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# **Apple iOS Devices and Studio Six AudioTools Software**

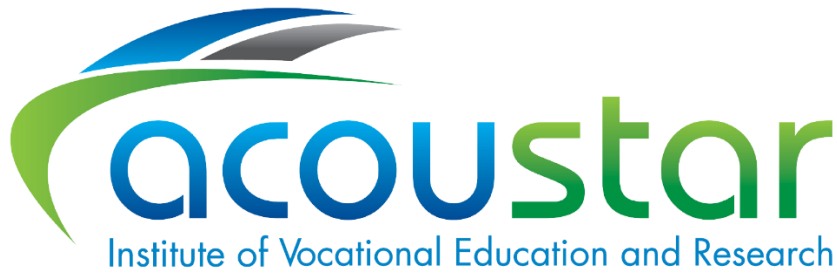
## **Operational Manual for Acoustic Measurements**

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Revision 10.0: January 2026

Noise Measurement Services Pty Ltd

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January 2026.

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(RTO Registration Identifier Code 41013), ABN 70 084 643 023

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## Contents

<b>This Manual</b> .....	5
Device Compatibility .....	5
Built-In Microphones.....	5
Installing AudioTools .....	5
<b>Apps and Microphones for Sound Level Measurements</b> .....	6
<b>STUDIO SIX DIGITAL APPS</b> .....	7
SPL Pro.....	8
SPL Graph .....	10
Audio File Analysis.....	18
Quick-start for SPLGraph.....	19
Setting up an iPhone for Noise Logging .....	20
Guided Access Mode.....	21
Using Single-App Mode for Long-Term Noise Monitoring.....	23
SCHEDULER.....	26
SPL Traffic Light .....	29
Dosimeter .....	31
RTA .....	34
FFT .....	37
SoundScope VR® Tools.....	48
Impulse Response .....	56
ETC - Energy Time Curve .....	70
Room Treatment .....	73
Generator .....	75
Recorder .....	78
Saving Data, Exporting, and Importing .....	80
Save to Photo Roll .....	82
Import and Process Audio Files.....	83
Calibration .....	86
iCloud Support.....	87
<b>TECHNICAL APP NOTES</b> .....	90

dB vs. dB – Understanding SPL Measurements .....	90
Headset Connected Microphones.....	93
Audio Output.....	94
iTestMic2 .....	95
Extending the Cable .....	96
iPrecisionMic Sound Analysis System .....	97
USING MICROPHONE CALIBRATION FILES .....	98

## This Manual

Studio Six has developed a very wide range of apps for use in acoustics, design and placement of speakers, and technical assistance (e.g. signal generators, transfer functions, design tools and calculators). Not all of these apps are described in this guideline, as we (Noise Measurement Services) are concentrating on the acoustics applications.

*Note: the expressions “we” and “the” occasionally in the text refers to the authors of this Manual, Studio Six Digital. Illustrations in the text are from screenshots from an iPad or iPhone – apps may display slightly differently between the two.*

The text for this Manual is drawn directly from the Studio Six Digital website and it is recommended that the reader visit the website and YouTube on a regular basis to check the blog and FAQ updates:

- <http://www.studiosixdigital.com/audiotools/>
- YouTube - Audiotools app or StudioSixDigital

### **Device Compatibility**

AudioTools is compatible with most iOS devices but better performance is achieved with iPhone X series (2021) or later devices.

- **Requires iOS 13.0 or later.**

### **Built-In Microphones**

All of these devices include built-in microphones. These mics tend to be very consistent from one unit to the next, and are wide-range. However, Apple does include a very steep high-pass filter (which cuts low frequencies), presumably as a wind and pop filter. The low-frequency roll-off for the internal mic in these devices is very steep, on the order of 24dB / octave starting at 250Hz.

You can create your own [microphone calibration file](#), if you would like to override the default compensation in AudioTools.

### **Installing AudioTools**

To install AudioTools on one of the compatible devices listed above, simply search the App Store for AudioTools and purchase to install. Please note, some features require additional in-app purchasing. Access to an iCloud account and gmail is very helpful for the saving of data.

***The appearance of some apps as loaded on your device may look different from the illustrations in this guide.*** This is due to updates in iOS software and updates to AudioTools apps.

## Apps and Microphones for Sound Level Measurements

The following commentary is part of the Acoustar Noise Management training program. The Studio Six apps are very comprehensive in the functions that they make available to the user. As a minimum, these apps provide sound levels and sound character (octaves, third octaves, etc).

For best results, however, an external microphone is needed.

### Apple iOS System

The Studio Six Digital apps tested by Acoustar for the noise monitoring training program include:

- AudioTools (full suite of applications)
- SPLGraph and SPL Graph Pro (all app options installed)
- Dual SPL Traffic Light
- FFT, RT60 and Transmission Loss
- SoundScope VR Tools



Photo: Apple iPhone with SPLGraph app and external microphones.

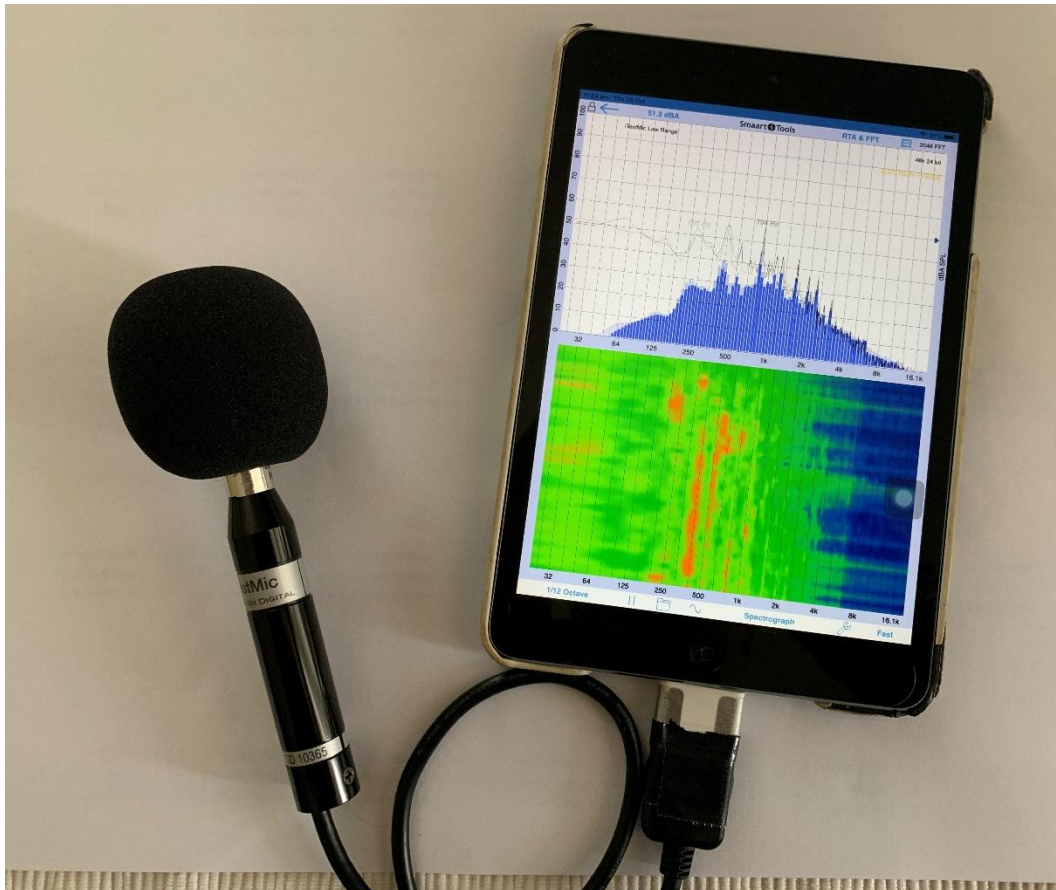
The microphones work with all the iOS system apps.

- Microphone 1: Class 1 Larson Davis microphone, MicW phantom power preamplifier and two channel StudioSix interface module
- Microphone 2: Class 1 Aco Pacific microphone and StudioSix Class 1 preamplifier
- Microphone 3: Class 2 StudioSix iTestMic microphone and preamplifier
- Microphone 4: Class 2 Dayton IMM-6 headset microphone
- Microphone 5: Class 2 Acoustar Primo EM246 headset microphone

## STUDIO SIX DIGITAL APPS

In this training guide we will be presenting apps that will be most often used in measuring environmental or workplace – occupational noise.

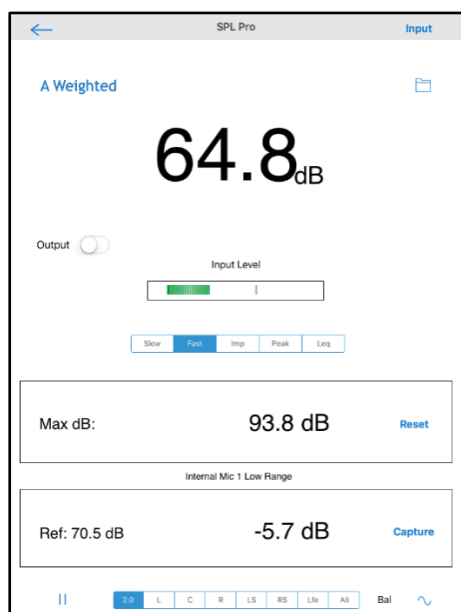
An external microphone is strongly recommended. The photo illustrates SoundScope VR Tools and an iTestMic.



Studio Six microphones are available with Lightning and USB-C connectors.

Connectors are available to allow connection of other microphones with TRRS connectors or USB-A cables.

## SPL Pro



SPL Pro is a professional-grade sound level meter for the iPhone. It incorporates all the features of a dedicated SPL meter -- ANSI modes Slow, Fast, Impulse, Peak, and Leq, A and C weighting, Octave band filters, and the ability to be calibrated.

See the SSD demo video for SPL Pro. This video was recorded on the simulator, within AudioTools.

[http://www.studiosixdigital.com/audiotools-modules-2/spl-modules/spl/spl\\_pro\\_demo\\_video.html](http://www.studiosixdigital.com/audiotools-modules-2/spl-modules/spl/spl_pro_demo_video.html)

See the "dB vs. dB" section to understand what the SPL numbers mean, and why they might be different on different modules.

SPL Pro conforms to all features of the ANSI and ISO standards for averaging sound level meters. To obtain this performance level, you will need to use SPL Pro with a suitable microphone, such as the iTestMic or Precision microphone.

### How to Use SPL Pro

Refer to the screen above.

#### Mode

SPL supports the standard ANSI decay times, and LEQ mode. All times are in terms of exponential decay, where the reading will decay by 20dB over the specified time.

**SLOW** -- this mode uses a 1-second decay time. Good for getting a general reading of the ambient sound level.

**FAST** -- this mode uses a 125ms decay time.

**IMPULSE** -- not used very much, normally Peak mode would be used. This mode has a 35ms decay time.

**PEAK** -- Peak mode shows the peak value received since the last screen update.

**LEQ** — LEQ is essentially average SPL over time. This mode does an equal-weighted time average of the incoming SPL level. A timer shows how long the Leq has been running. Touch Reset to start the averaging over from the start. Tap Reset to begin a new LEQ capture sequence. The cumulative SPL level will be displayed.

### **Filter**

You can select unweighted, which is wide-band; all frequencies are represented equally.

A-weighting rolls off lows and highs fairly severely, and can be compared to voice band.

C-weighting rolls off lows and highs gently, and is sometimes thought of as music weighting.

Octave Band filters, 31, 63, 125, 250, 500, 1k, 2k, 4k, 8k, and 16kHz. These are Type 1 ANSI filters that in effect isolate a single octave band. Often used for noise analysis, or to test masking signals.

### **Capture**

Tap the Capture button to store the current SPL level as the baseline reference level. This will be used to compute the real-time deviation in dB. Use this for seat-to-seat comparisons, or to see how the SPL is changing over time.

### **Generator**

Tap the Sine icon to turn on the pink noise generator output.

### **Output**

Turn this switch on to route the filtered input signal to the output.

### **Input Source**

Most iOS devices allow us to control the input gain of the microphone. For those devices, which include all iPhones, you will see two gain ranges when you go to the Input Sources page. Select the appropriate range for the environment as follows:

**Low Range** — With the internal iOS microphones, this will cover a range of approximately 30 - 100 dBA SPL.

**High Range** — This will extend the range to 50 - 120 dBA SPL.

### **FILES: 2.0, L, C, R, LS, RS, Lfe, All**

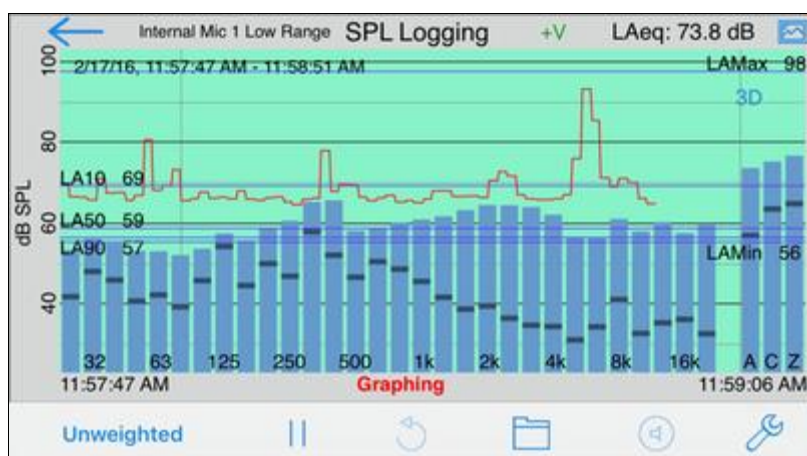
These options select a 5.1 signal if the option is installed. Normal setting is 2.0

## SPL Graph

SPL Graph is a module in Audio Tools and is also available as a stand-alone app at (2025) US \$10, the Octave Recording option at US \$20 and the Video Recording option at US \$20.

SPL Graph is a powerful sound level chart recorder and noise logging system for the iPhone, iPad, and iPod Touch. It works by recording the SPL for a period of time, applying an optional weighting filter or performing octave or 1/3 octave analysis, and plotting the sound level.

You can optionally record the audio or video for the graph, send notifications based on preset limits, and even automatically email graph results at the end of a test.



SPL Graph can be configured for continuous data logging, remote file saving or emailing of data, Ln statistical measurements, event notification, and more.

Check out the video demo of SPL Graph.

- <https://www.youtube.com/watch?v=pSnkrmPrgPY&feature=youtu.be>

**NOTE: 3D plot option is no longer available.**

SPL Graph can record up to 24 hours of 1-second resolution sound level data per file and can be configured to auto-save and restart for continuous operation.

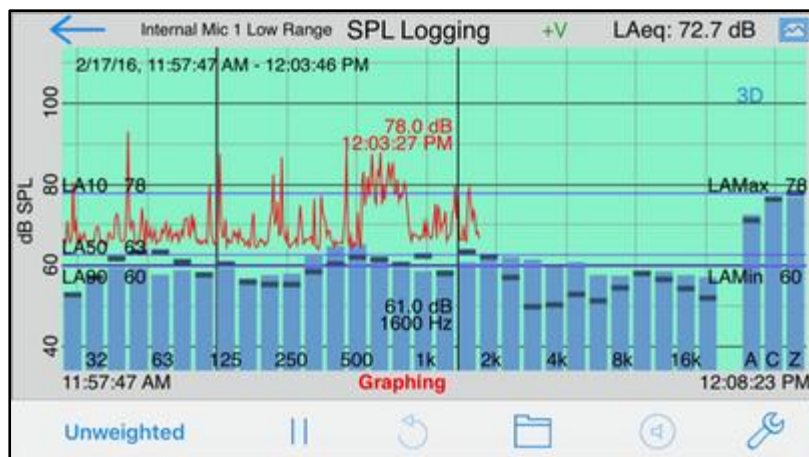
If, for example, a one-minute recording time interval is chosen the graph starts displaying a one-minute window, and as each minute is recorded, the graph re-scales automatically and adds another more time to show the data collected so far.

You can upload the data and recorded audio files to the PC or Mac. The file format is .WAV, .CAF, which is a compressed Apple format, or M4A, which is a 10X compressed file format. You can convert a .CAF it to a Windows-compatible file using a tool like AVS Audio Converter.

Also see the app note on Setting up an iPhone for Remote Noise Logging in this section.

## Octave and 1/3 Octave SPL Logging

**To set up Octave Logging, go to the Setup page in SPL Graph, and purchase the Octave Band Logging option, by tapping the Info button that appears over the Octave Logging selector.**



SPL Graph has an option for adding an SPL Octave and 1/3 Octave Logging module. This allows recording the frequency spectrum at every point on the graph (typically every second, although it can be longer), as well as recording the average spectrum for the entire measurement. We also plot the A, C, and unweighted (Z) SPL values along with the octave or 1/3 octave data.

Use the cursor to select any single data point on the screen and inspect the spectrum for that point.

The Octave Band Logging option also allows you to pick any single octave or 1/3 octave band, or overall, A, or C weighting, for the main red curve. And, the filter option for this curve can be selected and viewed even after the measurement has been completed.

Then, just select with Octave or 1/3 Octave Logging. The test will now run in that mode.

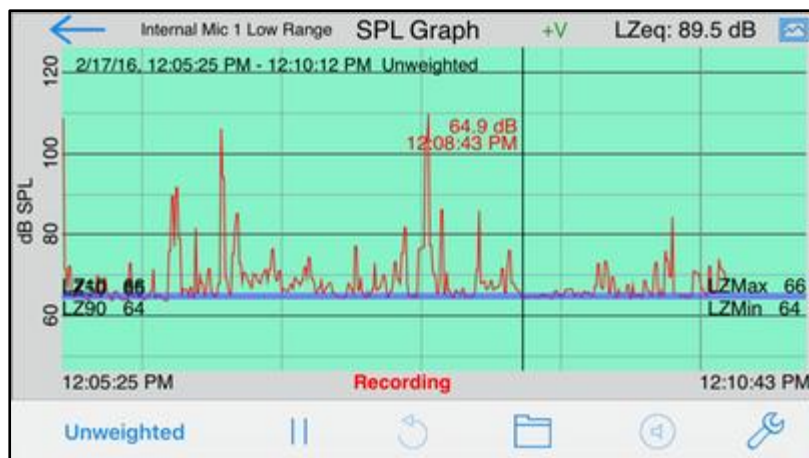
The octave and one-third octave band values are saved as unweighted Leq sound levels (LZeq) by default. The only time this is not true is when the A or C weighting is applied in RTA or FFT.

### Charging indicator

The “V” on-screen is the voltage indicator. If the “V” is green the iphone has more than 80% charge. If orange, the iphone has less than 80% charge. If the “+” sign is showing, the iphone is charging.

## Graphics

### (One-minute example)



The graph starts with a one-minute window, and as a minute is recorded, the graph re-scales automatically and adds another minute to show the data collected so far. Tap the “speaker” play button to play back the recorded audio and use the cursor to scrub the audio location on the graph. Use this feature to listen to events that you can see on the graph.

You can scroll and scale the graph vertically, in dB, by using standard swipe and pinch gestures. You can also scroll and expand and contract the time axis using gestures. Zoom out to a full 24 hours, or zoom in to a single minute, showing second resolution. Double-tap the screen to zoom out to show the entire graph on the screen.

The time scale grid changes dynamically, highlighting minutes, ten-minute, and hour lines as it runs. As the graph runs, the overall LEQ (average SPL) for the entire time period is computed and displayed on the screen.

Swiping across the graph brings up a cursor that displays the exact dB level and time for any point on the graph.

### Ln Statistical Data Logging

Ln statistics may be enabled on the setup page. When on, these values will be computed, on the overall data: LMax, LMin, L95, L90, L50, L10, L01

Select flat (Z), A, or C weighting for the Ln values (if you are running octave logging - otherwise the selected weighting is used), choose to place a Fast or Slow detector before the Ln calculations are made.

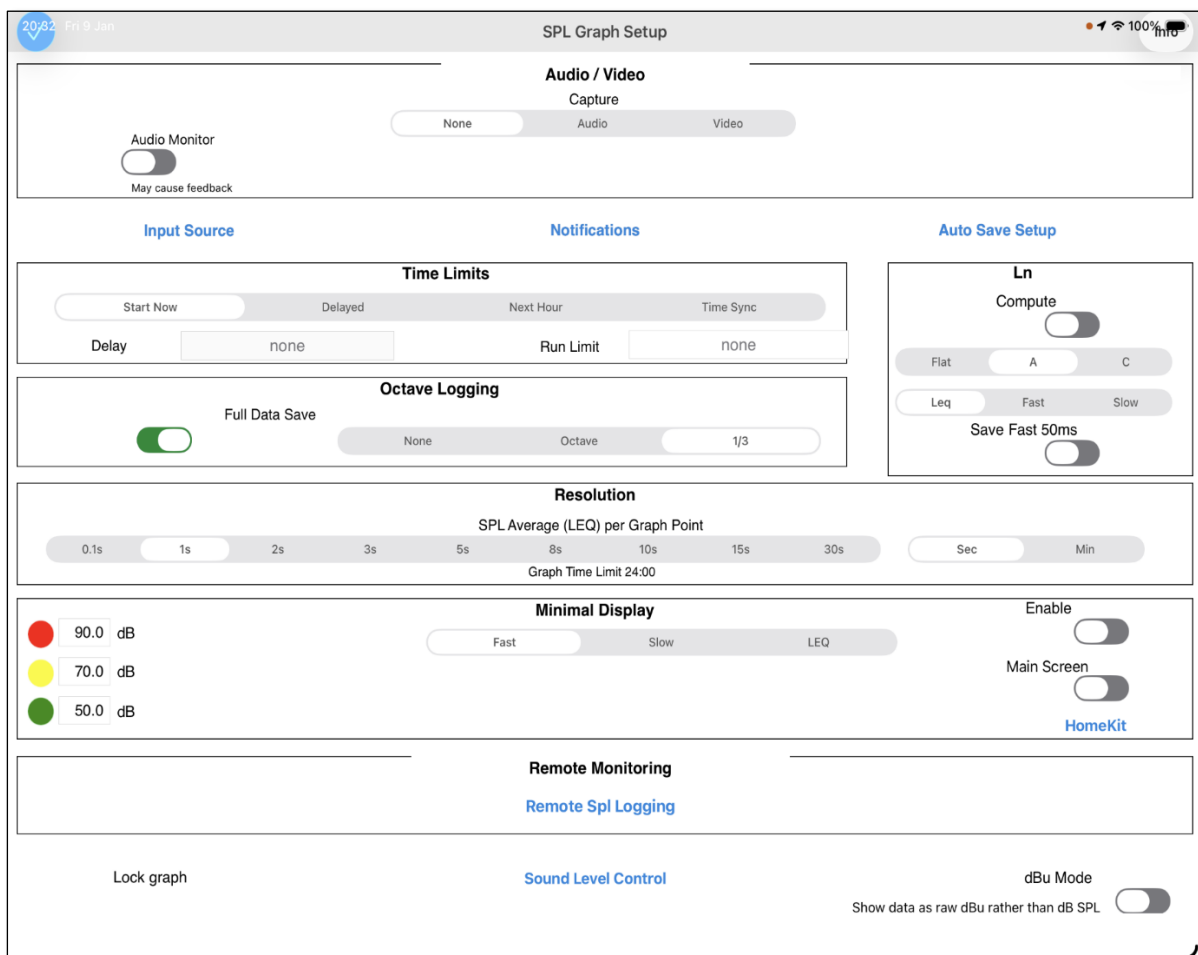
You can choose to also store 50ms (20 times per second) data to another file. This will be named the same as the main data file, with the .txt extension. It contains ASCII tab-delimited data and can be opened in Excel.

Note that more Ln values are stored to the file than are shown on the screen, for clarity of the display. If “Full Data Save” is turned on, these values are also stored for each data point (1.0s to 15m) that is recorded. In octave band mode, you can selected any single value, such as Z, A, or C weighting, or one of the octave or 1/3 octave bands for Ln calculations.

Ln is calculated at 0.1s resolution, which matches many traditional logging sound level meters. You can choose to insert a traditional Fast or Slow detector before the Ln calculations, to match the operation of legacy analog SLMs.

## Settings

SPL Graph has many options and features that allow you to customize it for any application, including setting it up as a continuous noise logging system.



## Audio/Video Recording Settings

**To set up Video Recording, go to the Setup page in SPL Graph, and purchase the Video Recording Option, by tapping the Info button that appears over the Audio/Video selector.**

SPL Graph can record up to 24 hours of audio or video, or it can be setup to only record events that exceed a preset threshold. When the threshold is reached, 10 seconds of audio before the event is recorded, and recording will continue for 10 seconds after event. Video will start at the event time and will extend 10 seconds past the end of the event.

For audio, you can select uncompressed WAV files, compressed CAF files (4x smaller), or M4A mpeg files, which are 10x smaller than wave files.

For video, you can choose between several sizes.

These files will be named the same as the stored file, with numeric suffixes following the file name.

Turn on Audio Monitor if you wish to listen to sounds being recorded. Note that this may cause feedback if you are using the internal mic.

Since the audio is recorded with the full dynamic range of the input, it may be difficult to hear the sounds that were recorded. Turn up the Playback Volume boost to increase playback level without changing the dB measurements.

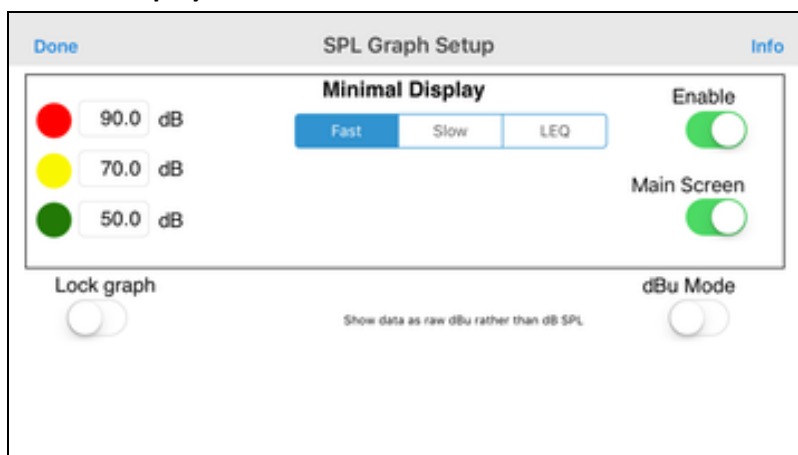
You can also use SPL Graph to record audio clips when a certain dB threshold is reached. To do this, check out the Notifications section below.

### Time Limits and Resolution

Resolution controls the amount of time that is averaged in each data point. This can be selected to match the situation or to match a noise standard. You can select from 50ms (if octave logging is off) to 60m resolution.

Using the Time Limits control you can allow SPL Graph to start immediately when you tap the microphone icon, or you can delay it by some time, lock it to even clock hours, or, with Time Sync, you can lock it to even multiples of the selected Resolution time. This allows you to run multiple copies of SPL Graph on different devices, and keep the data locked in time.

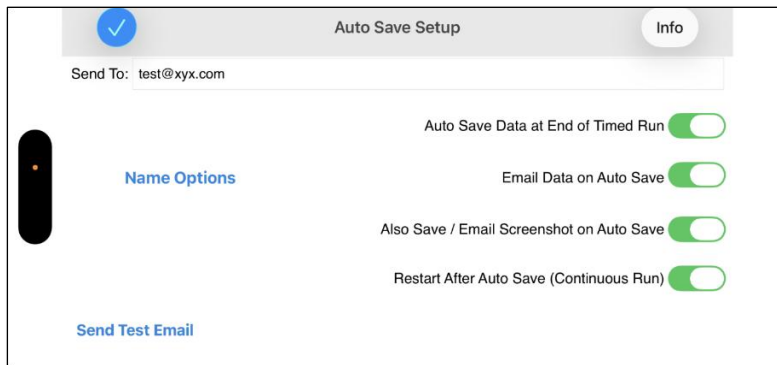
### Minimal Display



This feature allows SPL Graph to function with all of the data logging options and features running, while presenting a simple interface to the end user. This will be a simple screen, with only a dB reading, clock and nothing more. The background color of the screen will change depending on the limits set.

You can select Fast, Slow, or an Leq time, as well as the dB levels for the red, yellow, and green colors. Also, if you turn on the Main Screen switch, the dB level will appear on top of the graph.

### Auto Save Settings



To setup SPL Graph for data logging, first set a Run Limit on the main Setup page, so that the test will stop at a set time. This can be any convenient interval, up to 24 hours (1440 minutes).

Then, tap the Autosave Setup button, and set the options that you would like. Turn on Autosave to enable saving of data at the end of the run (when the Run Limit time is reached).

Then, if you want the results emailed, turn this option on and enter an email address. If a valid email address is set, the results will be emailed to that address at the end of the run. Note that if you are using iCloud you probably don't need to also email the results.

To continuously save results, also turn on the Restart After Save switch. SPL Graph can save data automatically at the end of a timed run, restart another run for continuous operation, and even email the results back to at the end of the run. You can also have a screen shot saved at this time and emailed along with the test data XLS file.

iCloud and Dropbox support mean that the data files can also automatically appear in the iCloud folder or Dropbox. Just enable iCloud or Dropbox on the General-Settings page, and every time that a file is auto-saved the data will appear on the cloud, if the device has internet connectivity. If it is offline, the data will be stored locally and migrate to the cloud automatically the next time that you open the app with internet available.

Auto Save can turn the iOS device into a powerful Type 1 approved sound level monitor, when used with an appropriate microphone, such as iPrecisionMic.

## Notification Settings

The screenshot shows the 'Notification Setup' interface. At the top, there is a blue checkmark icon and the title 'Notification Setup' with an 'Info' button. Below the title are two text input fields for 'send to email address 1' and 'send to email address 2'. A note below these fields states 'At least one email address required'. There is also an 'email subject line' input field. To the right of the 'email subject line' field are two toggle switches: 'iOS Notifications' and 'Enable Email'. To the right of the 'Enable Email' toggle is a 'Limit' field with the value '100 max'. At the bottom left, there is a 'Lockout' field with a time value of '00:00'. On the right side, there is a 'Notifications' list area with an 'Add' button at the bottom.

### Notifications

Notifications provide a method to get email or iCloud notifications upon SPL events. Multiple notifications are supported, and checked after each data point on the graph. If the graph resolution is set to 5 seconds, the notifications will be tested every 5 seconds.

There is a main notifications setting page and a page for each individual notification. SPL Graph can also automatically send out email notifications of SPL overage events. You can define up to 3 email addresses to receive the notification, the weighting, the LEQ time that the SPL level is exceeded for, and you can even limit the number of emails sent to prevent being bombarded with emails. Notifications can be set for different days, time of day, different Leq and statistical values, and allow the saving of an audio file to identify the sound recorded to iCloud and email.

### Level

Enter the level in dB to test.

### Time

Enter the time in mm:ss that the level must stay at to trigger a notification.

For Ln types, as each notification is tested, the test will look back this much time, recompute the Ln over that time interval, and trigger if the Ln value exceeds it.

### Time Limits

If desired, enter two 24-hour format times here. Notifications will only be tested between these time limits. Leave these blank to allow testing at any time of day.

### Day of Week Selector

Select the days of the week that you would like to apply this notification. Days in green will be checked, if the day is red it will be skipped.

### SPL Weighting

If you are operating in octave or 1/3 octave logging mode, you can choose A/C/Z or any of the octave or 1/3 octave bands to use as the notification trigger. If you are running on a single filter, that filter is used for computing the notification triggers.

### **Notifications make it easy to monitor remote SPL events.**

You can also choose to turn on iOS notifications. This will cause a notification to be shown locally on the iOS device, even if the app is running in the background. This will also cause the notification to be sent to Apple Watch.

### **Notifications – Record Audio**

If this is enabled, a clip of the audio that triggered the notification will be recorded and saved locally and to iCloud or Dropbox, if enabled. The clip time will be the same as the Leq / Ln time, up to a maximum of 30 seconds.

Audio clips are named starting with the letter N, followed by the date and time in ISO format, followed by the notification name. These names will be sorted by date/time, and you can assign different names to notifications created in different devices so the file name will be unique.

e.g. N20170724-132658\_Notification 1.wav

### **Audio and Video Recording**

The audio is recorded 16-bit, 48k, mono, as an uncompressed WAV file, or as a compressed CAF file using Apple's 4-to-1 IMA4 compression algorithm, or as a mpeg file using 10-to-1 compression. The storage requirements are shown here for 1 hour of audio:

- WAV file, uncompressed, 345mb/hr, 8.2gb/day
- CAF file, Apple compression, 86mb/hr, 2.1gb/day
- M4A file, mpeg compression, 34mb/hr, 0.8gb/day

To free up space, you can always delete the graph and audio or video files from the Save / Recall page.

### **File Saving**

If you exit the app, or are interrupted with a phone call, the graph data will not be lost. SPL Graph will automatically save the graph, and reload it when you next open the program. You can also save a graph and the XLS data on the iOS device, so that you can recall the graph later.

SPL Graph supports saving an unlimited number of graphs directly on the iOS device. You can recall these graphs and bring them up on the screen, and listen to the sounds that were made while the graph was recorded. You can also store an image of the screen to the photo roll.

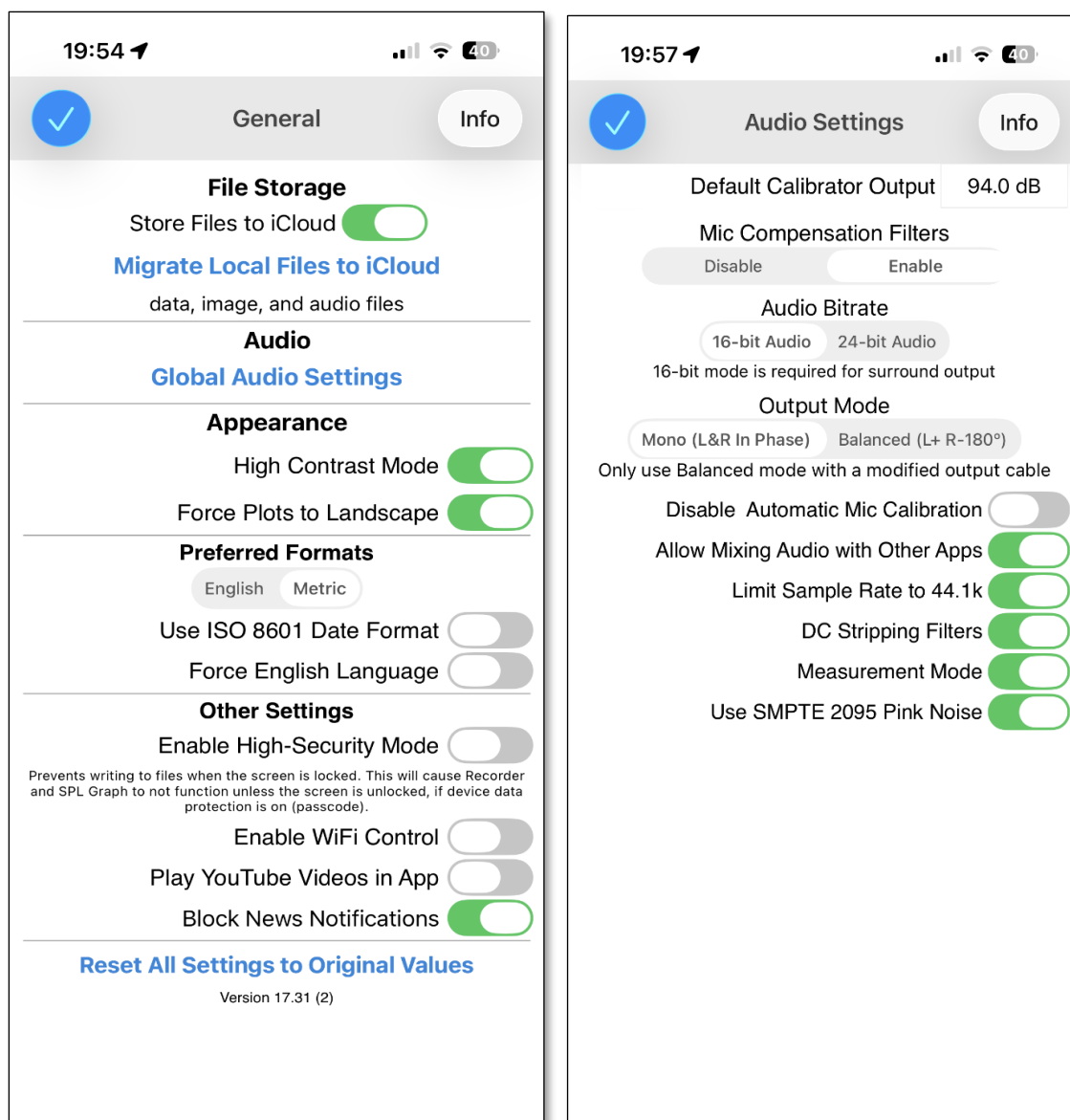
You can control the amount of data that you want stored by using the "Full Data Save" option on the main settings page. If this is turned off, you will only get a summary of the data. If you turn it on, you will get all the details for each data point.

### **Microphone Calibration**

The microphone (internal, headset or lightning port) calibration is set in the Microphone Setup Tab.

### **File Storage and Audio Settings**

File storage and audio settings are found under the Settings/General tab.



## Audio File Analysis

Audio file processing is available for files created in SPLGraph in the Audio Tools app. (That is, not in the SPLGraph stand-alone app). **The processing is available in FFT, RTA and SoundScope VR.** The audio file must be recorded in wave format (not CAF or m4a) and saved to iCloud. The file can then be recovered and opened for processing.

Open FFT and tap the 'spanner' on the bottom of the page. This takes you to the FFT Setup page. Tap Input Source. This will take you to the Input Source page. Tap 'Select Input File' on the bottom and choose the file.

It will now process in the Main Screen, looping, playing just as it was recorded. The slider can be used to change the file position.

## Quick-start for SPLGraph

The following sets up the app in a simple format to save Leq, Ln, and one-third octave data every second for 10 minutes. Audio and video are not saved using these settings.

### Tap and open the SPLGraph app

#### Tap the “SPOKE” emblem, top left corner of the screen to open the SETTINGS page

Tap GENERAL

Tap CLOUD FILE STORAGE and choose iCloud

Tap “Move Local Files to iCloud” and tap ‘Done’ to return to the ‘General’ screen

Leave all the other General Settings in their default condition.

Tap “Done”. The app is now back on the Settings page.

If you are using the internal microphone tap “Done”. This returns to the main screen.

#### Tap the “SPANNER” symbol at the bottom-right of the screen to open the SPL GRAPH SETUP page.

##### Audio/Visual

Set the “Audio/Video Capture” function to “None”

##### Time Limits

Set the “Time Limits” to “Start Now”

Leave the “Delay” at “none”

Set the “Run Limit” to 10 minutes: tap and type 00:10:00

##### Octave Logging

Tap “Full data Save” to “On” – that is, move the button to the right so it shows ‘green’

Tap the “1/3” option

##### Ln

Tap the “Compute” button to ‘green’ and tap to choose and accept ‘A’ and ‘Fast’

##### Resolution

Tap and save “1s” and choose “Sec”

##### Minimal Display

Leave in the default settings and tap “Done” top-left of screen

#### Tap “Auto Save Setup” just above the Ln screen

Record your email addresses as requested

Set all the options “ON”; that is, move the button right to ‘green’

Data is now stored and emailed every 10 minutes to your email address

Tap “done” to return to the ‘SPL Graph Setup’ screen

#### Tap “Notifications”

Enter your email address and move “Enable Email” button to ‘green’.

Set the SPL Weighting to “A weighted’

Tap “Done” to return to the “SPL Graph Setup” screen and ‘Done’ to return to the main screen.

### **Main screen**

Tap the weighting selection bottom left of the screen to 'A Weighted'

Tap the microphone symbol.

SPL Graph is now running and the chart will update every second for the next 10 minutes.

Data storage is continuous until the app is stopped.

## **Setting up an iPhone for Noise Logging**

An iPhone can be configured for unattended operation. If you do all of the below steps, you should have a solid iPhone that won't do anything other than run the app without interruptions.

### **Turn off all Notifications**

Settings->Notifications

For each app listed, select the app and turn off Allow Notifications.

### **Turn off Amber Alerts**

Settings->Notifications

Scroll all the way to the bottom of the page and turn off both AMBER Alerts and Emergency Alerts.

### **Turn off Background App Refresh**

Settings->General->Background App Refresh

Turn them all off.

### **Turn off all Automatic Updates**

Settings->iTunes & App Store

Turn them all off.

### **Forward Calls on the Phone**

Settings->Phone->Call Forwarding

Turn this on, and enter any phone number. This will ensure that in case a wrong number tries to call the phone, it won't ever ring.

### **Turn on Do Not Disturb**

Settings->Do Not Disturb

Turn on Manual. Turn off Repeated Calls. Set Allow Calls From to No One. Set SILENCE: to Always.

### **Turn Siri Off**

General->Siri

We don't want Siri listening waiting to do anything.

### **Turn Off Handoff**

General->Handoff & Suggested Apps

Turn Handoff off.

### **Turn Off Messages and Facetime**

Settings->Messages, Settings->Facetime

Turn these off.

### **Enable**

Turn on iCloud Drive, Keychain, and Find My Phone. You don't need an email account or backups.

We also need location services to be turned on, and microphone access.

## Guided Access Mode

Apple supports a mode that allows you to lock your iOS device into running one app, that cannot be interrupted. This is called Guided Access. With Guided Access, you can make your iOS device into a dedicated hardware device that is running one specific app.

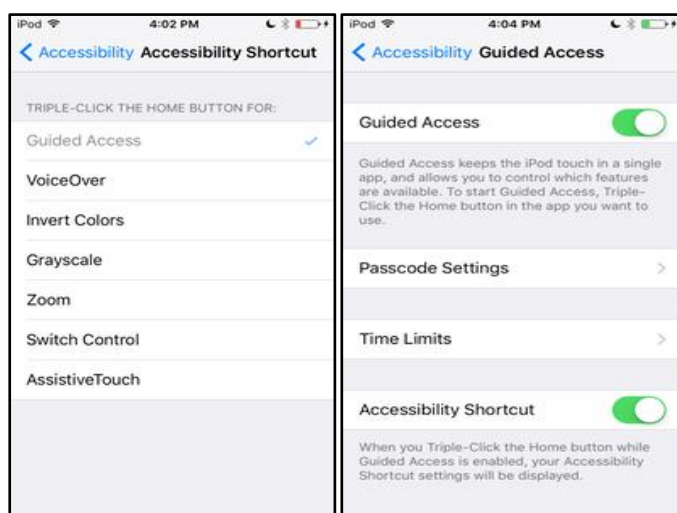
Guided Access always prevents things like operating system update notifications and running other apps, so we recommend that it always be used when running something like SPL Graph or Dual SPL Traffic Light for long periods of time, where you leave the iOS device unattended, or it is running any test that you don't want interrupted. There are several options available, including ones that prevent the wake/sleep button from operating, so that the device can't be powered off, and even one that disables all touch GUI operations or just parts of the screen.

Also, see our information about [Setting up an iOS device for Noise Logging](#) for more tips about preventing interruptions.

### Setting up Guided Access

Guided Access is a feature of iOS, so some of the options may change from time to time. We are documenting its usage in iOS 9. See the Apple documentation for more detailed information about Guided Access.

To enable Guided Access, open the iOS Settings app, and go to the General->Accessibility->Accessibility Shortcut page. Turn off any options other than Guided Access. This will simplify bringing up the Guided Access options later.

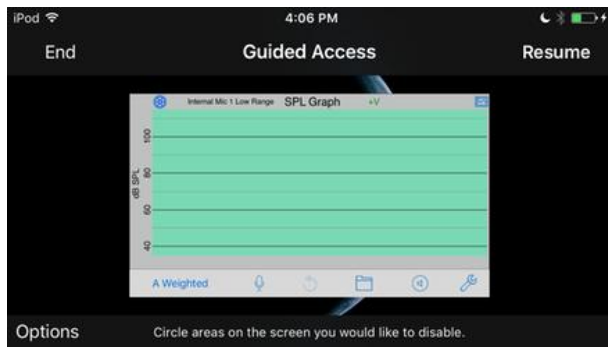


Now go back to the General->Accessibility->Guided Access page and turn on Guided Access and the Accessibility Shortcut. Also set a passcode so that you can totally lock out other users. This can be a different passcode than the device passcode.

### Using Guided Access With An App

Now you are ready to start using Guided Access. Exit Settings, and open the app that you want to run. In this example, we are using SPL Graph. Triple-click the home button to begin Guided Access mode for this app. You will see a notification appear briefly saying "Guided Access Started".

Now, triple-click the home button again and enter your passcode to bring up the Guided Access options page. It looks like this:

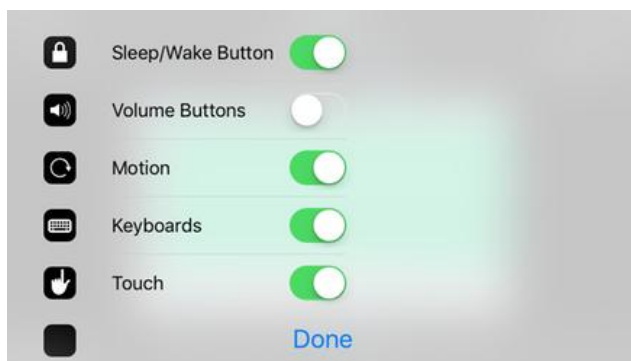


You can exit Guided Access mode by tapping End, or go back by tapping Resume.

Note that you can disable only parts of the screen if you like. In this example, I'm disabling access to the Toolbar and the Settings icon.



Tap the Options button to bring up this page, where you can select what you want or do want to be enabled.



Note that I have left the Sleep/Wake button active. Even in this case, you can't shut the device off, but you can put the app into the background. Turn off Touch if you don't want anyone who does not know the Guided Access passcode to be able to start or end the test. Tap Done to get back to the running app.

## Using Single-App Mode for Long-Term Noise Monitoring

Using Apple's iOS device supervised mode, an iOS device can be set up to run a single app, and even launch directly into that app after rebooting. The app cannot be shutdown, and no other app can be run. Siri can be disabled. The home button can be disabled, and much more. This is ideal for setting up a system for long-term noise monitoring.

Using a third-party device management service, the device location can be monitored, apps updated, and it can even be remotely rebooted, with the app restarting automatically after the reboot. We recommend using [SimpleMDM](#) for this service. They charge a small fee, currently no more than \$US3/month per device. Note that you will have to have internet connectivity to be able to remotely manage a device, either through WiFi or a cellular connection.

Single-app mode, using a supervised device, opens up the possibility to use Apple hardware as the basis for solid, reliable long-term noise monitoring, where the device can be managed from a remote location.

This method is superior to guided access mode, as it provides for [remote device management](#) and for automatically restarting the app after rebooting. You will need a Mac computer for this process.

### Overview

Follow these steps to set up an iOS device in Single-App Mode. They are described in detail in the sections below.

- Buy a dedicated iOS device and microphone. You don't want to do this on a device that you use for other purposes
- Activate Supervised Mode using Apple Configurator 2
- Turn off notifications on the device to prevent other potential interruptions
- Install the app, typically the SPL Graph or the SPL Graph Pro standalone app (not AudioTools) and adjust the settings in the app for your noise logging case
- Subscribe to a third-party Apple Mobile Device Manager Service, enroll your device, and configure the device for single-app mode using the device manager

See below for full instructions on each of these steps.

### Hardware

Decide which iOS device to use. We like iPad Mini, but other choices will work. Get the cellular data option if needed, and decide how much memory you need. Audio and video files can use a lot of space, so take that into account.

Pick your Studio Six Digital microphone option, from [iTestMic2](#), [iPrecisionMic](#), or [iAudioInterface2](#). Plan how you will power the system, whether using AC, battery, or solar. Get a [Lightning extender](#), if needed. If required, get the system [type certified](#).

Once you have your hardware, you can complete the set up process.

## Activating Supervised Mode

This is the first step in setting up an iOS device for remote management and single-app mode. Note that this process will completely wipe the device, so if there is any data that you need to get off the device, do it now. Once this step is done, the rest is fairly easy.

Before starting this process, go to Settings on the device, and turn off "Find my iPad/iPhone" and then log out of iCloud and iTunes.

Next, [follow these instructions from SimpleMDM](#), using the section for "Supervise a Device with Apple Configurator". This is probably a good time to setup an account with SimpleMDM, using their free 30-day trial. They have excellent support!

### Activating Supervise Mode information from SimpleMDM:

Apple Configurator is an OS X application. To supervise a device with Apple Configurator, you must have an OS X computer and USB cable available. Each device that is to be supervised will need to be connected to the computer.

**Note:** To get the URL mentioned in step 7 below, if you have signed up with SimpleMDM, you can go to the "Devices" page in SimpleMDM, tap the blue square "Enroll" button, and then tap the blue "Show Enrollment" button. Copy the URL on the right side of the screen.

1. Download the latest version of Apple Configurator. We're using Apple Configurator 2.4 in this guide. <https://itunes.apple.com/us/app/apple-configurator-2/id1037126344?mt=12>
2. Attach your iOS device to the computer using the USB cable.
3. Start Apple Configurator.
4. In the "All devices" view, click the iOS device.
5. Click "Prepare"
6. Select "Manual" from the "Configuration" drop down
7. On the "Enroll in MDM Server" screen, optionally define an MDM server using your SimpleMDM enrollment URL copied above.
8. On the "Supervise Devices" screen, make sure that the checkbox next to "Supervise devices" is checked.
9. Add the details of your company on the following screen if desired.
10. Generate a supervision identity when asked to do so if you haven't already.
11. Click the "Prepare" button once you reach the end of the dialog boxes.
12. The device will be prepared and reset.

## iOS Device Configuration

Now that Supervise mode is set up, you can turn off notifications, download the app, and get the iOS device all ready for single-app mode.

Follow our [guide for preparing a device for noise logging](#). Not all of these steps are crucial, but this is a good time to clean up the device to prevent an interruption from coming in.

Download SPL Graph, or SPL Graph Pro. You need one of these if you want the app to start up automatically into noise logging mode after a reboot.

We [recommend using iCloud](#) to transfer files remotely. If you are using it, sign into iCloud now on the device, but turn off everything except Keychain, Find My iPad (iPhone), and iCloud Drive. Leave SPL Graph access turned on.

Set up SPL Graph for your noise logging use case. You can always change these later, but this is a good time to get it ready for noise logging. This is where you set up the octave logging mode, time resolution, Ln mode, audio/video triggers, and time limits.

Make sure you turn on "Start Recording When App Opens". This option appears on the Auto Save Setup page in SPL Graph.

This is a good time to run some tests, and make sure everything is operating as you want it to, before locking the device into single-app mode. Proceed to the next steps when you are satisfied that all is good.

### **Set Up the Apple Mobile Device Manager Service**

Apple has a very rich and complex server-based system for managing enterprise devices, and although it can all be done for free, we highly recommend using a third-party MDM (Mobile Device Management) service. We have been very happy using [SimpleMDM](#) and recommend using their service.

You can sign up for a free 30-day trial, and while you are working through setting up your device they are available to provide excellent and timely tech support. You can start with their "[Planning Your Deployment](#)" support page, or just dive in to the device management screen, which appears after you sign up

From this page, if you have entered the URL in the Apple Configurator setup, your device will already appear in the list. If not, you will enroll your device, following the instructions that appear after you click the "Enroll Devices" button.

Once the device is enrolled, you will want to create a configuration that will be applied to it, for noise monitoring.

Click the "Configs" button on the left, and then select "Add Profile" on the right. Select "App Restrictions", and "Only Allow Restricted Apps". Click on "Add Apps", and type SPL Graph, and select the app that you will be using. Click Save.

Now, create a new Group on the devices page. This is where you setup all of your restrictions and policies that you will be applying to your iOS device. You can use it for more than one iOS device, if you are setting up a group of devices. Click the edit button to the right of the Group name, and look through all of the tabs that are there. Pay special attention to the Restrictions page, turn off anything you don't want to be enabled, like Siri, and then at the bottom right, click the "App restrictions" selector and pick the Config that you created above.

Finally, drag your device (or devices) into the new Group, or select the device using the checkbox and use the small menu on the upper right and select "Assign to Group".

To get started, select the device using the checkbox, and then use the menu in the upper right to reboot the device. The app should start running, and noise logging should begin.

### **Managing a Device Remotely**

Now that everything is setup and running, you can remotely manage the device, including doing things like rebooting it remotely, updating the iOS version, or even shutting the device down (but you can't wake it back up if you do this). You can also get information about a device, such as its location, by clicking its name.

## SCHEDULER

**Scheduler is a powerful feature that allows you to create a test schedule that includes a number of audio and acoustic measurements that run sequentially, automatically.**

You can control the length of time that each task runs, whether the generator is turned on, how long to wait between tasks, or whether each task is started manually.

Results are stored as each test completes, using a common naming format, so that you can go back and collect the results from the test.

### Using the Task Scheduler

Scheduler is located under the Settings Menu. The Scheduler can be used to set up a group of tests to be run sequentially, automatically. Results are stored at the end of each test using a common file name convention.

Scheduler cannot run every AudioTools module. For one thing, the module must be able to store data. Also, some modules require hardware interaction, and are not suitable for automatic test runs. In this document, we will call a "test" a complete test run, which may include many individual audio measurements, which we will call "tasks". Tasks are the modules that can run under Scheduler:

- SPL Pro
- SPL Graph
- RTA
- FFT
- ETC
- SoundScope VR
- Amplitude Sweep
- Speaker Polarity
- Speaker Distortion
- STIPA Pro
- Recorder

### The Scheduler Screen

When you first enter the Scheduler, you will see the main Scheduler screen.

Tests are stored in files, in the public/test folder on the iOS device, and on your Dropbox, if you have it linked. Each test file contains information about the test, and a list of tasks to run.

The test files present are shown in a table on the Scheduler screen. You can add tests with the + button, delete a test by swiping across it, edit a test by tapping the "i" or arrow disclosure button, or tap on the test table cell to start the test running.

After tapping the "+" button to create a new test, or tapping the disclosure button, you can edit the test file.

## **Editing a Test**

To create a new test schedule, tap the + on the Scheduler screen. This will bring up the Test screen.

## **The Test**

These are the parameters from the Test:

### **Test Name**

To change the name of the test, just edit the text field on the top of the Test screen. A new test will be created using the new name, and the old test (if already saved) will not be changed or deleted.

### **Start Delay**

Set an optional time to wait before the test begins. This allows you to move the iOS device, or to setup the testing environment before the test run starts. Time is shown in minutes and seconds.

### **Time Between Tests**

Set an optional time to wait in between each task. This can allow time for the room to quiet down between tasks, for example. Time is shown in minutes and seconds.

### **Prompt for Next Test**

Normally, each task starts automatically, after the Time Between Tests. Turning this option on allows you to control when the next task will start manually. The Scheduler will wait for you to tap a button before it continues on to the next task.

### **Lockout Local Control**

When a task is running, you can interact with the screen, which could affect the outcome of the measurement results. Turning on this option ensures that the task will run undisturbed.

Note: It is possible to create a scenario where a task is running, and you can't interrupt it, for example by setting a very long task run time with lockout turned on. The only way to exit the app would be by force-quitting it. To do this, double-click the menu button, and follow the iOS procedure for force-quitting an app, to end the app operation.

### **Task List**

Below the test settings is the list of tasks. This list will be empty until you add a task, using the "+" button. You can also delete a task by swiping across the table cell, or reorder the tasks after tapping the Edit button and moving them by touching the control on the right and dragging the cell to a new position in the list.

After you tap the "+" button, or when you tap the task table cell, the Task editing screen appears.

### **The Automated Task**

The test consists of a list of tasks that run in sequence. You can have as many tasks as you wish, but note that if the same task runs twice in a given test run, the last task run will overwrite any previous task data files (except in the case of the surround signal generator, see below).

### **Task Parameters**

The individual task settings, such as octave banding, weightings, decay times, and graph parameters are all set locally in the module. These settings are automatically saved, and will be in effect when the automated task runs. Make sure your tasks are setup the way that you want them before you start the test schedule.

The run time parameters for the task are set on the Task Screen. These include the length of time that the task will run, whether it will turn on the generator, and the task itself.

### **Generator**

Set up the generator for this task using the Generator panel. You can turn on the generator, select the signal type, and for sine or square waves, the frequency. You can also select the balanced / mono signal mode.

Note that some tasks, such as STIPA, will always use their special signal. You still have to turn on the generator switch if you want the signal to play.

### **Surround Signals**

Surround signals may be selected, if you have the Surround Generator module unlocked. When a surround signal is selected, the channel designator will be added to the file, just before the date, so that you can run a number of surround tests in the same test run without the files overwriting.

### **Run Time**

Set the time that you wish the task to run in this field. Note that you will have to take into account any special considerations for the actual task. For example, if the Amplitude Sweep module is set to run a 30 second sweep, make sure you allow enough task run time for the sweep to complete. The same thing applies to STIPA, which requires a certain test length to complete.

### **Select Task**

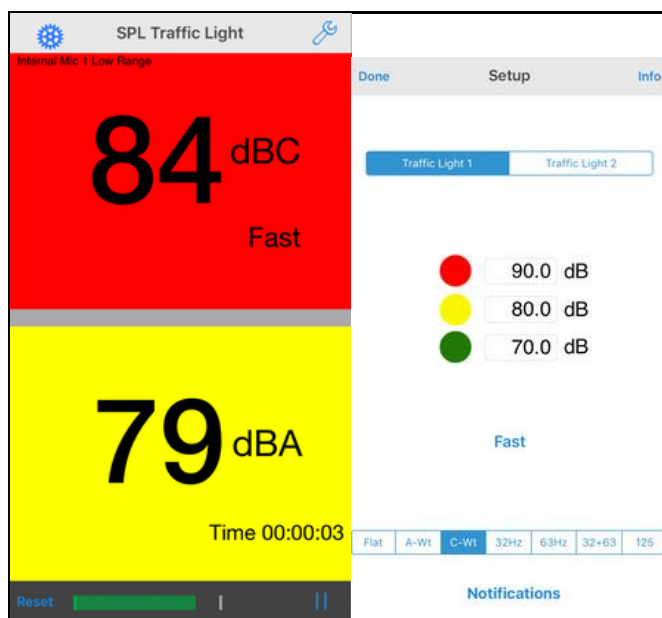
Select the task from the list of available tasks. If a measurement is not included in this list, it is not supported for automated tests

## SPL Traffic Light

SPL Traffic Light is available in two formats: as a dual-display and as single display. The app is a SPL monitor, designed to be used to monitor SPL levels for live concert sound, community noise, and any public space that needs to be in compliance with sound level regulations.

Use SPL Traffic Light with the built-in iOS device microphone, or pair it with the iTestMic for Class 2 results, or use it with the iPrecisionMic for Class 1 performance. Note that it is possible to certify the entire instrument as Class 1, by sending iPrecisionMic and the iOS device to an independent testing lab.

Having two sound level monitors allows SPL Traffic Light to adapt to nearly any community noise standard regulation, since you can set one meter for C weighted Fast, and the other for an Leq (average) time. The example here shows exactly that setup. This flexibility makes the SPL Traffic Light the most versatile SPL monitoring system available on any platform.



The top control selects which SPL monitor the settings apply to. Enter the dB trigger levels for the three colors, and select the weighting or octave band.

You can also enable email notifications, based on the display criteria for the red dB trigger level. Notifications can be based on just one SPL monitor triggering into the red zone, or either or both triggering. Enter the own gmail credentials for the email notification server. Note that Google's policies may require you to go to the own gmail settings, and enable access from a third party app. Set the three color trigger dB levels, dynamic response, and weighting separately for each SPL monitor.

**Done** **Notifications** **Info**

to@gmail.com **Enable Emails**  
At least one To: email address must be entered.

to@mac.com **Start / Stop Emails**

Over limits!

**Red Condition Trigger**

Left/Top	Right/Bottom	<b>Either</b>	Both
----------	--------------	---------------	------

**Lockout Time** 01:00 **Email Limit** 25 max

mine@gmail.com

Enter your own gmail account credentials to enable emailing results

See the Traffic Light videos for the single and dual displays at:

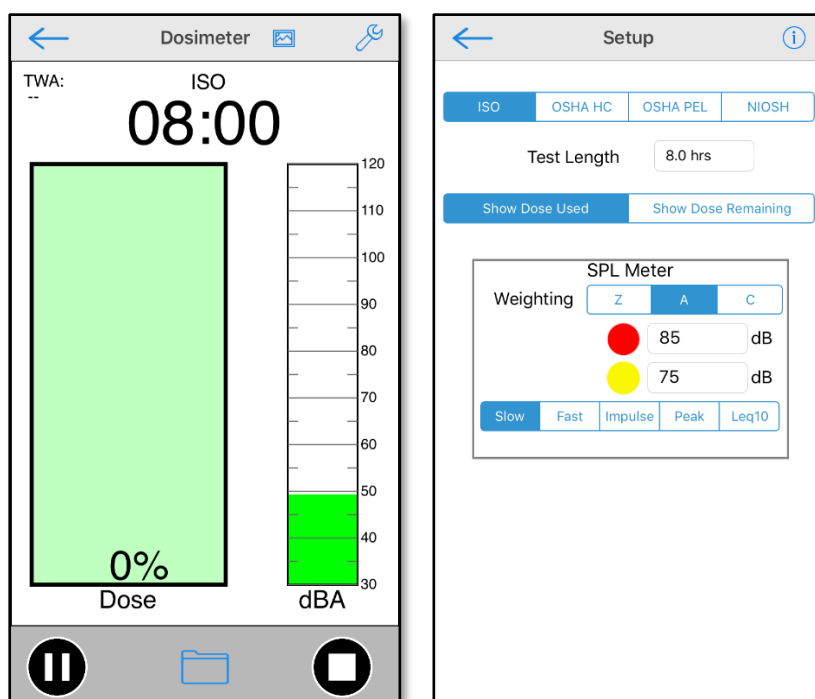
<http://www.studiosixdigital.com/audiotools-modules-2/spl-modules/spl-traffic-light.html>

## Dosimeter

Dosimeter is a dual-display and single display SPL monitor, designed to be used to monitor SPL levels for live concert sound, workplace noise, and any occupational noise activity that needs to be in compliance with sound level regulations. Use SPL Traffic Light with the built-in iOS device microphone, or pair it an iTestMic or iPrecisionMic. Dosimeter applies the following noise criteria:

ISO	ISO 1999:2013 is currently the internationally accepted standard for calculating noise exposure and risk of hearing impairment. The ISO standard applies a 3 dB exchange rate, no time weighting (i.e. LAeq is applied), no threshold and a criterion level of 85 dB
OSHA HC	OSHA ‘Hearing Conservation’ applies a 5 dB exchange rate, the use of a Slow time weighting, an 80dB threshold and a criterion level of 90 dB
OSHA PEL	OSHA ‘Permissible Exposure Level’ applies a 5 dB exchange rate, the use of a Slow time weighting, a 90dB threshold and a criterion level of 90 dB
NIOSH	National Institute for Occupational Safety and Health (NIOSH) recommends the use of a 3dB exchange rate, the use of a Slow time weighting, an 80dB threshold and a criterion level of 85 dB
TWA	Time weighted average – the sound levels are calculated over 8-hours for 100% dose

In addition, the sound level meter function can measure C-weighted peak values in a one-minute interval.



An excellent summary of the application of different noise exposure metrics is provided in:  
 Tingay J. & Robinson D. *A practical comparison of occupational noise standards*. Inter.noise 2014  
[https://www.acoustics.asn.au/conference\\_proceedings/INTERNOISE2014/papers/p366.pdf](https://www.acoustics.asn.au/conference_proceedings/INTERNOISE2014/papers/p366.pdf)

## Using Dosimeter

A Dosimeter measures a persons cumulative noise exposure over time. It was designed to help prevent hearing loss by allowing a user to monitor the amount of noise that they have been exposed to, which over time can correlate to hearing damage.

Typically, an 8 hour workday is considered, and the % noise exposure is shown as a "Dose". The idea is to keep the Dose below 100% for a day. There are several standards for the formula for computing Dose %. All of them use an "exchange rate", which may be 3 or 5dB, and a "criterion level".

If the user is exposed to the criterion level (for example perhaps 85dB) for 8 hours, they would hit exactly 100% dose. If you add the exchange rate dB, to get to perhaps 88dB, then 100% dose will be reached in 4 hours.

Different SPL filters and decay methods are specified depending on the standard.

The actual formula is somewhat more complex, and can include thresholds, below which no dose accumulates, and other factors.

## Operation

### Choosing the Method

Tap the wrench icon to bring up the Setup page, and select between ISO, OSHA HC, OSHA PEL, and NIOSH. Check your local legal requirements to see which standard you need to use.

All tests default to an 8 hour test time, which can be overridden if desired.

#### ISO

Criterion level 85, exchange rate 3.0, SPL Leq, A weighting. There is no threshold, so all sound contributes to dose, although low SPL levels do not add much.

#### OSHA HC

This is one of the methods used in the USA, and it is based on allowing 90 dBA exposure over 8 hours. It uses a 5dB exchange rate, so as sound increases 5dB the length of time to 100% dose is halved. It uses A weighting and Slow decay with a threshold at 90 dB.

#### OSHA PEL

This is another method used in the USA, and it is also based on allowing 90 dBA exposure over 8 hours. It uses a 5dB exchange rate. It uses A weighting and Slow decay with a threshold at 80 dB.

#### NIOSH

NIOSH is used in most EU countries. It is very similar to OSHA, although it uses an 85dBA normal exposure level, and a 3dB exchange rate. The threshold is 80dB, SPL Slow mode, A weighted.

### Dose Used / Remaining

Normally a Dosimeter will show the amount of dose used, starting at 0% and increasing to 100%. You can opt to see Dose % remaining. In this case it starts at 100% and decreased to 0 %.

## SPL Meter

Dosimeter also includes an SPL meter, which can be setup independently from the dosimeter settings. You can select Z/A/C weighting (Z = unweighted), Slow/Fast/Peak/Impulse/Leq10, where Leq10 is a rolling linear average of the last 10 seconds.

You can also set 2 trigger levels which will cause the SPL meter to change color if the current reading exceeds the trigger level

## Running the Test

Tap the Play/Pause button on the lower left corner of the screen to begin the test. The SPL Meter will begin showing the current SPL level, and the dose calculations will begin.

As the dose increases, the box will start to fill up, or empty out, depending on the Used/Remaining setting. The color will change from green to yellow to red, as the dose gets closer to 100%.

The SPL Meter reading will also change from green to yellow red, based on the trigger level settings.

Dosimeter will continue to run in the background, so you can shut off the display, or exit the app (the red recording bar will show on the top of the screen), and when you return to Dosimeter you the results will be showing.

If you need to pause the test, for example this would be used during a break at work, tap the Play/Pause button as needed to stop and start the test.

Tapping the Stop button will end the test. You can still save the file, until you press Play to start a new test.

## Saving and Recalling Files

To save the current test results of Dosimeter, tap the folder icon on the lower left side of the toolbar on the bottom of the screen. This will bring up the Save / Recall page.

Save the file by entering a file name and tapping Store File on the the popup that appears.

To recall a stored file, select it from the list to highlight it, and then tap Recall to bring up the results. Note that recalling a stored file will replace the current test data.

After recalling a test, you can continue the test, by pressing the Play/Pause button to start the test running.

To clear a recalled test, press the Stop button.

When you save the file, the app stores all of the current values, and it also stores a list of minute-by-minute values that include the Leq over the minute, and the Peak value reached in that minute. The filter setting of the SPL meter (Z/A/C) is used for these calculations. These values are saved in the .txt file, which may be opened in Excel or Numbers.

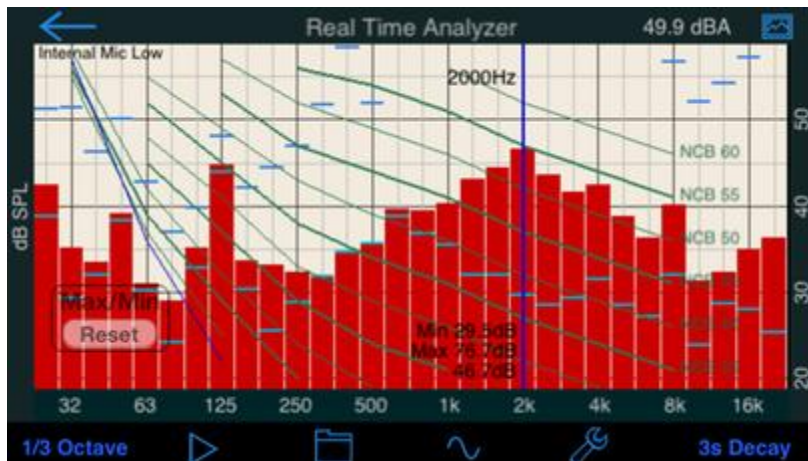
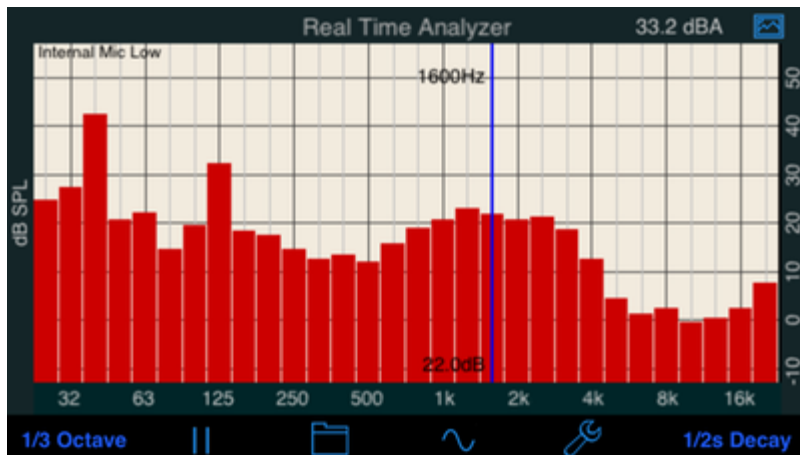
## Screenshots

Tap the screen shot button on the upper right toolbar to save an image of the test in your photo roll.

As with all iOS apps, you can take a screenshot of the entire screen by simultaneously pressing the Home and Power buttons on the device. The image will then be in your photo roll.

## RTA

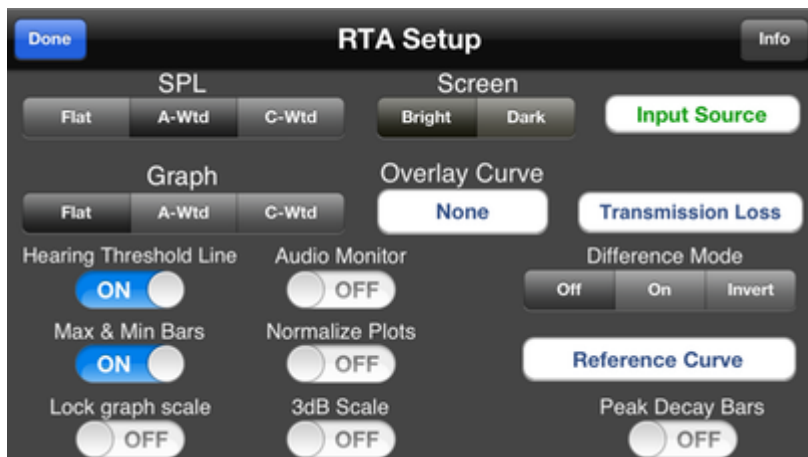
RTA is a full-featured filter-based one-third octave Real Time Analyzer.



\*\*\* NEW: Check out the new demo video of RTA.

### How to Use RTA

Here is the RTA main screen:



### **Band Size**

To use RTA, select the band size that you want, either Octave or 1/3 Octave. The octave and one-third octave band values are saved as unweighted Leq sound levels (LZeq) by default. The only time this is not true is when the A or C weighting is applied in RTA or FFT.

### **Decay Modes and Speed**

Select the decay mode and speed. You can select one of the exponential decay modes, which are labelled in seconds. The seconds indicate the amount of time for a bar to decay by 20dB.

Also, you can select Peak Hold, which holds the highest value that a bar has reached. To reset Peak Hold, re-select Peak Hold mode.

There is one more mode, Average. This mode performs a continuous equal-weighted average, from the time you start the RTA with the Play button in this mode, until you Pause the RTA. Even then, you can continue the average by pressing Play. To reset Average mode, tap the Reset button on the screen.

### **Play / Pause**

Touch the Play/Pause icon to begin. Anytime one of the parameters is changed, the RTA will revert to Pause so that the new parameters can be in effect for the most accurate readings.

### **Screen Scaling & Resolution**

Once the graph is running, you can adjust the screen dB scale by sliding the graph and up and down. You can also change the dB resolution showing on the screen by pinching -- pinch together to get more dB on the screen, or pinch apart to get less vertical dB, and thus more detailed resolution. Double-tap the screen to auto-fit the graph to the display.

You can turn on **Lock Graph Scale** if you want to set a graph range and not have it change on the main screen. The level may still be panned up and down, but the range will not change and the double-tap will not change the scale or range.

### **Saving a Screen Image**

You can take a snapshot of the screen by touching the Save Image button. The image will be saved in the photo roll, and can be emailed or transferred to the computer using various third party apps.

### **Noise Curve Overlays**

To display a noise curve overlay, flip the screen over by touching the info icon in the navigation bar, and select one of the overlays: NCB -- Balanced Noise Curve, RC -- Room Curve, PNC, NR, or Noise Rating, used in the EU, and the cinema large-room X-curve.

The overlay will appear on the graph. To read the noise curve value, find the lowest curve that does not have any bars touching it. You can interpolate between curves to estimate an exact curve number. Now see the overall noise overlay curve value -- in octave mode only, since the noise curve values are only defined for octave band mode.

### **Graph Weighting**

You can select none, A, or C weighting. None will show the actual level of each bar. If you select a weighting, the bars will show the weighted equivalent. This means that the lower frequencies will show lower values in A or C weighting.

### **Max / Min Bars**

You can turn on this option on the setup page. When active, the maximum and minimum levels of each bar is stored, and shown as blue and green bars on the screen.

To reset the bars, just double-tap the screen.

### **Peak Decay Bars**

Peak decay bars will show you the actual peak level of the band, no matter what decay mode you have selected. They automatically decay and will drop into the graph when there is no level above the bar.

### **Hearing Threshold Line**

This line shows the approximate level below which sounds are inaudible to the human ear. This varies somewhat by person, but even so it can be used as a guide to when sounds are not audible.

### **Overall SPL**

The overall unweighted dB SPL level is shown just above the graph, on the right side. Choose unweighted SPL, or A or C weighting on the setup screen.

### **Audio Monitor**

Turn this on to listen to the incoming audio signal in the output. Note that this may cause feedback. Turning on the generator disables Audio Monitor.

### **Pink Noise**

RTA includes a full-featured signal generator, which includes sine waves, square waves, white noise, and pink noise. Pink noise has equal energy in each octave (or 1/3 octave), so in theory if the system is flat, you will see a flat line on the RTA display.

### **Room Tuning**

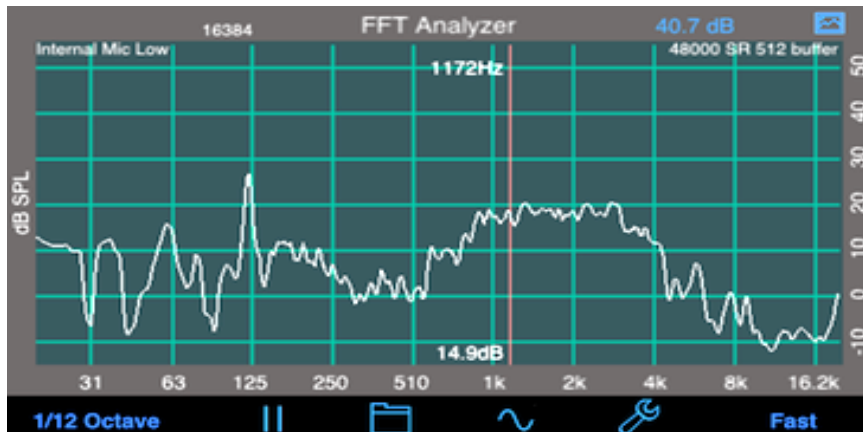
In practice, the RTA is really showing the sum of the direct sound as well as the reflections, so this is not 100% correct. Also, most people roll off the high end somewhat, and many like to boost the low end. So, use the RTA and it's information, but also use common sense, and don't make extreme EQ changes. You're usually better off making conservative changes in EQ, but you should definitely try moving speakers and subs around, and watch the effect in the RTA. Here are some links to learning the basics on room tuning with an RTA:

- [http://www.prosoundweb.com/article/print/whats\\_the\\_measurement\\_understanding\\_and\\_properly\\_using\\_rta\\_fft](http://www.prosoundweb.com/article/print/whats_the_measurement_understanding_and_properly_using_rta_fft)
- [http://mixonline.com/live/applications/audio\\_getting\\_room\\_tune/](http://mixonline.com/live/applications/audio_getting_room_tune/)
- <http://www.studiotips.com/rta.html>

## FFT

FFT is a high-resolution audio analysis tool available as an in-app purchase in AudioTools. It uses the Fast Fourier Transform (see below) to analyze incoming audio, and displays a very detailed graph of amplitude vs. frequency.

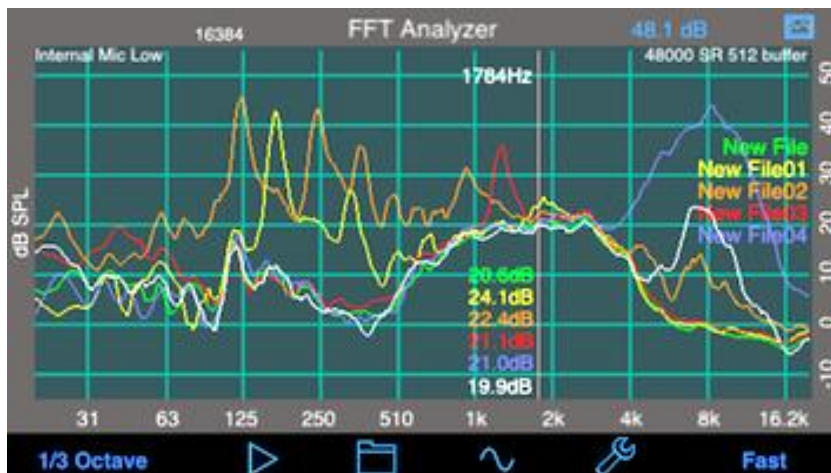
FFT showing full frequency range:



FFT showing low-frequency analysis range:



This application has been designed for acoustics work, and so the FFT bins have been normalized to octaves, to get a display that will show a flat line for pink noise. You can control both the level of graph smoothing and decay time, to get as much or as little detail as you require.



FFT showing multiple recalled measurements, on iPhone 5.

#### Features:

- FFT size from 4096 to 32k (on newer iOS devices)
- Difference mode to compare 2 graphs
- Peak frequency readout in real time
- Signal generator can generate sine waves, square waves, white noise, and pink noise.
- Cursor: Move the finger across the screen to get a cursor to read out exact dB levels and frequencies
- Touch-GUI: use pinch gestures to scale the graph and zoom in on frequencies.
- Double-tap to normalize the graph to full range, and fit the entire graph on the screen.
- Both full range (20-20kHz) and low range (5Hz to 3100Hz) are available.
- Overall dB display
- Save the graph image to the photo roll to include in a report
- Export the data in XLS format.
- FFT windowing available

#### FFT Configuration Examples

**Analyze Speaker Response:** Use Pink noise as the test signal, select Equal Points Per Octave, select 1/6 or 1/3 octave smoothing, select 1s Decay time.

**Music Analysis:** Signal generator off, select the 2048-point FFT, 0.5s Decay, 1/24th octave smoothing.

#### FFT Size

Choose the size of the FFT on the setup screen. The larger the size of the FFT, the more resolution you will have, but the slower the response time. If you choose Equal Points Per Octave, each octave will have high resolution (equivalent to the upper half of a 512 point FFT), but the lower octaves will

update much more slowly. Use this mode for steady-state sound inputs, such as pink noise. (See the section above for more information about FFT size).

### **FFT Windowing**

When turned on, the data is windowed before sending it to the FFT. This has the effect of reducing noise artifacts, and allowing greater dynamic range on the FFT. With windowing turned on, you can get greater than 100dB of dynamic range when looking at sine wave signals.

### **Operation**

#### **Smoothing**

Select Octave, 1/3 octave, 1/6 octave, 1/12 octave, 1/24 octave, or none. Smoothing averages the FFT dB values around each graph point logarithmically.

#### **Decay Mode**

The decay times apply to the graph dB values. A decay time of one second will cause a point to decay at the rate of 20dB/second. Peak Hold holds the highest value received, and Average is a true linear average of all readings over the time of the average. To clear Peak or Average mode, select another mode momentarily and then go back to Peak or Average mode.

NOTE: In EPPO mode, the decay time on the lower octaves is the same as the upper octaves, but since they are not being refreshed as often, they will jump up and then decay back down.

#### **Graph Scrolling**

The graph will scroll up and down when you slide one finger up and down on the screen.

Use a two-finger vertical pinch to adjust the screen scale, to see more or less dB on the screen. Use a horizontal open-pinch gesture to spread out the screen and zoom in on the frequency axis. When the frequency scale is zoomed, you can use two fingers to pan the graph horizontally.

At any time, double-tap the screen to normalize it. This will show the full frequency range, and fit the graph to the screen.

The state of the graph is stored as you make changes, so the next time that you start the FFT app, the zoom and scale settings are restored.

#### **Cursor**

Swiping left and right will bring up a cursor, which you can dismiss by swiping off the graph to the left.

#### **Generator**

Touch the sine wave icon to bring up the built-in generator. You can select the signal type, and for sine and square waves, the signal frequency. Note that digitally-produced square waves start to alias badly above about 2000 Hz, so you will get audio artifacts.

The generator frequencies always change smoothly, to prevent zipper noise, and turn on and off with soft muting.

Like the other calculations, the generator waveforms are created digitally using 64-bit floating point math, and are very accurate and low-distortion. Note that we have found that running the headphone output 1 click below maximum yields the lowest distortion waveforms.

## File Save and Recall

Tap the folder button to access the AudioTools advanced and complete save/recall system. See the Save / Recall page for full details.

## Overall dB Display

The overall, unweighted SPL level is shown at all times on the screen in the upper right-hand corner. This is the same value that is shown on the calibration screen.

## Clipping

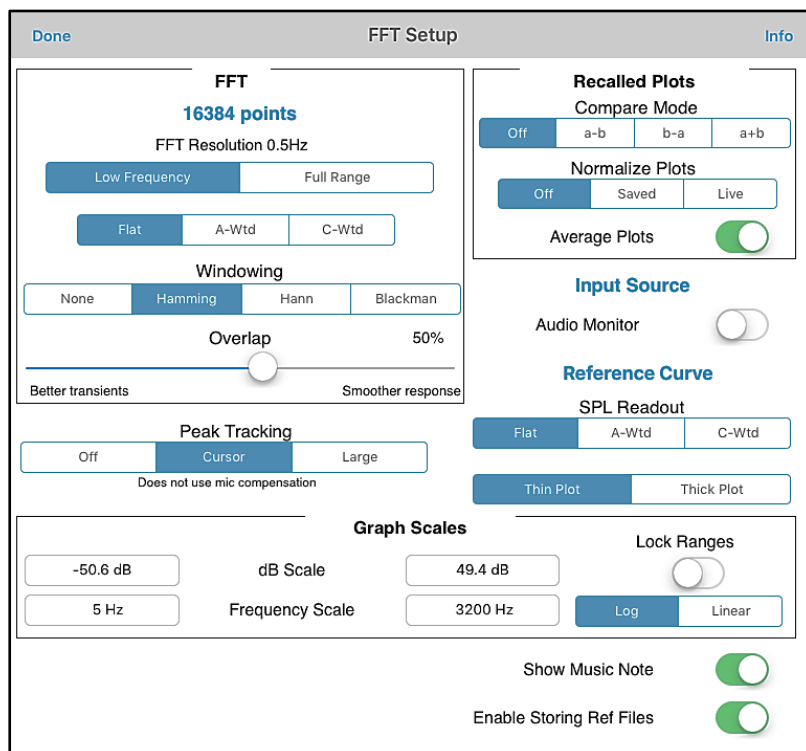
If clipping of the input occurs, the words "Clipping Detected" will be displayed above the graph in the upper left-hand corner in red for 1.5 seconds.

## Octave and one-third octave band values

The octave and one-third octave band values are saved as unweighted Leq sound levels (LZeq) by default. The only time this is not true is when the A or C weighting is applied in RTA or FFT.

## SETUP

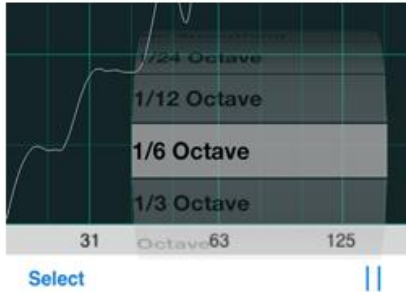
The March 2017 revision has additional features to the earlier (following) setup information.



Let us take a quick tour of the FFT Analyser's Interface:



**F -- Frequency Smoothing Selector:** Taping this select box will bring up the Frequency Smoothing Selector (below). This will combine a number of individual frequency bins into a larger bandwidth bin logarithmically. Smoothing options from 1 octave to 1/24th octave-wide smoothing are available. Taping No Smoothing will display each individual FFT bin on the graph. Tap the adjacent **Select** button to change the amount of smoothing currently being used for the analysis.

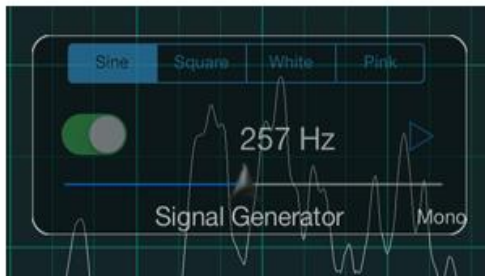


**G -- Start Analysis:** Taping the play/pause button will begin or stop the real time FFT analyzer.

**H -- Save/Recall Screen:** Taping the folder icon will bring up the Save/Recall FFT screen, where measurements can be stored, shared or recalled for comparison with the current measurement.

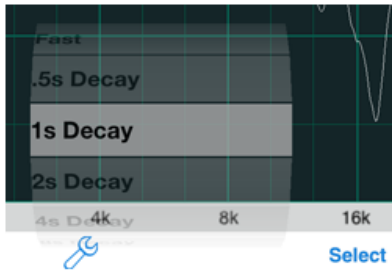
**I -- Generator:** The sine wave icon, when taped, brings up the Signal Generator (seen below). The generator will play back test signals from the output of the connected audio device or internal speakers of the iOS device. The generator can create sine or square wave tones from 5 Hz to 20,000 Hz, white noise or pink noise. To change the value of the frequency of the tone, either use the slider or simply tap on the current frequency displayed and type in the desired frequency with the pop-up keyboard.

When the iAudioInterface2 is connected and the Surround Generator modules has been purchased (*Utilities -> Surround Generator*), the option to play back the signal from any of the surround channels over the optical output of the iAudioInterface2 will also be available.

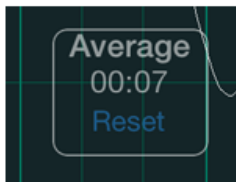


**J -- FFT Setup:** Tapping the wrench icon brings up the setup menu. This menu displays the configuration options of the FFT Generator, which will be described in detail in the [FFT Setup](#) section.

**K -- Decay Mode:** This selector (shown below) will adjust the decay time being used for analysis.



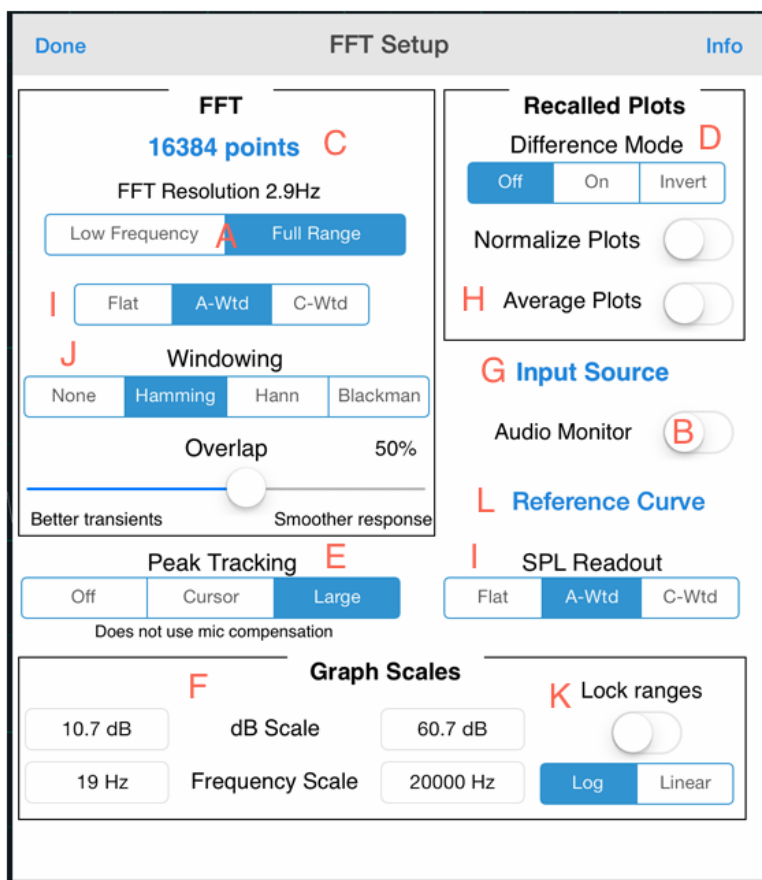
The decay times apply to the graph dB values. A decay time of one second will cause a point to decay at the rate of 20dB/second. Peak Hold holds the highest value received, and Average is a true linear average of all readings over the time of the average. To clear Peak or Average mode, tap the Reset button on the Average box, which appears when these modes are selected.



*NOTE: In EPPO mode, the decay time on the lower octaves is the same as the upper octaves, but since they are not being refreshed as often, they will jump up and then decay back down.*

**Clipping:** If clipping of the input occurs, the words "Clipping Detected" will be displayed above the graph in the upper left-hand corner in red for 1.5 seconds.

## FFT Setup Menu



Tapping the wrench icon will bring up the FFT Setup menu. From here, you can customize how the FFT Analyzer operates. Tapping the *Done* button at any point will bring you back to the main analyzer window. Let's take a look at what each option available does to the analysis.

**A – Frequency Range:** The FFT Analyzer has two options for frequency range: Low Frequency and Full Range. Full Range shows 20 Hz-20 kHz range, while Low Frequency mode shows 5 Hz to 3.1 kHz. The Low Frequency mode is especially useful when you need the most resolution in the lowest octaves of analysis -- measuring a subwoofer's response in a room for example.

**B – Audio Monitor:** Turn on or off to allow audio that is coming in to the audio interface to be presented at the output. *Note: Turning on the generator overrides audio-pass through.*

**C – FFT Type:** Taping this box will allow you to change the number of points being used for the analysis. 2,048, 4,096, 8,192, 16,384 and 32,768 are available, in addition to the EPPO mode. The FFT Resolution of your choice will be displayed in Hz below the FFT Type selection text.

**D – Difference Mode:** Difference mode will allow you to compare the frequency spectrum of an incoming signal to the currently measured signal. Tap the On button and then recall a reference signal from the Save/Recall screen (by tapping the folder icon from the main window). Notice the graph will turn green and the name of the recalled file will be displayed as shown below. The recalled graph is being subtracted from the current measurement. In the example shown here, to current measurement shows less high frequency energy than the measurement that was recalled. Turning on the the normalize plots switch will normalize the broadband SPL so that just the relative frequency spectrum will be compared, and not the absolute level. Taping the invert switch will switch the order of the subtraction -- the current response will be subtracted from the reference signal.

**E -- Peak Tracking:** Turning peak tracking on will track the FFT bin with the highest amplitude and display the frequency either on the cursor or in large text on the screen. Our algorithm uses the actual highest FFT bin, and does not use the calibration compensation, so it may not be the highest point on the graph.




**F -- Graph Scales:** This will select the frequency scale on the X-axis of the main analysis screen. Normally, this is set to Log, where the scale is marked by octaves. Choosing Linear will display a linear frequency scale. You can also set the lower and upper bounds of the dB Scale and Frequency Scale here.

**G -- Input Source:** This is the standard AudioTools input source selection screen, where you can choose microphone gain, or change settings.

**H -- Average Plots:** Turn on this switch to instantiate the average plot mode. When this mode is on, instead of recalling only a single plot at a time, any number of plots can be recalled and averaged. This holds true for difference mode as well, where  $n$  measurements recalled will be averaged together to be the basis for the computation. This is useful when you take numerous measurements in a room, for example, and want to compare them to the next individual measurement.

**I -- SPL Readout:** Adjusts the filter used for the broadband SPL reading on the main FFT Analyzer screen. Choose between Flat, A, and C-weighting filters. In the FFT Setup section, you can also apply Flat, A or C-weighting filters to the whole FFT analysis by changing the options there.

**J -- Input Windowing:** When turned on, the data is windowed before sending it to the FFT. Windows are used as a time weight function and to minimize frequency errors outside the FFT bin caused by the discrete nature of the sample and to reduce spectral leakage. These windows attempt to heavily weight the beginning and end of the FFT sample to be zero and the middle of the sample to be weighted towards unity gain. Read more about [windows for spectral analysis](#). There are three options for FFT Windowing: Hamming, Hann and Blackman. Hamming is the default used. Read more about [Hamming](#), [Hann](#) and [Blackman](#) windows. Underneath the windowing options is a slider to adjust the amount of overlap used in the FFT analysis. The default is 50%. By reducing the value of the slider, the analysis will give you a better transient response in your analysis -- usefully for impulsive sounds like drums. Moving the overlap to the right, gives the analysis a smoother overall response.

**K -- Lock ranges:** This switch will turn on and off the fixed X- and Y-axes of a given measurement. When lock ranges is turned on this lock icon  will be displayed on the main window analysis window. Any subsequent measurement or recalled measurement will be relative to this fixed scale.

**L -- Reference Curve:** Tapping this text will bring up the Reference Curve screen. This option is an in-app upgrade that when purchased is available program-wide in AudioTools. Reference curves are useful if you want to compare live measurements against a pre-defined level, or try to match the curve using EQ, for example, or to test whether a piece of equipment is within spec. Full details about usage are in the Reference Curves info screen.

#### Windows for spectral analysis:

[https://en.wikipedia.org/wiki/Window\\_function#Cosine\\_windows](https://en.wikipedia.org/wiki/Window_function#Cosine_windows)

## Using Gestures

Numerous gestures are supported on the main FFT Analyzer screen for adjusting the view of the current measurement.

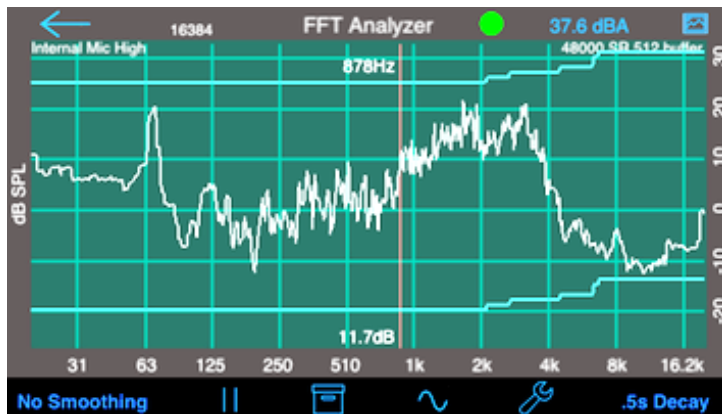
**Double-tap:** At any time, double-tap the screen to normalize it. This will show the full frequency range, and fit the graph to the screen.

**Graph Scrolling:** The graph will scroll up and down when you slide one finger up and down on the screen. Use a two-finger vertical pinch to adjust the screen scale, to see more or less dB on the screen. Use a horizontal open-pinch gesture to spread out the screen and zoom in on the frequency axis. When the frequency scale is zoomed, you can use two fingers to pan the graph horizontally. *Note: if Lock Graph Scale is turned on in the FFT Setup menu, the two-finger pinch gesture will not function.*

The state of the graph is stored as you make changes, so the next time that you start the FFT app, the zoom and scale settings are restored.

**Cursor:** Swiping left and right will bring up a cursor, which you can dismiss by swiping off the graph to the left.

### Reference Curve



FFT also includes support for the optional Reference Curves feature. The example above shows using a single reference curve, with a +/- dB range to say whether or not the live curve is within that range. The green dot shows that this curve passes.

### Full Range / Low Frequency Mode

Full Range shows 20-20kHz range, while Low Frequency mode shows 5Hz to 3100Hz.

### Audio Pass-Through

Turn on or off to allow audio that is coming in to the unit to be presented at the output. Turning on the generator overrides audio-pass through.

### Difference Mode

This switch turns difference mode on and off. When turned on, the most recently recalled graph (if any) is used as a baseline for the FFT function. In other words, the recalled graph is subtracted from the current FFT graph.

You can use Difference Mode to compare speakers, or do a before and after comparison of an acoustic space.

### **Peak Tracking**

Turns peak tracking on, showing the frequency either on the cursor, or in large text on the screen. The algorithm uses the actual highest FFT bin, and does not use the calibration compensation, so it may not be the highest point on the graph.

### **Input Source**

This is the standard AudioTools input source selection screen, where you can choose microphone gain, or change settings.

### **About the FFT Calculation**

**FFT** stands for Fast Fourier Transform, which is a mathematical algorithm that breaks a signal into frequency bins. Each bin is the same size, in Hertz. The size of the FFT determines the width of the bins in Hertz. Bin width = sample rate / FFT size. Since we are running at the iPhone's maximum sample rate of 48000 samples/second, for a 1024 point FFT each frequency bin would be 48 Hz wide. This gives us great resolution at 10kHz, but poor resolution at 32 Hz.

We can run larger and larger FFTs, but since we first have to store up all the samples to fill the FFT, and then do the math, the lag time starts to increase and the display becomes less and less responsive.

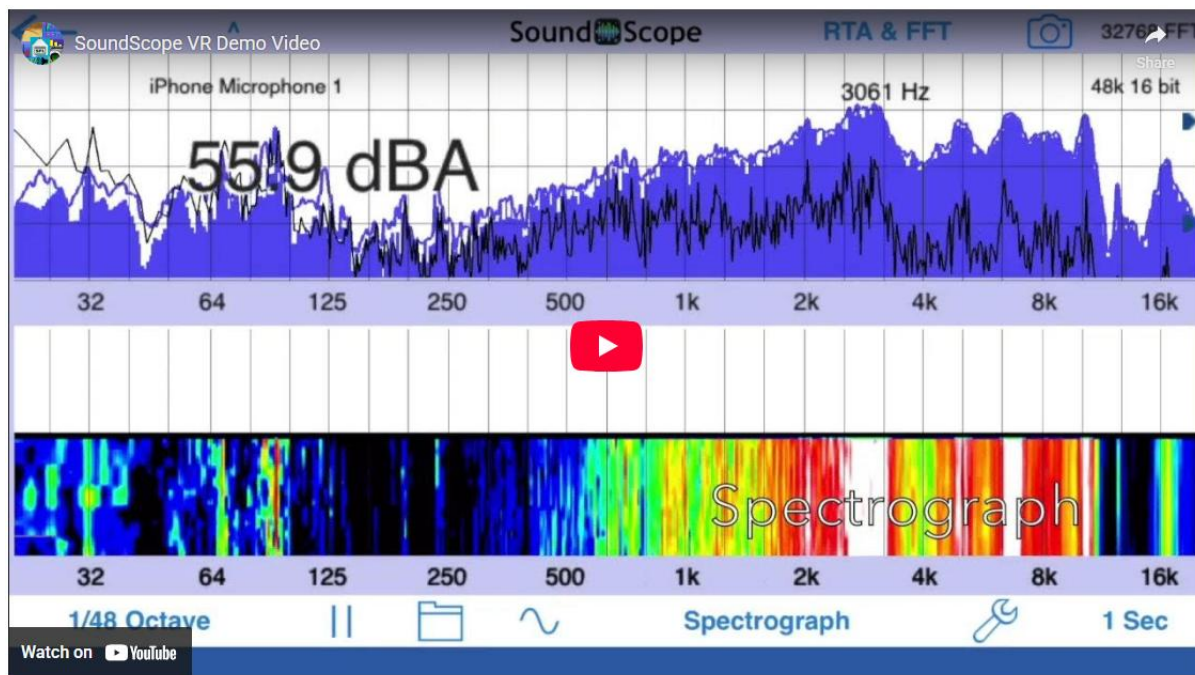
In FFT, we provide the choice of FFT size, currently from 4096 points to 16,384 points (32,576 on the newer iOS models). In addition, we provide another mode, which we call Equal Points Per Octave (EPPO). In this mode, we run a fairly small FFT (currently 512 points), but we only use the top octave from this FFT. So, we get a resolution at 10kHz of about 93Hz. Another way to look at it is that we get about 120 data points in the top octave (think of it as 1/120th octave resolution, which is about right).

Then, we decimate and filter to get the sample rate down to 24kHz, and then run another 512 point FFT. So again, we get 1/120th octave resolution. We continue this process right down to the lowest octave. The result is excellent resolution across the frequency spectrum. The cost is that each octave only updates half as quickly as the octave above it, so the low octaves update much more slowly. The upper octaves retain very quick response.

EPPO is best used with steady-state signals, such as pink noise, or to analyze constant noise signals. If you want to see the entire graph updating quickly, use 4096 or 8192 points. Note that due to the fact that there are individual FFTs running for each octave, you may see graphical anomalies in the noise floor -- for example, since the decimation filter cuts off frequencies above the Nyquist frequency, the lower FFTs don't even get the higher frequencies, and so might have a lower noise floor than the upper FFTs. This is normal. You can adjust the graph to move the entire FFT noise floor off the bottom of the screen to get a cleaner looking graph. All calculations are done in 64-bit floating point for the best accuracy and to get the lowest possible noise floor.

## SoundScope VR® Tools

This is the help guide for SoundScope VR® Tools on the iPhone, iPod touch, and iPad platform.



### GUI

This section describes how to use the Graphical User Interface to operate SoundScope VR.

#### Split-screen (iPad and larger iPhones only)

Use the single/split control to select from a single screen or split screen. You can use the graph type buttons on the top and the bottom of the screen to select which graphs you would like to see in either window.

#### These gestures apply to the RTA screens:

Double-tap to normalize the graph. This will expand the frequency scale to 20Hz – 20kHz, and auto-scale the dB axis to fit the current graph.

Swipe horizontally to move a cursor across the screen. The cursor will show the current dB levels at the selected frequency. In octave-band mode, the cursor will only stop at the center of the bands.

Pinch-zoom horizontally (use two fingers) to expand or contract the frequency scale. Once expanded, you can hold two fingers together and swipe horizontally to pan the frequency scale left and right.

Pinch-zoom vertically to expand or contract the dB scale. You can use a single finger to pan the dB scale up and down.

### **These gestures apply to the Spectrograph screen:**

When the spectrograph is running vertically, you can use a single finger to pan the graph down, so see activity that is in the history buffer. If the graph is in run mode, it will snap back to real time when you let go. If it is stopped, it will stay where you leave it. A scroll indicator appears on the side of the graph to show you how far you have moved into the history buffer.

Likewise, when the spectrograph is running horizontally, you can use one finger to slide the graph, showing the data from the history buffer on the screen.

### **Spectrograph & Lines behavior**

On the iPhone and iPod touch only, the RTA Lines display may be overlaid on top of the Spectrograph. In this case, the Spectrograph history function is only available when the graph is not running. When it is running, the normal RTA screen swipe gesture applies.

### **RTA**

This section describes how to use the Real Time Analyzer, or RTA.

### **FFT Based**

The SoundScope VR Tools RTA is based on data obtained from running an FFT. The more points in the FFT, the more resolution you will get on the RTA graph, but the tradeoff is update speed. You can set the FFT size on the setup page, which is accessed by tapping the wrench icon. A good balance between resolution and update speed might be 8192 points. Note that some devices will run the FFT faster than others, so experiment to find what works best for you.

### **Graph Type**

There are several graph types available:

- RTA Bars – Octave-banded modes are displayed as bars on the screen.
- RTA Lines – Frequencies are shown as a continuous line, with granularity to the selected octave band mode.
- RTA & FFT – Octave-banded modes are displayed as bars on the screen, with the underlying FFT also shown.
- Spectrograph – See Spectrograph description, below.

### **Banding Mode**

The banding mode determines how frequency data is shown on the screen. SoundScope VR Tools uses ISO standard banding and frequencies. The available banding modes are:

- Log — Frequency is displayed logarithmically across the screen. In this mode, the display is always shown in line mode.
- Lin – The frequency axis is linear, where the frequency axis midpoint is in the center of the screen. In this mode, the display is always shown in line mode.
- Octave – The frequencies are grouped into octave bands. Note that in an RTA, any single frequency peak will push the entire band up.

- 1/3rd Octave – The frequencies are grouped into 1/3rd octave bands.
- 1/6th Octave – The frequencies are grouped into 1/6th octave bands.
- 1/12th Octave – The frequencies are grouped into 1/12th octave bands.
- 1/24th Octave – The frequencies are grouped into 1/24th octave bands.
- 1/48th Octave – The frequencies are grouped into 1/48th octave bands.

### **Decay**

There are several decay modes available. These decay modes parallel the decay modes in SoundScope VR 7.

None – No decay, the display updates as quickly as possible.

- 1, 2, 4, 8, or 16 – In this mode, the FFT will be linearly averaged by the number selected.
- 1-10 seconds – This mode is specific to SoundScope VR Tools, and uses a proprietary algorithm developed for SoundScope VR 7. It is useful for acoustic analysis, since new data will rise quickly, but will then stay visible and decay more slowly.
- Inf – (Infinite). This mode will continually average FFTs, for any length of time. Use it to gather a sonic signature over time. To reset the averaging, select it again.
- Fast – ANSI / ISO Fast mode, with a time constant the same as an SPL meter set to Fast.
- Slow – ANSI / ISO Slow mode, with a time constant the same as an SPL meter set to Slow.

### **Overall dB Display**

The overall un-weighted dB level is shown on the top of the screen. To show this in a larger font, tap the number. Tap the same location to make the number smaller.

**The following items are set on the Setup page:**

#### **Peak Tracking**

You can turn on peak tracking on the Setup screen. If on, the highest peak for the current banding mode will be displayed near the actual frequency on the screen. In large mode, it is shown in a large font in one location on the screen.

#### **Difference Mode**

When you have recalled a stored graph, difference mode is available. It is turned on from the Setup page. When running, difference mode causes the stored the graph to be subtracted from the current graph, and the difference is shown on the screen, in dark green.

#### **Lock Graph Scale**

Turn this on to prevent any changes from being made to the graph scale.

#### **FFT Windowing**

FFT windowing improves the quality and signal-to-noise ratio of the FFT. Three variants are available, Hamming, Hann, and Blackman. *Acoustar Note: The Hann weighting is used as the window function for acoustical measurements.*

### **Spectrograph (Sonogram)**

A spectrograph or sonogram is basically a way to visualize frequencies over time. In essence, the audio spectral response is shown as a line across the screen, where louder frequencies are shown in brighter colors. So, as the spectrograph runs, you can see a history of sound events as color blotches on the screen.

To use the Spectrograph, you will set a high and low limit for the dB levels that you are interested in visualizing. The dB levels are set by dragging the markers that appear on the right side of any of the RTA displays. To move these, use a two-finger vertical pinch gesture, at the right side of the screen. Horizontal lines will extend out across the screen from the indicators, while you are adjusting the levels. Normally, the levels are set so that normal background noise is not visible, and only sound events above a certain threshold are visible.

You can also choose whether you want the Spectrograph bars to move up the screen, or to move from right to left. This is set on the Setup page. Tap the wrench icon to access this page. To make the Spectrograph move up the screen, turn on Vertical Run. When you are running in this mode, the RTA frequencies will be aligned with the color bars on the Spectrograph.

Horizontal run can be useful to visualize speaker array coverage. Play pink noise, and walk across the sound field, in front of the array. The frequency response can now be seen as a function of distance. If the frequency response of the coverage pattern was perfectly uniform, the color blob would not change as you moved.

You can also adjust how fast the Spectrograph moves, which also effects the amount of information that is visible on the screen. This setting is also on the Setup page.

Also, SoundScope VR saves a real-time history of recent Spectrograph activity. To see part of the graph that has scrolled off the screen, just touch and swipe to pull it back on the screen. If the Spectrograph is running, it will snap back to real time when you let go. If you stop the Spectrograph (by tapping the Play/Pause button on the bottom of the screen), you can scroll back to previous activity and the graph will stay put when you let go. When you tap Play again, it will move to the most current info.

Note that the Spectrograph display will be cleared any time that the banding or graph type changes, or on the iPad, when you change the screen orientation. To prevent orientation changes from occurring, you can lock screen rotation. To do this, double-tap the iPad home button to bring up the multi-tasking bar, swipe right, and you will see the screen lock icon. Tap this to prevent the screen from rotating.

Also note that changing the frequency axis only changes new data that is being saved to the Spectrograph screen, previous data will not be re-graphed to the new frequency axis.

The octave banding mode also interacts with the Spectrograph display. Larger octave modes make for more smoothed Spectrographs, and smaller octave modes (like 1/12th -1/24th octave) make for more detailed displays.

Note that the Spectrograph is not effected by the RTA decay settings. It always runs with no decay.

### **Save / Recall**

The Save / Recall feature is accessed by tapping the tilted-square “picture frame” icon on the bottom of the screen.

The functions are the same as those available from other modules in AudioTools, and include saving the raw FFT data to a tab-delimited text file, optionally storing GPS coordinates, a photo (for devices with cameras), and a notepad. Saved data can be synced to a computer over WiFi, by using the Utilities->Files function. When recalled, the recalled graph appears in maroon color on the screen.

If a graph has been recalled, Difference Mode is available.

### **Generator Panel**

Tap the Sine icon to bring up the Generator Panel. This panel gives you basic signal generator control from the SoundScope VR Tools screen.

### **On / Off**

Turn the signal generator on or off using the switch.

### **Signal Type**

Select the signal type by tapping the selector. You can select from sine wave, square wave, white noise, or pink noise signals.

### **Frequency**

Set the frequency by moving the slider, or by tapping the frequency number to bring up a keyboard where you can enter an exact frequency value.

### **Sweep Control**

You can start and stop the sweep generator from this screen. The sweep start and ending frequencies and sweep time are set on the main Generator screen (on the Utilities menu) in landscape mode. To dismiss the Generator Panel, tap the sine icon.

## Tips & Techniques

**White or Black Spectrograph** – If your spectrograph display is solid white, it indicates that all of the sound coming in is above the upper spectrograph marker is set too low. If the screen is all black, it means that the lower marker is set too high. You can use a two-finger pinch on the right edge of the screen to adjust them, or just double-tap the screen to set them to a good starting position.

**Fastest updates** – To get the quickest updates on the screen, go with a small-to-mid size FFT, say 4096 or 8192, and turn off the spectrograph. Also, you will get the quickest response drawing a single graph, and by using one of the lower decay rates, like 2, 1 second, or Fast.

**Quick Screen Scaling** – Double-tap the screen to auto-scale both the frequency and dB axis.

## Saving Data - iCloud

**Note:** The same process is used for SPL Graph files.

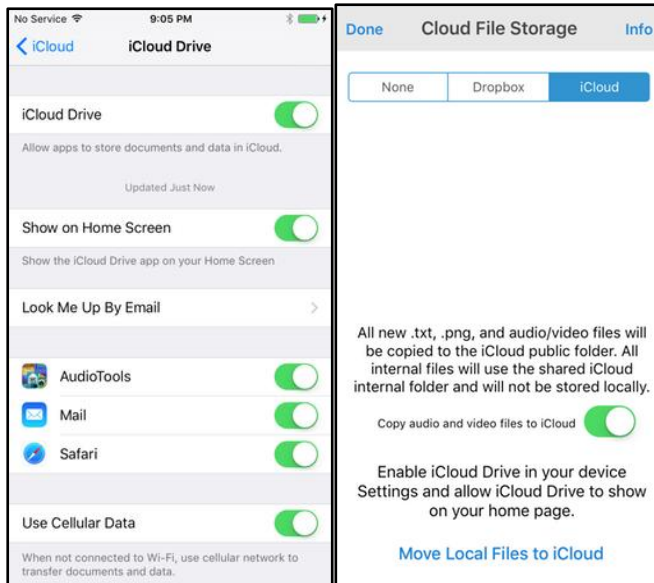
Apple iCloud is fully supported. Some of the features include:

- All files are now stored on iCloud, if enabled. This includes internal as well as public files such as the tab-delimited output files, audio files, image files, and text files.
- All files are stored under the "studiosixdigital" icon in iCloud.
- Access the files from any iOS device connected to the same iCloud account. Run tests on your iPhone, view them on your iPad without having to manually transfer any files.
- Get data and audio files on your computer instantly, even if the tests were done remotely.
- Easily import microphone calibration files and reference curves, just drop them into your iCloud on your computer.
- Files are cached on your device and uploaded automatically to iCloud when you have network connectivity.
- Easily manage your files from your computer or iOS device iCloud drive. Delete or rename files directly.

## Operation

To enable iCloud support in AudioTools, first make sure that you are logged into iCloud and that you have iCloud Drive turned on in your iOS device settings.

Next, turn on "Show iCloud Drive on the Home Screen". Not strictly required, but it is very useful to be able to see all the files that are stored and to be able to delete or rename them.



Apple gives you a free 5Gb iCloud drive, and it is fairly inexpensive to upgrade to larger sizes. Lastly, go to the Settings->General page in AudioTools and select iCloud as your cloud storage preference.

Tap the "Cloud File Storage" button on the top of the page in the File Storage box. That's it! iCloud is now enabled and ready to use.

### File Migration

If you have files that you would like to move from local storage to iCloud, run the Migrate Files function. To access this, just turn on iCloud, and tap the "Move Local Files to iCloud" button. The Migrate Files screen appears. Just tap "Begin File Migration" and wait for the process to complete. Files from the /public folder tree will be moved, not copied, so they will be deleted from local storage. Files from the internal folder will be copied.

The migrated files will be available immediately, whether or not you have internet connectivity. They will also be copied up to your iCloud when you are connected to the internet. All files will be assigned the file dates of the original files.

During the file migration process, the step number of type of file that is being copied will be shown on the screen. It is also possible to specify a certain step for this process, if you only need to move some files. See the File Migration Step Guide page for more information about this.

You can interrupt the file migration by pressing "Stop File Migration" the files in the public folder that have already been copied will be skipped, but internal format files will be copied again.

This process will overwrite files in iCloud with the same name, so be aware if you have iCloud files that may be duplicate local file names.

Note: With very large file sets, to prevent memory overruns you may need to run the File Migration one step at a time. It may also help to reboot your device between runs.

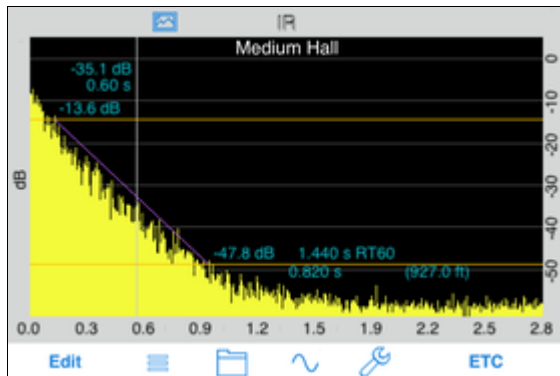
If you want to go back to local storage after migrating to iCloud, you have to manually move the files from the public folders back to the public folders using iTunes File Sharing. Just drop the entire public folder from iCloud to iTunes file sharing for the AudioTools app.

### **File Management**

Every data file will be saved on iCloud. Apple manages the syncing of files automatically, and you can easily access the files from your computer File Manager, or the iCloud Drive app on your iOS device. You can delete or rename files manually on your iCloud, using the iCloud Drive app on your device or by using the iCloud folder from your Mac, or from browser on any computer, by logging into your iCloud account at [icloud.com](https://icloud.com).

Note that if you are accessing files that were created on another device, the first time that they load it may take some time for iCloud to download them. This is normal, and the next time that you download them they will open immediately.

## Impulse Response



The Impulse Response module for AudioTools or standalone application provides an easy way to capture an IR audio file on iOS devices, and also calculates the most-needed metrics from the data. Impulse Response is an iOS port of a powerful mathematical model developed on desktop computers by Daniel Valente, Ph.D Architectural Acoustics, Rensselaer Polytechnic Institute. In seconds, a complete set of measurements is made that describe the acoustic character of a room, or the response of a loudspeaker.

Impulse Response on the iOS device will give you very good results, even with the built-in mic. Of course, you are limited to moderate SPL levels, and the lowest frequency bands will not be as accurate as when used with iAudioInterface2 or iTestMic, but Impulse Response will give you accurate reverb decay times and other measurements.

When you first access the Impulse Response recording screen, the reference sweep files will be downloaded. Or, you install them directly using iTunes. This is especially useful if you are using the Surround Signal Generator.

Be sure to check out our Impulse Response demo videos. Also see our two new videos, New Features in Impulse Response, and Gated Loudspeaker Measurements.

The Impulse Response can be computed either from recording an actual impulse, like a balloon pop or handclap, or from recording a swept sine wave which is the converted to an impulse through deconvolution, all from within the iPhone.

**Important: make sure you download our IR sweep files below, and play them from another iPod or a CD when recording an impulse response sweep. If you have not downloaded them in a while, please update to the latest versions on this page for best results.**

### Recording an Impulse Response

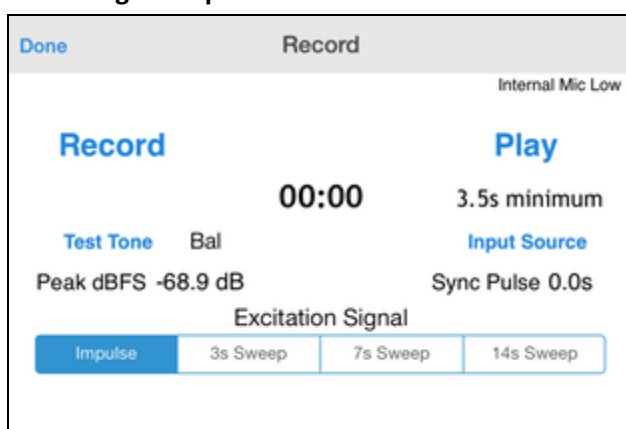
You can record either an actual impulse, or a swept sine wave that the app will deconvolve into an impulse. If you plan on recording a swept sine wave, download our three excitation signal files and burn them to a CD or put them on another iPod.

You can also play the sweeps on another iOS device with Remote Control Generator. Also, you can use AudioTools Wireless for remote recording of Impulse Response files.

To record your impulse response, go to the Impulse Response module in AudioTools, and tap the sine wave icon, which will bring up the Recording screen. The first time that you access this screen, the three reference swept sine signal files will be downloaded from our server and saved on your device. You can always re-download them by tapping the "reload" button. This could become necessary if we change the sweep files in the future.

Next, select the type of impulse response that you will be recording: Impulse, 3 second sweep, 7 second sweep, or 14 second sweep.

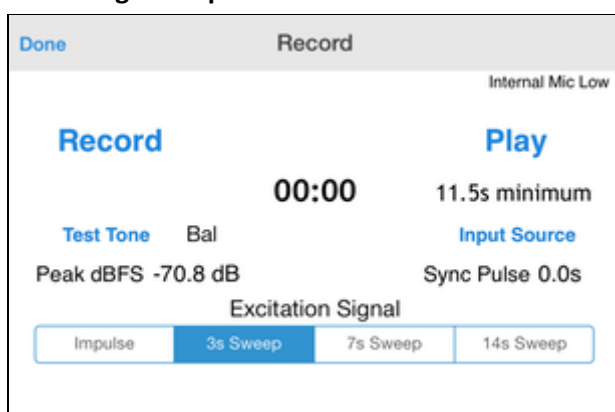
### Recording an Impulse



To record an impulse, such as a handclap or balloon pop, just start recording, and create the impulse. Make sure that the Clip indicator does not appear. You can also listen to the impulse to check it, by pressing the Play button. When you are happy with the recorded impulse, tap Done to return to the calculations screen.

After recording the impulse, tap Done to get back to the main screen, where you will see the ETC of the impulse.

### Recording a Swept Sine Wave



You can select a 3 second, 7 second, or 14 second sweep. The tradeoff is that the shorter files process much more quickly, and require less device memory (although we have not yet found a situation where any device has actually run out of memory), and the longer files generally will give you better a better signal to noise ratio (S/N). You may want to start with a 3-second sweep as you get your setup working properly, and then switch to a longer file if you need to.

Next, setup your playback system with the CD or iPod playlist that you created earlier. Connect to a system with only one speaker active, and try playing the sweep. Listen for obvious distortion or other problems.

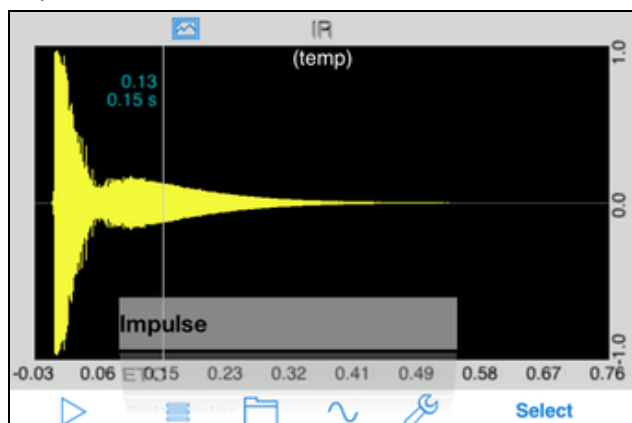
When you are ready to start recording, tap the Record button on the Recording screen, and then start the sweep playing. You will hear a short sync tone, followed 5 seconds later by the sweep. Wait until the minimum time displayed on the screen is reached before tapping Stop to end the recording. Watch the level meter as the sweep runs.

Check that "Clip" does not appear on the screen, and that the sweep got more than half-way up the level meter. The yellow area is perfectly fine. If you like, you can play back the sweep and listen to it. At the end of the recording, a message box will appear asking whether you want to Deconvolve the sweep, or Cancel. If you are happy with the recording, choose Deconvolve. A series of calculations will begin, that make take up to several minutes, depending on the speed of your device. The new models are much faster.

If all goes well, you will see the word "Done" in green, and you can tap Done and go on to the calculations screen. If there is a problem, it will be shown on the screen. The most likely problem is that the sync pulse may not be found. The sync pulse must occur at least one second after starting the recording, and must be within 20dB of the loudest part of the sweep. Also, the recording must be long enough to include at least 5 seconds of decay after the sweep. Normally, just waiting for the final sync pulse will allow enough time.

When you go back to the calculations screen, the ETC will be computed and shown on the screen. From here you can look at other parameters and metrics, or trim (edit) the IR.

#### Impulse Plot



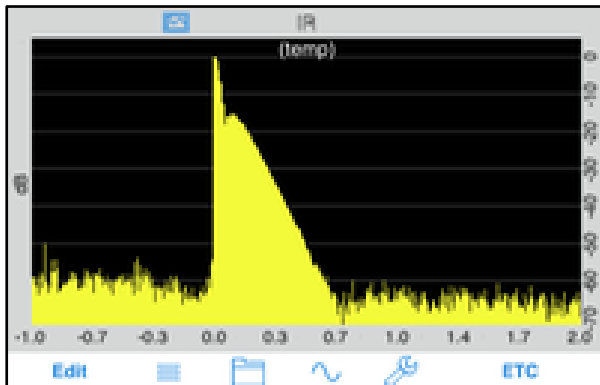
The Impulse plot shows the decay of the IR visually. You can use the cursor to read out the exact level magnitude and time.

Also, you can tap the Play button to play the impulse. This can be useful to listen to the sound of a pulse decaying in the room, especially if you have created the impulse from a swept sine, by deconvolution.

You can also use a pinch-zoom gesture to expand the image on the screen to see more detail.

### Editing the Impulse Response

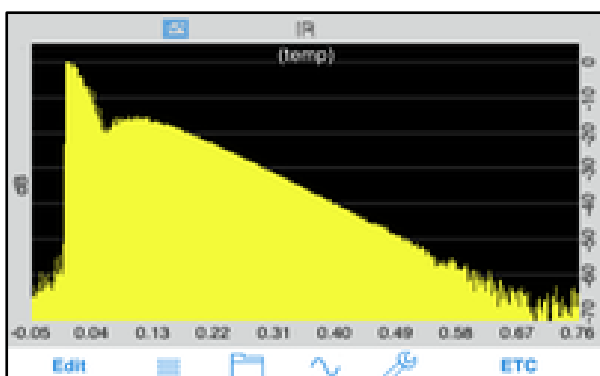
Often you can get better results by trimming the start and end of an impulse response. If you have recorded an actual impulse, it is highly recommended that you trim the result. If you have recorded a swept sine, sometimes the resulting IR will need some trimming before the impulse, and the noise after the decay curve can be trimmed to shorten the screen window for a better look at the data.



### Before editing IR

When running a swept sine, if the sample rate of the playback device is slightly different than the sample rate of the device that the app is running on, even by just a few Hz, you may see a shorter false peak before the actual impulse. It is important to trim this for the best results.

To edit an IR, go to the ETC screen, and use the pinch/zoom gesture to expand the display. Your goal is to remove extraneous sound before the actual impulse begins, without cutting into the impulse itself, and to remove noise after the decay ends, without cutting into the decay curve itself. The result needs to be at least 0.5 seconds long. 1.0 second is fine.



### After editing IR

When you have trimmed the ETC, tap the Edit button and select Save File. This will remove the areas of the IR that are not on the screen and the ETC and cause calculations to be re-done.

After trimming, you can then select one of these calculations to display in a bar chart, either by octave band or 1/3 octave band. Calculations are done as needed when you change graph selections.

### Windowing the IR

In some cases you will get better calculation results by windowing the IR. Windowing can also be used to inspect a portion of the IR, and to remove reflections from the IR so that you can see the frequency response of a loudspeaker, without the effects of the room. The window is applied before all of the calculations are done, but is used most often in conjunction with the FFT plot, in order to inspect the frequency spectrum of a portion of the IR.

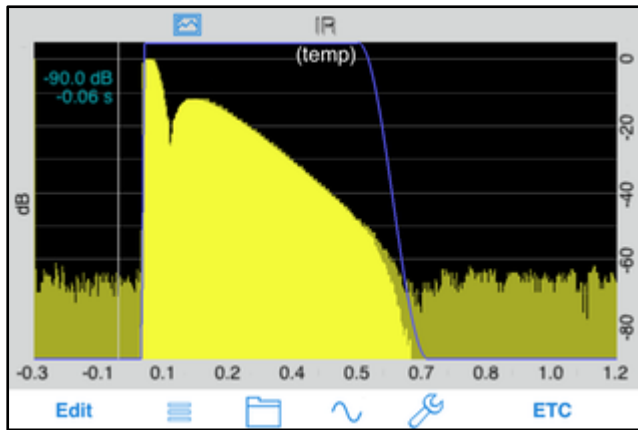
Windowing is controlled by these parameters, which are accessed on the Setup page. Tap the wrench icon to bring up the Setup page.



The left and right portions of the window are controlled separately, so that you can precisely control the window.

There are controls here for the size of the left and right windows, and the reference time. Normally you will reference the window to 0.0 ms, which is the time of the peak of the IR. You may shift the windows if you wish to inspect the frequency spectrum at some point in the decay, for example to see the sonic coloring of the room as the signal decays.

You can also select the function that shapes each window. Rectangular is a hard cut of all data before or after the window, but normally you will get a smoother FFT.



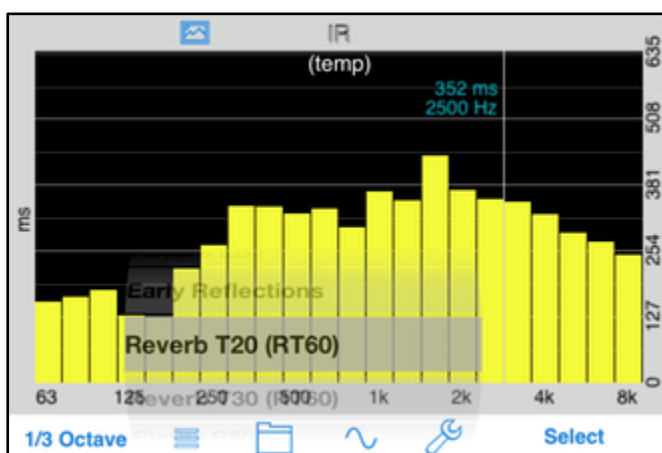
Here is an example of a typical windowed IR, using the settings shown above.

Note that we have windowed out the noise before the direct sound, and we have also windowed out most of the noise after the decay.

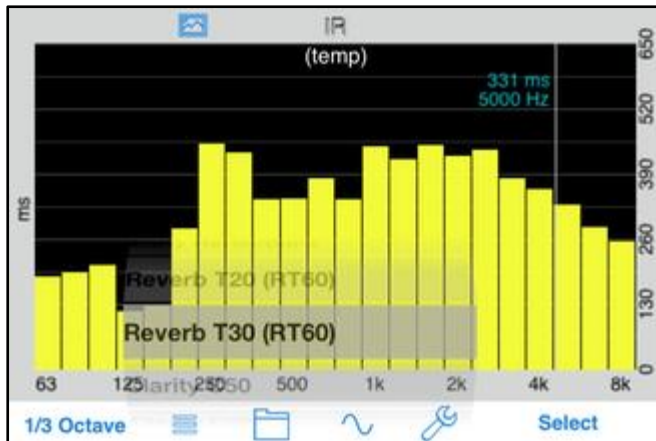
This is a typical use of windowing to get better overall IR results. Windowing can also be used to inspect loudspeaker frequency response, independent of room effects.

### Octave and 1/3 Octave Bar Charts

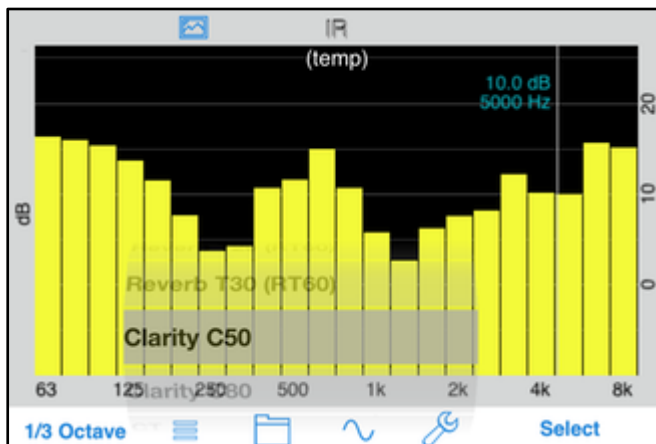
**T20** -- T20 is the decay rate of the impulse response or reverberation time, the time that it takes for a sound to decay by 60 dB in a space. By using a noise compensation technique to avoid inaccurate representations of reverberation time, the decay rate is calculated by determining the slope of the decay function from -5 dB to -25 dB, and extrapolating the time to a decay of 60 dB.



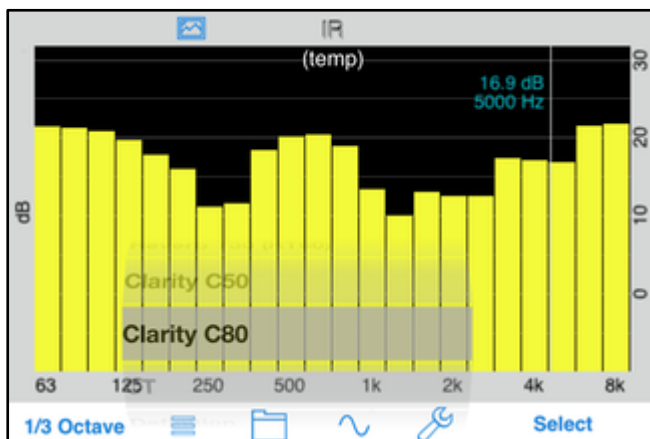
**T30** -- T30 is the decay rate of the impulse response or reverberation time, the time that it takes for a sound to decay by 60 dB in a space. By using a noise compensation technique to avoid inaccurate representations of reverberation time, the decay rate is calculated by determining the slope of the decay function from -5 dB to -35 dB, and extrapolating the time to a decay of 60 dB.



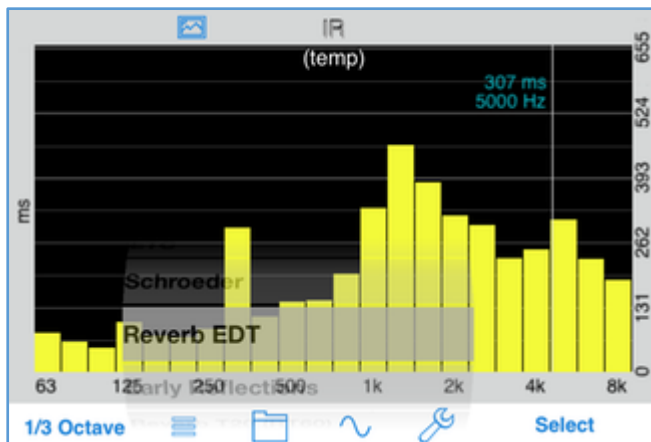
**C50** – The Clarity Factor (50ms), expressed in decibels, is the ratio of the early energy (0-50 ms) to the late reverberant energy (50-end of the decay of the IR). C50 is perceptually aligned with speech perception.



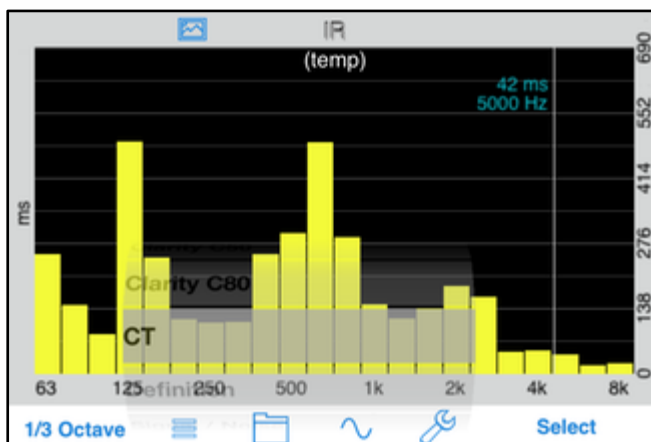
**C80** – The Clarity Factor (80ms), expressed in decibels, is the ratio of the early energy (0-80 ms) to the late reverberant energy (80-end of the decay of the IR). C80 is perceptually aligned with music perception.



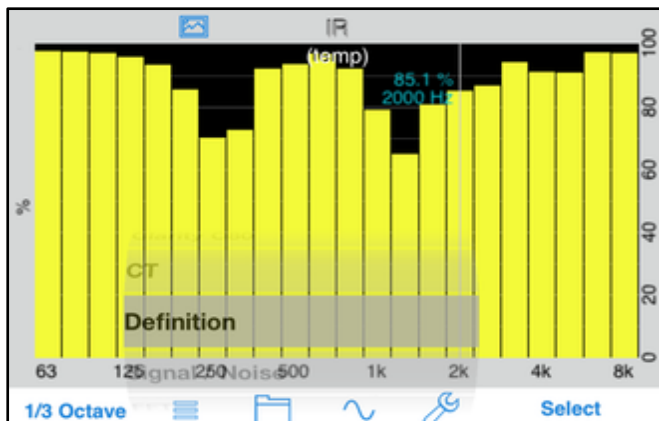
**EDT** – Early decay time represents the decay function of the IR in the slope of the early part of the energy decay curve. It is the slope of the curve limited from 0 dB to -10 dB extracted to a decay of 60 dB below to stopping of the direct sound energy. EDT is typically associated with the perceived reverberation time in a room.



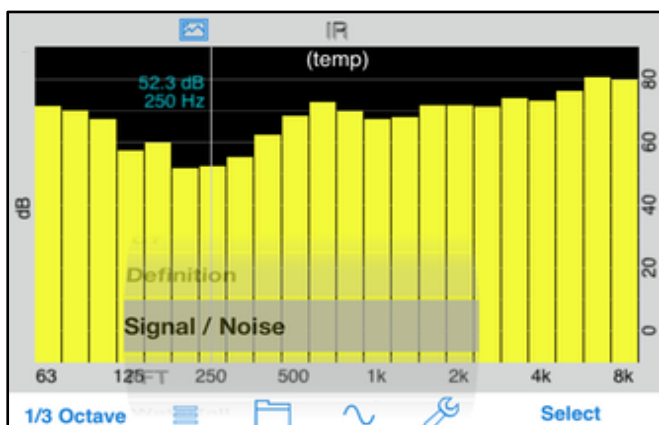
**CT** - Center time or  $T_s$  is the time after the onset of the direct sound to the time where half of the energy has decayed in the IR. It is the time corresponding to the "balancing point" or center of gravity of the squared IR. Center time is correlated with reverberation time, so center time increases as a function of reverberation time.



**Definition** – Similar to the C50 metric, definition represents the ratio of sound arriving in the first 50 ms of the IR compared to the rest of the IR. It is expressed as a percentage and correlates to speech perception in a room



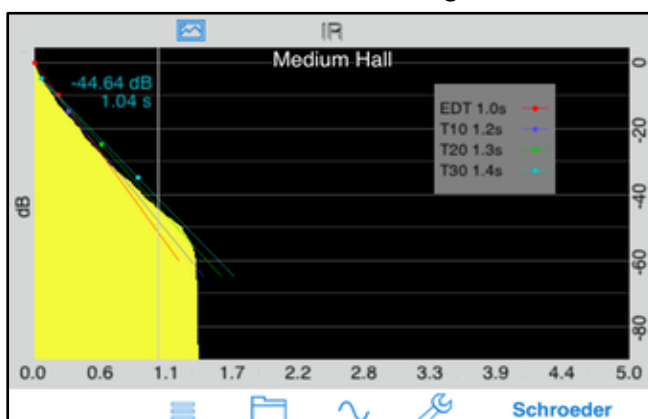
**S / N** – Signal-to-Noise ratio represents the difference between the measured signal captured by Impulse Response versus the noise floor present in the room under test. It is a good tool to verify that the measurement signal that is being used will yield quality results. Aim for a S/N ratio above 50 dB whenever possible or the reliability of the derived metrics of the IR will be reduced.



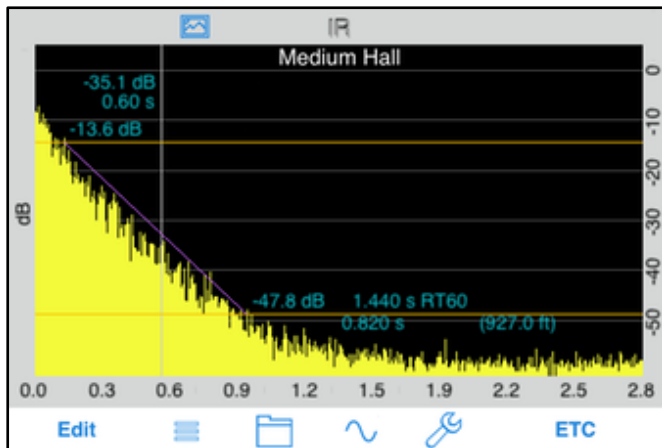
### Wide-Band Plots

Also, these plots are available, for the wide-band signal:

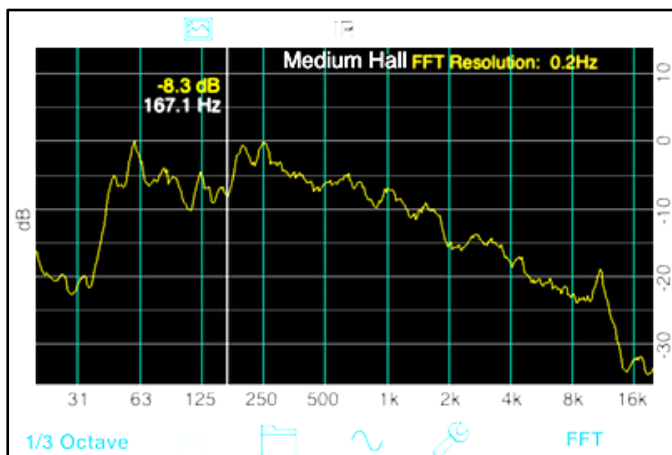
**Schroeder Plot** – The backwards integration of the decay function of the impulse response.



**ETC** -- This is the time-domain plot of the decay response of the IR

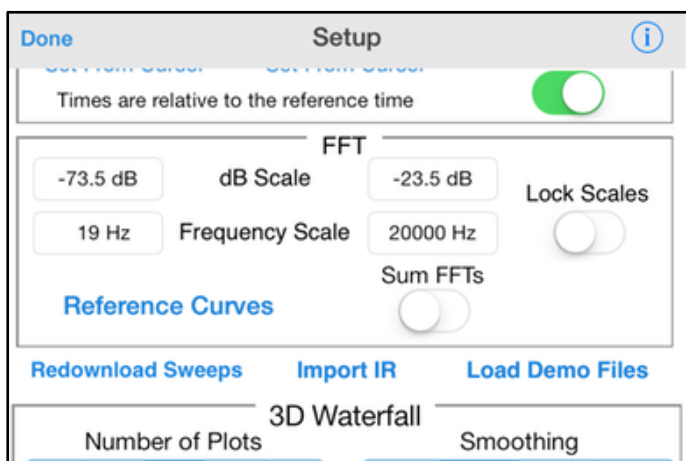


**FFT** -- The FFT of the ETC results in the frequency response graph for the signal.



The FFT has a cursor, that you can use to read out the exact dB level and frequency. You may change the smoothing from none to 1/12th, 1/6th, 1/3rd, or octave.

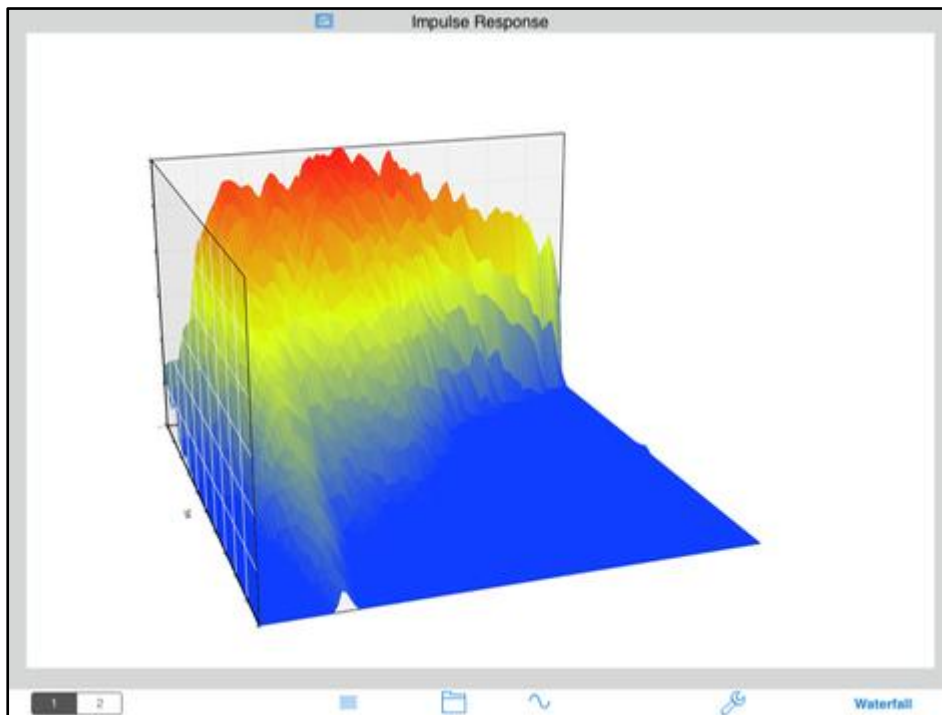
You can also use a pinch-zoom gesture to change either the dB or frequency range. Double-tap to return to full range. Two FFT plots may be seen, and a composite FFT plot may also be derived and drawn.



Here is the settings page for the FFT parameters. Note that the Reference Curves option is also available for this plot. You can also lock the FFT graph scales and manually set the graph scale range from this screen.

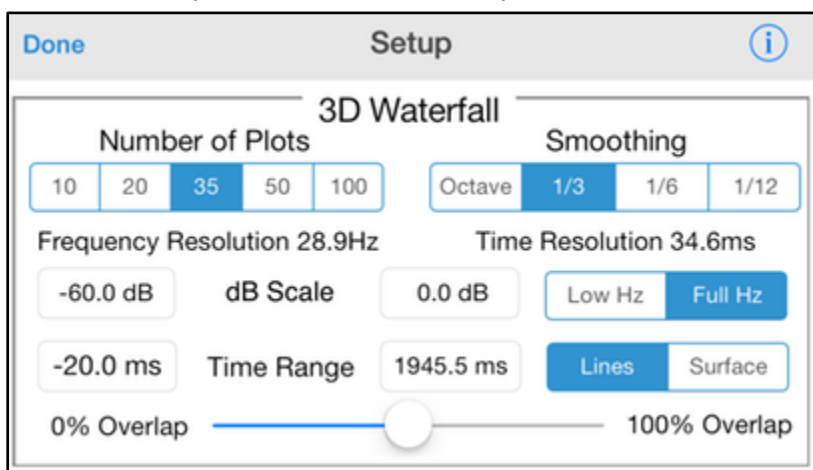
### Waterfall Plots

A 3D waterfall plot that shows the decay of the sound spectrum by frequency over time may be shown. You can select between a plot of lines, or a solid surface. You can also select a full frequency plot, or just see the low frequencies.



Waterfall plots are created by computing a number of individual FFTs, often called slices, each covering a small portion of the IR. The time range for the slices and the number of plots (slices) control the frequency and time resolution of the graph. You can also set the frequency smoothing for the plots, and the overlap, which will smooth the plots in time.

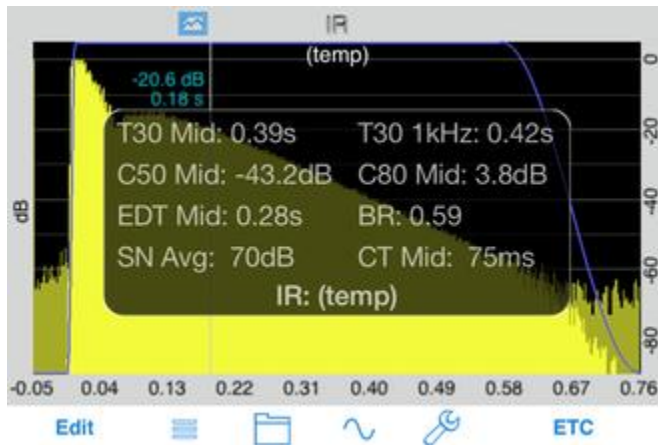
Here is the setup screen for the waterfall plots.



## Summary Page

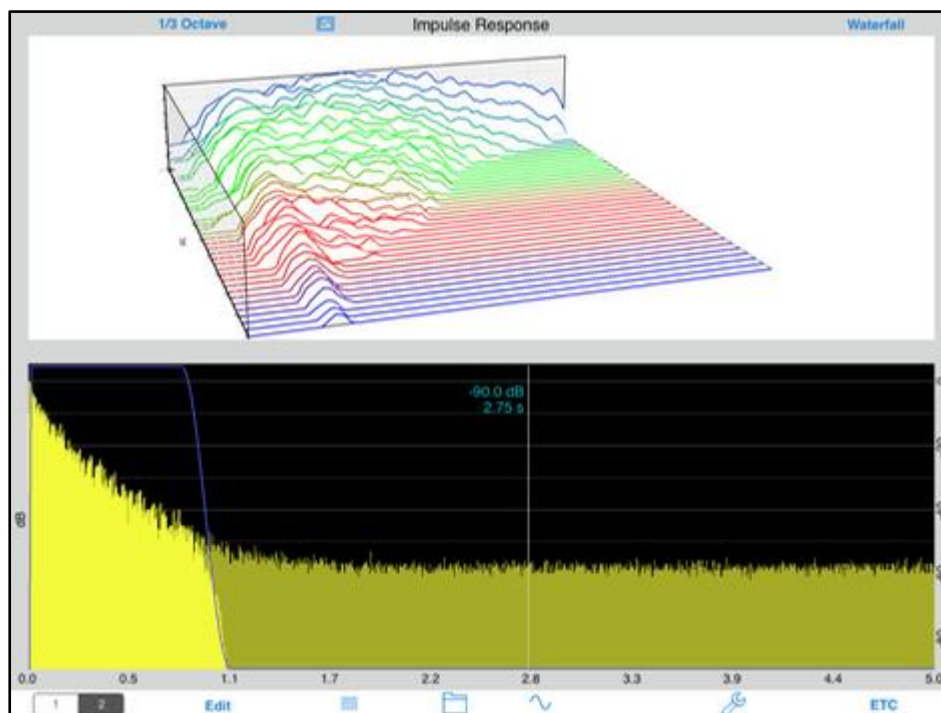
We have a summary page that shows a set of basic measurements:

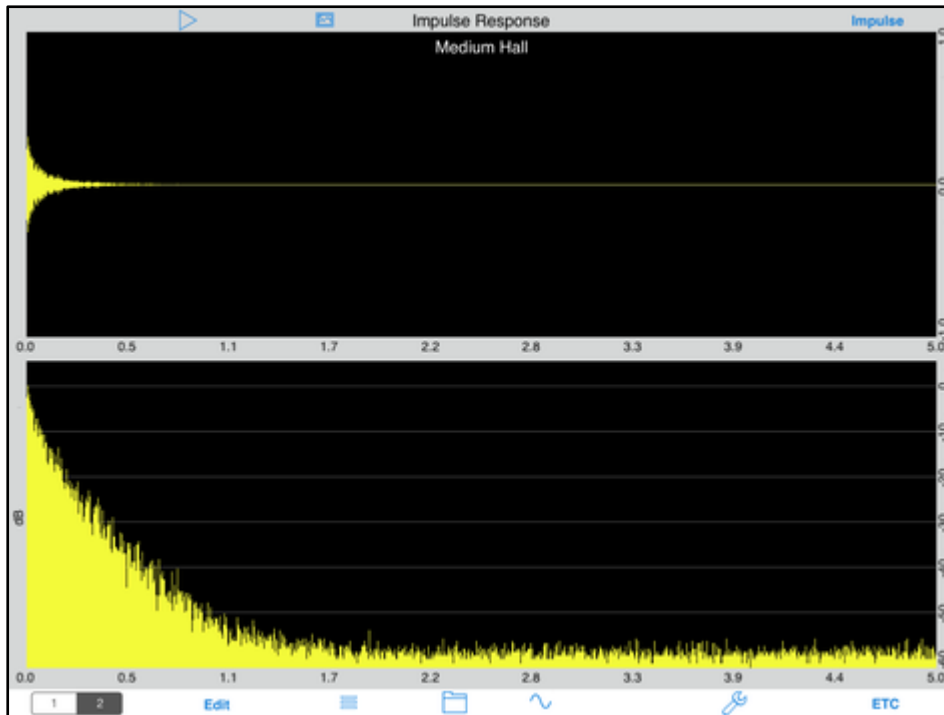
- T30/EDT/C50/C80 Mid Values – This is the average value for the Reverberation time, and Clarity in the measured room taken at the 500 Hz and 1 kHz Octave Bands.
- S/N Broadband – The overall signal-to-noise ratio, expressed in dB of the measured IR.
- Bass Ratio – The metric that correlates to the “warmth” of a room. It is calculated by adding the T30 values for the 125 Hz and 250 Hz octave-bands and dividing them by the sum of the T30 values for the 500 Hz and 1 kHz octave bands.



## Impulse Response on iPad

iPad is an excellent platform for Impulse Response. Since we have more screen real estate, we allow splitting the screen into two graphs, so you can see two different plots at the same time. This is great for things like windowing, where you can adjust the window using the ETC plot and instantly see the results on the FFT plot. Or, see the ETC and waterfall plots at the same time.

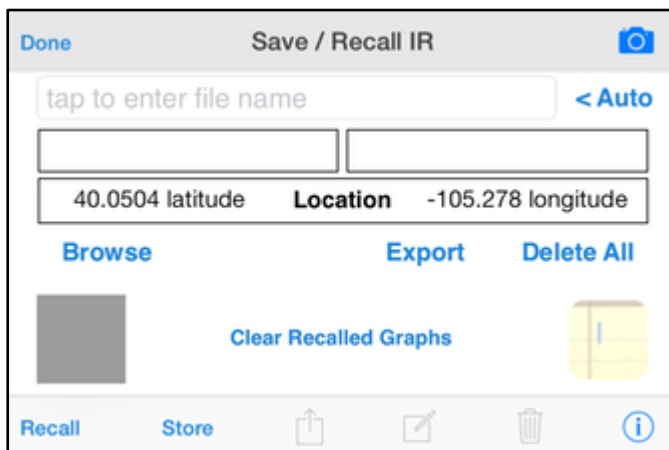




### Saving Results

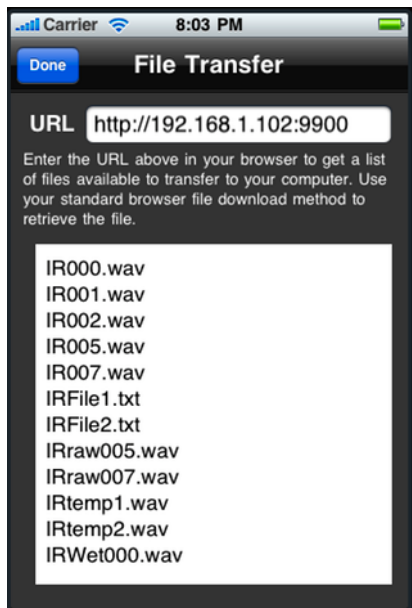
You can save an unlimited number of results on the device. For each IR, the raw audio file is saved, along with the processed IR. Also, a tab-delimited text file is saved that you can bring into any spreadsheet program.

You can enter your own text description, and the date/time and IR length are also stored with the data. You can even take a photo and store it with the IR. See our Save / Recall page for more information.



### Uploading IR Data to Your Computer

The "wet" recorded IR, the result of the deconvolution, and a tab-delimited file of the final calculations can be uploaded to a PC or Mac. The IR can be used as a source file for other programs. The tab-separated file is suitable for loading into Excel or any other typical editor.



### Obtaining the Test Signals

[Click this link](#) to go to the page that has our IR chirp test signals. They are archived in a .zip file. The files include a 3.5s chirp 7s chirp and a 14s chirp Each chirp starts with a sync pulse 1 second after the file starts, 5 seconds of silence, the chirp, and another 5 seconds of silence. When you are recording the chirp, make sure that start recording first, then start the chirp file playing, and let the entire file including the ending sync pulse play before stopping the recording.

There are two versions of the sync files. Use the "syncxxx10.wav" if you need to use the 10-second expected maximum decay, otherwise use the "syncxxx.wav" files.

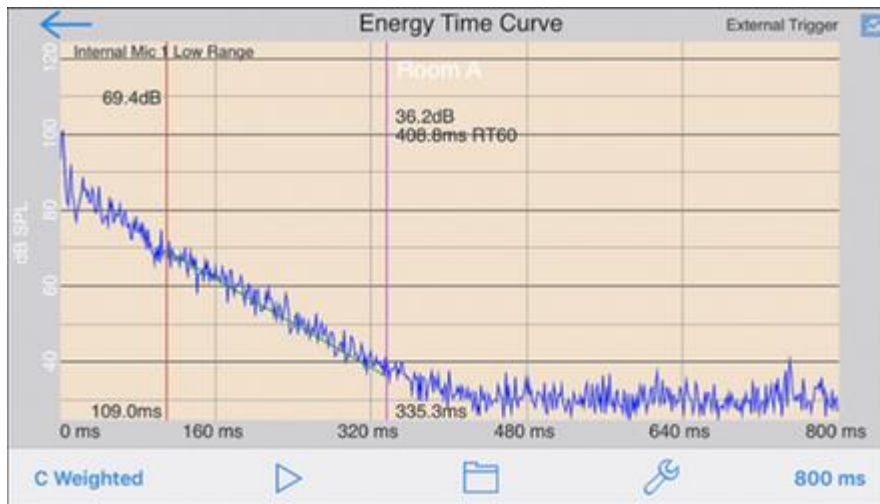
## ETC - Energy Time Curve

ETC measures room decay time graphically, by showing the decay of a pulse over time. Typically, you will make an impulse sound by popping a balloon. The graph will show the decay of this signal over time, and from this, the RT60 time can be computed.

See the demo video of this module.

### How to use ETC

Here is the Energy Time Curve main screen:



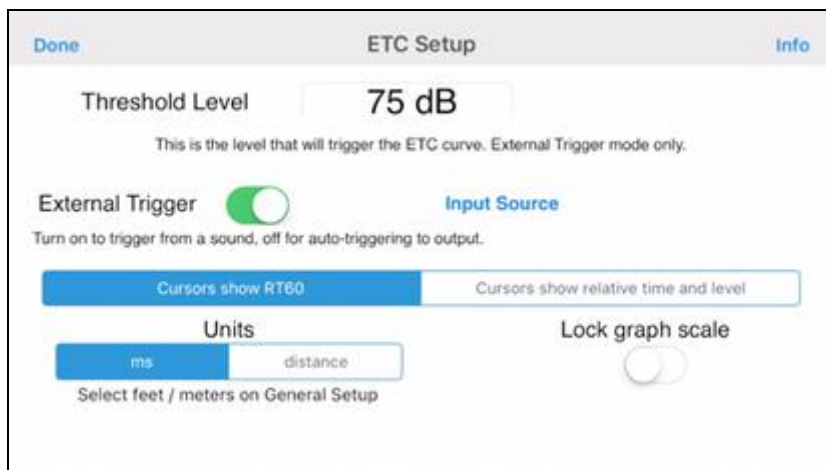
This shows a typical ETC measurement, made by simply snapping fingers in a small office, using External Trigger mode (see below). You can see the initial peak sound, and then the decay of the sound over time. A-Weighting was used to remove low frequencies (and very high ones) from the test. We used a 400ms time window to capture the full decay of the impulse.

After the test, we used a two-finger swipe gesture to move the red and purple cursors to roughly the start and end of the linear portion of the decay curve, and the app calculated the equivalent RT60 time of the decay (shown on the purple cursor, and with the green decay line).

Detailed information is below on setup and all of the options available.

### Setup Screen

Here is the ETC setup screen:



### External Trigger

If you will be making the impulse sound to trigger the graph, select External Trigger. In External Trigger mode, you can calculate RT60 times, but not absolute delay times.

Turn External Trigger off if you want to use the internal impulse signal from the iOS device. In this mode, you have to route the audio output of the iPhone to the sound system input. ETC will start the graph from the exact time that the pulse is sent from the iPhone. You can then see the time that it takes for the pulse to reach the iPhone from the speaker. Use this to set speaker delay times.

### Threshold Level

The Threshold Level is used to set the audio level at which the graph will trigger in External Mode. It has no effect in Internal mode. Set this value high enough above the ambient noise level (which can be seen for example, on the SPL Meter) to prevent inadvertent triggering, but low enough to allow the graph to be triggered when the impulse occurs.

### Units

You can select ms (milliseconds), or a unit of distance: feet or meters. If a unit of distance is selected, then the time in ms is converted to distance using the speed of sound. In most cases, you will want to use ms, but if you are interested in distance, for example in measuring speaker delay in Internal mode, you may want to use distance.

### Main Screen

On the main screen, you have one button to select the weighting, another to select the time window, and one more that lets you save a snapshot of the screen to the photo roll. There are also cursors that can be used for reading out exact dB, time, and RT60 times. And, the screen resolution and scale can be adjusted using gestures.

There are also buttons for saving and recalling graphs, entering the setup screen, and starting and stopping the test.

### Weighting

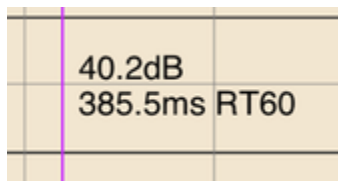
Touch this button to cause a picker to appear with the weighting choices. You can select ANSI A-weighting (think:voice), C-weighting (think:music), and any of 10 octave band weightings, which isolates that octave, or no weighting. For general use, we suggest using A-weighting to filter out rumble that would otherwise raise the ambient noise level and reduce the available decay range.

### Time Window

Touch this button to select the time window for the graph. Use shorter windows for smaller rooms, and larger windows for larger, more reverberant rooms. After you have seen the decay curve, if it doesn't decay all the way around, select a longer time. If it decays in a small part of the screen, select a shorter time window.

Note that if you have selected a distance unit on the flip side screen, this field will still be shown in ms, although all areas on the screen will be converted to the equivalent distance, using the speed of sound.

### Cursors



If you slide one finger horizontally across the screen, a cursor will appear that shows the exact dB level and time or distance for the point that intersects the cursor. If you use two fingers, you get a second cursor. By placing the two cursors at the start and end of the decay curve, the equivalent linear RT60 time is computed and displayed on the second (right-hand) cursor. To get the most accurate reading, make the green decay line as parallel as possible to the actual decay.

### Graph Scaling and Resolution

You can use the finger to slide the screen up and down, to properly fit the graph on the screen. You can also use a vertical pinch gesture to compress or expand the dB range of the graph, to see more detail, or to fit a graph on the screen. Double-tap the screen to normalize it to fit the curve currently present.

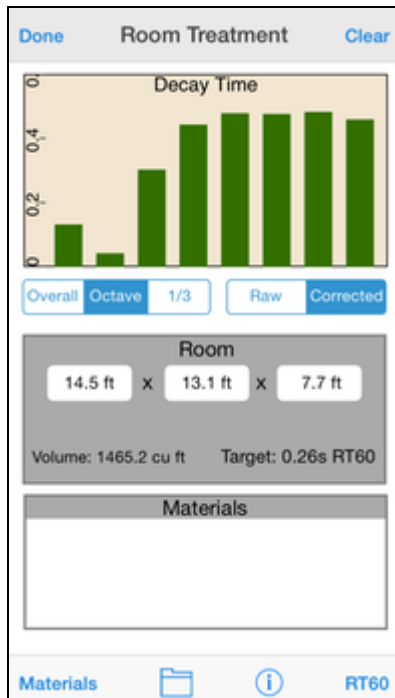
### Saving and Recall Graphs

AudioTools has a very advanced and complete save/recall system. See the Save / Recall page for full details.

### Capturing Images

To capture an image of the graph on the screen, including any cursors that are showing, touch the "Save Image" button. The current graph will be stored in a file in the photo roll

## Room Treatment



The Room Treatment module is a convenient and easy-to-use tool for measuring the RT60 decay times of a room, and for trying out various materials virtually, to see their potential effects on the RT60 time of the room.

Use this tool as an estimator to determine what set of materials you might use to correct room reverberation problems. The RT60 times are computed using an impulsive sound, using the algorithms developed in the advanced Impulse Response module.

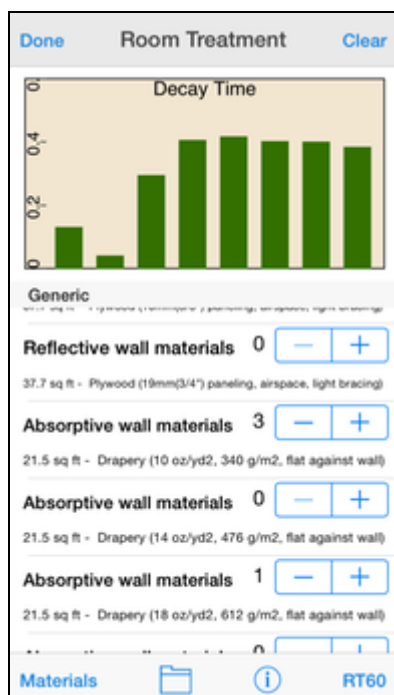
Materials from a group of participating manufacturers are shown, and in many cases you can even view details of the materials using information provided by the manufacturer.

To begin, set the room size, by entering the length, width, and height of the room. The target RT60 time using an industry average will be shown, along with the volume of the room.

### How To Measure RT60 Time

To measure RT times, tap the RT60 button in the lower right corner. A recording screen will appear. Tap **Record**, and a 5-second countdown will start. When the countdown reaches 0, pop a balloon. The sound should be roughly 1-2m (3-6 feet) from the microphone or iOS device.

Wait for a few seconds after the sound for the decay to die down, and press **Stop**. Now you can exit to the main Room Treatment screen, and the results will appear. You can see the results in overall, octave, or 1/3 octave mode.



### Applying Materials

To apply materials to the room to see the effect on RT60 times, tap the Materials button, and scroll through the categories to find some interesting materials. Tap the category to bring up the list of materials.

To try out a material, tap the + button to add one or more instances of the listed material. The effects on the RT60 times will be shown above, in real time. Add as many materials as you like, or tap the - button to remove materials.

You can save the room, including all of the materials, using the folder icon and the normal Save / Recall screen. Email the results to yourself to get a list of what you have used to correct the room.

### How it Works

The Room Treatment module uses the concept of Sabines to estimate room decay times. When the actual live RT60 times are computed, we derive the average overall Sabines for the room, and then as materials are selected we replace the Sabines for the area of the room now covered by the new material with the Sabines for that material, using industry-standard octave band Sabine information provided by the manufacturer or from published data for the generic materials.

This method will not be as accurate as using a full ray-tracing system and fully defining a room in great detail using a PC-based software program, but it will provide usable results very quickly.

## Generator

**Generator** is a highly accurate and versatile audio signal generator. It generates sine waves, square waves, white noise, and pink noise. The white and pink noise can optionally be octave-band filtered. All waveforms are highly accurate and low-distortion, created with real-time 64-bit floating point math and ANSI / IEC type 1 filters.

Generator also incorporates a pseudo-balanced output mode, that inverts the output signal polarity to one channel. When used with the iAudioInterface, you will get a signal that can be used for plugging into a balanced input. You can have a low-distortion, accurate signal generator on the iPhone. Check the specifications section below for more details.

### How to Operate Generator

This is the main generator screen:



First, to get a signal playing, turn off the mute (so the blue text goes away), turn up the fader on the bottom of the screen, and turn up the ringer volume on the side of the phone. You should now be able to hear something.

Next, select the signal type using the buttons on the top of the screen, and frequency, using the dial. The output automatically switches between the speaker (on the bottom of the iPhone) and the headphone/line out when you plug headphones or an audio cable into the iPhone.

### Frequency Selection Mode

For sine waves and square waves, there are three different frequency selection modes. These modes are chosen by using the buttons in the middle of the dial.

In concept, the outer ring selects the octave, and the inner ring selects the place in the octave. If the inner pointer is straight up, you are in the center of the octave. If the inner ring is 1/3 to the left, you are one-third octave below. The inner rings works differently, depending on the mode selected.

### Octave

If you select octave mode, when you turn the dial the frequency will settle on even octave frequencies: 31, 63, 125, 250, 500, 1k, 2k, 4k, 8k, or 16kHz. In this mode, the fine ring will always point to the top to indicate that it is set to the centre of the octave.

### One-Third Octave

If you select third octave mode, then when you turn the dial, the inner ring will settle on even third octave points. If you move up or down to the next octave, the outer ring will move to the appropriate octave.

### Fine

In fine mode, the dial moves freely, and you can select virtually any frequency. Note, that at higher frequencies you may not be able to select every single Hertz number, but you will have very fine control of the frequency. In this mode, as you move up or down to the next or previous octave, the outer dial will move to the appropriate octave value.

### Keyboard Input

If you want to select a specific frequency, just tap the frequency field and a numeric keypad pops up:



Enter any integer frequency value from 20 - 20,000 and the generator will immediately set that frequency. Note that the keyboard input is only active for sine and square waves.

Tap the Return key to dismiss the keypad.

### Quick - Set Buttons

If you touch either the 1000 or 10k button, the frequency will instantly set to either 1000Hz or 10kHz. This is useful if you are doing tests on equipment, and need to quickly access these values.

All settings are saved as you change them, so the next time that you start the Generator it will start as you left it.

### **Level Fader**

You can use the level fader to set the relative output volume. Each waveform has its own level setting that is accessed automatically as you change waveforms.

NOTE: The hardware level, set using the buttons on the side of the phone, set the overall output level.

### **Output Level & Distortion**

We have measured a max of +6.35dBu balanced, using the Balanced Cable Adapter. This is with the system volume (set on the side of the phone) set to maximum, and with the fader on the screen set to max. The distortion that we measure is less than .006% THD. The same distortion value is measured at the octaves, at 32, 63, 125, 250, 500, 1k, 2k, and 4kHz.

### **Approximate Output Levels**

These levels are for reference, and have been measured with an iPhone 3G with the hardware volume set to maximum. All values are in dBu, using the balanced cable adapter. For unbalanced levels, subtract 6.0 dB.

#### **Sine Wave**

- 1000Hz 6.85dBu
- 10k 6.87dBu
- 31Hz 6.75dBu

#### **Pink Noise**

- Full bandwidth -20.0dBu
- Octave band 1k -31.0dBu
- octave band 125 -31.0dBu
- Octave band 31 -31.0dBu
- Octave band 16k -31.0dBu

#### **White Noise**

- Full band -28.9dBu
- Octave bands vary

#### **Square Wave**

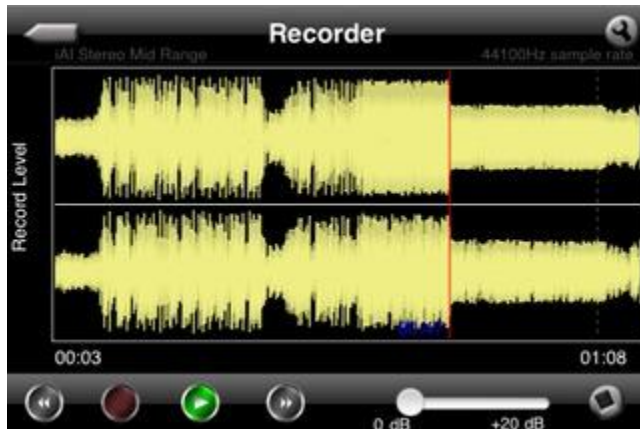
- 63Hz 3.43dBu
- 1000Hz 3.44dB

### **Getting the Generator Output Signal with iTestMic2**

- Some AudioTools modules require an output signal from the iOS device. It's easy to get this signal on most iOS devices.
- First, make or obtain a cable with a 3-conductor 1/8" TRS (not the 4-conductor plug, which is meant for microphone access). Set up the generator in AudioTools for balanced or mono mode, depending on the other end of the cable. If you are going 1/8" to XLR or 1/4" TRS, selected Balanced. If you are going to dual RCA plugs, select MONO
- Then, after you have plugged iTestMic2 into the iOS device, plug the 1/8" TRS cable into the headset jack. iOS will now route the output signal automatically to the headset jack.

## Recorder

You can record up to 24 hours in various sample rates and formats, mono or stereo. It works with any audio source that the iPhone, iPod touch, or iPad supports.



Recorder running on iPod touch with iAudioInterface. Here's how to use it.

### Recording Formats



Select between WAV (uncompressed 16-bit), Apple CAF (compressed), or Apple Lossless (iTunes AAC format). Also select the sample rate, from 8kHz, 22.050kHz, 44.1kHz, or 48kHz.

### Using Recorder with the built-in or headset mic

In this mode, you have one input channel available. If you record in stereo, the mic signal will be in the left channel. Mono recording will pick the left channel automatically.

### Using Recorder with iAudioInterface2

With iAudioInterface, you have several options.

Mono -- This mode selects the included microphone as the signal source. You can also select the gain range.

Stereo -- This mode selects the line input, and configures it as a stereo input. You can select the gain range as well.

### Monitor Mode

You can turn on record monitor, so the signal being recorded is played through the output. This may cause feedback when using the built-in mic.

When using iAudioInterface, the monitor signal is available in the headphones.

### Recording

If you need more gain, you can use the slider on the main screen to add up to 20dB of digital gain. There is no hardware gain control for the built-in mic.

Arm the recorder by tapping the red record enable button, and when ready, tap the green play button to start recording. The level is shown on the screen. If the signal touches the top of the graph you are clipping.

As you record past one minute, the graph collapses to show the total elapsed time. Up to 24 hours may be recorded.

After recording, you can pinch/zoom the graph to see any time, and you can swipe to place a cursor at any time. Tap play to start playing at that time.

The back and forward arrows move the play head to the start or end of the recording.

To stop recording, tap the pause or record button, and you will see an alert asking if you wish to stop the recording, pause, or continue. Recording continues until you pick an option.



If you select Pause, then you can resume recording at a later time by pressing the green play / pause button.

### Saving Files

If you are running iOS 4.0 or later, the recording will be saved in a temporary file when you exit the app, or if the battery is running out (in most cases -- but it is possible to lose a file under some conditions). The temporary file, if it exists, will be reloaded when the Recorder is restarted.

To save the recording, tap the square icon, and save it as you would any other file in AudioTools.

## Transferring Files

To transfer a recording to a computer, use the Files function on the Utility menu, or the Export button from the Save / Recall screen. Then enter the URL shown in any browser and download the files as you normally do in the browser.

## Saving Data, Exporting, and Importing

AudioTools includes a versatile and powerful system for saving and recalling test data and audio files, exporting them to a computer, and importing them into AudioTools running on another iOS device.



This feature is available throughout the app, in any module that saves a graph, and also in SPL Pro and STIPA.

Some modules can also save audio files. These include SPL Graph, Impulse Response, and the Recorder.

Complete instructions on transferring data files from one instance of AudioTools to another are available here. Also see the Save to Photo Roll option.

## Naming Files

You can name a file with any combination of up to 32 letters, numbers, and spaces. Files are stored in folders by file type (like RTA or FFT) so you can use the same file name for different types. There is no limit other than storage space for the number of files that you can store.

## Storing Files

When you store a file, it is saved on the device locally. The files are backed up to the computer when you back up the device, but **if you delete the app the stored files will also be deleted**. In most cases, a tab-delimited file of the raw data will also be saved along with the data needed to restore the graph.

In some cases, an audio file is also stored. The tab-delimited file will have the same name that you used to store the file, with the .XLS extension. Microsoft Excel will normally open this file directly. The contents of this file will vary by file type, but will always include the date and time of the measurement, in the local time zone.

There are other files that can be stored along with the measurement data.

--If you take a photo, the picture file will have the same name as the stored file, with the extension ".png".

--The notepad file, if you have created one, will be saved with the same file name, and the ".txt" extension.

### **Deleting Files**

When you delete a file, all files associated with that file name are deleted. This may include graph data, tab-delimited data, a photo, a notepad, and in some cases audio.

### **Browsing and Recalling Files**

Tap the Browse button to bring up a picker with a list of all stored files of the current file type. As you scroll the picker, the file name, date stored, and image thumbnail (if any) will appear. Tap done to exit the picker, or tap Recall to open the file. When you recall a stored file, the information needed to redraw the graph(s) will be recalled.

### **Transferring Files To The Computer**

You can either use the Export button on the Save / Recall screen, or the Utility->Files module to bring up the WiFi transfer screen. Or, you can leave the built-in WiFi server always running, by turning on the "Enable Background Server" option on the General page in the Settings menu.

Enter the URL shown in the browser on the computer, and then select the folder containing the files that you want, and either Ctrl-Click, or Command-Click on the file name to download it. The file will be in tab-delimited XLS format.

To get the raw data (for importing to another device), the photo, or the notepad, see the instructions below for iTunes File Sharing.

WiFi connectivity is required for this feature. You can transfer using a LAN, or set up an ad-hoc (peer-to-peer) local network on the PC.

You may also email the tab-delimited data file by tapping the compose icon in the toolbar.

### **Additional Media Files**

If there are additional files that have been created, they will appear in the same folder, with different extensions, such as .wav, .aif, or .caf for audio files, .txt for notepad files, and .jpg for image files.

### **iTunes File Sharing**

If you have a lot of files that you would like to transfer en masse, you can use iTunes file sharing. Open up iTunes, connect the iOS device and select it, and then select the Apps tab. Look down the page and you will see AudioTools listed. Select the Public folder (not the top-level apps folders) and click the **Save to....** button. Put it somewhere, and inside you will see all of the xls files, photo files, audio files, and notepad files in the folders.

### **Taking Pictures**

If the device has a camera, you may take a photo, which is then associated with the stored file name. Each stored file can have its own photo, and will take the name of the file, and add the .png extension. When you have stored photos, as you browse through the stored files, a thumbnail of the photo appears. Tapping the thumbnail brings up the photo full-screen, and from this screen you can email the photo to yourself, or save it in the photo roll.

### **GPS Location**

Before you store a file, you can obtain the current latitude and longitude coordinates and store them along with the data. The location will be shown in the tab-delimited file. This feature uses the location services of the device. Note that it will often take several seconds for accurate data to be obtained. Location data is shown when you browse to a stored file.

### **Notepad**

You can enter a text note file for each file. The notepad takes the name of the file, and adds the extension .TXT. You can enter as much text as you like for each notepad file.

## **Save to Photo Roll**

AudioTools supports saving graphs to the iOS device photo roll. Look for the camera shutter icon, which appears on all pages that support the save to photo roll function.

The image will be saved minus all of the controls, to provide you with a clean image for adding to a report. After you tap the button and save the image, check the photo roll for the saved graphs.

You can name the images before you save them, to identify them later. To do this, before tapping the camera shutter icon, tap the Save / Recall icon, and enter a name in the file name text field. Then tap Done on the keyboard to dismiss the keyboard, and tap Done once more on the prompt message box that appears. This will return you to the app, and the name will be showing on the screen.

You can also actually save the graph, or recall a previously stored graph, and in that case also the name will appear on the graph.

### **Saving the Complete Screen Image**

At any time, you can capture an exact image of the entire screen, by holding the Home and Power buttons on the iOS device. This is a function of iOS, and is available in all apps. Hold the buttons together at the same time until the app 'clicks'.

## Import and Process Audio Files

This document describes how to use audio wave files as the data source for audio processing functions.

### Audio Files

AudioTools modules normally take their input from a live input source, such as the built-in microphone or one of the external options, such as [iTestMic](#), [iPrecisionMic](#), or [iAudioInterface2](#). Starting with AudioTools 9.4, you can now use a wave file for input, for some modules. Functions that support this feature currently include RTA, FFT, SoundScope VR Spectrum, SPL Pro, and SPL Graph.

### Preparing an Audio File

Currently, only wave files using PCM format in either mono or stereo may be used for this feature. Make sure that the file is a PCM encoded 16-bit wave file, mono or stereo, and recorded at 48k if possible. 44.1k will also work, but some functions in AudioTools expect the 48k sample rate. The files must have the ".wav" extension.

The wave files must be stored in the SPL Graph public folder. All audio wave files that have been stored from the SPL Graph module will be automatically available to other modules, e.g. SoundScope VR Tools.

If you want to use your own wave file, just copy it into the SPL Graph public folder. There are different methods to do this, depending on your file storage choice.

### Using Internal Storage

If you are not using Dropbox or iCloud, connect your iOS device to a browser, just as you would to download a file. Navigate to the SPL Graph public page and use the [Upload File](#) button to transfer the file to the folder on the iOS device.

### iCloud

Loading a file into an application, e.g. SPL Graph.

On your iOS device go to Settings > General and check that your File Storage is set to iCloud.

If you wish to analyse a file from an external computer, log into [icloud.com](#) using your Apple ID. Apple will send a verification code that must be entered. Go to iCloud Drive. Open the folders Studiosixdigital > public > SPL Graph.

On your computer (e.g. Windows) open your file folder (e.g. File Explorer). Locate the file you want and Drop/Drag the file into the SPL Graph folder. This may take some time, depending on file size.

This is also why it is best to drag/drop a single file at a time.

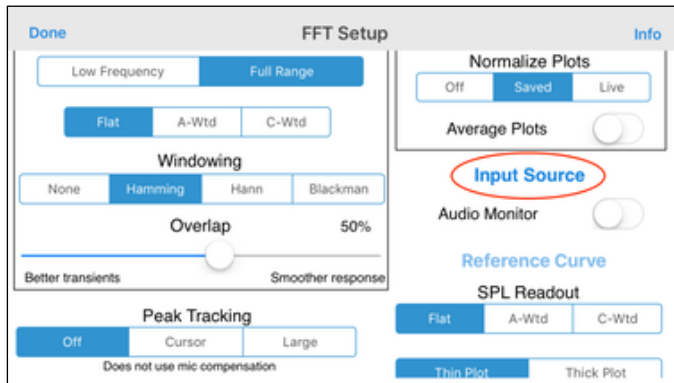
Open AudioTools.

Open SPL Graph > SPL Graph Setup (spanner symbol) > Input Source > Select Input File > Select File (Yellow highlight) > Done

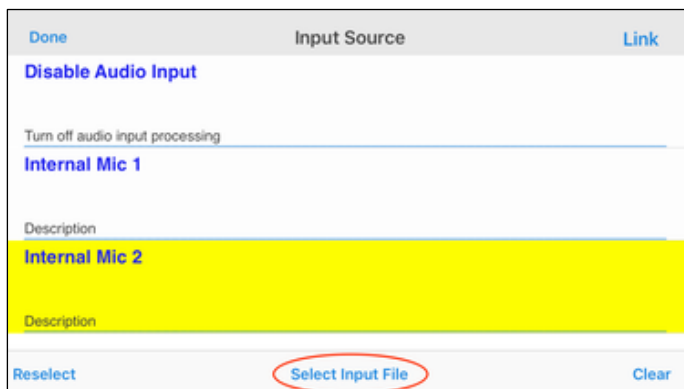
Return to SPL Logging screen > tap the microphone symbol

## Selecting a File

Files are selected from the **Input Sources** page, which is accessed on the **Setup** page for the individual function, or from the **Input** button on the SPL Pro main page. This image shows the **Input Sources** button on the FFT setup page:

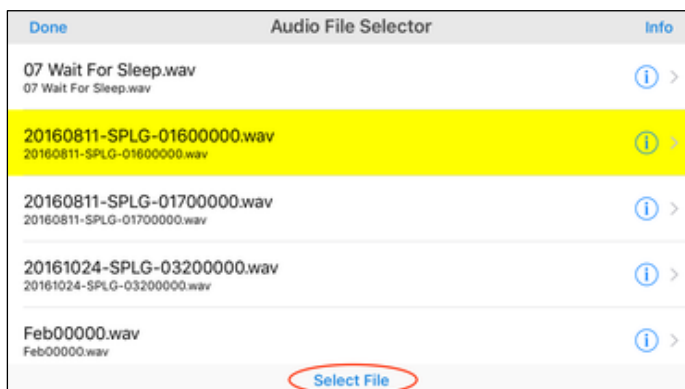


Tap the **Select Input File** button to bring up a list of available files.



Any wave files that were saved from SPL Graph, and any wave files that you have manually placed into the SPL Graph public folder will also be shown in the list.

Tap the row that shows the file that you wish to use, to highlight it. It will show up in yellow. Then tap the **Select File** button to open the file and make it available to the analysis function, such as FFT or SPL Pro.



Once you have selected and activated an input file, all modules that support external file processing will use that file, until you cancel the file processing and go back to live audio.

### **Audio File Navigation**

On the main audio analysis module screen, after you have loaded a wave file you will see a moving slider. This represents the relative position in the audio file that is currently being processed. The file will be processed from the beginning to the end, and then the position will loop back to the beginning and processing will continue.

For SPL Graph, processing will begin when you tap the Play/Pause button, as you would to start live audio analysis.

You can use the slider to change the current position in the file.

### **Going Back to Live Audio**

To return to normal real-time audio processing, go back to the **Input Sources** page on any of the supported modules, and tap the **Clear** button in the toolbar. The functions will return to live audio processing.

### **Re-selecting the Previous File**

From any of the supported module's Input Sources page, tap the Reselect button in the toolbar. If a file was previously loaded, it will be re-loaded.

### **Calibration**

For external audio files, no attempt is made to calibrate the external audio to absolute dB SPL. You can, however, change the calibration that is applied to file.

To do this, open the Settings->Microphone Setup page, and change the Trim value. For example, if it appears that the audio is +20 dB too high, enter a trim value 20 dB less than what is currently set.

You may wish to create a new calibration entry so that you do not alter the microphone live audio calibration. To do this, just tap the "+" on the top of the screen, and make your changes to that entry.

Also, you will probably want to disable microphone compensation, to prevent the current mic frequency compensation from being applied. This can be done globally, on the Settings->General->Global Audio settings page.

## Calibration

All of the apps come pre-calibrated for the typical iPhone built-in and headset mic, but you can adjust the calibration if you have access to a professional, calibrated meter to compare it to.

Also, in AudioTools, you can apply a microphone calibration correction file, by following these instructions.

Note that the default calibration for the internal iOS device mic is +7.0dB.

### Calibration for External Mics

AudioTools 7.2 includes a new advanced microphone calibration system. With this system, the app recognizes any new audio input source when it is first connected, identifies it, and creates a new group of calibrations for that input source.

Then the next time that input source appears, the calibrations that apply to it are recalled. For example, if you plug in one of the devices below the app will automatically switch to its calibration.

\* **Headset mic** -- There are some inexpensive headset mics available that may be used with AudioTools. Although there is no big advantage to using them, still it is convenient to store a calibration for that mic. AudioTools will now see the headset mic and apply its calibration.

\* **iTestMic and iPrecisionMic** -- Since each iTestMic and iPrecisionMic transmits its calibration when it is plugged in, there is only one calibration that will apply. This will happen automatically.

\* **USB Audio Interface** -- If are using iPad, you can connect the Apple Camera Connection Kit to use some USB audio interfaces. The app will recognize this, and switch to the calibration for that unit. Note that the app cannot distinguish between different USB interfaces, so if you use more than one you will need to select the correct one from the Microphone Calibration screen.

### Calibration Procedure

To adjust the calibration of SPL Meter, RTA, or any other app, follow these steps:

- For SPL or SPL Meter, first set the reference meter to the same settings as the app (choose A and Slow, for example, on both meters). For RTA or FFT, the app is reading unweighted, fast, so set the reference meter to match that.
- Now play pink noise or white noise through the system to get a reading on the reference meter in the range of 70-85dB. It is a good idea to turn down the bass, so that you are comparing mid-range frequencies.
- Go to the settings page on the app (flip the screen over by tapping the small letter i)
- Select the internal mic setting in the app
- Adjust the Trim field using the + and - buttons until the dB field on the app matches the dB reading on the reference meter.

That's it, you're now fully calibrated. But remember, we do NOT recommend the use of a Radio Shack SPL meter for reference, they are just not accurate enough.

## iCloud Support

**Note:** SSD now recommend using Apple iCloud instead of Dropbox. SSD will continue to support Dropbox until they cancel support for the API that SSD are using. Please note that at some point Dropbox support will be removed from the apps.

Apple iCloud is fully supported. Some of the features include:

- All files are now stored on iCloud, if enabled. This includes internal as well as public files such as the tab-delimited output files, audio files, image files, and text files.
- All files are stored under the "studiosixdigital" icon in iCloud.
- Access the files from any iOS device connected to the same iCloud account. Run tests on your iPhone, view them on your iPad without having to manually transfer any files.
- Get data and audio files on your computer instantly, even if the tests were done remotely.
- Easily import microphone calibration files and reference curves, just drop them into your iCloud on your computer.
- Files are cached on your device and uploaded automatically to iCloud when you have network connectivity.
- Easily manage your files from your computer or iOS device iCloud drive. Delete or rename files directly.

iCloud is the preferred method for storing files in the cloud and for accessing files on your computer. We prefer it over Dropbox for several reasons, the most important one being that Apple tightly integrates iCloud support into their apps. Also, having global access to test results from any iOS device on the same iCloud account is a huge advantage. No more awkward importing or exporting.

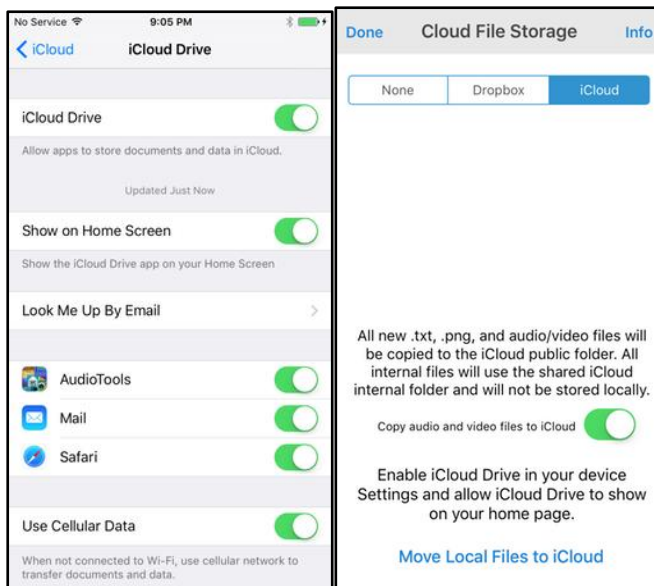
### Operation

To enable iCloud support in AudioTools, first make sure that you are logged into iCloud and that you have iCloud Drive turned on in your iOS device settings.

### Update iOS to the latest version.



Next, turn on "Show iCloud Drive on the Home Screen". Available in iOS 9. Not strictly required, but it is very useful to be able to see all the files that are stored and to be able to delete or rename them.



Apple gives you a free 5Gb iCloud drive, and it is fairly inexpensive to upgrade to larger sizes. Lastly, go to the Settings->General page in AudioTools and select iCloud as your cloud storage preference. Tap the "Cloud File Storage" button on the top of the page in the File Storage box. That's it! iCloud is now enabled and ready to use.

### File Migration

If you have files that you would like to move from local storage to iCloud, run the Migrate Files function. To access this, just turn on iCloud, and tap the "Move Local Files to iCloud" button. The Migrate Files screen appears. Just tap "Begin File Migration" and wait for the process to complete. Files from the /public folder tree will be moved, not copied, so they will be deleted from local storage. Files from the internal folder will be copied.

The migrated files will be available immediately, whether or not you have internet connectivity. They will also be copied up to your iCloud when you are connected to the internet. All files will be assigned the file dates of the original files.

During the file migration process, the step number of type of file that is being copied will be shown on the screen. It is also possible to specify a certain step for this process, if you only need to move some files. See the File Migration Step Guide page for more information about this.

You can interrupt the file migration by pressing "Stop File Migration" the files in the public folder that have already been copied will be skipped, but internal format files will be copied again.

This process will overwrite files in iCloud with the same name, so be aware if you have iCloud files that may be duplicate local file names.

Note: With very large file sets, to prevent memory overruns you may need to run the File Migration one step at a time. It may also help to reboot your device between runs.

If you want to go back to local storage after migrating to iCloud, you have to manually move the files from the public folders back to the public folders using iTunes File Sharing. Just drop the entire public folder from iCloud to iTunes file sharing for the AudioTools app.

### **File Management**

Every data file will be saved on iCloud. Apple manages the syncing of files automatically, and you can easily access the files from your computer File Manager, or the iCloud Drive app on your iOS device. You can delete or rename files manually on your iCloud, using the iCloud Drive app on your device or by using the iCloud folder from your Mac, or from browser on any computer, by logging into your iCloud account at icloud.com.

Note that if you are accessing files that were created on another device, the first time that they load it may take some time for iCloud to download them. This is normal, and the next time that you download them they will open immediately.

## TECHNICAL APP NOTES

### dB vs. dB – Understanding SPL Measurements

AudioTools provides many options for measuring and analyzing sound. A number of these include SPL dB values, and although they may all be displayed as a single numeric value, they may mean different things, or have different values. We will try to explain these differences here.

#### Overall SPL dB

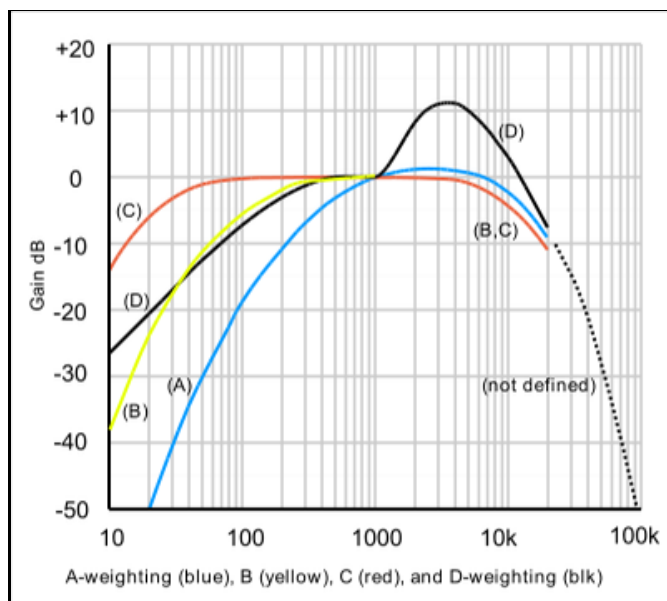
The most common measure is a simple overall, or wide-band, SPL dB value. This appears in many locations:

- SPL Meter
- SPL Pro
- SPL Traffic Light
- RTA graph, upper right corner
- FFT graph, upper right corner
- SoundScope VR Tools, upper left corner
- Microphone Calibration, dB field

This value is dynamic representation of the overall sound level in the room. It will vary as the sound in the room is louder or softer -- unless, that is, you are in Leq mode. Leq simply means sound energy average over time. So an Leq10 will typically be the "average" SPL level over 10 minutes.

The overall SPL level usually has a weighting applied to it. A weighting is simply a filter, or set of filters, that alter the effect of certain frequencies on the reading. Common weightings are A and C. Note in the graph below that A weighting removes a lot of energy in the low frequencies, as well as attenuating high frequencies, while C removes much less of the lows, and still some highs.

Some people think of A-weighting as "voice" and C-weighting as "music".



Given the difference between A-weighting and no weighting, if the ambient sound in the room has a lot of low frequencies (which are less audible, see curve below), then the difference between a A-weighted SPL reading and an unweighted SPL reading could be 30-40 dB or more.

Here's how this works in AudioTools. Say you open SPL Meter, which has only A and C weighting, and leave it set to A. The reading might be 35dB, in a typical quiet room. Now switch to RTA (which has choices for overall weighting, A, C, or none) or FFT (which only supports choices for weighting on some platforms and otherwise is "none"), and you might see 55dB.

Which number is right? Both, of cthese, but they will not match unless the same weighting is selected for both measures.

### **Octave or Fractional Octave Band dB**

Now we will look at how breaking up the audio spectrum into bands effects the dB levels that are displayed.

Say we have pink noise (which is wide-band noise filtered so that each octave or fractional octave band has the same energy, the same way that the ear hears it) at 80dB. What will the RTA show for the level of each octave band?

The answer is not 80 dB. A good way to visualize this is to remember that 80 dB really refers to an amount of acoustic energy. If we break up the audio spectrum into 10 bands, each band would hold 1/10 the energy of the total. But to add them, since we are working in dB, it is not a linear formula -- otherwise each band would be 8 dB!

The formula for the increase in summing equal loudness sources is

$$\text{dB} = 10 * \log_{10}(n) \quad \text{dB to add for } n \text{ sources}$$

Where n is the number of sources. For n = 10, the answer is 10. So, if the overall level was 80 dB, each octave band would be 70 dB.

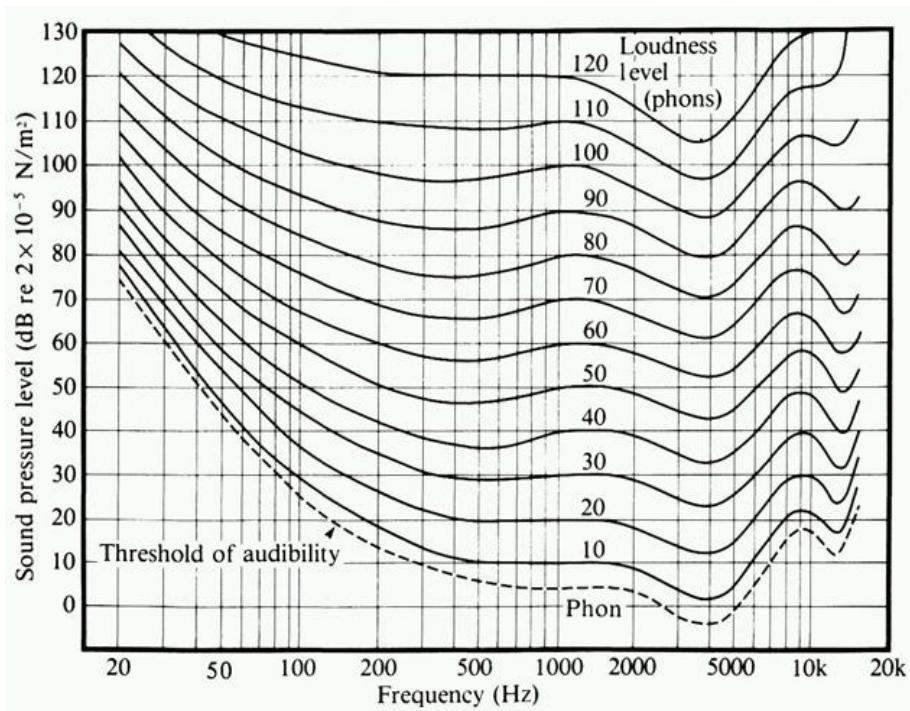
If you switch to 1/3 octave, the amount to add is 14.7 dB, so each band would be 65.3 dB.

What about sine waves? In this case, if we have a sine wave at 75 dB at 1000Hz, the 1000Hz octave or 1/3 octave band will read 75 dB, and the overall will show something slightly higher than 75 dB, since it adds the single band energy (75) with the other bands, again using a log10 formula.

### **Equal Loudness Curves and Threshold of Hearing**

Here is graph that shows how the human ear perceives loudness, by frequency and SPL level. The thing that is really obvious is at quiet levels, we don't really hear low frequencies. In fact, we can't even hear 60Hz until it's above 40dB, and we can't hear 20Hz until it reaches over 70dB!

So this is why an unweighted SPL reading might show 50 or 60 dB, in what we consider a very quiet room. The RTA or FFT will show the actual sound levels, and so become very useful tools for understanding the entire sound spectrum in a room.



## Headset Connected Microphones

The headset mic input on all current iOS devices uses the same filter as the built-in mic, (depending on iOS version) and so offers no improvement to performance over the built-in mic.

Because of this, **we can't recommend any mic that plugs into the headset connector**, such as micW. Although micW may perhaps be using a higher quality capsule than the iPhone mic capsule, since it is using the headset mic input, it is subject to the same filters and Apple analog electronics as the built-in mic.

Again, even in iOS 6, we see **no improvement in frequency response**, or flatness over the Apple built-in mic, with micW.

micW does have lower sensitivity, so it will clip at a higher SPL point, although its noise floor is also therefore higher, so it can't measure as low of noise levels. The calibration we normally see for this mic is around +13.

## Connecting an External Mic

The headphone / input jack on iOS devices has a 4th pin that has a small polarizing voltage on it with very low drive current. The Apple device monitors this line, and can tell when a typically headset mic is plugged in. If its not, they don't even turn on the mic input. Most people don't have very much success connecting a non-Apple mic to this port.

Some of the third-party mics, like MicW and IMM6, do use this input, but really they are just swapping one small mic capsule for another. No great improvement here.

Also, there are no analog inputs on either the 30-pin or Lightning jack, so its not possible to connect something there.

Really the only way to get an external mic into an iOS device is with one of the third-party adapters, like for example the iAudioInterface2 or iTestMic, which convert the mic signal to digital audio before routing it to the iOS device.

## Another Flaw in the Headset Jack

We have recently discovered another major flaw in the Apple headset connector. It seems that the way that Apple has implemented the headset jack as an input and output connector, when the output is active, it bleeds back into the mic input. This bleed can easily overpower the mic input signal, rendering the input completely useless.

The bleed gets worse as the output load impedance goes down, and as the output level increases. Using a typical high-impedance input, such as the line input on a consumer receiver, the bleed may be low enough that if the acoustic level in the room is fairly high, it won't make much of a difference to the measurement. The bleed is much worse when the generator is in mono mode, since the left and

right channels are both sending out the same signal. In balanced mode, the problem nearly disappears. However, in balanced mode, the signal to each channel gets distorted, apparently due to the crosstalk between the channels.

The summary is that if you do plug a mic into the headset jack, don't use the output. Even turning on the output with no load attached can cause phantom readings rising up to +20 dB at 20 kHz.

The amount of this bleed, or crosstalk, varies widely from model to model. In every case, there is at least 20 dB of boost at 20kHz. In some devices there is as much as 50 dB wide band — across the entire audio spectrum.

## **Audio Output**

You can get audio out of most iOS devices just by making a cable and plugging it into the iOS device headset jack.

The first trick is that the cable has to be an 1/8" 3-conductor plug. If it is a 4-conductor plug, the iOS device will switch its input to the headset jack, since it is sensing a microphone being plugged in.

You can make a number of different cables, including a stereo output cable, for example to have right and left RCA plugs, and you can also make a balanced cable, by connecting the tip of the 1/8" plug to the balanced +, and the ring to the balanced connector - just make sure you set the generator in AudioTools to match the type of cable you are using.

The second trick is that you have to plug this cable into the headset jack after connecting iTestMic. iOS has a rule that "the last one connected wins", so you have to plug this in last to grab the output audio away from the digital audio going to iTestMic.

## iTestMic2

### Specifications

#### Audio

- 20Hz – 20kHz +/- 3dB
- Omnidirectional pattern
- Free-field response
- 26 dBA – 120 dBA performance in two ranges; 26-96 dBA, and 48-120 dBA (typical)
- NC Limit: Below NC29
- Two gain ranges, 26-104 dBA, and 49-120 dBA
- Mono input signal, present at both Left and Right iOS device input channels

#### Output

- 3.5mm (1/8") stereo analog output jack (full volume level)
- Low-distortion output

#### iOS Device Charging – Lightning Model Only

- 1.3mm 5.0V charging input jack supplies up to 2.1A @5V to iOS devices
- Requires 3.5A 5V pin+ power adapter (included)

#### Microphone

- Excellent immunity to cell phone RF noise
- Factory calibration stored internally, calibrated with a NIST-traceable 94.0 dB pressure-compensated calibrator
- 1/2" nominal size, fits all standard calibrators
- Consumes less than 90ma in use
- 1.0m (37") Lightning cable length

### Compatibility

- Apple Lightning devices
- Apple USB-C devices
- Apple Camera Connection Kit (for Apple USB-C to Lightning adapter)
- CAUTION: Some 3rd party adapters do not implement the microphone function

### Technical Information

The dual-gain range mic preamp, A/D converters, D/A converters and USB digital audio interface are all contained within the mic itself, so no Apple analog electronics are used. This lets us bypass the heavy filtering and compression that are normally in use, and also to store calibration values that are read by software.

iTestMic2 is equivalent to having a pro Type 2-class test & measurement mic, low-noise matched preamp with two fixed gain ranges, A/D converter, DAC, and USB digital audio interface, all combined in one portable device.

You can get audio out of most iOS devices just by making a cable and plugging it into the iOS device headset jack. The first trick is that the cable has to be an 1/8" 3-conductor plug. If it is a 4-conductor

plug, the iOS device will switch its input to the headset jack, since it is sensing a microphone being plugged in.

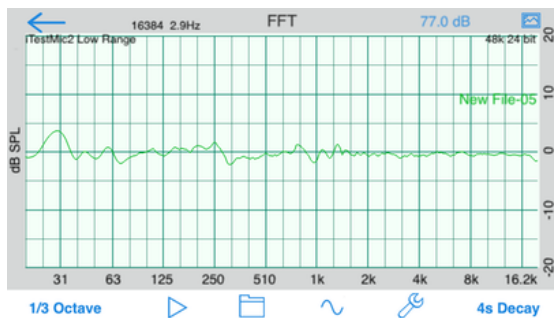
You can make a number of different cables, including a stereo output cable, for example to have right and left RCA plugs, and you can also make a balanced cable, by connecting the tip of the 1/8" plug to the balanced + ve, and the ring to the balanced connector - ve. Just make sure you set the generator in AudioTools to match the type of cable you are using.

The second trick is that you have to plug this cable into the headset jack after connecting iTestMic. iOS has a rule that "the last one connected wins", so you have to plug this in last to grab the output audio away from the digital audio going to iTestMic.

### OPTIMISE FREQUENCY RESPONSE

All microphones deviate from flat frequency response, and to optimize the frequency readings from iTestMic2, we first test every unit to be within tight standards of frequency response, and then we go one more step. Using a Class 1 iPrecisionMic as the standard, we create an individual frequency compensation file for each microphone. The files are stored in the Amazon cloud by unique serial number, and can be installed in any Studio Six Digital app with a single button tap.

To install the frequency calibration file, plug iTestMic2 into your iOS device running any of our apps, including AudioTools, and navigate to the Microphone Calibration page. Tap the "Get File" button, and the file is located using the unique serial number in iTestMic2, downloaded, and automatically applied. Once downloaded, the file will then be applied each time the iTestMic2 is plugged in.



This is a typical curve, after the frequency calibration file has been applied. The LF bumps are artifacts from the pink noise cycling.

### Extending the Cable

Due to data communications and transferring power to the iOS device, the cable length is limited. We do find that Lightning extender cables work fine. We have tested a 2m (6') extender and found that performance did not degrade.

## iPrecisionMic Sound Analysis System



iPrecisionMic is a precision, professional microphone that is also an iOS direct-connect Lightning accessory. iPrecisionMic is factory calibrated to  $\pm 0.1\text{dB}$  using a NIST traceable pressure-compensated calibrator. The calibration offsets are stored in the microphone's non-volatile memory, and are transferred automatically to an iOS device running the AudioTools app.

All of the active electronics are in the microphone body, including the regulated power supply, microphone preamplifier, precision 24-bit A/D converter, and the circuitry required to communicate with Apple devices via a digital audio link. This means that we are not reliant on the analog electronics stages in the iPhone or iPad, but rather we completely bypass them with a digital audio link.

### Features

- Meets Class 1 acoustical specifications for sound level meter per ANSI S1.4-2014 and IEC 61672-1:2002 and 60804:2000 Type 1.
- Meets Class 1 for ANSI S1.11 / IEC 61260:1995 Class 0 Octave and Fractional Octave Band Digital Filters, frequency range from 32Hz to 16kHz in octave bands, and 25Hz to 20kHz in 1/3 octave bands.
- Certification available.
- Fast, Slow, Impulse, Max, Min, Leq, Ln.
- Octave and 1/3 Octave logging.
- Z-, A-, or C-weighted spectra.

Connect iPrecisionMic to any iOS device with a Lightning connector, download the AudioTools app, and you have a precision sound level meter, ready for certification.

## USING MICROPHONE CALIBRATION FILES

AudioTools supports importing a file containing frequency response data for a microphone, and that response curve will be applied to the microphone in many AudioTools modules. The microphone response correction data will be applied in all modules that display frequency dependent information: RTA, FFT, SoundScope VR Tools I Single Channel, and Transfer Function. Note that it will NOT be applied to basic SPL measurements.

### How to Apply A Frequency Compensation File

Check below for the correct file format, and how to get the file in the folder that AudioTools uses to apply microphone compensation files, then follow these steps.

- Connect the microphone, since the app tracks different files for each microphone.
- Navigate to Settings->Microphone Setup
- Tap the **i** in the circle on the right to open the Microphone Calibration page
- Tap “Calibration File” to open the list of available files. These files are in the public/calibration folder, see below
- Locate your file and tap on it. You will see a blue arrow on the right
- Tap “Apply” on the lower left corner of the screen. If successful, you will get a confirmation message.

Note that the compensation file does not set the overall SPL calibration, see the [instructions for microphone calibration here](#). Things that may prevent loading a compensation file include:

- Microphone Compensation Disabled – This setting is on the Settings->General->Global Audio Settings page in the app
- Incorrect file format – See below for details

### Microphone Frequency Compensation File Format

AudioTools supports the pending AES standard for frequency response data (.frd) files, as well as most typical mic cal file formats. Specifically, files that conform to these rules may be read in:

- File names must have either the .txt or .frd extension.
- Files must contain ASCII characters (not binary data).
- Lines must have a frequency value followed by a dB value, separated by a tab, comma, or blanks. Values may be in IEEE format, integer format, or floating point. Extra values are ignored.
- Lines must be in order of ascending frequency.
- Frequencies are processed from high to low
- dB values are subtracted from actual dB (positive numbers lower the line on the chart)
- Any number of data points may be present.
- Lines beginning with ‘\*’ or ‘;’, or blank lines, are skipped.

The maximum resolution of input files that is supported is 1/12th octave, for a maximum of 12 octaves. Files with more resolution will be processed to average the values within each 1/12th octave point.

The algorithm works by starting from the highest frequency in the file and working its way down to the lowest. So, if you add an entry at 951Hz for 10dB, and one at 898Hz for 0, all frequencies from 898Hz to 951Hz will be **lowered** by 10dB.

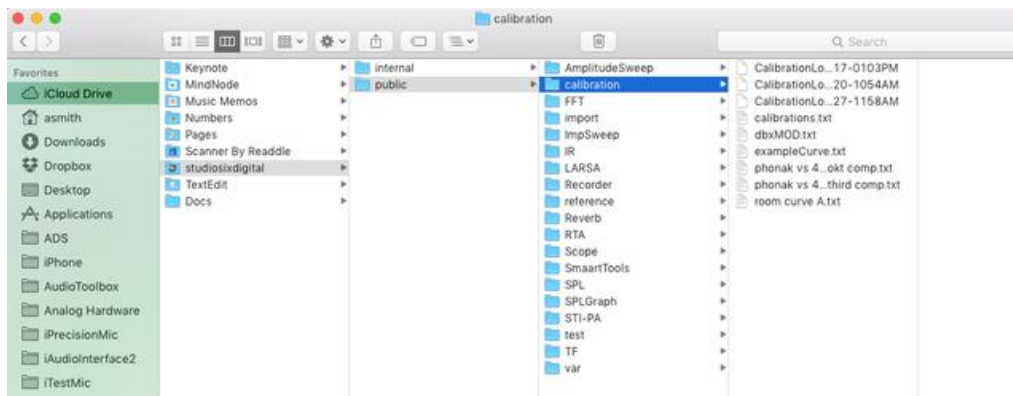
Then, depending on the module, the resolution may again be compressed. For example, RTA will process the compensation data appropriately for 1/3 or 1/1 octave mode.

To see how your data file was processed, go to FFT, Settings, and switch from Low to Full mode. When you return to the main screen, before pressing play you will be able to see the actual plot if you scroll down.

Here is an [example file to download](#).

Using iCloud to Import Microphone Compensation Files

Using iCloud is the easiest way to import files, and provides more advantages such as the ability to share files between devices. Setup iCloud by [following these instructions](#). Then, on your computer, navigate to the iCloud folder “calibration”, under public. If the folder does not exist, create it.



Next, copy your compensation file to the calibration folder. The next time you go to AudioTools, Settings->Microphone Setup, select your microphone by tapping the small “i”, and then tap the “Calibration File” button, you will see the file that you added from your computer.

Select the file and the calibration will be applied.

### Using the Files app on the iOS Device to Import the Calibration File

Since iOS 11, you will find a Files app on your iOS device. If you are using the internal file storage method rather than iCloud, navigate to the top level in Files, and tap “On My iPhone” (or iPad). From here, you will see a StudioSixDigital folder. Open this, and look for the “public” folder, within it will be the “calibration” folder. This is the place that you can paste or drop the file.

To get the file so that you can paste it there, you could email it to yourself, and in the email select the file and tap Copy from the menu that pops up. Then go back to the “calibration” folder above, hold your finger on the screen for a bit, and tap Paste when the popup menu appears. Now you can go back into AudioTools and the file will be there to apply.