Inductors with ferrite cores: measurement and simulation

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To achieve the high inductances required for specific passive filters, ferrite or alloy cores are used for inductors. Due to certain magnetic material properties of alloys or ferrites specific filter characteristics can be obtained. For best possible suppression of unwanted emissions of communication lines etc. precise knowledge of the magnetic material properties and the resulting inductances are required. Simultaneous measurement and simulation should contribute to a better understanding. To this end, a benchmark problem has been designed and manufactured. The complex permeability was extracted from measurement data. Simulations were carried out based on the measured complex permeability. The agreement between measurement and simulation is very satisfactory.

Keywords: benchmark; complex permeability; measurements; soft ferrites

1. Introduction

In this work, iron-based inductors were investigated for the best possible use in magnetic filters. Both the measurement and the subsequent determination of the complex permeability and possibly the permittivity are challenging tasks [1,2,3].

2. Results and discussion

The manufactured benchmark, consisting of the ferrite core provided with two wire windings, and the associated finite element model are shown in Fig. 1.

The input impedance Z of the coil with and without core was determined by measurements in the frequency range from 10kHz to 1GHz and the relative complex permeability μ_c=μ'+jμ'' was calculated. NetGen/NGSolve [4] has been used for the simulations. Some selected results are summarized in Tab. I and the behavior of μ_c and Z in the frequency range is shown in Fig. 2. A very satisfactory agreement between measurement and simulation was found.

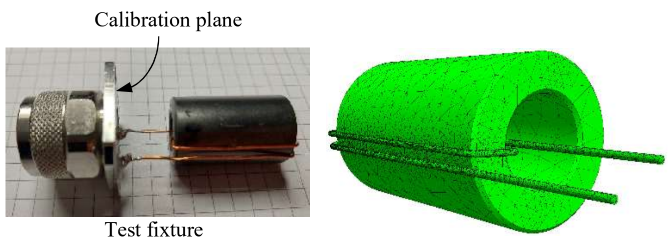

Figure 1: Round cable EMI suppression core (2675665702) of Fair-Rite Products Corp [5] with winding of two turns. Left: Photo of the test sample. Right: Finite-Element-Model based on the step-file of the manufacturer.

Tab. I: Input impedance Z: Measurement Z_M vs. simulation Z_S

Point	*f*	Z_M	$\|Z_M\|$	Z_S	$\|Z_S\|$
-	(MHz)	Ω	Ω	Ω	Ω
P1	2	508.2+*j*187.9	541.8	560.3+*j*207.5	597.4
P2	20	257.1−*j*108.4	279.0	240.8−*j*98.6	260.2
P3	200	157.7−*j*37.3	162.1	141.3−*j*8.073	141.6

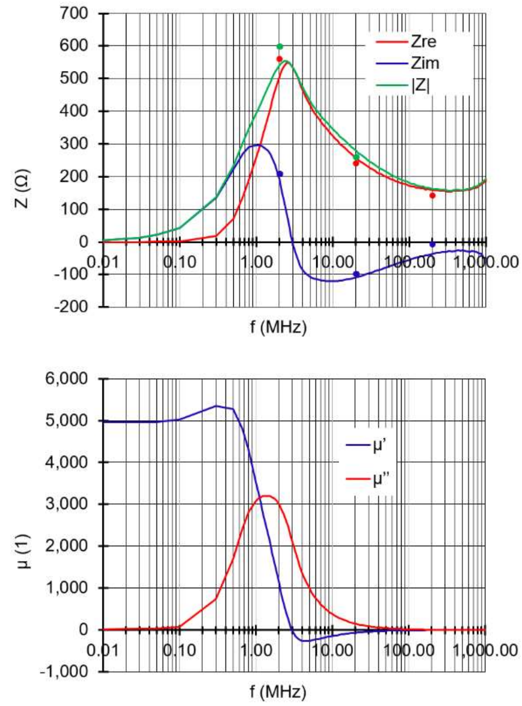

Figure 2: Measurement data: Above: Input impedance Z, dots are simulation results (P1, P2, and P3), compare with Tab. I. Below: Complex relative permeability $\mu_c = \mu' + j\mu''$.

References

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