the flux density "walks" into saturation. This problem is not a core limitation – any core would eventually reach saturation. This is a circuit problem, to which there are several circuit solutions which are beyond the scope of this paper.

Core Loss

Core loss is the most important core limitation in most SMPS applications. For acceptable losses, flux density swing ΔB must be restricted to much less than B_{SAT}. This prevents the core from being utilized to its full capability.

At low frequencies, core loss is almost entirely hysteresis loss. For today's power ferrites, eddy current loss overtakes hysteresis loss at 200-300kHz. In metal alloy cores, eddy current loss dominates above a few hundred Hertz.

Core manufacturers usually provide curves such as Fig. 2-3 showing core loss as a function of flux swing and frequency, combining hysteresis and eddy current losses. Core loss is usually expressed in mW/cm^3, sometimes in kW/m^3 (actually equal: 1 mW/cm^3 = 1 kW/m^3), sometimes in Watts/pound (horrors!!)

In these Core Loss vs. Flux Density curves, the horizontal axis labeled "Flux Density" usually represents *peak* flux density, with symmetrical sinusoidal excitation. In SMPS applications, *peak-to-peak* flux swing, ΔB, is calculated from Faraday's Law, where $\int Edt$ = applied Volt-seconds, N = turns, and A_e = core cross-section area:

$$\Delta B = \frac{1}{NA_e}\int Edt$$

The total flux swing, ΔB, is twice the peak flux swing referred to in the core loss curves as "Flux Density". Therefore, use $\Delta B/2$ to enter the core loss curves.

Hysteresis Loss

The hysteresis loops shown in the core material data sheets represent the core overdriven by a sinusoidal waveform from + to – saturation. In an SMPS application, the core is usually driven by a much smaller rectangular waveform with ΔB limited by core losses to a minor hysteresis loop as shown in Fig. 2-4.

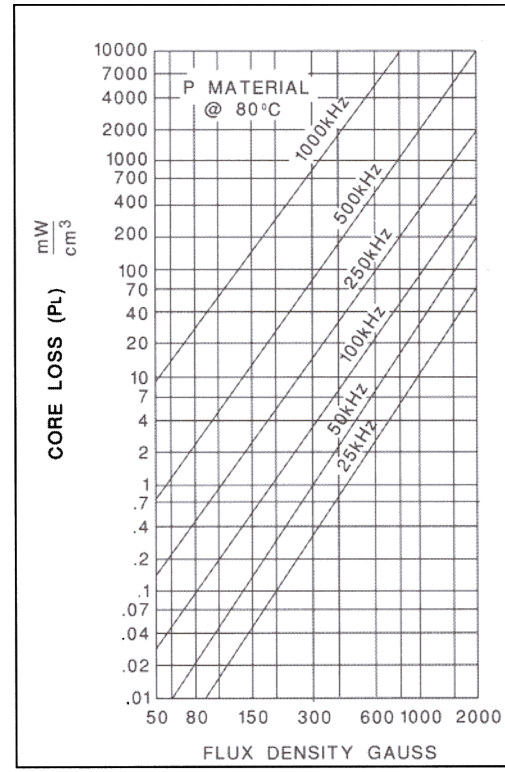

Figure. 2-3 Core Loss --"P" Material

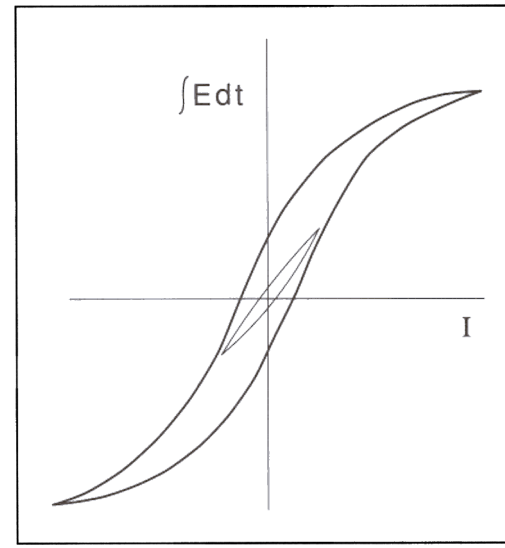

Figure. 2-4 – Minor Hysteresis Loop