HANDOUT

All Capacitors are "Audio Capacitors"

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There is an ongoing discussion within the audio engineering community about the sound quality of amplifiers concerning the audibility of signal distortions. Apparently, capacitors used for coupling and decoupling signals are suspected to be the source or at least a contributor to high-frequency distortions that influence the hearing impression. We have conducted a thorough study of harmonic distortions caused by commercial electrolytic capacitors as well as purpose-built items.

In order to find parameters that influence the harmonic distortions, we have investigated capacitors with different separation paper and electrolyte compositions. Those sample capacitors were assembled at near-mass production conditions. As a capacitor producer, Würth Elektronik (WE) expands continuously its objective knowledge base for capacitor development as well as a technical marketing strategy.

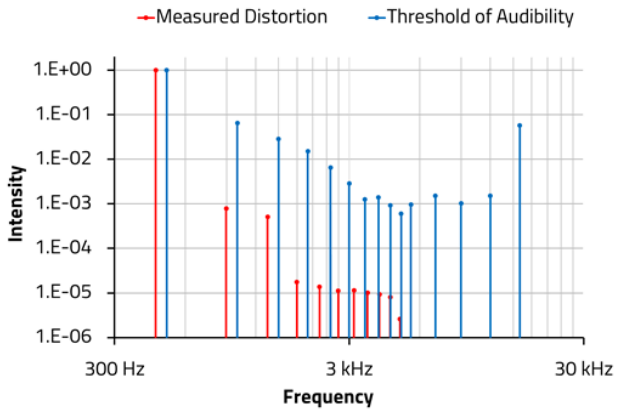

Figure 1: Measured voltage-signal frequency spectrum of 470µF aluminum electrolytic capacitor (WCAP-ASLI, 865080253012) at fundamental frequency of 448.9 Hz. Also shown, is the threshold of audible distortions as determined in psychoacoustic experiments for a fundamental at 500 Hz.

A representative measurement that illustrates the low degree of distortions caused by capacitors is shown in Figure 1. Here the harmonic distortions of a 470 µF capacitor, measured at a fundamental (frequency) of 449 Hz, are compared to values that constitute the human hearing threshold for distortion at a fundamental of 500 Hz.[1] Clearly, the measured amplitudes are orders of magnitudes below the hearing threshold. Although this is just one single measurement, it exemplifies the insignificance of capacitor-induced distortions.

The average of the total harmonic distortions (THD), in accordance with human hearing sensitivity, for all the investigated aluminum electrolytic capacitors is about 0.02%. The results suggest that the harmonics distortions are well below the threshold of audibility, which is at about 7%.

It can be concluded that the capacitors do not add significant distortions to fundamental frequencies as they transfer signals and thus, in good approximation, can be considered linear devices. Modifications of the electrolyte or separation paper have a negligible effect on the THD.

This finding is corroborated by other researchers as well.[2] In simple terms: All capacitors are "Audio Capacitors" and are suitable for audio applications.

Electrical engineers may still have the need to try different capacitors to meet their specific requirements of audio and other applications. For that, WE can provide a wide assortment of capacitor types with different specifications such as loss factor or connection type. Our portfolio, consisting of catalog- and project parts, contains high-quality products suitable for switching power supplies, electromagnetic interference suppression and audio applications.

If you have further questions concerning this research work or if you need any other support, please contact us via your sales representative.

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A.1 References

[1] H.Y. Lin, Measurement of Auditory Distortion with Relation Between Harmonic Distortion and Human Auditory Sensation, IEEE Transactions on Instrumentation And Measurement, IM-35:2 (1986)

[2] I. Z. Anderson, Evaluating Electrolytic Capacitors Specified for Audio Use: A Comparative Analysis of Electrical Measurements and Capacitor Distortion Products in Line Level Interstage Coupling Applications, Journal of the Audio Engineering Society, 68:7/8 (2020)

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