

FERRITE CORES FOR LOW-FREQUENCY EMI CABLE SUPPRESSION

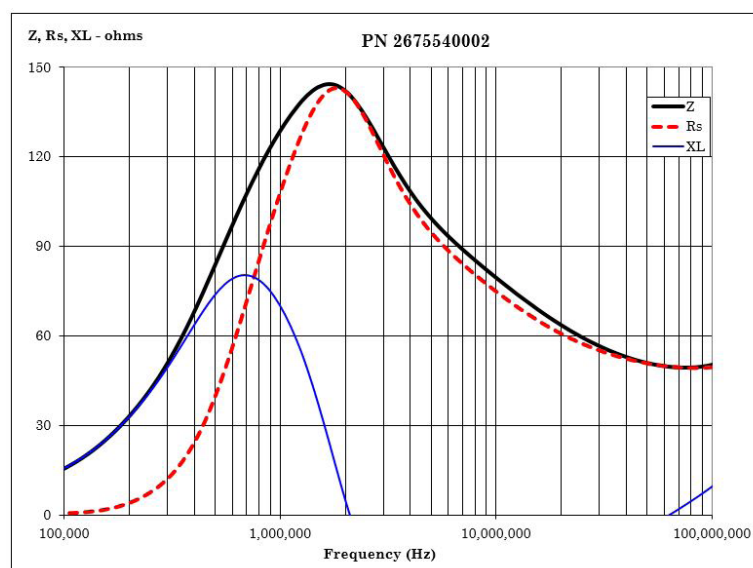
Ferrite cores (chokes) provide an inexpensive, and effective, way of coupling high-frequency resistance into a cable in order to reduce the common-mode current, and hence the radiation (or pickup) from the cable. They are commonly used on mouse, keyboard, video, and other peripheral cables connected to personal computers, as well as on power supply cables when a device is powered from an external transformer (wall-wart) or power supply. The ferrite core acts as a one-turn common-mode choke, and can be effective in reducing the conducted and/or radiated emission from the cable, as well as suppressing high-frequency pick-up in the cable. Basically ferrites can be thought of as high-frequency resistors, with little or no impedance at low-frequencies or DC. Ferrite cores are most effective in providing attenuation of unwanted noise signals above 10 MHz. The figure below shows a ferrite choke on a USB cable.



For low-frequency cable emission problems, typically below 10 MHz, ferrite chokes have not been very useful, since their impedance is too low, at these frequencies, to be effective. I have always wished for a similar, simple low-frequency solution to cable emission/susceptibility problems. My wish finally has been granted.

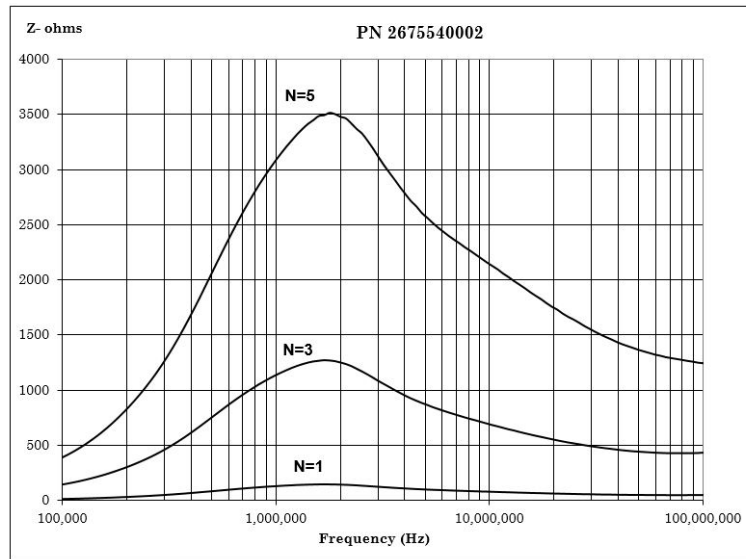
Recently Fair-Rite® Products Corp. introduced a new low-frequency, Type 75, ferrite material optimized for EMI suppression in the 200 kHz to 30 MHz frequency range. This material has an impedance peak in the 1 to 2 MHz range. Information on the new Type 75 ferrite cores is included in Fair-Rite®'s 17th edition catalog.

For example, part number 2675540002 (9/16" OD, 1/4" ID, and 1-1/8" long core) has a peak impedance of 160 Ω at about 1.6 MHz as shown below.



Type 75 ferrite cores can be especially useful in reducing emission problems in the 500 kHz to 10 MHz frequency range, across which the impedance of the above ferrite is greater than 80 Ω .

The impedance of ferrite cores can be further increased by using multiple turns. However, this also increases the inter-winding capacitance and degrades the high-frequency performance of the choke. Since the Type 75 material is intended for low-frequency use, this increase in capacitance is less of an issue, and two to five turns can be used with very little, if any, detrimental effect. The same 2675540002 core discussed above has an impedance of 1,400 Ω at 1.3 MHz when three turns are used, and an impedance of almost 4,000 Ω when five turns are used, see below. A three turn choke using this core will have an impedance greater than 500 Ω from 300 kHz to 20 MHz.



Even at 150 kHz, the low-end of the FCC/CISPR conducted emission measurement range, the three turn configuration has an impedance of approximately 250 Ω , and the five turn configuration has an impedance of approximately 700 Ω . Therefore, by using multiple turns high impedances can now be obtained at these low-frequencies.

Both smaller and larger cores are available from Fair-Rite. Type 75 cores ranging from 3/8" to 1-1/4" OD (7/32" to 3/4" ID) are listed in the Fair-Rite® catalog. At present only solid cores are available, but snap-on split cores should also be available later this year. Snap-on cores are convenient for troubleshooting, and can be easily applied as an after-the-fact fix to cables. Since the manganese-zinc (MnZn) Type 75 cores are slightly conductive (resistivity, $\rho = 3 \times 10^2 \Omega\text{-cm}$), care should be taken that they do not touch any live electrical terminals.

Give the new Fair-Rite Type 75 material a try for your low-frequency emission/susceptibility cable problems. You might be pleasantly surprised with the results.

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