Voltech™

AT3600 Applications

RECOMMENDED MEASUREMENTS FOR DC CHOKES.

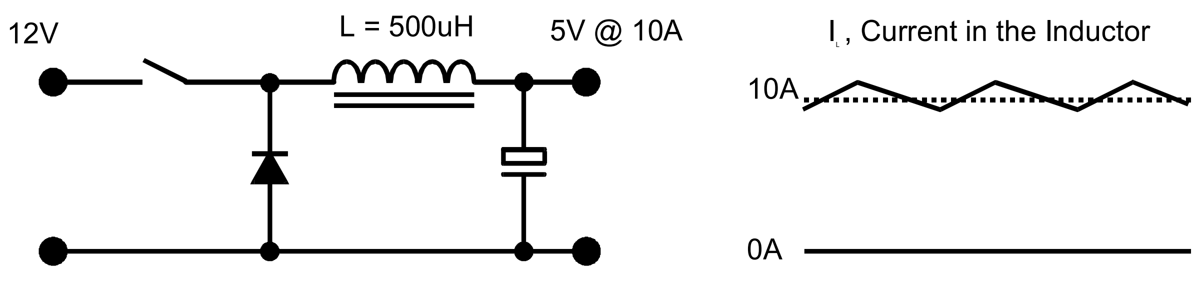
Test	Why
R - Winding Resistance	*Checks correct wire size has been used*
LS or **LP** - Inductance or **LSB** or **LPB** - Inductance with bias	*Checks for correct turns, and correct permeability or air gap*
TR - Turns Ratio (Multi-winding chokes)	*Checks turns and phasing of all windings*
LL or **LLO** - Leakage Inductance (Multi-winding chokes)	*Checks that winding have been correctly positioned on core or bobbin.*
IR - Insulation Resistance (Multi-winding chokes)	*Checks working insulation between windings.*

TESTING A WOUND COMPONENT THAT IS DESIGNED FOR DC BIAS CURRENTS

INTRODUCTION

Many wound components must operate with dc currents flowing through them. In some cases, the dc bias current is small (under 400mA), as for example in telecom transformers where a winding is in series with the dc power supply current to the telephone.

In other cases, the dc bias current is much larger, such as inductors used as output filters on power supplies:

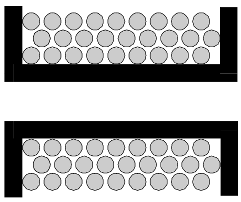


In all these cases the wound component must retain a specified inductance with the rated dc current flowing in the winding.

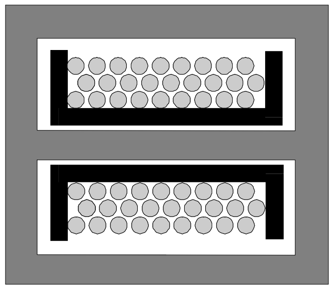
It is often assumed that to test such components it is necessary to test them with the rated current. This paper will show that although this is true for components rated for a few milliamps, components rated for higher dc currents (i.e. above approximately 400mA) can be fully production tested without a dc current.

DESIGN CONSIDERATIONS

Magnetic materials such as iron and ferrite generally have a high value of permeability i.e. a coil of a given number of turns will have much more inductance than the same core in air.

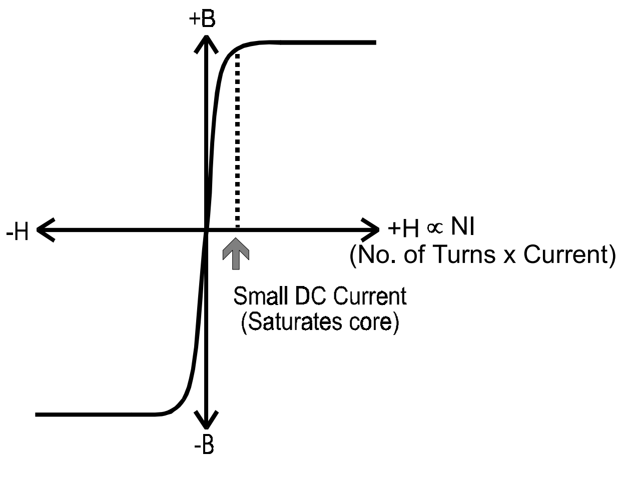


Air Core
L = 20μH



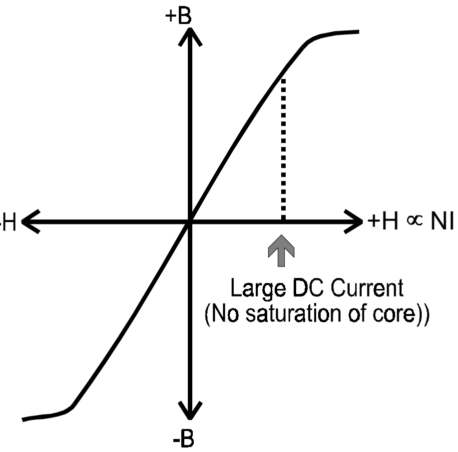
Same winding with ferrite core
L = 50mH

However, a wound component with a high permeability core has a very steep B-H curve, so can tolerate only a very small dc bias current or the core will saturate. If the core saturates the inductance will fall to a very low value.



B - H curve with a high permeability core

In order to make a coil that will operate with higher values of dc bias current it is necessary to reduce the permeability of the core .This is done by introducing air gaps in the magnetic circuit, either by using a physical spacing or by using a core made of a composite of magnetic and non-magnetic materials (providing the effect of air gaps). Cores with air gaps have a much lower overall permeability, and can tolerate much larger dc currents before saturating:



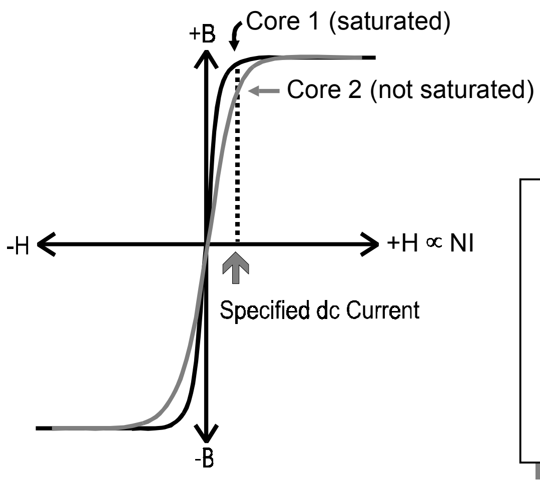
B - H curve with a low permeability core

TESTING

1. Cores for small dc bias currents

Wound components for small dc bias currents are generally constructed with cores having medium to high permability. The value of permeability of such cores varies from batch to batch, as it depends on the manufacturing process of the core itself. This variation results in a wide tolerance of the measured inductance of the winding, which is seen in the wide tolerance of inductance constant (A_L) of core manufacturers specifications.

This variation in inductance results in the possibility that some coils will be able to tolerate the specified dc bias current and some will not:



NO AIR GAP

A_L (nH per turn^2) is ± 30%
∴ L is ± 30%

Test at specified dc bias current ≤ 400mA.

B-H curve for medium to high permeability core.

The only sure way of verifying whether the coil can operate with specified dc current is to measure the inductance with this small dc bias current flowing , ensuring that the inductance is at least the specified minimum value.

2. Cores for larger dc bias currents

As mentioned earlier, coils for higher dc bias currents (greater than about 400mA) have a low permeability core due to air gaps. As the air gap is increased the permeability and therefore inductance, falls and the dc current capability increases, as shown for a constant turns on a typical air-gapped E-Core below:

Air Gap	Inductance	DC Current Capability
0mm	17mH	365mA
0.2mm	9mH	1.37A
0.5mm	6mH	2.06A
1.0mm	4.9mH	2.53A
2.0mm	3.9mH	3.18A
5.0mm	3.1mH	4A

Now, for cores with larger air gaps, the permeability and therefore the inductance is determined predominately by the size of the gap, and is <u>much less affected by variations in the core material</u>. This results in the variation in inductance being much smaller with a gapped core as the gap has a much more constant permeability than the magnetic material itself. The value of inductance will therefore be predictable within a tight tolerance.

It follows therefore that a measurement of inductance (without dc bias) of such a coil provides the necessary check that the core has the correct air gap and therefore has the ability to operate at the specified dc current.

WITH AIR GAP

A_L (nH per turn^2) is $\pm$ 5%
$\therefore$ L is $\pm$ 5%

L is determined by the air-gap.

Sufficient to test L
without bias.

Conclusions

Cores for low dc bias currents (<400mA)	Cores for high dc bias currents (>400mA)
Measure Inductance with specified dc current in winding. Accept wide limits on <u>range</u> of inductance values but result must be greater than a certain <u>min</u> value.	Measure inductance without dc bias current. Set limits as tight as possible eg 5% as means to verify gap.