

# FERRITE RODS, BARS, PLATES AND TUBES (cont')

Loop antenna has a height factor called effective height,  $h_e$  (in m), which when multiplied with field strength,  $F$  (in  $\mu\text{V/m}$ ), provides the loop-induced voltage (in  $\mu\text{V}$ ).

$$h_e = \frac{2\pi N A \mu_e}{\lambda}, \text{ in meter.}$$

$$\text{Loop Induced Voltage} = F h_e = \frac{2\pi N A \mu_e F}{\lambda}, \text{ in } \mu\text{V.}$$

Where  $N$  = no. of turns  
 $A$  = area in square meter ( $\text{m}^2$ )  
 $\lambda$  = wavelength in meter  
 $\mu_e$  = effective permeability of rod  
 and where  $d/\lambda < 1$ ,  $d$  = diameter of rod

It can be seen from the equation that the highest induced voltage occurs when the windings occupied the entire rod (when  $N$  is largest).

Initial Permeability, $\mu_i$	Maximum Permeability, $\mu_m$	Saturation Flux Density, $B_s$ , at 13 Oe	Recommended Frequency *Range (MHz)	Amidon Material
20	—	2000 at 40 Oe	80-100	68
40	—	3000 at 20 Oe	10-80	67
125	450	2350	5.0-30	61
250	375	2200	0.05-4	64
300	3600	3900	0.001-5	83
800	3000	2750	0.01-7	33
2000	4600	1150	0.001-2	77

\* Frequency ratings are for optimum  $Q$  in narrow-band tuned circuits.

**CHOKE Applications:** Both the #33, and the #61 rods are used extensively in choke applications. The #33 material should be selected for the 3.75 - 7.5 MHz (40-80 meters band). The #33 rods are also often used in speaker cross-over networks. The #61 material is most suitable for the 7.5-30 MHz (10-40 meters band) range. Due to the open magnetic structure of the rod configuration, considerable current can be tolerated before it will saturate.

There are several factors that have a direct bearing on the effective permeability of a ferrite rod, which in turn will effect inductance and 'Q', as well as the  $A_L$  value of the rod and its ampere-turns rating. These are: (1) Length to diameter ratio of the rod, (2) Placement of the coil on the rod, (3) Spacing between turns and, (4) Air space between the coil and the rod. In some cases, the effective permeability of the rod will be influenced more by a change in the length to diameter ratio than by a change in the initial permeability of the rod. At other times, just the reverse will be true.

Greatest inductance and  $A_L$  value will be obtained when the winding is centered on the rod rather than placed at either end. The best 'Q' will be obtained when the winding covers the entire length of the rod.

Because of all of the above various conditions it is very difficult to provide workable  $A_L$  values.

However we have attempted to provide a set of  $A_L$  and  $Nl$  values for various types of rods in our stock. These figures are based on a closely wound coil of #22 wire, placed in the center of the rod and covering nearly the entire length. Keep in mind that there are many variables and that the inductance will vary according to winding technique.

## EFFECTIVE PERMEABILITY

Coil placements and the length of windings on the rods, bars, plates and tubes affect the effective permeability of these devices. The corrected permeability for variation in coil length versus rod length is:

$$\mu' = \mu_e \sqrt[3]{(\ell_r / \ell_c)}$$

Where  $\mu'$  = corrected  $\mu$ ,  
 $\mu_e$  = effective permeability from the chart  
 $\ell_r$  = rod length in cm or inches  
 $\ell_c$  = length of coil windings in cm or inches

## EFFECTS ON 'Q'

The spacing between the turns has a significant effect on the 'Q', and the inductance of the rods. The best values of 'Q' are obtained when the coil turns are spaced one wire diameter apart, with the windings located at the center of the rod. Litz wire provides the highest level of 'Q'.

Reference: "Ferromagnetic Core Design Handbook" by Doug DeMaw.