of frequencies available. The higher the desired bandwidth, the higher the sample rate required. The possible values are:

<table>
<thead>
<tr>
<th>Bandwidth (Hz)</th>
<th>Sample Rate (S/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>1000</td>
</tr>
<tr>
<td>800</td>
<td>2000</td>
</tr>
<tr>
<td>1600</td>
<td>4000</td>
</tr>
<tr>
<td>3200</td>
<td>8000</td>
</tr>
<tr>
<td>6400</td>
<td>16000</td>
</tr>
<tr>
<td>12800</td>
<td>32000</td>
</tr>
<tr>
<td>25600</td>
<td>64000</td>
</tr>
<tr>
<td>51200</td>
<td>128000</td>
</tr>
<tr>
<td>102400</td>
<td>256000</td>
</tr>
<tr>
<td>204800</td>
<td>512000</td>
</tr>
</tbody>
</table>

icListen AF’s max bandwidth is 12800 Hz.

4.2.3.5 Data Format (Advanced)
The data format is adjustable when using waveform data. Data can be returned as 16 bit, 24 bit, or 32 bit, and in big or little endian.

As the resolution of the hydrophone is 24 bit, the 32 bit setting will actually return 24 bit data packed into 32 bits (the low byte is always 0 and can be ignored for this data).

Due to the fact that WAV files are defined as little endian, all requests for big endian logged data will also be modified to little endian before sending the setup to the instrument.

Note: 512 kS/s data must be set to 16 bits for Release 27 and below.

Note: If not in advanced mode, the data format is automatically set to 24 bit Little Endian.

4.2.3.6 Gain (Advanced)
In icListen AF/HF, the configurable gain setting applies digital gain to the waveform data. Gain is adjustable in steps of 6 dB, ranging from 0 dB to 48 dB.

This setting can only be adjusted for 16bit data, where it can be used to increase the sensitivity of the unit to compensate for the reduced resolution.

Note: If not in advanced mode, gain is automatically set to 0.
4.2.3.7 Duty Cycling

Duty cycling is available when waveform data is being logged. The logging cycle used is determined by the Cycle Time and Log Data Time fields. Data will be logged for the first Log Data Time minutes of the complete Cycle Time. In the screenshot above, this means that the first 10 minutes will be logged and the next 50 minutes will not, for the total of a 60 minute cycle. This cycle will be repeated continuously.

4.2.3.8 Spectrum Processing

The processing performed on frequency domain data can be configured by adjusting the processing mode, and the spectrum update rate.

Three types of FFT processing are available to icListen AF/HF: “Mean”, “Peak”, and “Filter”. Lucy will adjust the processing settings based on the update rate.

For a detailed description of how the FFT processing works, please refer to the icListen Operations Guide.

Advanced: icListen AF/HF returns spectral data relative to the Spectrum Reference Level, which is equal to the minimum spectral density measurement icListen can return. Valid values are between -120 and -180 dBV. Ocean Sonics recommends maintaining this at -120 dBV, unless making low noise/low amplitude measurements.
4.2.3.9 Logging Delay

The logging delay is used to set the time at which logging is started. This is applied to both waveform and FFT data logging (including triggered logging). If Enable Delay is not selected, data logging starts immediately. Prior to HF firmware release 16, time must be set before this setting is applied in order to maintain the proper delay.

4.2.4 Special Features Setup

The Special Features setup is available for icListen AF/HF (R23+).

The available options are:

- Synchronisation
  - Sync Type
  - Time Encoding/Decoding (R28+)
- Wake From Standby (R28+)
4.2.4.1 Synchronisation

![Synchronisation Figure]

The synchronisation options are used to configure icListen (R23+) to synchronise with other icListen devices or devices producing a Pulse Per Second (PPS) output. If you would like icListen to be a PPS master and synchronize other units to this icListen, select "Sync Out". If you would like icListen to be a PPS slave and synchronise to an existing source/another icListen, select "Sync In" and the correct polarity (Rising Edge/Falling Edge) of the signal. Select "Sync Disabled" if you would like no synchronization.

icListen (R28+) may also be configured to Encode/Decode the time from the PPS signal. This is done with the Encode time in PPS and Decode time from PPS checkboxes.

4.2.4.2 Wake from Standby

![Wake from Standby Figure]

The Wake from Standby option is used to configure an icListen (R28+) to wake from standby mode when the shorting plug is connected. When this option is enabled, the unit may also be woken by driving the sync line low.

4.2.5 icListen Epoch Setup

icListen epoch triggers are configured from the Epoch setup tab. Epoch trigger files may also be loaded or saved for icListen AF/HF. For more details on configuring epoch triggers see Epoch Triggering.
5  File Replay – Offline Operation

Lucy provides the operator with the ability to replay previously logged files including:

- Files created by icListen in WAV, FFT, or TXT format
- Files created by Lucy while collecting real-time data from icListen

The format of all of these files can be found in the icListen Log File Formats document.

Select the Replay button from the Lucy main panel to start the replay process. This will open a popup which allows selection of files. Multiple files may be selected. The files will be played in the order shown in the selection window. Files of different types may be played in the same sequence and the screen will be cleared when switching between file types.

A previously replayed file can be viewed once more by clicking the Again button, using the same settings. If multiple files have been replayed, pressing the Again button will play the most recently played file. The icListen button is opens the file utility which will be covered in the File Utility section.

The speed of the replay is set with the Replay Rate field. This ranges from “Real Time” to “Max” with 3 speeds in between. The display is still updated at the set refresh rate during replay; however the amount of new data per refresh is changed by the replay rate. “Real Time” is the rate which the data was initially displayed at, and the speeds increase respectively from there.

When a file is replaying, it may be paused or stopped using the controls shown below.

5.1  TXT Replay

TXT log files are stored in tab separated value (TSV) format. These files can be viewed by a spreadsheet viewer (such as Excel) as well as through Lucy. When replayed, the data is displayed as it was when initially received.

Certain settings (such as noise cancelling and chart scaling) are viewing aids only, and are not stored with the data.
On the replay panel the user has the ability to view the source of the file, which opens the file in the user’s default text editor.

Once the **Replay** button is pressed, the Replay Setup window disappears and the data starts to replay, at the selected rate. The TXT log files contain Spectrum data.

### 5.2 Wav Replay

After pressing the Replay button on the main panel and selecting a .wav file, the file will immediately start to play. This includes the waveform data, and also spectrum data at a rate of 4 FFTs per second. Audio playback may also be used. For more details on audio playback see *Audio Playback*. Display enhancement tools may be used as usual.

### 5.3 icListen LF FFT Replay

When an .FFT file is selected for replay, the file starts replaying immediately. These files only contain FFT data, and thus only the spectrum chart will be updated. The time series chart will either be blank or hidden, based on user settings. Display enhancement tools may be used as usual.
6 File Utility

The file utility is available for the icListen LF and icListen AF/HF (release 23+). It is used to navigate through the instrument’s filing system, and allow the operator to retrieve or delete logged data files. Configuration files and instrument firmware may be updated here as well. Data from icListen AF/HF (release 22 and earlier) is retrieved using SFTP/SCP with a program such as FileZilla, or through the web interface.

The file utility is opened by pressing the icListen button in the Files section of the main display. For icListen HF units running release 22 and below, this button will open the unit’s data page in the default web browser.

![Figure 6-1: File Utility Button](image-url)
6.1  icListen LF File Operations

Once the file utility panel has opened, the last viewed directory structure will be displayed. If this is the first time the utility is opened since Lucy was started, the connected volumes will be displayed. Some important system files are hidden from view, to prevent accidental loss. To view the contents of a directory, double click the directory name, and the contents will be requested and shown.

To download a file/directory, double click on the file in the selection tree; or single click to make the options on the right available, for retrieving or deleting the selected file/directory.

Clicking **Delete**, deletes the file/directory permanently from icListen after a confirmation popup. For directories this may take some number of minutes, if there are a lot of files. Completion is confirmed when the cursor stops spinning.
Clicking **Retrieve** saves a copy of the file/directory to the PC. When in progress, the following panel appears, showing the progress of the retrieval for each individual file.

![Progress Panel](image)

**Figure 6-4: Progress Panel**

Files may take a few minutes to retrieve, and at any point during the process, the file retrieval can be cancelled. This will leave a partial file on the user’s computer, but will not harm the file in the unit.
6.2  icListen AF/HF File Operations

Once the file utility panel has opened, the contents of the Data directory will be displayed.

To view the contents of a directory, click the directory name and the contents will be requested and shown. The contents will also be checked if the directory is checked.

To download files to the PC, check the box beside the desired files and then click Retrieve on the right side of the panel, as shown below.

Clicking Delete, deletes any checked file permanently from icListen, after a confirmation popup. Files will disappear from the display as they are deleted, and the progress panel will close upon completion. The delete process may be cancelled, but only the files not yet deleted will remain.

When a download, upload or delete is in progress, the following panel appears, showing the progress of the retrieval for each individual file.

![Figure 6-5: AF/HF File Utility Panel](image)

![Figure 6-6: File Options Example](image)
Files may take a few minutes to download, and at any point during the process, the file retrieval can be cancelled. Cancelling will not harm the files in the unit. If an upload is cancelled, the partial file on the unit is deleted.
6.3 Updates
Occasionally, icListen may need a firmware update. This should only be done with assistance from Ocean Sonics.

This section covers the process of updating the firmware.

6.3.1 icListen LF Firmware Update
Care is required when updating the instrument firmware. First ensure that only valid icListen firmware is used during the update. Power must not be removed from the instrument during the update process. When the Firmware button is pressed, a password prompt appears. Once the correct password is entered, a file select window opens. The password will be sent with any update file.

![Password Prompt](image)

Figure 6-8: Password Prompt

Once a firmware file is selected, the progress window appears. A second progress window appears during the verify stage. Before the final update step, there is a final warning and chance to cancel.

![Critical Stage Warning](image)

Figure 6-9: Critical Stage Warning

Once this is accepted a critical operation occurs in the icListen LF, and confirmation of completion is displayed.

To have the update apply, the icListen LF unit must be power cycled (unplug, wait 10 seconds, plug back in). Note that a reset is not sufficient; the unit must be powered off (unplugged).

Once the icListen LF boots, an enquire command should list the new firmware version.
6.3.2 icListen AF/HF Firmware Update

An icListen AF/HF is updated by uploading the update (.icu) file to the “update” folder on the hydrophone. This is done in Lucy by pressing the **Update** button and selecting the correct file. Once the file is successfully updated the hydrophone must be rebooted. About 5 minutes after the reboot, the unit will be ready to use with its new firmware.

**Note:** Updating an icListen AF/HF will clear all data logged internally to the hydrophone. Ensure any desired data has been retrieved before performing the update.
7 Epoch Triggering

In Epoch mode, icListen can be configured to detect specific signals in the real-time data, and perform a number of tasks based on those signals. When replaying data, Lucy can also be configured to detect specific signals. Lucy and icListen can each check the data with up to 5 independent triggers.

This section will cover the setup and removal of epoch triggers from icListen or Lucy.

**Note:** It is important to complete the icListen LF configuration before the Epoch settings, as some of the Epoch settings (frequencies, durations and logging) are dependent on the unit’s configuration. For icListen AF/HF any trigger out of frequency range will be disabled, all others will be adjusted for the new settings automatically, to maintain the same trigger.

**Note:** Lucy may round entries to the nearest values supported by icListen.

![Epoch Setup Tab](image)

The epoch setup tab is divided into 5 rows, with each row representing an epoch trigger.

Note: icListen LF does not maintain event numbers when enquired. This means that if you have 3 triggers and you remove number 2, and then enquire the setup again, only positions 1 and 2 will be filled. icListen AF/HF and Lucy maintain trigger numbering.
7.1 Trigger Conditions

The trigger conditions section is where users set up the details of a particular epoch trigger. These settings are what icListen/Lucy checks the new data against; to decide if an event has occurred.

The frequency range is the range in Hz over which the data is checked.

The signal conditions are the amplitude of the signal to check against (in µPa), the duration that the signal must be present/gone for (in seconds), and the test field (whether we are checking for a signal to become present (Greater) or disappear (Lower)).

7.2 Event Durations

The event durations, as shown above, are used for the duration of data logged for an event. As shown in the figure above, these settings are broken into 3 parts.

The limitations shown above as “Wave: Up to 63s”, and “Spectrum: Up to 32s” are the limits on the amount of data which can be logged in the Pre-Event and Duration stages. These limits change based on the icListen's setup.
If an event returns during the “Post Event” duration, icListen will return to the “Event” state shown in the figure above, and no new epoch message will be produced.

**Note:** Pre-event logging is only available on icListen AF/HF R30+.

### 7.3 Event Actions

The event actions are the tasks performed by the icListen when a trigger occurs.

#### 7.3.1 icListen LF Event Actions

The options for actions in icListen LF are:

- **Transmit FFT Data:**
  - Prepares a message containing FFT data for Lucy to retrieve when scanning.
  - **Note:** icListen must be configured to “On Epoch Trigger” mode for FFT data.

- **Transmit Wave Data:**
  - Prepares a message containing Wave data for Lucy to retrieve when scanning.
  - **Note:** icListen must be configured to “On Epoch Trigger” mode for Wave data.

- **Trigger Pulse**
  - Sends a pulse on the sync wire pair.
  - **Note:** icListen must be equipped with the optional sync interface for a pulse to be sent.

- **Logging**
  - Log either wave data or FFT data.
  - **Note:** icListen must be configured to “On Epoch Trigger” mode for logging.
  - **Note:** If another trigger is already logging Wave data, FFT logging will not occur.

**Note:** Triggered logging is not permitted above a bandwidth setting of 1600Hz (4kS/sec Sample Rate).
7.3.2  iCListen AF/HF Event Actions
The options for actions in iCListen AF/HF are:

Figure 7-6: iCListen AF/HF Event Actions

- Log Wav data
  - Logs a .wav file containing the waveform data during the trigger’s duration.
  - **Note:** iCListen’s Wave setup must be configured to “Epoch” or “Epoch & Log Duty Cycle” mode.

- Log FFT data
  - Logs a .TXT file containing the FFT data during the trigger’s duration.
  - **Note:** iCListen’s FFT setup must be configured to “Epoch” mode.

- Epoch Messages (Always active)
  - Logged and streamed by iCListen AF/HF.

7.3.3  Lucy Event Actions
The options for actions in Lucy are:

- Epoch Messages (Always active)
  - Can be Logged and Displayed by Lucy.

7.4  Lucy Click Detector Trigger

Figure 7-7: Click Detector Trigger

The Lucy click detector trigger is an epoch trigger, which checks if the click detector data has exceeded the configured threshold. This threshold can be set on the main panel when the click detector chart is active, as shown above. For more details see Click Detector.
7.5 Epoch Stream/Message Display

The epoch stream is a message stream which sends an ASCII string every time an event is triggered. This panel is opened by the **Epoch** button, which appears on the right side of the main display. This feature is available for icListen AF/HF and in Lucy.

The returned string includes the timestamp in the format YYYY-MM-DD HH:mm:SS, which is Y=year, M=month, D=day, H=hour, m=minutes, S=seconds.

The unit’s serial number is identified by the U #####, where # is the serial number, or “U Lucy” if the trigger was in Lucy.

The number of the Epoch which triggered is identified by Epoch #, where # is the trigger number.

The data sequence number is identified by Seq #, where # is the sequence number of the data point at which the trigger occurred.
The frequency range, test, amplitude, and duration being checked by the trigger are shown at the end of the line. The test is “>” (greater than), or “<” (less than) the selected amplitude. For click detection triggers, this will read “Click > x”, where x is the click detector limit of the trigger.

When Lucy or HF/AF (R28+) epoch detection is being used, there are epoch status indicators in the lower right corner of the Epoch Message panel. These indicators are numbers for each epoch which change colour for the status of the trigger. The colours are:

- **Blue**
  - Trigger signal present, pending duration.
- **Green**
  - Trigger active
- **Yellow**
  - Trigger signal gone, pending extension period.
- **White**
  - Trigger inactive
7.6 Event Active Time

The Lucy epoch detection can also calculate the percentage of time in a set duration where the trigger signal is present. One resulting line for each active epoch is sent as an epoch message to be both displayed and logged at the end of the duration, as shown below. The active time is shown as a percentage, such as “Active 23%”. The active time is calculated using the number of FFTs during the duration which contained the desired signal, divided by the total number of FFTs during the duration, and multiplied by 100 to form a percentage.

![Figure 7-9: Active Time Setup]

![Figure 7-10: Active Time Messages]
8 \textbf{Click Detector}

In \textit{Lucy}, the click detector takes a loaded in click model, and performs a cross correlation on the live or replayed FFT data. The click model is the same format as an FFT txt log. By default a harbour porpoise click model is provided and loaded. When an FFT text log is loaded for the click model, the first FFT result is used for the model signal. A new click model may be loaded from the \textit{Lucy Setup} page. When FFT data is received/replayed by Lucy, the new data is normalized and summed with the normalized signal from the click model. The result is then graphed. The click detector result may also be used for epoch triggering. The higher the resulting value, the closer the data is to the model. A small or negative result means the data is very different from the model. See \textit{Click Detector Chart} for more details on the graphed data.
9 Accelerometer/Magnetometer

The Accelerometer/Magnetometer data is accessed using the Compass icon on the right side of Lucy, as shown below. This data contains the x, y and z components of both Acceleration (in g) and the Magnetic Field (in nT). The graphs each show the minute of history for the each value.

Figure 9-1: Accelerometer/Magnetometer

Figure 9-2: Accelerometer/Magnetometer Icon
10 Runtime Logs

During operation, Lucy stores two additional files. These are the Job History file and Job Status file. These files are located in "C:\User\******\My Documents\Ocean Sonics\Lucy" where ***** is the username of the computer.

10.1 Job History File

The Job History File logs the current job details. This includes the date/time, the instrument serial number and firmware version, the version of Lucy being used, temperature, humidity, log file name, Client, Job ID, and Personnel. This file is updated whenever scanning is started.

Example Job History File Excerpt (generally viewed as a spreadsheet):

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Data</th>
<th>Serial and FW</th>
<th>SW</th>
<th>Temp</th>
<th>Hum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/11/10</td>
<td>13:51:21</td>
<td>Acou/Time</td>
<td>unit 504 v2.1.02</td>
<td>Lucy V2.1.0</td>
<td>24.2 C</td>
<td>29.4</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:11:00</td>
<td>Acou/Time</td>
<td>unit 504 v2.1.02</td>
<td>Lucy V2.1.0</td>
<td>23.8 C</td>
<td>30.4</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:15:57</td>
<td>Acou/Time</td>
<td>unit 504 v2.1.02</td>
<td>Lucy V2.1.0</td>
<td>24.2 C</td>
<td>29.4</td>
</tr>
</tbody>
</table>

DataFile   Client   JobId   Personnel
Lucy1.TXT  Lucy     "Lucy"  "Lucy"
Lucy1.TXT  Lucy     "Lucy"  "Lucy"
Lucy1.TXT  Lucy     "Lucy"  "Lucy"
10.2 Job Status File
The Job Status File logs the status bar updates, to ensure none are missed. This includes events such as device configurations, data errors, and file system usage. To ensure the file doesn't get too large, if a connection is lost for an extended period of time, the data error will only be recorded every 30 seconds. In this scenario it will be recorded when a successful connection is again established.

Example Job Status File Excerpt:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>18/11/10</td>
<td>14:31:58</td>
<td>Scanning Started</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:32:00</td>
<td>Directory Command Sent</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:32:07</td>
<td>icListen Configured Successfully</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:32:10</td>
<td>Scanning Stopped</td>
</tr>
<tr>
<td>18/11/10</td>
<td>14:32:11</td>
<td>Application Shutdown</td>
</tr>
</tbody>
</table>
11 FAQs
This section will go through some common questions and their answers.

Q. Why didn’t Find All Units find anything?

A1. Check to verify that your unit is connected to your computer/network properly and is powered. For Ethernet units, verify that the computer is connected to the same network as the hydrophone. If your icListen is plugged directly into your computer, it must be connected before Lucy is started. Restart Lucy and try again.

A2. Find All Units uses network broadcast messages, which may be blocked by some firewalls. To initially find your hydrophone you may want to disable your firewall. You may also want to add an exception to your firewall for Lucy.

Q. Why does my IP address not work for connecting to icListen?

A. Make sure that there are no leading 0’s in any of the address fields. For example, an address of 10.10.10.1 should not be typed as 010.010.010.001. This is because leading 0’s will cause the address to be interpreted as base 8 (octal) instead of base 10 (010 is treated as 8, not 10).

Q. How can I test that icListen is functioning properly before deployment?

A. Connect icListen to your computer and an appropriate power source and run Lucy. Once Lucy is started, click to open the icListen Setup panel (bottom right). On the Link Tab click Find All Units or enter the correct Port and Baud Rate (or Port and IP Address for Ethernet). The enquire status should report “Ready”. If desired, some data can be collected to further test the unit by pressing the start button at the top left of the main panel.

Q. I am connected to my unit, but cannot get data, how can I collect data?

A. While connected to the instrument, in the setup panel, check to ensure that the unit is configured to send data. For icListen LF this is changing to data “Always” on mode. For icListen AF/HF this can be done via streaming (FFT and Waveform) or scanning (FFT only). For more details on configuring your instrument see icListen LF Setup or icListen AF/HF Setup.
Q. **My icListen** is configured to send data, and **Lucy** is scanning, why am I not getting data?

A. Ensure you have the correct charts displayed to view the data. Also for Spectrum data check the time scale in the lower right, if the time scale is long (greater than an hour) it can take a long time for samples to appear. To test your unit, reduce the time scale to 1 minute to ensure you are receiving data. For waveform data, try reducing the sample rate while testing to ensure the link is working.

Q. How can I view the .wav files outside of **Lucy**?

A. Both **Lucy** and **icListen** .wav files follow the .wav file standards and can be viewed in most audio viewing/editing programs. Ocean Sonics recommends the free utility Audacity available at <audacity.sourceforge.net>.

Q. How can I view **Lucy**'s .txt logs outside of **Lucy**?

A. **Lucy**'s .txt logs can be opened in any spreadsheet editor, such as Microsoft Excel.

Q. What Operating System is required to run **Lucy**?

A. **Lucy** can run on Windows XP/Vista/7. Windows 8 is not officially supported; however, preliminary tests have shown it working.

Q. **My icListen** status reads “Waiting For Data”. How can I get data?

A. Firstly, wait 30 seconds and enquire again. If the status has not changed then check the **icListen LF** configuration to see if the unit is configured to send any data to **Lucy**. Setting the unit to send data to **Lucy** should change the status.

Q. The Spectrum chart is dominated by red (or it’s all black), how can I view my data?

A. Change the Reference display settings for the Spectrum Chart (see **Spectrum Reference**).
Q. The Desired chart is not visible on the display, how can I find the chart.

A. Any missing chart can be enabled, using the Show selection to the right of the desired chart. See Charts for more info.

![Figure 11-1: Show Chart](image)

Q. How can I connect to multiple Ethernet instruments through a router/radio?

A. This is done via port forwarding settings in the router/radio. The ports used by icListen for communication are:

**icListen AF/HF:**
- 50000 – Command & Control
- 51678 – Waveform Data Stream
- 51679 – Spectrum (FFT) Data Stream
- 51680 – Epoch Message Stream
- 51681 – Status Stream

**icListen LF:**
- 50000 (default, but can be configured, older LF units default to 23) – Command & Control

For icListen LF, only one port is used for communications, so simply connect to the port that your router has been configured to forward to icListen’s command & control port.

For icListen AF/HF, additional consideration must be given when forwarding ports for Lucy to be able to communicate with the instrument. Lucy will attempt to connect to all streaming ports by their relative port address from the command and control port, so all forwarded ports must have the same offset added to them for Lucy to communicate with them.

For example, if port 50100 is forwarded from the router to port 50000(Command & Control) on icListen, then Lucy will expect an offset of 100 for all of the other streaming ports as well (50100 – 50000 = 100). This means that port 51768 must be forwarded to 51678 (Waveform Stream), 51769 must be forwarded to 51679 (Spectrum Stream) and 51780 must be forwarded to 51680 (Epoch Stream).

Please refer to your router’s documentation for setting up port forwarding rules.
### Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Analog to Digital Converter</td>
</tr>
<tr>
<td>dB</td>
<td>Decibels</td>
</tr>
<tr>
<td>FFT</td>
<td>Fast Fourier Transform</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz</td>
</tr>
<tr>
<td>PPS</td>
<td>Pulse per Second</td>
</tr>
<tr>
<td>UI</td>
<td>User Interface</td>
</tr>
<tr>
<td>pk-pk</td>
<td>Peak to Peak</td>
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