# Terminology

## AL Value (nH/N²)
The inductance (nanohenries) of a core for 1 turn winding. It is measured at peak AC flux density of 10 gauss and frequency of 10kHz. $1nH/N^2 = 1mH/(1000turns)^2$

## Ambient Temperature
Temperature surrounding the devices or circuits. The ambient temperature is measured at 0.5inch(1.27cm) away from the devices or circuits.

## Attenuation
The ratio of output parameter (voltage, current, power, etc.) to input parameter. Unit is [dB]. In the case of power, dB is10log (output power / input power). In the case of current and voltage, dB is 20log (output current /input current), 20log (output voltage / input voltage) respectively.

**Coercive Force (Hc)** Refer to Hysteresis Curve.

## Common-Mode Noise
Electrical interference that is common to both lines in relation to the ground.

## Copper Loss [watts]
The power loss ($I^2R$) or heat generated by current (I) flowing in a winding with resistance (R).

## Core loss [watts]
Core loss is composed of eddy current loss, hysteresis loss and residual loss. Refer to Magnetic Design Formulae.

## Cross Sectional Area (A)
The effective cross sectional area of a core available for magnetic flux. The cross sectional area listed for toroidal cores is based on bare core dimensions.

## Curie Temperature, Tc [℃]
The transition temperature above which a core loses its ferromagnetic properties. Usually defined as the temperature at which $\mu i$ falls to 10% of its room temperature value.

## DC Resistance [Ω]
Resistance of winding when AC current is not applied.

## Differential Mode Noise
Electrical interference that is not common to both lines but is present between both lines. This is also known as normal mode noise.

## Disaccommodation
The proportional change of permeability after a disturbance of a magnetic material. It is measured at a constant temperature over a given time interval.

## Distributed Capacitance
In an inductor, each winding behaves as a capacitor having the distributed capacitance. Distributed capacitance is parallel with inductance in the circuit and causes self-resonance at a certain frequency. An inductor which has a smaller distributed capacitance extends a much higher self resonant freguency. So the inductor should be wound to have as small a distributed capacitance as possible.

## Eddy Current
When a varying electric or magnetic field passes through the conducting material, current which opposes the change of field is induced in it. This current is called eddy current. Because a conducting material has electric resistance, the eddy current results in heat loss. This is referred to as the eddy current loss.

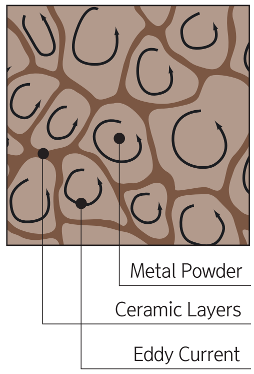


Figure 1. Eddy Current in Powder Cores

**Effective Permeability (μe)** Refer to Permeability.

## EMI
The acronym for Electromagnetic Interference is EMI.
Generally, EMI refers to unnecessary electrical energies such as noise.

**EMC** Electromagnetic Compatibility

## Hysteresis Curve (B-H Loop)

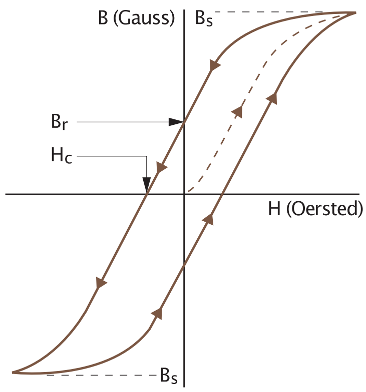


Figure 2. B-H Loop

When the magnetic material is taken through a complete cycle of magnetization and demagnetization, the magnetic flux density in that material behaves irreversibly according to the change of the magnetizing force.

The results are as shown in Figure 2. As H is increased in the neutral magnetic material, flux density B increases along the dashed line (initial magnetization curve) to the saturation point, Bs.

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When H is now decreased, the B-H loop transverses a path to Br (remanent flux density), where H is zero and the core is still magnetized. The magnetizing force H is now reversed to give a negative value. The magnetizing force required to reduce the flux Br to zero is called the coercive force (Hc). Along the initial magnetization curve, B increases from the origin nonlinearly with H until the material saturates. In practice, the magnetization of a core in an excited inductor never follows this curve because the core is never in a totally demagnetized state when the magnetizing force is first applied.

### Flux Density, Magnetic Induction, B [Gauss ; Tesla]
The corresponding parameter for the induced magnetic field in an area perpendicular to the flux path. Flux density is determined by the field strength and permeability of the medium in which it is measured.
$1T=10^4$ Gauss

### Incremental Permeability ($\Delta\mu$)
Refer to Permeability.

### Inductor
A passive device that prevents a variance of the current. Magnetic flux is induced in the inductor when current flows through the inductor, and the voltage induced by magnetic flux prevents the change of current. Induced voltage

$\xi = L \cdot di/dt$.

### Initial Permeability ($\mu i$)
Refer to Permeability.

### Leakage Flux
Leakage flux is the small fraction of the total magnetic flux in a transformer or common mode choke that does not contribute to the magnetic coupling of the windings of the device. The presence of leakage flux in a transformer or common mode choke is modeled as a small "leakage" inductance in series with each winding. In a multi-winding choke or transformer, leakage inductance is the inductance measured at one winding with all other windings short circuited.

### Litz Wire
A wire made by twisting and bundling some insulated wire.
It can decrease the copper loss at high frequency by reducing the skin effect.

### Magnetic Hysteresis
Refer to Hysteresis Loop.

### Magnetizing Force, H [Oe ; A/m]
The magnetic field strength which produces magnetic flux. The mmf per unit length. H can be considered to be a measure of the strength or effort that the magnetomotive force applies to magnetic circuit to establish a magnetic field. H may be expressed as $H=NI/\ell$, where $\ell$ is the mean length of the magnetic circuit in meters.
1 oersted=79.58A/m

### Mean Magnetic Path Length ($\ell$)
The effective magnetic path length of a core structure (cm).
Refer to Magnetic Design Formulae.

### Normal Mode Noise
Refer to Differential Mode Noise.

### Noise
Unnecessary electrical energy that rises in a circuit.

### Operating Temperature Range
The temperature at which a device can be operated normally. Above this temperature, the characteristics of the device can become inferior or the device may operate abnormally. In the case of the inductor, this temperature refers to the temperature rise by the copper loss or core loss. Refer to temperature rise.

### Permeability ($\mu$)
In magnetics, permeability is the ability of a material to conduct flux. The magnitude of the permeability at a given induction is a measure of the ease with which a core material can be magnetized to that induction. It is defined as the ratio of the flux density B to the magnetizing force H.

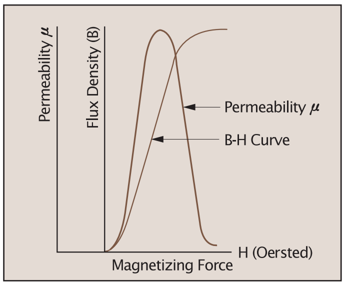


Figure 3. Variation of $\mu$ along the Magnetization Curve

Permeability : $\mu = B/H$ [Gauss/Oersted]

The slope of the initial magnetization curve at any given point gives the permeability at that point. Permeability can be plotted against a typical B-H curve as shown in Figure 3 Permeability is not constant, therefore its value can be stated only at a given value of B or H. There are many different kinds of permeability.

### Absolute Permeability ($\mu_o$)
Permeability in a vacuum

### Initial Permeability ($\mu_i$)
Slope of the initial magnetization curve at the origin, that is, the value of permeability at a peak AC flux density of 10 gauss (1 millitesla).

$\mu = B/H$ (Figure 4)

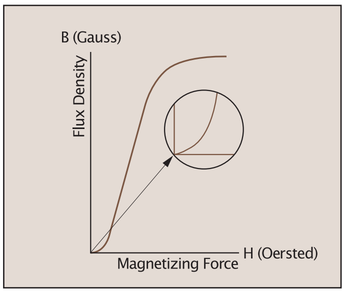


Figure 4. Initial Permeability

### Incremental Permeability ($\Delta\mu$)
The slope of the magnetization curve for finite values of peak-to-peak flux density with superimposed DC magnetization (Figure 5). Initial permeability can be thought of as incremental permeability with 0 DC magnetization at small inductions. The incremental permeability is expressed as the slope of the B-H characteristic at around the given operating point.

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$$\Delta\mu = \frac{\Delta B}{\Delta H}$$

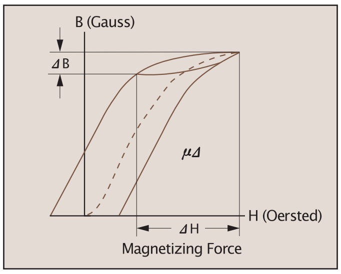


Figure 5. Incremental Permeability

### Effective Permeability ($\mu_e$)
If a magnetic circuit is not homogeneous (i.e. contains an air gap), the effective permeability is the permeability of a hypothetical homogeneous (ungapped) structure of the same shape, dimensions, and reluctance that would give the inductance equivalent to the gapped structure.

### Relative Permeability ($\mu_r$)
Permeability of a material relative to that of free space.

### Maximum permeability ($\mu_{max}$)
The slope of a straight line drawn from the origin tangent to the curve at its knee. (Figure 6)

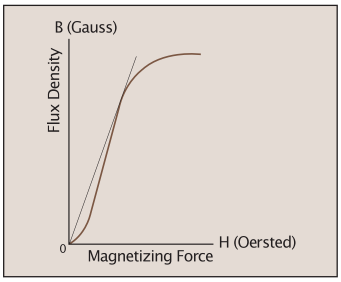


Figure 6. Maximum Permeability

### Rated Current
Continuous DC current that can flow in the inductor.
It is determined by the maximum temperature rise at the maximum storage temperature range. As rated current is related to power loss of the inductor, DC resistance of the inductor should be lowered or the inductor size should be increased in order to increase the rated current.

### Saturation Current
The current at which the inductance decreases below a critical percent inductance (10% or 20% of the initial inductance) by applying DC current to an inductor. In general the critical percent inductance is 10% for ferrite cores and 20% for metal powder cores. The decrease of inductance is caused by the magnetic characteristics of cores.
Cores can store a certain amount of flux density, but above that flux density the permeability and inductance of the cores decrease.

### Self Resonant Frequency, SRF
The frequency at which the resonance appears between distributed capacitance and inductance of an inductor. At this frequency, inductance and capacitance are canceled out and the inductor is almost a resistor having high impedance. Distributed capacitance that arises between wires and between wires and cores is parallel with inductance in circuits. Above the self resonant frequency, the capacitive reactance is dominant and the inductor works like the capacitor.

### Skin Effect
As the frequency is higher, the current flow is limited to the surface of the wire because the magnetic field in the center of the wire increases. The depth from the wire surface at which the current density at the wire surface decreases by 1/e (37%) is called "skin depth", and this is determined by the conductivity of the wire. As the frequency is higher, skin depth decreases, the reactance of wire increases and current flow is interfered. Litz wire may be used in order to decrease the skin effect.

### Storage Temperature Range
Temperature range in which the characteristics of a device can be preserved.

**Remanence, Br [Gauss ; Tesla]** Refer to Hysteresis Curve.

### Saturation
The point at which the flux density B in a magnetic material does not increase with further applications of greater magnetization force H. At saturation, the slope of a material's B-H characteristic curve becomes extremely small, with the instantaneous permeability approaching that of free space.
(relative permeability = 1.0)

### Saturation Flux Density, Bs [Gauss ; Tesla]
The maximum intrinsic induction possible in a material.
This is the flux level at which additional H-field produces no additional B-field.

### Temperature Rise ( ΔT)
The increase in surface temperature of a component in free-standing air due to the total power dissipation (both copper and core loss).
Approximate temperature rise is as follows ;

$$\Delta T(℃) = \left[ \frac{\text{Total Power Dissipation(Miliwatts)}}{\text{Surface Area(㎠)}} \right]^{0.833}$$

Total Power Dissipation = Copper Losses + Core Losses