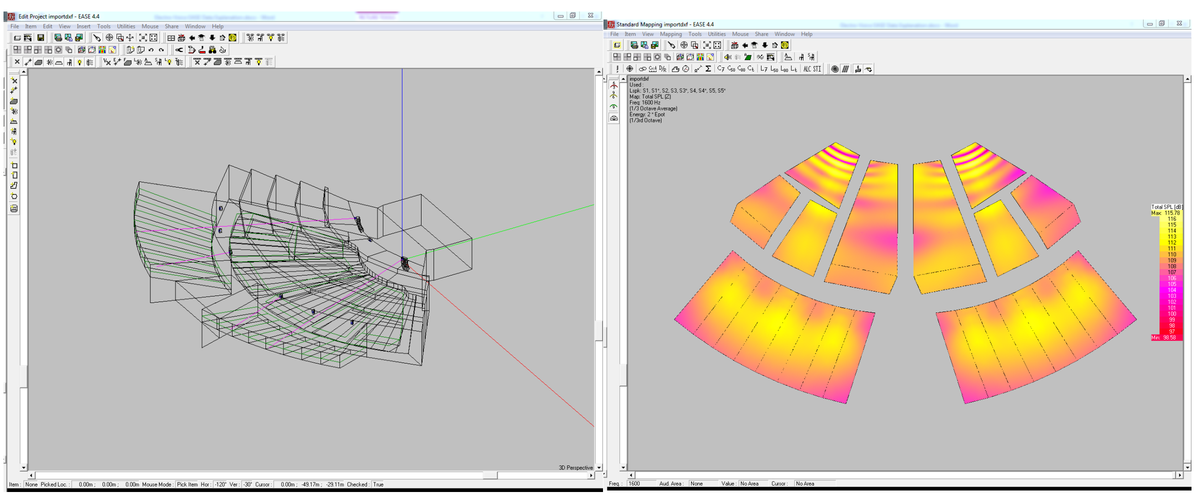
Electro-Voice EASE Data Explanation
11/9/2015
Michael Kasten

Introduction

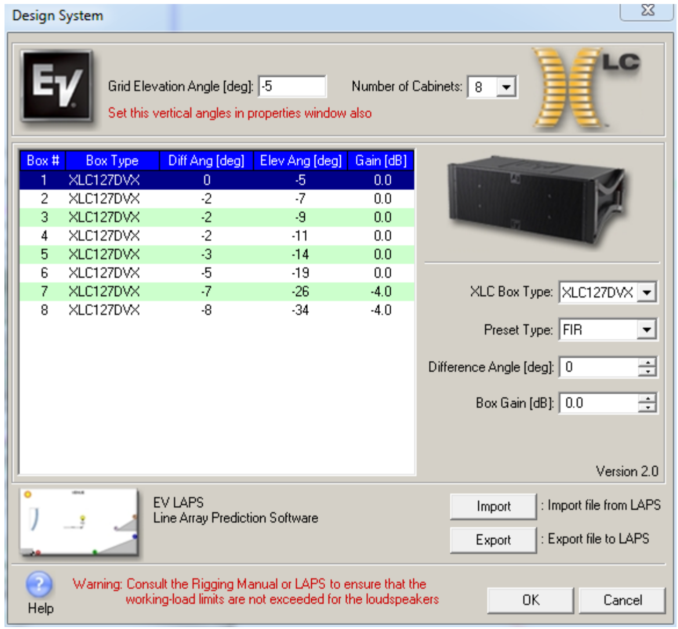
The loudspeaker industry is one of many industries that struggles to adopt and conform to one set of standards, often as there is no authority to set or enforce these standards. The result is that available manufacturers' data is not directly comparable from loudspeaker to loudspeaker. There are multiple methods that can be used to measure loudspeakers and acquire correct data. For example: SPL can be measured in the time domain or the frequency domain; or it can be measured with instantaneous peaks over very short durations of time or averaged over very long periods of time. All measurement methods can provide accurate SPL measurements, however, they will provide very different results when used or applied. Recently the AFMG (Ahnert Feistel Media Group) has taken measures to compensate for this in their simulation program EASE® (Enhanced Acoustic Simulation for Engineers) and their new data format, the GLL (Generic Loudspeaker Library).



Example of an EASE simulation with a room mapping and audio

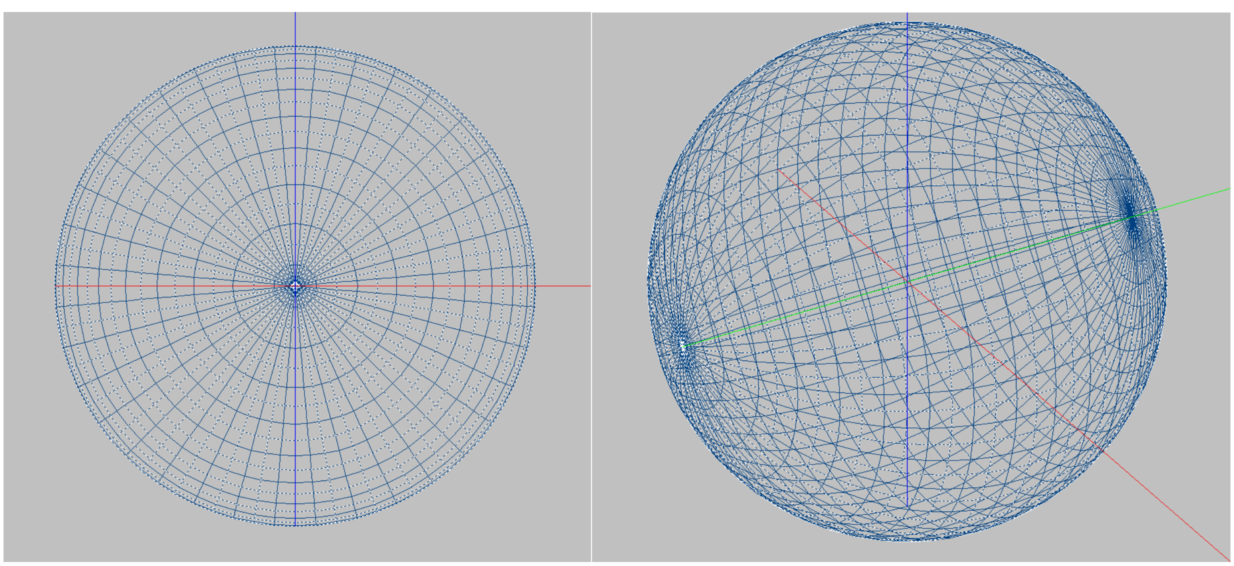
The SPK Format

To understand the difference of this new data format we must first look at the previous data formats of EASE. Since 1990 EASE has provided the ability to simulate the results of a loudspeaker or loudspeakers in a simulated 3D environment. While simple speakers were generally portrayed in a standard .SPK format, arrayed loudspeakers (clusters or lines of multiple loudspeakers) were often defined by the use of an additional program called a DLL. The DLL would typically take the acoustic data provided in one or more .SPK files and allow them to be physically articulated into an array with limitations set by the manufacturer. Therefore in most cases the acoustic data is still initially defined in the .SPK file format. It is now possible to use high resolution data in a DLL:

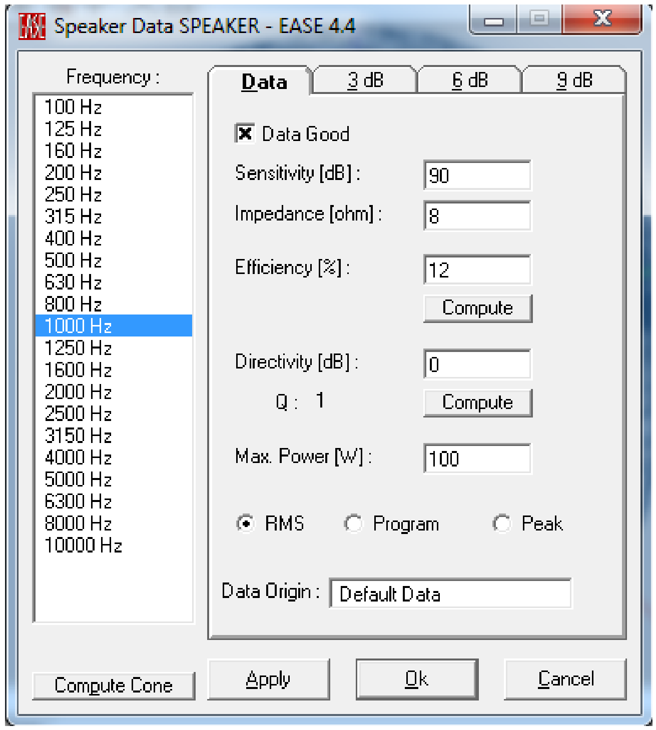


Example of a DLL used to build a line array

This data format has some limitations which were initially due to the lack of computing ability when the program was first developed. The .SPK format allows 3D polar balloon data to be imported for a system in 1/3-octave frequency resolution with up to 5-degree spatial resolution (angular difference between adjacent measurement points).

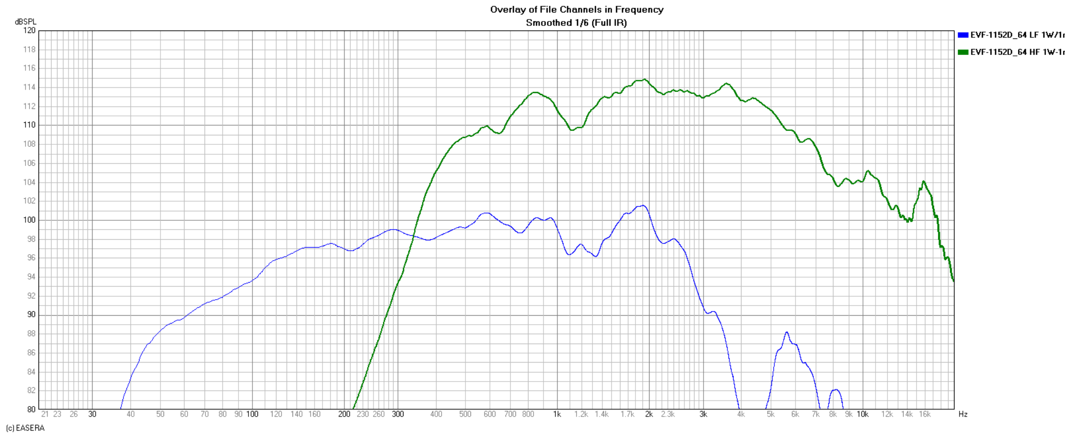

Images of a blank polar balloons, each intersection represents a measurement angle for 5 degree spatial resolution

The manufacturer would then enter in values for Sensitivity (dB), Impedance (ohm), and Max Power (W) for each 1/3-octave frequency band. This all seems straight forward, but there are ways that would allow manufacturers to manipulate this data.

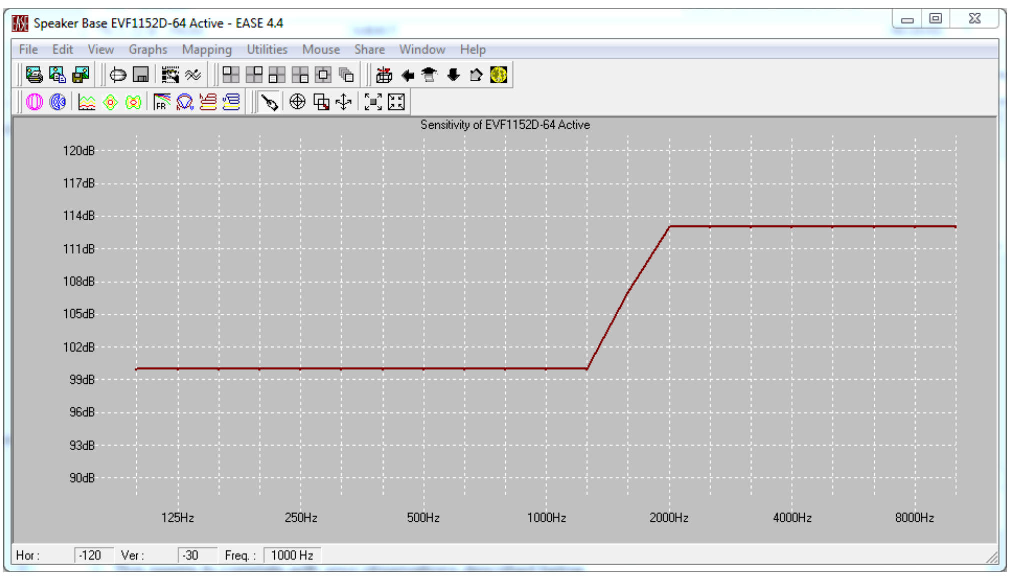


EASE Speaker Base Speaker Data Edit Menu, Used for SPK format

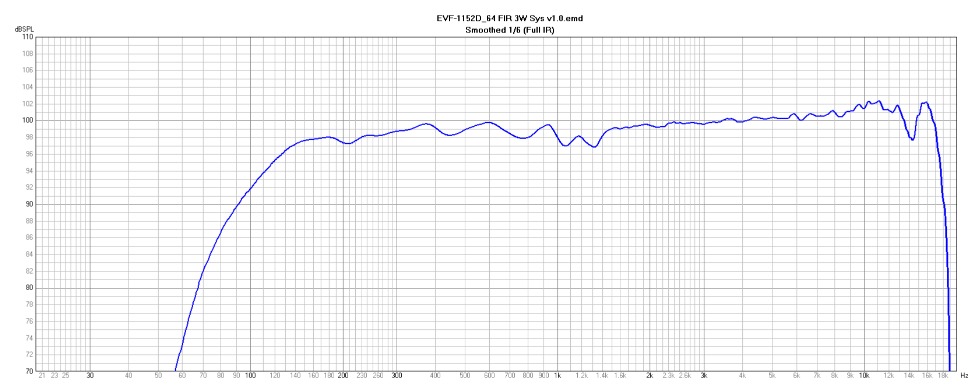
It is easy to specify the 1/3-octave sensitivity of a passive system or a single-transducer full-range system; it becomes much more difficult to define an active system or a powered system with the options which are provided. For example, how do you determine the sensitivity and Max Power values for a frequency band that is in the crossover transition to the next transducer band? Issues like this lead to the need to simplify the sensitivity values of these devices. Instead of having discrete values for 1/3-octave sensitivity it became common to provide a single sensitivity value for each transducer band and average the Sensitivity and Max Power at any crossover point. For example, if you had a 2-way system you would end up with a flat line from 100 Hz to the crossover frequency, and then there would typically be a large discontinuity as the low frequency section transitions to the much higher sensitivity high frequency section (see image below). This single sensitivity value is generally determined by looking at the sensitivity response of an unprocessed loudspeaker over a usable bandwidth and taking an average of the results. Since a typical loudspeaker response will vary in SPL over its usable band pass, each 1/3-octave frequency band will have some error. This reduces the accuracy of the overall SPL calculation.



Anechoic frequency response of unprocessed transducers from EVF-1152D/64



Example of sensitivity plot of a 2-way system in SPK file format



EVF-1152D/64 Active System Anechoic Frequency Response

One problem with this format is that it allowed the manufacturers to choose which format of max power to apply to the calculation (RMS, Program, or Peak). The definition of how these measurements are made is not fully agreed upon in the industry, there are several standards that define different bandwidths, time durations, and spectrums of noise, which all yield different results. Sometimes these are dramatically different. For Electro-Voice .SPK/DLL format EASE data, we have always provided our Max Power using the peak equivalent (RMS results of test + 6dB) results of our 8 hour AES2-1984 tests (more than the 2 hours AES spec) requiring that our transducers pass to meet our internal test and rating criteria. We chose to use the peak power as opposed to the other two options, to better help our customers determine appropriate amplifier pairings with our loudspeakers in order to provide adequate amplifier headroom.

The results of not having standardized methods to define sensitivity (in other than passive systems) and rated power test methods which have the option to be defined in either RMS, Program, or Peak all lead to the SPL calculations in the older format not only having questionable accuracy, but which also lead to widely varying specifications between manufacturers for products that should have very similar measurements. Additionally, there is no method for the customer to determine which method of measurement or which type of power is applied in order to adjust each manufacturers' product for a rational comparison. Current approaches also lack the ability to include parameters for limiters for thermal and mechanical protection.

Another contributor to the error in the SPL calculation is the way that EASE applied the power in the SPL calculations. In versions of EASE prior to 4.2, the calculations were done in what is defined as the multi-tone calculation method. This calculated the SPL increase of the maximum power as it applied to each 1/3-octave band pass; the calculation applied significantly more power to an individual transducer than it was rated for. For example, for a rated 500-watt speaker it would calculate the SPL as if 500 watts were applied to each individual 1/3-octave band pass as opposed to the entire speaker. This provided SPL results that were 13.2 dB higher than they should be.

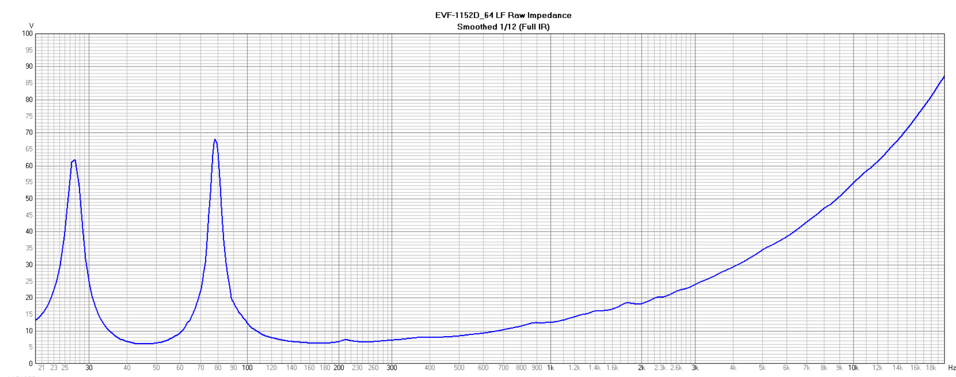
To summarize: The old .SPK/DLL format, a combination of limited data definition and erroneous SPL calculations have provided calculated SPL values that can be significantly incorrect. With 6 dB or more error from the Max Power options and the methods of determining these values, 13.2 dB of error from the multi-tone calculation method, and additional error caused by the single sensitivity values (as opposed to discrete 1/3-octave values) one could achieve more than 20 dB of error in your EASE SPL calculations. Correct results are still possible provided the user understands the data format and takes this information into consideration.

The GLL Format

In EASE version 4.2 and higher, AFMG has introduced the GLL to help reduce the limitations of the previous data format and calculation method. The GLL allows manufacturers to enter data in a meaningful way. This format allows high resolution impulse responses with up to 96 kHz sampling for each discrete angular measurement. This means significantly higher frequency resolution over the 1/3-octave of the previous format. Since the data is stored in impulse response, you also get high-resolution phase data which significantly contributes to the accuracy of the calculated results. Additionally, the spatial resolution can be as fine as 1 degree. This can be critical for line-array applications where each element has tightly controlled vertical coverage (typically < 10°) and splay angles are often measured in 0.5° increments. To put that into perspective, a typical 5-degree full spherical polar has 2,593 measurements, whereas a one degree full spherical polar measurement has 64,801 measurements. Every measurement does not require this high of a resolution; it is an option for applications such as line array elements.

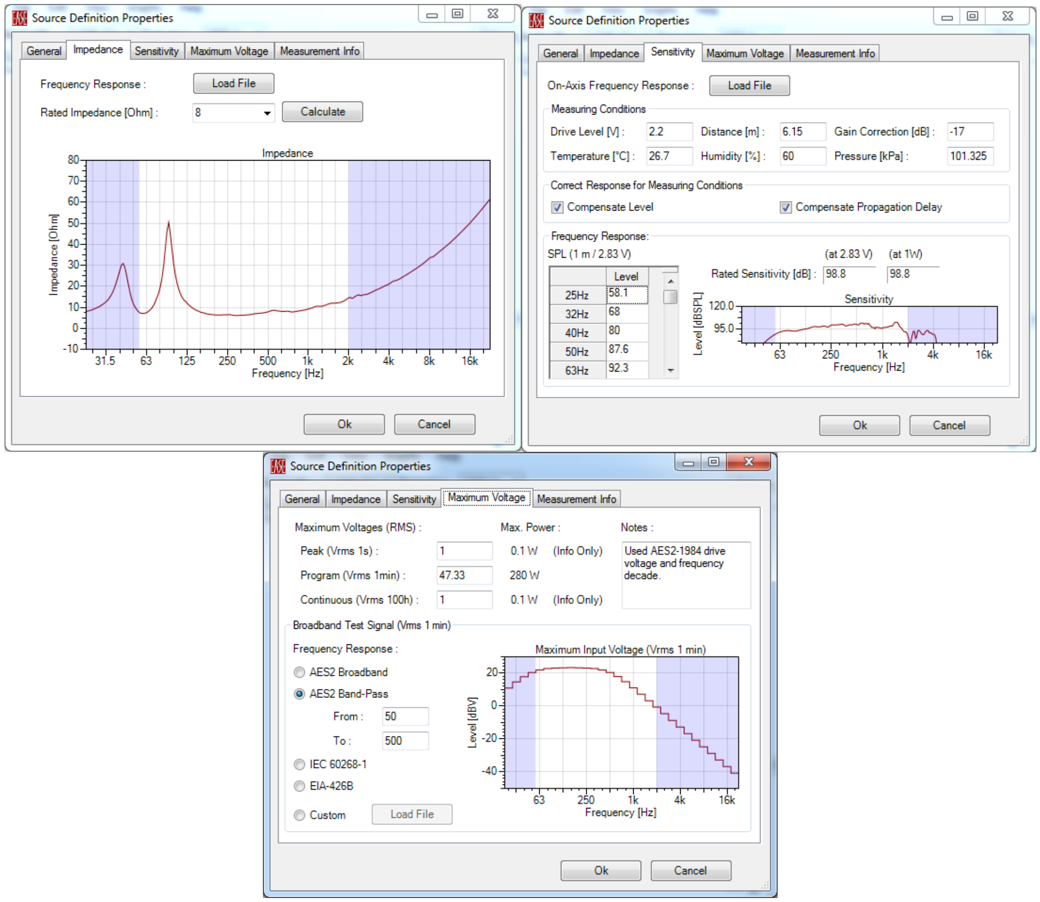
Most likely the largest difference is that the program allows individual polars to be imported for each transducer in the system. These can then be appropriately placed in a virtual cabinet and combined with electronic transfer function measurements of the passive crossover or active DSP parameters. This allows manufacturers to enter the correct sensitivity value and power ratings for each transducer. This solves the problem of determining sensitivity and power rating values within the crossover region. Instead, the power rating and frequency sensitivity is defined in each transducer and the crossover and equalization is defined separately for each band pass.

Unlike the .SPK format, there is only one usable value for maximum power, defined as Maximum Input Voltage as opposed to watts, and this is a much-improved method of defining the power handling of the system. The power is defined as the square of the applied voltage divided by the impedance; the question is what impedance value to use? Since moving-coil transducers do not have linear impedance, it is possible to get very different power ratings by using different values for the impedance. If you consider a typical impedance response of a woofer in a ported system, it has some nominal impedance, for example: 8 ohms. However, one could also define it by its minimum impedance, for example: 6.5 ohms. If you applied 50 Vrms noise for a power test you would get a power rating of 312.5 watts for the 8 ohm impedance value and 384.6 watts for the 6.5 ohm impedance value. Large differences are possible for two ratings if the same method is not applied; the benefit of using voltage applied to the speaker during the test (including system drive parameters) as opposed to the power rating of the speaker is clear.



Impedance measurement of the LF section of an EVF-1152D/64

The GLL format also allows us to provide the sensitivity and impedance in high frequency resolution which reduces (if not removes) any potential error from smoothing, rounding, or choosing a single value. Since each transducer is defined separately and combined mathematically in the GLL, the limit of the system can be defined as the first part of the system that reaches its maximum input voltage.



Three source definition windows from EASE Speakerlab which define a single transducers characteristics

Lastly, the multi-tone method of calculation is no longer a requirement and instead the pink-noise spectrum is applied. This would be equivalent to applying a broad band pink-noise signal to the input of your system. The maximum SPL of the system is the acoustic result of this pink noise when it is increased to maximum voltage of any part of the system.

Using the GLL greatly improves the quality of EASE simulations by reducing the variation of data entry methods. The accuracy of the measured data has been significantly increased by using high-resolution impulse responses. When done correctly it is possible to use this data to achieve realizable, measureable, and repeatable results. That being said, it is still possible to use simulated or theoretically perfect results (as opposed to measured data) or enter incorrect values for sensitivity, maximum input voltage or many other parameters. Therefore the user should be aware of the source of their data and how it was measured; it is possible for the results to look too good to be real.