American Cores & Electronics

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Iron Powder Cores

These cores are composed of finely defined particles of iron which are insulated from each other but bound together with a binding compound. The iron powder and binding compound are mixed and compressed under heavy pressure, and baked at high temperature. The characteristics of the cores are determined by the size and density of the core, and the property of the iron powder. Powdered iron cores do not saturate easily, and has high core temperature stability and Q. However, it is only available in low permeability (below μi = 110). The high temperature stability makes it suitable for applications such as narrow band filter inductors, tuned transformers, oscillators and tank circuits.

Iron Powder Cores are made in numerous and sizes: such as Toroidal Cores, E-cores, Shielded Coil Forms, Sleeves etc., each of which is available in many different materials. There are two basic groups of iron powder material: The Carbonyl Iron and, The Hydrogen Reduced Iron.

The Carbonyl Iron cores are especially noted for their stability over a wide range of temperatures and flux levels. Their permeability range is from less than 3 μi to 35 μi and can offer excellent 'Q' factors from 50 KHz to 200 MHz. They are ideally suited for a variety of RF applications where good stability and good 'Q' are essential. Also, they are very much in demand for broadband inductors, especially where high power is concerned.

The Hydrogen Reduced Iron cores have higher permeabilities ranging from 35 μi to 110 μi. Somewhat lower 'Q' can be expected from this group of cores. They are mainly used for EMI filters and low frequency chokes. They are also very much in demand for input and output filters for switched mode power supplies.

In general, toroidal cores are the most efficient of any core configuration. They are highly self-shielding since most of the flux lines are contained within the core. The flux lines are essentially uniform over the entire length of the magnetic path and consequently stray magnetic fields will have very little effect on a toroidal inductor. It is seldom necessary to shield a toroidal inductor.

The A_L value of each iron powder core can be found below. Use the given A_L value and the equation below to calculate the number of turns for a specific inductance.

Material #0, tan color (µi = l)
Most commonly used for frequencies above 100 MHz. Available in toroidal form only. Note: Due to the nature of this material the inductance resulting from the use of the given AL value may not be as accurate as we would like. Inductance vs. number of turns will vary greatly depending upon the winding technique.

Material #1, blue color (µi = 20)
A Carbonyl 'C' material, very similar to material #09 (gray) except that it has higher volume resistivity and better stability. Available in toroidal form and shielded coil form.

Material #2, red/gray color (µi = 10)
A Carbonyl 'E' iron powder material having high volume resistivity. Offers high 'Q' for the 2 MHz to 30 MHz. frequency range. Available in toroidal form and shielded coil form.

Material #3, gray color (µi = 35)
A carbonyl 'HP' material having excellent stability and good 'Q' for the lower frequencies from 50 KHz. to 500 KHz. Available in toroidal form and shielded coil form.

Material #6, yellow/gray color (µi = 8)
A carbonyl 'SF' material. Offers very good 'Q' and temperature stability for the 20 MHz to 50 MHz frequency range. Available in both toroidal form and shielded coil form.

Material #7, white color (µi = 9)
A carbonyl 'TH' material. Very similar to the #2 (red/gray) and #6 (yellow/gray) materials but offers better temperature stability than either. Available in both toroidal form and shielded coil form. Frequency ranges from 5 MHz to 35 MHz.

Material #10, black color (µi = 6)
A powdered iron 'W' material. Offers good 'Q' and high stability for frequencies from 40 MHz to 100 MHz. Available in toroidal form and shielded coil form.

Material #12, green/white (µi = 4)
A synthetic oxide material which provides good 'Q' and moderate stability for frequencies from 50 MHz to 200 MHz. If high 'Q' is of

prime importance this material is a good choice. If stability is of a prime importance, consider the #17 (blue/yellow) material. The #12 material is available in all sizes up to T-94 in toroidal form. Not available in shielded coil form.

Material #15, red/white (μi = 25)
A carbonyl 'GS6' material. Has excellent stability and good 'Q'. A good choice for commercial broadcast frequencies where good 'Q' and stability are essential. Available in toroidal form only.

Material #17, blue/yellow (μi = 4)
This is a new carbonyl material which is very similar to the #12 material except that it has better temperature stability. However, as compared to the #12 material, there is a slight'Q' loss of about 10 % from 50 MHz to 100 MHz. Above 100 MHz, the 'Q' will gradually deteriorate to approximately 20% lower. It is available in both toroidal form and the shielded coil form.

Material #26, yellow color (μi = 75)
A Hydrogen Reduced material. Most commonly used for EMI filters, DC chokes, Line filters, etc. The #26 is lower cost than #52 material, and is normally used for low cost, lower frequency applications.

Material #52, green color (μi = 75)
This material has same characteristics as #26, but has lower core loss, and better high frequency characteristics. Cost about 20% more than #26. Ideally suited for high frequency choke designs.

Material #28, mellon green (μi = 55)
A Hydrogen Reduced material. Good for higher temperature application. Has linear characteristics. Good high frequency features. Ideal for UPS chokes.

Material #8, white/orange (μi = 35)
High frequency material. Lowest core loss, but also the most expansive material. For high frequency filters filters, chokes, etc.

Material #47, olive green (μi = 110)
Highest permeability material. Core loss is quite high. Good for lower frequency applications.

Specifications: Magnetic Materials

Magnetic materials are used in applications such as power supply transformers, audio transformers, AC and RF filter inductors, broadband and narrow band transformers, damping network, EMI/RFI suppressors, etc. The basic characteristic of magnetic materials is the permeability (µ). It is a measure of how superior a specific material is than air as a path for magnetic line of force. Air has a µ of 1. Another characteristic of magnetic material is saturation. It is the maximum value of magnetic induction at a specified field strength. When a material saturates, it losses its linearity. Magnetic materials are available in many different types and sizes.

IRON POWDER CORES

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FERRITES

Ferrites are ceramics materials that can be magnetized to a high degree. The basic component is iron oxide combined with binder compounds such as nickel, manganese, zinc or magnesium. Two major categories of ferrites are manganese zinc (MnZn), and nickel zinc (NiZn). Ferrites are manufactured by homogeneously mixing the iron oxide with the binder, and calcinated (heating mixture to 1000°c). This causes partial decomposition of the carbonates and oxides. The mixtures are dry pressed into a core configuration, and finally sintered. This is done by gradually raising the temperature up to 1500°C in a kiln. Typically the cores will shrink by 10 to 20% of its original size after sintering. Ferrites can be manufactured to permeability of over 15, 000 with little eddy current losses. However, the high permeability of the ferrite makes it unstable at high temperatures, and saturates easily. It is suitable for applications such as DC to DC converters, magnetics amplifiers, etc. It must be noted that driving ferrites with excessive current may cause permanent damage to the core.

Ferrites are widely used as attenuators of unwanted high frequency signals. These ferrites are known as EMI/RFI suppressors. They are typically available as beads, split cores, flat ribbon core and toroidal cores. Ferrite tiles are also available for use in anechoic chambers.

Another application of ferrites are in transformers, inverters and inductors in the 5KHz to 100 KHz range. It is cheaper than tape wound cores and are used in applications where high flux density and high temperature stability are not critical.

Typical applications:

- Inverter power supplies: 5KHz to 500 KHz, and under 50 watts at 10 KHz. For high power application, use tape wound core as saturating core and ferrite core as output transformers.
- Fly back transformers
- High frequency power supplies (1 Kw)

Ferrite cores can be gapped to avoid saturation under DC bias conditions.

LAMINATED OR TAPE WOUND CORES

These cores are manufactured by using different steel grades with different widths and thickness, wound in circular manner. Tape wound cores have very high permeability and are used primarily in power transformers, reactors in 60 Hz to 400 Hz, DC to DC converters, and current transformers. It provides very high flux densities and good temperature stabilities. It is also the most costly core to manufacture.

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