Fundamentals of Power Electronics
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Lecture - 79
Area products and mfiles

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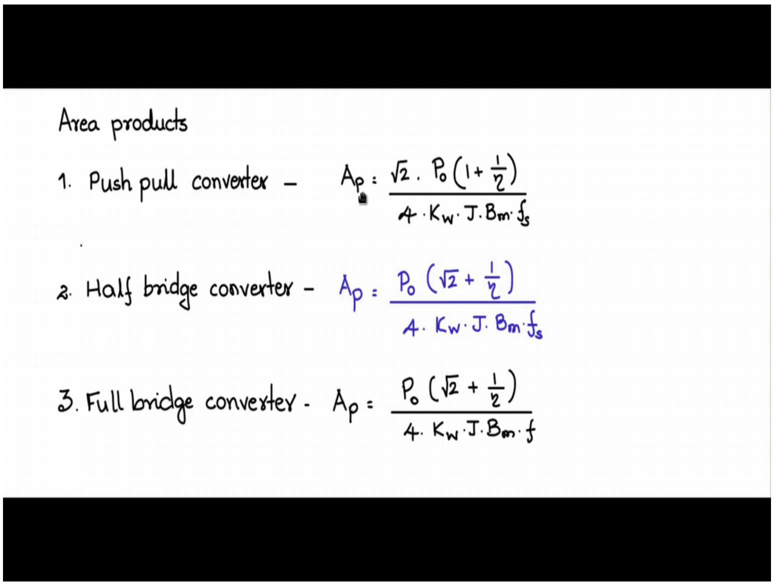

We discussed 3 converters; push pull converter, the half bridge converter and the full bridge converter. How do we design the transformers for this converters? We go by the area convert area product method we have discussed the area product method and then we use it to design the forward converter and we had developed generic area product equation. Using the generic area product equation we can find out the area product the push pull, I will give you the final derived formula for the push pull converter area product is equal to root 2 P naught 1 plus 1 by efficiency. Here efficiency is taken to be 0.8 first case.

So, efficiency will always be better than 0.8 and the denominator you have 4 K w window factor J current density which is 3 into 10 to the power of 6 ampere meter square B m for ferrites its point 2 for the transformer point 2 Tesla and then fs the switching frequency.

So, this is the area product for the push pull converter. If you use the same generic formula and then plugin the voltage and the power voltage and power into the generic equation, that is a half cycle average voltage you will get this. Likewise for the half bridge converter; half bridge converter transformer also the area product I will be providing you, here derived along same lines P naught into root 2 plus 1 by efficiency 1 by 0.8 divided by 4 K w J B m and f s.

The full bridge converter half bridge converter the transformers are very similar and the voltage wave shape across the primary and the current through them are all similar and therefore, you will have a similar area product equation. The difference of course, will come in the actual values the currents and the amplitude of the voltage. So, this is the area product for the full bridge converter.

So, you can try to derive these and verify them by using the same generic method, for deriving the area products. That we discussed for the forward converter as an example and also the low frequency AC 50 Hertz transformers to. So, use all these transformers have the same generic basis.

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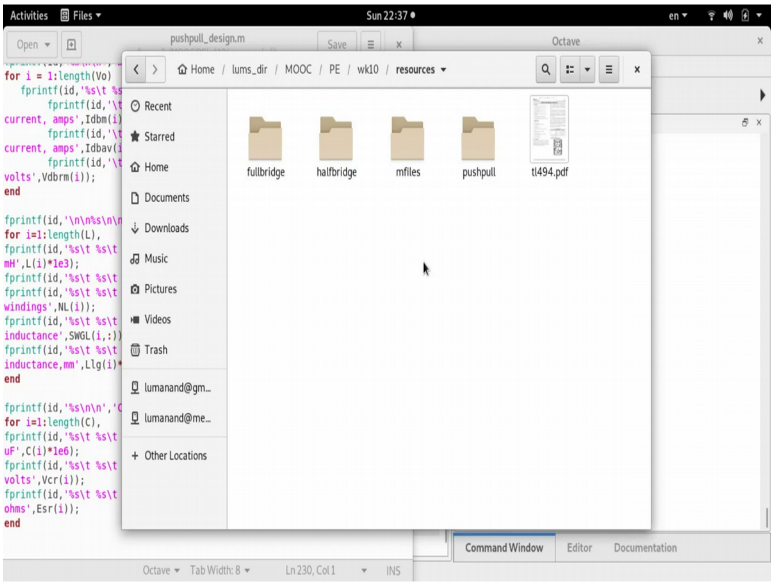

Let us now look at some m-files for designing the push pull converter the half bridge converter and the full bridge converter.

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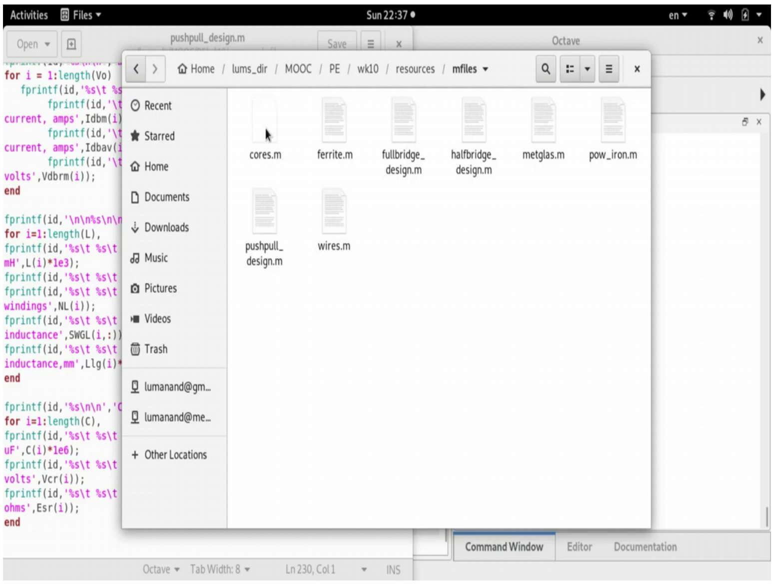

So, I have in the resources section a folder called mfiles within that like for the forward converter, we have some common mfiles that is a course, the ferrite, the ferrite course, the metglas core powder iron core and there is another m file on wire wires and wire gauges. So, these are common for all the converter design in the sense that they are data bases of the course and the wires.

You have 3 design files; one is the pushpull design dot mhalf bridge design dot m and the fullbridge design dot m and these are the design mfiles which you can run and they will make use of this course for right wires and other core and wire detail a details from these other mfiles. So, let me look at let me open the pushpull.

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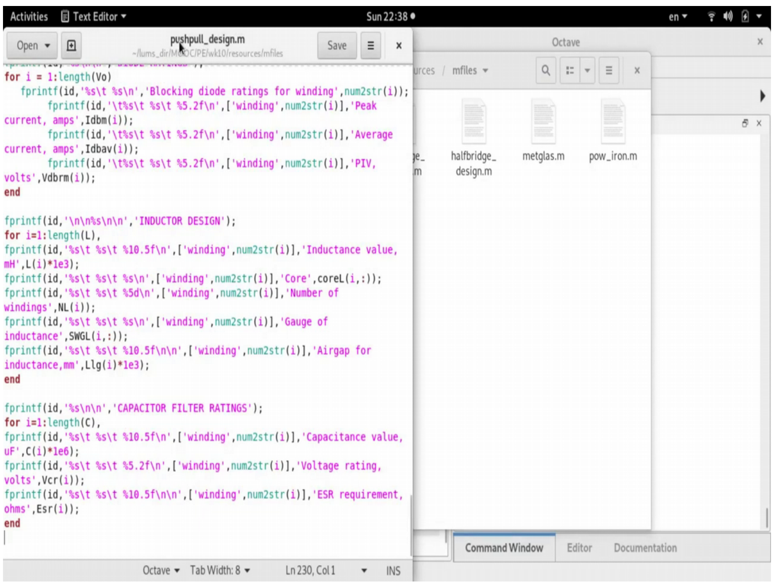

So, you see that here you have the pushpull design dot mfile.

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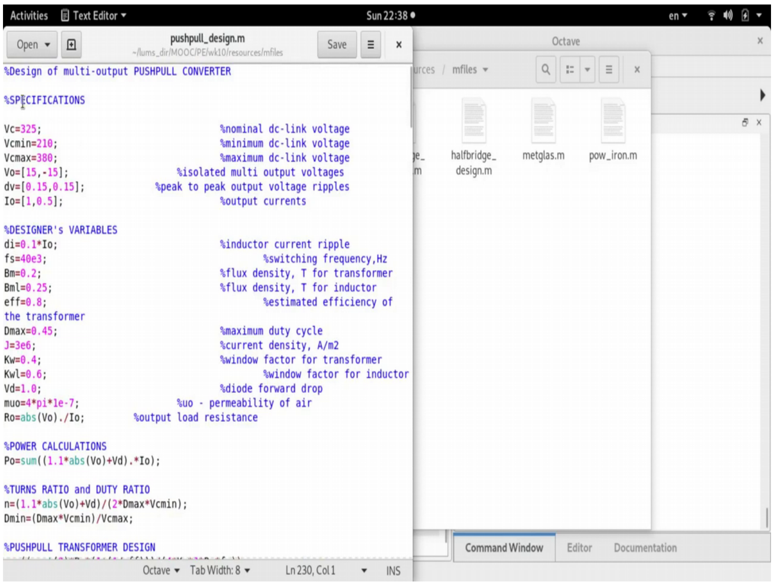

And it has a specification section as specified somethings observe here V naught is having is a vector of 2 elements which means it is a isolated multi output. There are two ORed secondarys. You have the delta v ripple and 1 amp and 0.5 amps for the 2 different outputs. And you have the set of designer variables and switching at 40 kilo Hertz here 0.2 Tesla for transformer flux density maximum 0.25 Tesla for inductors, Dmax of 0.45 which I have taken 3 amp per mm square or 3 into 10 to the power of 6 ampere meter square for the current density and window factors I have chosen like this.

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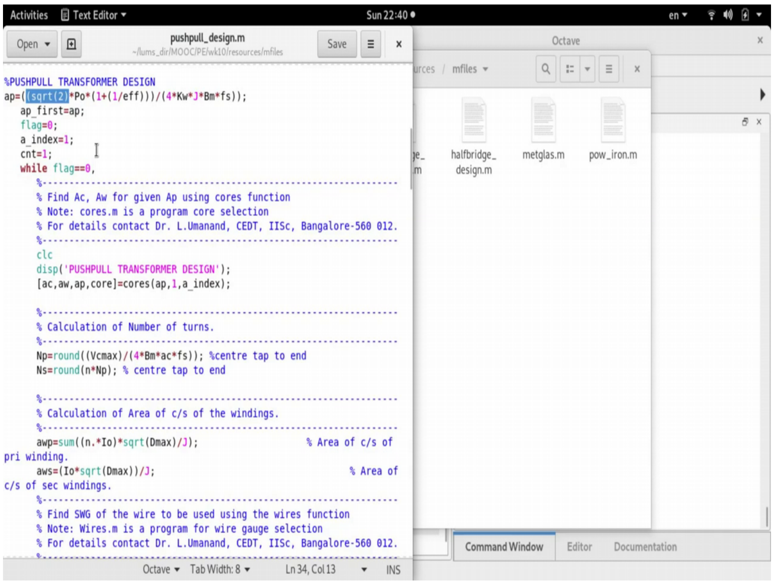

So, there is the power calculation and after you do the power calculation the terms ratio calculation and this is where it will be different from the forward transformer design which is a pushpull transformer. The area product of the pushpull transformer I have taken it according to the area product of the pushpull that I have just listed down. And the part of the design is similar to that in the forward converter where we call the course.

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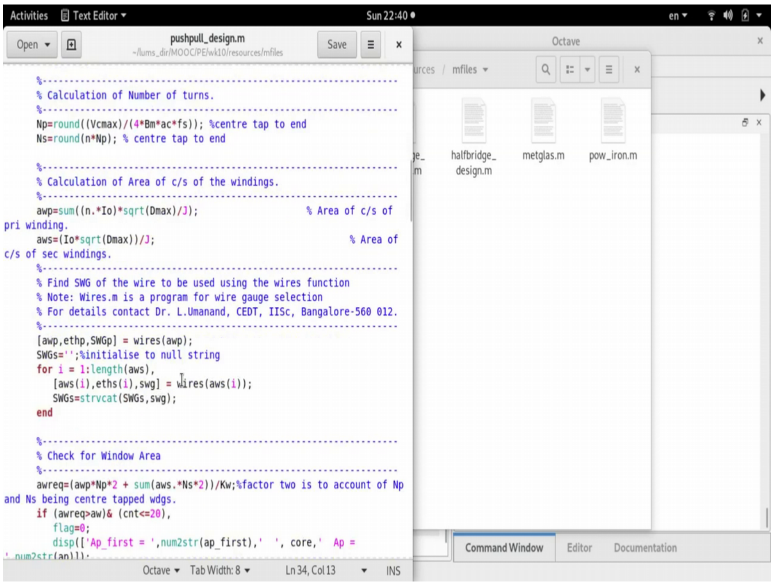

And the course selects the course and then wires for selecting the wire gauges and cross check the design.

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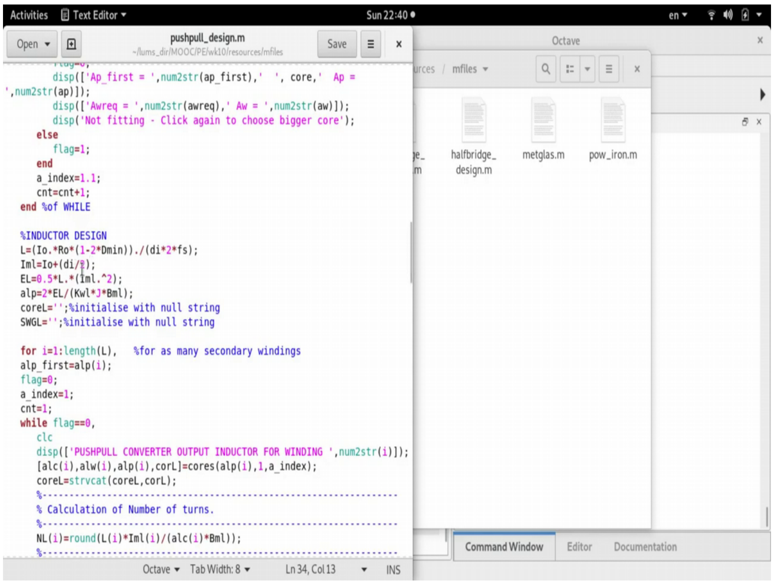

Then you have the inductors; inductors for every output mm isolated output we have 2 isolated output. So, 2 times it has to be done. So, inductor value calculation followed by energy calculation.

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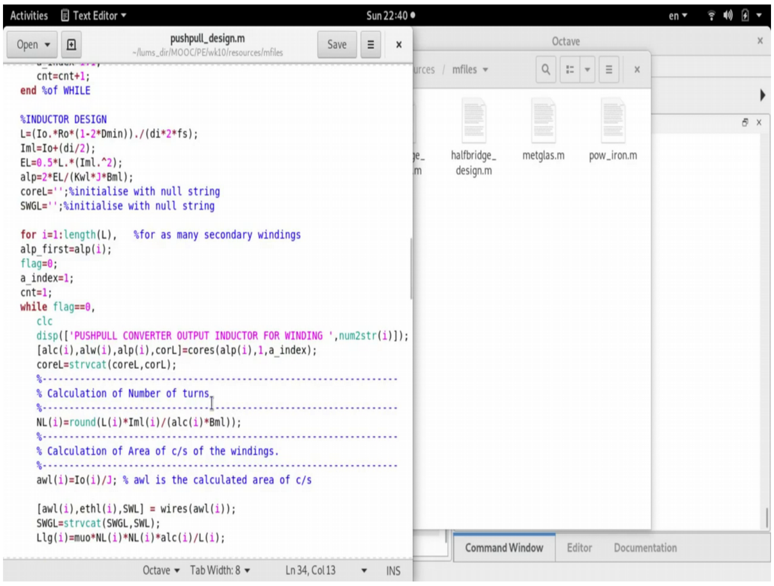

Then the selection of the core from the course function file and then the wires from the wires function file.

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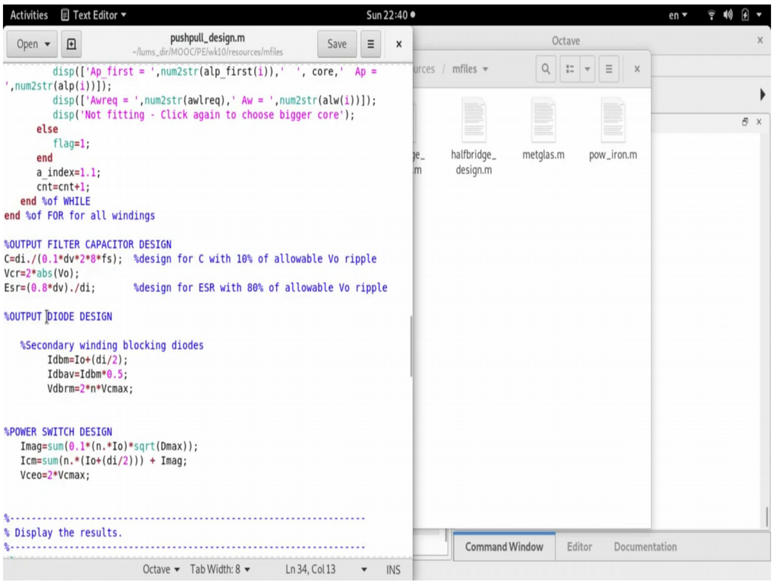

Then you have the design of the capacitors the output diodes power switch and then finally, to display the results.

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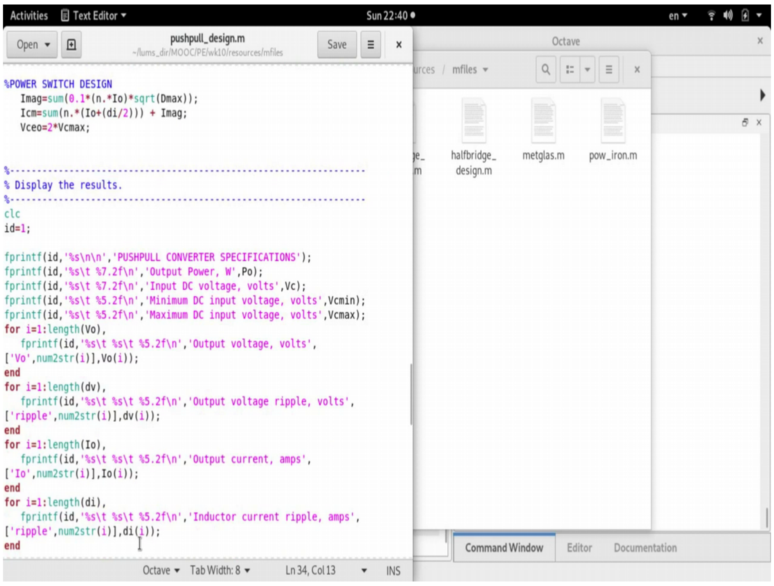

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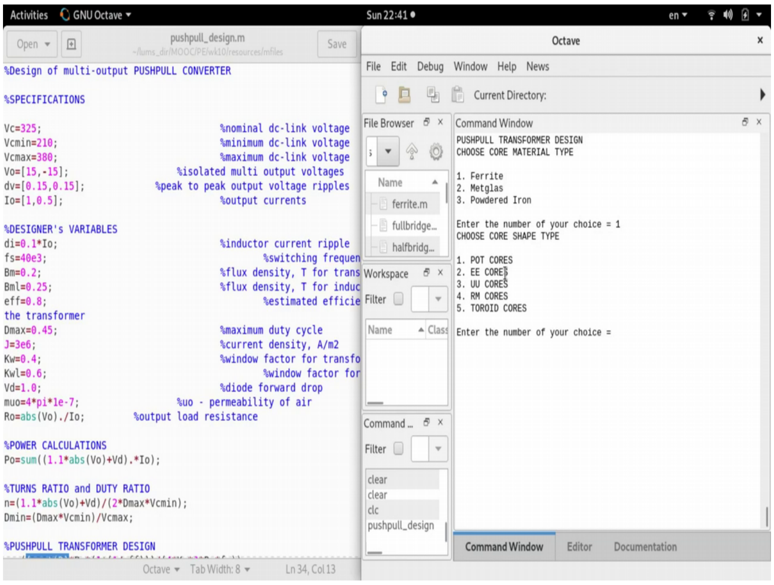

So, this is the pushpull design, I have given the specification here you can go in to octave or even matlab for that matter go into the respective folder resource folder I already have and I have here full bridge half bridge and pushpull. So, you type in pushpull design and it will ask for the type of the core material I am going to choose 1 which is Ferrite and then it will ask for the shape of the core material I am going to choose EE.

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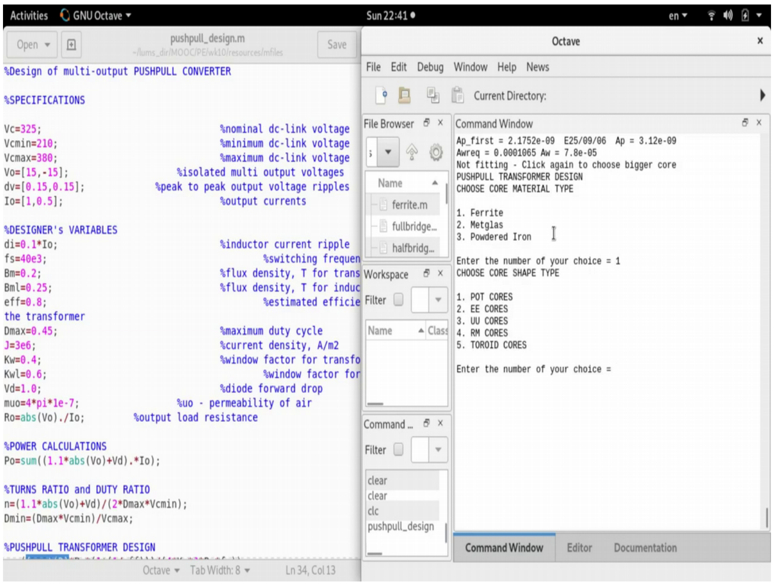

And I am going to choose 2 and you see here the area product calculated and then the window area cross check is not fitting. So, again you will have to choose the next bigger size core you can change the material if you want, but I will strict to ferried go ahead with ferried and the EE core.

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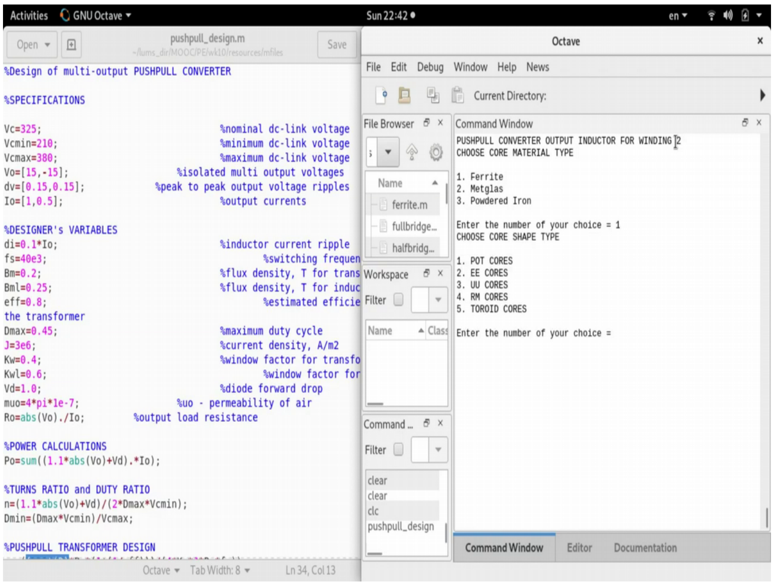

Let it choose the next higher one, it has chosen then it has gone for inductor a winding 1 I will choose Ferrite and EE CORE to keep the same inventory list, then inductor for winding 2 again you choose ferrite and I am choosing EE core.

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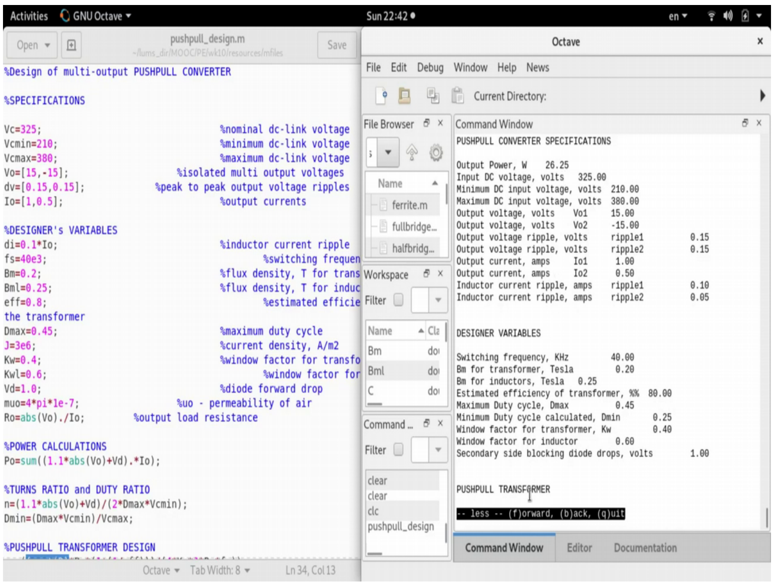

And then that is it the calculations are done and the results are displayed, you have the pushpull converter specifications then the designer variables.

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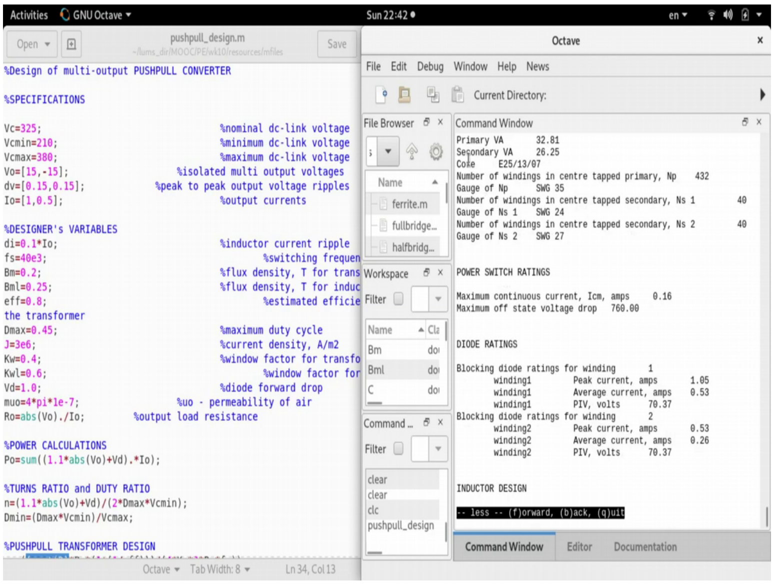

Then followed by the POWER SWITCH RATINGS diode ratings, inductor design.

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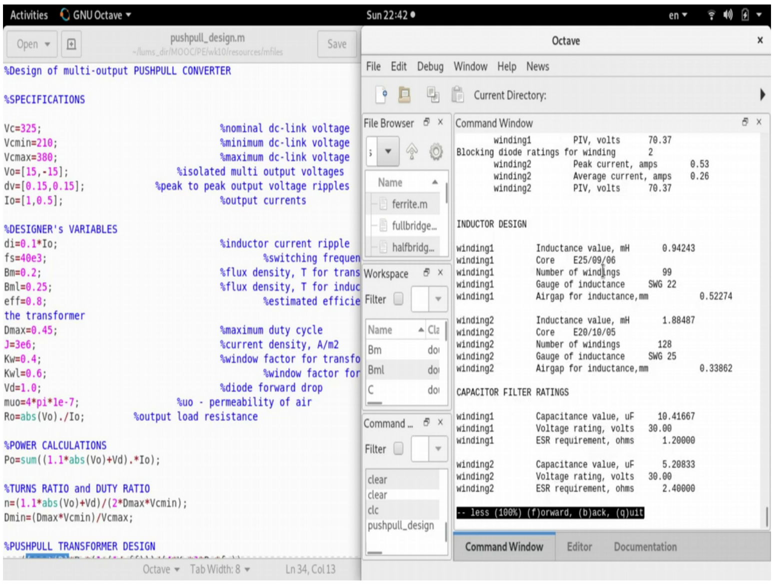

Inductor design with its core, air gap all those things capacitor filter rating and everything that is needed for rigging up the converter.

So, the pushpull converter design is designed in this fashion, I will allow you to play around with this specification and look into the equations and try to get more insight into the multi output push pull converter mfile.

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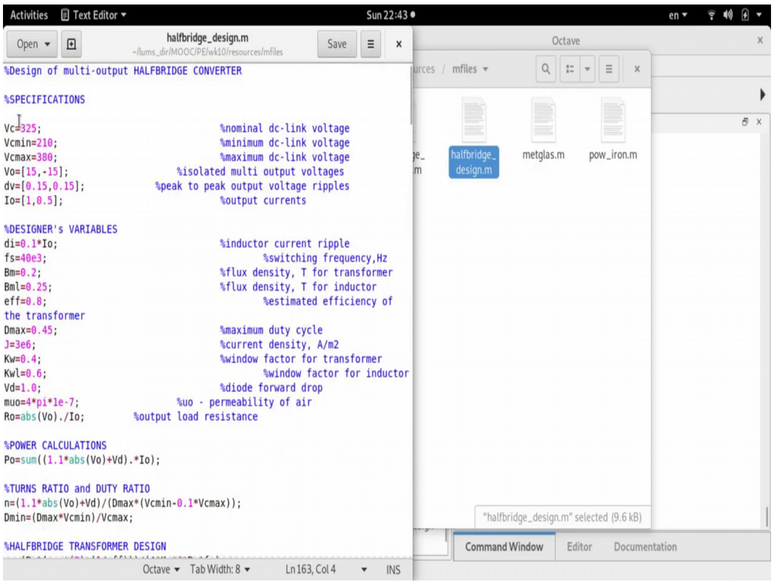

Likewise, I have the half bridge design m file, you can look into that also. I have kept the same specifications and so, that you can compare. Slightly I have changed the output specs, but otherwise I have essentially kept the same simplification.

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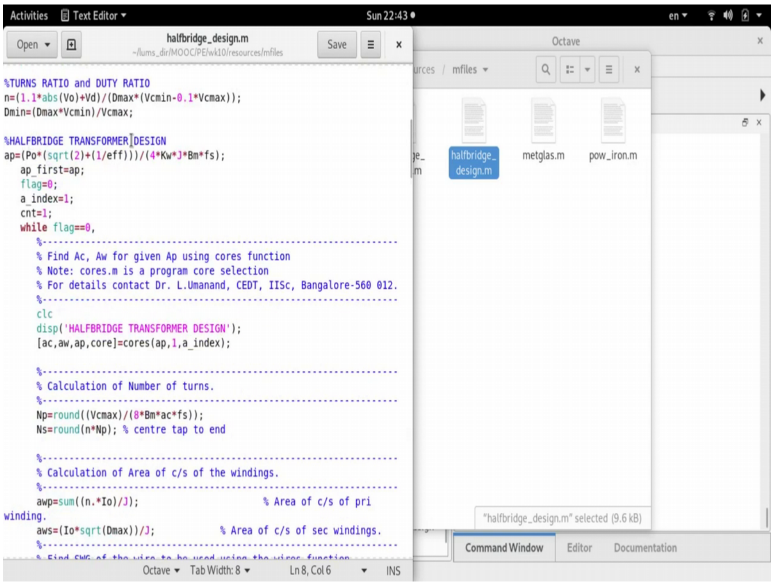

Here also everything is same except for the half bridge transformer design, the area product which this equation will change just like as I have listed shortly a while back.

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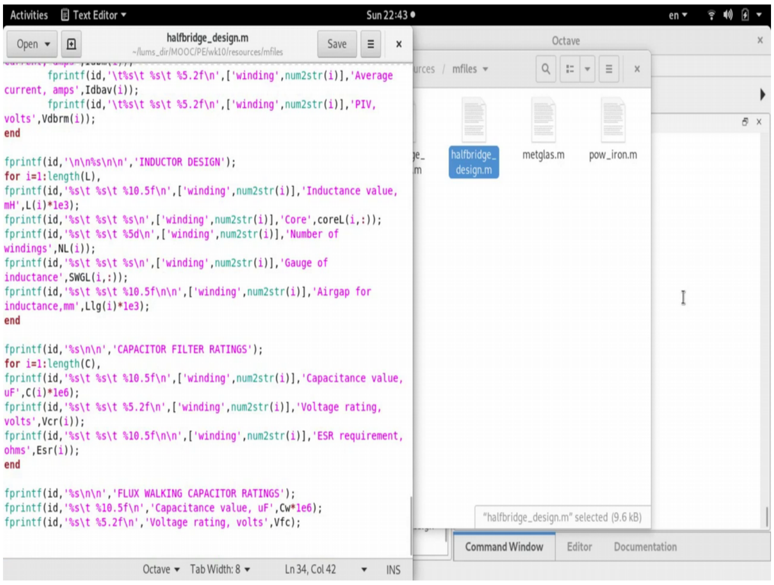

So, you can execute this design like I did for the pushpull and try to find out the design values.

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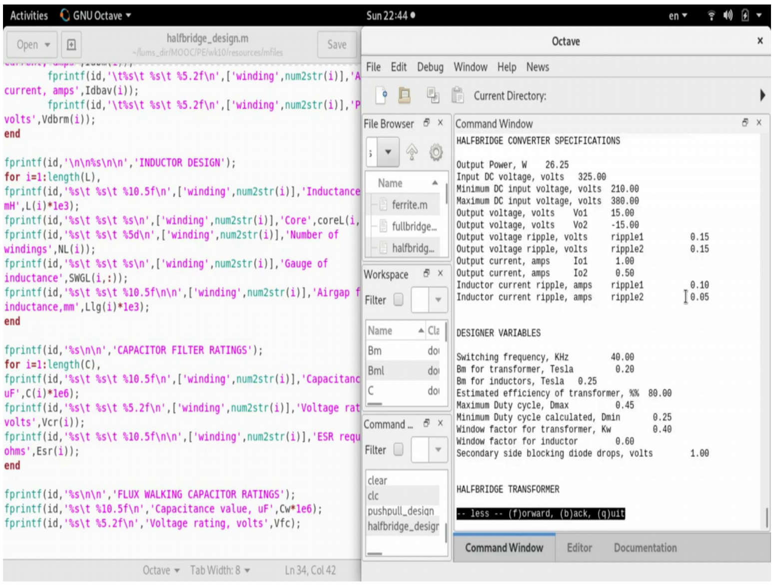

I will just run it through half bridge converter design, it goes in the same fashion I will choose Ferrite E CORES again Ferrite EE CORE Ferrite for the inductor Ferrite inductors. So, you can you will get the mm design values, you can read through the values later on and here in the case of the half bridge I am also calculating the flux working capacitor ratings for so, that if you want to use the flux walking prepare prevention using capacitors you can use it, for small powers this is really fine. In a similar way I have also with me here the full bridge design mfile.

So, very very similar except for the area product. The area product in the case of the half bridge and the full bridge are same. So, even those equations remain the same. You just have to run full bridge and do the same process of selecting the core, selecting the shape and go through the process of selecting the core for the inductor shape, inductor 2 shape and then you get the results.

So, just walk through the design values, you will probably get a hang of the numbers for the a typical design of this specification. So, I will allow you to play around with the specs and get try to get more insight into the design of the converters using this mfile as a template.