**Indian Institute of Science**

**Design of Photovoltaic Systems**

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**NPTEL Online Certification Course**

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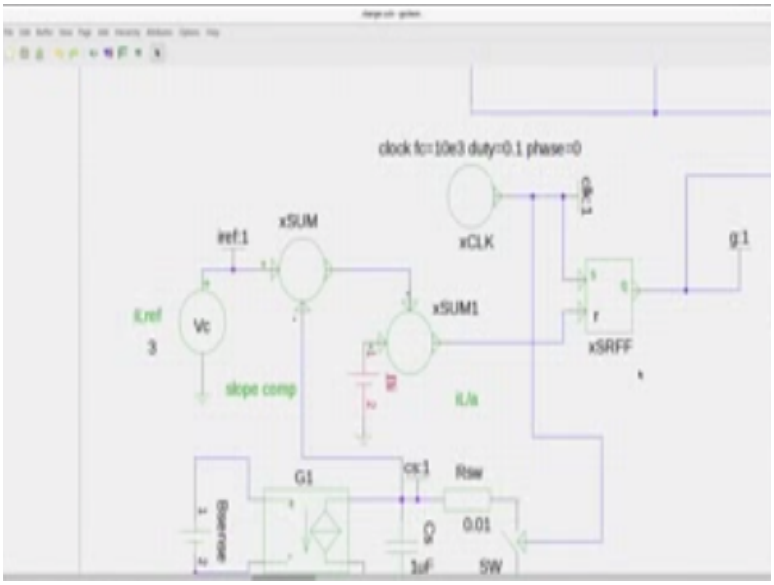


Let us now see how we go about simulating the battery charger circuit with current control, with slope compensated current control. So let me open this charger schematic in vision. So this is the schematic that I have for you PV sub I think now I am familiar with how to include the sub circuit file, now this is schematic. I discussed while discussing in theory I discussed about the buck converter.

But here in the implementation I thought we will use the buck-boost converter, this is the buck-boost converter circuit, so that you will get familiarize with one more converter into remote control. So we have this for the voltaic source, it is the same source that we had modeled earlier, short circuit current of two amps, voltage scale factor of 20, and then I am having buffer capacitor CT, this VIPV with value 0, VIQ with value 0 or the current sensing voltage sources.

I have a switch here which is the inductor, and the inductor current measurement sensor, diode D and the battery, observed with the battery is put in position where here it is plus 1 is + 2 is – because the buck book circuit you will have a negative voltage coming cross the output and therefore you have to appropriate connect the battery terminals and of course the load now how are we getting the PWM signals for due cycle control this is the SR latch we have discussed about that now there is this summing junction where I am having IL measured.

So I am using this sense there is this source here and I am sensing it from the source so you see that this E is a B source which is giving a voltage equivalent of the current which is flowing in the inductor so voltage is equal to I current flowing through the VIL voltage source so here basically I have a voltage equivalent of the inductor current and I have the IL reference coming in here which is IL ref – the slope composited sort with wave form.

Now I have interchanged the + and – here if I zoom in you will see that I have made this + I have made this – this is to make simulation block simpler we have put a comparator here with a – and + with an inversion here and this comparator block I have removed and then did a sign change here itself – and + the insertion caused by the comparator is brought forward and I have inverted the sign here because there is summit comparator at the input to the SR latch itself so that is the only change.

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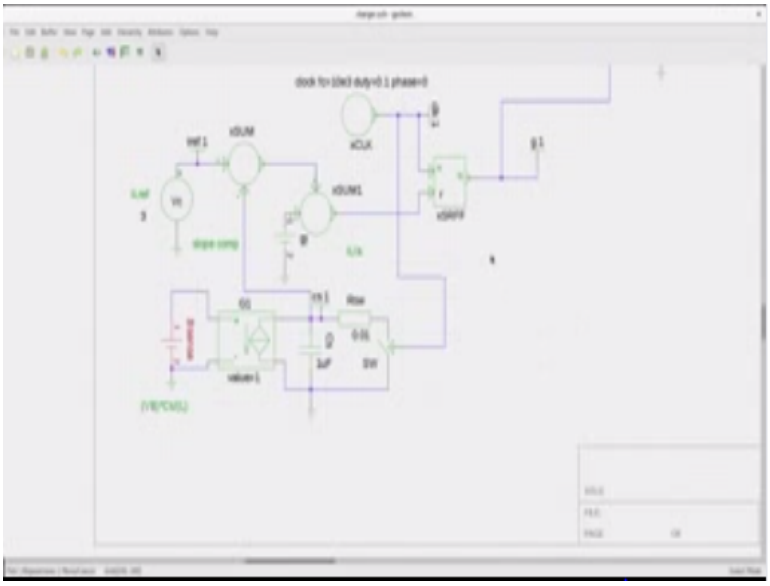

If you go to the slope compensation thing now here I am having a v source B source and I am getting a voltage equivalent of $V_0$ / L, L is 10m this 1 micro current is coming because of this $V_B$ into CS / L so that is the formula that I have used that we have discussed, so ψ inductor value is 10m read that what is I have use so this is the formula now this voltage will drive this voltage controlled current source so there will be a current that is coming out through this and then it will be charging up this capacitor.

And if we monitor the volt potential here you will get the voltage equivalent of I-slope and every time there is a clock giving a pulse it also reset this switch short circuit in the capacitor and discharging the capacitor so you will get the sort to weigh on this how those way forms attracts from the reference way form and that is what is given as reference, slop compensated reference so this exactly the block schematic that they are simulating and here this $V_C$ in this case of MPBT case it will come from the output of the MBPT controller and will defined the I- so now let us simulate this.

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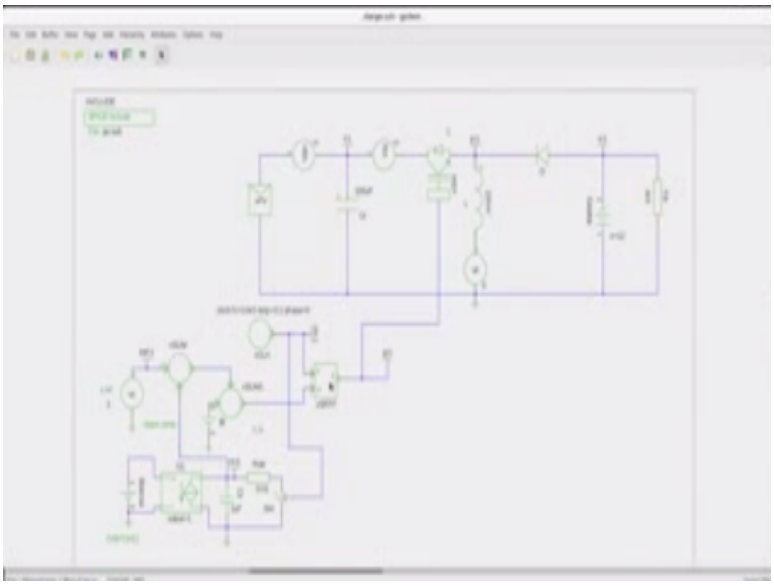

Here a point that you need to notice that this SR latch is introduced now the subset circuit of the SR latch is included is PV dot sub and the simply file for this is also included in the set of files and folders which have provided as resource in the last week session, this is the voltage controlled current source we see cs and it is a spice simulation block itself, so the rest all you are familiar with let us simulate this.

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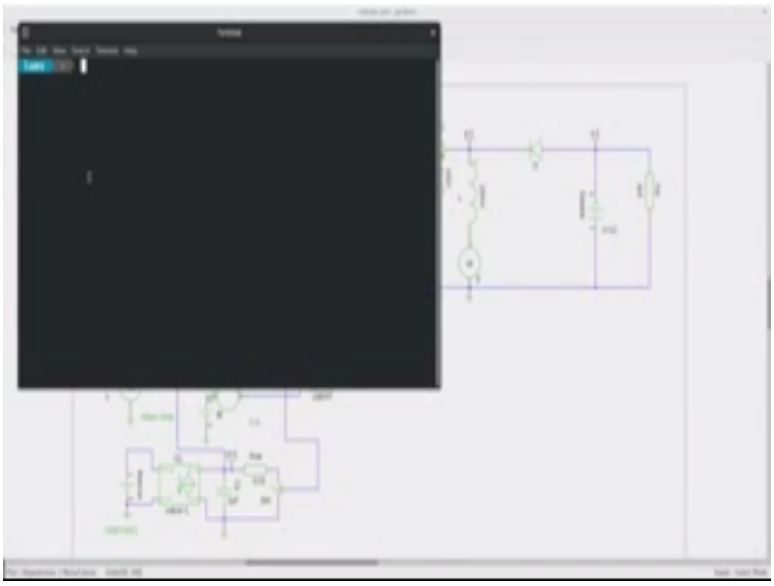

So let me open the terminal window let me go to vb's in the folder which contains all this files I will generate the net list first charger.net by executing the gnet list and then now I will run ng spice, NG spice charger.cir so it will start stimulating let it stimulate and after stimulating we will look at some important wave forms. Let us plot the iLref the inductor current and we will see.

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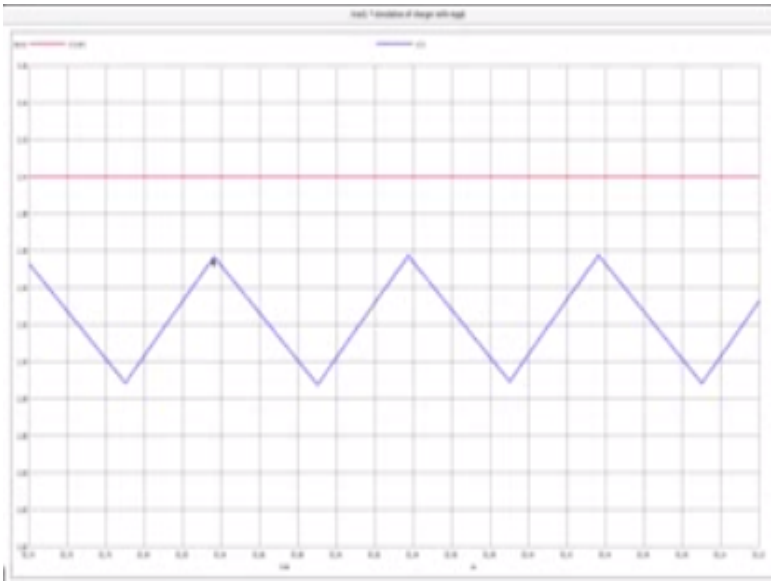

So the red one is iLref3 which is at 3 amps and let me expand it so and the blue is the inductor current, now you see that the inductor current is not reaching up to iLref the reason is that we have a slope compensated modified reference which is falling down from iLref value and when it is falling from iLref value the inductor current will cross it over somewhere less than IL rough value and change state and then start into the down slope mode.

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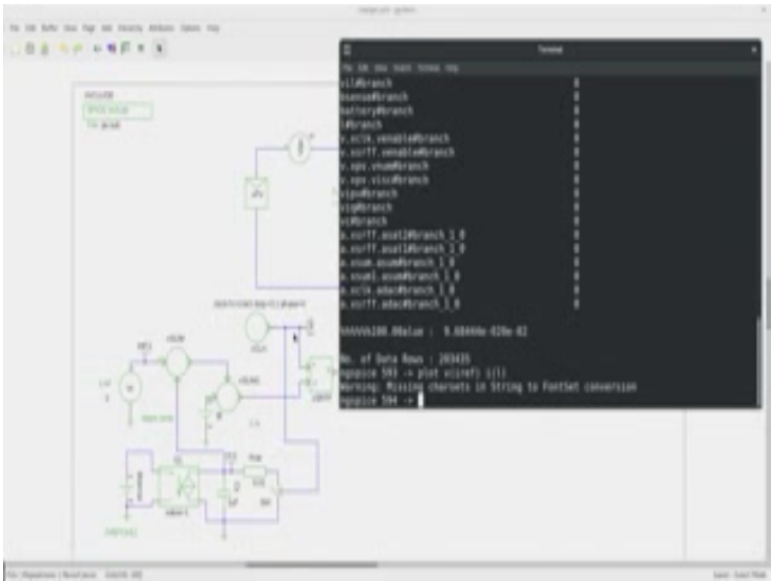

Let us observe the clock were form and the voltage across this Cs capacitance the voltage across the Cs capacitance this suppose to be like a sort would were form with the positive slope let us compare them and see if we are getting were from like this theory so let us plot voltage of the clock and the voltage across the Cs node.

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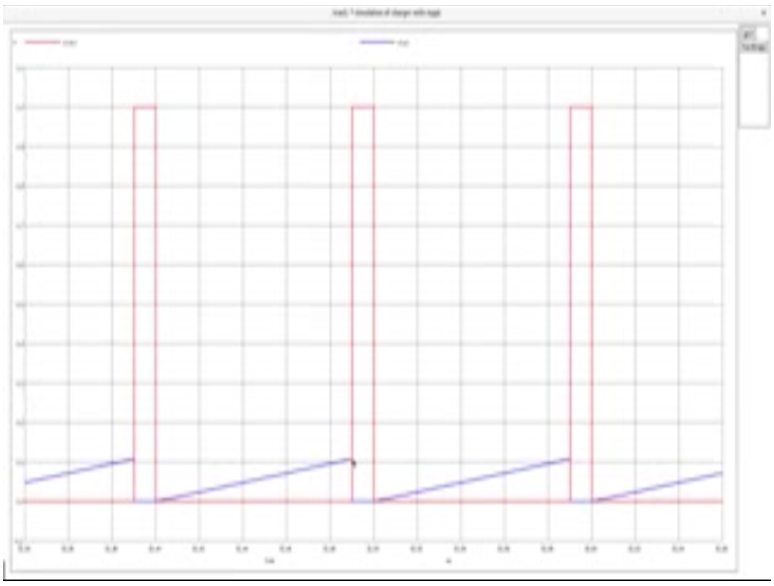

So let me expand that let me select the various small narrow region and you see that this red pulse is the clock pulse very small duty cycle so whenever red pulse comes there is a reset of the voltage across the capacitance Cs and then it rises again and the starting of the next year cycle clock pulse comes reset and rises and so on.

You have control and deciding the duty cycle of the clock so this is as per what we are expecting let us now see this modified IL reference that is the slope compensated reference here which is the Il rough- I slope and compare it with the inductance current IL.

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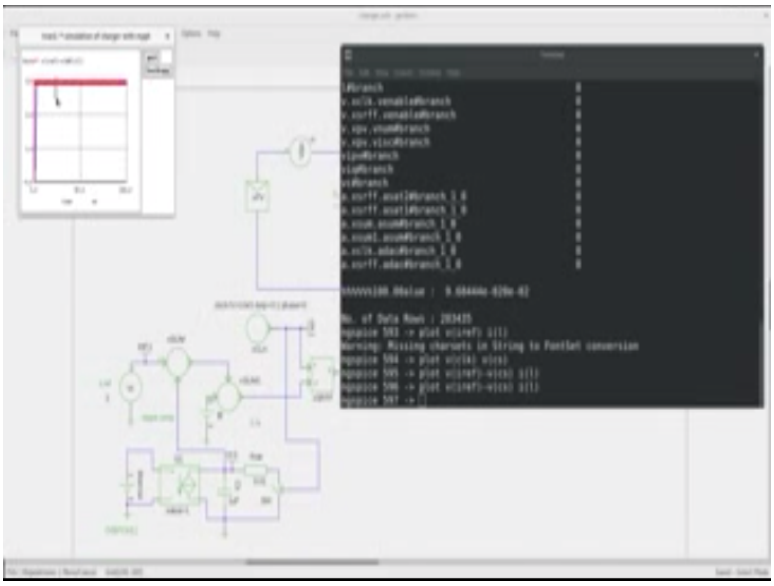

So plot so let me plot the difference between these two and the IL so it will hear something like that let us take  a very narrow region, so that we will be able to zoom it like that.

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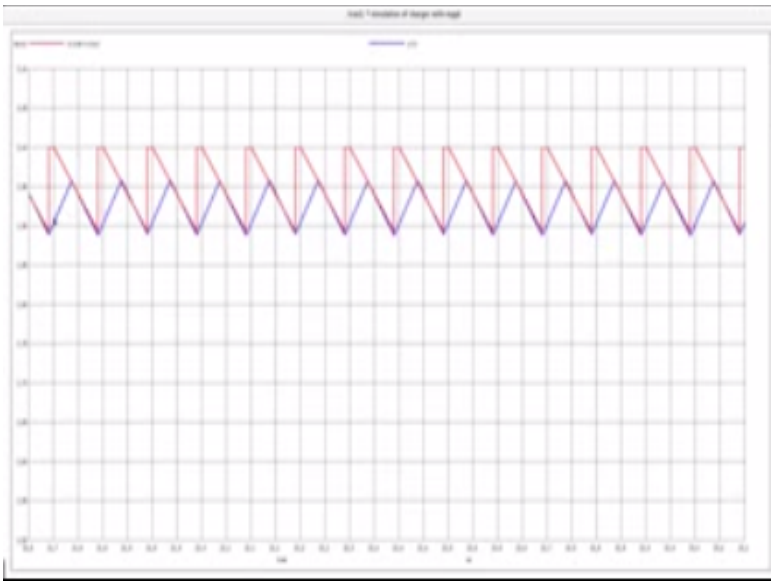

Now here you see the blue line is $i_l$ and the red line is the modified or the slope compensated reference. So you see with the flowing whenever the clocks comes in here and then it starts following subtracting, and I can rise it back the $i_{lref}$ was at 3 amps, then the 3 amps starts following down with the same slope as the down slope. This is the inductor current the moment it hits this or the down slope which is the device and the inductor is following, so on it keeps going. So this is also behaving exactly like what we anticipated and you see that the inductor current is controlled to whatever value you said.

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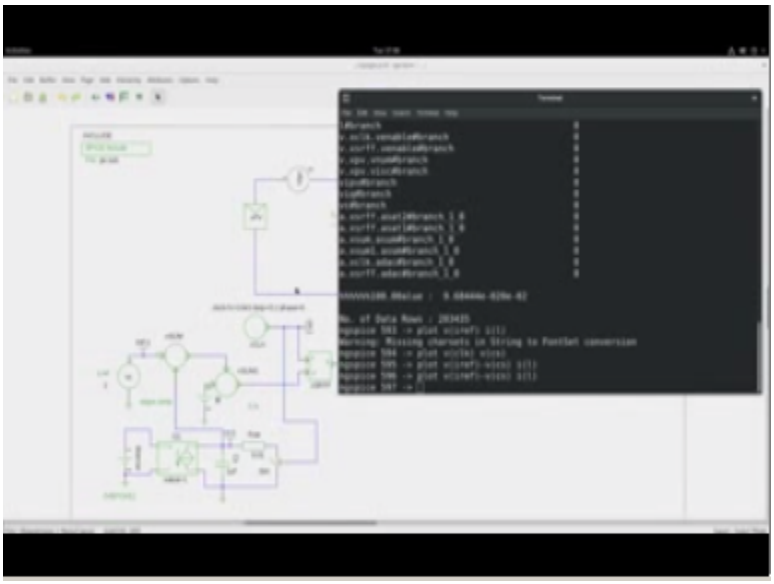

Now let us see the voltage across the PV panel and current through the PV panel and just check how much amount of power is been transferred to the load to charge the battery in the load so if we check the power drawn from the PV panel see that.

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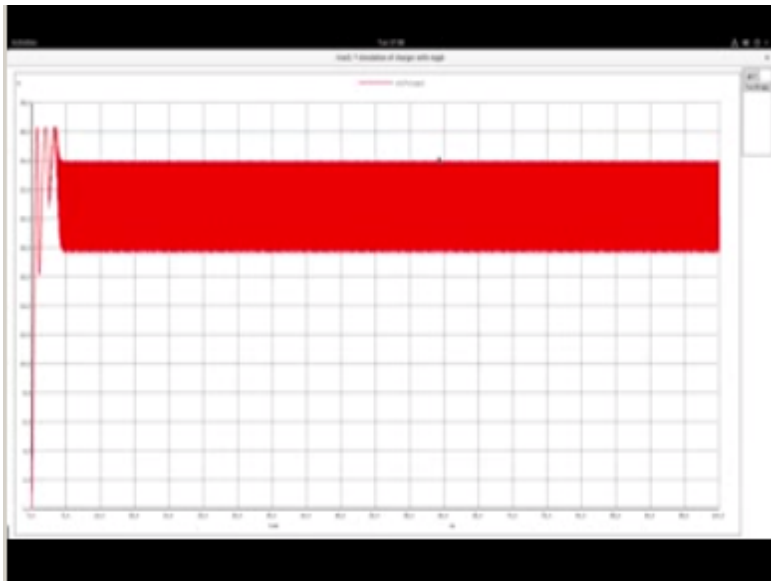

It is covering around 24 close to the peak power operating point so therefore you see that adjusting this IL referred value place a role in actually deciding the amount of power that is being drawn from the PV panel.

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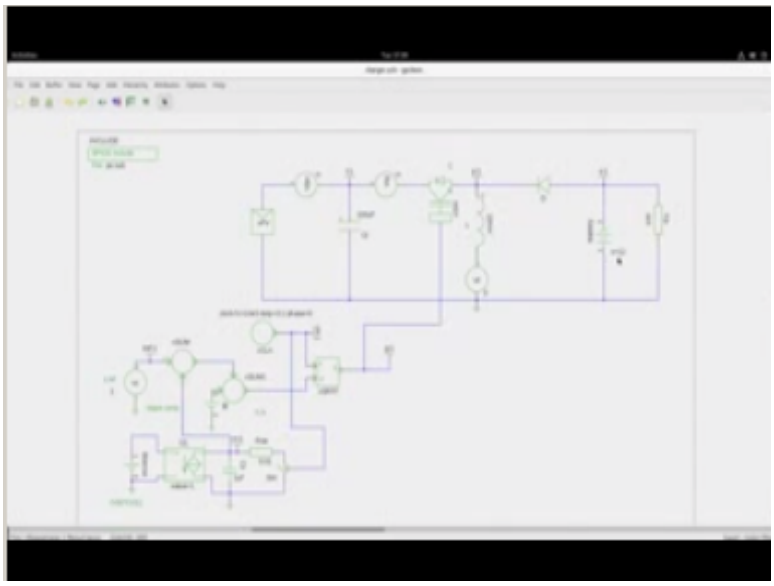

Because the battery potential is more or else fixed more or else constant at round 12 volts so this way this buck regulator buck boost regulator that we have used here can be used as a slope compensated current controlled charger for the battery drawing power at maximum power from the PV source so I will let you to explore this simulation on yourself and try to gain more inside from this simulation schematic.