Simple Clamp-On Current Transformers

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During the process of running some experiments on coupling between verticals and towers I realized that it would be very handy to have a current transformer (CT) which I could clamp around one leg of a grounded tower. The following is a description of what I came up with. I will describe two current transformers. The first is very simple and a bit rough-and-ready but it seems to work well. The second if much larger and mounted on a spring-clamp assembly so you can just clamp it around a tower leg in a moment.

A simple CT

The first core I chose was Fair-Rite part number 5943003801 toroidal core. I purchased the core from Mouser Electronics, catalog number 623-5943003801. The core has an internal diameter of 1.4" which is enough to go around the legs of a Rohn 25G tower. However, this core is not large enough to go around the legs of larger towers like the 45G or 55G. For that I bought a larger Fair-Rite core (5943015901) from Dexter Magnetic Technologies. The smaller cores cost only about $3 each but the larger one goes for $28. Figure 1 is a picture of the two cores. The larger core has an ID of 2.2".I chose the type 43 Ni-Zn ferrite because it has the highest permeability over the frequency range of interest (1-10 MHz). I wanted to use only a single turn for the secondary and needed all the permeability I could get to maximize the shunt impedance.

The first step was to cut the core. For this I used a Dremel tool with a sacrificial cut-off wheel and also a diamond cut-off wheel as shown in figure 2.

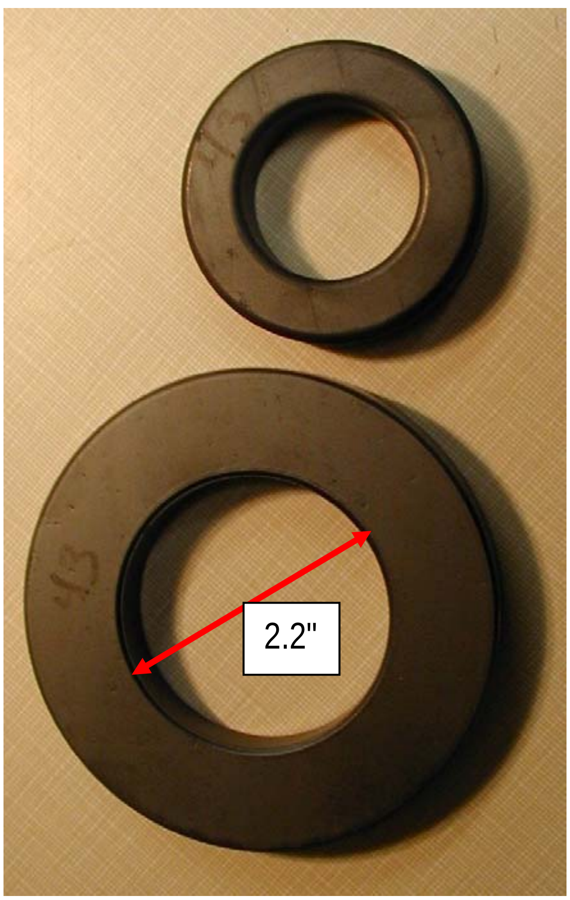

Figure 1, a couple of core choices.

Figure 2, using a Dremel tool to cut the core.

After the core was cut I wrapped a layer of electrical tape around the core as shown in figure 3. The next step was to cut a strip of copper and mount a BNC connector at one end as shown in figure 4.

Figure 3, core half with tape.

Figure 4, secondary winding.

I then bent the copper strip around the core as shown in figure 5 and secured it in place with some tape as shown in figure 6.

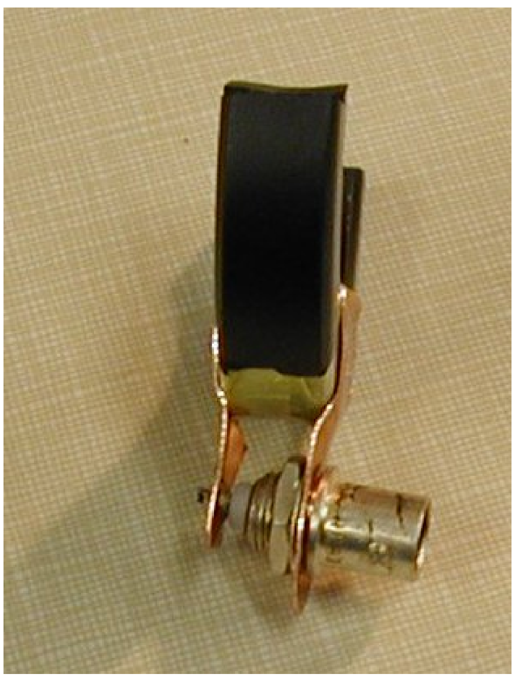

Figure 5, one turn secondary winding.

Figure 6, final assembly of the CT.

The final assembly is shown in figure 6. To clamp the two core halve together I just used a cable tie. For convenience I sometimes use a Velcro reusable tie as shown in figure 7 which also shows the CT installed on a tower leg. Note the CT in figure 7 is an earlier version where I just wrapped a single turn of wire around the core for the secondary. That worked fine but was a bit floppy and fragile. The winding arrangement in figures 5 and 6 is much sturdier.

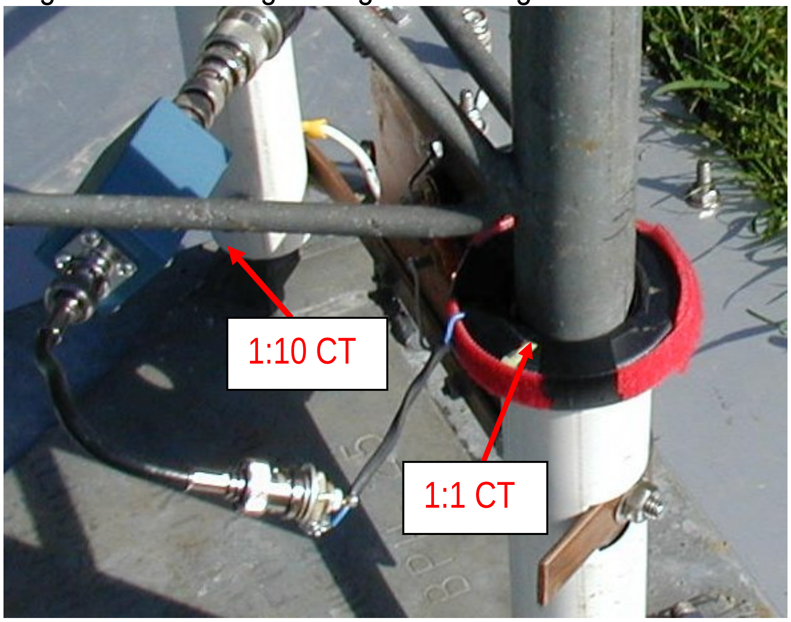

Figure 7, CT around a Rohn 25G tower leg.

There is another CT shown in figure 7. That's the blue box. In the box there is a small 1:10 CT with BNC connectors at either end. I felt this approach was more flexible than winding more turns on the large CT. By using an auxiliary CT I can make up several with different turns ratios to suit the occasion and simply connect the one I want or go straight to the primary of the 1:1 CT around the tower leg.

I measured the impedance of the 1:1 CT secondary on my network analyzer and got the results shown in figures 8 and 9.

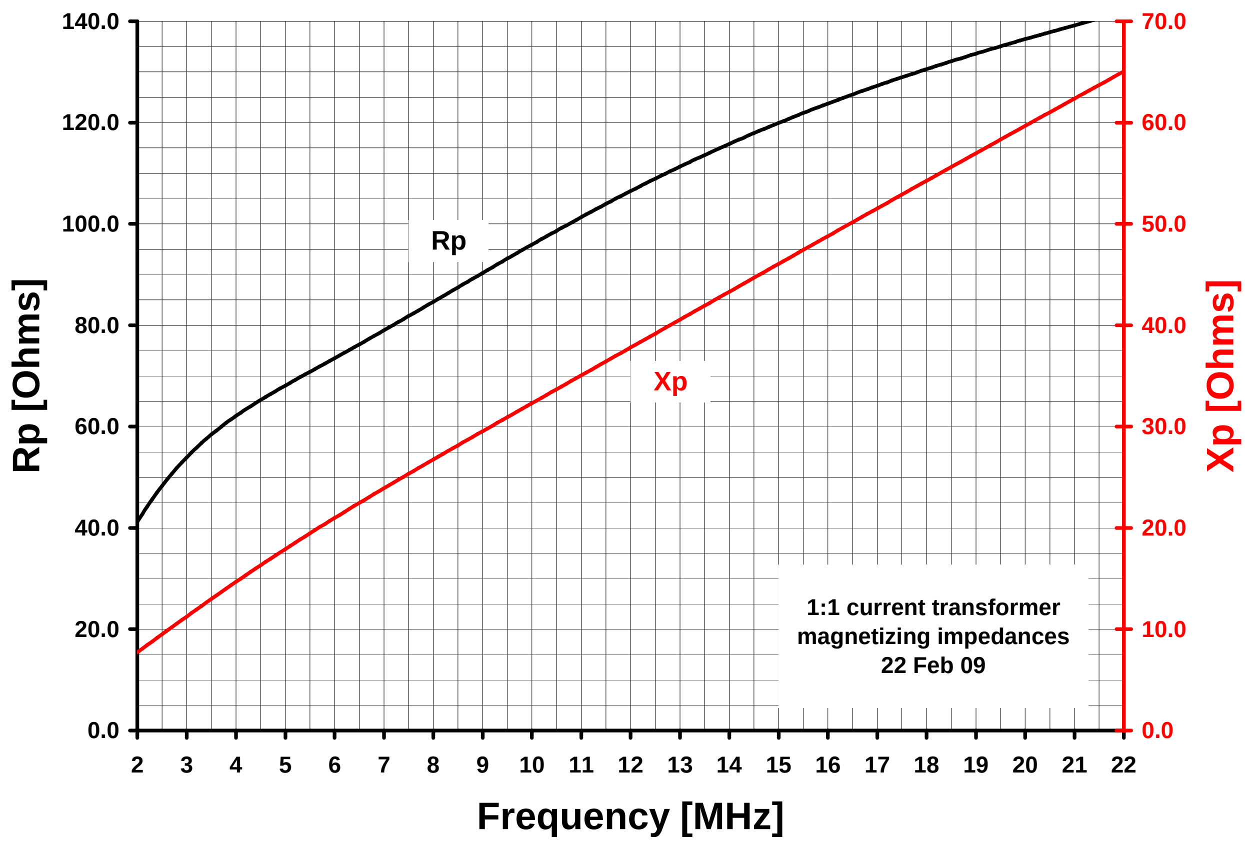

Figure 8, parallel resistance (Rp) and reactance (Xp) for the large 1:1 CT.

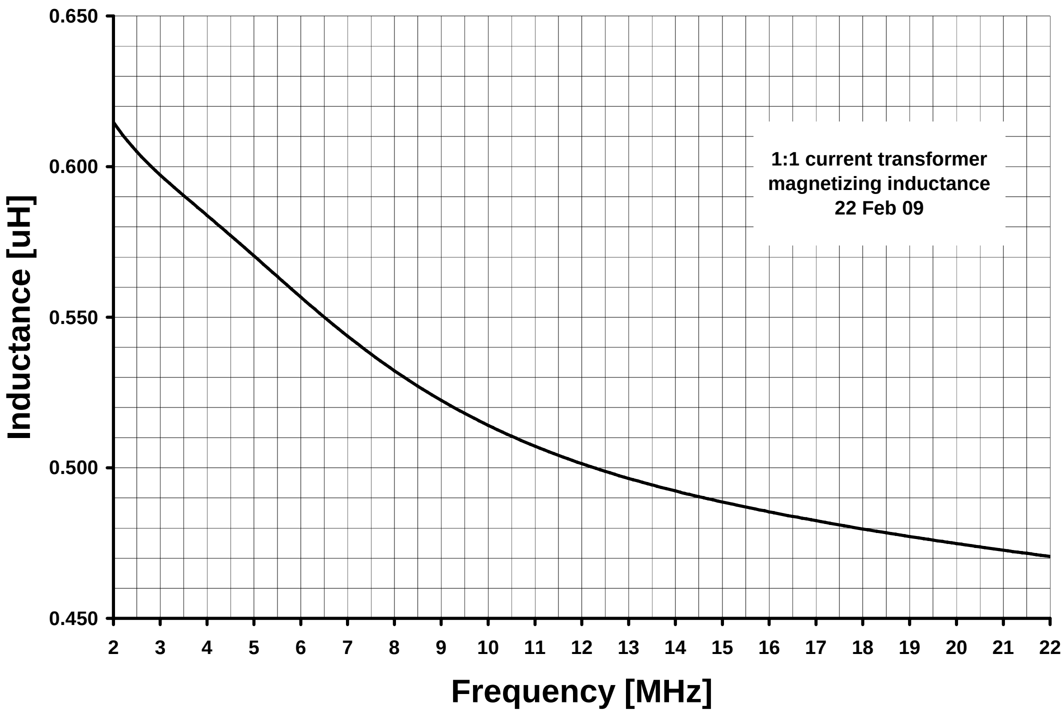

Figure 9, magnetizing inductance on the secondary.

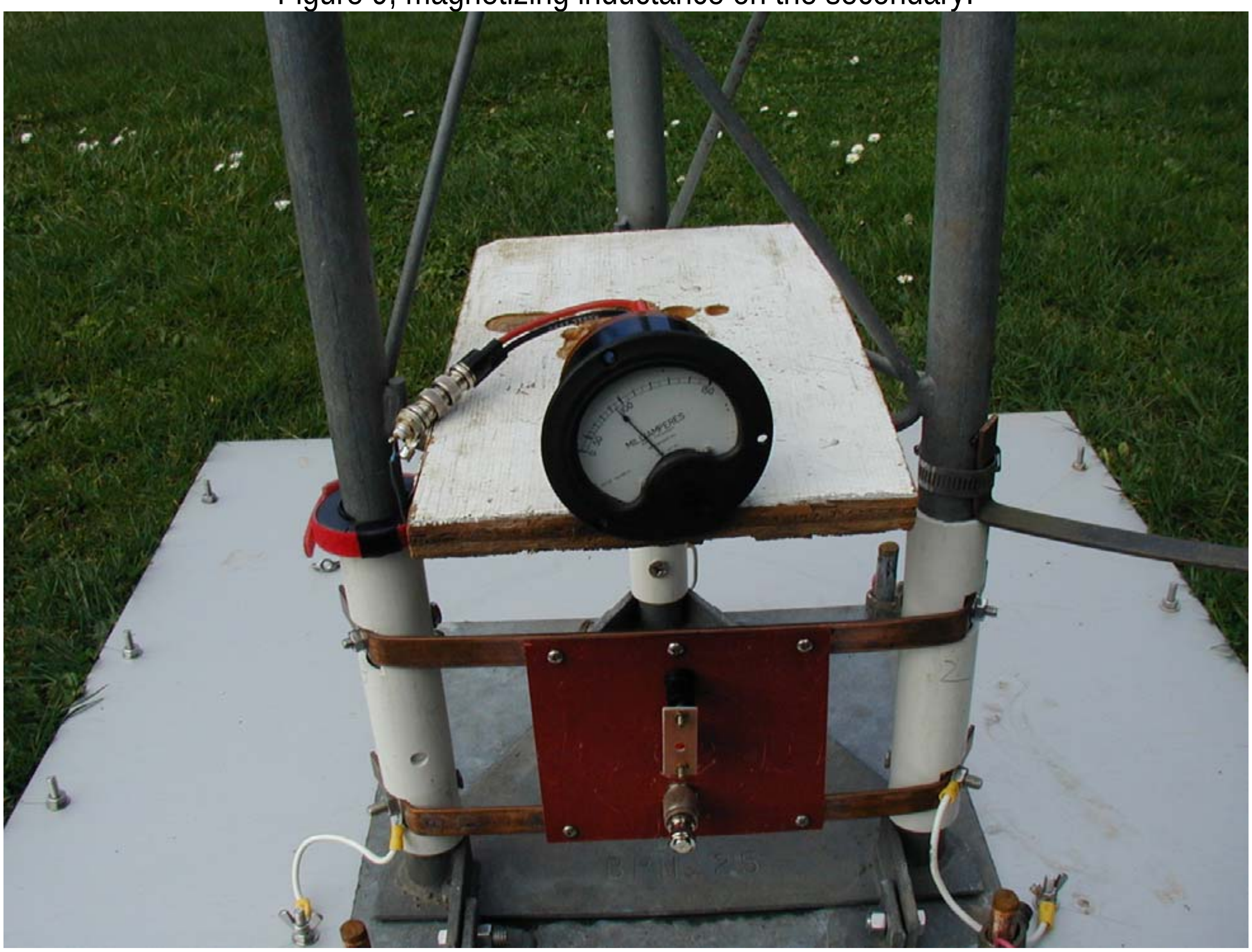

Figure 10, tower leg current when excited from nearby vertical.

One of several tests I ran with the CT around the tower leg is shown in figure 10.
What I was doing in this particular case was driving the nearby (70') 40m vertical at 7.150 MHz with a 100 W. The total current through a RF ammeter at the tower base was about 340 mA. The current through the CT to the RF ammeter was about 90 mA. This is a bit less than a third of the total base current which is no surprise as there is no reason to expect the leg currents to divide exactly in thirds and the current transformer shunt impedance will also reduce the current a somewhat.

With the CT installed as shown in figure 10, I used the ammeter as a current null indicator while I adjusted a trap (a shunt loop with a series capacitor) attached to the side of the tower. You can see just a bit of the loop bracket on the lower right of figure 10. I was able to get a very sharp, -40 dB null right at 7.150 MHz without any trouble. The null I'm talking about here is the coupling from the vertical to the tower. This is a very practical way to tune decoupling traps on grounded towers.

I also tried tuning the null by measuring the current in the trap loop. The idea was to tune the decoupling loop for maximum current. This is the conventional wisdom for tuning this kind of trap (decoupling loop) but it doesn't seem to work too well. The reason is that the current peak is relatively broad whereas the null is quite narrow and, depending on the where the tower is resonant, the peak in the loop current may be at a somewhat different frequency than the null. This means that the null, which is quite narrow, may end up at the wrong frequency. The problem is you are dealing with a double tuned circuit when you look at the loop current. I will discuss this in more detail in a later article after I finish some experiments now in progress.

A larger CT

After working a bit with the CT described above I realized that I needed a CT with a much larger diameter center hole to fit around the legs of larger towers or around a combination of tower leg and wire bundle. Also the use of a wire tie to hold the CT was a bit hokey. It worked but not very easily.

I was inspired by a clamp-on CT built by Greg Ordy, W8WWV. So I got my hands the much larger core (Fair Rite 5943015901) with an ID of over 2" and an OD of just under 4". I also went down to a local woodworkers store and bought a spring clamp. The result is shown in figure 11. As in the first CT I used only a single turn but that's not enough for many measurements so I used an external 1:10 transformer, like that shown in figure 7, when I needed more turns. As can be seen if figure 7, that transformer is quite small being just a signal level device.

Figure 11, clamp-on current transformer.

Conclusion

These current transformers are not objects of great beauty but I've found them very useful in my experiments. There are of course a number of things I haven't tried yet. One for example would be to make up three CTs and put one around each leg with the secondaries in series or parallel. Maybe you can even excite the tower this way with some kind of matching network?