# New better build of the STEAP TPU 2021

by

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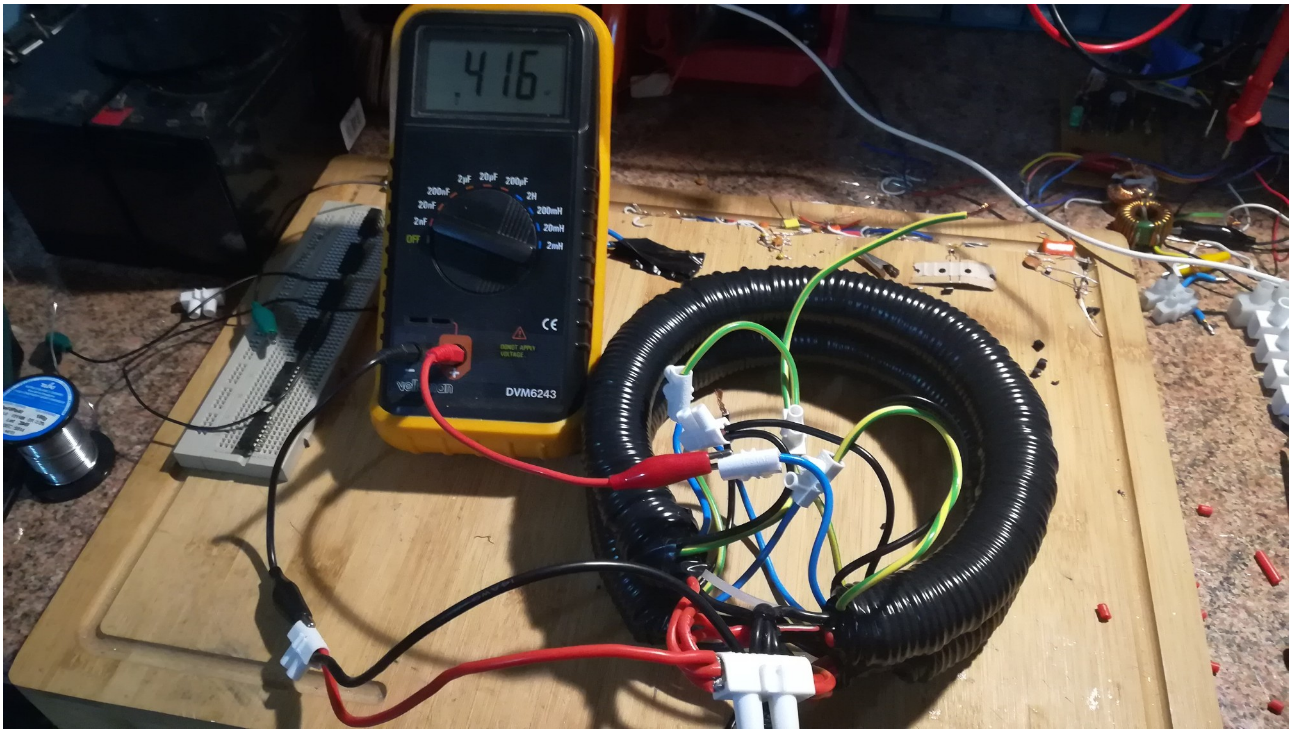
Slowly I am building a better TPU now that I understand the inner workings of this unit. Here I am going to document the build, first some photographs to help understand the toroid itself.

This is the collector core loops and the first solenoid wound over the top. The white/transparent looking wire is a piece of nylon wire guide as used for pulling wires through tubes, it is there as a support and former only.
The second and third coils are wound over the top of this in the same direction and the same length from start to finish (not wire length but coil length, same number of turns). The gap is 5cm, 2” which is for making connections without causing possible arc over due to HV.

All the core loops in the end are connected together to create the ground plate of the C1 capacitor, the inside of the solenoid coils form the other plate of C1.




Above shows both top and bottom toroids finished, each toroid measures 12,5cm ID and 18,5cm OD. This is not two TPU's but a reduction in diameter, the top and bottom solenoids are connected as though a continuation of each solenoid, such as "a to a1" etc. the join is the centre tap connection ( see schematic). All the loops (cores) are joined together forming the ground of the toroid ONLY. Shown on my capacitance meter is the "OVERALL" capacitance from the core to the coils, the individual capacitance from each solenoid layer is shown below.

1st coil (a,a1) to core is 0.340nF
0.70nF
2nd coil (c,c1) to core is 0.270nF   0.35nF by differential calculation
0.35nF
3rd coil (b,b1) to core is 0.235nF

Other measurements are inductance from the Mosfets "A" and "C" drains to the "B" drain.

0.067mH and 0.056mH accordingly and so giving a on its own an inductance of 0.011mH, I have measured this out of curiosity because this forms an inductive reactance delay between the "A" and "C" discharges.

The resonant frequency of the TPU is very difficult to measure with an oscilloscope, as many have found. By measurement and calculation an idea can be obtained.

0.340nF & 0.067mH gives us 1.054MHz
0.270nF & 0.067mH 1.183MHz
0.235nF & 0.067mH 1.263MHz
1kHz by differential calculation
0.340nF & 0.056mH gives us 1.153MHz
0.270nF & 0.056mH 1.294MHz
0.235nF & 0.056mH 1.387MHz

Now is it coincidence or not that the overall beat frequency by differential calculation between "a" and "a1" comes to exactly 1kHz.

When SM was talking about frequencies and mixing, he really was talking about timing, what a drummer does in a musical group, the BEAT to the music.

The frequency does not really matter, the toroid will run at its natural resonant frequency as long as it is pinged considerably lower than that natural resonance. It is the beat that you are looking for, like below.

| | | |
|---|---|---|
| "A" 5000Hz | | |
| | 5507.83Hz | |
| "C" 10507.83Hz | | 7.83Hz |
| | 5515.66Hz | |
| "B" 16023.49Hz | | |

The input frequency WILL NOT AFFECT THE RUNNING FREQUENCY, the running frequency will be the natural resonance frequency of the LCR at that point of entry. What it does affect is the timing, or phase, between the resonant points of entry when the duty cycles are adjusted. With the TPU we are looking at DISCHARGE times in relation to the frequencies, not the Mosfet ON times, it is the allowed natural resonance time, so at "A" it will have more time than at "C", as shown in the charge and discharge drawing of the sequencer pulses.

After a wasted morning doing tests and finding a bad SG lead giving some unexpected persistent results, I have started doing more resonant tests on this new TPU. This time I have used conventional tests with and without C2 at both the "A" input coil and the "C" input coil, the results are shown below. (they are as close as I can get because the difference is so small between "A" and "C" with and without C2+grd.

A sweep of 60MHz was made with a sine wave between inputs and loop ground with the b1 coil end left unconnected, (without C2), and then with C2 connected to b1 and ground loop.

"A" to loop ground 27.78MHz+-
"A" " " " with C2 to ground from b 28.57MHz
"C" to loop ground 27.78MHz +-
"C" " " " with C2 to ground from b 28.57MHz

The difference is so small between "A" and "C" that I can't measure it.

As can be seen C2 @ 0.22uF creates a 0.79MHz difference.

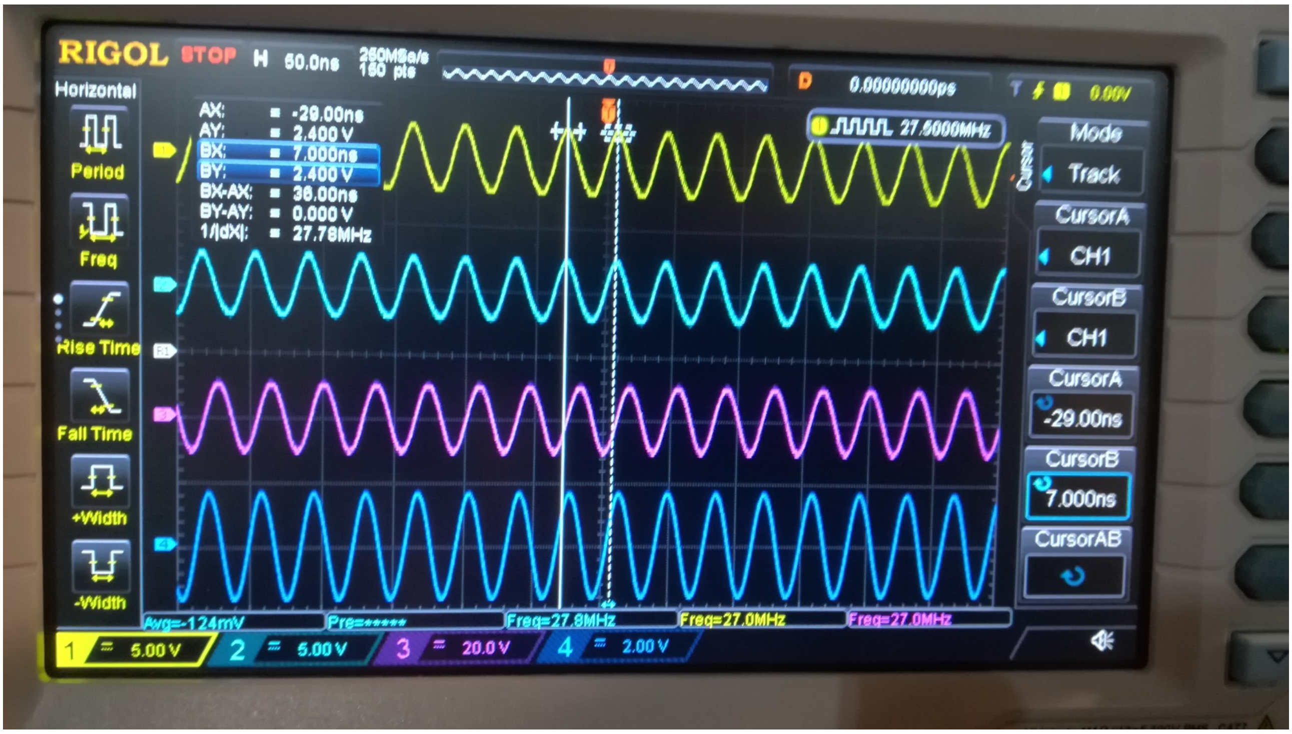
The difference between the calculated resonance and the measured resonance is huge! Well it can only be put down to the complicated C1 capacitance which a calculator can not envisage, but running a sine wave parallel can pick up the peak amplitude, which is what I have done.

The TPU will resonate at whatever it has as an LCR in it's build, so each build will be different, but what will be ALWAYS the same is the ratios as stated at the beginning. As I have with this new build a resonance (without C2) of 27.78MHz, I will use as my "base" frequency for "A" as 2.78kHz, "C" as 5.56kHz and "B" as 8.34kHz, and tune with appropriate duty cycles.

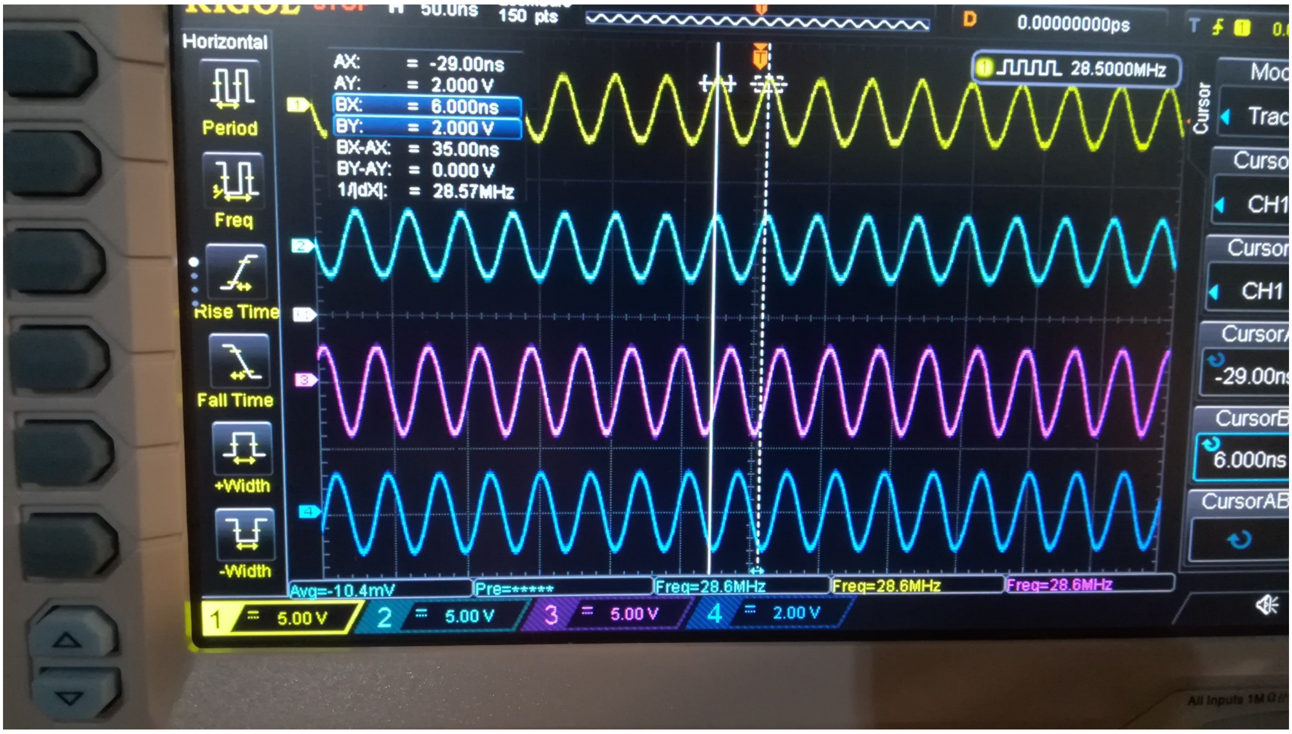

On this scope shot you see on the top right the SG frequency, 27.71MHz at 5v for a maximum amplitude wave at resonance, AY= 2.52v peak, with a resonant frequency of 27.78MHz. Other resonant frequencies were noted below this frequency at sub harmonics, eg. 13.89MHz, but the 27.78MHz has the highest amplitude. This was done at “a” and also at the joint of “a1” and a”, the result was the same, but inputting at both at the same time with the same frequency gives the following scope shot.


Here you can see the delay caused by the inductive reactance of coil “a”, note the frequencies are the same, and the SG was set to zero degree phase shift for both signals.

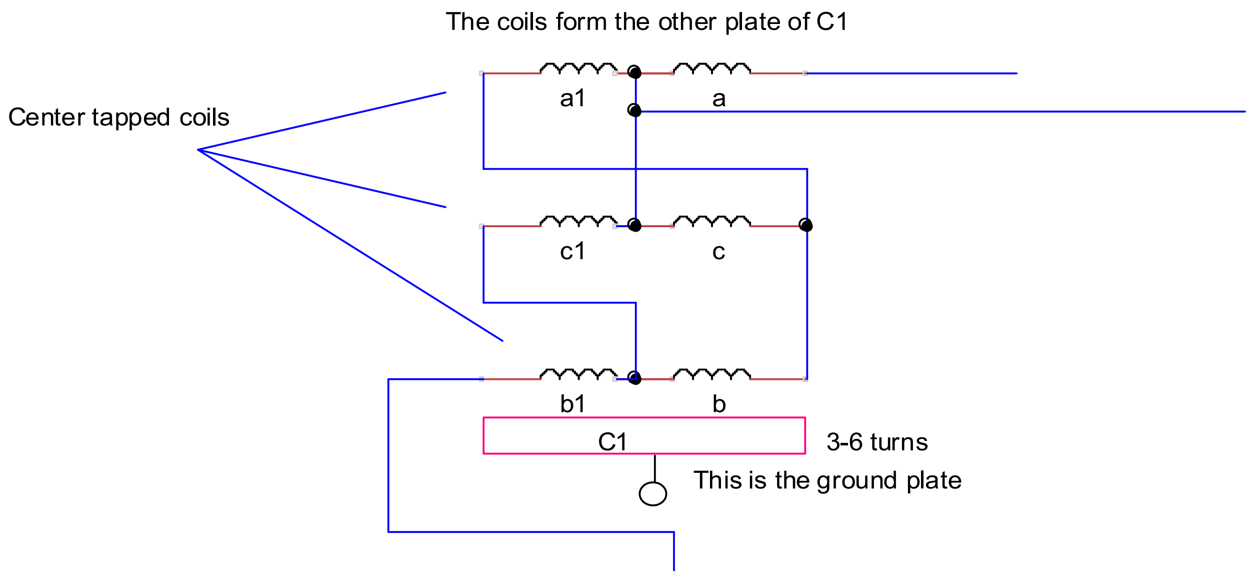
The following scope shot is showing the 4 signals along the TPU, the first two are as in the previous scope shot, but separated. The pink is between “c1” and “b1/b”, the blue is at the end of “b1”, no other connections are made to Mosfets or charge chokes, only C1 and the coils.




The next scope shot is with the addition of C2 and connected to loop ground, so the higher frequency of 28.57MHz.




Note the delay line effect to the signals, now if T1/2, T3 and T4 were laid over one another what do you see!! and you are only looking at 1/27,000,000 or 1/28,000,000 +- of a second in the OFF time of “A” and “C” Mosfets, so you will have to calculate the number of peaks with relation to the OFF time.


The coils form the other plate of C1
Center tapped coils
a1
a
c1
c
b1
b
C1
3-6 turns
This is the ground plate