1. <u>ECD V3.0</u>

1.1 NEW CC TECHNOLOGY

This ECD has been built incorporating the last technology about the Control coils and Mobius ring.

The CC implementation in this case has been optimized in order to reduce the amount of heat generated while delivering continuous power to the lamp load (about 70 – 100W). The new design does provide:

1. segmenting,
2. layering.

In particular the 3 Control Coils are now wounded using 4 segment and 4 layers as in following figure where you see just a single layer 5 segment coil on the annular cork support containing inside the 6"Mobius (you can see the two –two-wire lamp-cord protruding outside from left.

<u>CC specifications:</u>

Coil Primary	
Wire type	Copper enameled wire 0.75 mm diameter (AWG 21)
Wire lenght	5 m.
Number of sections	5
Number of layers	2
Winding direction	CCW

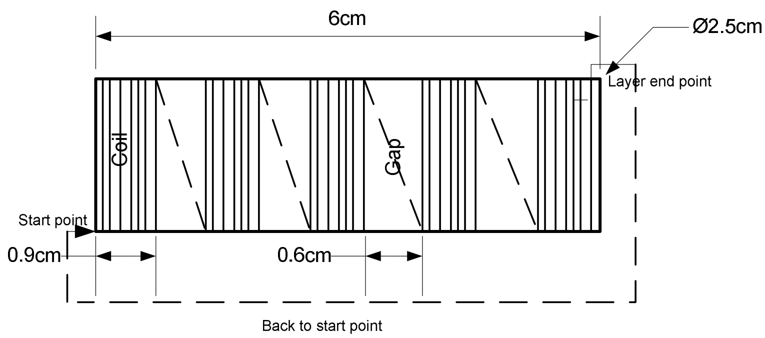
Coil Secondary	
Wire type	Copper enameled wire 0.4 mm diameter (AWG 25)

Wire lenght	10 m.
Number of sections	5
Number of layers	2
Winding direction	CCW

So there are a total of 4 layers as the secondary is double of the primary.

Winding instructions

As in fig you have two prepare two piece of wire according to the tables and run them parallel creating 5 small bunch of turns. At the end of the layer you have to run the wire back to the start point, apply a black scotch isolation tape and then run the second layer, the third and the fourth final layer. Of course the smaller (primary wire will end approximately at the end of the second layer …no problem).

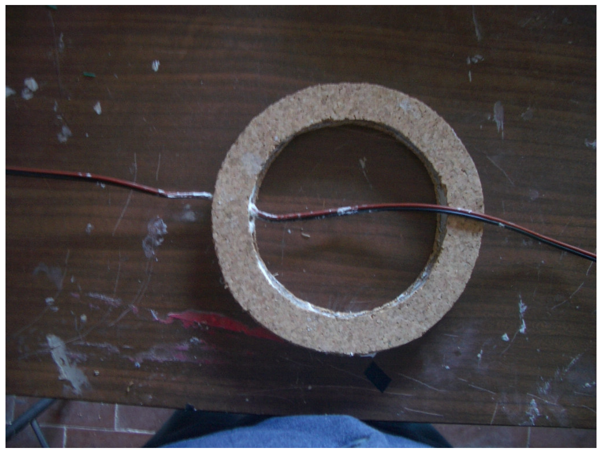


At the end you obtain 3 CCs spaced by 120 degrees like in following figure

Note: Taking as a start point the Mobius output leads, the CCs are placed in a CCW way.

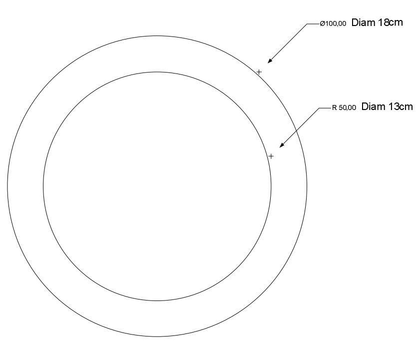
1.2 NEW MOBIUS COLLECTOR TECHNOLOGY

The new collector this time is not one turn but 5 turns of lamp-cord wire. The reasonn behind that kind of choose is <u>to enhance the difference with the smaller loop </u>as the smaller loop is there just to 'create' a difference and so a bigger potential gradient. The wire is wounded like a pancake coil in the sense that the turns are coiled horizontally and are glued onto an annular Cork support (both lower and upper) as in following figure.



The protruding wires are the coil start/end. The cork material function is to allow for coil vibration.

Mobius collector	
Wire type.	Copper multi-stranded lamp wire 1.5 mm diameter (each wire).
Turns number	5
External annular support diameter.	18 cm
Internal annular support diameter.	13 cm.
Winding direction	CCW



Note: the coil is set to the centre of the annular support and glued on it with just a little of silicon adhesive paste.

Final assembled ECD is like this:

You can see that the smaller loop is supported by a PVC tube in order to get it fixed at 44mm. of highness respect to the bigger lop inside the cork. On each CC there is provision for connecting the coils wires.

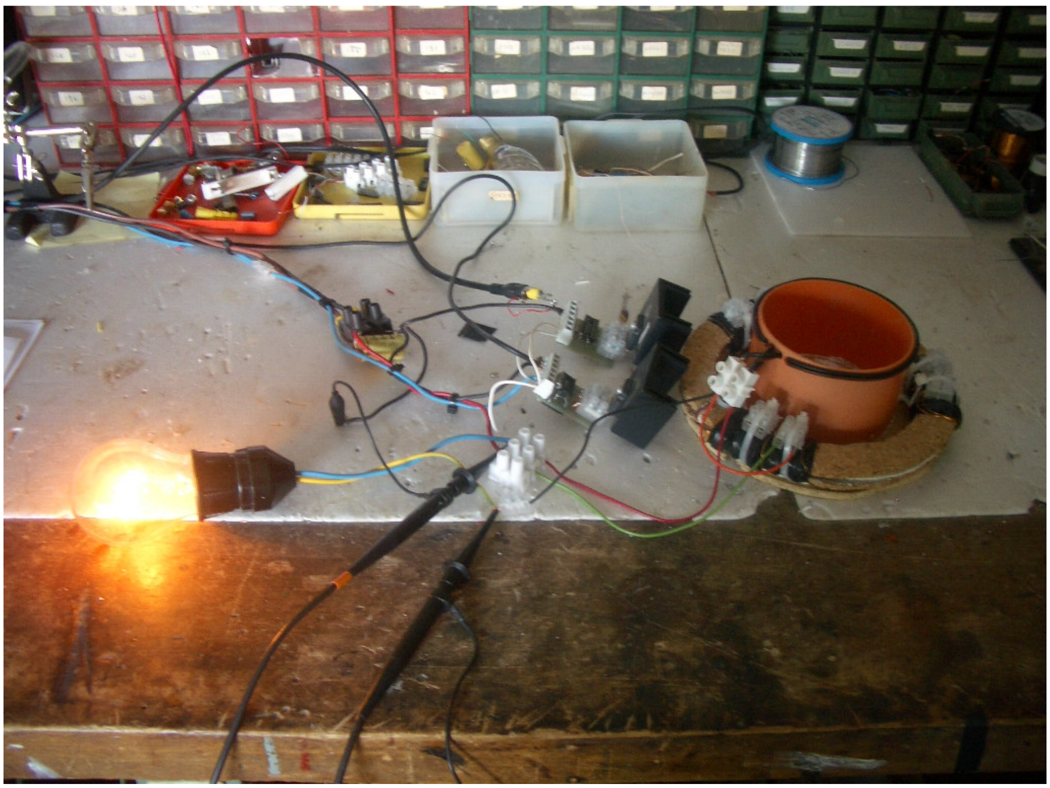
1.3 TESTS WITH DIFFERENT SETUPS

1.3.1 Setup: 1 CC and 2 frequencies – 2 driver boards

The purpose of these tests is to ascertain that the ECD is operating and look for the overall response also comparing with equivalent tests previously done with the other kind of CCs.

The following test is run with:

- only one CC connected (look in fig: only one CC is connected),
- two synchronized frequencies applied using two driver boards as in figure.

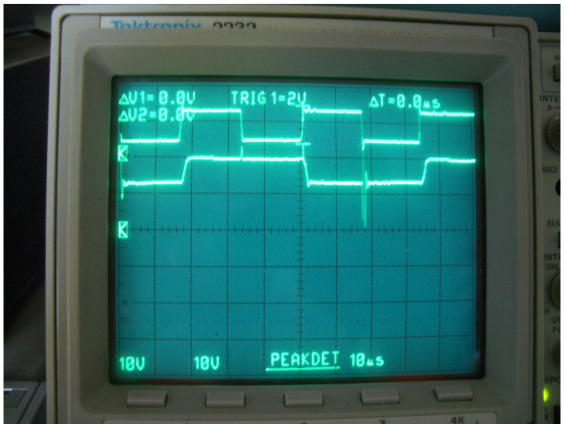


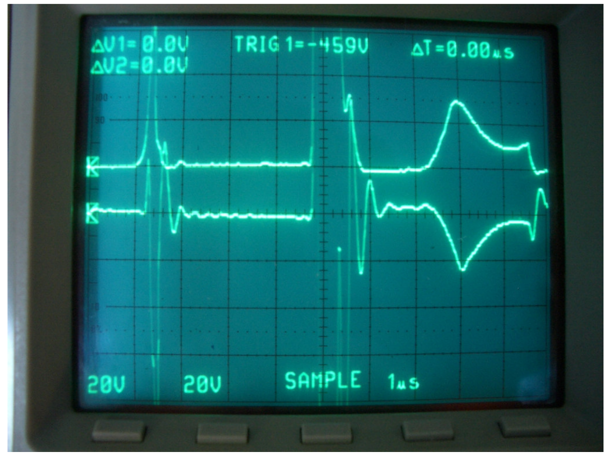
This standard configuration is the one that generally does provide near the best results in terms of output power and simplicity. The connected load-lamp is 230V/60W.

The generators are outside the view as now my working place for safety issues has been moved at least 2 meters away on the left. In this case the 2 signals are fed using 2 m. of thin coaxial cable and this pose a problem because of the stray capacitance that worsens the pulses rise time.

In the first fig the waveforms refers to the two synched input freq: f1= 35KHz, F2=70KHz, while the second fig does refer to signal on both load wire (Zero & Phase point) taken respect to ground.

Note: in the latter case the vertical scale has been set to 20V/div to show the details, the peaks amplitude is actually about 500V.





Test conditions:

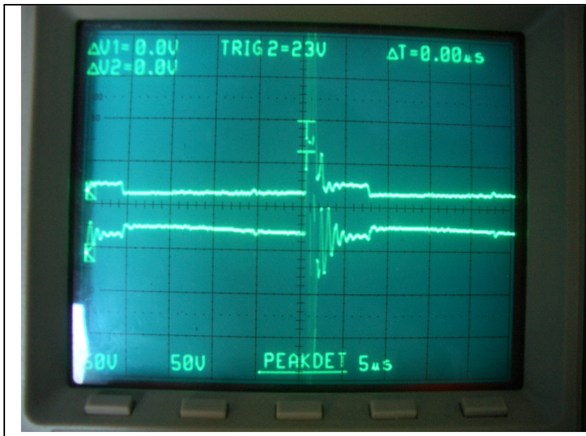
Power Supply setting	+12V
Current delivered to ECD	2 A
F1	35 KHz
F2	70 KHz

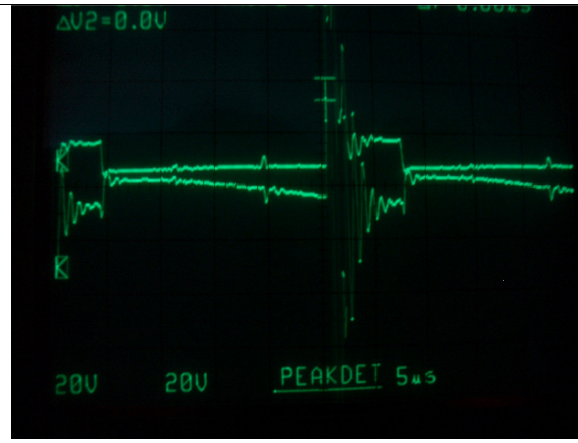
Notes:

1. The coils are cold: about 40 degrees centigrade. This confirm that the design has been correct.
2. There is a new artifact that appears in coincidence when both the input waveforms are at 0 level. You see that after the main peak trailing edge and after 1 microsecond does start an artifact. This may be due to reflections & standing waves as it is not possible to move it with freq variations so it’s related to physical dimensions.

1.3.2 Setup: 2 CC and 2 frequencies – 2 driver boards

In this test I've series connected two CCs. It does means that I have put in series both primary and secondary windings.



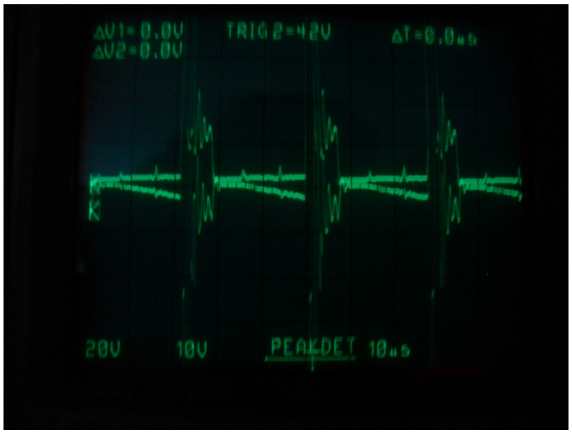


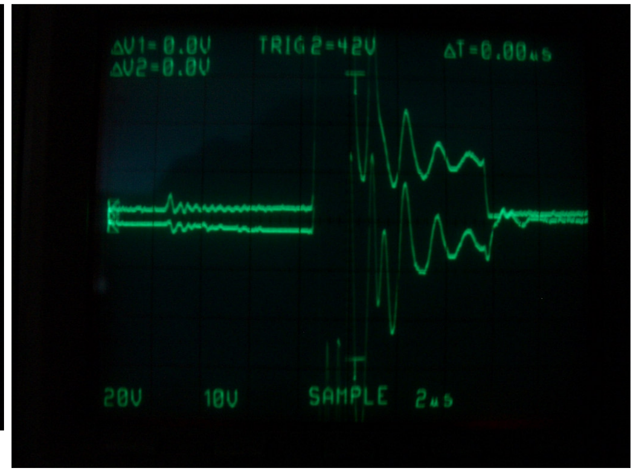
Test conditions are as before. Both figures are the same but with different vertical scale. It is possible to note that in this case the artifact is near the main peak actually has been incorporated by the main BEMF peak. Peak amplitude are almost the same. From first fig it is possible to appreciate that the Phase signal does show a 2-3 cycles oscillation of about -100V @ about 1 MHz.

It goes without saying that there are not big differences from previous setup.

1.3.3 Setup: 3 CC and 2 frequencies – 2 driver boards

These tests are run with 3 freq where the lower two are synched.





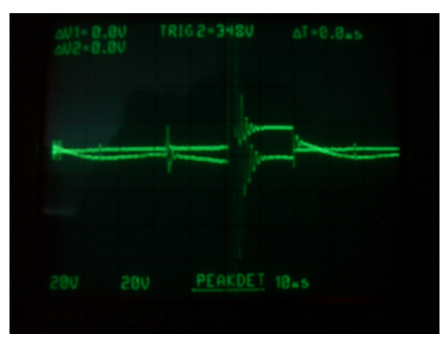
Test conditions:

Power Supply setting	+12V
Current delivered to ECD	1.1 A
F1	35 KHz
F2	70 KHz

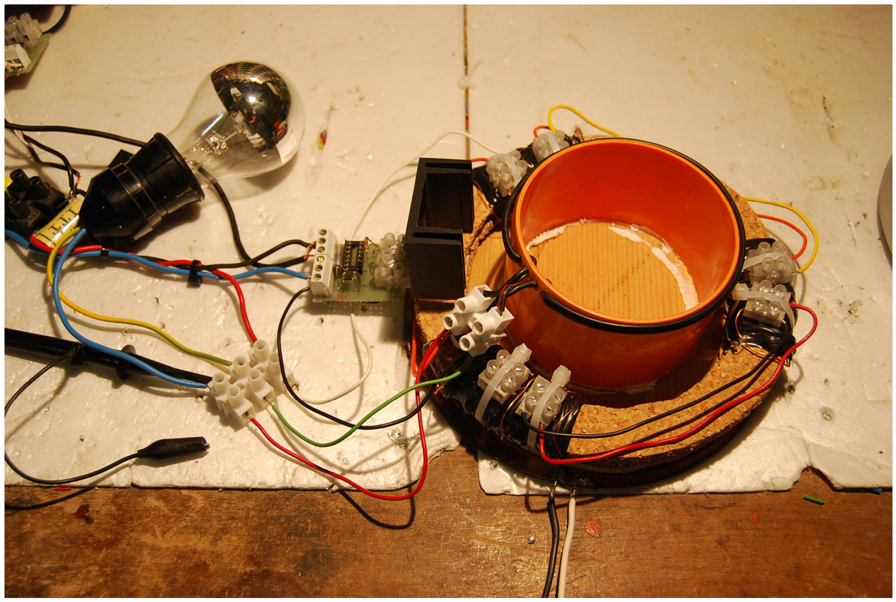
Please note that in this case the best conditions (output power) is met with following setup:

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	1.7 A
F1	27 KHz
F2	13.5 KHz

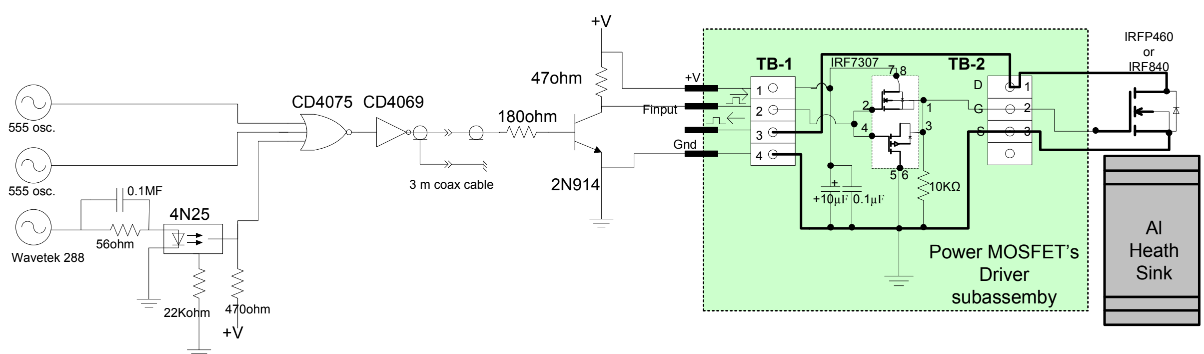


1.3.4 Setup: 3 CC and 3 frequencies – single drive board



As shown in fig this time I've connected all the 3 CCs and I'm using <u>only a single drive-board</u>: it means that the 3 frequencies are ORed before at digital level.

The driver setup is now as in following figure.



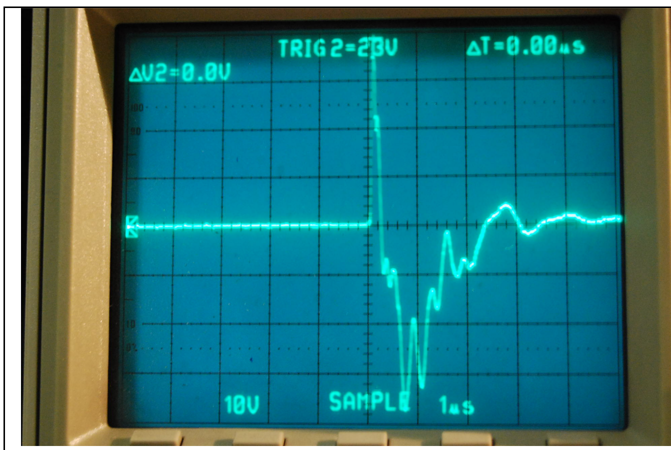
In this circuit you can note that on the left there are 3 square-wave generators. The Wavetek is protected by the use of the optical isolator 4N25. The 4075 + 4069 are used to make the logical OR plus cable driving capability. The 2N914 is needed to maintain the 10 nanosecond range rise time to drive the 'Driver board' subassembly.

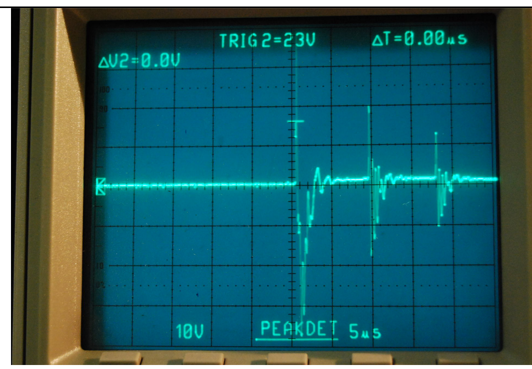
Extreme care should be taken to use adequate bypass capacitors on power supply rails as well as ferrite beads in order to stop any spurious signal coming back to PS: remember that the heavy switching capabilities of IRFP460 does generate lot of impulsive hash of every kind able to tamper with any near electronics.

The lamp in this test is connected directly to Phase & Zero points and for safety the scope's probe is not connected but just put near the 60W lamp Phase lead.

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	3.4 A
F1	35 KHz
F2	70 KHz
F3	105 KHz



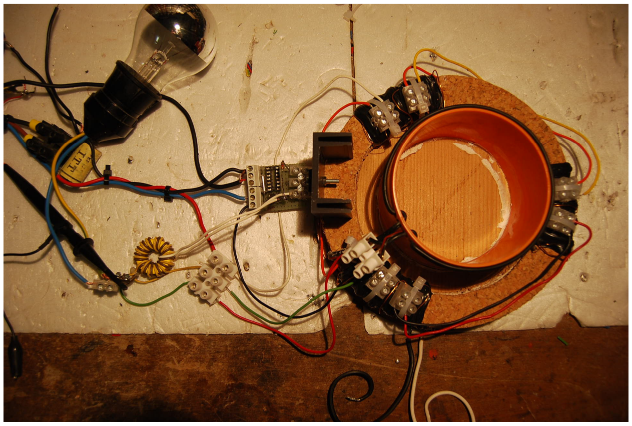


From now on I will define the lamp light as: **Full**, **Medium** and **low**, this only to give a feedback to readers.

So in this case the light is Full (also the current delivered to ECD is High).

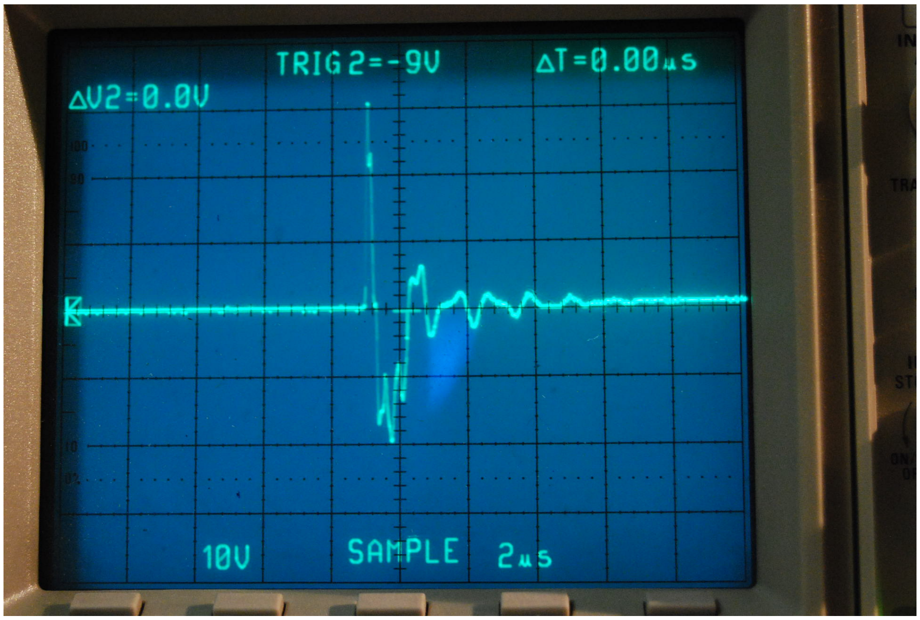
The waveform in fig is different from the usual as there is neither trace of sinus nor any Seed but rather as in fig there are two additional similar but damped artifacts just after the big peak never seen before. Remember that the vertical scale is faked as the probe is not connected.

Then I tried to connect the load using an isolation torrid like in following pic.



DSC075

In following pic is the same signal previously reported and it is possible to note that the torrid did create some ringing. The light on the lamp were almost the same.



DSCS070

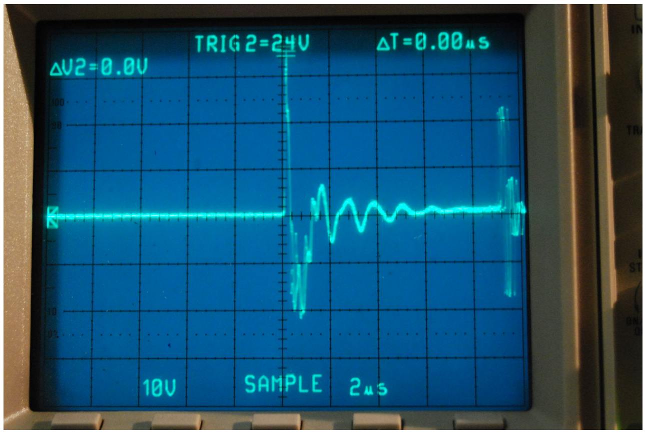
Then I did again the frequency tuning as I discovered that now the ECD has its maximum at 5KHz range. THIS IS A GREAT DIFFERENCE, probably this is provoked by the low freq torrid resonance. In fig is the output for the following setup:

Test conditions:

Power Supply setting	+12V

Current delivered to ECD	3.5 A
F1	5 KHz
F2	10 KHz
F3	106.8 KHz

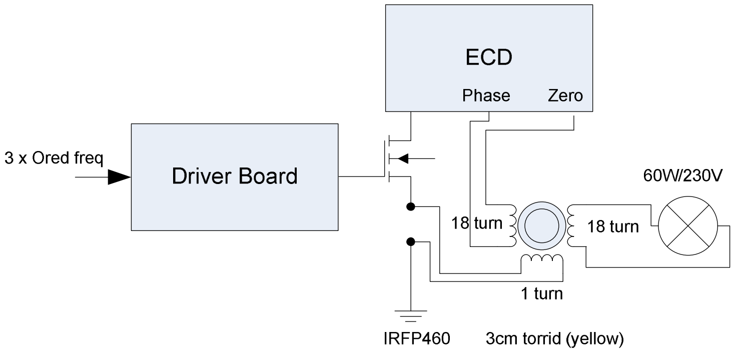
In this case the light were Medium /Full. As you can see and I expected the waveform is similar to previous and the lamp-light is Medium



DSC072

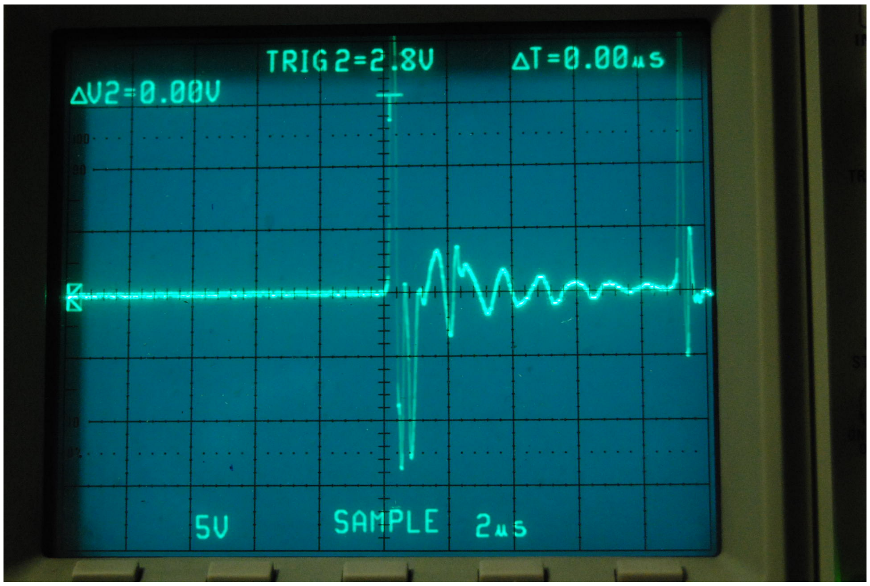
1.3.5 Setup: 3 CC and 3 frequencies – single drive board- Feedback

Taking as good that last setup I know tried several feedback methods taking advantage by the torrid presence. So I used just 1 turn on torrid put in series with the MOSFET's Source lead.



Test conditions:

Power Supply setting	+12V
Current delivered to ECD	3.5 A
F1	5.04 KHz
F2	10.00 KHz
F3	105.00 KHz



DSC074

So we see here still the torrid ringing but now there is a MUCH stronger negative oscillation in MHz range with same peak amplitude.

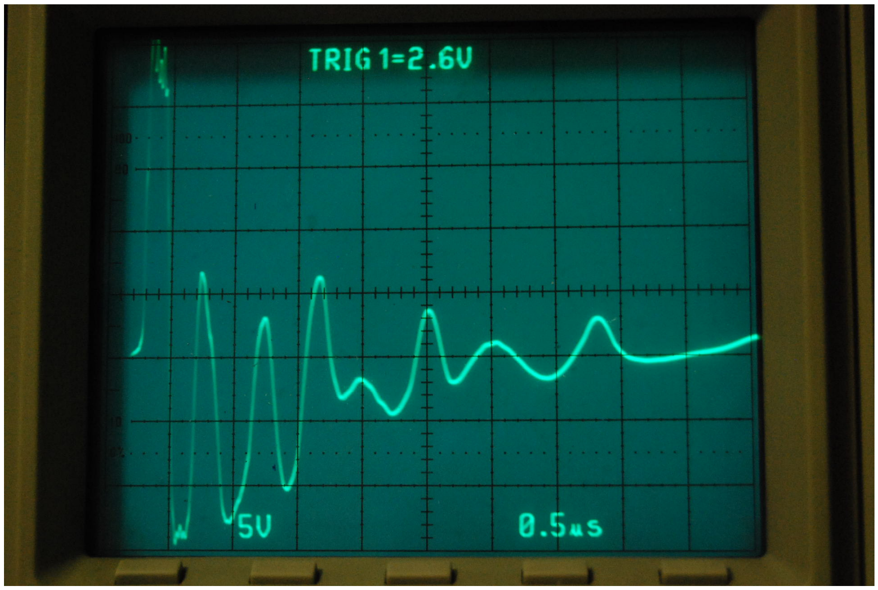
In order to understand the mechanism I decided to make the things easy and so I started another batch test starting from the easiest configuration and going on.

<u>Test with a single optimized frequency</u>

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	1.2 A
F1	10.00 KHz

F2	-
F3	-



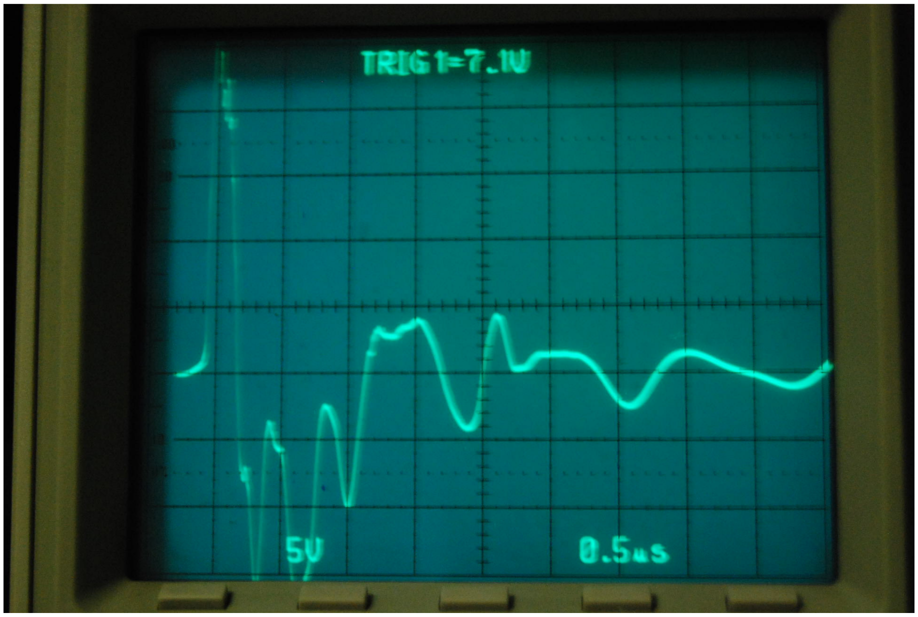
DSC076

In this condition the lamp light is Medium – Low.

<u>Test with 2 optimized frequency (asynchronous)</u>

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	2.5 A
F1	10.00 KHz
F2	20.00 KHz
F3	-



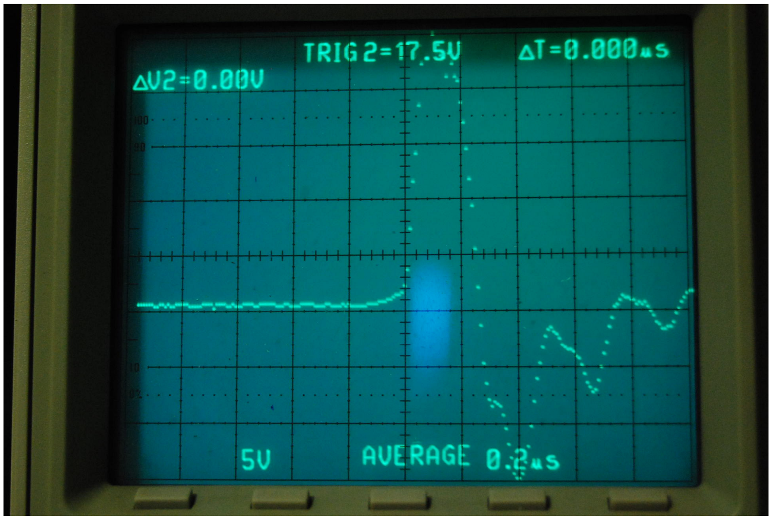
DSC077

Here the 0 reference line is 1Div under the screen centre. In this condition the lamp light is Full.

Test with 3 optimized frequency (asynchronous)

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	3.6 A
F1	10.00 KHz
F2	20.00 KHz
F3	120.00 KHz



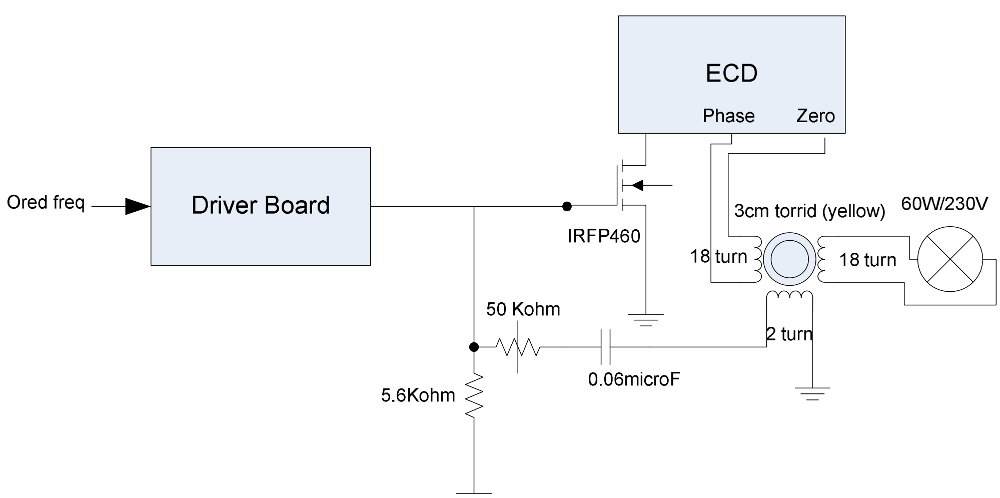
DSC078

It is clear that 120KHz is not the correct 3rd frequency! In this condition the lamp light is Medium.

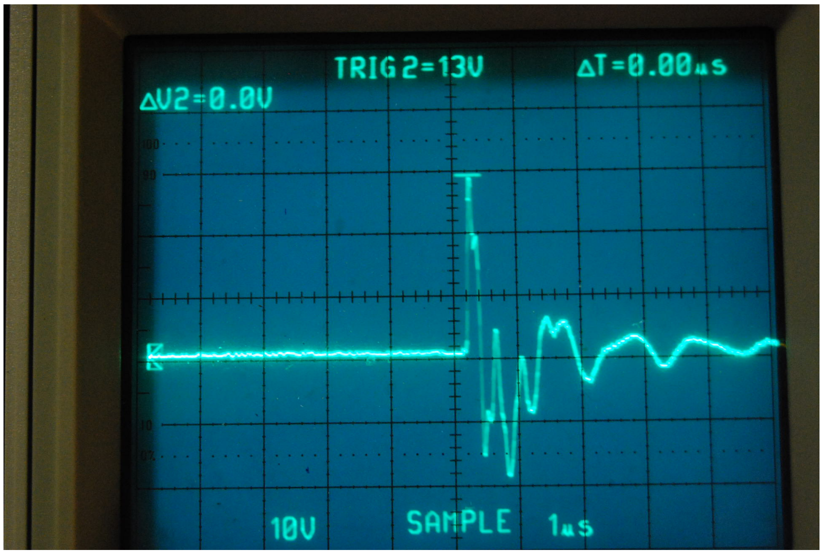
At this point I thought to use another feedback setup: directly on MOSFET's Gate as it follows.

Test conditions:

Power Supply setting	+12V
Current delivered to ECD	2.8 A
F1	10.00 KHz
F2	20.00 KHz
F3	120.00 KHz

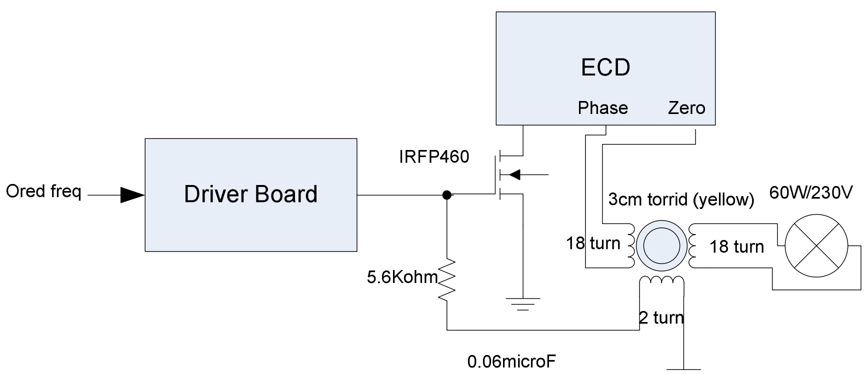


Here there are some effect but not evident as before in DSC077. To note that durig the test I saw the carbon trimmer sparking in its interior.



DSC079

So I tested this other configuration with same condition as before.



Nothing different of course!