Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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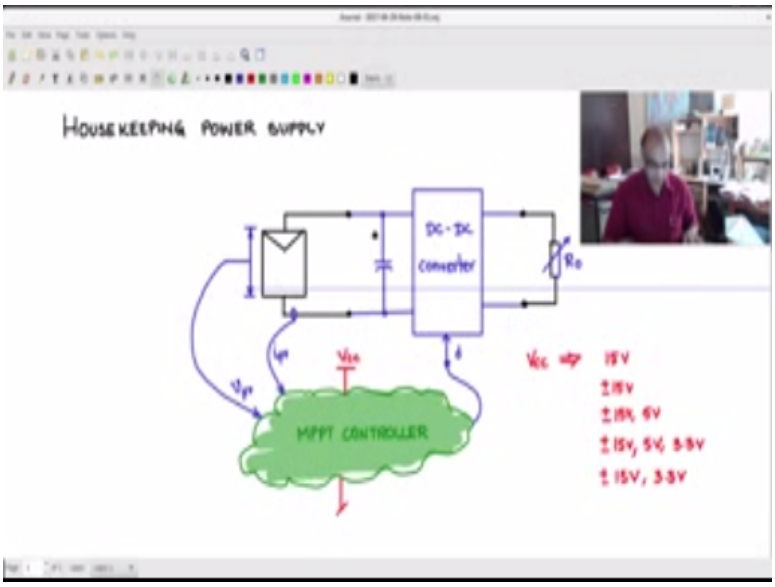

We have discussed the DC-DC converter acting as the power interface between the PV source and R_0 by impedance control and we have also seen how the various MPPT algorithms operate. One of the practical points that I would like to mention at this point is housekeeping power supply. What is housekeeping power supply? It is actually the power supply that will be powering up this MPPT controller.

Let me mark the power supply positive and the ground point like this. So this MPPT controller itself should have a power supply because it needs to power of lot of component which are there within, you may use analog op-amps, analog circuits in which case you will need for the VCC here + - 15 volts. So probably you may need VCC to be a single parts of 15 volts 0 15v, you may probably need dual power supply of + - 15v.

Or if there are digital logic then you may need +- 15v and 5v supply. And nowadays microcontrollers and microprocessors have 3.3v and therefore you made a 3.3v. So like that you depending upon what components going to the MPPT controller you will need specific power supplies that will power of the various components. Now the power supply that

powers of this MPPT controller is called the house keeping power supply from where should it draw the power.

Of course it has to draw the power from the PV source only, because that is the only source available. And which is the correct point to draw the power and board, so that is what I just want to sensitise you on this practical point.

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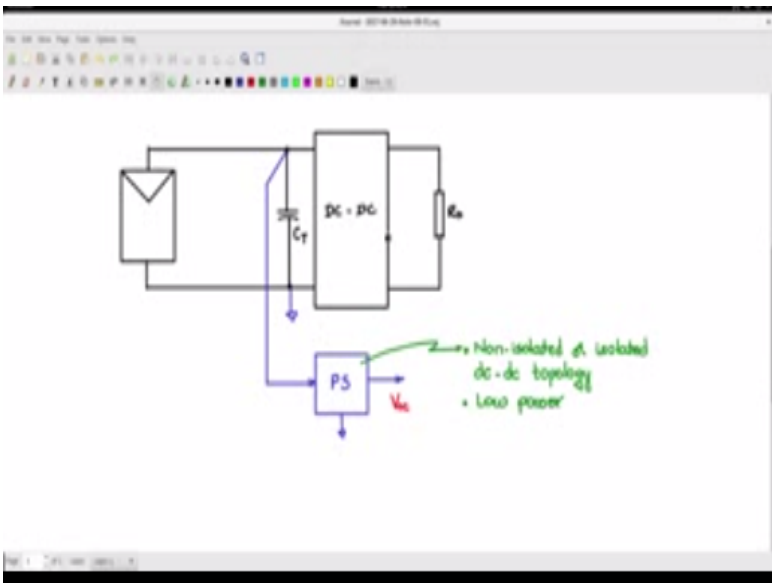

Consider this PV source and the DC-DC power supply which is acting as a interface between R_0 and the PV source. You have above the capacitor CT and across the buffer capacitor CT let us tap of a line, and let us draw the input for the power supply from here. So this will act as the input to the power supply circuit, so PS is the power supply circuit which will deliver some output.

Now this PS power supply is itself a DC-DC converter. So normally you may have an isolated DC-DC converter for very low power applications and you may have an isolated DC-DC converter topology for higher power applications. But in general compare to this load power, the power drawn for this purpose will be very low for power supply purpose will be low power.

Note that, this power supply output which I am showing here which I will mark as VCC it need not to be a single supply, it can be a multiple supply depending upon the requirements of the MPPT controller. Now this supply, also supply not only the MPPT controller circuits, it also has to supply any gate drive circuits for the power switches which are there within this DC-DC converter.

So if I am having power switch an IGPT power switch where the gate drive requirement needs isolate get to drain, get to source drive. Then that case you need to have isolated supplies for that purpose also. So you may land up with isolated power supplying in some cases depending upon the placing of the switches here, depending upon the switch to topology that you may use and have combination of isolated and non-isolated power supplies at the outputs here.

This topology where I am taking the power input from the terminals of the PV is generally for low power, low voltage, for low voltage king of an application. So in low voltage applications this here may be around 60v to 40v open circuit. And therefore, you may have around 12v under normal operating condition if it is 60v open circuit or it may be around 32 to 33v operating condition for a 40v type of module.

So that can be directly converted through a power supply and then the required output can be obtained by non-isolated DC-DC converters too. But in cases, in applications where the terminal voltage here is very large, let us say you are trying to put energy into the grid, in such a case, is voltage may be 700v open circuit and under operating conditions it may come down to 600v.

So you may have a very high voltage here and that needs to be converted to 5v, 3.3v of the step down ratio is very large and non-isolated type of supplies will not give good solution, therefore you may have to going for and isolated topology. That in such a case one may also consider taking from the output side if the output voltage is lower than the terminal, the terminals of the PV source.

So the output voltage is lower than you can probably you have a lower step down ratio to obtain the VCC which will power of the micro controller and the VPT controller bolts, and also the gate drive circuit. But if you are taking from the output side then there is one problem at starter there is no power for switching on the switches of the DC-DC converter.

So no voltage will come to the output, so there is no power house keeping power supply, in term there is no power supply for the gate drive circuit. So the circuit will never start. How do we make it start in such cases?

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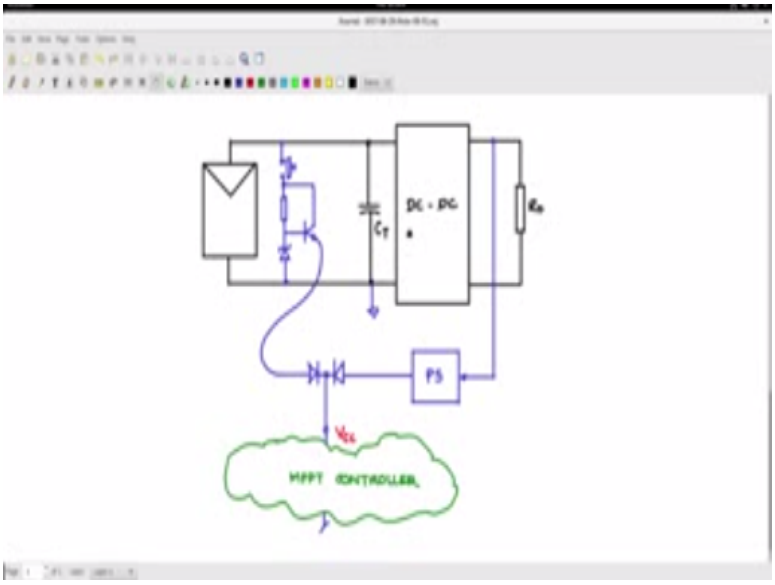

Let us draw the input to the power supply from the output side of the DC-DC converter which is the power supply and then it provides an output. Now here across the PV source what we will do is build a small shunt regulator. So I will provide a switch there, I have a resistance and designer regulator. Now I will boost the current by having BJT operated in the linear region.

And I will interface them in this fashion, I put a diode here, I will put a diode here also. And that the centre point I will take out, so I will connect this here and this will be VCC. So how will this operate? So during this start you will see that there is no power for the DC-DC converter. So therefore, 0 the output of this power supply is also low. So what I will do, I will press this reset button, you press the reset button, there is voltage apply across this resistance is in a combination and this will be at some potential.

Now let us say I will keep this at 16v. Now 16v - 0.7 will occur here, because this will now be in the linear region 16 – 0.7, 14.3, 14.3 – 0.7 will be 13.6, so 13.6 will appear across here. So this VCC will be used for generating the gate drive for switching this DC-DC converter. So the moment that switches of the DC-DC converter switches on the output will start developing.

Now that will be using input to this power supply and that will give the necessary output. Now that will be at 15v, now 15v -14.3 it will reverse by this diode and power will flow from this power supply into the microcontrollers and the other components at make up the MPPT controller board, and also the gate drive for the DC-DC converter. So all you need is for this to be on for just few milliseconds.

So that there is enough number of cycles high frequency carrier cycles that will build up the voltage for the DC-DC converter. So actually when you press and leave it the human reaction time himself is around 10 milliseconds, there is more than sufficient number of high frequency cycles possible for the DC-DC converter to build up the voltage which will build up this voltage and which will then start self sustaining itself.

So this is the start up circuit that one may use, because you adjust using it for fraction of time with very small duty cycle, this portion even though it is a linear regulator will not consume much, because this is only use for start up. And then after this is release this will not consume any power at all. So this is the trick that is done for starting up in case you take from the output side.

Now when you take on this output side this power supply can be any type of power supply and most of the time this will be an isolated power supply which will have multiple windings here and each other winding has I said specific load that they need to supply for example the 3.3v will go to microcontroller, the + - 15v will go to the op-amps type of circuits and like that then power supply here each power supply winding will have a function.

Now there will be one or two windings for gate drive. So let us there is one power semiconductor switch here with floating source then one of the windings will be use for gate drive of this particular semiconductor switch in the DC main DC-DC converter. So therefore, housekeeping power supply design itself is very very important and then one has to give lot of thought to it.

Most of this week, we had discussed on the MPPT algorithm and the MPPT issues with respect to the DC-DC converter. I have not discussed anything on the design of the DC-DC converter, but there are host of books and lot of literature available in the net and also NPTEL lectures which is more DC-DC power conversation, NPTEL lectures by Prof. Ramnarayanan and myself.

They are also available where lot of information on DC-DC converter is given where you can refer to that and try to design and get more insight with respect to the DC-DC converters. So now completing this power supply powers of this MPPT controller board and along with this house keeping power supply this whole portion return is drawn in blue will form the house keeping power supply and that is needed for the MPPT controller board to work properly.

One important point to be noted with respect to the MPPT controller is that by putting this power supply and the start a power supply to power of this, there is some power which is

consumed by these MPPT controller board and also the gate drive for the DC-DC converters. You should note that this power supply itself acts as an additional load either here or when you put it here.

That is on additional load, there will not be any change in the function of the MPPT controller, because it is sensing the IT and VT at the terminals and the current flowing through the PV panel, and therefore the power that is delivered from the PV source also includes contains the power that is needed by the power supply to supply the MPPT controller.

So therefore, operation why there is no issue with MPPT controller by introducing this power supply, it will still be tracking to the peak power point. However, I would like to at this point mention two points, one is the power supply circuit, the housekeeping power supply circuit should not consume more power than what is being deliver to R_0 because it does not meaningful, that is one point that you have to keep in mind.

The cost of this power supply and all these MPPT controller algorithm should not be prohibitively high, should not be much higher than your main DC-DC converter and R_0. So then again it is not meaningful to have MPPT tracker. So it makes sense to have a maximum power point tracker only if the cost of this MPPT controller and the associated housekeeping power is much lesser than the main power and the load.

And the loss in power to this housekeeping power supply in the MPPT controller should be very low compare to the amount of power that is to be deliver to R_0. So these two things you keep in mind before deciding whether MPPT is really required or not for that particular application.