



APx EQ WAV Files utility

Background

The “APx EQ WAV Files” utility was developed in late 2012 to enable equalization of WAV audio files, primarily so that compensation curves could be applied to generator waveforms in acoustic testing. If you have not yet downloaded the utility, go to www.ap.com and search on APx EQ .wav Files Utility to locate the download link.

Generator equalization is commonly utilized when measuring microphones, to compensate for frequency response variations in the stimulus speaker. To do this, a high-quality measurement microphone is used to measure the frequency response, which is then inverted. This creates an equalization curve that can be applied to the generator to cancel out response variations. For greater precision, the (typically small) response variations of the measurement microphone can be factored in as well. When utilizing a mouth simulator to test portable device mouthpieces, the equalization compensates not only for speaker performance, but for the acoustics of the mouth simulator’s mouth and throat cavity.

The addition of generator Output EQ to the core APx500 software (version 3.4, November 2013) has largely made this utility unnecessary. However, there are two use cases for which APx EQ WAV Files remains useful.

Current Use Cases

1. Driving a Mouth Simulator with complex waveforms at standard levels

Since APx500 version 3.4, the Output EQ feature can apply an arbitrary equalization curve to the generator output for transducer compensation. However, Output EQ was designed with sine sweeps in mind, and may have difficulties attaining sufficient levels with complex waveforms typical of speech when used with some mouth simulators.

Here’s why: the Output EQ feature sets the output level so that the specified equalization curve will not drive the generator into clipping. If, for example, the curve calls for a 15 dB boost at 7 kHz, APx will reduce the generator level by 15 dB to accommodate the boost. When used with a sine sweep, this design is straightforward and works well.

When using complex waveforms such as PESQ or POLQA speech samples with some mouth simulators, the level reduction to accommodate the equalization curve can reduce the output level so far that the required Active Speech Level cannot be achieved at the driver. This depends upon the gain of the mouth simulator’s power amplifier and the sensitivity of its driver.

You’ll find instructions for using this utility beginning on page 3.

2. Achieving precise, highly detailed equalization for other purposes

A second use case arises if you require a generator response that more closely matches your specified EQ curve. The Output EQ feature uses a 30-pole real-time filter that provides excellent results, as shown in Figure 1. Instead, the EQ WAV Files Utility convolves the signal in the WAV file with a filter derived from the EQ curve in the CSV file, and can provide a more detailed, more accurate match. If this is important to your application, you may want to try it.

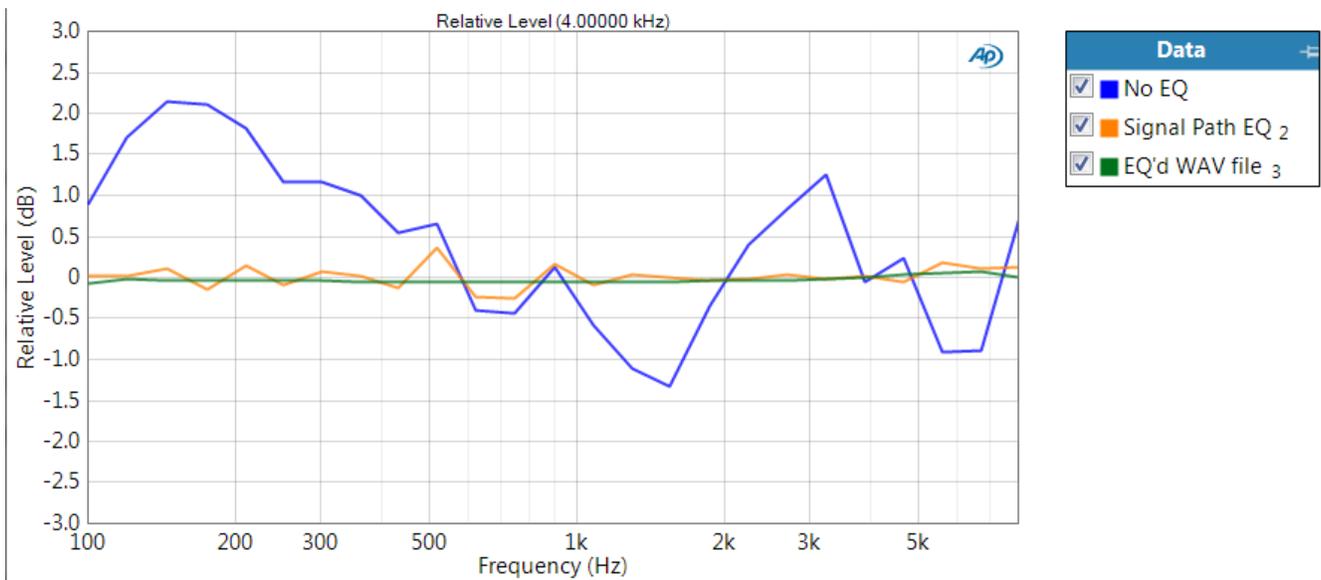


Figure 1. This graph illustrates the typical performance of the EQ WAV Files utility, compared to that of the APx500 Signal Path Output EQ.

Figure 1 was derived as follows:

1. First, we measured the response of a loudspeaker used for speech testing, using the log chirp stimulus in the APx Continuous Sweep measurement.
2. Next, we created a multitone stimulus WAV file with tones spaced at about 1/3 octave from 100 Hz to 8 kHz. Using this multitone, we measured the response of the loudspeaker, resulting in the blue trace.
3. Then, we measured the response a second time, using the inverted response curve from step 1. This produced the result shown by the orange trace.
4. Finally, we used the APx EQ WAV Files utility to equalize the multitone WAV file. When we used this as the stimulus, the measurement produced the result shown by the green trace.

New features

A second utility called “Test EQ’d WAV File” has been added to the distribution that provides a comparison between the specified EQ curve (the CSV file) and the actual equalization accomplished in the modified WAV file. This utility is discussed beginning on page 4.

Using the APx EQ WAV Files Utility

The Utility has a simple user interface as shown in Figure 2, whose controls are described in Table 1.

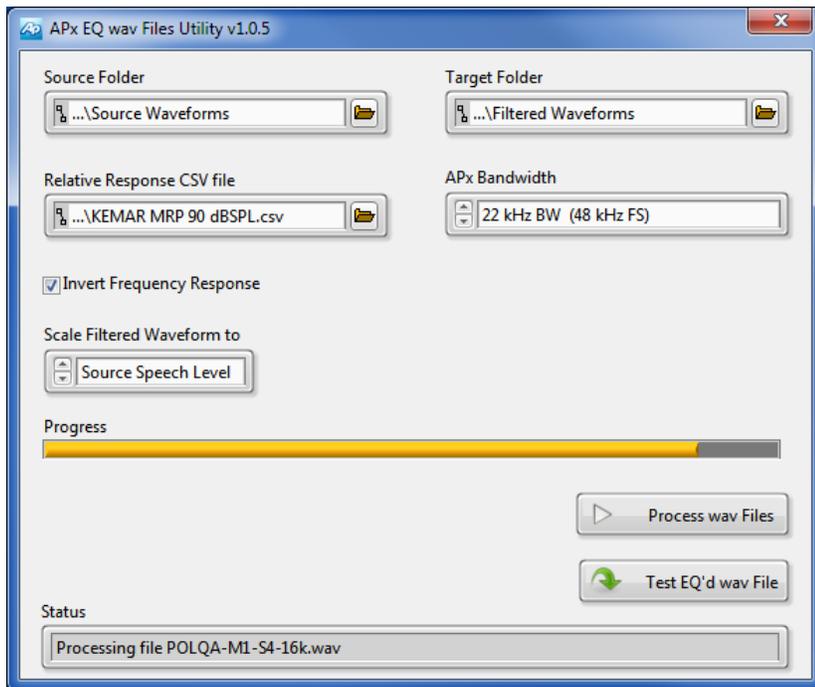


Figure 2. The APx EQ wav Files Utility window during .wav file processing

Table 1. Controls in the Windows version of the APx EQ wav Files Utility

Control Name	Control Description
Source Folder	Specifies the path to a folder containing the source .wav files to be equalized. Note: When the utility is installed, a folder containing various speech waveforms and a white noise waveform are added to the system at <MyDocuments\Audio Precision\EQwav\Source Waveforms>. This folder is selected by default
Target Folder	Specifies the path to a folder where the EQ'd files will be saved. The default value is <MyDocuments\Audio Precision\EQwav\Filtered Waveforms>.
Relative Response CSV File	Specifies the name of a CSV file to be used as the EQ curve. This data should be a Relative Frequency Response curve exported from the APx500 control software using the All Points data export specification. The default is set to the file "KEMAR MRP 90 dB SPL.csv" which is installed with the utility. This file contains the measured frequency response of a mouth simulator from 50 Hz to 16 kHz.
Invert Frequency Response	When checked, the EQ curve will be inverted before it is applied.
Scale Filtered Waveform to	Used to specify the EQ'd .wav file scaling; if Source Speech Level is selected, the EQ'd .wav file will be scaled such that its speech level (per IEC 60268-16 Annex J) matches that of the source .wav file.

Control Name	Control Description
Process wav Files	When clicked, the utility will apply the specified EQ curve to all of the .wav files in the source folder and save the EQ'd files in the target folder.
Test EQ'd wav File	When clicked, this button invokes an application that can be used to test an EQ'd .wav file by comparing its frequency response relative to the original source waveform to the specified EQ curve.

The Test EQ'd wav Files Application

The application, which is shown in Figure 3, can be used to verify the EQ process for one pair of .wav files (source and EQ'd) at a time. It computes the magnitude of the Frequency Response Function (FRF) between the EQ'd .wav file and the source .wav file and plots the relative frequency response on the same graph as the specified EQ curve. A description of its controls is listed in Table 2.

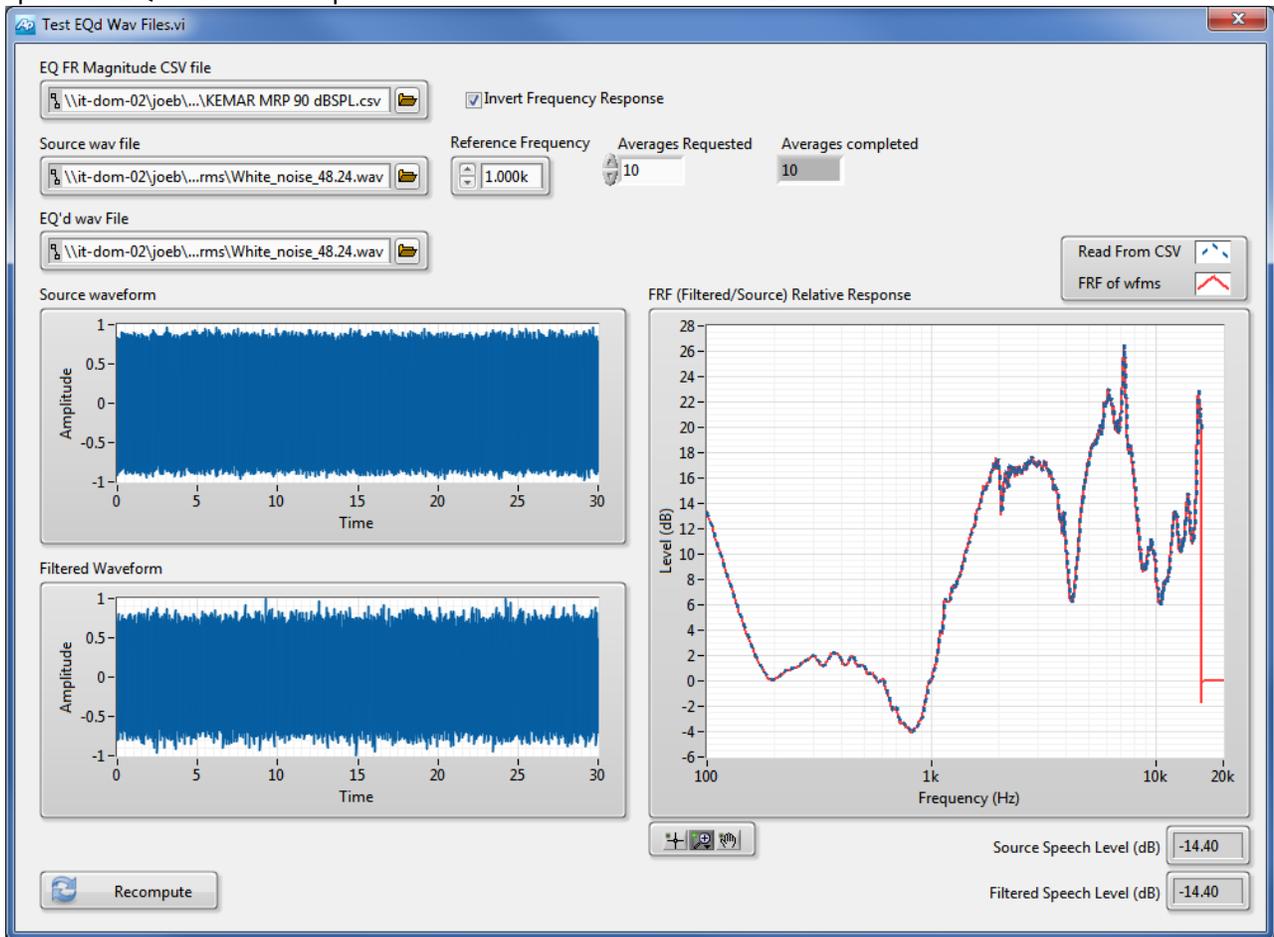


Figure 3. The Test EQ'd wav Files application

Table 2. Controls in the Test EQ'd wav Files Application

Control Name	Control Description
EQ FR Magnitude CSV File	Specifies the name of the CSV file that the applied EQ curve was read from.
Source wav file	Specifies the path to a source .wav file that was EQ'd.
EQ'd wav File	Specifies the path to the EQ'd .wav file.
Invert Frequency Response	When checked, the EQ curve read from the CSV file will be inverted before it is plotted. Note: The check state of this control should match the setting used to EQ the files.
Reference Frequency	Specifies the frequency at which the response curve read from the CSV file and the computed FRF curve are normalized.
Source Speech Level (dB)	Indicates the speech level (per IEC 60268-16 Annex J) of the source .wav file.
Filtered Speech Level (dB)	Indicates the speech level (per IEC 60268-16 Annex J) of the EQ'd .wav file.
Averages Completed	Indicates the actual number of averages in the computed FRF.
Recompute	When clicked, recomputes the FRF based on the current control settings and updates the graph. The Recompute button should be pressed after changing any of the dependent controls.



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