Magnetic Delay Effects

1. Introduction

The introduction of a magnetic delay between primary and secondary of a transformer affects the performance and offers the potential for overunity operation. A study has been made of a transformer using a ferrite ring core where the primary and secondary are wound on opposite sides, thus introducing a delay path. This paper presents some of the findings of that study.

2. Core Material

The ring core uses 3F4 ferrite and has an OD of 107mm, an ID of 65mm and a thickness of 18mm. Taking its relative permeability as the quoted figure of 900, and operating at a frequency of 1MHz, the phase delay from primary to secondary is about 5°. This has yet to be confirmed by measurement.

3. Magnetic Domain Modelling

The modelling has used 10 turns for the secondary and a notional 1 turn for the primary driven by a 1 amp peak current. The magnetic delay is taken from a propagation velocity of *c*/sqrt(900) which should be an overestimate of the velocity since it doesn't take account of the dielectric constant of the ferrite. All the power losses are referenced to an effective secondary series resistance; that includes the primary coil losses, the secondary coil losses and the core losses. No other power loss, e.g. to an external load, is considered. The losses are considered to be valid power output, thus a unity COP (power output divided by power input) is expected under classical theory. This holds true in the model when there is no magnetic delay, but when the delay is included the power balance is affected, there can be an anomalous loss or gain of power. This indicates that either the model is wrong or that Prof. Turtur is correct in claiming that field propagation connects to zpe.

The losses are obtained from a Q value, in this instance a Q of 100 is assumed. The inductance of the 10 turn secondary is 158µH and the series resistance is 9.94Ω. Resonance at 1MHz occurs with a capacitor value of 160pF, and this is indicated by a peak in primary input power. At that peak the COP is unity, but away from resonance the COP deviates from this value. Figure 1 shows the input and output power for different values of capacitor, where it can be seen that for values lower than 160pF the COP is less than unity, while for greater values the COP exceeds unity.

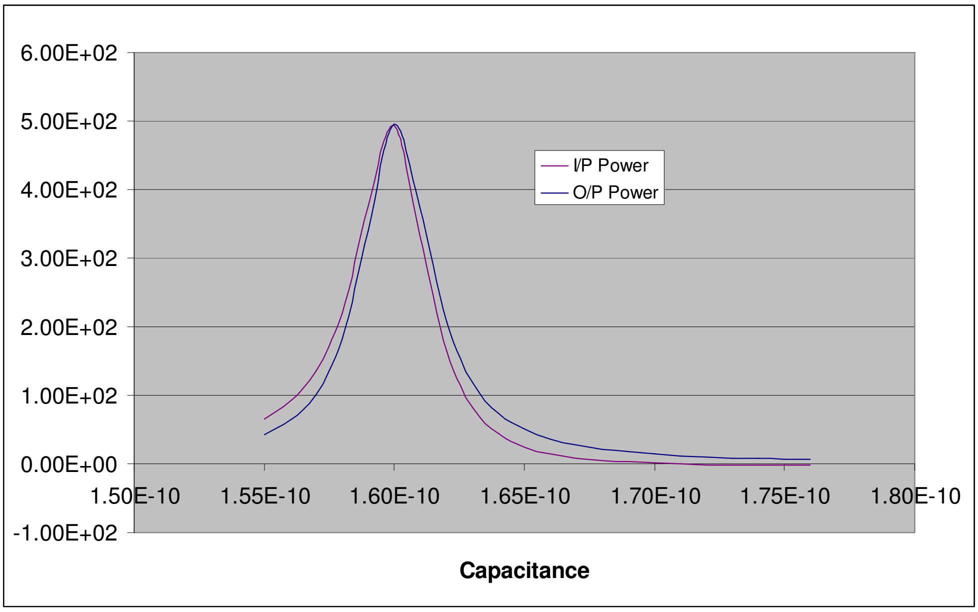

Figure 1.

Although not obvious in Figure 1, at a certain capacitance value the input power passes through zero. Figure 2 is an expanded part of Figure 1 showing that zero crossing. At that point the COP is infinite and above that point the COP is negative, indicating that the device could self oscillate.

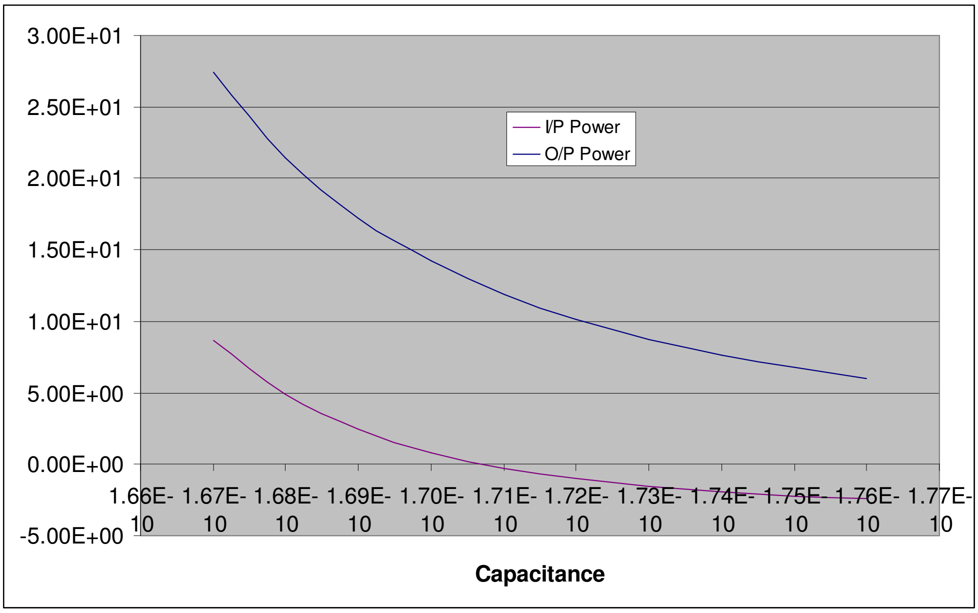

Figure 2.

Note the small change of capacitance needed to reach the infinite COP point. In practice it would be better to hold the value fixed at 160pF and vary the frequency. Figure 3 shows the results for this experiment, while Figure 4 is an expanded version to show the zero crossing.

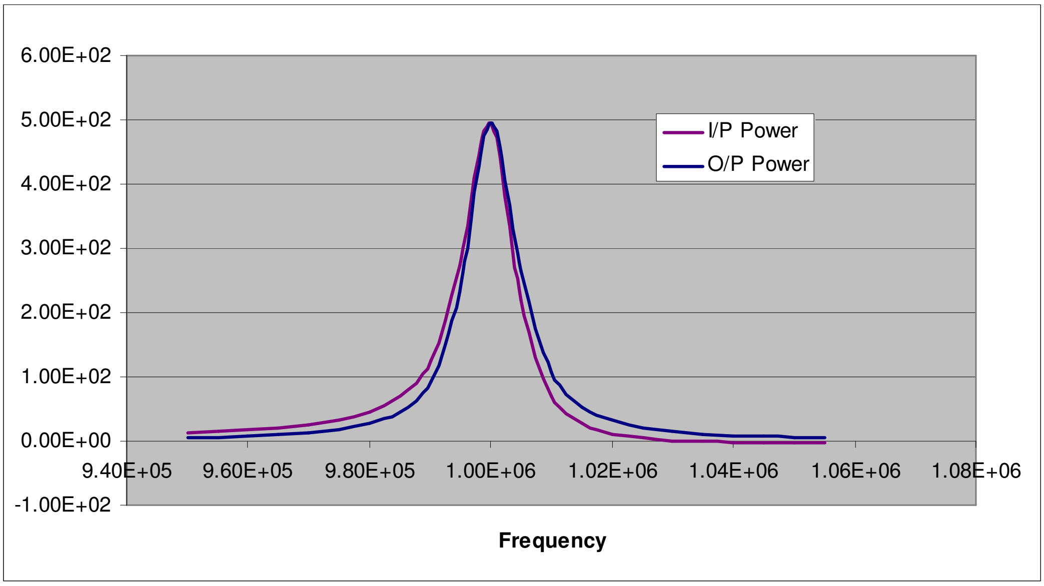

Figure 3.

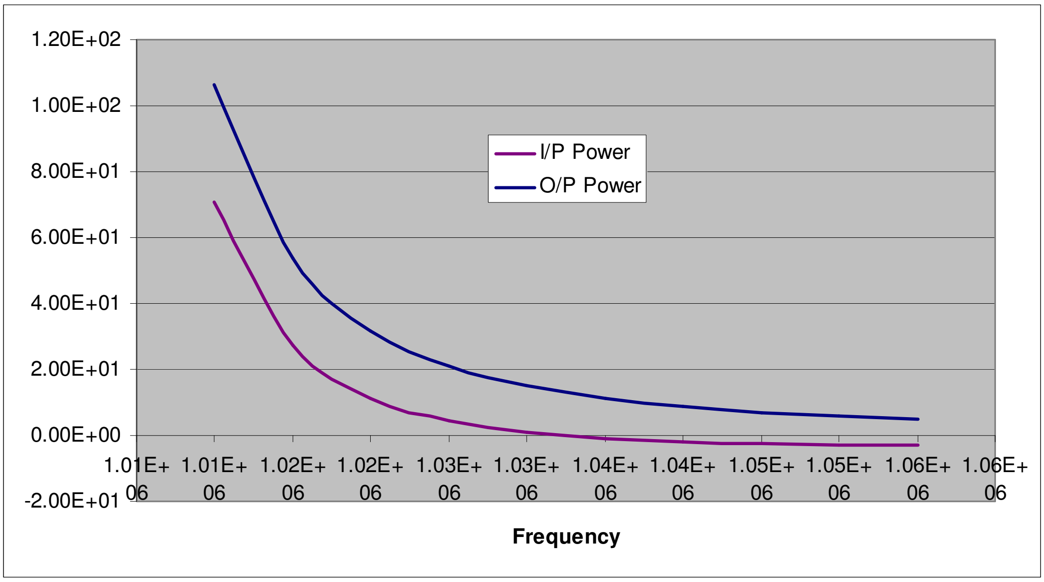

Figure 4.

4. Discussion

Because the output power used in this analysis represents losses, and not useable power, it is very difficult if not impossible to measure in an experiment. It is likely that the trend shown in the figures would be masked by actual loss and would go unnoticed. If say an unloaded Q of 200 could be achieved, then a deliberate load could be applied to bring the loaded Q down to the 100 value used. Then it should be possible to measure useful COP through the resonance range and look for the trend of increased value one side of resonance and reduced value on the other side. Even if due to losses the COP's were all less than unity, that trend would indicate the correctness of the model and the connection to zpe.