

# Comparison of losses measurements of ferrites for design purposes

Fabien Sixdenier<sup>a</sup>, Sanae Mensouri<sup>a</sup>, Ulrich Soupremanien<sup>b</sup>, Alexandre Barthillat<sup>a</sup>, Christian Martin<sup>a</sup>

<sup>a</sup> *Universite Claude Bernard Lyon 1, Ampère, UMR5005, INSA Lyon, Ecole Centrale de Lyon, CNRS, Villeurbanne, F-69100, France*

<sup>b</sup> *Université Grenoble Alpes, CEA-Liten, 17 Avenue des Martyrs, CEDEX 9, 38054 Grenoble, France*

Ferrites are the most common used materials in power electronics magnetics components. The design phase of magnetic components deeply rely on the magnetic losses reliability that will have a critical impact on the final design. This study presents a comparative experimental analysis based on measurements conducted using three distinct test benches. Results are compared to the datasheet and between benches.

**Keywords:** magnetic losses, reliability, ferrites

## 1. Introduction

Ferrite materials, particularly MnZn-based compositions, remain widely used in power electronics due to their high resistivity and favorable magnetic properties at medium frequencies. However, despite decades of research and characterization, the accurate determination of magnetic losses in these materials remains a major challenge due to a large uncertainty in the datasheets concerning the losses. This uncertainty complexifies the design. This study presents a comparative experimental analysis based on measurements conducted using three distinct test benches.

## 2. Methods

All benches measure the losses on toroidal samples. The same sample is used for all measurements. The two first benches belonging to Ampere-lab, both use the IEC60404-1 standard and are quite similar in their approach but differ in some technical details (hardware and software). One is commercial and entirely closed (Elettrofisico) and the other one has been designed and assembled entirely by our lab (Ampère). The third bench (CEA) differ in his approach as it does not follow the IEC60404-1 (except for the sample). Technical details about all benches will be given in the extended version. The materials under test include several commercial MnZn ferrites commonly used in transformers and inductors for switched-mode power supplies. In this abstract only results measured on a FairRite77 material will be presented.

## 3. Results and discussion

Figure 1 shows measurements of magnetic losses versus frequency on a toroidal Fair-Rite77 material measured by the 3 benches at 2 different amplitudes  $B=50$  mT and  $B=100$  mT with  $B$  imposed as sinusoidal waveform.

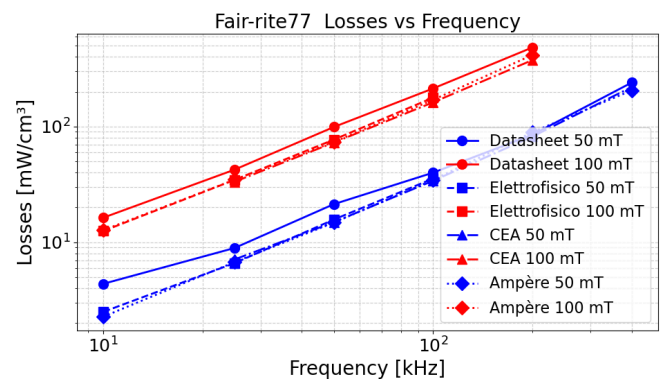


Figure 1: Losses versus frequency for amplitudes  $B=50$  mT and  $B=100$  mT

Results clearly show that all benches measure lower losses than expected in the datasheet except for one point at 50 mT in high frequency.

## 4. Conclusion

Despite the fact that measurement protocols exist for a long time for toroidal samples. The differences between benches is still present and some errors with the datasheet can occur. This contributes to give a bad image (black magic) of the magnetic materials/components sizing for power electronics. This study calls for more collaboration between teams about measurement of losses of ferrites and (re)define if needed some protocol.

## References

- [1] Wm. T. McLYMAN. "TRANSFORMER AND INDUCTOR DESIGN HANDBOOK." CRC Press, 2011.
- [2] F. Fiorillo, "Characterization and Measurement of Magnetic Materials", 2004
- [3] Carlo Appino, Nicoleta Banu, Clémentine Delaunay, Fabien Sixdenier, Charles Joubert, et al.. Interlaboratory comparison of two-dimensional magnetic measurements. *Soft Magnetic Materials Conference*, Sep 2023, Prague (Czech Republic), Czech Republic.

This work has been financed by the french national agency ANR, and is a part of the PROJECT PIMCOMAP (ANR-22-CE05-0032).