Asymmetrical Two Winding Transformer using RLE

This paper will demonstrate the potential gain mechanism with a simple two winding transformer when using the RLE concept to reduce or eliminate the Lenz effect.

Referring to the simulation schematic below in Fig1, we see a transformer T1 with a primary L1 and secondary L2 with a coupling of 0.8 . Notice the measured aid and buck inductances of L1 and L2 but in particular the aid which is 10.46mh. This is larger than the sum of L1 and L2 due to the coupling factor K=.8 of the coils which is primarily determined by their shape and position on the core relative to one another. With equal windings and a perfect coupling of K=1, the aiding inductance would be double the sum of their inductances (neglecting coil resistances). So, in this case if we had K=1, we would measure 11.6mh in the aid mode.

Now let's consider what we would achieve if we could somehow charge each winding independently.

In our example, we will charge L1 to a point of 100ma which requires an energy level of .1^2*2.9e-3/2 = 14.5uJ and save this energy temporarily. Now charge L2 in the same manner for a total energy stored or consumed of 29uJ. If we now connect L1 and L2 in the aid mode with a combined inductance of 11.6mh with 100ma stored in each, we can now realize a combined energy stored of .1^2*11.6e-3/2 = 58uJ or twice the original input energy. The key is to somehow accomplish the independent charging in order to reach a theoretical maximum COP=2.

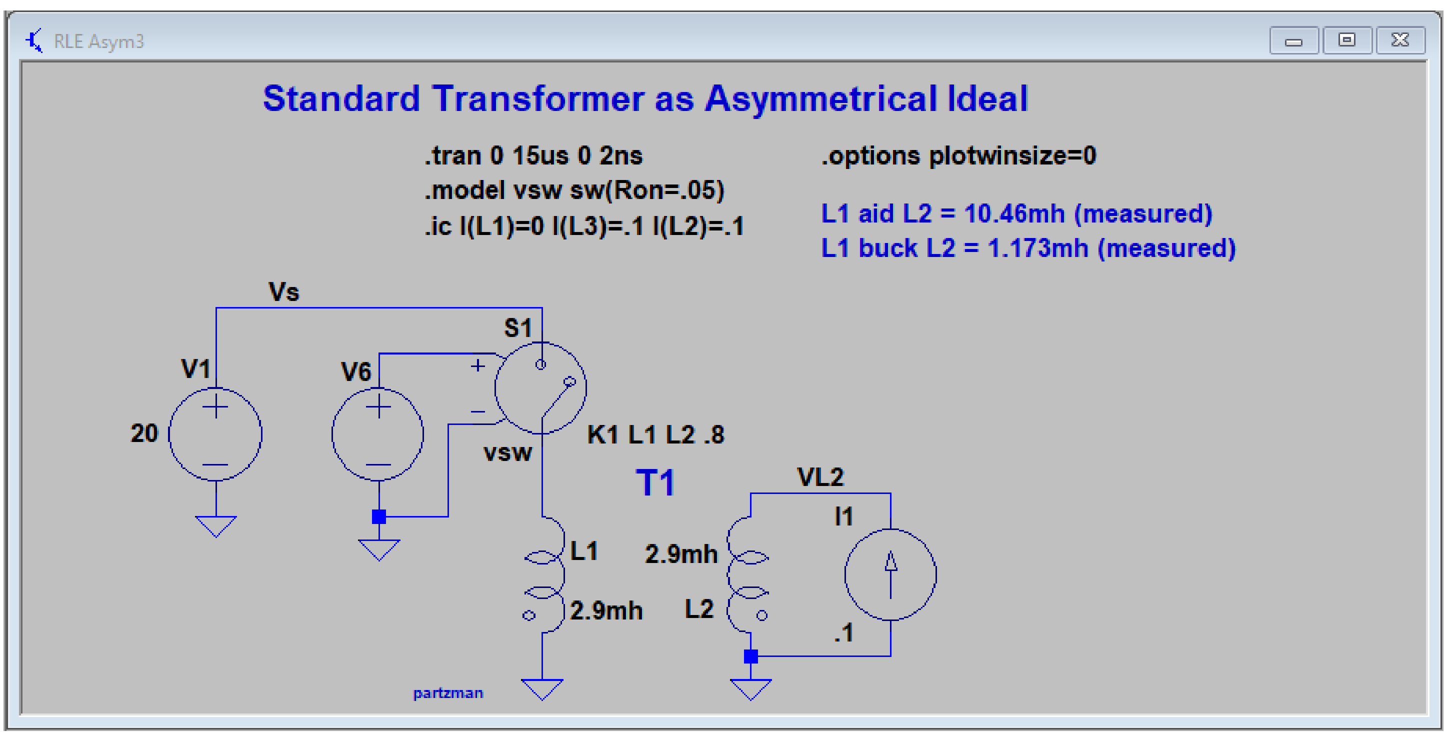

Figure 1

In Fig2 below we see the plot results of the simulation using an ideal constant current load I1 across the secondary L2 which will exhibit no di/dt or current change over time and therefore, there will be no Lenz effect and independent charging of L1 and L2 will be the result.

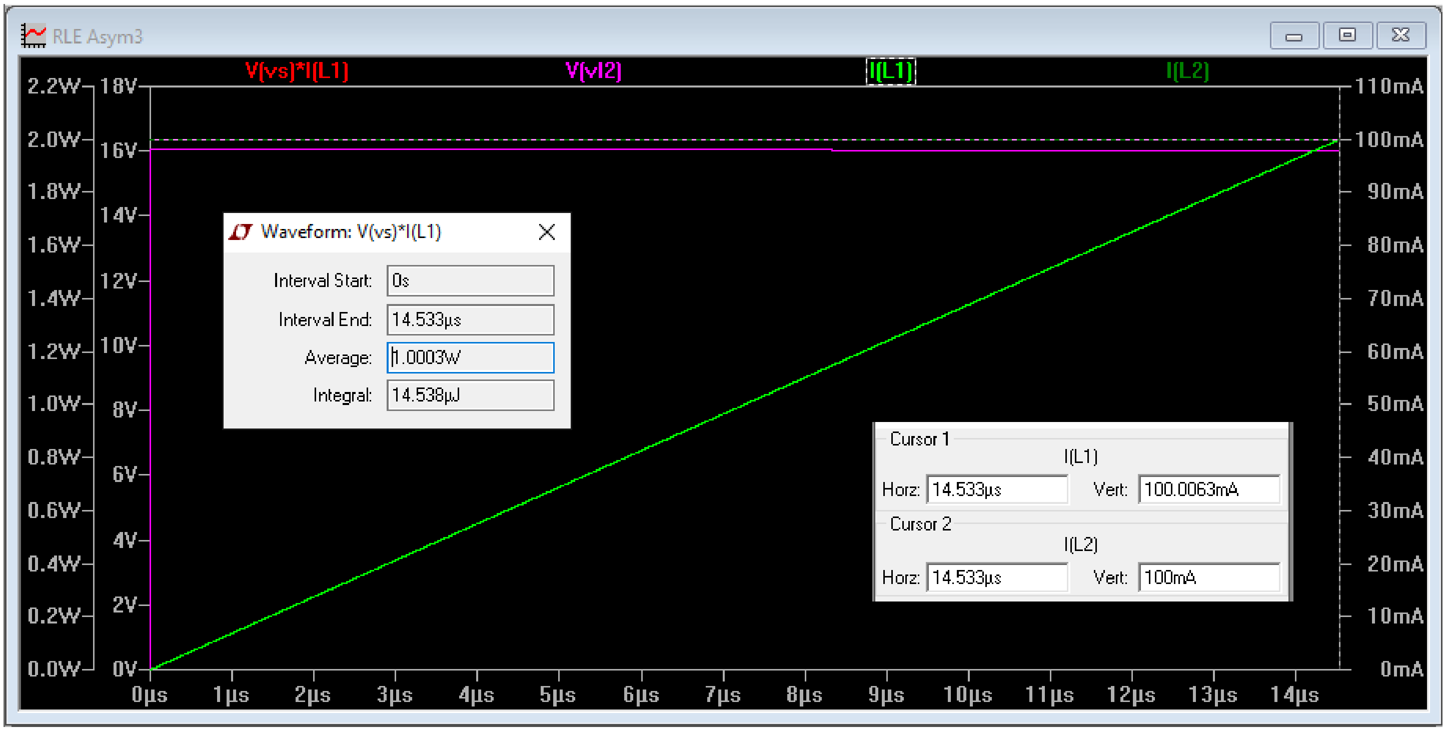

Figure 2

From the plot we first note the peak current of 100ma reached in the primary L1 as indicated with cursor 1 over the period of 14.533us. We can then calculate the effective input inductance as L = E*dt/di = 20*14.533e-6/.1 = 2.906mH. This is nearly the same as the designated value as shown on the schematic which indicates there is no Lenz effect present. The pre-charged secondary current in L2 is also 100ma shown by cursor 2 and maintained by I1 through this same period.

The energy drawn from the 20vdc power supply is measured by V(vs)*I(L1) and shown to be 14.538uJ. The energy required to pre-charge L2 is U = i^2*L/2 = .1^2*.0029/2 = 14.5uJ. The total input energy Uin = 14.538uJ + 14.5uJ = 29.038uJ.

The output energy available with L1 and L2 now connected in series in the aid mode with the resulting inductance of 10.46mH will equal Uout = .1^2*.01046/2 = 52.3uJ. Therefore the COP = Uout/Uin = 52.3/29.038 = 1.80 which represents an ideal overunity of 180% for this coupling factor K=.8 .

The problem with this concept at this point is that our ideal positive current source (conventional current flow) is feeding a positive target. This is not possible with any conventional current source circuitry as far as this author is aware of but, it is possible with a charged inductor with suitable inductance. The next example will demonstrate this.

In Fig3 below, we see the same circuit as before only now the I1 current source has been replaced with a 100mH inductor L3 that is pre-charged to 100ma and is used as the constant current source for the secondary L2. We will now see that although this would provide a solution that should yield similar results to the ideal current source, we will discover a problem.

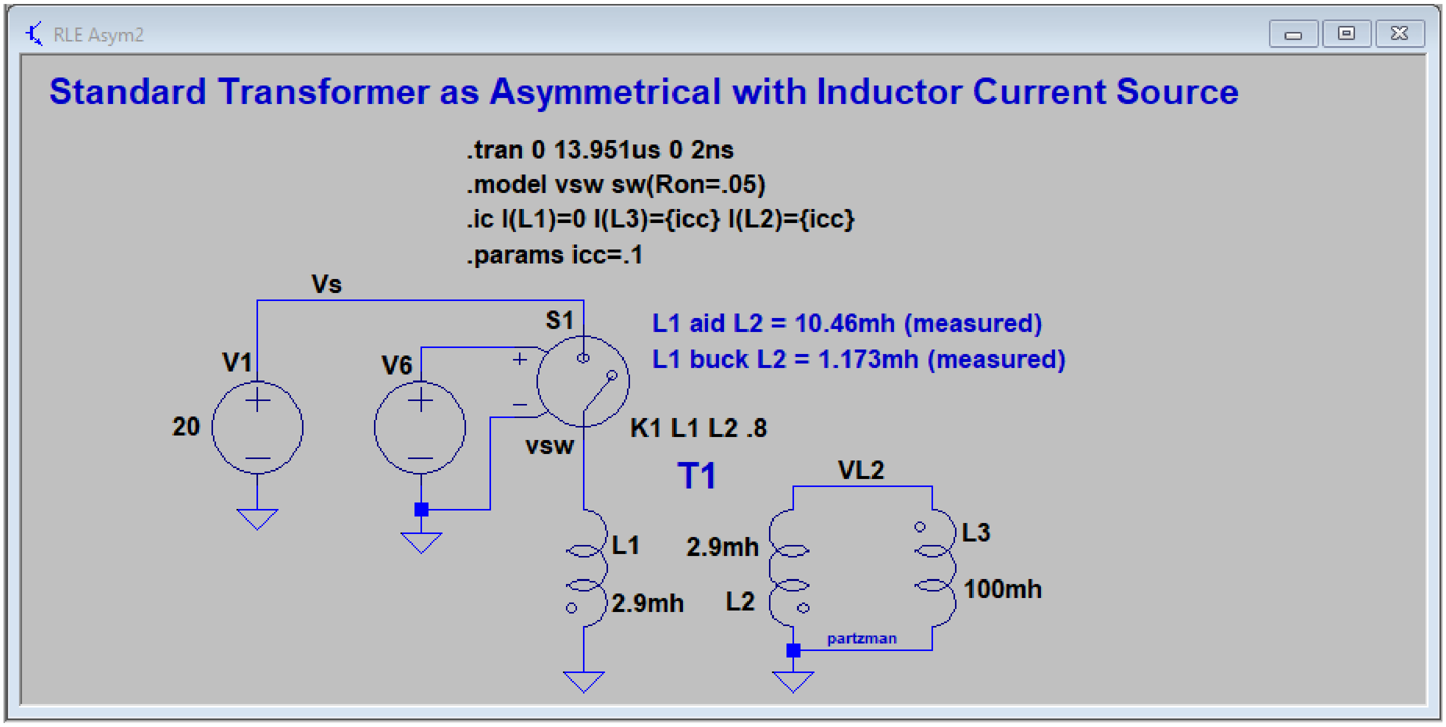

Figure 3

Fig4 below shows the plot results of our new schematic.

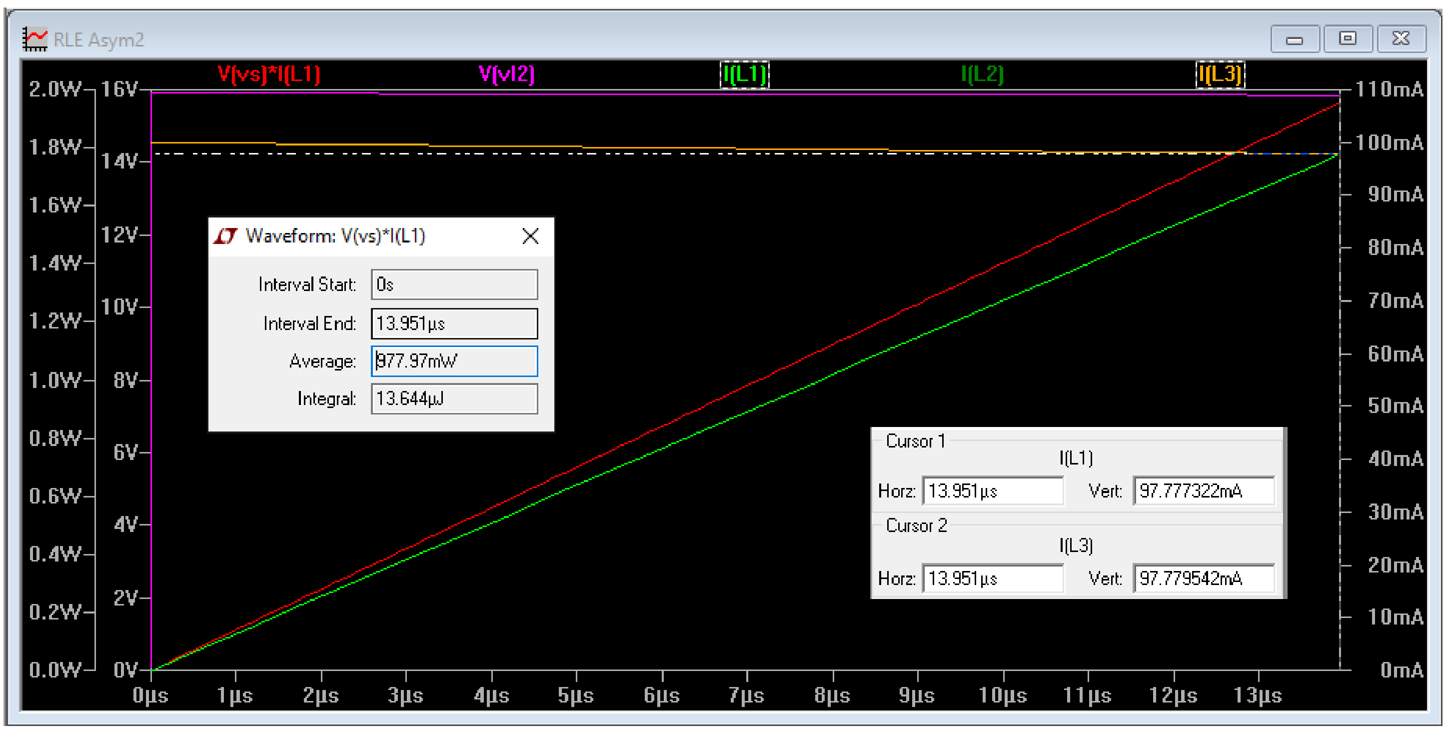

Figure 4

Here we see the peak current reached in L1 with cursor 2 is 97.777ma. So, the effective input inductance is L = E*dt/di = 20*13.951e-6/.097777 = 2.85mH which indicates a slight amount of Lenz effect taking place.

The input energy in this example is 13.644uJ. The pre-charge of L2 is .1^2*.0029/2 = 14.5uJ. So far so good however, we now see that the current in L2 and L3 has dropped to 97.7795ma from the starting value of 100ma. This represents a loss in energy in L2 and L3 but the loss in L2 will be accounted for in our output energy calculation so we will focus on the loss in L3. The starting energy in L3 is U = i^2*L/2 = .1^2*.1/2 = 500uJ . The ending energy in L3 after 13.951us is .0977795^2*.1/2 = 478uJ . Therefore, the loss in L3 is (500e-6) – (478e-6) = 22uJ resulting in a total input energy of 13.644uJ+14.5uJ+22uJ = 50.144uJ .

The output energy from the series aid connection of L1 and L2 is U = i^2*L/2 = .09777^2*.01046/2 = 49.99uJ . The resulting COP = 49.99/50.144 = .997 or less than unity. So what has happened?

The cause of the above result is due to the energy loss in L3 as a result of the voltage across this inductor. In the plot we see the voltage is represented by V(vL2) which is ~15.9 volts average and from this we see that the current lost will be di = E*dt/L = 15.9*13.951e-6/.1 = 2.16ma which is close to the actual loss of 2.3ma. We are ignoring the IR loss in L2 and L3 which would make up the difference.

So, here is the dilemma this project has faced in how to overcome this problem. Much time and effort has been spent to find some form of solution and after many months, a solution was found. This will be the focus of the next paper.

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