■ A. Closer at Ferrite Impedance(細說鐵氧磁體阻抗)

The previously described complex impedance of ferrites can be analyzed further if the situation considered is limited to small fvapplied magnetization forces (i.e., small forward current, few turns of conductor around through the core). In such cases, the application of incremental increases in magnetizing force H to a ferrite will result in a corresponding increase in magnetic flux density B in the core. This operation typically displayed graphically via a devices B-H curve, as shown in Figure 3.
如果考慮僅施予一小的磁化力(意即小電流，電感的線圈圈數少)的狀況下，前述之鐵氧磁體復合阻抗可以被進一步分析，在此情況下施以一逐漸增加的磁化力H於一鐵氧磁體上，會在鐵芯中產生一相對應增加的磁通量密度 B，此過程通常藉一儀器以B-H曲線圖表示出來，如圖例三。

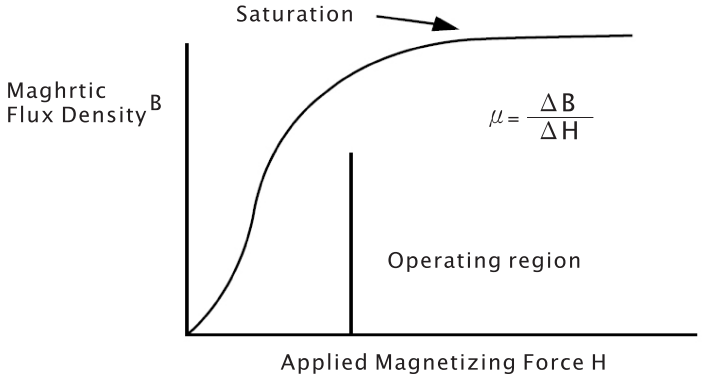

Figure 3 : Virgin B - H curve for a typical ferrite

With the previously mentioned restrictions, the impedance of a given ferrite bead or core can be expressed as:
在先前所提到的限制下，一鐵氧磁體磁珠或鐵芯的阻抗值可以下式表之:

$$Z = R(f) + j\omega L(f)$$

The frequency dependent loss term arises from the loss of energy incurred as a result of oscillation of microscopic magnetic regions (called domains) within the ferrite. The loss and the ferrite impedance can be expressed in terms of a complex permeability as:
此與頻率相依的損失項是由鐵氧磁體中在微觀下磁性區域(稱為磁區)的震盪而招致的能量損失所產生，此損失與鐵氧磁體之阻抗可以以複合導磁率表示:

$$\begin{aligned} Z &= K\{j\omega\ \mu_o[(\mu'(f)-j\mu''(f))]\} \\ &= K\omega\ \mu_o\mu''(f)+jK\omega\ \mu_o\mu'(f) \\ &= R(f)+j\omega L(f) \end{aligned}$$

Where :

$\mu'(f)$ = the real component of the frequency dependent series complex relative permeability
與頻率相依之串聯複合相對導磁率的實部
$\mu''(f)$ = the imaginary component of the frequency dependent series complex relative permeability
與頻率相依之串聯複合相對導磁率的虛部
K = a constant corresponding to the number of windings and the
對應於線圈繞圈數及鐵芯尺寸的常數
μ_o = permeability of free space
真空之導磁率
w = radian frequency = 2pf
角頻率=$2\pi f$

The loss tangent (tan d) of a ferrite material can be defined as the ratio of the imaginary part to the real part of the material's relative permeability.
鐵氧磁體材料的損失正切(tan d) 可定義為此材料相對導磁率之虛部對其實部之比值。

$$\tan d = \frac{\mu''(f)}{\mu'(f)}$$

Figure 4 gives a graphical representation of the loss tangent. As is true with the permeability, the loss tangent is frequency dependent. The loss tangent is an intrinsic property of a given ferrite material formulation. Choosing a particular ferrite material corresponds to choosing a particular loss tangent and an associated impedance versus frequency characteristic.
圖例四為損失正切的圖形表式，如同導磁率，損失正切亦與頻率相關，損失正切為-鐵氧磁體-固有的特性，選擇一特定之鐵氧磁體材料，會對應到一特定的損失正切及與頻率相關的阻抗特性。

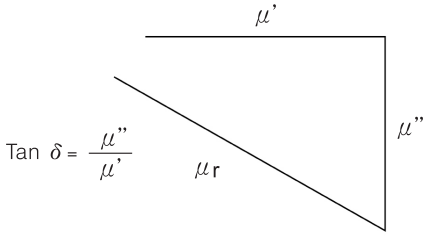

FIGURE 4: Graphical representation of the loss tangent