Spectrum Analyzer

Avia™ DSP Help Guide

Crestron Electronics, Inc.

CRESTRON

Crestron product development software is licensed to Crestron dealers and Crestron Service Providers (CSPs) under a limited non-exclusive, non-transferable Software Development Tools License Agreement. Crestron product operating system software is licensed to Crestron dealers, CSPs, and end-users under a separate End-User License Agreement. Both of these Agreements can be found on the Crestron website at www.crestron.com/legal/software_license_agreement.

The product warranty can be found at www.crestron.com/warranty.

The specific patents that cover Crestron products are listed at patents.crestron.com.

Certain Crestron products contain open source software. For specific information, please visit www.crestron.com/opensource.

Crestron, the Crestron logo, and Cresnet are either trademarks or registered trademarks of Crestron Electronics, Inc. in the United States and/or other countries. Other trademarks, registered trademarks, and trade names may be used in this document to refer to either the entities claiming the marks and names or their products. Crestron disclaims any proprietary interest in the marks and names of others. Crestron is not responsible for errors in typography or photography.

This document was written by the Technical Publications department at Crestron. ©2016 Crestron Electronics, Inc.

Contents

1 Introduction

1 Making Measurements

4 Smoothing

4 Decay

4 Windowing

©2016 Crestron Electronics, Inc.

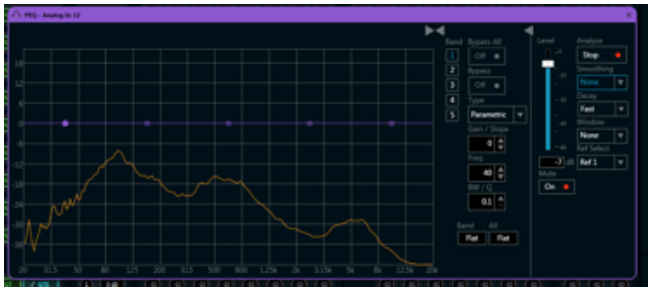
Equalization is an important tuning procedure for the delivery of an acoustically optimized system and the spectrum analyzer is the audio technician's tool of choice for this task. By analyzing the system configuration and measuring room response (the audio system's interaction with the acoustic environment), equalization can be applied to deliver a more intelligible and natural sounding system.

Every room has "modes" that are natural resonances and these are excited by an amplified sound system. Modes can be reflections where the energy from the loudspeaker may bounce off of hard surfaces and continue to other surfaces to bounce again. This reflected acoustic energy can interact and build, impacting speech intelligibility and presentation playback.

In addition, the loudspeaker system has performance characteristics that can be addressed and optimized with equalization. Best practice dictates addressing room tuning first and then configuring AEC, dynamics, gating and other functions.

Making Measurements

A measurement microphone is required for spectrum analysis. A mic with an omnidirectional pick up pattern and flat frequency response will provide the best results for the initial setup. If you don't have a measurement mic use the installed mic for your conferencing system. Place the mic in the center of a conference table to begin the measuring and tuning process.



This is a spectrum display with an abundance of low frequency HVAC mechanical noise from the return air plenum servicing the conference room. The noise has a clear peak centered @ 100Hz. Taming this kind of mechanical noise may require intervention by the HVAC designer. It is a building system generated noise and cannot be equalized "out" of the room as a sound system function. A low frequency "cut" filter can be used to eliminate this noise from entering the DSP system.

©2016 Crestron Electronics, Inc.

The channel strip (shown below) containing the EQ object is the source and the input strip Gain object is used to adjust the mic feeding the analyzer. The level control and mute on the analyzer are the same level and mute controls found on the signal generator. This dual location minimizes switching between objects during the tuning process.

The Mute, Level and dB Display in one object update the other object.

The output of the signal generator must be assigned to one of the Ref bus that is selected in the spectrum analyzer.

This configuration is sending pink noise from the onboard signal generator to Analog Out 2 in the matrix feeding the in-room loudspeakers.

The analyzer runs with the Stop/Start button. You can select white noise, pink noise or tone from the signal generator to feed into the room loudspeaker system. Most tunings begin using a random pink noise source which is preferred for equalization because it is closest to how we hear; there's equal acoustic energy per octave.

Adjust the levels in the room so that the pink noise is of sufficient level to begin masking normal speech; it may appear loud and this is expected. We want to excite the room and listen for any obvious excitations and rattle from items in the room such as a light fixture or the suspended ceiling grid. These fixtures may come alive and can resonate when the pink noise is turned up. We definitely want to identify any resonant issues prior to further tuning. Some mechanical remediation may be required to deal with a light fixture that buzzes or a HVAC vent that rattles.

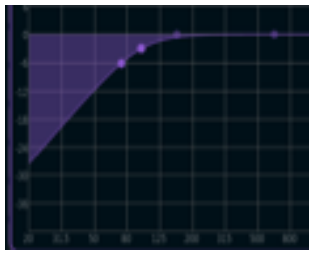
If you have identified a fixture that is resonant and you want to zoom in on the excitation frequency, switch the signal generator over to Source – Tone and frequency sweep the room. With the Tone source selected adjust the level to the point where the room level is sufficient to excite the fixture. Right click on the Sine Freq box and a horizontal slider is presented. Grab the slider and slowly drag it left to right; the frequency of the tone will display in the window.

The range is 20Hz to 20kHz and as you move the slider make note of the frequency (or frequencies) that excites the fixture - this is a resonant frequency. You'll address these resonances by adding notch filters later during equalization.

A treated space with pink noise source is shown. The low frequency variances are expected in a typical conference room.

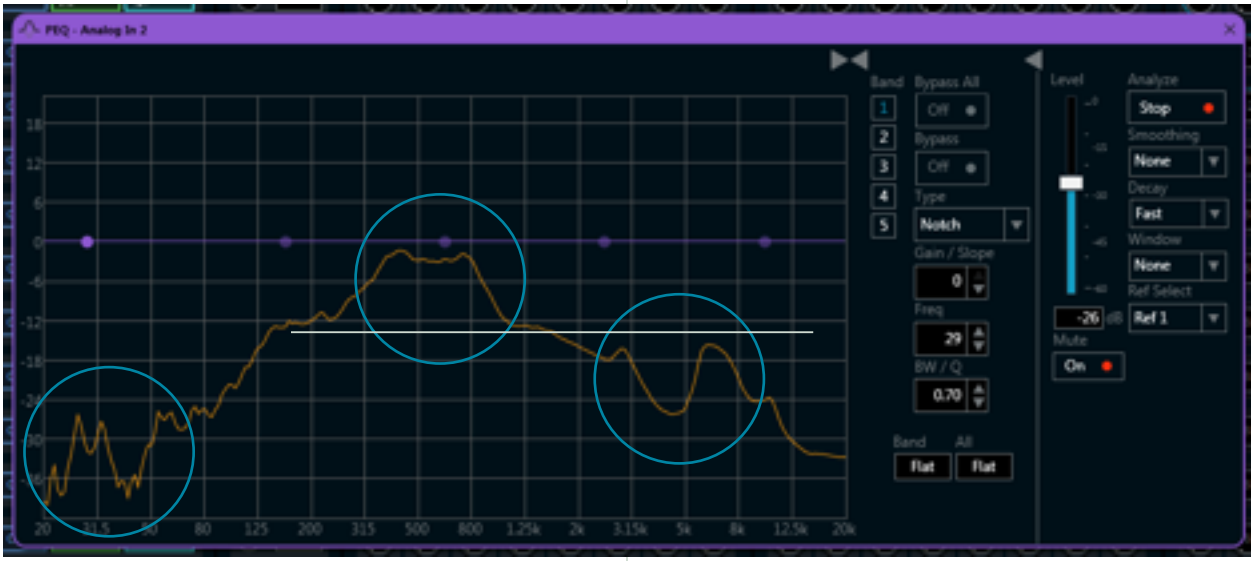
©2016 Crestron Electronics, Inc.

The room measurement (below) has three primary areas of interest to achieve a flat response that's approximated by the horizontal pale green line as the target; this line is a graphic overlay for clarity and is not part of the tool. Reading left to right the first area of interest is the low frequency end of the scale that is outside of the speech range but is definitely in the mechanical noise range. We don't want to pick up this noise so we apply a sharp **Low Cut** filter.



In the **mid-range** we can set a parametric filter centered about the 500Hz region and cut -6dB, and use a bandwidth of 0.5 octave to help tame the rise. We start by using modest amounts of input so we don't overshoot our target and to develop a feel for the depth and response of the controls in the space.

The **high frequencies** 3-6kHz range have a clear dip that will be brought up by adding EQ centered at 4.8kHz with a gain of 6dB and a BW of 1.0. This is at the upper end of the voice range and is largely responsible for the consonant sibilance or sharp "S" sounds. You don't have to add much EQ as these sounds will fill-in with modest gain.



©2016 Crestron Electronics, Inc.

Smoothing

When analyzing a room you can engage smoothing, a process by which the frequency response samples are modified to provide enhanced visual resolution and presentation. This presentation is useful for making decisions about the filter center frequency depth and width that's best to achieve a desired result. The data points of the sample are modified so that individual points that are higher than the immediately adjacent points (presumably because of noise) are reduced, and points that are lower than the adjacent points are increased. The result is an averaged frequency response that does not possess as many magnitude peaks. Smoothing sample ranges are selectable and can be applied in full octave and/or fractional increments. The one octave smoothing will have the fewest amplitude peaks (wide range) while a 1/24 octave will have more peaks (narrow range).

In the mid and high frequencies the ear perceives loudness at 1/3rd to 1/6th resolutions and that's why a smoothed measurement of 1/6 or 1/12 octave is often used as it best correlates what you hear to the displayed measurement.

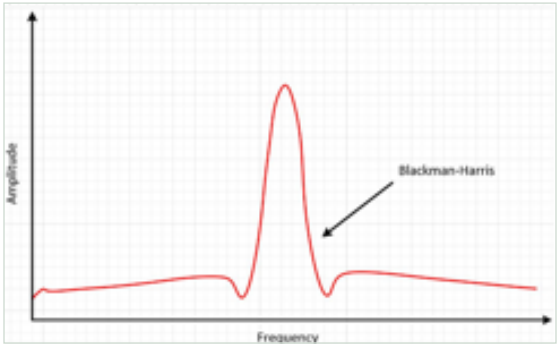
Decay

When making room measurements, it can be useful to adjust the rate at which the response is refreshed for dynamic sources. This control can enhance the visualization of what's happening in the space so that problem areas show up more clearly and lead to corrective EQ inputs.

Windowing

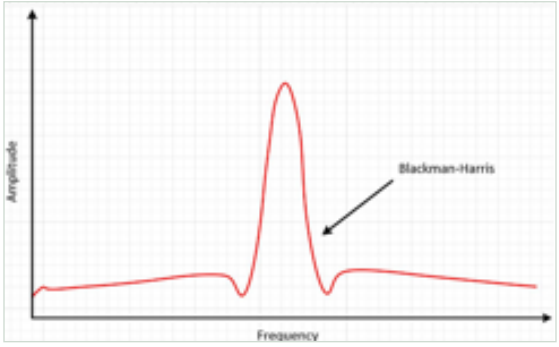
When measuring with the spectrum analyzer, you may encounter situations where discontinuities cause an apparent smear of the information. To help clarify what's happening, you can use the windowing technique or "apply" a window. As you measure each sample frequency it will display based on magnitude with peaks that have side lobes. In essence, by changing the roll-off rate of a higher amplitude peak we change the side lobes and this will have an impact on how an adjacent lower magnitude signal is influenced and displayed. By changing the roll-off rate of the side lobes you change the potential smear on adjacent peaks that are your frequency of interest.

The **Hamming and Hanning windows** both have a sinusoidal shape and result in a wide peak but low side lobes. The Hanning window touches zero at both ends eliminating discontinuity. The Hamming window doesn't quite reach zero and has a slight discontinuity in the signal. The Hamming window is better for cancelling the nearest side lobe but doesn't cancel any others.



Blackman windowing has a spectrum with a wide peak and the greatest side lobe compression of the 3 types offered. It is the most useful for examining closely spaced frequencies.

Windowing functions are useful for advanced users requiring different frequency resolutions in their measurements. Example sinusoidal signals of equal amplitude are shown using the three windowing options with their characteristic lobes:



©2016 Crestron Electronics, Inc.

Crestron Electronics, Inc.
15 Volvo Drive Rockleigh, NJ 07647
Tel: 888.CRESTRON
Fax: 201.767.7576

www.crestron.com

Spectrum Analyzer
Avia™ DSP Help Guide
12.16

Specifications subject to
change without notice