BASIS

1.1. Distortions by Virtue of Saturation Occurrences

The inductances investigated (the term inductor denotes the same) are used in passive networks (diplexers) for speakers. The simplest type is the air core inductor. A packing made of copper wire is put about a non-magnetic support (mostly plastic). The alternating current that flows through the inductor leads to the creation of a magnetic field that brings about frequency dependent, electric properties. The electric properties of an inductor are characterised by the inductance with the unit of measurement Henry[H].

The number of turns and the geometric dimensions of the inductor determine the magnitude of the inductance. In passive networks for speakers inductances of approximately 0.10 mH to 30.0 mH can be found.

Another type of inductor is the so-called core inductor. Inside the magnetic field of the inductor there a body made of a material with magnetic properties can be found, the core. The core intensifies the magnetic field and hence increases the inductance of the inductor. Depending on the structural shape the inductance can be multiplied compared to the air core inductor (Factors 3 to > 100).

The core inductor shows compared to the air core inductor a lower ohmic resistance, or a smaller size, as to reach the same inductance less twists or a thinner wire need to be applied on the support.
The disadvantage of the core inductor is the limited ampacity. It is not because of the ampacity of the copper coil, its ampacity is given by the cross section of the copper wire, but because of saturation phenomena in the core material.

Contrary to the air core conductor, where the magnetic field gets stronger the higher the current within the inductor is (linear correlation), for the core inductor a point exists, where the magnetic field despite an increase in current does not increase to the same degree. This behaviour is called saturation.
Modulation in the saturation region comes along with non-linear behaviour and generates distortions, which occur in the higher range of performance.
An investigation of the saturation boundaries can be carried out by measuring the distortion factor when the current through the inductor is increased. When the distortion factor rises steeply the saturation region is reached.

An air core inductor does not show such distortions as a matter of principle.

The saturation behaviour of a core inductor is defined by the core material, the core design and the cross-section.

As materials for inductor cores are on the one side soft magnetic ferrites, on the other side iron materials found. The ferrites used are sinter ceramics. They are of a dark grey colour and quite fragile. Ferrites consist of a compression-moulded powder and can be formed into manifold shapes. Shapes such as cylinder- and tube cores, mushroom-, bobbin- and bell cores (peeling cores) can be found.

Within the iron materials cores made of sintered metal (iron powder compression-moulded under pressure) and cores made of laminated iron sheets can be found. Cores made of sintered metals are, similar to ferrites, produced in manifold shapes. They are very susceptible to breakage (much more delicate than ferrites). At Intertechnik only a cylindrical sintered metal core (Corobar core), which is inserted into a plastics body and consequently protected, is used. The laminated cores consist of punched iron sheets, which are stratified to packets. Common are the so-called I-cores or E-cores. These core types are mechanically very robust and can be screwed together or riveted for secure anchorage (for large or heavy inductors).

The saturation behaviour of ferrite and iron core inductors is very different. The iron core material has a considerably higher saturation induction. I.e. the current that is needed to reach saturation in a core made of iron material is approx. by a factor if 8 higher than in comparable ferrite cores. The core types employed at Intertechnik cannot be brought to saturation with a power output below 1000W at 4 Ohm (measured at inductances of 10 mH). The current necessary to reach saturation puts a thermally unacceptable load on the copper coil. Therefore measurements concerning saturation for iron core inductors had to be dispensed with.

BASIS

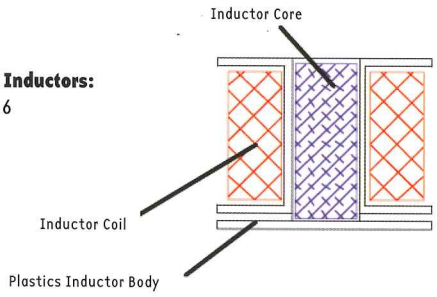
1.2. Distortions due to non-linear characteristic curves of core materials

Measurements at iron cores inductors were only carried out for the comparative consideration of the distortion of different inductor types at small outputs.
Distortions are also generated by the non-linearity of the characteristic magnetisation curve of the core material in the zero point region. They already originate at small modulations (low outputs). The linearity of the characteristic curve is essentially determined by the magnetic properties of the core. The distortion component in the process that is unpleasant for the ear is the K3 fraction (3rd harmonic). The measurements are limited to this harmonic.

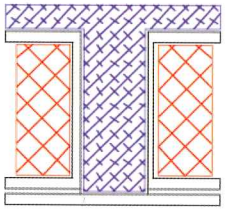
1.3. Kinds of core inductors and overview of types

Ferrite Core Inductors

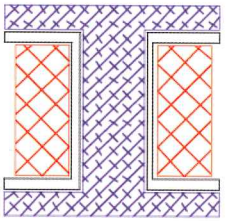
Bar Core Inductors:
HQR 32/26



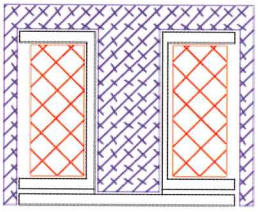
Mushroom Style Core Inductor:
HQP 43/40
HQP 56/35



Bobbin Style Core Inductor:
HQ 40/30
HQ 43/45
HQ 58/41
DR 56/35
DR 56/61

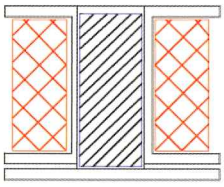


Bell Core Inductor:
HQG 40/30
HQG 43/45
HQG 58/41
HQG 70/43

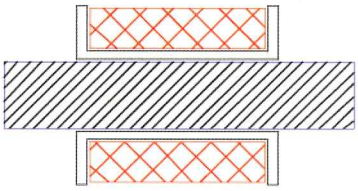


Iron Core Inductors

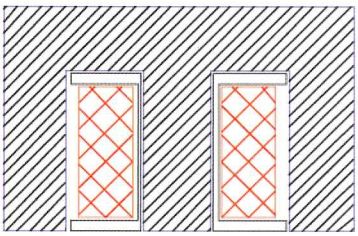
Bar Core Inductors:
CO 30/22
CO 44/35
CO 55/35
CO 62/41



I-Core Inductors:
I - 78
I - 96
I - 130
I - 150



E-Core Inductors:
E - 96
E - 130



Torus Core Inductors:
TO - 1000