FERRITES AND SPECIAL PURPOSE RESISTORS

The use of ferrite beads provides many designers a convenient way of adding high frequency noise rejection in a circuit. They are generally small, do not add any dc resistance or loss to the circuit, and are installed by simply slipping them on to component leads and wires.

It was in the early 1960's when ferrites formed into a small sleeve configuration became known as a "bead"; and were found to be effective in suppressing transient spikes. Ferrite beads can be small (0.038 in on up) or large as shown in Figures 1 and 2. They are relatively inexpensive (in large quantities some are less than a penny), and are produced in a wide variety of materials. Millions are now in use suppressing all types of transients and interfering signals containing frequencies of approximately 1 MHz and above.

Basically, ferrites are electromagnetic materials consisting of mixtures of iron oxide and metallic oxides of nickel, zinc, manganese (or combinations thereof), which are calcined, milled, spray-dryed, molded or extruded and sintered at temperatures of 1100° C or higher. The resultant ferrite is a polycrystalline, ceramic material with a spinel structure. It is very hard and, if machined, requires diamond wheel grinding.

All ferrites have a permeability and quality factor ($Q = X_L/R_S$) which are frequency sensitive. Over the specific frequency range for which the material is designed, this permeability (directly proportional to inductance) and the series losses of the material R_s are relatively constant. But as frequency increases above the operational range, permeability decreases while losses increase rather drastically. Both characteristics continue in this manner until, respectively, a minima and maxima are reached. Thus we have, in essence, a frequency-sensitive "resistor"–in actual operation an impedance consisting of a decreasing inductive reactance and increasing series resistance. Each material has a frequency at which it becomes effective as a suppressor of high frequencies (see Figs. 3 and 4).

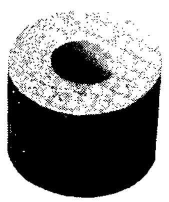

Figure 1: Ferrite bead inductor.

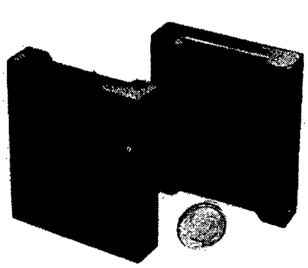

Figure 2 **Two-part bead** is used around flat ribbon cable to suppress computer transients.

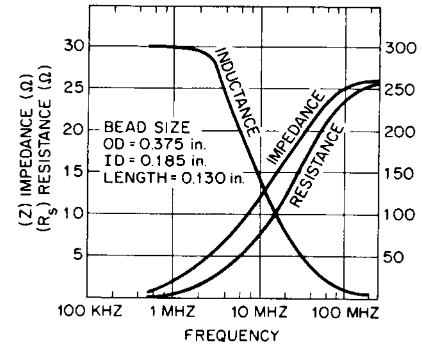

Figure 3 **Effect of varying frequency** on impedance, resistance and inductance of a typical bead material (Ceramag 7D).

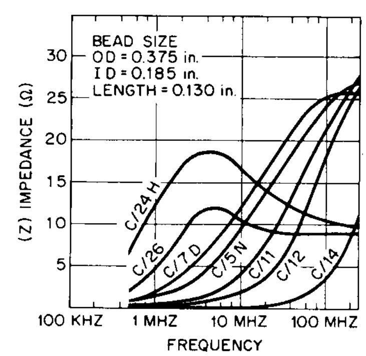

Figure 4 **Frequency-impedance relationship** of several Ceramag materials.

SPECIAL PURPOSE RESISTORS

Special purpose resistors (SPR's) available from Stackpole are designed to work in series with the load to provide needed high frequency attenuation or insertion loss. SPR's have been used for years in automotive ignition systems to suppress the pulsating RF ignition interference. They are also very useful for steady state as well as transient interference conditions and can be the solution to a problem where there is an unusual electrical rating beyond commercial resistor specs. When space or cooling is a problem, SPR's can be formed into a variety of rods, discs, sleeves, rings, flats, squares or other specially designed shapes.

In cases where exceptionally high transients are encountered in hypercritical areas, the SPR may be used to reduce the transient signal. The resistor should be inserted with the load or as close to the source of the noise as possible.

Special purpose resistors consist of carbon particles dispersed in a matrix of either sintered ceramic materials, or thermally cured organic resins containing inert fillers. The ceramic special purpose resistors are thermally stable, chemically inert, durable units suitable for adverse conditions. The organic bonded special purpose resistors are a less expensive alternative in less stringent environments.