Cross-PC 5.0 paper

Energy and Global Responses

Renato Giussani

updated to version 5 from

Pierfrancesco Fravolini

Starting with version 3.0 of Cross-PC program lets you calculate the acoustic power emitted by the entire diffuser, as a function of frequency, and to draw the trend of the reverberant field in a closed volume.

The simulation of the interaction with the environment goes then to verify, on demand, including the effect of reflection on the floor (more or less absorbent) and to add up all the contributions calculated direct release, in order to assess the overall response perceptible from a hypothetical listener. Naturally ... for any position in the half-space in front of the system itself.

This possibility makes the Cross-PC capable of providing reliable qualitative hypothetical interaction of acoustic waves emitted by the system in question with a simple closed environment.

The transaction which is the basis of all the new possibilities simulation offers, is to calculate the spectrum of the total acoustic power emitted by the system and in its weighing with an absorption coefficient of linear variable (and arbitrarily) with frequency.

The reverberant field which arises in the environment has a level inversely proportional, among other things, to the product of the absorption coefficient of the medium chosen for the total area of the walls of the environment itself (including the floor and ceiling).

In exchange for the extreme simplification of the hypothesis, at the base of the calculations related to the determination of the spectrum and the level of the reverberant field in the environment, the user benefits from the opportunity to obtain qualitative results of considerable importance to the computer while providing a data set very low.

The values must be known in fact only the following:

- the volume of the environment.
- the value of the absorption coefficient of the medium.

Let there then the golf any doubt about the limits of the simulation offered by the program. First, the Cross 3.0 can not be given to the exact acoustic characteristics of any listening environment.

One of the simplifications adopted, consisting in the exclusion of any calculation relating to the field of stationary waves conceivable, involves for example that the acoustic field is always calculated for the condition field limit perfectly diffuse, at any frequency. As many of you know very well, this hypothesis at low frequencies is quite far from reality in most cases. Conversely be held quite likely that both the medium to high frequencies. By contrast, a similar approximation offers at least two advantages: the

- makes available a field value reverberated quite likely on most of the audio spectrum without having to make calculations very long and laborious.
- avoids having to communicate to the program all the dimensions of the environment, as well as (to be able to really use the additional calculations) the position of the system and of the listening point within its environment.

Starting from the ambient volume communicated, the Cross assumes an inner surface total (all walls more floor and ceiling) equal to that of a cube having the same volume. It 'easy enough to verify that, with the characteristic size of most domestic Italian, this simplification leads to results very acceptable.

Take for example a rectangular room of 3,8x4,5x3,0 meters, for a floor area of 17.1 square meters. Its volume is 51.3 cubic meters, and its inner surface of 84.0 square meters.

Simplifying assumption Cross implemented in 3.0, by entering the data of only 51.3 cubic meters this calculates an area equal to six times the square of the cube root of 51.3, or 82.62 square meters, with an error of '1 , 64%.

The acoustic power equations found on the treated to recite that the acoustic power radiated by an acoustic source is proportional, among other things, the square of the average acoustic pressure of an arbitrary spherical surface that encloses the same source, multiplied by the surface itself.

In practice, the Cross, to determine the performance of the acoustic power emitted as a function of frequency, using the values of the sound pressure generated to sixty meters away from the system, for four values of the horizontal angle relative to the axis of the tweeter and nine values the vertical angle. The total number of calculation points in the front half space the system is 36. The rear output is then taken into account by putting it equal to the value of the emission at + 90 ° to the axis of the tweeter.

Subsequently, the program switches to calculate the level of reverberant acoustic field resulting from the release into the environment of the sound power calculated.

To achieve this result, the calculations take into account further simplification of arbitrary assumptions.

As for the absorption factor, which can theoretically assume a variable value from zero, for zero absorption, for one, for total absorption, the program assumes first that this build up of about four times the passing of 20 to 20,000 Hz. The values attributable the absorption coefficient can be chosen within the range of 0.2 / 0.8. But do not consider it as truly equal to the average of those hired in fact, from all internal surfaces of the environment, in all the different frequencies of the audio spectrum. The value to be reported to the Cross is absolutely arbitrary and only indicative of the greater or lesser capacity of the environment a reverberant field: then be adapted for tests to its environmental condition, perhaps after making some comparisons with measurements of speaker systems published specialized magazines.

For a given volume environment, the level of the reverberant field generated by an omnidirectional source having a flat response, is shown on our usual log-log graph as a straight line descending at a rate of about 0.16dB / octave.

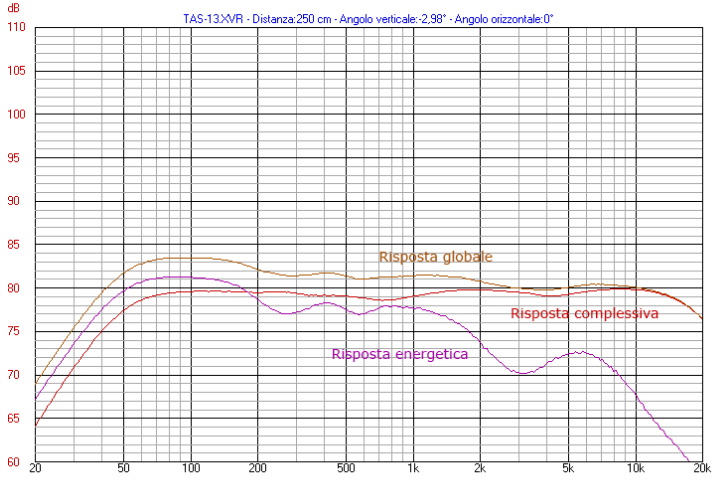
Any change in the volume environment is translated by the program in the total variation of the absorbing surface.

If, for example, the volume is decreased up to determine a surface area equal to a quarter of the initial one, the sound pressure level of the reverberant field environment becomes double.

The "Energy" and "Global" Response

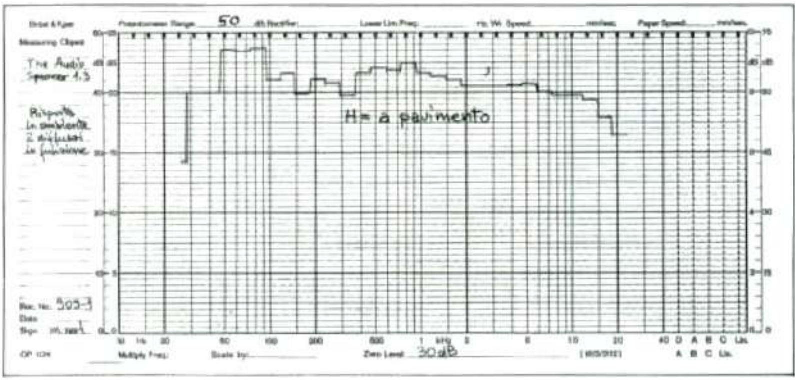
After setting the parameter values of a given speaker system, you can then extend the provision of its services to include an evaluation of the reverberant field that this can generate in a hypothetical listening environment. Its graph, which we called "**Energy Response**", has the usual appearance of a frequency response and is usually characterized by a downward trend, with more or less regularity. The energy response should not be understood as the "power response of the system."He wants to be rather the representation of pressure detectable in a closed non anechoic, which features our speaker system, after excluding the direct field. In practice, what the program presents might only be measured by subtracting from the entire field of acoustic waves that reach the microphone in the environment, the waves that reach proveniendo system directly, without undergoing any reflection.

Actually what is heard in the room is always the sum of the two contributions, direct and reverberant. Here then is that the program has been put in a position to add to the energetic response calculated, the usual "overall response" equivalent to the detection in an anechoic chamber. The result was called "**Global Response**" and that is what we hear.



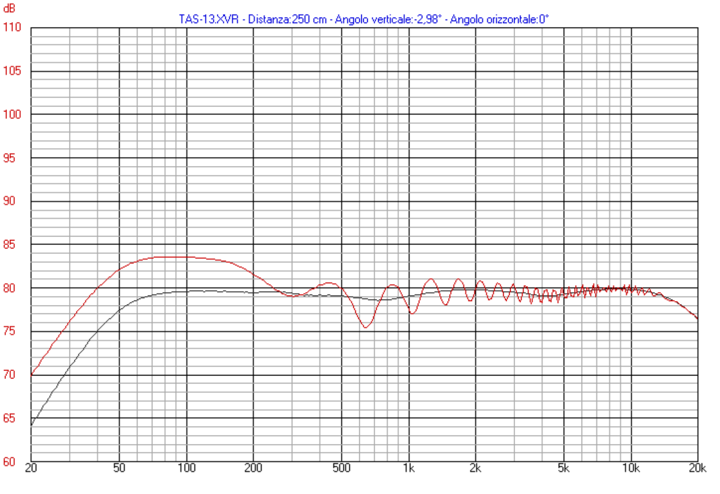
The total response is the one that can be measured in an anechoic chamber and is the sum of speakers emissions' that come directly into the microphone.

The global response also takes into account instead of the reverberant field in the listening room (energetic response), which adds to the total response . The global response can be compared with the measurements made in the environment with pink noise third octave.



The floor

The first system with which I tried to verify the information provided by the new functions of the Cross was the kit "the audio speaker". As many of you will certainly remember, the audio speaker has a cabinet with vertical very pronounced (similar to the Audiolab Delta 4) and during its design I had to repeatedly assume that the proximity of the woofer to the floor would have involved a some increase its level of emission. The first test of the calculation of the overall response of the TAS-13, during the development of the Cross 3.0, unequivocally demonstrated a level of low frequencies well below that found in all our measures in the environment. Hence the decision to implement rapid, on the spot, the possibility to calculate the contribution to the field from the first direct reflection of a "hypothetical" floor. From the point of view of the calculation routine it was added to the acoustic pressure of the direct field that generated from the system's virtual reflected from the floor. To make it a little more realistic I also introduced an absorption coefficient of the floor, which is also variable at will, and arbitrarily increasing with frequency.



The result of the calculations of the overall response of the TAS-13, with and without the floor, are shown in the figure and demonstrate the validity of the assumptions made during the design of the system.