# Sovran
## Academy

chario

Technology For Your Dreams

Sovran Academy

## The Phase Curve

Human audio-perception system relies upon stimuli comparison to correctly localize acoustic sources, computing the wave-fronts reaching the two ears at the same time. At present time Duplex Theory is the best hypothesis researchers have to explain the ear-brain function.

Frequencies below about 700 Hz are processed by determining the arrival time to each ear-pinnae and this is referred to as ITD (inter-aural time delay). Frequencies above about 1,400 Hz are processed by determining the energy flow delivered to each era-pinnae and this is referred to as IAD (inter-aural amplitude difference)

We soon recognize Duplex Theory not to be exhaustive because it fails to correctly explain the localization process within the missing 700-1,400 Hz range. At these frequencies head& torso are enough obstructive to modify the incoming wavefront (diffraction) so that the crossover from ITD to IAD is not linear and localization cues are not flawless.

The proprietary WMT™ Chario Loudspeakers principle fully exploits this fault to fool the ears and dissimulating the presence of two or more radiators on the front baffle of the cabinet, giving the audiophile the sensation of listening to a large 1-Way full-range speaker in order to introduce an intentional masking of the discontinuity performance at crossover region.

The use of any analogical electrical filter to cut out the acoustic output of both woofer & tweeter beyond their own bandwidth, causes an acoustic signal delay within the crossover region, whose mirror image in the transformed domain is named acoustic phase delay measured in degrees.

chario

Technology For Your Dreams

Keeping under tight control the envelope of the acoustic phase delay curve for mid-high frequencies in a speaker system is a sine qua non condition to assure the quality of any electro-acoustic design. Sovran design strategy is based on the concept of slope as it is commonly known in everyday life. The hypothesis is the following:

> If the slopes of the phase plot of mid-woofer and tweeter are the same (i.e. parallel curves) as the radiation angle increases over the horizontal plane, then the auditory sensation is invariant both for direct & early-reflected wave-front (side wall).

Now, because drivers acoustic output is made uniform over a wide angle, the audiophile is given the chance to modulate the stereo-kinetic stage in width and/or depth. This geometrical representation exchange could be possible with other kind of loudspeaker systems, but only Sovran keeps unchanged the perceived timbre. A clear-cut explanation of the layout is depicted on both Fig.1 & Fig.2 .

Any speaker rotation in between allows the audiophile to mix the two sensations.

Technology For Your Dreams

Sovran Academy

## The Schroeder Frequency

In a standard 3way system the 80-250 Hz audio range is radiated by a unique driver. Floor-standing designs show a classical vertical array Tweeter/Midrange/ Woofer closely spaced at some hight from the floor, even though the designer splitted the low frequency electrical power among two or more woofers in order to increase dynamic headroom. ( FIG.3) Because we are focusing our attention on low frequency behaviour of speaker array, let's leave other designing considarations apart for a while.

The very important matter herewith is about the physical distance between the acoustic centers of subwoofer & woofer, both responsible for radiating the critical range below the Schroeder Frequency. For standard living room (80 $m^3$ ) it is around roughly 300 Hz and it causes the number of resonances per octave to be equal or less than three. This in turn means that any speaker will deliver acoustic power to the environment in a very odd way such as large peaks & dips because of strictly modal behaviour of the confined volume.

Apart from timbral aberration, there is another subtle byproduct known as bass mono effect responsible for the sensation of collapsed space inward the ears , with a lack of spaciousness, due to the similarity of reflected energy with respect to direct energy in all kind of small-sized rooms.

FIG.1 (from left to right):
The stand-mounting systems are provided with a single radiator covering the critical range, hence d=0 in both cases. The first floor-standing system is a common 3way double/paralleled woofer for which we can assume d=0.2m or so, while the rightmost system is usually configured as triple/paralleled woofer, but sometimes the three woofers could be splitted to cover more than the critical range up to 500-600 Hz.

In all practical cases there is no significant space gap between adjacent frequency components within the critical range, and everyone promptly realizes that for any possible combination there is only one acoustic ray reaching the listener's left or right ear, bacuse all single components start from the same point in space. This is noway a feature by itself, because it has to be so if we need a coherent wavefront to give the listener the first information via direct path.

But looking at the matter from a psychoacoustic point of view, we must take into account the perception of reflected sound to engrave a credible sound image. Of course, due to the fact that all possible critical range frequencies share the same application point, we are forced to say that reflected energy spectrum is a replica (not perfect) of direct energy spectrum, or differently stated, they are coherent, this is because their wavelenghts are of the same order of the room size. A simple drawing explaining the actual but more complex phenomenon is shown in FIG.5, where blue&red rays simulate the same path run by different components after one or more reflections off boundaries. Moreover, because the wavelenghts range from roughly 1.5m through 7m, there is no noticeable variation in the coherence function if different components are radiated by the floor-standing arrays which offer a modest 0.2-0.4m space gap.

Totally different will be the acoustic frame relative to Academy SOVRAN for which the space gap between subwoofer and woofer is about 1.1m. Furthermore, the two sources are mathematically different because they are jointed around 100Hz by means of a large overlapping Xover topology, allowing an interference pattern to be extended from 80 through 250 Hz, in which both drivers radiate the same component but with a different figure of phase, magnitude and application point, aimed to greatly reduce the coherence function at listener's ears.

When the minimum size of a confined space is larger than the maximum radiated wavelenght the Schroeder Frequeny is very low and there is no stationary field (reactive energy) hence the perception of air within and around acoustic sources is completely described by the binaural velocity vector, which can take place because long acoustic paths ensure the reverberated field to be ergodic i.e. different wavefronts show random phase. In small spaces like living rooms, both short acoustic paths and highly energized stationary field destroy the original de-correlation at low frequencies by super-imposing the room signature.

In FIG.6 is depicted the random phasor summation at listener's ears due to different path run by each component

## Correlation and Coherence

To better identify this kind of radiating doublet we need to rely upon the concept of Correlation, i.e. the degree of similarity of two audio signals. In this case we are only interested in pressure values sampled in the vicinity of the listener's head within an ordinary living room. Because the two signals are simple sinusoids ( frequency components of the time signal) the measure of correlation could give us misleading figures because it is defined as the cosine of the phase difference. Every time the two signals reach the receiver in quadrature (90°) the correlation coefficient will be null against any evidence. Then, it is necessary to gather further non-ambigous information by means of Coherence Function.

Given two signals x(t) and y(t) for each frequency value we define the following:

$$COH^2(f)_{xy} = (|G_{xy}(f)|^2) / (|G_{xx}(f)|)*(|G_{yy}(f)|)$$

COH := coherence
$G_{xy}$ := cross-correlation power spectrum
$G_{xx}$, $G_{yy}$ := auto-correlation power spectrum

The major implication of these concepts is that for home listening (speaker systems) the use of extremely high crossover slopes to reduce the interfering transition region is not a good sounding choice…

Sovran Academy

Of course, someone may argue that such an array could be detractive with respect to on axis direct-path listening. To remove any doubt FIG.7,8,9 show the standard complex anechoic frequency response taken at 3m (normalized to 1m for SPL sensitivity comparison)

The adopted relative phase alignment is a function of minimum listening distance of 2.5 m and critical range minimum wavelenght of 1.3m in order to stabilize the front stage and to maximally de-correlate first reflections with respect to direct path..

When the minimum size of a confined space is larger than the maximum radiated wavelenght the Schroeder Frequeny is very low and there is no stationary field (reactive energy) hence the perception of air within and around acoustic sources is completely described by the binaural velocity vector, which can take place because long acoustic paths ensure the reverberated field to be ergodic i.e. different wavefronts show random phase. In small spaces like living rooms, both short acoustic paths and highly energized stationary field destroy the original de-correlation at low frequencies by super-imposing the room signature.

**Mario Marcello Murace**
R&D Chief to Head (EE)
Psychoacoustics Lab
www.chario.it
m.murace@chario.it

chario
Technology For Your Dreams

Sovran
Academy

## Data Sheet

| | |
|---|---|
| **Low Frequency Load** | Subwoofer NRS $2\pi$ sr Vented Isobaric Compound<br>Woofer Back Firing Slot with Aperiodic Tuning |
| **Vent Geometry** | Bi-dimensional Hyper-Exponential Hourglass Type |
| **Configuration** | 3 way Reversed Vertical Alignment Floor-Standing |
| **Drivers** | 1 Tweeter 32 mm SILVERSOFT™ dome NeFeB motor<br>1 Woofer 170 mm ROHACELL® Full-Apex™ Poly-Ring NeFeB motor<br>2 Sub 200 mm Natural Fibres Poly-Ring HF motor |
| **Sensitivity** | 90 dB SPL normalized to 1m with 2.83 Vrms / de-correlated L/R pink noise within IEC 268-13 listening room |
| **Low Frequency Cut Off** | 35 Hz @ -3dB referred to $C_4$ WETS |
| **Crossover Frequencies** | 100/1,180 Hz |
| **Mid-High Alignment** | LKR4 Derived ($\Delta\phi$=45deg) |
| **Rated Impedance** | Modulus 4Ω (min 3.0) Argument ±36° |

**Suggested Amplifier**

| | |
|---|---|
| **Normal amping** | Rated for 180 W/4 Ω Average Power Max<br>Run the cable from your power amplifier to the lower terminals of the subwoofer binding-post, then connect the upper terminals to the binding-post of the mid-high unit by means of the short cable delivered with the speakers. |

chario
Technology For Your Dreams

# Sovran Academy

| | |
|---|---|
| **Bi-amping** | Rated for 120 W/4 Ω Average Power Max<br>Run the cable from your power amplifier to the lower terminals of the subwoofer binding-post leaving the upper ones idle. Do the same to connect the power amplifier to the binding-post of the mid-high unit |
| **Size** | 1220 x 240 x 440 mm ( H x W x D ) |
| **Weight** | 47 kg |
| **Cabinet** | Solid walnut or solid cherry and HDF. The structure is made up of two cabinets: the lower containing two subwoofers and the upper containing one midrange and one tweeter. The two wooden structures are separated by means of four cylindrical proprietary-engineered elastomer puffers which act as vibration de-couplers dissipating mechanical energy by orthogonal elongation |
| **Speakers orientation** | Refer to FIG.1 and Fig.2 for the desidered effect |
| **Listening distance** | Optimum speaker-listener distance is within 3.0 - 3.5 m |
| **Listening layout** | A carpeted floor in front of the speakers is recommended |
| **Side and Back walls** | Should stay 1 m away from the speaker front baffle at least |

Notes

1. All quantities in SI Units
2. Average Power computed as $V^2$rms / R
3. Specs subject to change without notice

chario

Technology For Your Dreams

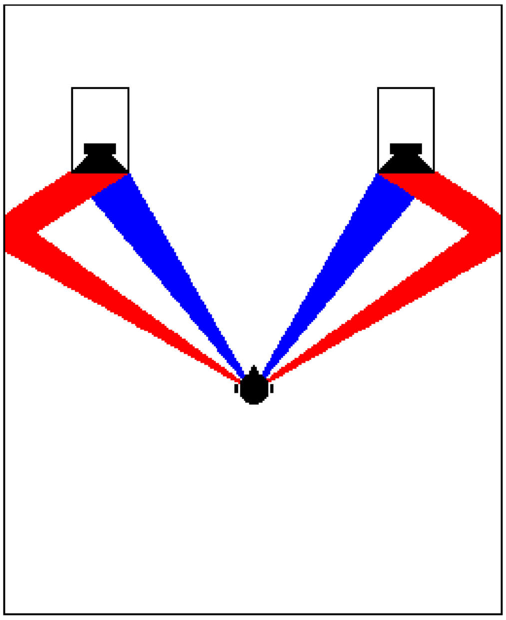

**FIG.1**

Sovran are set parallel to the front wall. The standard stereophonic triangular layout provides the listener with two wave-fronts of similar energy content: direct path (blue) and reflected path (red). This layout exploits the early side-reflection (Haas effect) to enlarge the sonic stage beyond the physical distance of the two speakers.

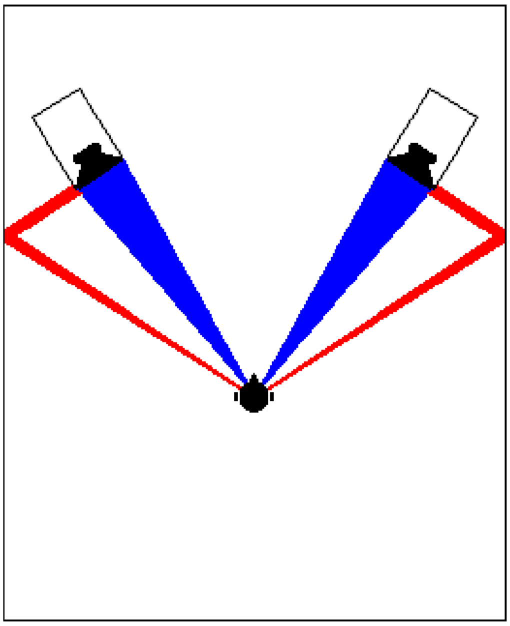

**FIG.2**

Sovran are tilted toward the listener. The standard stereophonic triangular layout provides the listener with two wave-fronts of different energy content: direct path (blue) and reflected path (red). This layout exploits the early side-reflection reduction to deepen the sonic stage beyond the front wall.

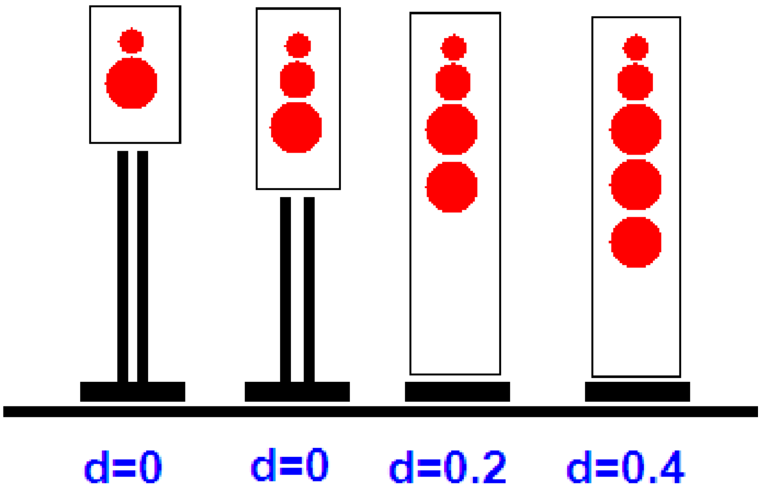


FIG.3

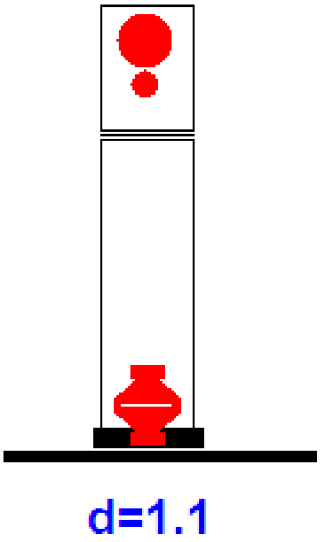


FIG.4

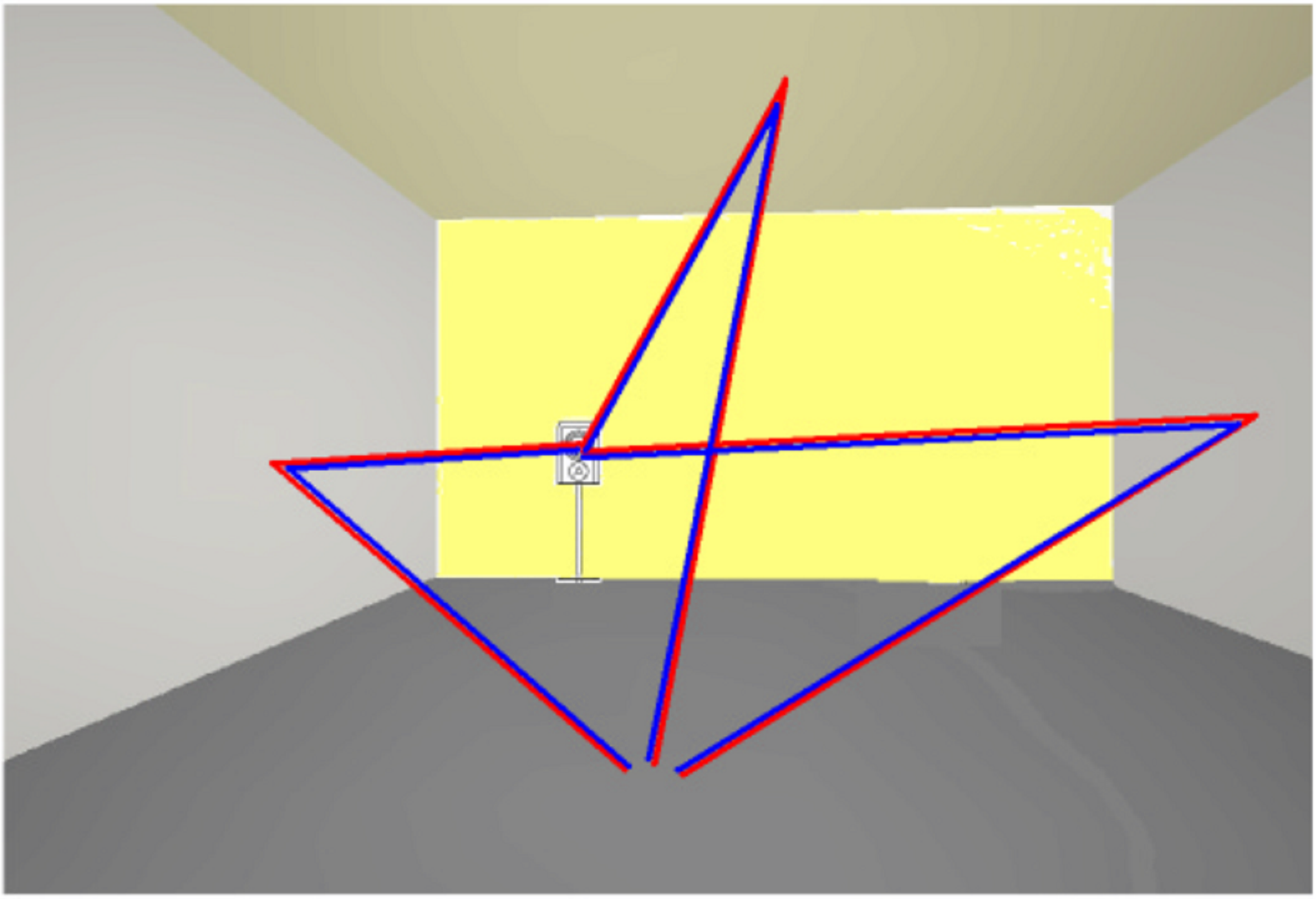

FIG.5

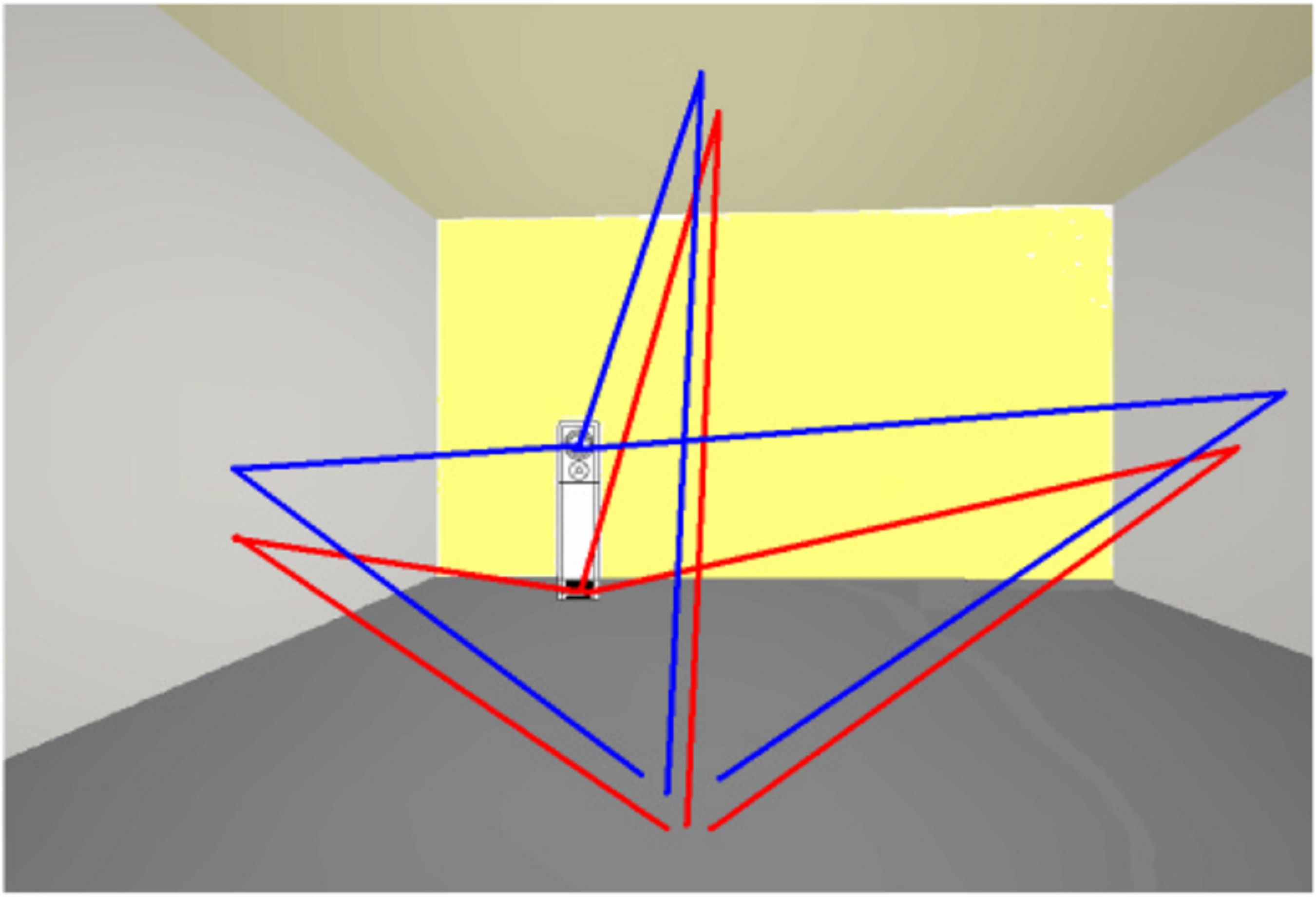

FIG.6

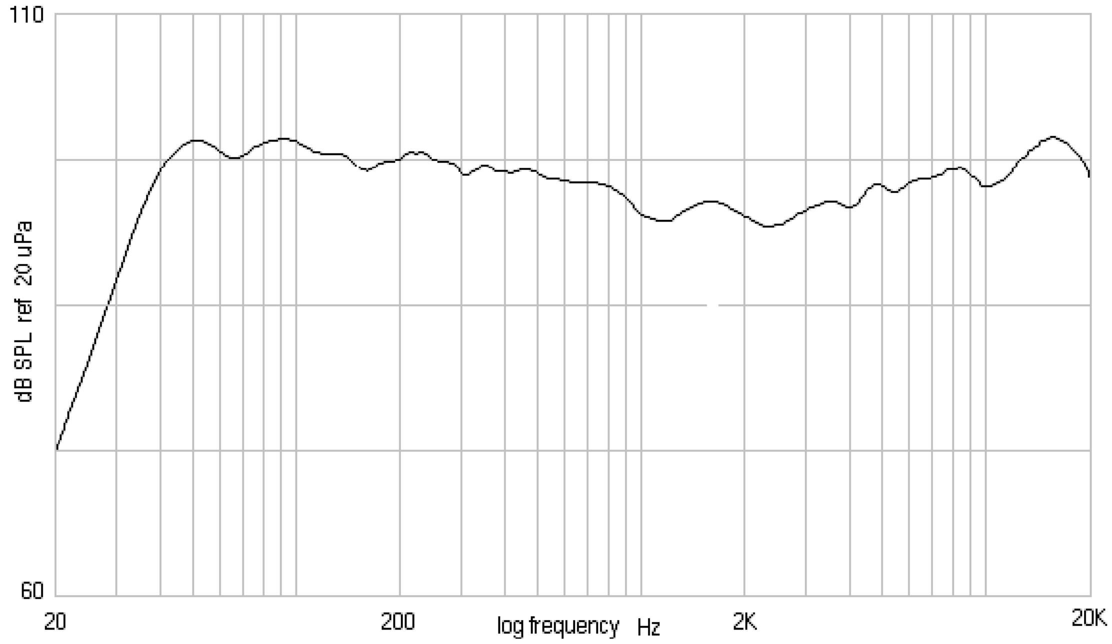


**FIG.7** Amplitude Frequency response

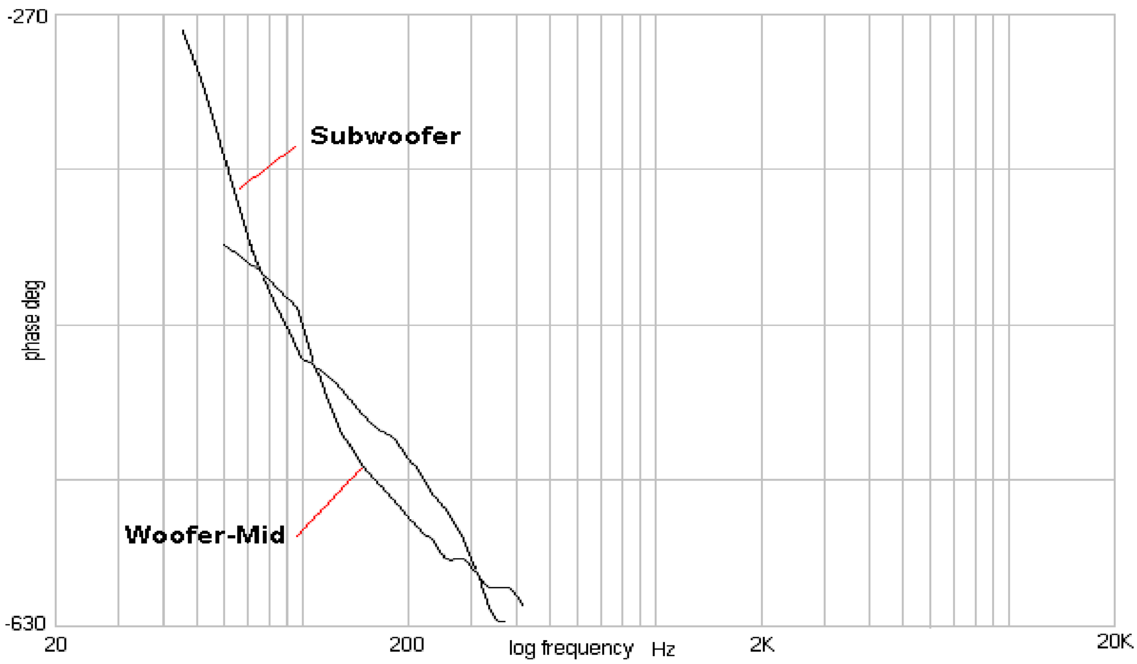


**FIG.8** Relative Acoustic Phase

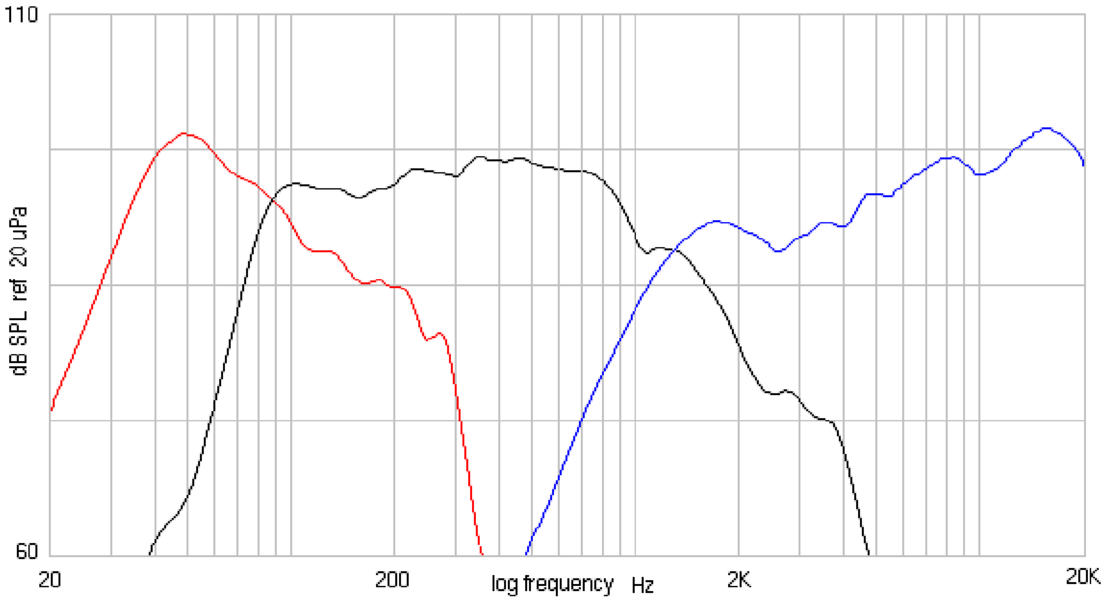


**FIG.9** Single Drivers Amplitude Frequency Responses

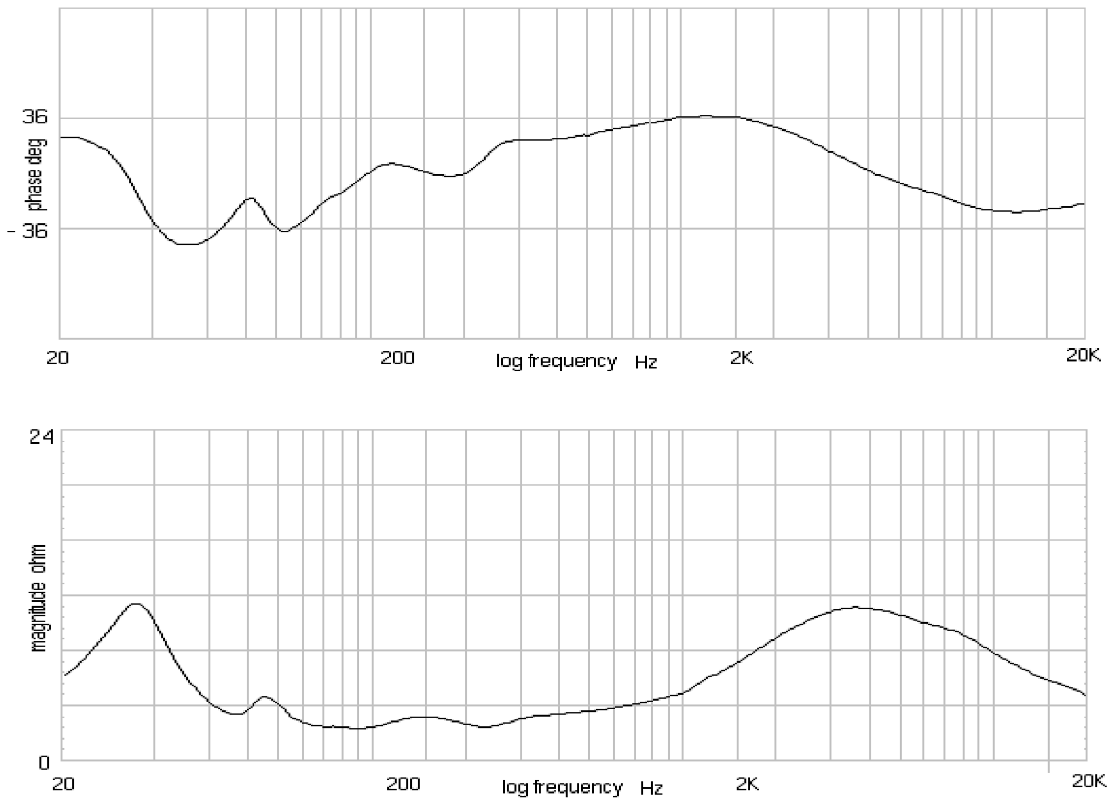


**FIG.10** Impedance Modulus and Phase