COMMUNITY DATA MEASURMENTS

Community's data measurements comprise a battery of tests done on each product. The measurement methods and data post-processing programs have been carefully thought out to both eliminate inaccuracies and variables, as well as to provide specifications that reflect the true performance of each product. No loudspeaker products are perfect, therefore achieving maximum performance requires knowing what they do, "warts" and all. As such, Community's data and resulting specifications are minimally manipulated. This is done only to the extent necessary to eliminate detail beyond that perceivable within normal human hearing and production tolerances. See the technical note "To Smooth or Not To Smooth…".

A WORD ABOUT WATTS

The following statement appears at the bottom of Community's specification sheets: "Watts: All wattage figures are calculated using the rated nominal impedance."

This means three things.

1. The wattage figures in the specification sheet are useful and should be used for selecting amplifier watts using the loudspeaker's nominal impedance.
2. The wattage figures are directly comparable to those of other manufacturer's loudspeakers who calculate watts similarly (and they all do).
3. Loudspeaker wattage is normally calculated from the input voltage squared divided by the nominal impedance. However, a loudspeaker's impedance normally shows considerable variation with frequency. Also the voltage to current phase angles of the input signal are rarely measured. Both of these quantities are required to calculate power correctly. Thus the wattage numbers that appear in loudspeaker specifications rarely, if ever, equal the actual power to loudspeakers. Amplifier wattage is similarly calculated but is based on resistive loads that do not vary with frequency and where voltage and current are in phase. As such it does not accurately represent what power it would deliver to any given loudspeaker.

Given the above, measuring and specifying the actual power delivered to a loudspeaker would be relatively meaningless for selecting a properly sized amplifier. Further, such ratings would not be comparable to those of other loudspeaker products. Thus, as used by both loudspeaker and amplifier manufacturers, it can and should be inferred that "watts" is merely a mathematical substitute for voltage. Community uses the "watts" convention only for comparative purposes, not as scientifically accurate numbers.

THE MEASUREMENTS

The following lists the measurements Community makes on each of its loudspeaker products and describes the post-processing involved with each. These measurements form the basis for and, in most cases, directly provide the numbers used in the performance specifications listed in the specification sheets. All measurement data is post-processed using custom Visual-Basic programs that generate Excel spreadsheets and charts within them. We use a minimum of 9 post processing programs for each product to generate its specifications.

1 Meter Maximum SPL

This measurement takes 1/3 octave SPL data using a pink noise test signal and calculates the SPL at 1 meter for that data. This is used to measure the maximum SPL by using the maximum, or nearly maximum, rated voltage input to the loudspeaker. The RMS value of the pink noise input is accurately measured. The SPL measurement is normally made at a distance of 20 feet / 6 m from the loudspeaker and extrapolated to 1 meter. The bandwidth of the input signal, except for component drivers, is almost always 20Hz to 20 kHz. The post-processing program calculates the SPL over any desired 1/3 octave defined bandwidth using the square root of the sum of the squares method for adding the individual 1/3 octave band SPLs. The maximum peak SPL is based on the test signal peak to average ratio.

Distortion and Maximum Input

The distortion measurements provide 2^{nd} and 3^{rd} harmonic distortion for the loudspeaker at different power levels. Usually we measure at 1%, 10%, 25%, and 50% of rated power for full systems and included 100% and 200% of rated power for drivers.

A measurement must be made for each for each power level and each type of distortion generating three files for each power level – one for the fundamental, one for the 2^{nd} harmonic, and one for the 3^{rd} harmonic distortion.

Typically, power handling specifications are used indicate a point beyond which the loudspeaker or driver may be damaged or no long function. Instead of this, Community's maximum input ratings and recommended amplifier power are selected as the points up to which the loudspeaker or driver will provide low distortion, high quality sound. Therefore distortion measurements largely determine and verify the maximum input ratings for Community Loudspeakers and drivers. Our philosophy is that a maximum input rating should represent what a loudspeaker CAN do rather what the loudspeaker CANNOT do.

EASE File Program
(Sub program within polar programs)

This is found in and is part of the polar programs. It is used for exporting the polar data generated into text formats (*.EXP files) that the EASE program recognizes and can import. There are 4 types of EASE files that can be made:

1 Octave polar symmetrical data (180º x 90º data) at 10 degree points.
1 Octave polar asymmetrical data (180º x 180º data) at 10 degree points.
1/3 Octave polar symmetrical data (180º x 90º data) at 5 degree points.
1/3 Octave polar asymmetrical data (180º x 180º data) at 5 degree points.

The <u>*.EXP</u> files are then imported to EASE using the EASE program to create a <u>CATALOG.LSP</u> file.

The older DOS-based EASE program uses 1 octave files and 10º data. The new Windows-based EASE program uses 1/3 octave files and 5º data.

Frequency Response 2

This program generates a frequency response of the loudspeaker using two files. One is for data taken in the far field (~40 feet) from 20 Hz to 20 kHz at approximately 40 Hz resolution. The other file is data taken in the near field (~4 feet) from 20 Hz to 2 kHz at approximately 10 Hz resolution. The program splices the two data streams together at 500 Hz. The resulting graphs are normalized to show the SPL at 1 watt @ 1 meter input for each data point. Because of the higher resolution, this yields a much more accurate graph for low frequencies. Any variations in SPL between the LF and HF data is normalized using the HF SPL around 200 Hz and normalizing the LF data at 200 Hz to this value.

The Excel post-processing program applies 12% (1/8 octave) smoothing to the data to eliminate minor and insignificant variations. The graph is also normalized to show the SPL at a 1 watt @ 1 meter input for each data point. The program also calculates the +/- dB variation over a user selected frequency range. It calculates the frequency range between the +/- 10 dB LF and HF frequency points which are used to specify the operating range. The data used for the +/- dB calculations is 33% smoothed (1/3 octave data).

Frequency Response 1

This measurement generates a frequency response graph of the loudspeaker using a single "full-range" <u>*.TDS</u> file. This is normally used for subwoofers, compression drivers, and such products that have limited bandwidth and a single measurement resolution can be used to provide sufficient data points over its operating range.

The Excel post-processing program applies 12.5% (1/8 octave) smoothing to the data to eliminate minor and insignificant variations. The graph is also normalized to show the SPL at a 1 watt @ 1 meter input for each data point. The program also calculates the +/- dB variation over a user selected frequency range. It calculates the frequency range between the +/- 10 dB LF and HF frequency points which are used to specify the operating range. The data used for the +/- dB calculations is 33% smoothed (1/3 octave data).

Impedance

This measures the impedance of the loudspeaker, normally using two files for full range systems. One is data taken from 20 Hz to 20 kHz at approximately 40 Hz resolution. The other is data taken from 20 Hz to 2 kHz at approximately 5 Hz resolution. The program splices the two data streams together at 200 Hz. The use of high resolution data for the lower frequencies provides much more accurate low frequency data. A single data file can be used in this program, such as for compression drivers, limited band-width loudspeakers where a single measurement resolution can be used to provide sufficient data points.

The post-processing program also allows setting the band-pass for finding the minimum impedance point for the loudspeaker. This capability is there because this point may be at a frequency well outside the range of interest for the device being tested. The program also finds the minimum point over the entire range of data collected, which may or may not be the same point as that for the band-pass selected.

Polar Data Programs:

1 octave symmetrical polar data
1 octave asymmetrical polar data
1/3 octave symmetrical polar data
1/3 octave asymmetrical polar data

These programs generate polar and isobar graphs from the complete set of 5º data points taken by the TEF20. They also generate the files that can be imported into either the DOS or newer Windows-based EASE program. Generating the EASE files requires the user to enter octave or 1/3 octave sensitivity data from one of the sensitivity programs.

The differences between the polar programs have to do with whether the data is smoothed by the TEF20 system to 1 octave or 1/3 octave and whether it was collected as 1/4 sphere data (180º x 90º) or 1/2 sphere data (180º x 180º). The former we call symmetrical data as the loudspeaker is assumed to be symmetrically constructed vertically and horizontally and therefore radiates the same way in all four quarters of a sphere. The latter we call asymmetrical data as the loudspeaker is symmetrically constructed in one plane but not the other. This means it will radiate differently on either side of either its horizontal or vertical axis and thus a half sphere of data is needed to accurately depict the dispersion.

The data is measured at a distance of 40 feet / 12.2 m at 40 Hz resolution. For plotting purposes, the data is normalized to a relative 0 dB point for each octave or 1/3 octave band. Because of the lower resolution, noise, or other data artifacts, lower frequency data below 200 Hz may not show what should be a generally smooth circular or ovoid graph shape. Fortunately, higher frequency data is much more stable and consistent around the sphere and plots above approximately 200 Hz are quite accurate.

1 and 1/3 Octave Polar Data Using Only Horizontal & Vertical Data

These measurements generate polar data using only horizontal and vertical 5º data points taken by the TEF20. They are useful for loudspeakers whose physical size prevents full rotation thus limiting data to simple horizontal and vertical polars. They also generate EASE files that can be imported into either the DOS or newer Windows-based EASE program.

The differences between the polar programs have primarily to do with whether the data is smoothed by the TEF20 program to 1 octave or 1/3 octave.

The post processing program interpolates the 5º data between the horizontal and vertical data points by dividing the difference in SPL between these points into equal increments and using these numbers to make up a complete 90º x 360º matrix for each frequency band. While this does not produce “true” data for each 5º point, it is nonetheless a useful approximation and produces the data needed for the EASE program. The interpolated data is similar to the "elliptical lobe" calculation in EASE. For plotting purposes, the data is normalized to a relative 0 dB point for each octave or 1/3 octave band.

Axial Q & DI from Symmetrical and Asymmetrical 1/3 Octave Polar Data

These post-processing programs calculate the axial Q and Directivity Index of the loudspeaker by comparing the average SPL from all 5º points around the loudspeaker to the SPL on axis. Only 1/3 octave data is used for best resolution over the entire frequency range of data. Each

5º data point is “weighted” according to the percentage area of the total sphere of data that it represents. In this way each point represents the same SPL per unit area, or sound power, as every other point. Because of the way the speaker is rotated, these areas are the same as those that would be subtended by 5º latitude and longitude lines around the earth. At the poles (representing the on-axis point and the point directly behind the loudspeaker) the areas are small compared to those at the equator (which wraps around the sides, top, and bottom of the speaker). Thus the areas near the poles get “less weight” than those at the equator.

The program also plots the -6 dB horizontal and vertical beamwidths using an algorithm for calculating -6 dB isobars. The nominal horizontal and vertical coverage angles and the deviations from same are calculated from this data.

1/3 and 1 Octave RTA Sensitivity Using Pink Noise

These programs calculate the loudspeaker's 1W/1m sensitivity using pink noise octave and 1/3 octave SPL readings. This requires accurate determination of the amplitude of both the input signal and the measurement distance to the loudspeaker. We use the RMS value of the input signal measured using 3 different meters listed in the article titled "The Community Measurement System". This is done to ensure consistency, accuracy, and to eliminate the possibility of an incorrect value should a meter malfunction. This would be an immediately obvious difference with the other two meters.

To ensure realistic sensitivity data, two unusual methods are employed in this measurement. First, the input signal is almost always an unfiltered 20 Hz to 20 kHz signal meaning no band limiting is done on the signal except for compression drivers where frequencies about 2 octaves below their rated LF response are filtered out simply to protect the driver. This means the system or driver is being fully excited over its operating bandwidth and beyond. Second the measurement is usually made at a significant fraction of the device's rated input with the duration of the measurement being 30 seconds or more. This means that any power compression effects are reflected in the resulting sensitivity data. In turn, this means that if you calculate a desired SPL from the sensitivity rating you can realistically expect it to be correct.

The usual measurement distance is about 20 feet / 6.1 meters and extrapolated to the equivalent SPL at 1 meter distance. The depth of the speaker is taken into account, which is usually the distance from the face of the loudspeaker to the driver diaphragm. Normally, this distance will only affect the results if the driver is a significant distance (~10” or more) from the loudspeaker face, such as for horns or deep enclosures. This distance also becomes more critical if the data must be taken relatively close the loudspeaker. Because this measurement does not reject sound reflections from the test environment, their influence has been determined and factored into the results.

During post-processing the data is extrapolated to a “1 watt” level. The watt is based on the loudspeaker’s nominal impedance rating. The 1 watt SPL is calculated over any desired 1/3 or 1 octave center defined bandwidth by using the square root of the sum of the squares of the individual 1/3 octave or 1 octave band SPLs. The 1 octave RTA data is used for comparing to the 1/3 octave data primarily as a crosscheck to ensure accuracy.

At the bottom of each specification sheet is a statement similar to the following that details the particulars of the measurement for that product:

Example: "Sensitivity: Free field pink noise measurement at 20 ft / 6.1 m at 50% power; extrapolated to 1 meter and an input of 2.83 volts RMS."

Sensitivity Using TDS Data

This program uses TDS data primarily as verification of RTA data noting the caveats discussed below.

This program uses data points generated in a TDS measurement, typically 2048 points. Because the resolution is constant there are an unequal number of data points between any two frequency bands. TDS uses a sine wave signal, which is a very different signal than pink noise. Consequently we usually see differences in the results between the TDS and RTA programs on the same loudspeaker. Generally, the 1/3 octave pink noise sensitivity is a dB or so higher than those calculated from TDS data. Also, the sensitivities calculated using individual TDS data points and the smoothed 1/3 and 1 octave TDS data vary around 1 dB to 1.5 dB.

As pink noise is more representative of a real broadband audio signal we feel it is the more accurate measurement. However, because we know the differences between the two methods, the TDS data does provide a good crosscheck on the pink noise data.

Other Tests

From time to time other tests are performed on particular Community's products as needed to better understand how to present their performance. In most cases these tests or variations on standard tests are custom designed for a specific product whose performance cannot be readily characterized by our standard tests. For example, the asymmetrical dispersion pattern or the WET2V8 required orienting the loudspeaker in our test apparatus differently from other products in order to provide meaningful specifications. This was because it is simply not designed to project sound "on-axis".

Chuck McGregor
Community Professional Loudspeakers
Chester, PA USA