Neville Thiele Method™ Crossover Filters

BSS Audio

New Crossover designs

What is the Neville Thiele Method™ * Crossover Filter?

A Neville Thiele Method™ Crossover Filter (NTM™) is a new type of electrical/acoustical filter offering significant performance advantages over all previous crossover filter types in audio applications. The filter was developed by Neville Thiele (pronounced "Teel").

Technical overview

It is not possible to provide one loudspeaker driver to cover all audible frequencies. Even if the frequency response could be achieved, the large size of the driver required to shift enough air at low frequencies would offer an impossibly directional beam at high frequencies because at small wavelengths, the differing path lengths from the extremities of the diaphragm to the listener would cause cancellations off-axis. It is necessary to provide more than one driver and to split the bands with an electrical filter or crossover. This filtering can be done by passive, active or digital means, external to or within the loudspeaker cabinet.

Ideally, the filtering is done so that when acoustically combined, the drivers produce a constant output across the whole range of frequencies of interest. Some crossover filter designs do not achieve this. Additionally, the signal phase behavior with frequency should offer smooth transitions to achieve a constant group delay. Many crossovers do not achieve this either.

Another important consideration is that the crossover should control the beaming properties so that listeners off-axis do not hear anomalies in the response. Many crossovers do not achieve this.

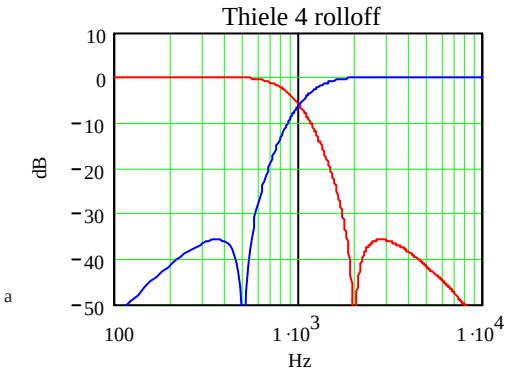
Finally, the signal should be quickly attenuated outside the optimum band of operation for each driver to avoid driver anomalies such as resonance and over-excursion distortion at low frequencies. Here some other crossover shapes have limitations.

The Thiele Crossover Filter achieves all these objectives.

- It sums to give constant output against frequency.
- It has a well-behaved phase response.
- It keeps the phase difference between adjacent drivers at zero degrees throughout the crossover region to prevent beam shifting.
- It has the highest known rate of attenuation in the stop band of all conventional analogue or analogue-equivalent filters of similar order.

How does it work?

The NTM™ crossover uses a unique notched response to achieve a very steep roll-off rate outside the pass-band. The 4th order Thiele crossover amplitude response looks like the diagram overleaf. You will see that notches in the responses speed-up the rate of roll-off. Beyond the notch, the response rises again, but remains respectably attenuated.



Advantages

An NTM™ Crossover Filter sums precisely to give constant output and well defined phase response, which is identical between the drivers (zero degrees difference) throughout the crossover region.

At the same time the NTM™ filter enables far greater rates of attenuation with frequency outside the pass band for each speaker.

Shape	Order	Amplitude Response Flatness	Group Delay Flatness	Polar Response	Roll-off Rate
BUT 6	1st	●●●●●●	●●●●●●	●	●
BUT 12*	2nd	●	●●●●●	●●●●●●	●●
BES 12*	2nd	●●●●●	●●●●●●	●●●	●
L-R 12*	2nd	●●●●●●	●●●●●●	●●●●●●	●●
BUT 18*	3rd	●●●●●●	●●●●●●	●●	●●●
BUT 24	4th	●	●●●●	●●●●●●	●●●●
BES 24	4th	●●	●●●●●●	●●●●●	●●●
L-R 24	4th	●●●●●●	●●●●	●●●●●●	●●●●
BUT 48	8th	●	●	●●●●●●	●●●●●
L-R 48	8th	●●●●●●	●●	●●●●●●	●●●●●
NTM™ 36	4th	●●●●●●	●●●●	●●●●●●	●●●●●
NTM™ 52	8th	●●●●●●	●●	●●●●●●	●●●●●●

** Requires polarity inversion*
BUT is Butterworth, BES is Bessel, L-R is Linkwitz-Riley
NTM™ is Neville Thiele Notch

The advantages are:

- Controlled frequency/phase response
- Faster roll-off rates enabling lower distortion and/or smaller drivers for a given low corner frequency of reproduction. This is particularly valuable in applications where space is at a premium. Driver and cabinet design constraints are also eased since designers can work 'closer to the edge' where resonance, breakup, or other anomalies may occur.

It can be seen from these comparisons that the 4th Order NTM™ crossover shape offers the best group delay flatness of any crossover shape with a roll-off of at least 24dB/Octave.

Furthermore, the 8th order NTM™ shape offers the steepest roll-off rate of all the crossover shapes compared here.

For many years, Linkwitz-Riley crossovers have been the 'industry standard' as they offered the best compromise for most of the important parameters.

The new NTM™ crossover shapes now represent the optimal combination of characteristics for most applications, assuring it at least a place alongside Linkwitz Riley, if not becoming the new industry standard.

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