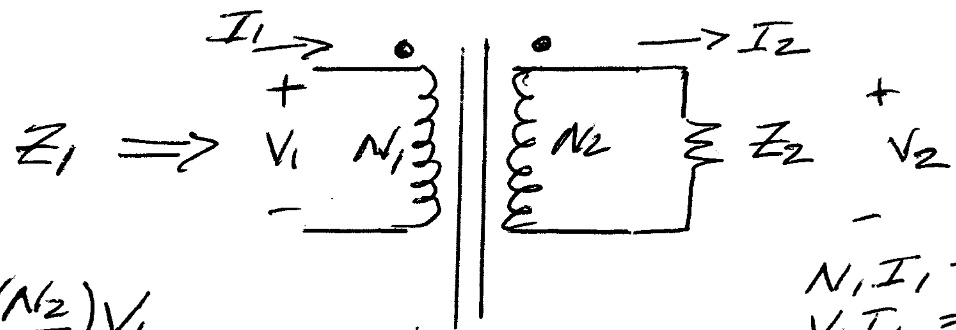
USEFUL TRANSFORMER INFORMATION



LOSSLESS TRANSFORMER

$N_1 I_1 = N_2 I_2$ LENZ LAW

$V_1 I_1 = V_2 I_2$ CONS. OF ENERGY

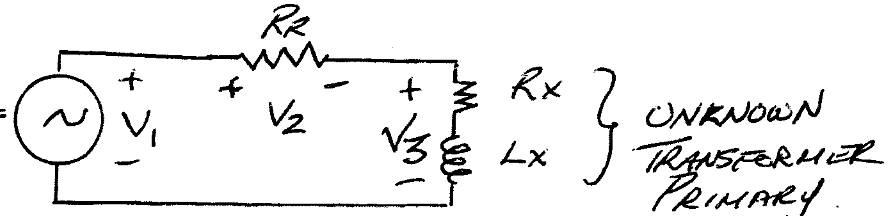
$$V_2 = \left(\frac{N_2}{N_1}\right) V_1$$

$$I_2 = \left(\frac{N_1}{N_2}\right) I_1$$

$$Z_1 = \left(\frac{N_1}{N_2}\right)^2 Z_2$$

IF YOU WANT TO MEASURE THE PRIMARY INDUCTANCE OF A TRANSFORMER, BUT HAVE ONLY A DVM AND A VOLTAGE SOURCE USE THE CIRCUIT BELOW:

V_1 IS A 60Hz VOLTAGE SOURCE ISOLATED FROM THE A.C. LINE SUCH AS A VARIAC PLUGGED INTO AN ISOLATION TRANSFORMER.



R_R SHOULD BE ≈ 20K Ω FOR MEASURING PRIMARY INDUCTANCE.

PROCEDURE:

① ADJUST VOLTAGE V_1 TO ≈ 50 VRMS → RECORD THE EXACT VOLTAGE.

② MEASURE V_2 AND V_3 AND RECORD BOTH OF THEM.

③ CALCULATE $R_X = R_R\left(\frac{V_1^2 - V_2^2 - V_3^2}{2V_2^2}\right)$ OHMS.

④ CALCULATE $L_X = \sqrt{\frac{R_R^2}{4\pi^2 f^2 V_2^2}\left(V_3^2 - \frac{1}{4V_2^2}\left(V_1^2 - V_2^2 - V_3^2\right)^2\right)}$

⑤ TOO MUCH TROUBLE?

A QUICK WAY: SET V_3 TO ≈ 50 VRMS, MEASURE V_2 AND RECORD IT.

CALCULATE $I_{PRI} = \frac{V_2}{R_R}$, NOW $V_3 = I_{PRI}(R_X + j\omega L_X)$

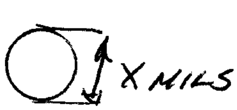
LET'S PRETEND $R_X = 0$ (CLOSE ENOUGH FOR ROCK 'N ROLL)

CALCULATE $L_X \approx \frac{V_3 R_R}{V_2 \times 2\pi f}$ Henrys

$= \frac{V_2 R_R}{377 V_2}$ Henrys for 60Hz V_1

AREA OF A WIRE OR TOROID HOLE IN CIRCULAR MILS

1 mil = 0.001"



AREA IN CIRCULAR MILS IS X^2

A RECTANGULAR MAGNET WIRE, SAY 0.100" × 0.200" WOULD HAVE A CROSS SECTIONAL AREA OF 100×200 mils WHICH WOULD BE 100×200 = 20,000 SQUARE MILS. TO CONVERT THIS TO CIRCULAR MILS MULTIPLY BY 1.27 TO GET 25,400 CIRCULAR MILS.

FERRITE AND POWDER CORE DATA BOOKS ARE YOUR FRIENDS FOR INDUCTANCE CALCULATIONS ETC.

IN GENERAL $L = A_L \times N^2$ ← TURNS

A_L: INDUCTANCE FACTOR IN nanohenrys/turn^2

FOR A LAMINATED STRUCTURE OR ANY MAGNETIC STRUCTURE WITH A DISCRETE AIR GAP:

$$L = \frac{4\pi \times 10^{-9} N^2 A_C}{l_g + \frac{l_c}{\mu_\Delta}} \text{ Henrys}$$

N = turns
A_C = CORE AREA IN cm^2
l_g = CORE PATH LENGTH IN cm
l_c = AIR GAP LENGTH IN cm
μ_Δ = INCREMENTAL PERM. OF CORE MATL

IF THIS IS A DEVICE WHICH IS GAPPED TO ACCOMMODATE D.C. BIAS THEN THE D.C. FLUX DENSITY IS AS FOLLOWS:

$$B_{dc} \text{ (in gauss)} = \frac{0.4\pi N I}{l_g + \frac{l_c}{\mu_{dc}}}$$

SINCE YOU MAY NOT HAVE ACCESS TO μ_{DC} INFO, ERR ON THE SAFE SIDE BY SETTING $\frac{l_c}{\mu_{dc}} = 0$

So B_{dc} in gauss (WORST case) $= \frac{0.4\pi N I}{l_g}$ once again, l_g in cm, I in amps dc.

AC FLUX DENSITY IS GIVEN BY:

$$B_{MAX} = \frac{E \times 10^8}{4.44 \times f \times N \times A_C} \text{ gauss}$$

f: frequency; N: turns; A_C: net core area in cm^2

Valid for sinusoidal waveforms only, E in rms volts.