OUTPUT FILTER FOR MY CW 500kHz TRANSMITTER

By Luiz Amaral
PY1LL/AC2BR

Introduction

In the design of my medium wave CW 500kHz transmitter, the output circuit delivers a square wave that must be suitable filtered before going to the antenna. Due the legal rules on harmonics emission, the filter needs to have at least seven poles (four capacitors and three inductors). We will describe just this filter in this article that is one of the applications of the homemade capacitors showed in QEX Jan/Feb 2012.
Due the high inductances involved in that low frequency, it was necessary to use good quality ferrite cores and well adapted for that frequency.
The chosen cores were those used in TV yokes due the information of other articles that presented them as a good choice for HF baluns, with very low loss[1].

The construction

In the present case we needed two 14.9μH wound on two similar cores and one 19.7μH wound on another core model[2].
Figure 1 shows one of the used core, where we see the two ferrite halves and two mounting steel clamps.

FIGURE 1

[1] **For example see the article here: http://py2wm.qsl.br/balun/Balun_with_free_ferrite.pdf**
[2] **It is not easy to get new yoke ferrite cores then I used some from scrap. However it is difficult to get surplus yoke cores with the same shape and size. My friend, Celso, PY2TS, got them for me.**

Figure 2 shows the drawing of a typical yoke ferrite core with its many dimensions.
Here ETD means External Top Diameter, ITD Internal Top Diameter, H Height, EBD External Bottom Diameter and BT Base Thickness.

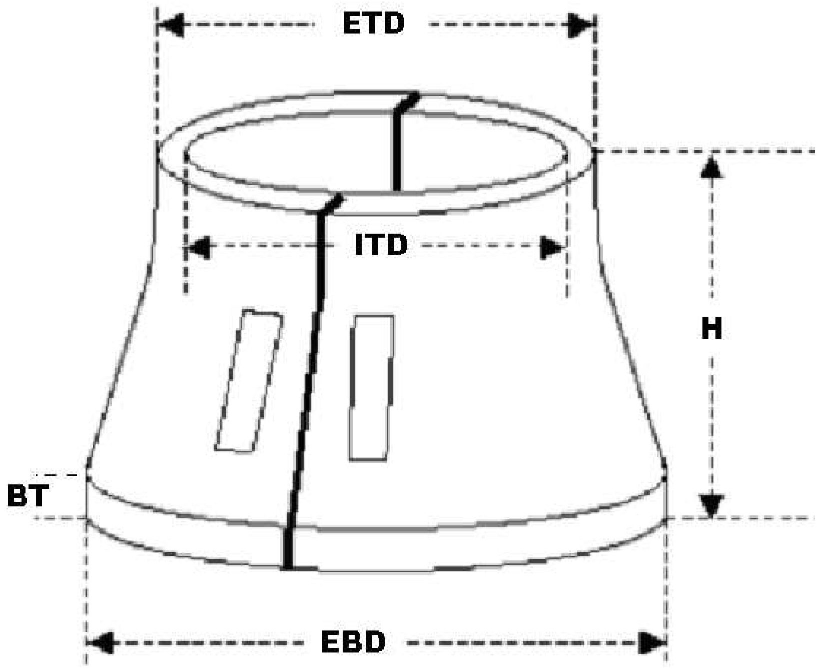

FIGURE 2

For the 14.9µH inductors, the dimensions are: ETD = 60mm; ITD = 47mm; H = 43mm; EBD = 91mm and BT = 4.5mm; Their AL values are 414 and 400.
For the 19.6µH inductor, the dimensions are: ETD = 60.5mm; ITD = 47.5mm; H = 43mm; EBD = 89mm and BT = 5mm. Its AL value is 400.
The used wire for the three inductors were rigid 2.5mm diameter copper hemmed with plastic used in electric installations.
The inductance values were measured with a LRC meter SmartTweezer® model ST-AD rev. 3.
Although with identical dimensions, the two first cores present slight different AL values and this resulted in six turns without gap on the AL = 414 core and seven turns with gap adjusted with Teflon® tape used by plumbers for the AL = 400 core. The 19.6µH was made with seven turns without gap. Gaps are used because numbers of turns are integers or at least half-integers and fine adjust are not possible by changing them.
The AL values were determined for each core by winding three turns and using the expression:

$\mathbf{AL = L / n^2}$, where **L** is the inductance measured in nH and **n** the number of turns, fixed in three at the present case.

So, AL values are given in nH/turn^2, as it is conventional in the pertinent literature. For fixing the inductors in the metallic filter box, I used plastic discs and bolts with nuts[3]. The original bolt had a ring on its head is shown in Figure 3. This ring was cut off as in Figure 4, where the plastic washers are also shown.

---

[3] The plastic bolt is one of those used for mounting toilet covers, very easily found.

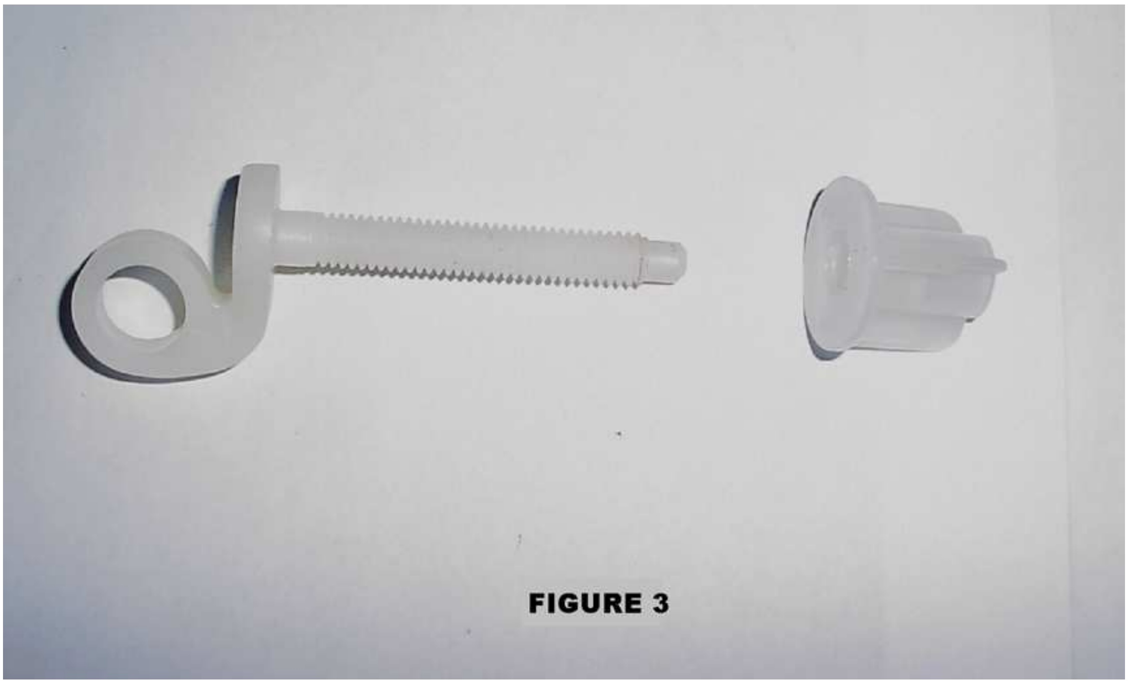

FIGURE 3

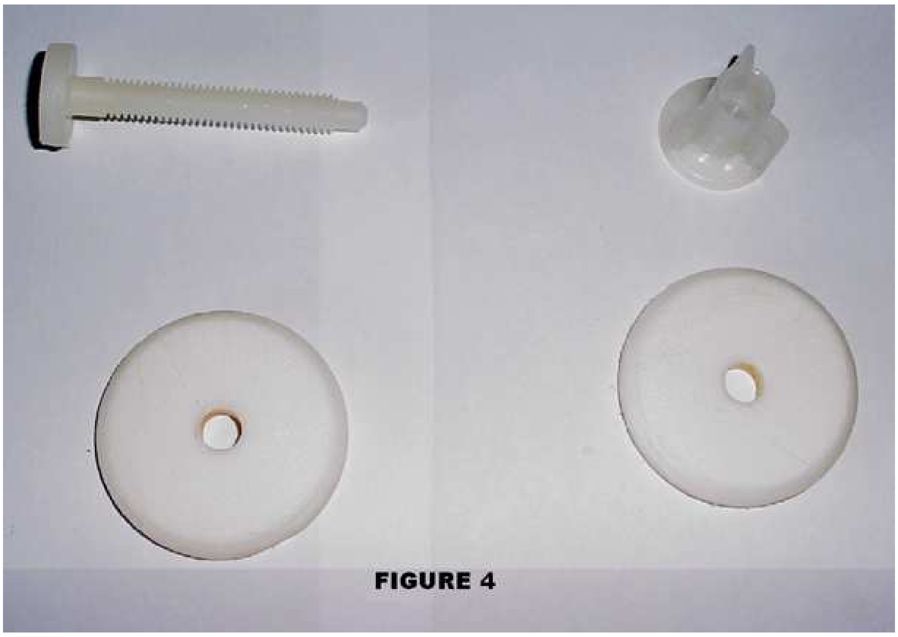

FIGURE 4

Note the (45° to 60° angle) bezel at the rim of the plastic washers. These bezels are used for adjusting the washers on the wires of the inductors.
For correctly fixing the inductors I used an open circuit second winding only to balance the pressures and make the centering easier (using the washer bezel), as in Figure 5.

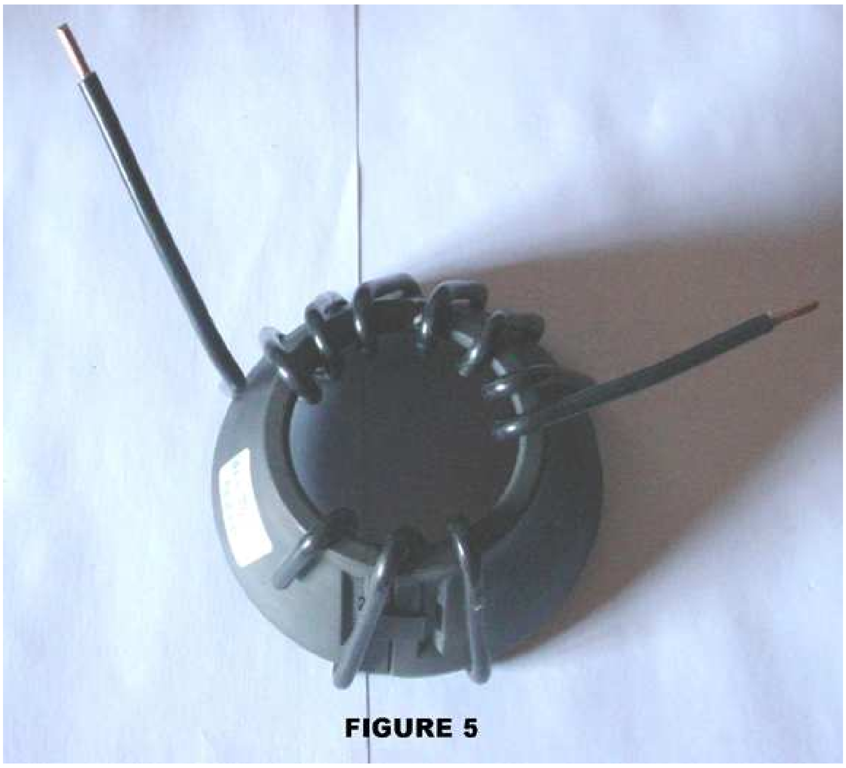

FIGURE 5

The top turns are the inductor itself and the bottom ones are the open circuit windings used only for centering purposes, with the external and internal washers as in Figures 6 and 7.

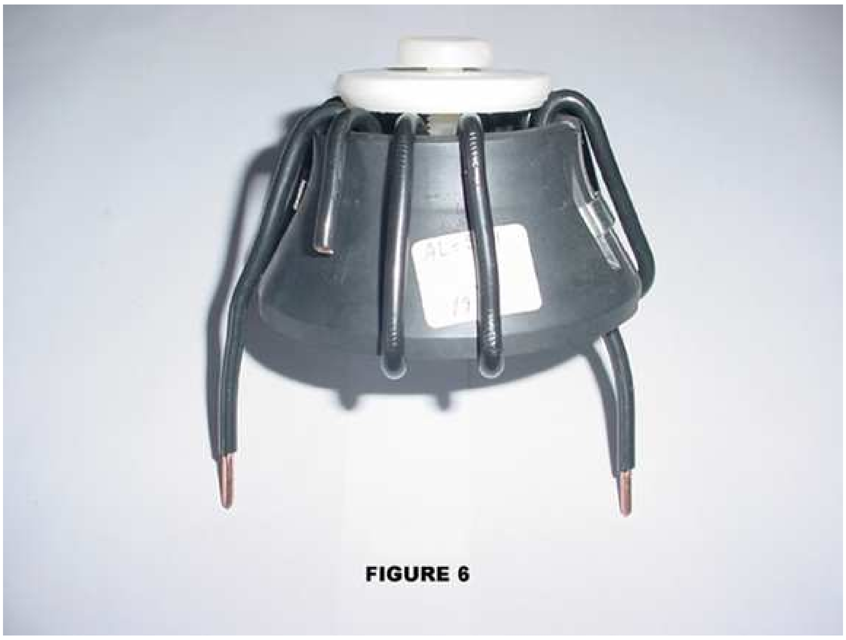

FIGURE 6

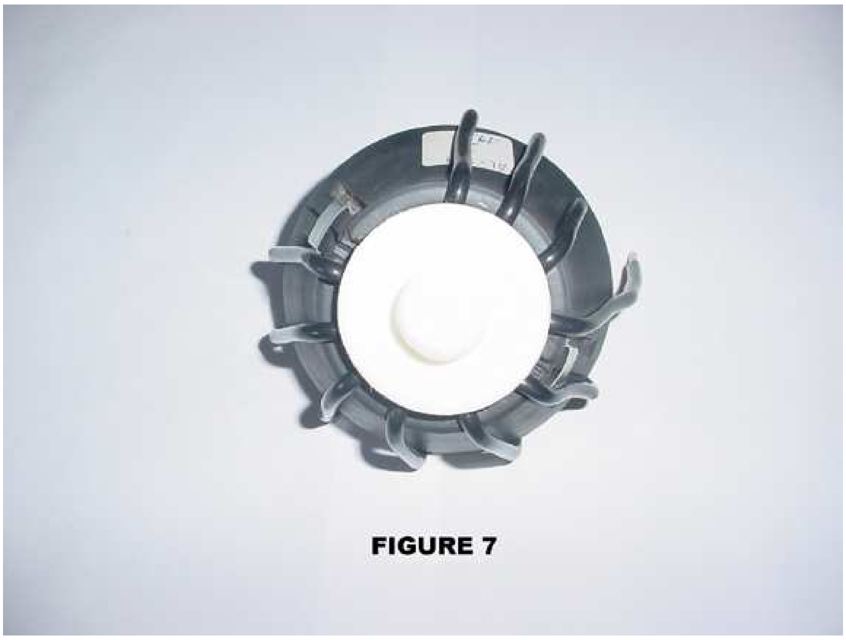

FIGURE 7

Something important is that inductance measurements were performed very close to metallic plates, including iron, and their values were not altered, showing that the dispersions are meaningless.
So, it is possible to assemble the filter within metallic boxes, even iron made, without affecting the results.
The little dispersion also permits that the inductors can be mounted in any relative position with no mutual coupling among them, something that would alter the response curve of the filter.
Figure 8 shows the three inductors wound, but still with no extra centering turns.

FIGURE 8

FIGURE 9

The filter aluminum box with its cover is shown open and with no components in Figure 9. We can see the eight metallic L's for fixing the filter capacitors, the plastic bolts for the inductors mounting with the bottom centering discs and the input and output PL-259 (UHF) with a copper bar connecting their grounds for better conductivity and where the capacitors ground terminals are soldered.
Figure 10 shows the box open but with all components mounted.

FIGURE 10

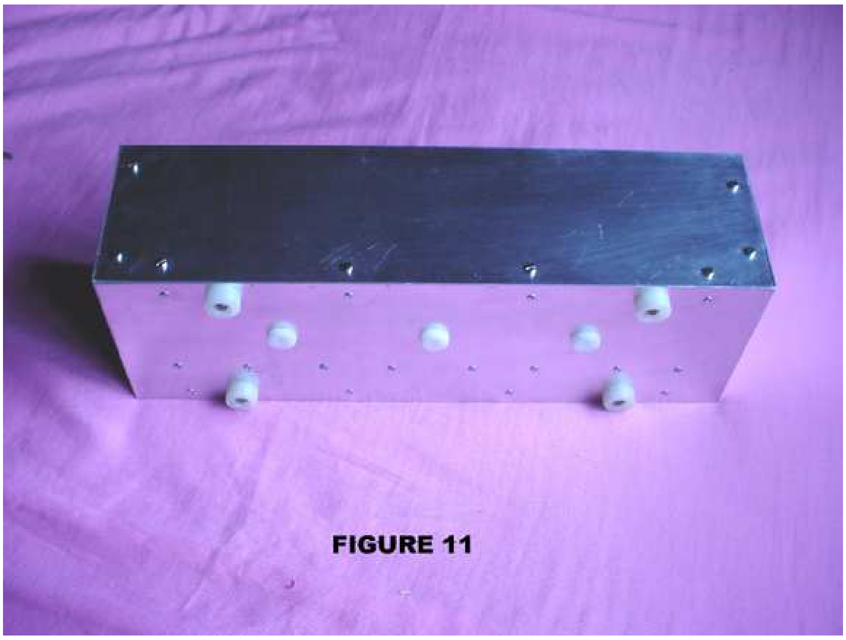
FIGURE 11

In Figure 11 is the bottom view of the box already closed, where we can see the plastic feet. Figure 12 shows the filter box view in normal position. Its dimensions are 45cm x 15cm x 12cm and aluminum made.


FIGURE 12

The filter diagram is shown in Figure 13 and its response is shown in Figure 14. The program ELSIE for LC filters was used for the calculations.

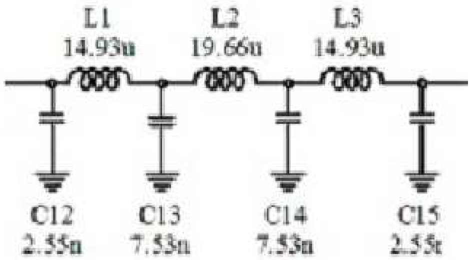

FIGURE 13

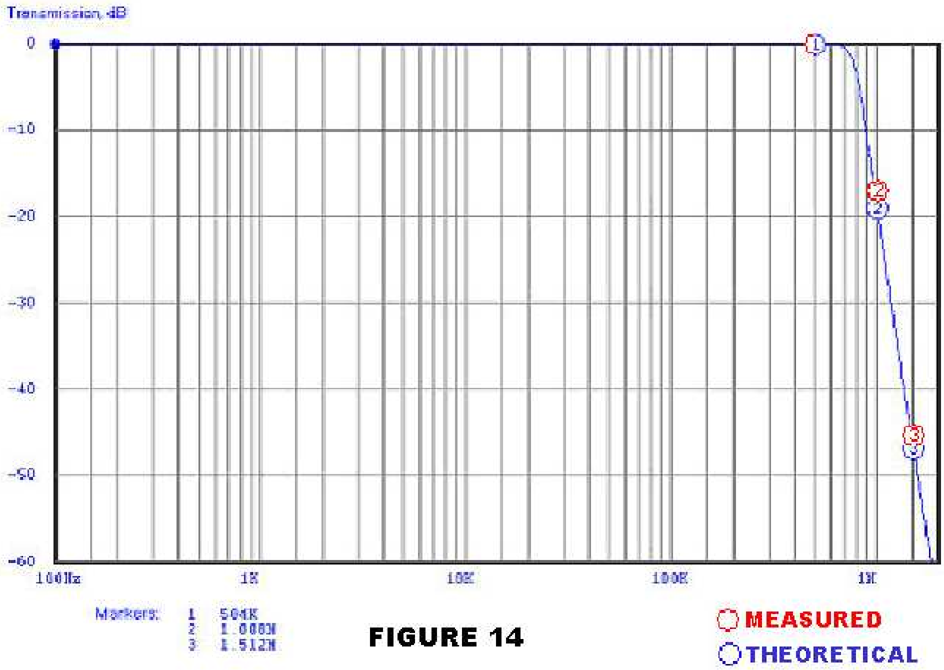

FIGURE 14

Figure 14 shows the theoretical result besides the measured one so that a very useful comparison can be made. The results were performed with 50Ω in the load and generator and with the filter box closed.

The measured values are: point 1, 0dB; point 2, -17.9dB; point 3, -46dB. Note that the square waves have negligible even harmonics but, even so, the attenuation in the region of 1MHz was 17dB.

The used equipment were a function generator MINIPA® model MFG-4202 with 50Ω output impedance and an oscilloscope HITACHI® model V-223.

The reflected impedance at the filter input in the passband when loaded with 50Ω was also 50Ω. The confirmation of this fact was performed by measuring the generator output voltage with and without the loaded filter. The loaded voltage was exactly half of the unloaded one.